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.

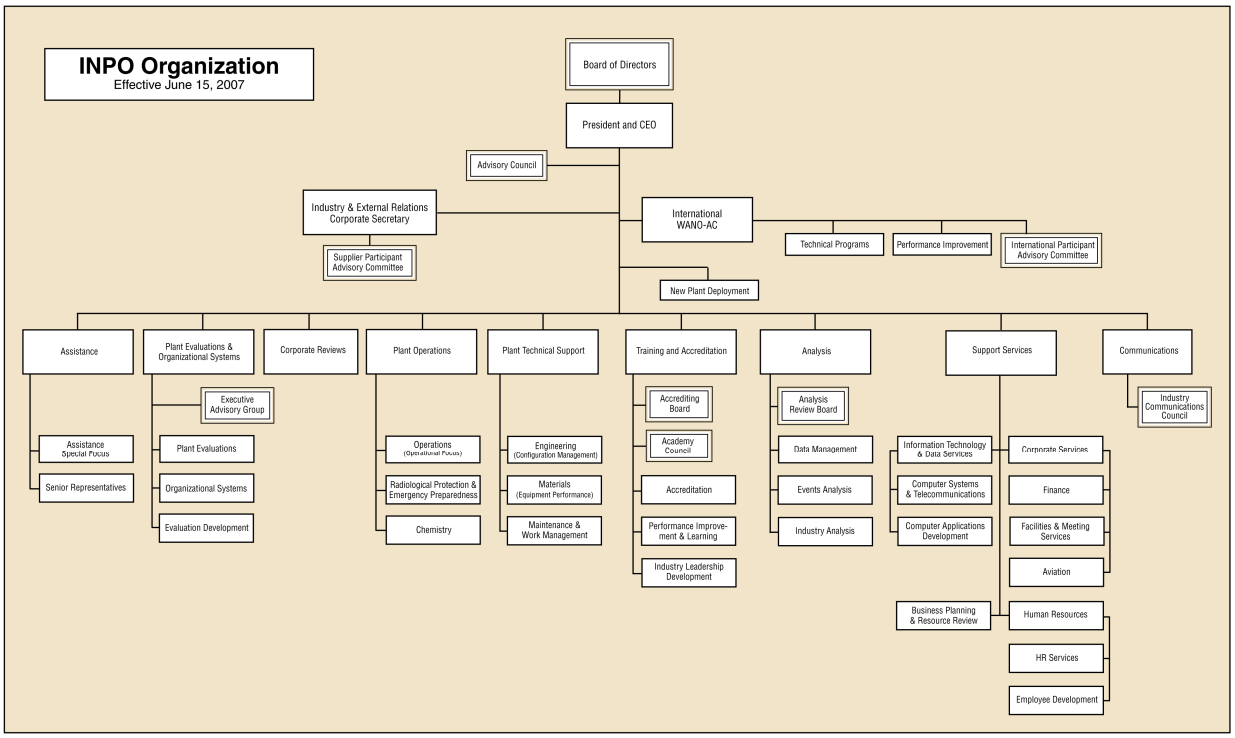
The nuclear industry's commitment to go beyond compliance with regulations and continually strive for excellence, with INPO's support, has resulted in substantial performance improvements over the last 28 years. For example, in the early 1980s the typical nuclear plant had a capacity factor of 63 percent, 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 teams 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

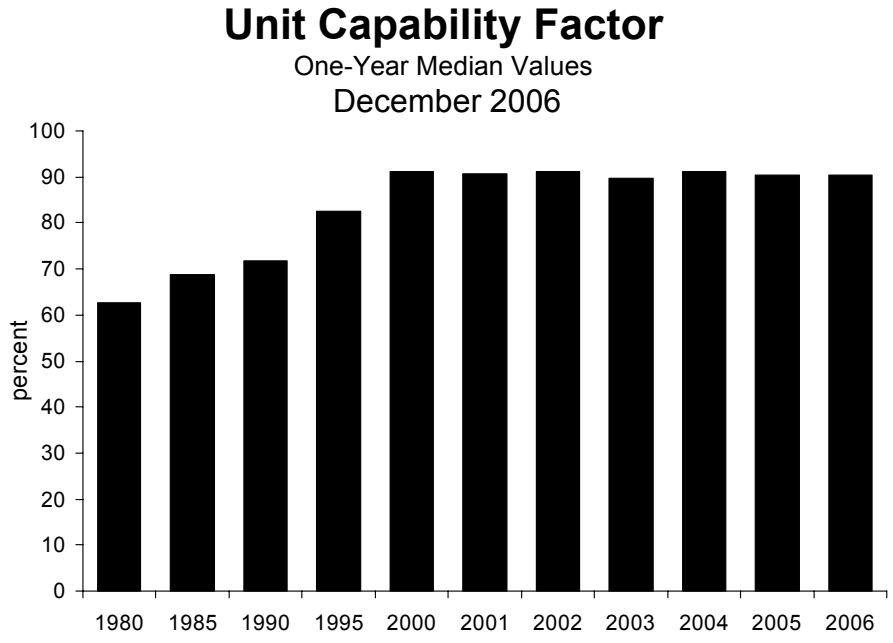
The commercial nuclear electric power industry in the U.S. has made substantial, sustained and quantifiable improvement in plