ARTICLE 15. RADIATION PROTECTION

Each Contracting Party shall take the appropriate steps to ensure that, in all operational states, the radiation exposure to the workers and to the public caused by a nuclear installation shall be kept as low as is reasonably achievable, and that no individual shall be exposed to radiation doses that exceed the prescribed national dose limits.

This section summarizes the authorities and principles of radiation protection, which include the regulatory framework, regulations, and radiation protection programs for controlling radiation exposure for occupational workers and members of the public. Article 17 addresses radiological assessments that apply to licensing and to facility changes.

The changes in this section are an updating of doses and an expanded discussion of Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as Is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50; work on the International Commission on Radiological Protection (ICRP) recommendations; and ground water contamination.

15.1 <u>Authorities and Principles</u>

Generally, U.S. radiation control measures are founded on radiological risk assessments by the United Nations Scientific Committee on the Effects of Atomic Radiation and the U.S. National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation. The risk management recommendations promulgated by the ICRP and the National Council on Radiation Protection and Measurements (NCRP) reflect these assessments. On the basis of these assessments and recommendations, the EPA develops "generally applicable radiation standards" for use by the other Federal agencies, including the NRC. Considering these recommendations and standards, the responsible agencies, such as the NRC, then establish regulations.

The principles that are the basis of the U.S. radiation protection programs are generally consistent with the principles espoused by the ICRP. That is to say, (1) it is known that large doses of ionizing radiation can be deleterious to human health, and (2) it is considered prudent to assume that small doses may also be harmful, with the probability of a deleterious effect being proportional to the dose. The ICRP-recommended protection principles of "limitation," "justification," and "optimization" are acknowledged but are proving difficult to implement.

Of these principles, "limitation" is the most practicable. The regulations establish dose limits, and these limits cannot be exceeded without violating the regulations. There is a lengthy history of the doses being kept within the limits for workers (NUREG-0713, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities," Volume 24, issued October 2003) and members of the public living near nuclear power plants (NUREG/CR-2850, "Dose Commitments Due to Radioactive Releases from Nuclear Power Plant Sites in 1992," Volume 14, issued March 1996).

"Justification," the recommendation that any activity involving radiation exposure should be shown to be beneficial before the activity is undertaken, has proved on occasion difficult to demonstrate. The risks or benefits of a new application of radioactive material can seldom be determined in advance with complete accuracy. The "justification" activities in the United States are generally limited to the licensing process. In general, the NRC will reject an application to use or produce radioactive materials if it determines that the application is frivolous (i.e., that the overall benefit to society is outweighed by the risk of the radiation exposure associated with the activity). For some large applications, such as the generation of electricity from nuclear power, national policy establishes the justification. Since the National Energy Policy favors nuclear power (i.e., the net benefit for the United States is deemed to be positive), the licensing process under 10 CFR Part 50 does not specifically address the justification for licensing a nuclear power plant.

Rather than "optimization," the United States has used the concept of ALARA, although the two principles are consistent. As a guiding principle, ALARA (with varying terminology) dates back to 1939 (at least in the United States) and is defined in the regulations for occupational workers and members of the public.

For decades, 10 CFR Part 20 has addressed the ALARA criterion for occupational radiation exposure but more as an admonition than as a requirement. In 1994, the regulation was changed to require that all licensees develop, document, and carry out an ALARA program. The NRC would judge compliance with this requirement on the basis of a licensee's capability to track and, if necessary, reduce exposures, and not on whether exposures and doses represented an absolute minimum or whether the licensee had used all possible methods to reduce exposures.

For control of radiation exposure to members of the public, the NRC modified 10 CFR Part 50 by adding Appendix I. Issued in 1975, this appendix requires that radioactive releases from nuclear power plants be kept ALARA. This requirement led to the establishment of numerical objectives (i.e., 0.00005 sievert (Sv) (0.005 rem) in a year to the most highly exposed individual). Similar EPA requirements for other facilities soon followed this NRC requirement. It is not clear that these requirements satisfy the intent of the ICRP, but they are sufficient to keep public doses well below the local variation in doses from natural sources.

Although U.S. regulations are generally consistent with ICRP recommendations, to date, certain constraints have limited the extent to which the U.S. regulations coincide with those of the ICRP. One important constraint has been the desire for regulatory stability. Revising the regulations to incorporate every new ICRP position would impose a serious burden on the licensees without a commensurate benefit. Furthermore, for nuclear power reactors, new requirements are constrained by the Backfit Rule (10 CFR 50.109), which essentially requires that any increase in regulatory requirements be justified by a commensurate improvement in safety. Consequently, U.S. regulations were founded on older (rather than the most recent) recommendations of the ICRP. Nevertheless, the Commission has directed NRC staff to work closely with the ICRP and other national and international organizations to assist in developing the 2007 ICRP recommendations. The NRC may revise its regulations, in whole or in part, depending on the nature of these recommendations.

15.2 <u>Regulatory Framework</u>

Requirements for radiation protection were developed to implement laws passed by Congress. These laws are the Atomic Energy Act, the Energy Reorganization Act, and the Uranium Mill Tailings Radiation Control Act of 1978.

NRC regulations establish the primary direct controls over licensees. Various documents provide additional guidance and clarification. Specifically, these documents include regulatory guides, topical staff and contractor reports (NUREG series), generic letters, technical specifications, and license conditions. These documents are supported by international standards, consensus national standards, and authoritative recommendations (such as those of the ICRP and NCRP). However, these supporting documents have no official status unless they are referenced in or adopted by a regulation or documents providing regulatory guidance, such as regulatory guides or Standard Review Plans. Of particular importance are NUREG-0800, which guides the staff in reviewing safety analysis reports, and Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 3, issued in November 1978, which guides the applicant in writing safety analyses. Chapter 11 of NUREG-0800 addresses the control of radioactive effluents. Chapter 12 addresses radiation protection. Chapter 15 details how to calculate offsite and control room operator doses for design-basis accidents. Paragraph (g) of 10 CFR 50.34 requires the evaluation of the facility against the Standard Review Plan.

As discussed under Article 6, the Reactor Oversight Process has cornerstones for radiation safety. The cornerstone Public Radiation Safety focuses on the effectiveness of the plant's programs to meet applicable Federal limits involving the exposure, or potential exposure, of members of the public to radiation and to ensure that the effluent releases from the plant are ALARA. The cornerstone Occupational Radiation Safety focuses on the effectiveness of the plant's program(s) in maintaining the worker dose within the regulatory limits and providing occupational exposures that are ALARA.

15.3 Regulations

The regulations that apply to radiation protection are 10 CFR Part 20 and 10 CFR Part 50.

10 CFR Part 20. This part of the NRC regulations establishes requirements for radiation protection for all NRC licensees. Specific requirements for specific operations and specific kinds of licenses supplement the requirements in 10 CFR Part 20. In particular, these supplementary requirements include 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"; 10 CFR Part 34, "Licenses for Industrial Radiography and Radiation Safety Requirements for Industrial Radiographic Operations"; 10 CFR Part 35, "Medical Use of Byproduct Material"; 10 CFR Part 39, "Licenses and Radiation Safety Requirements for Well Logging"; 10 CFR Part 40, "Domestic Licensing of Source Material"; 10 CFR Part 50; 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material"; 10 CFR Part 71, "Packaging and Transportation of Radioactive Material; and 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."

The most recent major revision of 10 CFR Part 20, issued in 1991, adopted the recommendations, quantities, and models recommended in ICRP Publication 26, "Recommendations of the International Commission on Radiological Protection (Adopted January 17, 1977)," issued in 1991, and ICRP Publication 30, "Limits of Intakes of Radionuclides by Workers," dated 1978–1982, as well as some recommendations from NCRP Report No. 91, "Recommendations on Limits for Exposure to Ionizing Radiation," issued June 1987. The regulations in 10 CFR Part 20 provide relatively comprehensive coverage of general requirements for radiation protection and 10 CFR Part 20 itself is divided into subparts, with each subpart addressing a specific area of radiation protection, such as occupational and public dose limits, positing, surveys, monitoring, waste disposal, and reporting.

The details of the requirements in 10 CFR Part 20 are not entirely consistent with international standards such as IAEA's Basic Safety Standards. The main areas of difference include use of the effective dose equivalent in 10 CFR Part 20 versus use of the effective dose in the Basic Safety Standards; an annual occupational dose limit on the effective dose equivalent of 0.05 Sv in 10 CFR Part 20 versus 0.02 Sv in the Basic Safety Standards; and use of the ICRP-30 biokinetic models in 10 CFR Part 20 versus the more recent models used in the Basic Safety Standards. The NRC is planning to revise its regulations in the near future to bring them closer to international standards. However, in the interim, NRC licensees are permitted to use the effective dose in place of the effective dose equivalent and to use the more recent internal dosimetry models in place of those recommended in ICRP-30, with prior NRC approval. In addition, many licensees and agencies have administrative dose limits that are similar to, or lower than, those in the Basic Safety Standards, and most other licensees operate at occupational doses far below those limits and standards, and therefore, are considered ALARA. In some cases, the occupational doses do exceed 0.2 Sv per year, but these are a very small fraction of the total, and efforts are continuing to reduce these doses to lower levels. In the interim, and until NRC's regulations are brought into closer formal conformance with international standards, the current 10 CFR Part 20 provides a level of radiation protection that in almost all situations is comparable to that provided by international standards.

10 CFR Part 50. This is the principal regulation that addresses the safety of nuclear power plants. However, only a small part directly addresses radiation protection. (The revised dose criteria for design-basis accidents appear in 10 CFR 50.34(a)(1)(ii)(D) for future licensing actions after implementation of the revised rule in 1997. The dose criteria for siting and determining the exclusion area low population zone and population center distance for nuclear power reactors are stated in 10 CFR 100.11(a).) Even so, the sections of 10 CFR Part 50 that do affect radiation protection are significant. Of particular importance are 10 CFR 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents—Nuclear Power Reactors," and Appendix I to 10 CFR Part 50 and 10 CFR 50.34(g), which requires NRC review of the in-plant radiation protection program.

15.4 Radiation Protection Activities

Radiation protection activities apply to occupational workers and to members of the public.

15.4.1 Control of Radiation Exposure of Occupational Workers

In addition to focusing on personnel qualifications for licensing, the NRC's oversight and regulation of the radiation protection programs ensure that the safety analysis report and radiation protection plan properly address each item in 10 CFR Part 20, as well as the "Instruction to Workers" provisions of 10 CFR Part 19, "Notices, Instructions, and Reports to Workers: Inspection and Investigations," and the provisions of the relevant regulatory guides, such as Regulatory Guide 1.8, "Personnel Selection and Training," issued March 1971, and Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable," Revision 3, issued June 1978.

Once the NRC issues a license, it maintains an active regulatory program, which includes routine monitoring of licensee and regional reports to alert NRC staff of potential problems in radiation safety. Significant health physics problems can trigger significant reactive regional inspections or a generic communication to the industry.

NRC staff has been collecting the annual occupational exposure data for light-water reactors since 1969. The doses are strongly influenced by the amount and kind of maintenance performed, so the individual plant collective doses fluctuate from year to year. Still, clear trends are evident. Using the average collective dose per reactor as the reference statistic, one can conclude that the doses were almost randomly variable before the accident at TMI Unit 2. Thereafter, the doses increased as a result of the extensive modifications required of all nuclear power plants in response to new NRC requirements. The average collective dose reached a peak of 7.91 person-Sv (791 person-rem) per reactor in 1980. Since then, doses have declined almost steadily to the current level of slightly above 1 person-Sv (100 person-rem) per reactor, where they have remained for the past 8 years (1998–2005, the last year for which the data have been compiled). The 2004 average collective dose value of 1.0 person-Sv (100 person-rem) per reactor was the lowest average collective dose recorded since data collection began in 1969. Although the average doses for both PWRs and BWRs have been steadily declining, the average BWR dose has exceeded the average PWR dose since 1974. Over the past 5 years, the average BWR dose has exceeded the average PWR dose by roughly 90 percent (in part, because of the higher average dose rates and larger work force at BWRs). In 2005, the 78,127 workers at nuclear plants received 115 person-Sv (11,456 person-rem) for an average of 0.0015 Sv (0.15 rem) per worker. This represents an 84-percent drop in average worker dose from the 1973 value of 0.0095 Sv (0.95 rem) per worker.

15.4.2 Control of Radiation Exposure of Members of the Public

The regulations in 10 CFR 50.34a and Appendix I to 10 CFR Part 50 define the ALARA plant objectives for effluents. Appendix I also specifies effluent monitoring, environmental monitoring, investigations, land-use censuses, and reporting. Section IV.B of Appendix I to 10 CFR Part 50 requires the licensee to establish an appropriate surveillance and monitoring program that will:

> 1. Provide data on quantities of radioactive material released in liquid and gaseous effluents...;
>
> 2. Provide data on measurable levels of radiation and radioactive materials in the environment to evaluate the relationship between quantities of radioactive material released in effluents and resultant radiation doses to individuals from principal pathways of exposure; and
>
> 3. Identify changes in the use of unrestricted areas (e.g., for agricultural purposes) to permit modifications in monitoring programs for evaluating doses to individuals from principal pathways of exposure.

Appendix I requirements are supplemented by 10 CFR Part 20.1501, "General," which requires, in part, that a licensee perform surveys to evaluate potential radiological hazards and to demonstrate compliance with the public dose limits in 10 CFR 20.1301 and 10 CFR 20.1302.

Therefore, a licensee is responsible for performing radiation surveys at its facility to look for radioactive materials that have the potential to affect workers and members of the public. Potential survey sites can include areas that have been previously impacted by licensed radioactive material, as well as areas that may be impacted by licensed radioactive material in the future. For onsite spills and leaks that may contain licensed radioactive material, 10 CFR 20.1501 requires a licensee to conduct appropriate radiation surveys and monitoring to determine the radiological hazard (i.e., dose assessment) to workers and to determine if there is a viable pathway to the unrestricted area, which could result in a potential radiological hazard to members of the public. The surveys and monitoring can continue over a period of time or become an ongoing monitoring program so that the licensee can adequately characterize the extent and source of the contamination from the spills or leak.

In the past three years, there have been several discoveries of radioactive ground water contamination at nuclear power facilities located throughout the United States. Investigation has determined that most of the contamination resulted from undetected leakage from facility SSCs that contained or transported radioactive liquids. All unmonitored releases resulted in varying levels of onsite tritium ground water contamination, with one facility detecting low levels of tritium (below EPA drinking water standards) in offsite residential drinking wells. Current data show no immediate public health impact and a very low probability that there will be an impact in the future.

The NRC has responded to reports of ground water contamination by conducting inspections and assessing the safety significance of these events, in addition to evaluating licensee performance in identifying and taking corrective actions. The NRC has also issued Information Notices (IN 2004-05, "Spent Fuel Pool Leakage to Onsite Groundwater," dated March 3, 2004, and IN 2006-13, "Ground-Water Contamination Due to Undetected Leakage of Radioactive Water," dated July 10, 2006) describing unmonitored and unplanned leakage at several nuclear power stations.

Both the NRC and industry have worked to resolve the technical and programmatic issues leading to the ground water contamination events. In March 2006, the NRC Executive Director for Operations established a Liquid Radioactive Release Lessons Learned Task Force to assess lessons learned related to the unmonitored release of radioactive liquid to the environment at power reactor sites and to recommend possible agency actions in this area. The task force completed its assessment and issued its report on September 1, 2006. The most significant conclusion reached by the task force was that these events had no public health impact. However, because of the high level of public concern and the potential for contaminated ground water to migrate off site undetected, the task force made several recommendations to the NRC. These generally addressed enhanced regulations or regulatory guidance for unplanned, unmonitored releases and additional reviews in the areas of decommissioning funding and license renewal. The staff is currently evaluating all recommendations for implementation.

In parallel with the NRC efforts, the nuclear industry also responded to the ground water contamination events. The Nuclear Energy Institute has developed a voluntary Groundwater Protection Initiative that licensees have endorsed unanimously. The Groundwater Protection Initiative required each participating nuclear plant to have a plan in place by July 2006 that established several short-term actions, such as developing an enhanced communication protocol to ensure notification of State and local officials of less significant unmonitored release events. The industry initiative also required several long-term actions to improve leak detection monitoring capability and improve understanding of site hydrology and geology.

ARTICLE 16. EMERGENCY PREPAREDNESS

1. **Each Contracting Party shall take the appropriate steps to ensure that there are onsite and offsite emergency plans that are routinely tested for nuclear installations, and cover the activities to be carried out in the event of an emergency.**

   For any new nuclear installation, such plans shall be prepared and tested before [the installation] commences operation above a low power level agreed [to] by the regulatory body.

2. **Each Contracting Party shall take appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.**

3. **Contracting Parties that do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.**

This section discusses (1) emergency planning and emergency planning zones, (2) offsite emergency planning and preparedness, (3) emergency classification system and action levels, (4) recommendations for protection in severe accidents, (5) inspection practices and regulatory oversight, (6) response to an emergency, and (7) international arrangements.

This section was revised to describe the fundamental changes in response to national emergencies as a result of the terrorist events of September 11, 2001, as well as the response to Hurricane Katrina in August 2005.

16.1 Background

The NRC's responsibilities for radiological emergency preparedness stem from NRC licensing functions under the Atomic Energy Act and the Energy Reorganization Act. Both statutes specifically authorize the agency to promulgate regulations that it deems necessary to fulfill its responsibilities under the acts. Following the accident at TMI Unit 2 in March 1979, the regulations were amended to require significant changes in emergency planning and preparedness for U.S. commercial nuclear power plants. The NRC's emergency planning regulations are now an important part of the regulatory framework for protecting public health and safety and have been adopted as an added conservatism in the NRC's defense-in-depth safety philosophy of multiple-barrier containment and redundant safety systems. Before a full-power operating license can be issued, NRC regulations require a finding that there is reasonable assurance that adequate measures to protect public health and safety can and will be taken in a radiological emergency (10 CFR 50.47(a)).

Emergency planning in the United States recognizes that a spectrum of accidents could exceed the design-basis accidents that nuclear plants are required to accommodate without significant public health and safety impacts. For design-basis accidents, the small releases that might occur would not likely require responses such as evacuating or sheltering the general public. These actions become important only in considering accidents that are much less probable than design-basis accidents. NUREG-0396, "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light-Water Nuclear Power Plants," issued December 1978, and NUREG-0654/FEMA-REP-1 (NUREG-0654), "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," Revision 1, issued November 1980, describe the emergency planning basis.

16.2 Offsite Emergency Planning and Preparedness

The accident at TMI Unit 2 revealed that much better coordination and more comprehensive emergency plans and procedures were needed if the NRC and the public were to have confidence in the readiness of onsite and offsite emergency response organizations to respond to a nuclear emergency. Participation by State and local governments in emergency planning for nuclear power plants in the United States was, and still remains, largely voluntary. Before the accident at TMI 2, there had been no clear obligation for the State and local governments to develop emergency plans for radiological accidents, and the Federal role was one of assistance and guidance. After the accident, the NRC amended its emergency planning regulations to require, as a condition of licensing, that each applicant and licensee submit the radiological emergency response plans of State and local governments that are within the plume exposure zone, as well as the plans of State governments within the ingestion pathway zone (10 CFR 50.33(g) and 50.54(s)).

In December 1979, the President directed FEMA to take the lead in ensuring the development of acceptable State and local offsite emergency plans and activities for nuclear power facilities. The NRC and FEMA regulations and a memorandum of understanding between the two agencies, dated September 14, 1993, subsequently codified the role and responsibilities of DHS/FEMA.

DHS/FEMA provides its findings regarding the acceptability of the offsite emergency plans to the NRC, which has the ultimate responsibility for determining the overall acceptability of radiological emergency plans and preparedness for a nuclear power reactor. The NRC will not issue a license to operate a nuclear power reactor unless it finds that the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in a radiological emergency. The NRC bases its finding on a review of the DHS/FEMA findings and determinations as to whether State and local emergency plans are adequate and can be carried out, and on its own assessment of whether the onsite emergency plans are adequate and can be implemented (10 CFR 50.47(a)).

The principal guidance for preparing and evaluating radiological emergency plans for licensee and State and local government emergency planners is NUREG-0654/FEMA-REP-1, Revision 1, a joint NRC and FEMA document, issued November 1980. NUREG-0654 gives evaluation criteria for meeting the emergency planning standards in the NRC and FEMA regulations (10 CFR 50.47(b) and 44 CFR Part 350, "Review and Approval of State and Local Radiological Emergency Plans and Preparedness," respectively). These criteria provide a basis for licensees and State and local governments to develop acceptable emergency plans.

The NRC and DHS/FEMA coordinate their efforts in evaluating periodic emergency response exercises, which 10 CFR Part 50, Appendix E. IV. F.2, requires to be conducted every 2 years at all operating nuclear power plant sites. These full-participation exercises are integrated efforts by the licensee and State and local radiological emergency response organizations that have a role under the plan. The NRC evaluates the licensee's performance, and DHS/FEMA evaluates the response by State and local agencies. In some cases, various Federal response agencies also participate in these exercises. Any weaknesses or deficiencies identified by the NRC or DHS/FEMA as a result of the exercise must be corrected through appropriate remedial actions. Besides the biennial exercise of the plume exposure pathway plans, States must participate in an ingestion pathway exercise every 6 years with a nuclear power plant located within the States. There is no requirement to involve members of the public in any of the emergency preparedness exercises.

16.3 Emergency Classification System and Emergency Action Levels

The NRC regulations establish four classes of emergencies in order of increasing severity. Specifically, these are (1) unusual event, (2) alert, (3) site area emergency, and (4) general emergency. The specific class of emergency is declared on the basis of plant conditions that trigger the emergency action levels. Typically, licensees have established specific procedures for carrying out emergency plans for each class of emergency. The event classification initiates all appropriate actions for that class, including notification of offsite authorities, activation of onsite and offsite emergency response organizations, and, where appropriate, protective action recommendations for the public. These same emergency classes are also found in the State and local plans that support each nuclear power plant.

NUREG-0654 gives examples of initiating conditions for each of the four emergency classes. These conditions form the basis for each licensee to establish specific indicators, called emergency action levels. These levels provide a clear basis for rapidly identifying a possible problem and notifying the onsite emergency response organization and the offsite authorities that an emergency exists. Under NRC regulations, the licensee and State and local governmental authorities must discuss and agree upon the levels, and the NRC must approve them. In Regulatory Guide 1.101, "Emergency Planning and Preparedness for Nuclear Power Reactors," Revision 4, issued July 2003, the NRC endorsed the guidance in NUMARC/NESP-007, "Emergency Planning and Preparedness of Nuclear Power Plants," Revision 2, issued January 1992, and NEI 99-01, "Methodology for Development of Emergency Action Levels," Revision 4, issued January 2003, as acceptable alternatives for developing emergency action levels.

16.4 Recommendations for Protective Action in Severe Accidents

The technical basis and guidance for determining protective actions in the United States for severe (core damage) reactor accidents are given in NUREG-0654, Supplement 3, "Criteria for Protective Action Recommendations for Severe Accidents," Revision 1, issued July 1996, and EPA 400-R-92-001, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents," issued May 1992. These documents reflect the conclusions that have been developed from severe accident studies, such as NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," issued December 1990.

Guidance for response procedures and training manuals for NRC staff appears in NUREG/BR-0150, "Response Technical Manual 96." The NRC's guidance on evacuation and sheltering in the event of a nuclear power plant accident is consistent with guidance in IAEA TECDOC-953, "Method for the Development of Emergency Response Preparedness for Nuclear or Radiological Accidents," and TECDOC-955, "Generic Assessment Procedures for Determining Protective Actions During a Reactor Accident," both issued in 1997. Additional generic communications have been issued regarding protective action recommendations.

The NRC considers evacuation and sheltering to be the two primary protective actions and prefers prompt evacuation for the population near a plant in a severe reactor accident. However, the NRC is currently evaluating this position, as under some circumstances, it may be better to shelter in place.

In addition, a supplemental protective action for the general population involves using the thyroid-blocking agent potassium iodide. The NRC amended its regulations for emergency planning (10 CFR 50.47(b)(o) in 2001. This amendment, "Consideration of Potassium Iodide in Emergency Plans," requires that each State consider giving potassium iodide to the general public as a protective measure, supplementing evacuation and sheltering. The NRC found that potassium iodide is a reasonable, prudent, and inexpensive supplement to evacuation and sheltering for specific local conditions. The NRC has funded an initial supply, as well as replenishment of expired potassium iodide tablets, for States that choose to give potassium iodide to the general public as part of their emergency plans. To date, 21 States have requested and received potassium iodide tablets. The NRC distributes 65-mg and 30-mg tablets. In January 2002, the NRC, in cooperation with the cognizant agencies, updated the Federal policy statement on potassium iodide prophylaxis to reflect the changes in NRC regulations. In September 2006, the Commission approved replenishment plans for initial State supplies.

16.5 Inspection Practices—Reactor Oversight Process for Emergency Preparedness

The NRC's Reactor Oversight Process, discussed in Article 6, addresses emergency preparedness. Specifically, the process allows the licensee latitude in managing emergency preparedness programs, including corrective actions, as long as the performance indicators and inspection findings are within an acceptable performance band. As explained in Article 6, the NRC handles inspection findings through its Significance Determination Process.

Emergency preparedness is the final barrier between reactor operations and protection of public health and safety. As such, emergency preparedness is a major component of the Reactor Oversight Process and is one of the seven recognized cornerstones of safety in the process. The objective established for this cornerstone is, "Ensure that the licensee is capable of implementing adequate measures to protect the public health and safety during a radiological emergency." Oversight of this cornerstone is achieved through three performance indicators and a supporting risk-informed inspection program. The performance indicators are drill and exercise performance, emergency response organization drill participation, and alert and notification system reliability. The performance indicator for drill and exercise performance monitors timely and accurate licensee performance in drills, exercises, and actual events when presented with opportunities to classify emergencies, notify offsite authorities, and recommend protective actions. The indicator for emergency response organization drill participation measures the percentage of key members of the licensee's emergency response organization who have participated in proficiency-enhancing drills, exercises, training opportunities, or an actual event over a certain time. The alert and notification system reliability indicator monitors the reliability of the offsite alert and notification system, which is a critical link for alerting and notifying the public of the need to take protective actions.

Under the Reactor Oversight Process, this cornerstone includes the following inspectable areas:

- Correction of Emergency Preparedness Weaknesses: Inspectors evaluate the licensees' programs for problem identification and resolution as they relate to emergency preparedness.

- Drill Evaluation: Inspectors evaluate drills and simulator-based training evolutions in which shift operating crews and licensee emergency response organization members participate.

- Exercise Evaluation: Inspectors independently observe the licensee's performance in classifying, notifying, and developing recommendations for protective actions, and other activities during the exercise. The inspectors also ensure that the licensee's critique is consistent with their observations.

- Alert and Notification System Evaluation: Inspectors verify the compliance of the testing program with program procedures.

- Emergency Action Level Changes: Inspectors review all of the licensee's changes to emergency action levels to determine if any of the changes have decreased the effectiveness of the emergency plan.

- Emergency Response Organization Staffing and Augmentation System: Inspectors review the augmentation system to determine whether, as designed, it will support augmentation of the emergency response organization in accordance with the goals for activating the emergency response facility.

- Reactor Safety—Emergency Preparedness: Inspectors verify that the data reported for the performance indicator values are valid.

- Emergency Action Level and Emergency Plan Changes: Inspectors sample changes to the emergency plan to ensure that the effectiveness of the emergency plan has not decreased.

- Force-on-Force Exercise Evaluation: Inspectors evaluate force-on-force exercises with respect to integration of security, plant operations, and emergency response. [Force-on-Force exercises assess a nuclear plants' physical protection to defend against the DBT. A full exercise, spanning several days, includes both table-top drills and simulated combat between a mock commando-type adversary force and the nuclear plant security force. The exercises are an essential part of NRC's oversight of plant owners' security programs and their compliance with NRC security requirements.]

Although DHS/FEMA has no direct regulatory authority over State and local governments, and the evaluators of FEMA exercises are not considered inspectors, the exercise findings of

DHS/FEMA carry substantial weight in the NRC's regulatory process. DHS/FEMA notifies the State government and the NRC of significant deficiencies in offsite performance shortly after the exercise, and DHS/FEMA issues a formal exercise report about 90 days after the exercise. This report describes the DHS/FEMA exercise findings, and the findings are expected to be closed either before or during the next exercise. Because of the potential effect of deficiencies on offsite emergency preparedness, they are expected to be corrected within 120 days of the exercise. Failure of offsite organizations to correct deficiencies in a timely manner could lead DHS/FEMA to withdraw its finding of "reasonable assurance."

16.6 Responding to an Emergency

Fundamental changes have occurred in the response to national emergencies as a result of the terrorist events of September 11, 2001, and Hurricane Katrina in August 2005. This section explains the roles of the Federal Government, licensees, State and local governments, and the NRC. It also explains the security aspects supporting the response.

16.6.1 Federal Response

The Federal response structure has been revamped with the creation of DHS and the implementation of Homeland Security Presidential Directive 5. This directive establishes the Secretary of Homeland Security as the primary Federal official for managing domestic incidents. Under the Homeland Security Act of 2002, DHS is responsible for coordinating Federal operations within the United States to prepare for, respond to, and recover from terrorist attacks, major disasters, and other emergencies.

Specifically, DHS will assure overall Federal incident management coordination responsibilities when any one of the following four conditions applies:

(1) A Federal department or agency acting under its own authority has requested DHS assistance.

(2) The resources of State and local authorities are overwhelmed, and the appropriate State and local authorities have requested Federal assistance.

(3) More than one Federal department or agency has become substantially involved in responding to the incident.

(4) The Secretary has been directed by the President to assume incident management responsibilities.

The framework that outlines the responsibilities of the Secretary of Homeland Security, DHS, and other Federal, State, and local entities is the National Response Plan, soon to be the National Response Framework, and its associated annexes. The framework provides guidance on Federal coordinating structures and processes to prepare for, respond to, and recover from domestic incidents such as terrorist attacks, major disasters, and other emergencies.

The Federal response to a potential nuclear/radiological incident is designed to support the efforts of the facility operator and offsite officials. For such emergencies, Federal response activities are conducted in accordance with the Nuclear/Radiological Incident Annex. The

Nuclear/Radiological Incident Annex describes the roles of DHS, coordinating agencies (i.e., the NRC in this type of emergency), and other supporting Federal agencies. During this type of incident, DHS is responsible for the overall domestic incident management, while the coordinating agency will coordinate the Federal on-scene actions and assist State and local governments in determining measures to protect life, property, and the environment. The coordinating agency may respond as part of the Federal response as requested by DHS under the framework, or in accordance with its own authorities. During less severe incidents, the coordinating agency will oversee the onsite response, monitor and support owner or operator activities (when there is an owner or operator), provide technical support to the owner or operator if requested, serve as the principal Federal source of information about onsite conditions, and, if requested, advise the State and local government agencies on implementing protective actions. The coordinating agency will also provide a hazard assessment of onsite conditions that might have significant offsite impact and ensure that onsite measures are taken to mitigate offsite consequences.

16.6.2 Licensee, State, and Local Response

The NRC recognizes the nuclear power plant operator (licensee) and the State or local government as the two primary decisionmakers in a radiological emergency at a licensed power reactor. The licensee is primarily responsible for mitigating the consequences of an incident on site and recommending timely and proper protective actions to State and local authorities. The State or local governments are ultimately responsible for implementing proper protective actions for public health and safety.

16.6.3 The NRC's Response

In fulfilling its legislative mandate for protecting the public health and safety, the NRC has developed a plan and procedures that detail its response to incidents involving licensed material and activities (NUREG-0728, "NRC Incident Response Plan," Revision 4, November 23, 2003). In accordance with that plan, the NRC will initially assess any reported event and decide whether or how it will respond as an agency. The NRC will generally dispatch a team to the site for all serious incidents to meet its statutory and regulatory obligations as the coordinating agency. The team may assist the State in interpreting and analyzing technical information while updating other responding Federal agencies on event conditions and coordinating any multiagency Federal response.

Once the NRC has decided to respond as an agency, the agency's Operations Center in the Washington, DC, area and the associated regional Incident Response Center are activated. The NRC Headquarters Operations Center will then (1) maintain continuous communications with the facility, (2) assess the incident, (3) advise the facility operator and offsite officials, (4) coordinate the Federal radiological response with other Federal agencies, and (5) respond to inquiries from the national media. The staff at the NRC Headquarters Operations Center includes emergency preparedness and response experts and personnel experienced with liaison activities. Early in an incident, the Regional Administrator provides operational authority from the affected regional office, and, if necessary, from the regional Incident Response Center because regional office personnel are usually most familiar with details of the affected facility. When a major NRC onsite presence is required, the NRC will dispatch a team from the affected regional office. The NRC Headquarters Operations Center will direct NRC response for about 4–8 hours until the lead is transferred to the NRC site team, if applicable.

As soon as the NRC site team arrives at the facility and is ready to assume the agency's leadership role, it is given certain authorities and responsibilities which may include the authority to direct the agency's response. The NRC site team then sends representatives to response centers that are used by the facility and offsite officials to coordinate the response. The NRC site team has access to extensive radiological monitoring capabilities through DOE, including field teams and aerial monitoring. The NRC site team also sends representatives to the joint information center established by the facility or local government to interact with the media.

The NRC regularly participates in exercises of its response program to ensure readiness to respond, participating in nuclear power plant, fuel cycle facility, and Federal interagency exercises each year. The NRC participates in the planning and conduct of the Top Officials (TOPOFF) exercises. The NRC's participation in such exercises gives the agency a valuable perspective on multievent response. This perspective improves interagency cooperation and imparts a better understanding of response roles during emergencies.

16.6.4 Security Aspects Supporting Response

Before September 11, 2001, the security measures at nuclear facilities provided reasonable assurance that the health and safety of the public would be protected in the event of an attack encompassed by the DBT of radiological theft and sabotage, which is described in 10 CFR 73.1, "Purpose and Scope." Since September 11, 2001, the nuclear industry has significantly enhanced its defensive capability as a result of the voluntary actions taken by licensees in response to the advisories issued by the NRC, and as required by the orders issued February 25, 2002, and January 7, 2003, and followed by the three orders issued April 29, 2003. The enhancements include security measures against threats from an insider, waterborne attack, vehicle bomb attack, and land-based assault. In addition, one of the orders issued April 29, 2003, identified a revised DBT against which licensees must be prepared to defend. The NRC is codifying through rulemaking (Article 6) many of the security requirements that were newly imposed on licensees by order following September 11, 2001. The NRC will consider additional measures in the future as necessary.

The NRC receives a substantial and steady flow of information from the national intelligence community, law enforcement, and licensees and continually evaluates this information to assess threats to regulated facilities or activities. The NRC works with a variety of other Federal agencies, particularly DHS and the Homeland Security Council, to ensure that security around nuclear power plants is well coordinated and that responders are prepared for a significant event. If an event were to occur, the NRC would coordinate the resources of more than 18 Federal agencies, to mitigate the radiological consequences of a serious accident or successful attack.

16.7 <u>International Arrangements</u>

The NRC has agreements with its neighbors, principally Canada and Mexico, and commitments to IAEA.

Under its signed agreements with Canada and Mexico, the NRC will promptly notify and exchange information in the event of an emergency that has the potential for trans-boundary effects. The agreement with Canada is the "Agreement Between the Government of the United States of America and the Government of Canada on Cooperation in Comprehensive Civil

Emergency Planning and Management." The procedure specified in "Administrative Arrangement Between the U.S. Nuclear Regulatory Commission and the Atomic Energy Control Board of Canada for Cooperation and the Exchange of Information in Nuclear Regulatory Matters" implements the agreement. (Both documents are dated June 21, 1989.)

The agreement with Mexico is the "Agreement for the Exchange of Information and Cooperation in Nuclear Safety Matters," which is implemented by the "Implementing Procedure for the Exchange of Technical Information and Cooperation in Nuclear Safety Matters Between the Nuclear Regulatory Commission of the United States of America and the Comision Nacional de Seguridad Nuclear y Salvaguardias of Mexico." (Both documents are dated October 6, 1989.)

To meet the U.S. commitment under the IAEA "Convention on Early Notification of a Nuclear Accident," the NRC will promptly notify IAEA if a serious accident occurs at a commercial nuclear power plant. Afterward, the NRC will work with the Department of State to update IAEA.

Since 2001, the United States has fully participated in the INES by evaluating operating reactor events and reporting to IAEA any events resulting in a categorization of INES Level 2 or higher.

ARTICLE 17. SITING

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented for

(i) evaluating all relevant site-related factors that are likely to affect the safety of a nuclear installation for its projected lifetime

(ii) evaluating the likely safety impact of a proposed nuclear installation on individuals, society, and the environment

(iii) re-evaluating, as necessary, all relevant factors referred to in subparagraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation

(iv) consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request, providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation

This section explains the NRC's responsibilities for siting, which include site safety, environmental protection, and emergency preparedness. First, this section discusses the regulations applying to site safety and their implementation. It emphasizes regulations applying to seismic, geological, and radiological assessments. Next, it explains environmental protection. Article 16 discusses emergency preparedness and international arrangements, which would apply to Contracting Parties in obligation (iv), above.

New information reported since the previous U.S. National Report includes early site permit review activities, new developments in seismic hazard analyses, the use of an alternative source term, and updated guidance.

17.1 Background

The NRC's siting responsibilities stem from the Atomic Energy Act, the Energy Reorganization Act (as discussed earlier), and the National Environmental Policy Act. These statutes confer broad regulatory powers on the Commission and specifically authorize the NRC to promulgate regulations that it deems necessary to fulfill its responsibilities under the acts.

The NRC's siting regulations are integral to protecting public health and safety and the environment. Siting away from densely populated centers has been, and will continue to be, an essential component of the NRC's defense-in-depth safety philosophy (see Article 18), which also includes multiple-barrier containment and redundant safety systems. The primary factors that determine public health and safety are the reactor design and construction and operation of the facility. However, siting factors and criteria are important in ensuring that radiological doses from normal operation and postulated accidents will be acceptably low, natural phenomena and man-made hazards will be properly accounted for in the design of the plant, and the human environment will be protected during the construction and operation of the plant.

For the first time since the 1970s, the nuclear power industry in the United States is seeking approval for sites that could host new nuclear power plants. To ensure that the agency can effectively carry out its responsibilities associated with, among others, an early site permit application, the NRC consolidated regulatory functions to (1) manage near-term future licensing activities, (2) work with stakeholders regarding new reactor licensing activities, and (3) assess the NRC's readiness to perform new reactor licensing reviews.

In 2003, applicants submitted three early site permit applications to the NRC for sites in Virginia, Illinois, and Mississippi. In 2006, an applicant submitted an early site permit application for a site in Georgia. The sites are in proximity to existing nuclear power plants, which enables the applicants to use existing physical and administrative infrastructures and existing programs and siting information and to reduce the impact on the environment compared to the impact a plant would have on an undeveloped location.

In anticipation of these applications and to ensure that future license applicants and the public understand the NRC's review process of programs and siting information, the NRC documented its review process and criteria in RS-002, "Processing Applications for Early Site Permits," issued December 2003.

The NRC expects to receive an unprecedented number of applications that require siting evaluations principally under the combined license application provisions of 10 CFR Part 52. While many of these applications will be for locations close to existing facilities, some will be at locations where applicants requested construction permits under 10 CFR Part 50 but plants were not completed, and yet others will be at previously undeveloped ("green field") sites.

17.2 Safety Elements of Siting

This section explains the safety elements of siting. After providing a short background, it explains seismic and geological assessments. It then discusses radiological assessments performed for initial licensing, as a result of facility changes, and according to regulatory developments that have occurred since the licensing of all U.S. operating plants.

17.2.1 Background

The NRC's site safety regulations consider societal and demographic factors, manmade hazards (such as airports and dams), and physical characteristics of the site (such as seismic and meteorological factors) that could affect the design of the plant. The requirements are specified in 10 CFR Part 100, "Reactor Site Criteria"; Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to 10 CFR Part 100; Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or after January 10, 1997," of 10 CFR Part 100; and 10 CFR 100.23, "Geologic and Seismic Siting Criteria." The requirements in 10 CFR 100.23 apply to applicants for an early site permit, a combined license, a construction permit, or an operating license on or after January 10, 1997. Regulatory Guides 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," issued March 1997, and 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," issued March 2007, describe methods acceptable to NRC staff for implementing those requirements, and NUREG-0800, Section 2.5.2, Revision 3, guides the staff in its reviews.

The applicant's safety analysis report must describe characteristics in and around the site and contain accident analyses that are relevant to evaluating the suitability of a site. A number of regulatory guides provide guidance regarding issues of site safety that applicants need to address. NUREG-0800 guides the staff in reviewing the site safety content of these reports. RS-002 identifies parts of NUREG-0800 that apply to the review of early site permits.

Once licensed to operate, the licensee is expected to monitor the environs around the nuclear power plant and report changes in the environs in its safety analysis report that may affect the continued safe operation of the facility.

17.2.2 Assessments of Seismic and Geological Aspects of Siting

The siting regulations stated in Section 17.2.1 above detail the assessments applying to seismic and geologic aspects of siting. More recent developments in assessments include the performance-based approach for determining the site-specific ground motion response spectrum and the safe-shutdown earthquake. The performance-based approach combines the site seismic hazard curves and seismic fragility curves for nuclear structures to meet a specified performance target. RG 1.208, which was developed as an alternative to Regulatory Guide 1.165, describes this new approach in detail.

Regulatory Guide 1.208 also incorporates recent developments in the area of seismic hazard assessment. These recent developments include the use of cumulative absolute velocity filtering in place of a lower-bound magnitude cutoff, as well as guidance on the development of earthquake time histories, site response analysis, and the location of the ground motion response spectrum within the soil profile.

In 2003, the three early site permit applicants used the EPRI Central and Eastern United States (CEUS) seismic source models as a starting point for their site applications. Applicants updated the EPRI source models to reflect advances in CEUS seismic and geologic source modeling. In addition, EPRI updated its ground motion models for generic use in new plant probabilistic seismic hazard analyses for sites located in the CEUS in 2003.

Advanced reactor designs are reviewed and certified under 10 CFR Part 52, and they use high seismic design input that is independent of any site, but are capable of being sited in majority of currently existing sites. All new and advanced reactor designs are required to demonstrate that they have a plant level seismic margin of 1.67 times the design basis safe shutdown earthquake with high confidence (95%) in low (5%) probability of failure.

In summary, new seismic demand for design of new reactors ensures that the frequency at which nuclear structures, systems and components will reach the threshold of elastic limits under seismic loads combined with dead, live and postulated accident loads is 10^{-5} per reactor year. Hence the margin of a plant to failure under a design basis seismic events is greater than 1.67.

17.2.3 Assessments of Radiological Consequences

The Reactor Site Criteria Rule, 10 CFR Part 100, is the regulation under which all U.S. operating plants were licensed. It contains provisions for assessing whether radiological doses from postulated accidents will be acceptably low. The NRC has issued the following regulatory guidance for licensees to implement the requirements regarding the radiological criteria of 10 CFR Part 100:

- Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling-Water Reactors," Revision 2, June 1974

- Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized-Water Reactors," Revision 2, June 1974

- Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Revision 1, November 1982

Although applicants perform dose analyses primarily to support reactor siting, licensees are required to evaluate the potential increase in the consequences of accidents that might result from modifying facility SSCs. Commitments (including the radiological acceptance criteria) made by the applicant during siting and documented in its final safety analysis report remain binding until modified. Consequently, a licensee must evaluate the potential consequences of design changes against these radiological criteria to demonstrate that the design changes result in a design that still conforms to the regulations and commitments. If the consequences increase more than minimally, as outlined in 10 CFR 50.59 (or require a change to the technical specifications), as discussed in Article 14, the licensee must obtain NRC approval before implementing the proposed modification.

There have been regulatory developments since the licensing of all U.S. plants now operating. These include a revision to 10 CFR Part 100 in 1996; NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants" issued February 1995; Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," issued July 2000, which guided the use of NUREG-1465; and 10 CFR 50.67, "Accident Source Term," which allowed licensees to use alternative source terms. (The previous U.S. National Report discussed these developments.)

The NRC has applied the 1996 revision to 10 CFR Part 100, along with the alternative source term, in its design certification review for a passive advanced light-water reactor, the AP600. More recently, the agency has applied the practice to the AP1000 with similar results and is expected to apply it for all contemplated light-water reactors, including the economic and simplified boiling water reactor (ESBWR) design certification review. For other-than-light-water reactor designs, applicants will have to describe their rationale for an appropriate accident source term characterization which will be subject to NRC independent review.

The industry continues to explore the use of the alternative source term in implementing cost-beneficial licensing actions at operating reactors. Some of these applications resulted in improved safety equipment reliability and in reduced occupational exposures. Since the issuing of 10 CFR 50.67 more than half of the operating reactor licensees requested either full implementation of the alternative source term or selective implementation for certain regulatory applications. Operating plant licensees have also used the alternative source term to analyze the adequacy of certain engineered safety features in meeting the operability requirements in their operating reactor technical specifications.

17.3 Environmental Protection Elements of Siting

This section explains the environmental protection elements of siting. It covers the governing documents and site approval process. Since the last operating plants in the United States received licenses, issues have arisen that must be considered in siting reviews. This section explains the effect of these issues on siting reviews.

17.3.1 Governing Documents and Process

The environmental protection elements of siting consist of the plant's demands on the environment (e.g., water use and effects of construction and operation). These elements are addressed in 10 CFR Part 51, which implements the National Environmental Policy Act, consistent with the NRC's statutory authority, and reflects the agency's policy to voluntarily apply the regulations of the President's Council on Environmental Quality, subject to certain conditions. Integrating environmental reviews into its routine decisionmaking, the NRC considers environmental protection issues and alternatives before taking any action that may significantly affect the human environment.

The site approval process leading to the construction or operation of a nuclear power plant requires the NRC to prepare an environmental impact statement. The updated and revised environmental standard review plans (NUREG-1555) guide the staff's environmental reviews for a range of applications, including green field (i.e., undeveloped sites) reviews for construction permits and operating licenses in 10 CFR Part 50, for early site permits in 10 CFR Part 52, Subpart A, "Early Site Permits," and for combined licenses in 10 CFR Part 52, Subpart C, "Combined Licenses," when the application does not reference an early site permit. Article 19, in Regulatory Guide 1.206, "Combined Operating Licenses for Nuclear Power Plants," and RS-002, dealing with early site permits, discuss these governing documents and processes. Environmental standard review plans are also appropriate for environmental reviews of applications for combined licenses in 10 CFR Part 52, Subpart C, when the applications reference an early site permit. Reviews of early site permit applications are limited in the sense that (1) the reviews focus on the environmental effects of reactor construction and operation that have characteristics that fall within the postulated site parameters and (2) the reviews need not assess benefits (e.g., the need for power). The environmental information in applications for combined licenses that reference an early site permit is limited to consideration of (1) information to demonstrate that the design of the facility falls within the parameters specified in the early site permit, (2) new and significant information on issues previously considered in the early site permit proceeding, and (3) any significant environmental issue not considered in any previous proceeding on the site or design.

The environmental standard review plans in Supplement 1 to NUREG-1555 guide the staff's environmental review for license renewal applications under 10 CFR Part 54, which is discussed in Article 14.

Several other NRC actions on siting and site suitability require environmental reviews, including issuance of limited work authorizations (10 CFR 50.10(e)(1) to (e)(3), 10 CFR 52.25, "Extent of Activities Permitted," and 10 CFR 52.91, "Authorization to Conduct Site Activities"), early partial decisions (10 CFR 2.600, "Scope of Subpart," in Subpart F, "Additional Procedures Applicable to Early Partial Decisions on Site Suitability Issues in Connection with an Application for a Permit to Construct Certain Utilization Facilities," of 10 CFR Part 2), and preapplication early reviews of site suitability issues (Appendix Q, "Preapplication Early Review of Site Suitability Issues," to 10 CFR Part 50).

17.3.2 Other Considerations for Siting Reviews

Since the NRC last issued construction permits under 10 CFR Part 50 in the 1970s, and coincident with the publication of the initial environmental standard review plan, many changes to the regulatory environment have affected the NRC and applicants seeking site approvals. These include new environmental laws and regulations, changes in policies and procedures resulting from decisions of courts and administrative hearing boards, and changes in the types of authorizations, permits, and licenses issued by the NRC. The following paragraphs highlight some of these changes and their effects on the environmental standard review plans.

In the late 1980s, the NRC issued regulations that provided an alternative licensing framework to 10 CFR Part 50, which provided for a construction permit followed by an operating license. The new framework provided in 10 CFR Part 52 introduced the concept of approving designs independent of sites, and approving sites independent of designs, and then efficiently linked the approvals to result in the approval to construct and operate the facility. As discussed earlier, the NRC has received four early site permit applications under 10 CFR Part 52 and is actively conducting siting reviews.

Toward that end, the NRC issued RS-002, which embodies the environmental guidance in NUREG-1555, the environmental standard review plan, and the outcome of interactions with stakeholders. In addition, the NRC is revising 10 CFR Part 52 to reflect experience gained in its use and to provide guidance on the preparation of combined license applications, including guidance on environmental issues, in RG 1.206.

As described in previous U.S. National Reports, other relevant regulatory developments include:

- Presidential Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority and Low-Income Populations," issued February 1994, which instructed Federal agencies to make "environmental justice" part of each agency's mission by addressing disproportionately high and adverse human health or environmental effects of Federal programs, policies, and activities on minority and low-income populations

- the Yellow Creek Decision, which determined that the authority of the NRC is limited in matters that are expressly assigned to EPA

- changes in the economic regulation of utilities that have expanded the options to be addressed in considering the need for power in environmental impact statements

- design alternatives to mitigate the consequences of severe accidents

ARTICLE 18. DESIGN AND CONSTRUCTION

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur

(ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis

(iii) the design of a nuclear installation allows for reliable, stable, and easily manageable operation, with specific consideration of human factors and the man-machine interface

This section explains the defense-in-depth philosophy and how it is embodied in the general design criteria of U.S. regulations. It explains how applicants meet the defense-in-depth philosophy and how the NRC reviews applications and conducts inspections before issuing licenses to ensure that this philosophy is implemented in practice. Next, this section discusses measures for ensuring that the applications of technologies are proven by experience or qualified by testing or analysis. Section 14.2 of this report also addresses this obligation. Finally, this section discusses requirements regarding reliable, stable, and easily manageable operation, specifically considering human factors and the man-machine interface. Article 12 also addresses this obligation.

The changes reported since the previous U.S. National Report are an updating of design certifications that are either completed or under review, governing documents, and experience.

18.1 Defense-in-Depth Philosophy

This section explains the defense-in-depth philosophy followed in regulatory practice and the governing documents and regulatory process relevant to designing and constructing a nuclear power plant. It also discusses relevant experience and examples.

18.1.1 Governing Documents and Process

The defense-in-depth philosophy, as applied in regulatory practice, requires that nuclear plants contain a series of independent, redundant, and diverse safety systems. The physical barriers for defense in depth in a light-water reactor are the fuel matrix, the fuel rod cladding, the primary coolant pressure boundary, and the containment. The levels of protection in defense in depth are (1) a conservative design, QA, and safety culture, (2) control of abnormal operation and detection of failures, (3) safety and protection systems, (4) accident management, including containment protection, and (5) emergency preparedness.

Appendix A to 10 CFR Part 50 embodies the defense-in-depth philosophy. General design criteria cover protection by multiple fission product barriers, protection and reactivity control systems, fluid systems, containment design, and fuel and radioactivity control. The NRC staff amplified its defense-in-depth philosophy in Regulatory Guide 1.174, which provides guidance on using a PRA in risk-informed decisions on plant-specific changes. The general design criteria establish the minimum requirements for the principal design criteria, which in turn establish the necessary design, fabrication, construction, testing, and performance requirements for SSCs that are important to safety.

To ensure that a plant is properly designed and built as designed, that proper materials are used in construction, that future design modifications are controlled, and that appropriate maintenance and operational practices are followed, a good QA program is needed. To meet this need, General Design Criterion 1 of Appendix A to 10 CFR Part 50 and its implementing regulatory requirements specified in Appendix B to 10 CFR Part 50 establish QA requirements for all activities affecting the safety-related functions of the SSCs.

Pursuant to the two-step licensing process set forth in 10 CFR Part 50, an applicant for a construction permit must present the principal design criteria for a proposed facility in its preliminary safety analysis report (see 10 CFR 50.34). For guidance in writing a safety analysis report, the applicant may use Regulatory Guide 1.70. The safety analysis report must also contain design information for the proposed reactor and comprehensive data on the proposed site. The report must also discuss various hypothetical accident situations and the safety features to prevent accidents or, if accidents occur, to mitigate their effects on both the public and the facility's employees. After obtaining a construction permit under 10 CFR Part 50, the applicant must submit a final safety analysis report to support an application for an operating license, unless it submitted the report with the original application. This report gives the details of the final design of the facility, plans for operation, and procedures for coping with emergencies. The preliminary and final safety analysis reports are the principal documents that the applicant provides for the staff to determine whether the proposed plant can be built and operated without undue risk to the health and safety of the public. The NRC expects that future applications to build nuclear power plants will use the combined license process under 10 CFR Part 52. Applications submitted under Part 52 must meet all of the Part 50 requirements. A significant difference in the Part 52 process is that the final safety analysis report must be submitted before authorization is granted to begin construction. Article 19 discusses the combined license review process.

The NRC staff reviews safety analysis reports according to NUREG-0800 to ensure that the applicant has satisfied the general design criteria and other applicable regulations. The staff reviews each application to determine whether the plant design meets the Commission's regulations (10 CFR Part 20, 10 CFR Part 50, 10 CFR Part 73, and 10 CFR Part 100). These reviews include, in part, the characteristics of the site. In addition, each application for a nuclear installation must have a comprehensive environmental report that provides a basis for evaluating the environmental impact of the proposed facility. Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Stations," Revision 2 issued July 1976 provides applicants with information on writing environmental reports. The NRC staff reviews the environmental reports according to NUREG-1555. In reviewing an applicant's submittal, the staff, supported by outside experts, conducts independent technical studies to review certain safety and environmental matters. The staff states its conclusions in an environmental impact statement and a safety evaluation report, which it may update before granting the license. Under the two-step licensing process in 10 CFR Part 50, the NRC does not issue an operating license until construction is complete and the Commission makes the findings set forth in 10 CFR 50.57, "Issuance of Operating License." For applications submitted under

10 CFR Part 52, the Commission must find that all acceptance criteria in the combined license are met prior to operation of the facility.

The NRC maintains surveillance over nuclear power plant construction to ensure compliance with the agency's regulations to protect public health and safety and the environment. The NRC's inspection program has been anticipating that future applicants for construction of a nuclear power plant will apply for a combined license under 10 CFR Part 52. The NRC has developed an inspection program for future nuclear plants licensed under 10 CFR Part 52.

The new inspection program revises the 10 CFR Part 50 construction inspection program. It incorporates inspections, tests, analyses, and acceptance criteria (ITAAC) from 10 CFR Part 52, as well as lessons learned from the inspection program used in the previous construction era (1970–1980), and considers modular construction at remote locations.

Before construction, the NRC inspection program focuses on the applicant's establishing a QA program to verify that applications submitted to the NRC meet specified requirements in 10 CFR Part 52 and are of a quality suitable for docketing. Inspection Manual Chapter 2501, "Early Site Permit," lists inspections for this phase.

Once the NRC receives an application, the inspection program focuses on supporting the NRC staff's preparation for the mandatory Atomic Safety and Licensing Board hearing and the final Commission decision on whether a combined license should be granted. Inspection Manual Chapter 2502, "Pre-Combined License Phase," lists inspections for this phase.

During construction, inspectors sample the spectrum of the applicant's activities related to performance of the ITAAC in the design-basis document to confirm that the applicant is adhering to quality and program requirements. NRC inspectors will verify successful ITAAC completion on a sampling basis and will review all ITAACs. The NRC will publish notices in the *Federal Register* of those ITAACs that have been completed. Inspection Manual Chapter 2503, "ITAAC," lists inspections for this phase.

As the applicant completes construction, the inspection program focuses on verifying the adequacy of the licensee's preoperational programs such as fire protection, security, training, radiation protection, startup testing, and programs that enable the transition of the organization from construction to power operations. Inspection Manual Chapter 2504, "Non-ITAAC Inspections," lists inspections for this phase.

18.1.2 Experience

18.1.2.1 Regulatory Framework for the Reactivation of Watts Bar Unit 2

The Watts Bar Nuclear Plant (WBN) is located in southeastern Tennessee and is owned by the TVA. The site has two Westinghouse designed PWRs. WBN Unit 1 received a full power operating license in early 1996, and was the last power reactor that was licensed in the United States. TVA stopped construction activities at WBN Unit 2 in mid 1980s. TVA is planning to resume WBN 2 construction and pursue operating license approval under 10 CFR Part 50. The construction permit for WBN 2 is currently active and expires in 2010.

TVA initiated a study of the feasibility of resuming construction of WBN Unit 2 with a planned start of the facility by 2013. By letter dated August 3, 2007, TVA notified the Director of NRR 120 days in advance of the reactivation of construction in accordance with the Commission Policy Statement on Deferred Plants.

The NRC will perform necessary regulatory review before issuance of operating license for WBN Unit 2. The regulatory framework for the potential reactivation WBN Unit 2 will include inspection and licensing activities.

18.1.2.2 Design Certifications

For more than 30 years, the Atomic Energy Commission and the NRC have reviewed applications submitted under the two-step licensing process in 10 CFR Part 50 and documented their reviews in safety evaluation reports and their supplements for 110 nuclear installations. Subsequently, the NRC has certified four standard plant designs under the design certification process in 10 CFR Part 52—General Electric's advanced BWR (1997), and Westinghouse's System 80+ (designed and licensed by Combustion Engineering), AP600, and AP1000 (1997, 2000, and 2006, respectively). General Electric's ESBWR design is currently under review for design certification.

18.2 Technologies Proven by Experience or Qualified by Testing or Analysis

The earlier discussions in Section 18.1.1 and Section 14.2 address the qualification of currently used technologies. The NRC ensures that new technologies are proven as required by 10 CFR 52.47(b). This rule requires demonstration of new technologies through analysis, appropriate test programs, experience, or a combination thereof. Most recently, Westinghouse used separate effects tests, integral systems tests, and analyses to demonstrate that its passive safety systems will perform as predicted in its safety analysis reports for the AP600 and AP1000 standard plant designs.

18.3 Design for Reliable, Stable, and Easily Manageable Operation

The NRC specifically considers human factors and the human-system interface in the design of nuclear installations. For safety analysis reports, the NRC reviews the human factors engineering design of the main control room and the control centers outside of the main control room. Article 12 also discusses human factors.

18.3.1 Governing Documents and Process

To support its reviews of the human factors engineering issues associated with the certification and licensing of new plant designs, the NRC uses Revision 1 of Chapter 18 of NUREG-0800, and Revision 2 of NUREG-0700, "Human-System Interface Design Review Guideline," issued May 2002. The NRC also uses Revision 2 of NUREG-0711 for evaluating the design of next-generation main control rooms. NUREG-0800, Section 14.3.9 provides additional guidance. Moreover, the NRC developed a new guidance document for use in reviewing combined license applications; that document, Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," includes sections that address the human factors engineering review of combined license applications.

18.3.2 Experience

The NRC's recently formed Office of New Reactors is actively reviewing new plant designs and preparing for the review of combined license applications. The NRC is currently conducting a design certification review of General Electric's ESBWR and is reviewing preapplication documents submitted by vendors who anticipate filing applications with the NRC in the future.

18.3.2.1 Digital Instrumentation and Controls

In recent years, nuclear facility and byproduct licensees have begun replacing their analog instrumentation and control (I&C) safety systems and equipment with digital systems and equipment. While digital technology has the capability to improve operational performance, the introduction of this technology into nuclear facilities and applications poses a variety of challenges for the NRC and the nuclear industry. In particular, these challenges include (1) the increased complexity of digital technology compared to analog technology; (2) rapid changes in digital technology that require the NRC to update its knowledge of the state-of-the-practice in digital system design, testing, and application; (3) new failure modes associated with digital technology; and (4) the need to update the acceptance criteria and review procedures used in consistently assessing the safety and security of digital systems. In response to these technical challenges, in January 2007, the NRC formed a digital I&C steering committee. The steering committee will provide management focus on the NRC regulatory activities in progress across several offices, interface with the industry on key issues, and facilitate consistent approaches to resolving technical and regulatory challenges. The members of the steering committee include management representatives from the various NRC offices that have regulatory responsibilities related to digital I&C.

Digital instrumentation and controls raises issues that were not relevant to analog systems. Examples of such issues include the following:

1. A common-cause failure attributable to software errors was not possible with analog systems. This potential weakness may require a consideration of diversity and defense-in-depth in the application of digital I&C systems.
2. Digital system network architectures also raise issues such as interchannel communication, communication between nonsafety and safety systems, and cyber security that must be reviewed closely to ensure that public safety is preserved.
3. Highly integrated control room designs with safety and nonsafety displays and controls will be the norm for new reactor designs. Human Factors design and Quality assurance during all phases of software development, control, and validation and verification are critical.

The Digital Instrumentation and Control steering committee has formed the following six task working groups that focus on key areas of concern:

- Cyber Security
- Diversity and Defense-in-Depth
- Risk-Informed Digital I&C

- Highly-Integrated Control Room - Communications
- Highly-Integrated Control Room - Human Factors
- Licensing Process Issues

Additionally, as directed by the Commission, the NRC staff is planning a public workshop to explore the feasibility of an integrated digital instrumentation and control and human-machine interface test facility. The staff is involving stakeholders in other government agencies, the national labs, industry, vendors and universities.

18.3.2.2 Cyber Security

After September 11, 2001, the NRC issued two security-related orders to require power reactor licensees to implement measures to enhance cyber security. These security measures required an immediate identification and assessment of computer-based systems deemed to be critical to the operation and security of the facility. Additionally, licensees were expected to implement any immediate and necessary corrective measures to protect against the cyber threats at the time the orders were issued.

Recognizing that licensees likely used various approaches in the architectural design and implementation of plant computing networks, the NRC embarked upon an effort to develop a cyber security self-assessment methodology that could be uniformly applied to U.S.-based nuclear facilities. Development of such a methodology would provide a means to ensure that the assessments performed by each facility would follow a consistent, repeatable approach, thereby providing comparable metrics to understand the relative cyber security posture of each facility. The assessment methodology was developed by a multidisciplinary team from Pacific Northwest National Laboratory with input from the NRC and nuclear power industry representatives and issued as NUREG/CR-6847 "Cyber security Self-Assessment Method for U.S. Nuclear Power Plants."

Using NUREG/CR-6847 as a foundation, the Nuclear Energy Institute (NEI) Cyber Security Task Force developed a comprehensive guidance document, NEI 04-04, "Cyber Security Programs for Power Reactors," that licensees can use to develop and manage an effective cyber security program. In December 2005, the NRC staff accepted NEI 04-04 as an acceptable method for establishing and maintaining a cyber security program at nuclear power plants.

In parallel with the development effort of NEI 04-04, the NRC revised existing regulatory guidance on use of computers in nuclear digital safety systems. In addition, the NRC has implemented a significant and continuing research program in cyber security for digital plant control systems. Finally, it is codifying the mandated cyber security enhancement requirements in the two security-related NRC orders by amending its regulations.

ARTICLE 19. OPERATION

Each Contracting Party shall take appropriate steps to ensure that:

(i) the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning program demonstrating that the installation, as constructed, is consistent with design and safety requirements

(ii) operational limits and conditions derived from the safety analysis, test, and operational experience are defined and revised as necessary for identifying safe boundaries for operation

(iii) operation, maintenance, inspection, and testing of a nuclear installation are conducted in accordance with approved procedures

(iv) procedures are established for responding to anticipated operational occurrences and to accidents

(v) necessary engineering and technical support in all safety related fields is available throughout the lifetime of a nuclear installation

(vi) incidents significant to safety are reported in a timely manner by the holder of the relevant license to the regulatory body

(vii) programs to collect and analyze operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies

(viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal

The NRC relies on regulations in Title 10, "Energy," of the *Code of Federal Regulations* and internally developed associated programs in granting the initial authorization to operate a nuclear installation and in monitoring its safe operation throughout its life. The material that follows describes the more significant regulations and programs corresponding to each obligation of Article 19.

This update discusses the revised Operating Experience Program.

19.1 <u>Initial Authorization to Operate</u>

All currently operating reactors in the United States received licenses under the two-step process in 10 CFR Part 50. This licensing process requires both a construction permit and an operating license. The additional licensing processes in 10 CFR Part 52 provide for site approvals and design approvals in advance of construction authorization. In addition, 10 CFR Part 52 includes a process that combines a construction permit and an operating license with conditions into one license (combined license). Both the two-step and the combined license processes require NRC approval to construct and operate a nuclear power plant.

The Advisory Committee on Reactor Safeguards, an independent statutory committee established to advise the NRC on reactor safety, reviews each application to construct or operate a nuclear power plant. The committee begins its review early in the licensing process by selecting proper stages at which to hold a series of meetings with the applicant and NRC staff. Upon completing its review, the committee reports to the Commission.

The public also has an opportunity to have its concerns addressed. The Atomic Energy Act requires that a public hearing be held before a construction permit, early site permit, or a combined license may be issued for a nuclear power plant. A three-member Atomic Safety and Licensing Board, which consists of one lawyer who acts as chairperson and two technically qualified persons, conducts the public hearing. Members of the public may submit statements to the licensing board, or they may petition for leave to intervene as full parties in the hearing.

To obtain NRC approval to construct or operate a nuclear power plant, an applicant must submit safety analysis reports. Article 18 describes the final safety analysis report and the NRC's review of the application for an operating license. A public hearing is neither mandatory nor automatic for an application for an operating license under 10 CFR Part 50. However, soon after the NRC accepts the application for review, it publishes a notice that it is considering issuing the license. This notice states that any person whose interest might be affected by the proceeding may petition the NRC for a hearing. If a public hearing is held, the same process described for the hearing for the construction permit applies.

A combined license, issued under Subpart C of 10 CFR Part 52, authorizes construction of a facility in a manner similar to a construction permit under 10 CFR Part 50. Just as for a construction permit, the NRC must hold a hearing before the decision on issuance of a combined license. However, the combined license will specify the inspections, tests, and analyses that the licensee must perform and the acceptance criteria that, if met, are necessary and sufficient to provide reasonable assurance that the facility has been constructed and will be operated in conformity with the license and the applicable regulations. After issuing a combined license, the NRC staff will verify that the licensee has performed the required inspections, tests, and analyses, and before operation of the facility, the Commission must find that the licensee has met the acceptance criteria. At periodic intervals during construction, the NRC staff will publish notices of the successful completion of inspections, tests, and analyses in the *Federal Register*. Then, not less than 180 days before the date scheduled for initial loading of fuel, the NRC will publish a notice of intended operation of the facility in the *Federal Register*. An opportunity for a second hearing exists, but petitions for this hearing will be considered only if the petitioner demonstrates that one or more of the acceptance criteria have not been (or will not be) met, and the specific operational consequences of nonconformance would be contrary to providing reasonable assurance of adequate protection of the public health and safety.

An early site permit, issued under Subpart A of 10 CFR Part 52, provides for resolution of site safety, environmental protection, and emergency preparedness issues, independent of a specific nuclear plant design review. The application for an early site permit must address the safety and environmental characteristics of the site, and evaluate potential physical impediments to the development of an acceptable emergency plan or security plan. Additional detail may be submitted on emergency preparedness issues up to a complete emergency plan. The staff documents its findings on site safety characteristics and emergency planning in a safety evaluation report and findings on environmental protection issues in an environmental impact statement. The early site permit may also allow nonsafety site preparation activities, subject to redress, before the issuance of a combined license. The NRC will issue a *Federal Register* notice for a mandatory public hearing, and the Advisory Committee on Reactor Safeguards will perform an independent safety review. A construction permit or combined license application may reference the early site permit.

Under Subpart B, "Standard Design Certifications," of 10 CFR Part 52, the NRC may certify and approve a standard plant design through a rulemaking, independent of a specific site. The issues resolved in a design certification have a more restrictive backfit requirement than issues resolved under other licenses. That is, the NRC cannot modify a certified design unless the modification is necessary to meet the applicable regulations in effect during design certification, or to ensure adequate protection of public health and safety. An application for a combined license under 10 CFR Part 52 can incorporate by reference a design certification, an early site permit, or both. The advantage of this approach is that the issues resolved by rulemaking for design certification and those resolved during the early site permit hearing process are precluded from reconsideration at the combined license stage.

19.2 Definition and Revision of Operational Limits and Conditions

The license for each nuclear facility must contain technical specifications that set operational limits and conditions derived from the safety analyses, tests, and operational experience. The regulations in 10 CFR 50.36 define the requirements that apply to the plant-specific technical specifications. At a minimum, the technical specifications must describe the specific characteristics of the facility and the conditions for its operation that are required to adequately protect the health and safety of the public. Each applicant must identify items that directly apply to maintaining the integrity of the physical barriers that are designed to contain radioactive material. Specifically, 10 CFR 50.36 requires that the technical specifications must be derived from the analyses and evaluation in the safety analysis report. Licensees cannot change the technical specifications without prior NRC approval.

In 1992, the NRC issued improved vendor-specific (e.g., Babcock and Wilcox, Westinghouse, Combustion Engineering, and General Electric) standard technical specifications in NUREGs 1430-1434, and periodically revises them on the basis of experience. The NRC issued Revision 3 to these NUREGs in June 2004.

The NRC encourages licensees to use the improved standard technical specifications as the basis for plant-specific technical specifications. The agency also considers requests to adopt parts of the improved standard technical specifications, even if the licensee does not adopt all of the improvements. These parts, which will include all related requirements, will normally be developed as line-item improvements. To date, over half of the operating commercial nuclear plants have converted their technical specifications to the improved standard technical specifications.

Consistent with the Commission's policy statements on technical specifications and the use of PRA, the NRC and the nuclear industry are developing risk-informed improvements to technical specifications. These improvements, or initiatives, are intended to maintain or improve safety while reducing unnecessary burden and to bring technical specifications into congruence with the agency's other risk-informed regulatory requirements (in particular, the risk management requirements of the Maintenance Rule in 10 CFR 50.65(a)(4)).

19.3 Approved Procedures

In the United States, operations, maintenance, inspection, and testing of a nuclear installation are conducted in accordance with approved procedures. Each nuclear facility is required to follow the QA requirements in Appendix B to 10 CFR Part 50. Article 13 describes the QA Program. Criterion V in Appendix B to 10 CFR Part 50, requires that licensees establish measures to ensure that activities that affect quality will be prescribed by appropriate documented instructions, procedures, or drawings. Revision 3 to NRC Regulatory Guide 1.33 provides supplemental guidance. The rule that addresses the need to perform maintenance according to approved procedures is 10 CFR 50.65, and 10 CFR 50.65(a)(4) requires licensees to assess and manage the increase in risk that may result from proposed maintenance activities.

19.4 Procedures for Responding to Anticipated Operational Occurrences and Accidents

The documents providing recommendations and guidance on procedures for responding to anticipated operational occurrences and accidents are NUREG-0737, "Clarification of TMI Action Plan Requirements," issued November 1980; NUREG-0737, Supplement 1, "Requirements for Emergency Response Capability," issued January 1983; and NUREG-0899, "Guidelines for the Preparation of Emergency Operating Procedures," issued August 1982.

After the 1979 accident at TMI Unit 2, the NRC issued orders requiring licensees to develop procedures for coping with certain plant transients and postulated accidents. It also issued NUREG-0737 in 1980 and Supplement 1 to that document in 1983, which recommend that licensees develop procedures to cope with accidents and transients that are caused by initiating events analyzed in the final safety analysis report with multiple failures of equipment.

NUREG-0899 gives programmatic guidance for developing emergency operating procedures. To ensure that proper procedures had been developed to respond to plant transients and accidents, the NRC reviewed each plant using the guidance in NUREG-0800, Section 13.5.2.

19.5 Availability of Engineering and Technical Support

The NRC's Reactor Oversight Process, discussed in Article 6, includes techniques to ensure that adequate engineering and technical support is available throughout the lifetime of a nuclear installation. Several of the inspection procedures focus on ensuring the maintenance of adequate support programs. Licensees also report performance indicators. Depending on inspection findings and performance indicators, the NRC conducts additional inspections to focus on the causes of the performance problems as prescribed by the Reactor Oversight Process Action Matrix.

19.6 Incident Reporting

Two of the many elements contributing to the safety of nuclear power are emergency response and the feedback of operating experience into plant operations. The licensee event reporting requirements of 10 CFR 50.72, "Immediate Notification Requirements for Operating Nuclear Power Reactors," and 10 CFR 50.73, "Licensee Event Report System," help to achieve these, as 10 CFR 50.72 provides for immediate notification requirements via the emergency notification system, and 10 CFR 50.73 provides for 60-day written licensee event reports.

The NRC staff uses the information reported under these regulations in responding to emergencies, monitoring ongoing events, confirming licensing bases, studying potentially generic safety problems, assessing trends and patterns of operational experience, monitoring performance, identifying precursors of more significant events, and providing operational experience to the industry.

The NRC modified these rules in 1992 and 2000 to delete reporting requirements for some events that were determined to be of little or no safety significance. The modified rules continue to provide the Commission with reports of significant events for which the NRC may need to act to maintain or improve reactor safety or to respond to heightened public concern. The modified rules also better align requirements on event reporting with the type of information that the NRC needs to carry out its safety mission. The NRC issued Revision 2 to NUREG-1022, "Event Reporting Guidelines, 10 CFR 50.72 and 50.73," in October 2000, concurrently with the rule changes.

NUREG-1022 is structured to assist licensees in prompt and complete reporting of specified events and conditions. It specifically discusses general issues that have been difficult to implement in the past such as engineering judgment, time limits for reporting, multiple failures and related events, deficiencies discovered during licensee engineering reviews, and human performance issues. It also includes a comprehensive discussion of each specific reporting criterion with illustrative examples and definitions of key terms and phrases.

Event reporting under these rules since 1984 has contributed significantly to focusing the attention of the NRC and the nuclear industry on the lessons learned from operating experience to improve reactor safety. Over the years, decreasing trends in the number of reactor transients and significant events and improvements in reactor safety system performance have been evident.

19.7 Programs to Collect and Analyze Operating Experience

The NRC revised its Operating Experience Program in 2005, as described in the introduction to this report. Upon launching the revised Operating Experience Program, the NRC implemented a number of recommendations concerning better defined roles and responsibilities, a central clearinghouse, and improved collection, storage, and retrieval of information on operating experience.

The Operating Experience Program has four phases, which address all attributes of an effective operating experience program. Management Directive 8.7, "Reactor Operating Experience Program," (September 28, 2006) explains these phases in detail. This directive also delineates the roles and responsibilities for all participants in the Operating Experience Program and explains the need to periodically assess the program effectiveness. The definition of each phase and the significant program activities and changes under each phase are as follows:

- Phase 1—The first phase of the operating experience process involves collecting, storing, and making operating experience information available to the NRC staff. Through information technology, the NRC has made significant advances in this area, enabling staff to locate and evaluate operating experience information with ease. The collected operating experience includes those inputs considered new information about recent events or conditions at a plant, as well as previously "analyzed" information. Licensees responding to regulatory reporting requirements provide most of the new information. Other sources include NRC inspection reports, INES events, the Incident Reporting System, and other internally generated reports on operating experience. The previously analyzed information contains insights and lessons learned related to the subject operating experience topic. Sources of this type of information include generic communications, inspection findings, INPO reports, and other studies and reports related to operating experience.

- Phase 2—In this phase, the clearinghouse screens a new piece of operating experience information to determine if it has potential significance. The NRC has formalized the screening process through the program guidance documents to ensure a systematic approach to reviewing operating experience. The staff applies a set of screening guidelines that considers risk and qualitative factors, such as potential generic implications, adverse trends, or new phenomena, to screen in those operating experience inputs that are potentially significant and deserving of a more detailed evaluation. Operating experience information screened in for further evaluation becomes a formal assignment, and a clearinghouse staff member gathers additional information to prepare to evaluate the issue. The staff screens out operating experience information that does not meet any of the screening guidelines but may communicate this information to cognizant technical experts or inspection staff. The staff also tracks such information to identify any adverse trends.

- Phase 3—After operating experience information is screened in and communicated to various stakeholders, clearinghouse staff or other technical staff evaluate it to clearly determine its significance for plant operation and safety. The purpose of the evaluation is to glean insights and lessons learned that can be applied toward agency action. The evaluation determines the risk significance and/or identifies other safety or agency concerns associated with the information. The staff generates a report documenting any insights gained and recommending appropriate ways to apply the lessons learned to future regulatory activities. These evaluations have supported improved communication and integration between the clearinghouse, the technical staff, and the regional offices.

- Phase 4—Once the assigned staff member evaluates the screened-in item and recommends further action, the clearinghouse management decides, in consultation with other appropriate NRC managers when necessary, whether to adopt the recommendations. Identified options for applying the lessons learned consist of (1) communicating operating experience lessons learned to various internal and/or external stakeholders through reports, briefings, email listservs, or generic communications, (2) taking regulatory action through a generic communication to require responses from the licensees or issuing orders for actions, and (3) influencing agency programs such as inspection, oversight, licensing, incident response, security, rulemaking, and research. Application always involves communication of the issue to internal stakeholders. Less common outcomes of recommendations are rulemaking or transfer to the agency generic safety issues program.

19.8 Radioactive Waste

The NRC has regulations and guidance for nuclear power reactor licensees to help ensure the safe management and disposal of low-level radioactive waste. Onsite low-level waste must be managed in accordance with the NRC regulations in 10 CFR Part 20 and 10 CFR Part 50. For instance, Subpart K, "Waste Disposal," of 10 CFR Part 20 deals with the treatment and disposition of radioactive waste as an aspect of licensee operations. In addition, GL 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites," dated November 10, 1981, provides guidance on measures for ensuring the safe storage of low-level waste.

Notwithstanding the preceding regulations and guidance, the economics of waste disposal in the United States have encouraged practices to minimize radioactive waste. In the past decade or so, disposal costs have risen significantly, and volumes of waste produced have decreased greatly as operations technology evolves. Nuclear power reactors now generate only small amounts (about 1000–2000 cubic feet per unit) of operational waste each year.

For storage, waste is put into a form that is stable and safe to minimize the likelihood that it will migrate (e.g., if it were a liquid). Waste that is put into storage is in a form that is suitable for disposal, or at least a form that can be made suitable for disposal. The NRC has specific regulations for the storage of greater than Class C low-level waste produced by nuclear power reactors in 10 CFR Part 72. For designing and operating low-level waste disposal facilities, the NRC has detailed regulations in 10 CFR Part 61.

The U.S. Government addresses the spent fuel and radioactive waste programs, including high-level waste, in detail in a report prepared to satisfy the reporting requirements of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The latest report (DOE/EM-0654, Revision 1, October 2005) is available on the DOE Environmental Management Web site.

APPENDIX A NRC STRATEGIC PLAN 2004–2009

NRC Major Challenges for the Future

The U.S. Nuclear Regulatory Commission (NRC) identified major challenges for the future in its strategic plan for 2004–2009; those that apply to the reactor safety arena are listed below. The NRC is currently working on a new strategic plan.

The Changing Regulatory Environment

The many industries that use radioactive materials are changing, particularly with regard to nuclear safety, security and emergency preparedness, risk-informed, performance-based regulations, energy production, and waste management, creating challenges that must be met. The section below describes changes expected within the next 5 years.

- NRC strategic initiatives will significantly emphasize strengthening the interrelationship among safety, security, and emergency preparedness.
- The majority of operating nuclear power plants will have applied for license renewal to help meet the country's demand for energy. A primary challenge is to monitor, manage, and control the effects of aging so that safety is ensured for the renewal period.
- The U.S. Department of Energy (DOE) will apply to construct and operate the country's high-level radioactive waste repository. The timing of this action will challenge the allocation of the NRC's resources.
- The U.S. nuclear power industry will show a growing interest in licensing and constructing new nuclear power plants to meet the Nation's demand for energy. Challenges include analyzing in detail the vulnerability to accidents and security compromises, as well as developing inspections, tests, analyses, and acceptance criteria for construction
- The NRC, Agreement States (described in Article 8), and licensees will continue to devote increasing attention to the security of radioactive materials and facilities. The primary challenge facing the NRC is to emerge from the period of uncertainty in post-September 11 security requirements; determine what long-term security provisions are necessary; and revise regulations, orders, and internal procedures as necessary to ensure public health and safety and the common defense and security in an elevated threat environment.
- The NRC will continue to see increased requirements to coordinate with a wide array of Federal, State, and local agencies related to homeland security and emergency planning. The NRC currently conducts emergency preparedness exercises that involve a wide array of governmental agencies and emergency response personnel and use cooperative intergovernmental relationships to balance and inform national response capabilities.

- The regulatory climate is expected to adjust to both internal and external factors (described below). Challenges include materials degradation at nuclear power plants, new and evolving technologies, and continuing review of ongoing operational experience.

Key External Factors

The NRC's ability to achieve its goals depends on a changing equation of industry operating experience, national priorities, market forces, and availability of resources. The following section discusses significant external factors, none of which the NRC can control but all of which could affect the agency's ability to achieve its strategic goals.

Receipt of New Reactor Operating License Applications. The U.S. nuclear industry has indicated a new and growing interest in licensing and constructing new nuclear power plants. If the NRC receives a substantial increase in new reactor operating license applications beyond those currently anticipated, the agency would have to significantly reallocate resources to review applications in a timely manner and inspect construction activities. In addition, the high level of public interest likely to be associated with such applications would require significant efforts by the NRC to keep stakeholders informed and involved in the licensing process.

Significant Operating Incident (Domestic or International). A significant safety incident could cause an unexpected increase in safety and security requirements that would likely change the agency's focus on initiatives related to its five goals until the situation stabilized. Because NRC stakeholders (including the public) are highly sensitive to many issues regarding the use of radioactive materials, even events of relatively minor safety or security significance can sometimes require a response that consumes considerable agency resources.

Significant Terrorist Incident. A significant terrorist incident anywhere in the United States could significantly alter the Nation's priorities. This, in turn, could affect significance levels, a need for new or changed security requirements, or other policy decisions that might impact the NRC, its partners, and the industry it regulates. In particular, the impact on State regulatory and enforcement authorities might affect their ability to work with the NRC in achieving its goals. A significant terrorist incident at a nuclear facility or activity anywhere in the world would likely cause similar changes in the NRC's priorities and potentially in U.S. policy regarding export activities, the NRC's role in international security, and/or requirements for security at U.S. nuclear power plants.

Timing of the DOE Application and Related Activities for the High-Level Waste Repository at Yucca Mountain. The proposed repository for spent nuclear fuel represents a major effort for the NRC in planning, review, analysis, and ultimate decision making regarding the licensing of the facility. The agency has begun to ramp up this effort to respond to DOE preapplication activities. The timing of the Department's actions will heavily influence the NRC's resource allocation decisions over the next several years. Acceleration or delay in the DOE activities will most likely require reprogramming of NRC resources, which may affect other programs that are directly associated with achieving the agency's goals.

Homeland Security Initiatives. Emergency preparedness activities with Federal, State, and local agencies continue to increase in scope and number. This affects the agencies' priorities and workloads. As more resources are diverted to external coordination activities, previous work activities must be reprioritized.

Legislative Initiatives. Many legislative initiatives under consideration by Congress could have a major impact on the NRC. In particular, pending energy legislation, if enacted, would affect the agency's priorities and workload. Increasing interest in diversified sources of energy and energy independence could cause an increase in license applications for nuclear power plants. Any attendant increase in resources devoted to license review and analysis might affect the agency's ability to achieve its goals for the planning period.

APPENDIX B NRC MAJOR MANAGEMENT CHALLENGES FOR THE FUTURE

By law, the Inspector General of each Federal agency (discussed in Article 8) is to describe what he or she considers to be the most serious management and performance challenges facing the agency and assess the agency's progress in addressing those challenges. Accordingly, the Inspector General of the NRC prepared his annual assessment of the major management challenges confronting the agency. The latest report, published in October 2006, can be found on the NRC's public Web site.

In his assessment, the Inspector General defined serious management challenges as "mission-critical areas or programs that have the potential for a perennial weakness or vulnerability that, without substantial management attention, would seriously impact agency operations or strategic goals." The most serious management challenges facing the NRC may be, but are not necessarily, areas that are problematic for the agency. The challenges identified represent critical areas or difficult tasks that warrant high-level management attention. In the 2006 report, the Inspector General identified the following nine management challenges to be the most serious as of September 30, 2006. They are not ranked in order of importance. Eight of the nine challenges are essentially the same as those highlighted in the previous U.S. National Report. In 2006, the Inspector General identified a new challenge, titled Ability to Meet the Demand for Licensing New Reactors and removed the challenge Intra-Agency Communication.

Challenge 1: Protection of nuclear material used for civilian purposes

This challenge, which concerns materials control and accounting, is outside the scope of this report and is not covered here.

Challenge 2: Protection of information

NRC employees often generate and work on sensitive information that needs to be protected. Such information can be sensitive unclassified information or classified national security information that is contained in written documents and electronic databases. As a result of ongoing terrorist activity worldwide, the NRC continually reexamines its document control policies. The NRC faces the challenge of balancing the need to protect sensitive information from inappropriate disclosure against its goal of openness in the agency's regulatory processes. In 2006, the NRC made various efforts to protect sensitive information, including personal information, from inappropriate disclosure.

Challenge 3: Development and implementation of a risk-informed and performance-based regulatory oversight approach

The NRC faces the challenge of integrating probabilistic risk assessment (PRA) into regulatory decisionmaking. In fiscal year 2006, the NRC initiated an effort to address the quality of PRAs and develop standard regulatory risk-informed activities. However, full implementation of PRA quality standards will take a number of years.

The NRC has made progress in implementing a risk-informed and performance-based approach at the Nation's 104 operating commercial nuclear power reactors. For example, the agency has combined its Reactor Inspection Program and Reactor Performance Assessment Program to implement the revised Reactor Oversight Process. An integral part of the Reactor Oversight Process is the baseline inspection program that was developed using a risk-informed approach to determine a list of areas to inspect within the seven established cornerstones of safety.

Application of the risk-informed, performance-based approach in the baseline inspection program requires continual refinement. Because it is a living program, the agency dedicates resources to continually reassess and modify it as necessary based on operating experience and industry performance. A recent Reactor Oversight Process self-assessment recognized that regional inspection resources warrant a sizeable increase in staff for the next few years. Potential shortfalls in inspection resources pose a challenge to the agency's ability to ensure that the risk-informed, performance-based approach applied in the baseline inspection program is up to date and reflects lessons learned.

Challenge 4: Ability to modify regulatory processes to meet a changing environment

The NRC faces the challenge of maintaining its core regulatory programs while adapting to emerging changes in its regulatory environment. These changes are listed in the NRC's Strategic Plan. One change is of such significance that the Inspector General has isolated it as a separate challenge (see Challenge 9). The anticipated workload associated with gearing up to receive license applications for new reactors will strain the NRC's current resources. Preparing for the anticipated burden on resources intensifies the challenges posed by other changes in the NRC's regulatory environment. In particular, the NRC must be able to adapt to the following:

- uncertainty in the expected number of applications for license renewals submitted by industry in response to the Nation's demand for energy production

- a heightened public focus on license renewals resulting in contentious hearings

- uncertainty in the expected number of licensee requests to increase power levels

Reactor License Renewal. The NRC's license renewal program is one of the major elements of its regulatory work. The NRC could receive approximately 25 to 30 additional applications to renew operating licenses over the next several years. Because the decision to seek a renewal is the responsibility of the nuclear power plant owner(s), anticipating the number of applications presents a challenge to the NRC. Recent agency experience reflects industry's strong interest in license renewal. Additionally, the NRC will encounter challenges related to a heightened public interest in license renewals that may lead to more contentious hearings. Until 2006, it was unlikely for the NRC to grant hearings on license renewals. In 2006, however, the agency granted the first two such hearings, and the license renewal staff anticipates more.

Applications To Increase Power Output. As of May 2007, the NRC approved 113 power uprate increases, and 11 are pending review. Over the next 5 years, the NRC expects 27 additional requests, which may affect the ability of NRC staff to maintain established review schedules. To address the increase in power uprate requests, the agency is continuing to improve the process on the basis of lessons learned from completed reviews. The process improvements include more detailed analysis of specific technical issues and related efficiencies. Some of the technical issues include power uprate testing programs and reactor systems methods. Also, the

NRC has implemented more rigorous acceptance reviews for power uprate applications to improve the efficiency of the process.

Challenge 5: Implementation of information resources

The NRC relies on a wide variety of information systems to fulfill its responsibilities. In recent years, the agency has created large databases of publicly available information, including the NRC Web site and the Agencywide Documents Access and Management System (ADAMS) public reading room. The following paragraphs highlight some of the NRC's efforts to strengthen and support the agency's business needs using information technology strategies.

<u>Information Security and Federal Information Security Management Act Compliance</u>. The NRC received a low grade on Federal computer security for 2005. To ensure that the agency's systems have adequate security controls to protect information resources, the NRC has engaged a contractor to enhance agencywide information systems security.

<u>Microsoft Office Deployment</u>. The NRC is developing a plan to deploy Microsoft Office Professional software suite; Microsoft Office products will become the agency's standard within the coming year replacing Corel WordPerfect as the agency's standard word processing format.

<u>ADAMS</u>. The Office of Information Services is planning to update ADAMS and then replace it in 2010. This change will present a major challenge to the NRC. The initial cost of the system exceeded agency estimates, and the system took longer to become operational than anticipated and initially failed to significantly improve document management. The challenge will be to incorporate the lessons learned from the first ADAMS experience into an effective transition to a new system.

Challenge 6: Administration of all aspects of financial management

The NRC must be a prudent steward of its fiscal resources through sound financial management. Financial management challenges include preparation of financial statements in accordance with applicable requirements, financial systems replacement, sound budget formulation planning, and efficient and effective procurement operations.

Challenge 7: Communication with external stakeholders throughout the NRC's regulatory activities

The NRC's strategic goal to ensure openness expressly recognizes that the public must be informed about, and have a reasonable opportunity to participate in, the regulatory process. The NRC states that public involvement in, and information about, its activities is the cornerstone of strong, fair regulation of the nuclear industry, and therefore, provides opportunities for citizens to be heard.

Owing to the nature of its business, the agency needs to interact with a diverse group of external stakeholders (e.g., Congress, the general public, other Federal agencies, and various industry and citizen groups) with clear, accurate, and timely information about its regulatory activities.

The NRC enhanced its outreach to external stakeholders in several ways. The agency responded to an extraordinarily high number of stakeholder requests for more information and to numerous congressional inquiries. The agency also conducted extensive interviews with the media and meetings with residents of local communities and State and local government officials to discuss new initiatives, reported events, and other significant regulatory activities.

The NRC encourages public participation and comments applicable to new reactor licensing activities through open meetings, Commission meetings, advisory committee meetings, and other opportunities open to the public. In addition, public meetings between NRC's technical staff and applicants or licensees are open to interested members of the public.

In this post-September 11 environment, the NRC continues to face challenges in determining an appropriate balance between its strategic goal of openness and the need to protect sensitive information. The agency has traditionally been committed to the principles of openness, fairness, and due process. In addition, the Freedom of Information Act requires Federal agencies to make information available to the general public by request or through automatic disclosure of certain types of information.

Challenge 8: Managing human capital

The NRC continues to be challenged by growth in new work at a time when senior experts are increasingly eligible to retire. To mitigate the impact of the challenge, the agency established a Human Capital Council to find, attract, and retain staff members who possess critical skills; implemented human capital provisions of the Energy Policy Act; identified staffing/training and development needs; moved forward with knowledge management strategies; and monitored the attrition rate.

Challenge 9: Ability to meet the demand for licensing new reactors

There is a growing list of U.S. licensees that are considering new nuclear power plant construction. These licensees intend to apply for early site permits, combined licenses, and design certifications. Title 10, Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," of the *Code of Federal Regulations* (10 CFR Part 52) outlines the NRC's licensing process. The agency is involved in several significant activities to ensure that it is prepared to review the first of the combined operating license (COL) applications which is expected in 2007–2008. These activities include the following:

- reviewing industry's guidelines for a COL application
- determining what actions are necessary to prepare for receipt of a COL application
- assessing rulemaking activities for the licensing process
- reviewing early site permit applications
- developing the Multinational Design Approval Program with international regulators, which will take advantage of worldwide nuclear safety, licensing, and operating experience

The NRC has already certified some new reactor designs under the new 10 CFR Part 52 licensing process. Under this approach, the agency preapproves or certifies new reactor designs and allows licensees to apply for an early site permit and/or a COL using one of the preapproved designs. Also, the NRC intends to apply a design-centered approach to facilitate effective, efficient, and timely review of multiple COL applications. This approach streamlines and shortens the NRC review process.

Although the 10 CFR Part 52 application process has advantages for both the NRC and the nuclear industry, it nevertheless represents a significant challenge because of the increased workload and pressure on the agency to create the infrastructure necessary to support review of new plant licensing applications.

As the NRC enters a new era of reactor regulation, it faces many challenges. In addition to ongoing license renewal activities, the agency will face the first round of new reactor applications since 1978. The NRC estimates that it may receive 20 or more applications in the coming years and that upward of 450 new staff positions will be needed to review these applications.

Coinciding with the dramatic increase in regulatory responsibilities will be the retirement of many senior staff members who have experience in licensing reactors from the 1960s, 1970s, and 1980s. The agency's ability to effectively review and license the new generation of commercial nuclear reactors will depend significantly on how well employees, new to the process, are trained and developed into effective reviewers and regulators at the staff and senior management level. Furthermore, construction oversight of future plants will be equally or even more challenging.

The review of new applications involving new reactor technologies, a new licensing process, and new staff untested in this realm necessitates a strong control process to ensure that the agency meets its review and licensing objectives. Specific challenges include the following:

- Project Management—Effective technical and communications skills are essential for the focal point (the project manager) of NRC and licensee interactions.

- Construction Inspection Oversight—The NRC must reinstitute this program which has been dormant for many years.

- Technical Review Process—The NRC must have a defined process for ensuring that all requisite technical reviews are conducted, documented, and approved.

- Standard Review Plan—As it did for the previous generation of reactors, the NRC must have a comprehensive Standard Review Plan for examining a license application. Additionally, consistent implementation of the Standard Review Plan is vital.

- Safety Evaluation Reports—The agency needs a solid process for compiling its regulatory examination into a safety evaluation report. This report reflects the agency's conclusion about a plant's ability to operate safely. It is essential that such conclusions be documented and approved.

APPENDIX C REFERENCES

American National Standards Institute (ANSI), ANSI N18.7-1976, "Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants," 1976

American Society of Mechanical Engineers (ASME), "Boiler and Pressure Vessel Code," Section XI

———, ASME-RA-5-2002, April 2002, and Addendum 1, December 2003, and Addendum 2, December 2005

Federal Emergency Management Agency (FEMA), FEMA-REP-1 (See NUREG-0654.)

———, Federal Policy Statement on Potassium Iodide Prophylaxis, January 2002

International Atomic Energy Agency, Safety Series No. 75-INSAG-4, "Safety Culture," Vienna, 1991

———, TECDOC-953, "Method for the Development of Emergency Response Preparedness for Nuclear or Radiological Accidents," Vienna, 1997

———, TECDOC-955, "Generic Assessment Procedures for Determining Protective Actions During a Reactor Accident," Vienna, 1997

International Commission on Radiological Protection, ICRP Publication 26, "Recommendations of the International Commission on Radiological Protection (Adopted January 17, 1977)," Oxford, Pergamon Press, 1991

———, ICRP Publication 30, "Limits of Intakes of Radionuclides by Workers," eight volumes, Oxford, Pergamon Press, 1978–1982

National Council on Radiation Protection and Measurements, NCRP Report No. 91, "Recommendations on Limits for Exposure to Ionizing Radiation," June 1987

Executive Order 12898, "Federal Actions To Address Environmental Justice in Minority and Low-Income Populations," 59 FR 7629, February 1994

Nuclear Energy Institute, NEI 04-04, "Cyber Security Programs for Power Reactors," November 18, 2005.

Homeland Security Presidential Directive 5 (HSPD 5), "Management of Domestic Incidents," March 4, 2003. Available at http://www.whitehouse.gov/XXXXX as of June 2007.

National Energy Policy, March 27, 200X. Available at http://www.whitehouse.gov as of June 2007.

U.S. Congress, Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq.

———, Debt Collection Improvement Act, 5 U.S.C. 5514 et seq.

———, DOE Organization Act, 42 U.S.C. 7101

———, Energy Policy Act of 2005, 16 U.S.C. 797 note et seq.

———, Energy Reorganization Act of 1974, as amended, 42 U.S.C. 5801 et seq.

———, Federal Civil Penalties Inflation Adjustment Act, 28 U.S.C. 2461

———, Federal Food, Drug, and Cosmetic Act, 21 U.S.C. 301

———, Freedom of Information Act, 5 U.S.C. 552 et seq.

———, Hobbs Act (See Administrative Orders Review Act.)

———, Homeland Security Act of 2002, 6 U.S.C. 101

———, National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321 et seq.

———, Nuclear Non-Proliferation Act of 1978, 22 U.S.C. 3201 et seq.

———, Price-Anderson Act of 1957, 42 U.S.C. 2012 et seq.

———, Uranium Mill Tailings Radiation Control Act of 1978, 42 U.S.C. 6907 et seq.

U.S. Department of Energy, DOE/EM-0654, Revision 1, "Second National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management." DOE in cooperation with the U.S. NRC, U.S. Environmental Protection Agency, and U.S. Department of State. DOE: Washington, DC. October 2005.

U.S. Department of Homeland Security, National Response Plan, March 18, 2003

U.S. Environmental Protection Agency, EPA-400-R-92-001, "Manual of Protective Action Guides and Protective Actions for Nuclear Incidents," May 1992

U.S. Nuclear Regulatory Commission, "Agreement Between the Government of the United States of America and the Government of Canada on Cooperation in Comprehensive Civil Emergency Planning and Management" and "Administrative Arrangement Between the United States Nuclear Regulatory Commission and the Atomic Energy Control Board of Canada for Cooperation and the Exchange of Information in Nuclear Regulatory Matters," June 21, 1989

———, "Agreement for the Exchange of Information and Cooperation in Nuclear Safety Matters" and "Implementing Procedure for the Exchange of Technical Information and Cooperation in Nuclear Safety Matters Between the Nuclear Regulatory Commission of the United States of America and the Comision Nacional de Seguridad Nuclear y Salvaguardias of Mexico," October 6, 1989

———, "Availability and Adequacy of Design Bases Information at Nuclear Power Plants; Policy Statement," 57 FR 35455, August 10, 1992

———, Bulletin 2003-02, "Leakage from Reactor Pressure Vessel Lower Head Penetrations and Reactor Coolant Pressure Boundary Integrity," August 21, 2003

———, "Commission Policy Statement on the Systematic Evaluation of Operating Nuclear Power Reactors," 49 FR 45112, November 1984

———, Draft Regulatory Guide 1145, "Combined License Applications for Nuclear Power Plants (LWR Edition)," September 2006

———, "Final Policy Statement on Technical Specification Improvement for Nuclear Power Reactors," 58 FR 39132, July 22, 1993

———, Generic Letter 81-38, "Storage of Low Level Radioactive Wastes at Power Reactor Sites," November 10, 1981

———, Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," September 13, 2004, ADAMS Accession No. ML042360586

———, Generic Letter 2006-02, "Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power," February 1, 2006

———, Information Notice 97-78, "Crediting of Operator Actions in Place of Automatic Actions and Modifications of Operator Actions, Including Response Times," October 23, 1997

———, Information Notice 2004-05, "Spent Fuel Pool Leakage to Onsite Groundwater," March 3, 2004

———, Information Notice 2005-26, "Results of Chemical Effects Head Loss Tests in a Simulated PWR Sump Pool Environment," September 16, 2005, ADAMS Accession No. ML052570220

———, Information Notice 2005-26, Supplement 1, "Additional Results of Chemical Effects Tests in a Simulated PWR Sump Pool Environment," January 20, 2006, ADAMS Accession No. ML060170102

———, Information Notice 2006-13, "Ground-Water Contamination Due to Undetected Leakage of Radioactive Water," July 10, 2006

———, Information Notice 2006-30, "Summary of Fitness-for-Duty Program Performance Reports for Calendar Years 2004 and 2005," December 21, 2006

———, Inspection Manual Chapter 0350, "Oversight of Operating Reactor Facilities in a Shutdown Condition with Performance Problems"

———, Inspection Manual Chapter 2501, "Early Site Permits"

———, Inspection Manual Chapter 2502, "Pre-Combined License Phase"

———, Inspection Manual Chapter 2503, "ITAAC"

———, Inspection Manual Chapter 2504, "Non-ITAAC Inspections"

———, Inspection Manual Chapter 2509, "Browns Ferry Unit 1 Restart Project Inspection Program"

———, Inspection Procedure 41500, "Training and Qualification Effectiveness"

———, Inspection Procedure 42001, "Emergency Operating Procedures"

———, Inspection Procedure 42700, "Plant Procedures"

———, Inspection Procedure 71111.11, "Licensed Operator Requalification Program"

———, Inspection Procedure 71152, "Identification and Resolution of Problems"

———, Inspection Procedure 95003, "Supplemental Inspection of Repetitive Degraded Cornerstones, Multiple Degraded Cornerstones, Multiple Yellow Inputs, or One Red Input"

———, Management Directive 8.7, "Reactor Operating Experience Program," September 28, 2006

———, Management Directive 10.159, "The NRC Differing Professional Opinions Program," May 16, 2004

———, NUREG-0396, "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants, EPA-520/1-78/016," December 1978

———, NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," FEMA-REP-1, Rev. 1, November 1980

———, NUREG-0654, Supplement 3, "Criteria for Protective Action Recommendations for Severe Accidents (Draft Report for Interim Use and Comment)," Rev. 1, July 1996

———, NUREG-0700, "Human System Interface Design Review Guideline," Rev. 2, May 2002

———, NUREG-0711, "Human Factors Engineering Program Review Model," July 1994

———, NUREG-0713, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities," Vol. 24, October 2003

———, NUREG-0728, "NRC Incident Response Plan," Rev. 4, November 23, 2003

———, NUREG-0737, "Clarification of TMI Action Plan Requirements," November 1980

———, NUREG-0737, Supplement 1, "Requirements for Emergency Response Capability," January 1983

———, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," 1981, 1984, and 1987 (formerly NUREG-75/087)

———, NUREG-0899, "Guidelines for the Preparation of Emergency Operating Procedures," August 1982

———, NUREG-0933, "A Prioritization of Generic Issues," October 2006

———, NUREG-1021, "Operator Licensing Examination Standards for Power Reactors," Rev. 8, April 1999

———, NUREG-1022, "Event Reporting Guidelines, 10 CFR 50.72 and 50.73," Rev. 2, October 2000

———, NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," December 1990

———, NUREG-1220, "Training Review Criteria and Procedures," Rev. 1, January 1993

———, NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants," May 1996

———, NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants," February 1995

———, NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal," March 2000

———, NUREG-1577, Revision 1, "Standard Review Plan on Power Reactor Licensee Financial Qualifications and Decommissioning Funding Assurance," February 1999

———, NUREG-1600, "General Statement of Policy and Procedures for NRC Enforcement Actions (Enforcement Policy)," July 2000

———, NUREG-1650, "U.S. National Report for the Convention on Nuclear Safety," September 2001, September 2004

———, NUREG-1764, "Guidance for the Review of Changes to Human Actions, Draft Report for Comment," December 2002

———, NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," July 2005

———, NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants," July 2001

———, NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," July 2001

———, NUREG/CR-2850, "Dose Commitments Due to Radioactive Releases from Nuclear Power Plant Sites in 1992," Vol. 14, March 1996

———, NUREG/CR-6838, "Technical Basis for Assessing Exemptions from Nuclear Power Plant Licensed Operator Staffing Requirements 10 CFR 50.54(m)," February 2004

———, NUREG/CR-6847 "Cyber security Self-Assessment Method for U.S. Nuclear Power Plants," October 2004

———, "OIG 2005 Survey of NRC's Safety Culture and Climate," OIG-06-A-08, February 10, 2006

———, "Policy Statement on Deferred Plants," (52 FR 38077, October 14, 1987)

———, "Policy Statement on Use of PRA Methods in Nuclear Activities," 60 FR 42623, August 16, 1995

———, RG 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling-Water Reactors," Rev. 2, June 1974

———, RG 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized-Water Reactors," Rev. 2, June 1974

———, RG 1.8, "Personnel Selection and Training," March 1971 and RG 1.8, "Qualification and Training of Personnel for Nuclear Power Plants," Rev. 2, April 1987

———, RG 1.20, "Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing," November 2006

———, RG 1.33, "Quality Assurance Program Requirements (Operations)," Rev. 3, November 1980

———, RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Rev. 3, November 1978

———, RG 1.84, "Design, Fabrication, and Materials Code Case Acceptability, ASME Section III," March 2003

———, RG 1.101, "Emergency Planning and Preparedness for Nuclear Power Plants," Rev. 4, July 2003

———, RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Rev. 1, November 1982 (reissued with corrected page 1.145-7, February 1983)

———, RG 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," January 2004

———, RG 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," March 1997

———, RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," July 1998 and Rev. 1, November 2002

———, RG 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications," August 1998

———, RG 1.178, "An Approach for Plant-Specific Risk-Informed Decisionmaking for Inservice Inspection of Piping," September 2003

———, RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," July 2000

———, RG 1.188, "Standard Format and Content of Applications to Renew Nuclear Power Plant Operating Licenses," July 2001

———, RG 1.192, "Operation and Maintenance Code Case Acceptability, ASME OM Code," June 2003

———, RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Rev. 1, January 2007

———, RG 1.206, "Combined Operating Licenses for Nuclear Power Plants," June 2007

———, RG 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion, March 2007

———, RG 4.2, "Preparation of Environmental Reports for Nuclear Power Stations," Rev. 2, July 1976 and Supplement 1, "Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses," August 1991

———, RG 8.8, "Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable," Rev. 3, June 1978

———, Review Standard (RS-001) for Extended Power Uprates, December 2003

———, Review Standard (RS-002) for Processing Applications for Early Site Permits, December 2003

———, "Safety Goals for the Operation of Nuclear Power Plants: Policy Statement; Republication 51 FR 30028," August 21, 1986

———, SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs," April 2, 1993

———, SECY-06-0164, "NRC Knowledge Management Program," July 25, 2006

———, SECY-06-0208, "Status of the Accident Sequence Precursor Program and the Development of Standardized Plant Analysis Risk Models," October 5, 2006

———, SECY-06-0244, "Final Rulemaking—10 CFR Part 26—Fitness-for-Duty Programs," December 22, 2006

———, SECY-07-0063, "FY 2006 Results of the Industry Trends Program for Operating Power Reactors and Status of Ongoing Development," April 3, 2007

———, "Severe Reactor Accidents Regarding Future Designs and Existing Plants; Policy Statement," 50 FR 32138, August 8, 1985

APPENDIX D ABBREVIATIONS

ADAMS	Agencywide Documents Access and Management System (NRC)
ALARA	as low as reasonably achievable
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BPV	boiler and pressure vessel
BWR	boiling-water reactor
CCDP	conditional core damage probability
CEUS	Central and Eastern United States
CFR	*Code of Federal Regulations*
CRGR	Committee To Review Generic Requirements (NRC)
CY	calendar year
DBT	design-basis threat
DHS	U.S. Department of Homeland Security
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
EPU	extended power uprate
ERDA	U.S. Energy Research and Development Administration
ESBWR	Economic and Simplified Boiling-Water Reactor
FDA	U.S. Food and Drug Administration
FEMA	U.S. Federal Emergency Management Agency
FPL	Florida Power and Light
FTE	full-time equivalent
FY	fiscal year
GL	generic letter
I&C	Instrumentation and control
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IG	Inspector General
IN	information notice
INES	International Nuclear Event Scale
INPO	Institute of Nuclear Power Operations
IP	inspection procedure
IPA	integrated plant assessment
IPE	individual plant examination
IRRS	Integrated Regulatory Review Service
IRRT	International Regulatory Review Team
ISAP	Integrated Safety Assessment Program
ISO	International Organization for Standardization

ITAAC	inspections, tests, analyses, and acceptance criteria
IT/IM	information technology/information management
KM	knowledge management
LAR	license application request
LOCA	loss-of-coolant accident
Mwth	Megawatts Thermal
NCRP	National Council on Radiation Protection and Measurements
NEA	Nuclear Energy Agency
NNAB	National Nuclear Accrediting Board
NRC	U.S. Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation (NRC)
OM	operation and maintenance
OSART	Operational Safety Assessment Review Team
PRA	probabilistic risk assessment
PS&G	Public Service Electric and Gas Company
PSR	periodic safety review
PWR	pressurized-water reactor
PWSCC	primary water stress-corrosion cracking
QA	quality assurance
RPP	risk-informed and performance-based plan
RS	review standard
SAT	systems approach to training
SE	safety evaluation
SEP	systematic evaluation program
SSC	structure, system, and component
STP	South Texas Project
Sv	sievert
TMI	Three Mile Island
TOPOFF	top officials (emergency response exercise)
TSO	technical support organization
TVA	Tennessee Valley Authority
TXU	Texas Utilities
WENRA	Western European Nuclear Regulators' Association
WBN	Watts Bar Nuclear Plant

APPENDIX E ACKNOWLEDGMENTS

Contributors to this report include the following technical and regulatory experts from the NRC. The project manager was Jon Hopkins; the preparer of the report was Merrilee Banic.

Abu-Eid, Rateb
Alexion, Thomas
Banic, Merrilee
Bavol, Bruce
Brown, Eva
Casto, Gregory
Crockett, Steven
Decker, David
Dinitz, Ira
Dusaniwskyj, Michael
Erlanger, Craig
Fields, Leslie
Ford, William
Frumkin, Daniel
Foster, Jack
Gareri, Mario
Ghasemian, Shahram
Harrison, Donald
Hart, Michelle
Hiltz, Thomas
Hoffman, Stephen
Hopkins, Jon
Huyuk, Douglas
Imboden, Stacy
Jackson, Christopher
James, Lois
Jolicoeur, John
Khanna, Meena
Lauron, Carolyn
Lewis, Robert
Li, Yong
Liu, Christiana
Magruder, Stewart
McConnell, Matthew
Mendiola, Anthony
Milligan, Patricia
Miranda, Samuel
Monninger, John
Morris, Scott
Munson, Cliff
Murphy, Martin
Paige, Jason
Pascarelli, Robert
Perez, Donna-Marie
Prescott, Paul
Ramey-Smith, Ann
Rand, Jennifer
Schwartzman, Jennifer
Scott, Michael
Stuchell, Sheldon
Virgilio, Rosetta
Westreich, Barry
White, Bernard
Williams, Donna
Yoder, Matthew
Zalcman, Barry
Zimmerman, Jacob

ANNEX 1 U.S. COMMERCIAL NUCLEAR POWER REACTORS

SOURCE: U.S. Nuclear Regulatory Commission (NRC) and licensee data as compiled by the NRC

RELEVANT ARTICLE: Article 6

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Arkansas Nuclear 1 Entergy Operations	PWR	2568	12/74 05/34
Arkansas Nuclear 2 Entergy Nuclear	PWR	3026	03/80 07/38
Beaver Valley 1 First Energy Nuclear Operating Company	PWR	2689	10/76 01/16
Beaver Valley 2 First Energy Nuclear Operating Company	PWR	2689	11/87 05/27
Braidwood 1 Exelon	PWR	3586.6	07/88 10/26
Braidwood 2 Exelon	PWR	3586.6	10/88 12/27
Browns Ferry 1 Tennessee Valley Authority	BWR	3293	08/74 12/13
Browns Ferry 2 Tennessee Valley Authority	BWR	3458	03/75 06/14
Browns Ferry 3 Tennessee Valley Authority	BWR	3458	03/77 0716
Brunswick 1 Carolina Power and Light, Co.	BWR	2923	03/77 09/16
Brunswick 2 Carolina Power and Light, Co.	BWR	2923	11/75 12/14

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Byron 1 Exelon	PWR	3585.6	09/85 10/24
Byron 2 Exelon	PWR	3586.6	08/87 11/26
Callaway AmerenUE	PWR	3565	12/84 10/24
Calvert Cliffs 1 Nuclear Power Plant, Inc.	PWR	2700	05/75 07/34
Calvert Cliffs 2 Nuclear Power Plant, Inc.	PWR	2700	04/77 08/36
Catawba 1 Duke Energy Power Company, LLC	PWR	3411	06/85 12/43
Catawba 2 Duke Energy Power Company, LLC	PWR	3411	08/86 12/43
Clinton AmerGen Energy Co.	BWR	3473	11/87 09/26
Columbia Generating Station Energy Northwest	BWR	3486	12/84 12/23
Comanche Peak 1 TXU Generation Company LP	PWR	3458	08/90 02/30
Comanche Peak 2 TXU Electric & Gas	PWR	3458	08/93 02/33
Cooper Nebraska Public Power District	BWR	2381	07/74 01/14

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Crystal River 3 Florida Power Corp.	PWR	2568	03/77 12/16
Davis-Besse First Energy Nuclear Operating Company	PWR	2772	07/78 04/17
D.C. Cook 1 Indiana/Michigan Power Co.	PWR	3304	08/75 10/34
D.C. Cook 2 Indiana/Michigan Power Co.	PWR	3468	07/78 12/37
Diablo Canyon 1 Pacific Gas & Electric Co.	PWR	3338	05/85 09/21
Diablo Canyon 2 Pacific Gas & Electric Co.	PWR	3411	03/86 04/25
Dresden 2 Exelon	BWR	2957	06/70 12/29
Dresden 3 Exelon	BWR	2957	11/71 01/31
Duane Arnold Nuclear Management Co.	BWR	1912	02/975 02/14
Edwin I. Hatch 1 Southern Nuclear Operating Co.	BWR	2804	12/75 08/34
Edwin I. Hatch 2 Southern Nuclear Operating Co.	BWR	2804	09/79 06/38
Fermi 2	BWR	3430	01/88

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Detroit Edison Co.			03/25
Ginna Nuclear Power Plant, LLC	PWR	1520	07/70 09/29
Grand Gulf 1 Entergy Operations, Inc.	BWR	3833	07/85 11/24
H.B. Robinson 2 Carolina Power and Light Co.	PWR	2339	03/71 07/30
Hope Creek 1 PSEG Nuclear, LLC	BWR	3339	12/86 04/26
Indian Point 2 Entergy Nuclear Operations	PWR	3216	08/74 09/13
Indian Point 3 Entergy Nuclear Operations	PWR	3216	08/76 12/15
James A. FitzPatrick Entergy Nuclear Operations	BWR	2536	07/75 10/14
Joseph M. Farley 1 Southern Nuclear Operating Co.	PWR	2775	12/77 06/37
Joseph M. Farley 2 Southern Nuclear Operating Co.	PWR	2775	07/81 03/41
Kewaunee	PWR	1772	06/74

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Dominion Energy			12/13
La Salle 1 Exelon	BWR	3489	01/84 04/22
La Salle 2 Exelon	BWR	3489	10/84 12/23
Limerick 1 Exelon	BWR	3458	02/86 10/24
Limerick 2 Exelon	BWR	3458	01/90 06/29
McGuire 1 Duke Energy Power Company, LLC	PWR	3411	12/81 06/41
McGuire 2 Duke Energy Power Company, LLC	PWR	3411	03/84 03/43
Millstone 2 Dominion Generation	PWR	2700	12/75 07/35
Millstone 3 Dominion Generation	PWR	3411	04/86 11/45
Monticello Nuclear Management Co.	BWR	1775	06/71 09/10

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Nine Mile Point 1 Constellation Nuclear	BWR	1850	12/69 08/09
Nine Mile Point 2 Nuclear Station, LLC	BWR	3467	03/88 10/26
North Anna 1 Dominion Generation Operating Utility	PWR	2893	06/78 04/38
North Anna 2 Dominion Generation	PWR	2893	12/80 08/40
Oconee 1 Duke Energy Power Company, LLC	PWR	2568	07/73 02/33
Oconee 2 Duke Energy Power Company, LLC	PWR	2568	09/74 10/33
Oconee 3 Duke Energy Power Company, LLC	PWR	2568	12/74 12/34
Oyster Creek AmerGen Energy Co., LLC	BWR	1930	12/69 04/09
Palisades Nuclear Management Co.	PWR	2565	12/71 03/11
Palo Verde 1 Arizona Public Service Co.	PWR	3990	01/86 12/24
Palo Verde 2 Arizona Public Service Co.	PWR	3990	09/86 12/25
Palo Verde 3 Arizona Public Service Co.	PWR	3990	01/88 03/27

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Peach Bottom 2 Exelon	BWR	3514	07/74 08/33
Peach Bottom 3 Exelon	BWR	3514	12/74 07/34
Perry 1 First Energy Nuclear Operating Company	BWR	3758	11/87 03/26
Pilgrim 1 Entergy Nuclear	BWR	2028	12/72 06/12
Point Beach 1 Nuclear Management Co.	PWR	1540	12/70 10/30
Point Beach 2 Nuclear Management Co.	PWR	1540	10/72 03/33
Prairie Island 1 Nuclear Management Co.	PWR	1650	12/73 08/13
Prairie Island 2 Nuclear Management Co.	PWR	1650	12/74 10/14
Quad Cities 1 Exelon	BWR	2957	02/73 12/32
Quad Cities 2 Exelon	BWR	2957	03/73 12/32
River Bend 1 Entergy Nuclear Operations, Inc.	BWR	3091	06/86 08/25

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Salem 1 PSEG Nuclear, LLC	PWR	3459	06/77 08/16
Salem 2 PSEG Nuclear, LLC	PWR	3459	10/81 04/20
San Onofre 2 Southern California Edison Co.	PWR	3438	08/83 02/22
San Onofre 3 Southern California Edison Co.	PWR	3438	04/84 11/22
Seabrook 1 FPL Energy Seabrook	PWR	3587	08/90 10/26
Sequoyah 1 Tennessee Valley Authority	PWR	3411	07/81 09/20
Sequoyah 2 Tennessee Valley Authority	PWR	3411	06/82 09/21
Shearon Harris 1 Carolina Power and Light Co.	PWR	2900	05/87 10/26
South Texas Project 1 STP Nuclear Operating Co.	PWR	3853	08/88 08/27
South Texas Project 2 STP Nuclear Operating Co.	PWR	3853	06/89 12/28
St. Lucie 1 Florida Power & Light Co.	PWR	2700	12/76 03/36
St. Lucie 2 Florida Power & Light Co.	PWR	2700	08/83 04/43

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Summer South Carolina Electric & Gas Co.	PWR	2900	01/84 08/22
Surry 1 Dominion Generation	PWR	2546	12/72 05/32
Surry 2 Dominion Generation	PWR	2546	05/73 01/33
Susquehanna 1 PPL Susquehanna, LLC	BWR	3489	06/83 07/22
Susquehanna 2 PPL Susquehanna, LLC	BWR	3489	02/85 03/24
Three Mile Island 1 AmerGen Energy Co.	PWR	2568	09/74 04/14
Turkey Point 3 Florida Power & Light Co.	PWR	2300	12/72 07/32
Turkey Point 4 Florida Power & Light Co.	PWR	2300	09/73 04/33
Vermont Yankee Entergy Nuclear Northeast	BWR	1912	11/72 03/12
Vogtle 1 Southern Nuclear Operating Co.	PWR	3565	06/87 01/27
Vogtle 2 Southern Nuclear Operating Co.	PWR	3565	05/89 02/29
Waterford 3 Entergy Nuclear Operations, Inc	PWR	3716	09/85 12/24

Plant Name and Operating Utility	Reactor Design Type	Licensed Power (MWth)	Operating Lifetime
Watts Bar 1 Tennessee Valley Authority	PWR	3459	05/96 11/35
Wolf Creek 1 Wolf Creek Nuclear Operating Corp.	PWR	3565	09/85 03/25

PART 3

Convention on Nuclear Safety Report:

The role of the Institute of Nuclear Power Operations in supporting the United States commercial nuclear electric utility industry's focus on nuclear safety

September 2007

INPO®

1. Executive Summary

Following the event at Three Mile Island, the U.S. nuclear electric utility industry established the Institute of Nuclear Power Operations (INPO) in 1979 to promote the highest levels of safety and reliability—to promote excellence—in the operation of its nuclear electric generating stations. The Institute is a nongovernmental corporation that operates on a not-for-profit basis and does not issue capital stock. Under United States tax law, the company is classified as a charitable organization that "relieves the burden of government."

Since its inception, all organizations that have direct responsibility and legal authority to operate or construct commercial nuclear electric generating plants in the United States have maintained continuous membership in the Institute. There are currently 27 members of INPO. In addition, many organizations that jointly own these nuclear power plants are associate members. A number of international utility organizations and major supplier organizations also voluntarily participate in the Institute's activities and programs.

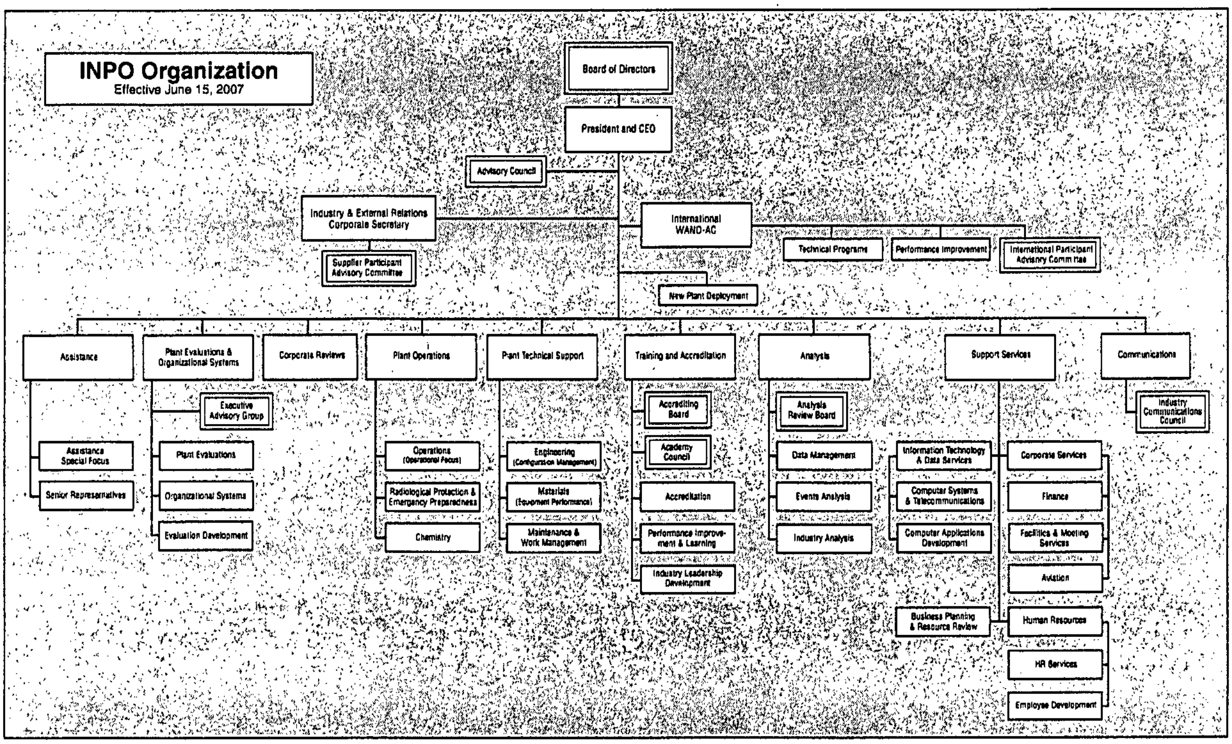
In forming INPO, the nuclear utility industry took an unusual step. The industry placed itself in the role of overseeing INPO activities, while at the same time endowing INPO with ample authority to bring pressure for change on individual members and the industry as a whole. That feature makes INPO unique. The industry clearly established and accepted a form of self-regulation through peer review by helping to develop and then committing to meet INPO's performance objectives and criteria. The industry's recognition that all nuclear utilities are affected by the action of any one utility motivated its commitment to and support of INPO. Each individual member is solely responsible for the safe operation of its nuclear electric generating plant(s). The U.S. Nuclear Regulatory Commission (NRC) has statutory responsibility for overseeing the licensees and verifying that each licensee operates its facility in compliance with federal regulations to assure public health and safety. INPO's role, encouraging the pursuit of excellence in the operation of commercial nuclear electric generating plants, is complementary but separate and distinct from the role of the NRC.

The nuclear industry's commitment to go beyond compliance with regulations and continually strive for excellence, with INPO's support, has resulted in substantial performance improvements over the last 28 years. For example, in the early 1980s the typical nuclear plant had a capacity factor of 63 percent, experienced six automatic scrams per year, had high collective radiation dose, and experienced numerous industrial safety accidents among its staff. Today, median industry capacity factor is above 91 percent, most plants have zero automatic scrams per year, and collective radiation dose and industrial accident rates are both lower by a factor of 7 when compared to the 1980s.

This report is intended to provide an understanding of the Institute's role and its major programs in support of the U.S. commercial nuclear electric generating industry.

2. Organization and Governance

In many ways, the Institute's organizational structure is similar to a typical U.S. corporation. A Board of Directors, composed of senior executives of its member organizations and elected annually by INPO's members, provides overall direction for the Institute's operations and activities. Currently, the Board consists of 12 CEOs and 2 presidents from the member utilities. The Institute Bylaws specify that at least 2 directors shall have recent experience in the direct supervision of operation of a facility that generates electricity or steam for commercial purposes through the application of nuclear power. Also, at least one director shall represent a public utility. The president and CEO of the Institute, normally a single individual, is elected by and reports to its Board of Directors. An organization chart is presented below.



Because the INPO Board of Directors is made up of utility executives, the industry believes that it is important to also have support from an Advisory Council of distinguished individuals mainly from outside the nuclear generation industry to provide diversity of experience and thought. This Advisory Council of 9 to 15 professionals from outside INPO's membership meets periodically to review Institute activities and provide advice on broad objectives and methods to the Board of Directors. Members include prominent educators, scientists, engineers, and business executives, as well as experts in organizational effectiveness, human relations, and finance.

Institute activities to enhance nuclear plant safety and reliability are reflected primarily in its four cornerstone programs: periodic on-site evaluations of each nuclear plant and corporate support organizations, training and accreditation, events analysis and information exchange, and assistance. Nuclear technical divisions are organized to carry out the cornerstone functions. Other functional areas, such as support services, industry and external relations, and communications, support the nuclear technical divisions as well as the Institute's overall mission.

The National Academy for Nuclear Training operates under the direction of INPO and integrates the training efforts of all U.S. nuclear utilities, the activities of the National Nuclear Accrediting Board, and the training-related activities of the Institute. An INPO executive serves as the executive director of the Academy.

Non-U.S. nuclear organizations from 12 different countries or provinces participate in the Institute's International Participant Program, managed by the World Association of Nuclear Operators (WANO)-Atlanta Center at INPO's request. This program involves the active exchange of information on nuclear plant operations among utility organizations around the world. Each international participant organization is represented on an advisory committee that provides advice on the operation of this program as well as input on other Institute programs as appropriate.

Organizations engaged in providing commercial design, engineering, nuclear fuel cycle, or other services directly related to the construction, operation, or support of nuclear electric generating plants also participate in INPO through the Supplier Participant Program. This program allows supplier organizations to share experience and expertise with Institute members and provides a means to provide feedback on operational experience to the suppliers. Currently, there are 18 companies from around the world in the Supplier Participant Program.

The industry actively participates in the oversight of INPO's programs. Representatives from member utilities serve on the Executive Advisory Group, the Academy Council, the Analysis Review Board, and the Industry Communications Council. The Executive Advisory Group advises INPO management on the programs and products in the nuclear technical areas. The Academy Council provides advice in the areas of training, accreditation, and human performance. The Analysis Review Board advises on INPO analysis activities, and the Industry Communications Council advises on effective communication of INPO programs and activities. Frequently, ad hoc industry groups are established to provide input on specific initiatives.

Financial and Human Resources

The 2007 operating budget is $81.6 million, primarily funded through member dues. Dues, approved annually by the Board of Directors, are assessed based on the number of each member's nuclear plant sites and units.

The Institute's permanent staff of about 300 is augmented extensively by industry professionals who serve as loaned employees or international liaison engineers on assignments of, typically, 18 to 24 months. Loaned and liaison employees comprise about one-third of the total technical staff. They gain extensive experience and training while providing current industry expertise and diversity of thought and practices. A small number of permanent Institute employees serve in loaned assignments to member organizations, primarily for professional development. The total number of both permanent and loaned employees is approximately 360 people.

Institute resources and capabilities are further enhanced by the extensive use of U.S. and international utility peers and executive industry advisors. These peers participate in a wide range of short-term activities, especially on evaluation and accreditation teams that visit nuclear plants. Peers enhance the effectiveness of the INPO teams by offering varied perspectives and providing additional current experience. The peers benefit from learning other ways of conducting business that can be shared with their stations. In 2006, the industry provided INPO with more than 600 peers for short term assignments.

3. INPO's Role Within the Federal Regulatory Framework

The nuclear utility industry in the United States, like other industries that may affect the health and safety of the general public, is regulated by the federal government. This regulatory function is based principally on the Atomic Energy Act of 1954, as amended, and is carried out by the U.S. Nuclear Regulatory Commission. In 1979, following the accident at Three Mile Island Nuclear Station, the President of the United States appointed a commission to investigate the accident. The commission, which came to be known as the Kemeny Commission, helped influence the industry's decision to create INPO as a method of self-regulation.

The industry created INPO to provide the means whereby the industry itself could, acting collectively, improve the safety and reliability of nuclear operations. Industry leaders envisioned that peer reviews and performance objectives and criteria based on excellence would be effective in bringing about improvements. In the broad sense, the ultimate goals of the NRC and INPO are the same, in that both strive to protect the public; therefore, both review similar areas of nuclear power plant operations. In granting INPO its not-for-profit status, the U.S. government acknowledged that INPO's role reduces the burden on the government through the conduct of its activities. However, the industry does not expect INPO to supplant the regulatory role of the NRC. It was recognized that in establishing and meeting its role, INPO would have to work closely with the NRC, while at the same time not becoming or appearing to become an extension of or an advisor to the NRC, or an advocacy agent for the utilities. As recognition of their different roles but common goals, the NRC and INPO have entered into a Memorandum of Agreement that includes coordination plans that cover specific areas of mutual interest.

The conduct of plant and corporate evaluations is one of INPO's most important functions. It is also the function that is closest to the role of a regulator. While the two roles, evaluation and regulation, may appear similar, they do differ in some ways. The industry and INPO jointly develop numerous performance objectives and criteria (POCs). INPO then conducts regular, extensive, and intrusive evaluations to determine how well they are being met. These performance objectives are broad statements of conditions that reflect a higher level of overall plant performance—striving for excellence, and thus often exceeding regulatory requirements. These performance objectives, by their very nature, are difficult to achieve consistently.

Because of the differences in the roles of INPO and the NRC, the industry maintains a clear separation between INPO evaluations and NRC inspections. The industry expects INPO to keep the NRC apprised of its generic activities. While INPO interactions with an individual member are maintained private between that member and INPO, stations are encouraged to make their INPO plant evaluation results and accreditation results available to the NRC for review at each utility or site.

The industry recognizes the need for the NRC to assess the overall quality of INPO's products and the success of its programs. Therefore, the industry expects INPO to provide the NRC with information on INPO programs and activities, including the following:

- copies of selected generic documents
- access to other pertinent information, such as the Equipment Performance Information Exchange (EPIX) database, as described in specific agreements
- observation of certain INPO field activities by NRC employees, with agreement from members
- observation of National Nuclear Accrediting Board sessions

INPO regularly participates in industry-led working groups and task forces that interface with the NRC on specific regulatory issues and initiatives relative to the Institute's mission and strategic objectives. These cooperative interactions have led to the elimination of some redundant activities, benefiting INPO members while enabling both the NRC and INPO to maintain or strengthen focus on their respective missions. For example, the Consolidated Data Entry System, operated by INPO, collects operating data that the NRC uses in its industry oversight process.

INPO has implemented a policy and appropriate procedures with regard to the handling of items that are potentially reportable to the NRC. INPO's policy is to inform utility management of such items during the normal course of business so that the utility can evaluate and report the items as appropriate. If INPO becomes aware of a defect or failure to comply that requires a report under federal regulation, the Institute has an obligation to ensure that the item is reported if it has not already been reported by the utility.

4. Responsibilities of INPO and Its Members

INPO members are expected to strive for excellence in the operation of their nuclear plants, to meet INPO performance objectives, and to meet the intent of INPO guidelines. This effort also includes the achievement and maintenance of accreditation of training programs for personnel who operate, maintain, and support their nuclear plants. Members are expected to be responsive to all areas for improvement identified through INPO evaluation, accreditation, and events analysis programs.

A special procedure, approved by the INPO Board of Directors, provides guidance if a member is not responsive to INPO programs, is unwilling to take action to resolve a significant safety issue, has persistent shortfalls in performance, or has accreditation for its training programs put on probation or withdrawn by the National Nuclear Accrediting Board. The procedure specifies that INPO and the member's management work to resolve any issues in contention using a graduated approach of increasing accountability. Specific options for accountability include interactions between INPO's chief executive officer and the member's chief executive officer and, if necessary, the member's board of directors. One option also includes suspending INPO membership if the member continues to be unresponsive. Suspension of membership has never been needed but would have a significant impact on the utility's continued operation, including limiting the ability of the utility to obtain insurance.

Furthermore, members are expected to fully participate in other generic INPO programs designed to enhance nuclear plant safety and reliability industrywide. Examples include providing INPO with detailed and timely operating experience information and participating fully in the loaned employee, peer evaluator, and WANO performance indicator programs. Members share information, practices, and experiences to assist each other in maintaining high levels of operational safety and reliability.

In return, INPO is expected to provide members with results from evaluation, accreditation, and review visits including written reports and an overall evaluation numerical assessment that characterizes performance relative to standards of excellence. The industry expects INPO to follow up and verify that effective corrective actions are implemented.

There is clear understanding between INPO and its members that both parties must maintain the confidentiality of INPO evaluation reports and related information, including not distributing this information external to the member utility organization. Members and participants are also expected to use information provided by the Institute to improve nuclear operations and not for other purposes, such as to gain commercial advantage. Members avoid involving INPO or INPO documents in litigation.

INPO members that are also members of the collective insurance organization Nuclear Electric Insurance Limited (NEIL) have authorized and instructed INPO to make available to NEIL copies of INPO evaluation reports and other data at the Institute's office. NEIL reviews these reports and data for items that could affect the insurability of its members.

INPO performance objectives and criteria are written with input from and the support of the industry. However they are written without regard to constraints or agreements, such as labor agreements, of any individual member. Each member is expected to resolve any impediments to their implementation that may be imposed by outside organizations.

INPO does not engage in public, media, or legislative activities to promote nuclear power. Such activities would undermine INPO's objectivity and credibility and may jeopardize the Institute's not-for-profit status.

5. Principles of Sharing (Openness and Transparency)

Throughout the changes that have occurred in the U.S. electric industry, including the process of electric deregulation, the industry has reaffirmed INPO's mission to promote the highest levels of safety and reliability—to promote excellence—in the operation of nuclear electric generating plants. Even with U.S. utilities now in competition in certain areas there is a clear understanding of the need to continue sharing pertinent operational information in order to continuously strengthen safety and reliability. Nuclear utilities believe that this cooperation is fundamental to the industry's continued success.

Through INPO, nuclear utilities quickly share information important to safety and reliability, including operating experience, operational performance data, and information related to failure of equipment that impacts safety and reliability. The industry also actively supports benchmarking visits to support the sharing of best practices and the concepts of emulation and continuous improvement.

INPO also facilitates industry information sharing by including participation of industry peers in the INPO cornerstone programs—plant evaluations, training and accreditation, analysis and information exchange, and assistance. INPO communicates sharing through a variety of methods including the secure member Web site, Nuclear Network®, written guidelines, and other publications.

While the industry and INPO recognize that rapid and complete sharing of information important to nuclear safety is essential, there is a clear understanding that certain information is private in nature and is not appropriate to share. Examples are INPO plant-specific details of evaluation and accreditation results, personal employee and individual performance information, and appropriate cost and power marketing data.

6. Priority to Safety (Safety Culture)

The U.S. nuclear industry believes that a strong safety culture is central to excellence in nuclear plant operations, due in part to the special and unique nature of nuclear technology and the associated hazards—radioactive by-products, concentration of energy in the reactor core, and decay heat. Within our members' power plants and within INPO, the elements, activities, and behaviors that are part of a strong safety culture are embedded in everything that we do day to day and have been since INPO was formed in 1979.

> The U.S. nuclear industry has defined safety culture as follows: ***An organization's values and behaviors—modeled by its leaders and internalized by its members—that serve to make nuclear safety the overriding priority.***

To support line managers in fostering a strong safety culture, the nuclear industry developed the ***Principles for a Strong Nuclear Safety Culture*** in November 2004. The principles were incorporated into the performance objectives and criteria as the foundation of nuclear safety in May 2005. The eight principles that are the foundation of a strong nuclear safety culture are:

1. Everyone is personally responsible for nuclear safety.
2. Leaders demonstrate commitment to safety.

3. Trust permeates the organization.
4. Decision-making reflects safety first.
5. Nuclear technology is recognized as special and unique.
6. A questioning attitude is cultivated.
7. Organizational learning is embraced.
8. Nuclear safety undergoes constant examination.

As part of its focus on safety, the industry utilizes INPO, through evaluations and other INPO activities, to identify and help correct early signs of decline in safety culture at any plant or utility. Further, the industry has defined INPO's role as follows:

- Define and publish standards relative to safety culture.
- Evaluate safety culture at each plant.
- Develop tools to promote and evaluate safety culture.
- Assist the industry in providing safety culture training.
- Develop and issue safety culture lessons learned and operating experience.
- Make safety culture visible in various forums such as professional development seminars, assistance visits, working meetings, and conferences including the CEO conference.

Safety culture is thoroughly examined during each plant evaluation. Each evaluation team is expected to evaluate safety culture throughout the process, including during the preevaluation analysis of plant data and observations made at the plant. The results of this review are included in the summary on organizational effectiveness and may be documented as an area for improvement as appropriate. Aspects of a plant's safety culture are discussed with the CEO of the utility at each evaluation exit briefing.

In 2002, INPO published Significant Operating Experience Report (SOER) 02-4, *Reactor Pressure Vessel Head Degradation at Davis-Besse Nuclear Power Station.* The purpose of the report was to describe the event and the shortfalls in safety culture that contributed to the event, as well as to recommend actions to prevent similar safety culture problems at other plants. This event is considered a defining moment in the U.S. nuclear power industry, highlighting problems that can develop when the safety culture at a plant receives insufficient attention. The SOER recommendations have been implemented at every U.S. nuclear power station and INPO evaluation teams have reviewed each station's actions. Briefly, the recommendations encompass discussing a case study on the event with all managers and supervisors in the nuclear organization, periodically conducting a self-assessment to determine the organizational respect for nuclear safety, and identifying and resolving abnormal plant conditions or indications at the station that cannot be readily explained. This SOER has also been shared with World Association of Nuclear Operators and re-published as a WANO document.

7. Cornerstone Activities

a. Evaluation Programs

Members host regular INPO evaluations of their nuclear plants approximately every two years. Additional evaluative review visits are periodically conducted on corporate support and other more specific areas of plant operation. During these evaluations and reviews, the INPO teams use standards of excellence based on the performance objectives and criteria (POCs), and their own experience and their broad knowledge of industry best practices. This approach shares beneficial industry experience while promoting excellence in the operation, maintenance, and support of operating nuclear plants. Written performance objectives and criteria, developed by INPO with industry input and review, guide the evaluation process and are the bases for identified areas for improvement. The evaluations are performance-oriented, emphasizing both the results achieved and the behaviors and organizational factors important to future performance. The evaluations focus on those issues that impact nuclear safety and plant reliability.

i. Plant Evaluations

Teams of approximately 15 to 20 qualified, experienced individuals conduct evaluations of operating nuclear plants, focusing on plant safety and reliability. In 2006, U.S. utilities received 33 plant evaluations or WANO peer reviews. The evaluation teams are augmented by senior reactor operators, other peer evaluators from different utilities, host utility peer evaluators, and an executive industry advisor. The scope of the evaluation includes the following functional areas:

- operations
- maintenance
- engineering
- radiological protection
- chemistry
- training

In addition, teams evaluate cross-functional performance areas—processes and behaviors that cross organizational boundaries and address process integration and interfaces. The following cross-functional areas are evaluated:

- safety culture
- operational focus
- configuration management
- equipment reliability/work management
- performance improvement (learning organization)
- organizational effectiveness

Team managers, in addition to leading and coordinating team activities, provide a focal point for evaluation of station management and leadership, concentrating on evaluating leadership, organizational effectiveness, safety culture, and nuclear oversight topics.

The performance of operations and training personnel during simulator exercises is included as a key part of each evaluation. Also included, where practicable, are observations of refueling outages, plant startups, shutdowns, and major planned evolutions.

Formal reports of strengths and areas for improvement are provided to the utility, along with a numerical rating of overall plant performance. As part of the 1983 annual INPO Chief Executive Officer (CEO) Workshop, INPO prepared a set of indicators for each nuclear station that reflected station participation in and commitment to INPO programs. This information was provided to each CEO. One of these indicators was an assessment of each station's overall performance based on INPO evaluations and the judgment of INPO team managers and senior management.

With the approval of the Board of Directors, it was decided that an assessment of overall station performance in the context described above would be made after each evaluation and shared privately with the CEO at the exit meeting. Eventually a numerical assessment was developed and each station is now provided an assessment from 1 (Excellent) to 5, which is defined as a level of performance where the margin to nuclear safety is substantially reduced. Such a process reflects the desire of utility managers to know more precisely how their station's performance compares relative to the standards of excellence. It is also in keeping with INPO's responsibility to the individual CEO and to its members for identifying low-performing nuclear plants and for stimulating improvement in performance.

Even though standards for performance have risen substantially over the years, the number of plants in the 1 and 2 categories has remained relatively constant, even as standards of excellence have improved. Additionally, several conclusions can be drawn from evaluations over the years. Excellent plants (category 1) and category 2 plants show strong leadership, are self-critical, do not tolerate complacency, are operationally focused, have exceptional equipment performance, and effectively use training to improve performance. Attributes of category 3 and 4 stations may include leaders not setting high standards, a weak self-critical attitude, weak day-to-day operations, broad equipment problems, and deficient fundamental knowledge and skills in several areas. It has been over a decade since a station has been assessed in the 5 category.

The utility responses to the identified areas for improvement, along with their commitments to specific corrective action, are included in the final report. In subsequent evaluations and other interactions INPO specifically reviews the effectiveness of actions taken to implement these improvements.

In addition to the strengths and areas for improvement provided in the evaluation report, team comments that are subjective are often communicated to the member CEO during the evaluation exit meeting. These comments, often more intuitive, are intended to help utilities recognize and address potential issues before they adversely affect actual performance. Copies of the plant evaluation report are distributed according to a policy approved by the Institute's Board of Directors.

The industry also hosts WANO peer reviews conducted by the WANO-Atlanta Center. These are conducted at each U.S. station approximately every six years and are performed in lieu of an INPO plant evaluation at each station. These peer reviews use a methodology similar to that of plant evaluations, but with teams augmented with international peers.

Numerous improvements have been made in plant safety and reliability as a result of addressing issues identified during evaluations, peer reviews, plant self-assessments and comparison and emulation among plants. The time plants operate versus the amount of time they are shutdown has improved significantly, the frequency of unplanned shutdowns has decreased markedly, and the reliability and availability of safety systems has measurably improved.

ii. Corporate Evaluations

Member utilities that operate multiple nuclear stations request that INPO conduct corporate evaluations on a four- to six-year interval. Corporate evaluations at single nuclear station utilities are conducted only when requested by the utility or when deemed necessary by INPO. The INPO-conducted corporate evaluations reflect the important role of the company headquarters in supporting the successful operation of plants within a multi-site fleet. Three corporate evaluations were conducted in 2006.

A tailored set of performance objectives and criteria define the scope of activities and the standards for corporate reviews. The corporate review focuses on the impact that the corporation has on the safe operation of its nuclear plants. Areas typically evaluated during a corporate review include the following:

- direction and standards for station operation, including the organizational alignment, communications, and accountability for strategic direction, business/operational plans, and performance standards
- governance, monitoring and independent oversight of the nuclear enterprise
- support for emergent station issues and specialty areas such as major plant modifications, including replacement of steam generator and reactor vessel heads and station upgrades to extract more power and efficiency
- performance of corporate functions such as human resources, industrial relations, fuel management, supply chain management and other areas, as applicable to the nuclear organization

INPO members use corporate evaluation results to help ensure that essential corporate functions are providing the leadership and support necessary to achieve and sustain excellent nuclear station performance. As a consequence of responding to issues identified during corporate evaluations, appropriate resources and leadership attention have often been re-focused on improving station safety and reliability.

iii. Other Review Visits

The industry also utilizes INPO to conduct review visits in selected industry-wide problem areas to supplement the evaluation process. These visits are typically initiated by INPO and are evaluative in nature. The results of review visits may be used as an input to the evaluation process. The visits are designed as in-depth reviews of technical areas that could have a significant impact on nuclear safety and reliability. Such areas include critical materials issues that affect the structural integrity of the reactor coolant system and reactor vessel internals of both boiling water reactors (BWRs) and pressurized water reactors (PWRs). Other areas include components or systems that are significant contributors to unplanned plant transients and forced loss rate, including main generator and transformer, switchyard and electrical grid components. In 2006, 54 review visits were conducted.

Similar to plant evaluations and peer reviews, review visits evaluate station performance against the INPO performance objectives and criteria to a standard of excellence. In some areas, such as materials, industry groups have developed detailed technical guidance that each utility has committed to implement. The materials review visit team's also use this guidance to ensure program implementation is consistent and complete and meets the industry-developed standards.

Review visit teams are led by an INPO employee and include industry personnel who have unique expertise in the area of the review that is not typically within the skill set of INPO members of plant evaluation or peer review teams. Review visits typically include a week of preparation followed by a week on site.

Review visit reports contain beneficial practices and recommendations for improvement. These reports are sent to the station site vice president. For potential safety-significant recommendations, INPO may request a response. Each of the recommendations that require a response is followed up by the subsequent plant evaluation or WANO peer review team to ensure identified issues are addressed. Periodically, INPO compiles the beneficial practices and recommendations and posts the information on the secure member Web site to allow all utilities to benchmark their programs.

Details of selected review visit programs are discussed below.

Pressurized Water Reactor (PWR) Steam Generator Review Visits

Steam generator review visits were initiated in 1996. In the early 1980s, steam generator tube leaks and ruptures were significant contributors to lost power generation and were the cause of several events deemed significant by INPO. The industry as a whole became more sensitive to the importance of steam generator integrity as a contributor to core damage frequency analysis. The industry, through the Electric Power Research Institute (EPRI) Steam Generator Management Program, developed and maintained detailed guidance on qualification and implementation of nondestructive testing techniques, engineering assessments of steam generator integrity, and detection and response to tube leakage and ruptures. In mid-1995, the industry requested INPO to help improve the prevention and detection of steam generator degradation by verifying correct and consistent implementation of industry guidance at individual stations and to evaluate steam generator management programs to standards of excellence. As a result, the steam generator review visit program was established. Other review visits that were initiated later used the steam generator review visit process as a model.

Steam generator review visits focus on steam generator in-service inspection and repair, use of qualified personnel and techniques for eddy-current examinations of tubes, tube plugging procedures, assessment of current inspection results, chemistry conditions that affect steam generators, and steam generator primary-to-secondary leak detection, monitoring, and response.

In general, steam generator management programs have steadily improved and are implemented effectively, as evidenced by the lack of safety-significant events and events that contribute to lost generation. Steam generator replacements have also contributed to overall improved performance. Consequently, few significant issues are currently identified during steam generator review visits. However, the review visits have identified a need for improved timeliness in implementing industry-developed or revised guidance, and improved rigor in inspecting for, evaluating, and retrieving loose parts.

Boiling Water Reactor (BWR) Vessel and Internals Review Visits

In 2001, BWR vessel and internals review visits were initiated at the request of the industry. In the early 1990s, vessel and internal issues caused by intergranular stress corrosion cracking became significant contributors to lost power generation. Safety concerns associated with this degradation prompted the industry to form the EPRI BWR Vessel and Internals Project. This group developed detailed guidance to address inspection, mitigation, repair, and evaluation of degradation for components important to safety and reliability.

BWR vessel and internals review visits focus on nondestructive examinations, inspection scope and coverage; evaluation of crack growth and critical flaw size;

effectiveness of strategies to mitigate intergranular stress corrosion cracking, including hydrogen addition and application of noble metals; and chemistry conditions that effect long-term health, including potential affects on fuel.

Industry overall performance has improved as evidenced by the lack of safety-significant events and events that contribute to lost generation. However, an analysis of review visits during 2005 identified some noteworthy shortfalls in BWR vessel internals program implementation. INPO presented this information to the BWR Vessel and Internal Project Executive Committee and summarized the adverse trend in a letter to the industry. Considerable improvement was noted during the review visits conducted in 2006, particularly in management oversight and the reduction of program deviations.

PWR Primary Systems Integrity Review Visits

PWR primary systems integrity review visits were initiated in 2003. Since the early 1980s, a number of notable events associated with leakage from PWR borated systems have resulted in additional oversight by the NRC and INPO. In some cases, these leakage events have resulted in corrosion and wastage of reactor coolant system pressure-retaining components. The EPRI PWR Materials Reliability Program was formed as an industry initiative in 1998 to develop guidance to address materials degradation issues. Because of the importance of primary systems integrity, INPO began performing in-depth review visits focused on boric acid corrosion control and Alloy 600 degradation management, including dissimilar metal butt welds.

PWR primary systems integrity review visits focus on the inspection and evaluation of reactor coolant system pressure-retaining components; the qualification of nondestructive examination personnel and techniques; and the monitoring and response to unidentified leakage in containment, including management guidance and operator procedures.

As a result of these industry efforts, performance appears to be improving. Stations are identifying degradation before leakage occurs. Stations have also more aggressively pursued indications of minor unidentified leakage. Alloy 600 dissimilar metal butt weld examinations and/or mitigation will continue over the next few years as the enhanced industry-defined actions continue to be performed and inspections take full advantage of improved nondestructive examination techniques.

Transformer, Switchyard, and Grid Review Visits

Transformer, switchyard, and grid review visits were initiated in 2004. Many transformers have been in service for numerous years and are often the original station transformers. Considering this aging—along with the recent trends of power uprates, license renewal and increased loading—these transformers may be operating with a reduction in margin. With this decrease in margin the need for increased monitoring, trending, and predictive and preventive maintenance became apparent in order to identify and mitigate potential problems before they result in on-line failure. Additionally, a series of events in 2003, including the blackout in the northeastern United States and parts of Canada, reinforced the need for nuclear plants to have reliable offsite power. There was also renewed focus on how nuclear plant conditions and electrical power system line-ups to the switchyards can help minimize and prevent grid events.

The transformer, switchyard, grid review visits focus on communication and coordination with grid operators, including formal agreements and implementing procedures, adequacy of offsite power, and predictive and preventive maintenance for large power transformers and switchyard equipment.

While isolated events related to switchyards, transformers, and grids continue to occur, additional rigor in maintenance and interfaces has shown noted improvement. Additionally, sharing of information and lessons learned among utilities is resulting in implementation of barriers to prevent future events. It is expected that as the review visits continue, the number and significance of events will be reduced.

Main Generator Review Visits

Main generator review visits were initiated by the industry in 2004 following identification of an adverse trend involving failures of main generators and related support systems. The number of main generator failures that hindered power production and/or extended an outage had doubled from 1999 to 2003. During this time, unplanned scrams caused by generator problems increased to around five per year from the previous average of two per year. The most frequent generator maintenance challenges involved support systems such as stator cooling water and the exciter and often included human performance elements. As a result of industry identification of this adverse performance, INPO began conducting main generator review visits to focus on improving the performance of main generators.

Main generator review visits focus on performance and condition monitoring to ensure the generator is operating within design parameters and to detect early signs of equipment degradation, preventive and condition-based maintenance to address the effects of aging, outage planning to ensure that important main generator work is performed, and knowledge and skill levels of personnel to ensure proper workmanship.

The adverse trend of events in 2003 and 2004 has stabilized and may be beginning to improve. Proactive monitoring of main generator and support systems has improved. For example, one station accelerated plans for rotor replacement to repair excessive hydrogen leakage after the significance of the leakage was determined.

b. Training and Accreditation Programs

The U.S. commercial nuclear electric industry strongly believes that proper training of plant operators, maintenance workers, and other support group workers is of paramount importance to the safe operation of nuclear plants. As a result, the industry established the National Academy for Nuclear Training in 1985 to operate under the responsibility of INPO. An INPO executive serves as the Academy's executive director. The industry formed the Academy to focus and unify high standards in training and qualification and to promote professionalism of nuclear plant personnel. The Academy integrates the training-related activities of all members, the independent National Nuclear Accrediting Board, and the Institute. Through INPO, the Academy conducts seminars and courses and provides other training and training materials for utility personnel, as well as manages an industrywide educational assistance program.

All U.S. nuclear plants have accredited training programs and are branches of the Academy. A utility becomes a member of the Academy when all its operating plants have achieved accreditation for all applicable training programs.

INPO interacts with all members in preparing for, achieving, and maintaining accreditation of training programs for personnel involved in the operation, maintenance, and technical support of nuclear plants. These interactions, similar in content to the accreditation efforts of schools and universities, include evaluations of accredited training programs, activities to verify that the standards for accreditation are maintained, and assistance at the request of member utilities. Written objectives and criteria that are jointly developed with the industry guide the accreditation process.

Unlike our role in the plant evaluation and assessment process described above, INPO is not the accrediting agency. The independent National Nuclear Accrediting Board examines the quality of utility training programs and makes all decisions with respect to accreditation. If training programs meet accreditation standards, the Board awards or renews accreditation. If significant problems are identified, the Board may defer initial accreditation, place accredited programs on probation, or withdraw accreditation. Accreditation is maintained on an ongoing basis and is formally renewed for each of the training programs every four years. The National Nuclear Accrediting Board, comprised of training, education and industry experts, is convened and supported by INPO, but it is independent in its decision-making authority. Board members are selected from a pool of individuals from utilities, post-secondary education, nonnuclear industrial training, and NRC nominations. Each Board consists of five sitting members, with a maximum of two utility representatives to assure Board independence from the nuclear industry.

The accreditation process is designed to identify strengths and weaknesses in training programs and to assist in making needed improvements. The process includes self-evaluations by members, with assistance provided by INPO staff; on-site evaluations by teams of INPO and industry personnel; and decisions by the independent National

Nuclear Accrediting Board. Members are expected to seek and maintain accreditation of training programs for the following positions or skill areas:

- shift managers
- senior reactor operators
- reactor operators
- nonlicensed operators
- continuing training for licensed personnel
- shift technical advisors
- instrument and control technicians and supervisors
- electrical maintenance personnel and supervisors
- mechanical maintenance personnel and supervisors
- chemistry technicians
- radiological protection technicians
- engineering support personnel

In 2002, the industry updated the accreditation objectives to place additional emphasis on training for performance improvement. It was recognized that in striving for excellence, training must be an integral part of each plant's business strategy and daily operations to ensure a highly trained workforce. This approach strengthens the link between the analysis of performance gaps and the training that results in tangible improvements in people and plant activities. The five-step systematic approach to training remains the essential tool for providing training that is results oriented. Both line and training organizations are expected to work together to analyze performance gaps and to design, develop and deliver training that improves knowledge and skills to measurably improve plant performance. Such an approach to improving worker knowledge and skills contributes to high levels of safety as seen in industry gains in equipment reliability, safety system availability, collective radiation exposure, worker safety, as well as fewer events. The role of training will continue to be vital in coming years as many experienced workers retire and new workers enter the workforce.

In 2006, the National Nuclear Accrediting Board renewed accreditation for 148 of 160 training programs presented by 27 member stations. Twelve programs at 2 stations were placed on six-month probation and required to upgrade their training programs. After considerable corrective actions and investment, both stations were successful in having their programs' accreditation renewed following the probation period and after presenting their improvements to the Accrediting Board.

While the accreditation process is independent of the NRC, it is recognized and endorsed by the NRC as a means for satisfying regulatory training requirements. In its *Annual Report on the Effectiveness of Training in the Nuclear Industry* the U.S. Nuclear Regulatory Commission noted that, "Monitoring the INPO managed accreditation process continued to provide confidence that accreditation is an acceptable means of ensuring the training requirements contained in 10CFR50 and 10CFR55 are being met." In addition, the NRC assessment of the accreditation process indicates that continued accreditation remains a reliable indicator of successful systematic approach to training implementation and contributes to the assurance of public health and safety by ensuring that nuclear power plant workers are being trained appropriately.

i. Training and Qualification Guidelines

The Academy develops and distributes training and qualification guidelines for operations, maintenance, and technical personnel. These guidelines are designed to assist the utility in developing quality training programs and in selecting key personnel.

Training and qualification guidelines are revised and updated periodically to incorporate changes to address industry needs and to take into account lessons learned from other INPO programs such as evaluations, accreditations, events analyses, working meetings, and workshops. These training and qualification guidelines provide a sound basis for utility training programs.

ii. Courses and Seminars

The industry benefits extensively from courses and seminars that the Academy conducts to help personnel better manage nuclear technology, more effectively address leadership challenges, and improve their personal performance. In 2006, nearly 1,000 industry employees, including many international representatives, participated in more than 70 courses and seminars. Examples of courses and seminars conducted are as follows:

- Goizueta Director's Institute (focused on the directors of member Boards)
- Chief Executive Officer Seminar
- Reactor Technology Course for Utility Executives
- Senior Nuclear Executive Seminar
- Senior Nuclear Plant Management Course
- Human Performance Fundamentals Course
- Event Investigation Training
- High Performance Teamwork Development
- professional development seminars for operations shift managers, operations supervisors, maintenance supervisors, engineering supervisors, radiation protection and chemistry supervisors, and training supervisors
- seminars for new plant managers and for new managers in operations, radiological protection, chemistry, maintenance, engineering, and training

INPO, in partnership with the Goizueta Business School of Emory University, conducts "The Impact of the Governance Revolution on the Nuclear Power Industry," a nuclear education course for directors in the nuclear industry. Since its inception in 2006, the program has attracted 84 participants from member and international utilities.

In February 2006, the National Academy for Nuclear Training e-Learning (NANTeL) system was launched. Using web-based technologies allowing distance learning, NANTeL training includes courses and proctored examinations for plant access, radiation worker, human performance, and industrial safety qualification to industry standards. By July 2006, all member utilities had agreed to participate in the system by accepting generic training and updating the industry's Personnel Access Data System for training course completions. The system offers 90 generic and site-specific training courses. By June 2007, more than 28,000 industry workers had used the system, completing nearly 120,000 courses.

c. Analysis and Information Exchange Programs

The analysis and information exchange programs improve plant safety by identifying the causes of industry events that may be precursors to more serious events. Stations are required to share operating experiences and lessons learned with INPO, which then analyzes and rapidly communicates the information to the industry through a variety of methods and products. In addition, INPO analyzes a variety of operational data to detect trends in industry performance and communicates the results to the industry.

INPO operates and maintains extensive computer databases to provide members and participants ready access to information on plant and equipment performance and operating experience. These databases are accessible from INPO's secure member Web site. For example, the industry uses Nuclear Network®, a worldwide internet-based communication system, to exchange information on the safe operation of nuclear plants. The World Association of Nuclear Operators also uses Nuclear Network® as a primary means for communicating and exchanging operating experience among its members and regional centers.

i. Events Analysis Program

INPO reviews and analyzes operating events from both domestic and international nuclear plants through its Significant Event Evaluation and Information Network (SEE-IN) Program. The program is designed to provide in-depth analysis of nuclear operating experience and to apply the lessons learned across the industry. Events are screened, coded, and analyzed for significance; and those with generic applicability are disseminated to the industry in one or more of the following forms, beginning with events of greatest importance:

- Significant Operating Experience Reports (SOERs)
- Significant Event Reports (SERs)
- Significant Event Notifications (SENs)

Members support the events analysis program by providing INPO with detailed and timely operating experience information. Operating experience information is freely shared among INPO members. The U.S. industry submits more than 2000 operating experience entries every year, or about 30 to 40 per station. These entries enable a single station to multiply its experience base for identifying problems. This experience base includes safety systems, which have similar components across many stations. For example, one station recently discovered scoring of a cylinder on an emergency diesel generator (EDG) that could render the EDG inoperable. Other stations were able to use this information to take actions to inspect their EDGs prior to actual equipment malfunction. A key to this success is the timeliness of reporting. Stations typically report events in less than 50 days after the occurrence of an event.

Members are required to evaluate and take appropriate action on recommendations provided in SOERs. During on-site plant evaluations, INPO teams follow up on the effectiveness of each station's actions in response to SOER recommendations. For example, during a recent plant evaluation, team members reviewing SOER recommendations identified a potentially significant transformer problem that likely would lead to catastrophic failure if not corrected in a timely manner. This was avoided because of lessons documented in an SOER. Topics of SOERs in recent years include loss of grid, reactivity management, reactor core designs, transformers, unplanned radiation exposures, and rigging/lifting of heavy loads.

Members should review and take actions as appropriate on SENs, SERs, and other reports provided by INPO. INPO evaluates the effectiveness of utility programs in extracting and applying lessons learned from industry-wide as well as station internal operating experience.

All operating experience reports since the start of the SEE-IN program are maintained and searchable in databases available on the secure member Web site. This supports members in applying historical lessons learned as new issues are analyzed or activities are planned. INPO also provides "just-in-time" briefing summaries in numerous topical areas in a format designed to help plant personnel prepare to perform specific tasks. These documents provide ready-to-use materials to brief workers on problems experienced and lessons learned during recurring activities.

ii. Other Analysis Activities

Industry operational data from a variety of sources—events, equipment failures, performance indicators, and regulatory reports—are analyzed to detect trends in industry performance. Results of analyses are communicated to the industry. One method to communicate trends is through the use of Topical Reports. These documents typically review events and other data over a period of years to summarize performance trends and causes and suggest actions. Subjects of recent Topical Reports include fuel reliability, foreign material intrusion, intake cooling blockage, large motor failures, and contractor personnel performance. Stations use these reports to assess their performance and identify improvements. In addition, individual plant performance data is analyzed, with results used in support of other INPO activities such as evaluations and assistance.

iii. Nuclear Network® System

Nuclear Network is an international electronic information exchange for sharing nuclear plant information. It is the major communication link for the Significant Event Evaluation and Information Network (SEE-IN) and the WANO event reporting system. Operating experience information, significant event reports, and other nuclear technical information are transmitted by the system.

The system includes a special dedicated method for reporting unusual plant situations. This feature allows the affected utility to provide timely information simultaneously to all Nuclear Network® users—including the U.S. industry, INPO's international and supplier participants, and WANO members—so the affected station does not have to respond to multiple inquiries. In addition, members are therefore promptly informed of problems occurring at one station such that they can implement actions to prevent a similar occurrence.

iv. Performance Data Collection and Trending

INPO operates and maintains a Consolidated Data Entry (CDE) system as a single process by which to collect data and information related to nuclear plant performance. Members provide routine operational data in accordance with the WANO Performance Indicator Program or regulatory requirements on a quarterly basis. This plant data is then consolidated for trending and analysis purposes. Industry-wide data, plus trends developed from the data, is provided to member and participant utilities for a number of key operating plant performance indicators. Members use this data for comparison and emulation, in setting specific performance goals, and in monitoring and assessing performance of their nuclear plants.

In the mid-1980s, the industry worked with INPO to establish a set of overall performance indicators focused on plant safety and reliability. These indicators have gained strong acceptance and use by utilities to compare performance, set targets, and drive improvements. Examples of indicators collected and trended include unplanned automatic scrams, safety systems performance, unit capability factor, forced losses of generation, fuel reliability, collective radiation exposure, and industrial safety accidents.

The industry has established long-term goals for each indicator on a five-year interval, beginning in 1990. The U.S. industry goals for 2010 represent challenging performance targets in these areas. Key performance indicator graphs for U.S. plants are shown in Appendix A.

v. Equipment Performance Data

INPO operates and maintains the Equipment Performance and Information Exchange (EPIX) system, which tracks the performance of equipment important to safety and reliability. The industry reports equipment performance information to EPIX in accordance with established guidance. Member utilities use the data to identify and solve plant equipment performance problems, with the goal of enhancing plant safety and reliability. The information is also used by the Institute for performance trending to identify industrywide performance problems. The data is also available to the Nuclear Regulatory Commission to support equipment performance reviews by the regulator.

d. Assistance Programs

Between evaluations, a station can request and receive assistance in specific problem areas to help improve plant performance. In addition, INPO monitors the performance of member utility stations between evaluations to identify areas in which assistance can be used to improve plant performance or respond to declining performance. The purpose of this monitoring is to identify, as early as possible, stations that exhibit indications of declining performance so that proactive assistance can be provided to help reverse the performance trend. INPO also provides members with comparisons of their plants' performance with overall industry performance in a variety of areas.

A majority of assistance visits to member utilities by INPO personnel and industry peers are at the request of the stations. This assistance is targeted for specific technical concerns, as well as for broader management and organizational issues. While assistance is generally requested by a station, in some cases INPO may suggest assistance in a specific area to stimulate improvements.

Assistance resources are provided using a graded approach that provides a higher priority to those plants that need greater performance improvement. An INPO management senior representative is assigned to each station to facilitate assistance efforts. Station and utility management maintains close liaison with the senior representative to help identify where INPO resources can best be used to address specific issues and help improve overall station performance.

When significant performance shortfalls persist at a station or when performance trends indicate chronic conditions could detract from safe and reliable plant operation INPO will follow a policy of graduated engagement with the member utility. For a nuclear plant that shows either consistently poor performance over several evaluation cycles or if a significant decline in performance between evaluation cycles, the INPO staff will recommend and obtain concurrence from the INPO CEO to include the plant in a special focus category. For plants that need special focus, INPO will establish a Special Focus Oversight Board that will conduct scheduled periodic reviews to determine the effectiveness of station improvement activities and provide rapid feedback. The board membership will normally include both industry and INPO executives.

Documents that describe nuclear safety principles, effective leadership and management practices, and good work processes and practices are provided to assist member utilities. Members help INPO develop these documents and then use them to address specific improvement needs.

Workshops, seminars, working meetings, and other activities are also conducted to assist in the exchange of information among members and to support the development of industry leaders and managers.

INPO facilitates information exchange among member utilities by identifying and cataloging information on a wide range of activities that stations are doing especially well. This information on effective programs and practices is shared with members on request and through a number of other forums. This assistance fosters comparison and the exchange and emulation of successful methods among members.

i. Assistance Visits

Members may request assistance visits in specific areas of nuclear operations in which INPO personnel have experience or expertise. Such visits are normally conducted by INPO personnel and industry peers. For example, if a member requests assistance in some specific aspect of maintenance, INPO will include a peer from another plant that handles that aspect of maintenance particularly well. Written reports that detail the results of the visits are provided to the requesting utility. In most cases, actual methods and plans for improving performance are included as part of the assistance visit.

In 2006, INPO provided 289 assistance visits, with 327 industry peers. Key areas of assistance provided included operational focus, maintenance and work management, engineering programs, chemistry, radiological protection, human performance, and industrial safety. Additional areas of assistance focus added in 2006 include operations fundamentals and organizational effectiveness in response to evaluation results that have indicated that leadership issues are contributing to performance gaps at some stations.

Effectiveness reviews performed by INPO approximately six months after assistance visits show that assistance visits are highly valued by station management and are contributing to improved performance. As an example, one performance indicator INPO uses to trend effectiveness of the assistance programs is the average number of areas for improvement (AFI) identified in an evaluation that are related to similar areas for improvement identified in a previous evaluation. This indicator shows continuous improving performance since 2005..

In addition to assistance visits to stations for specific functional areas during 2006, experienced senior representatives specifically assigned to each station made 157 visits to member stations to interact with station management and to monitor for early signs of performance decline.

ii. Development of Documents and Products

Several categories of documents and other products are designed and developed to help member utilities and participants achieve excellence in the operation, maintenance, training, and support of nuclear plants. Key categories of INPO documents and products are as follows:

- Principles documents address professionalism, management and leadership development, human performance, and other cross-functional topics important to achieving sustained operational excellence. These documents are prepared by INPO with substantial involvement of industry executives and managers. The principles extracted from the documents are used extensively in evaluation and assistance activities.

  The first of the principles documents was *Principles for Enhancing Professionalism of Nuclear Personnel,* which addresses human resource management areas focused on developing nuclear professionals, including personnel selection, training and qualification, and career development. Two supplemental documents—*Management and Leadership Development* and *Excellence in Human Performance*—build on the original document. Utility executives use *Management and Leadership Development* as assistance to identify, develop, assess, and select future senior managers. *Excellence in Human Performance* provides practical suggestions for enhancements in the workplace that promote excellent human performance.

  In 1999, INPO distributed *Principles for Effective Self-Assessment and Corrective Action Programs*. This document emphasizes the importance of establishing a self-critical station culture and identifying the key elements of effective self-assessment and corrective action programs.

- Guideline documents establish the bases for sound programs in selected areas of plant operation, maintenance, and training, as well as cross-functional areas of direct importance to the operation and support of nuclear stations. Guidelines assist members in meeting the objectives used in evaluations and accreditation. The guidelines are recommendations based on generally accepted industry methods. They are not directives, but are intended to help utilities maintain high standards. Although member utilities do not have to follow each specific method described they are expected to strive to meet the intent of INPO guidelines.

- Good practices, work process descriptions, Nuclear Exchange documents, and other documents are provided to assist members. Typically, these documents are developed from programs of member utilities and INPO's collective experience. They are synthesized into a document by the INPO staff, with industry input and review. In general, the documents define one method of meeting INPO performance objectives in specific areas. It is recognized that other programs or methods may be as good or better. Utilities are encouraged to use these documents in developing or improving programs applicable to their plants. These documents can be used in whole or in part, as furnished, or modified to meet the specific needs of the plant involved.

Various other documents are produced, such as analysis reports and special studies, as needed. Other assistance products include lesson plan materials, computer-based and interactive video materials, videotapes, and examination banks. National Academy for Nuclear Training magazine *The Nuclear Professional* published quarterly, features how plant workers have solved problems and made improvements that enhanced safety.

iii. Workshops and Meetings

INPO sponsors workshops and working meetings for specific groups of managers on specific technical issues as forums for information exchange. This exchange provides an opportunity for INPO and industry personnel to discuss challenges, performance issues, and areas of interest. It also allows individuals from members and participants to meet and exchange information with their counterparts. In 2006, nearly 1,200 industry personnel participated in more than 70 meetings and workshops.

8. Other Key Initiatives and Focus Areas

The industry continuously provides feedback to INPO on issues that affect station operation. Many INPO initiatives are based on industry trends and important focus areas. Some of the initiatives that are underway or being developed are described below.

a. Fuel Reliability

In 2005, U.S. nuclear utilities established a goal of achieving and sustaining zero fuel-cladding failures. While overall fuel performance has been significantly improved over the past 20 years, cladding leaks continue to occur, with a small percentage of units operating with one or more leaking fuel rods at any given time. These leaks are well within the regulatory limits set by the NRC but do not meet the standards of excellence set by the U.S. industry and INPO. Domestic and international utilities, fuel vendors, EPRI, and INPO are working together to improve fuel performance by addressing each of the primary causes of cladding failures. The industry and INPO used operating experience to develop a series of guidelines for improving fuel reliability. The guidelines include subjects such as foreign material mitigation, corrosion and crud deposition, and fuel surveillances. The first review visit to evaluate utility strategies for achieving excellent fuel performance was conducted in May 2007.

b. Operator Fundamentals

Weaknesses in operator fundamentals were identified through the review of several industry events in 2004 and early 2005. Additionally, approximately 55 percent of INPO areas for improvement written in the operations area during this same period focused on operator fundamentals. Industry events were analyzed using a Significant Event Report, and major causes were revealed, including shortfalls in human performance, weaknesses in operator training, overreliance on processes and procedures to resolve performance problems and a reduction in operator experience.

An industry meeting of operations and training managers was held in July 2005 to present the performance weakness and identify some actions to resolve the problem. The first item achieved was agreement on an industry-wide definition of operator fundamentals. Focus groups, composed of operations managers who represented each company or organization, were subsequently formed to engage the industry in identifying and addressing the causes of the weaknesses identified. The overall goal is to reduce the number of unplanned scrams and INPO-classified significant events and plant transients, as well as reducing safety system unavailability, caused by weaknesses in operator fundamentals.

Actions have been taken to date in each of the four focus areas: improving operating crew human performance, improving operator fundamentals training, addressing issues in Emergency Operating Procedure use, and providing assessment guidance for the industry.

Operator fundamentals continue to be an integral part of operations leadership seminars, working meetings and workshops. Seventeen operator fundamentals assistance visits were completed in 2006 with 15 scheduled for 2007. An industry benchmarking meeting on the training of operator fundamentals was held in June 2007.

c. Emergency Preparedness

In 2007, INPO reestablished its emergency preparedness section to help the industry continue to improve its readiness to respond to radiological and other site emergencies. This initiative was begun in response to a need identified in 2002 by the Nuclear Energy Institute (NEI) and a subsequent industry review led by INPO of 25 plants over three years. During these visits, opportunities for improvement were identified that included more timely and accurate classifications, notifications, and protective action recommendations; strengthened drill programs; and increases in emergency response organization staffing.

The review visits that began in May 2007 will address emergency plan implementation and help members identify and prepare for radiological emergency situations in advance by focusing on emergency plan performance fundamentals and industry best practices identified during the previous three years. Similar to other review visits, performance objectives and criteria will be used as the bases of the reviews. In addition, INPO is revising its emergency planning guidelines and performance fundamentals as an aid to the industry by working with NEI and leaders in emergency planning. Stations will host the review visits during station emergency plan drills and critiques. In addition to reviewing the drill, INPO will perform an evaluation of other programmatic areas. Review teams will identify gaps to excellence in performance and make recommendations for improvement. A summary of the recommendations for improvements and beneficial practices will be posted on the secure member Web site and communicated widely.

d. New Plant Design and Construction

For many years, no new nuclear plants have been built in the U.S. However, as a result of the need for additional power, concerns over the environmental effects of carbon-based fuels, the streamlined licensing process, and financial incentives provided by the 2005 Energy Policy Act, U.S. utilities are once again planning new plant construction. To support this effort, in 2006 INPO formed a New Plant Deployment group to engage with the nuclear industry and plan for INPO's involvement though application of its cornerstone programs.

In 2006, INPO updated a report entitled *Operating Experience to Apply to Advanced Light Water Reactors,* which includes the lessons learned from significant events, to include experience from operations and maintenance activities that should be addressed in design of new plants. This document is being used by INPO participant plant designers and by utility groups in their review of the new designs.

INPO also engaged utilities planning to submit license applications in a series of benchmarking trips in 2006 and 2007 to international utilities and plant designers in France and Japan, an aircraft company, and a coal plant with advanced control systems. These trips provided an opportunity to learn more about new technologies that have evolved since the last period of nuclear plant construction, most notably in plant standardization, computerized man-machine interface, and modular construction. The information gathered from these trips is being promulgated in a report to INPO members.

To support plans for training the new plant workforce, INPO prepared a report entitled *Initial Accreditation of Training Programs for New Reactors,* which provides a process for achieving accreditation of training programs prior to implementation. In addition, INPO will be reviewing the guidelines of the National Academy for Nuclear Training and several technical process description documents to make any necessary adjustments for the new plant environment.

In the future, INPO plans to provide assistance and review visits to its member nuclear suppliers and utilities as the design and construction phases evolve. These may include startup readiness reviews prior to plant operation and international benchmarking efforts.

e. Staffing

The U.S. nuclear electric generation industry expects a significant number of experienced workers to retire over the next five years. INPO is working closely with the U.S. nuclear utilities and the Nuclear Energy Institute on a range of strategies to recruit and retain new workers, train new employees, and help educate the next generation of workers. In addition, the industry and INPO have intensified their recruiting efforts to address ethnic diversity issues, expand opportunities for women, and attract talented employees needed in specific professions, such as nuclear engineering and health physics.

Recent surveys conducted by the Nuclear Energy Institute indicated that within the next five years, up to 27 percent of all workers in the nuclear energy sector will be eligible for retirement and that another 13 percent may be lost for other reasons. Key suppliers to the nuclear energy industry, which include architect/engineering firms, construction firms, fuel suppliers, and reactor manufacturers, anticipate that 32 percent of their workers will be eligible to retire by the end of 2009.

There are some signs of near-term shortages in key groups of workers including operators, operator instructors, radiation protection professionals, outage workers, and nuclear engineers. For example, some projections indicate that in 10 years, demand will be more than double the supply of radiation protection professionals. Adding to the challenge, nuclear engineers—like all workers in the nuclear energy industry—require extensive education and training. While enrollments in nuclear engineering programs have more than tripled since 1998 to about 1,800 in 2006, new university programs are needed to prepare the next generation of nuclear engineers.

INPO evaluates staffing and workforce planning routinely during plant and corporate evaluations and shares identified strengths and areas for improvement with the industry. As part of the accreditation process, training programs are reviewed to ensure they support station staffing plans for the future. In addition, INPO has frequently shared station strengths broadly with the industry in articles in nuclear industry periodicals, on the secure member Web page, and during industry workshops focused on knowledge transfer and retention.

The industry is pursuing initiatives to supplement companies' internal training and development programs aimed at growing the number of qualified technicians and craft personnel. Several companies have partnered with local technical and community colleges to develop these workers, including 28 separate programs involving companies engaged with a local community college or technical school. For example, FirstEnergy Corporation joined with several community colleges in Ohio to train future workers in skilled crafts. In a similar effort, AmerenUE's Callaway plant in Missouri partnered with Linn State Technical College and the University of Missouri-Columbia to offer an associate's degree program to train future radiation protection workers and nuclear technicians. This program has been expanded to include industry and community college partnerships in other states, including Arizona, California, Texas, and Virginia.

The National Academy for Nuclear Training manages an industry educational assistance program, which is administered by INPO, to provide undergraduate scholarships and graduate fellowships for students majoring in nuclear or nuclear-related engineering or power generation health physics programs. Scholarship and fellowship recipients are encouraged to pursue careers in the nuclear power industry. For 2007-2008, the budget of $850,000 will fund 120 scholarships and 22 graduate fellowships. For the five years

2002-2006, 56 percent of scholarship students and 75 percent of fellowship students accepted jobs in the U.S. commercial nuclear power industry.

The U.S. government is also supporting efforts in this area. In 2006, the U.S. Department of Energy awarded grants totaling $27 million to 37 universities to educate technical specialists in nuclear power generation, medicine, and scientific research. Although funding for university nuclear engineering programs has been uneven over the past decade, the federal government has become more aware of the industry's staffing challenges. In addition, the nuclear power industry provides matching grants to universities to support research and other educational programs, and many companies contribute generously to universities and colleges directly.

9. Relationship With World Association of Nuclear Operators

U.S. nuclear utilities are represented in the World Association of Nuclear Operators (WANO) through INPO, which formally serves as the ordinary member. As such, INPO coordinates the U.S. nuclear utilities' activities in WANO. INPO also provides operational support and facilities for the WANO-Atlanta Center (WANO-AC), one of the four WANO global regional centers. The WANO-AC Governing Board usually appoints an INPO executive to serve as the Atlanta Center director.

INPO provides WANO-AC with resources in terms of seconded staff to support the center's day-to-day operation. Personnel from INPO's technical staff support WANO activities such as peer reviews and technical support missions. To minimize duplication, INPO also provides WANO-AC with administrative support services, such as payroll, computer support, and employee benefit administration.

INPO supports the full range of WANO activities and programs and facilitates direct contacts between U.S. and other WANO members. Such activities and programs include the following:

- Peer reviews that are conducted at the request of INPO members by WANO teams of U.S. and international peer reviewers who identify strengths and areas for improvement associated with nuclear safety and reliability. When conducted at a U.S. INPO member plant, a WANO peer review is performed in lieu of an INPO plant evaluation.
- WANO exchange of operating experience information, which provides detailed descriptions of events and lessons learned to member utilities worldwide.
- Performance indicator data that is collected, trended, and disseminated to facilitate goal-setting and performance trending and to encourage emulation of the best industry performance.
- Technical support missions, which are conducted to allow direct sharing of plant operating experience and ideas for improvement.
- Professional and technical development courses, seminars, and workshops, which are designed for enhancing staff development and sharing operating experience.

At INPO's request, WANO-AC provides management and support services for the conduct of the International Participant Program. This program facilitates the direct exchange of information and experience through INPO access to the secure member Web site, seminars, workshops, INPO documents, and exchange visits. International participants may chose to have liaison engineers located in the INPO offices for training and professional development to assist in the exchange of information. The international participants also provide INPO with advice on a wide range of nuclear-safety-related issues through membership on the International Participant Advisory Committee. The INPO International Participant Program is smaller in scope and complementary to the broader industry participation in WANO.

The U.S. industry and INPO receive a substantial benefit through their relationship with WANO and the international nuclear community. Many improvements have been implemented in the U.S. based on lessons learned from more than 340 units that exist outside of the U.S. INPO works to remain fully aware of trends in the global nuclear industry and continues to strengthen relationships in this area.

10. Conclusion

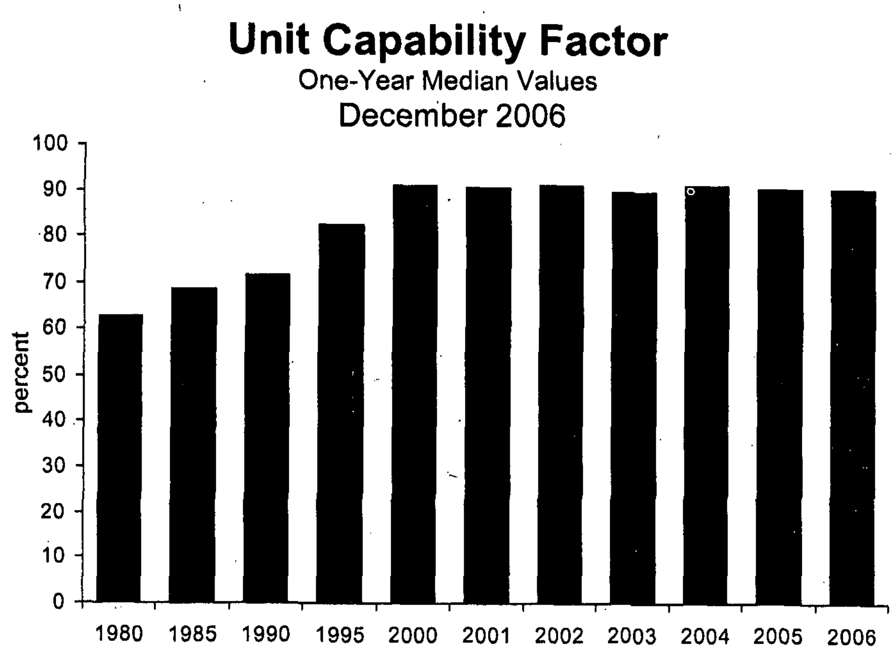
The commercial nuclear electric power industry in the U.S. has made substantial, sustained and quantifiable improvement in plant safety and performance during the nearly three decades since the Three Mile Island event. The leaders who guided this industry over decades of challenge and change showed great insight when they recognized the need for an unprecedented form of industry self-regulation through peer review. The industry members acknowledged that nuclear energy would remain a viable form of electric power generation only if it could ensure the highest levels of nuclear safety and reliability – the achievement of excellence – in nuclear electric generating plants. It responded to this challenge by creating an independent oversight process of the highest integrity and requiring of themselves an uncompromising commitment to the standards and ethical principles that are essential to success.

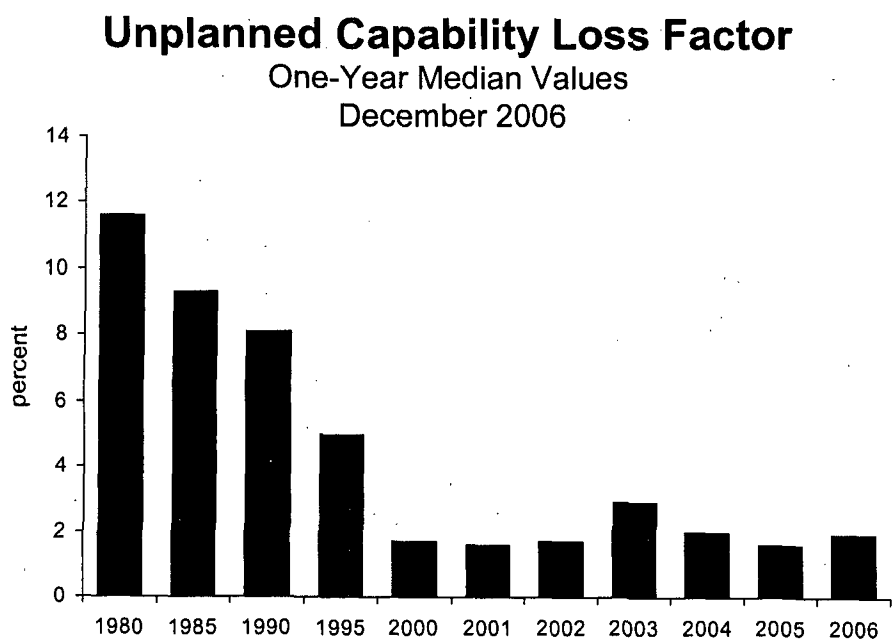
This insight and commitment to integrity has provided the foundation for a unique, sustained partnership between INPO and its members. INPO is pleased to serve as an essential element of an industry that has raised its standards and improved its performance in nearly every aspect of plant operation. We at INPO do not take credit for this success but we do take pride in our contribution to it.

But we also recognize that the pursuit of excellence is a continuing journey, not a destination. The U.S. nuclear industry, as it evolves and advances, will continue to encounter situations that challenge both people and equipment in a business environment that is competitive, complex, and increasingly global in character.

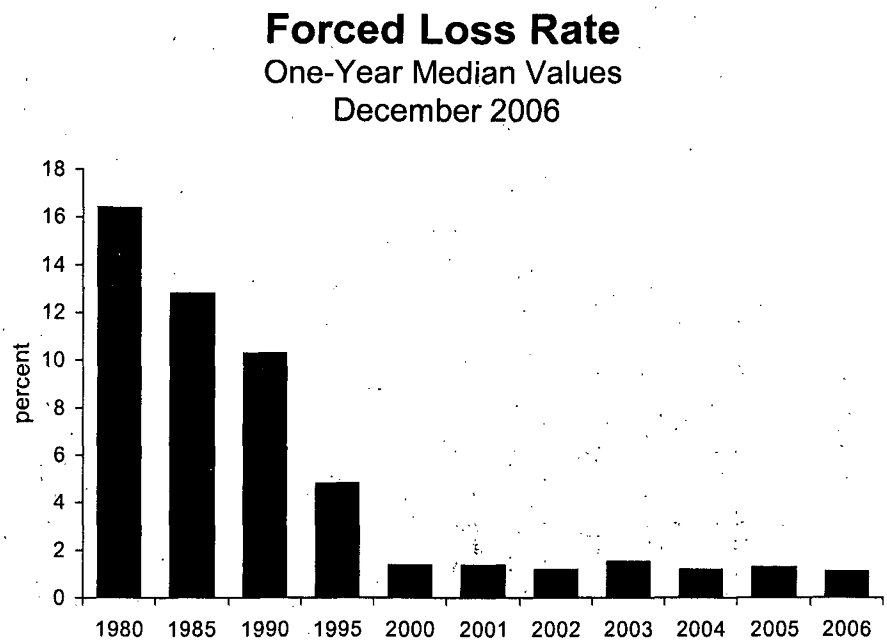
These challenges, while demanding, are not insurmountable. The U.S. commercial nuclear electric generating industry, in partnership with INPO, will continue the tradition of both sharing insight and acting with integrity, and in so doing, will continue on the shared journey to ever-higher levels of excellence.

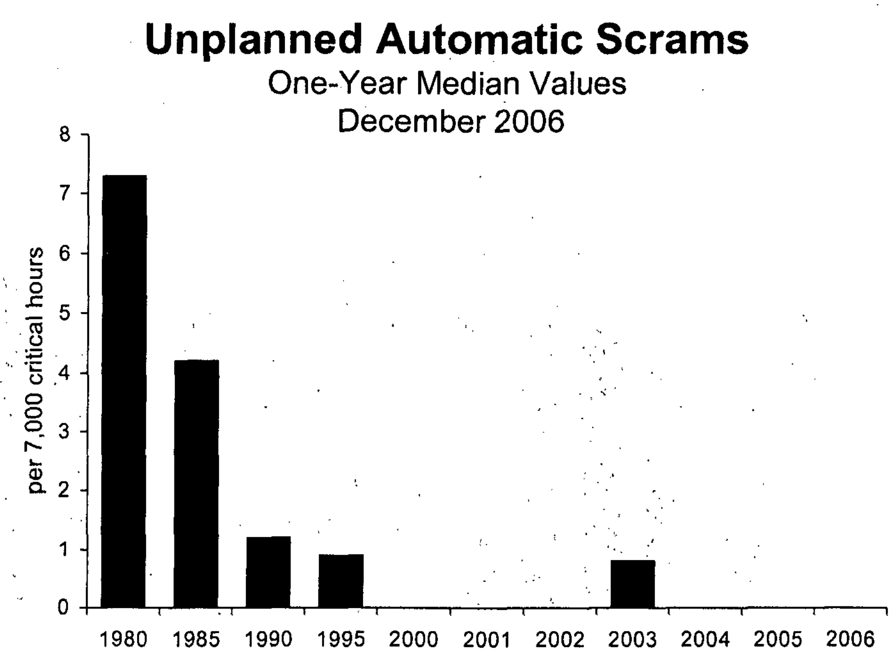
U.S. Nuclear Electric Industry Performance Indicator Graphs





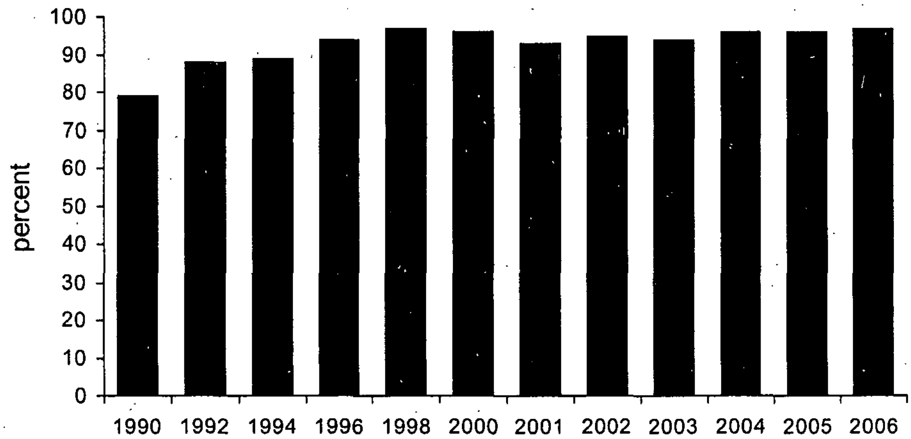
U.S. Nuclear Electric Industry Performance Indicator Graphs



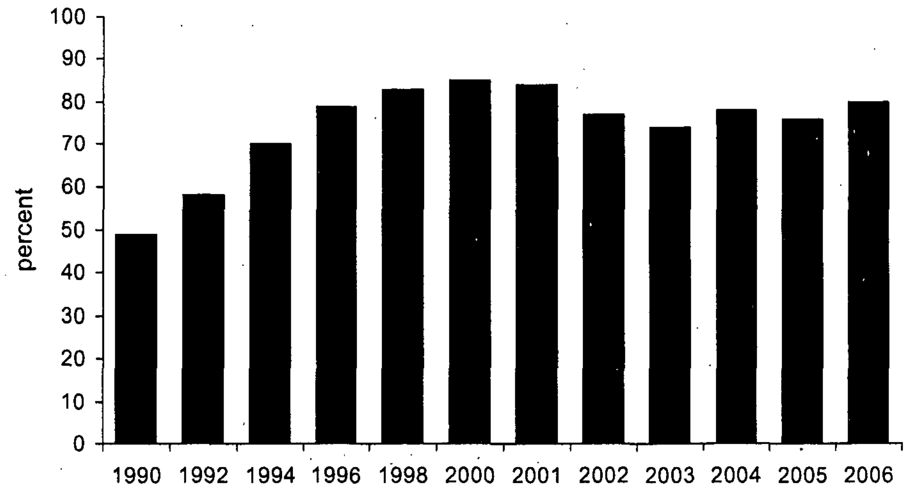


U.S. Nuclear Electric Industry Performance Indicator Graphs

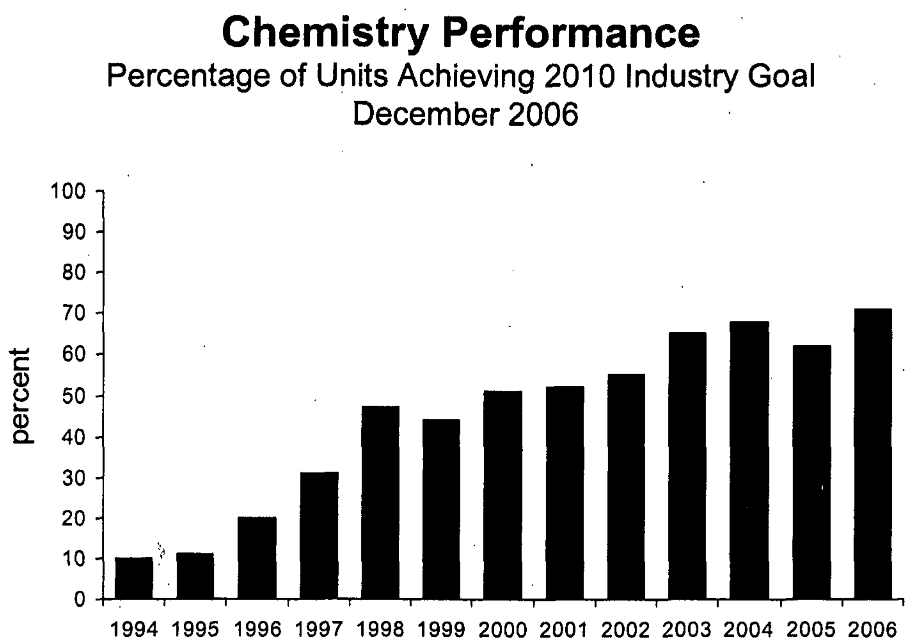
Safety System Performance
Percentage of Systems Achieving 2010 Industry Goal
December 2006

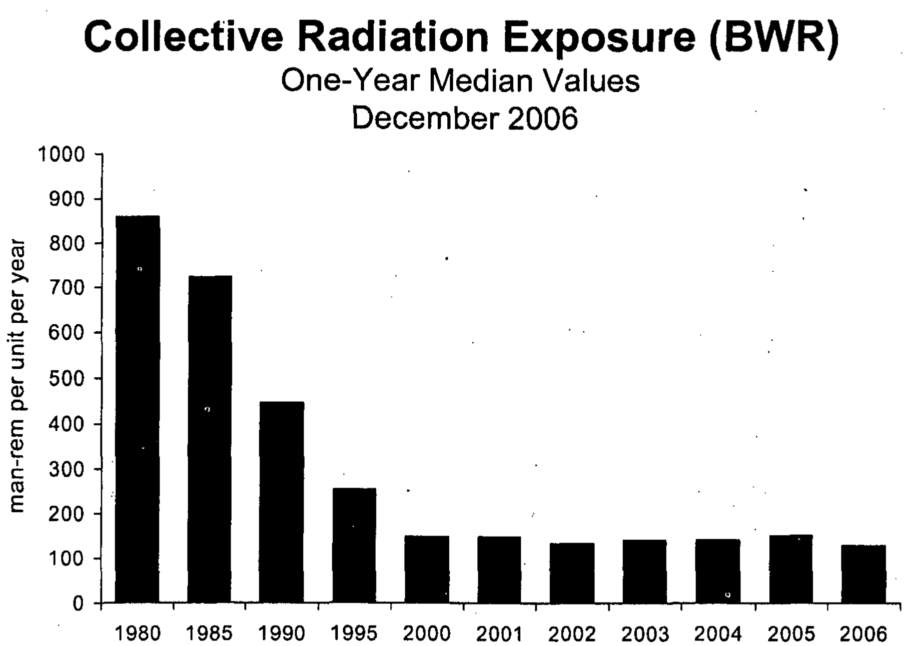


Fuel Reliability
Percentage of Units Reporting Zero Defects
December 2006

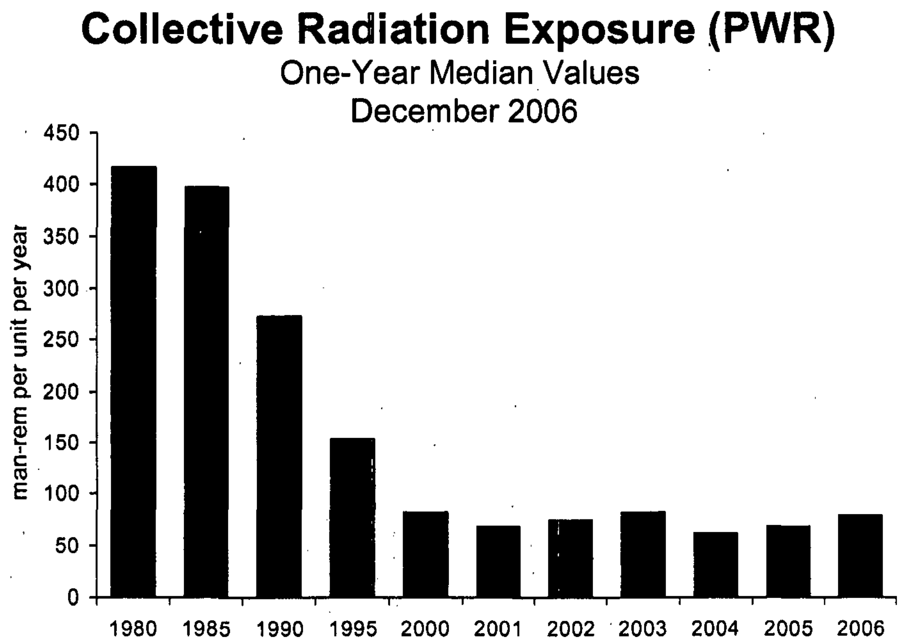


U.S. Nuclear Electric Industry Performance Indicator Graphs





U.S. Nuclear Electric Industry Performance Indicator Graphs



NRC FORM 335 (9-2004) NRCMD 3.7

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG-1650, Rev. 2

2. TITLE AND SUBTITLE

The United States of America Fourth National Report for the Convention on Nuclear Safety

3. DATE REPORT PUBLISHED

MONTH	YEAR
Sept.	2007

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

U.S. Nuclear Regulatory Commission

6. TYPE OF REPORT

7. PERIOD COVERED *(Inclusive Dates)*

Oct. 2004-Sept. 2007

8. PERFORMING ORGANIZATION - NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington DC 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

same as item 8 above

10. SUPPLEMENTARY NOTES

This report is an update to NUREG-1650, Rev. 1

11. ABSTRACT *(200 words or less)*

The United States Nuclear Regulatory Commission has updated NUREG-1650, Rev. 1, "The United States Third National Report for the Convention on Nuclear Safety," issued September 2004, and will submit this report for peer review at the fourth review meeting of the Convention on Nuclear Safety at the International Atomic Energy Agency in April 2008. This report addresses the safety of land-based commercial nuclear power plants in the U.S. It demonstrates how the U.S. Government achieves and maintains a high level of nuclear safety worldwide by enhancing national measures and international cooperation, and by meeting the obligations of all the articles established by the Convention. These articles address the safety of existing nuclear installations, the legislative and regulatory framework, the regulatory body, responsibility of the licensee, priority to safety, financial and human resources, human factors, quality assurance, assessment and verification of safety, radiation protection, emergency preparedness, siting, design and construction, and operation. New to this update is a contribution by the Institute of Nuclear Power Operations (INPO) describing work done by the U.S. nuclear industry to ensure safety.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

Convention on Nuclear Safety (CNS), treaties, nuclear plants, programs, challenges, reviews, legislation, regulation, reactor oversight, public participation, probabilistic risk analysis, PRA, performance-based, risk-based, quality, safety, knowledge management, human capital, security, siting,design, construction, operations, new reactors, radiation protection, emergency preparedness, financial, human factors, Institute of Nuclear Power Operations, INPO, export import

13. AVAILABILITY STATEMENT

unlimited

14. SECURITY CLASSIFICATION

(This Page)
unclassified

(This Report)
unclassified

15. NUMBER OF PAGES

16. PRICE

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

OFFICIAL BUSINESS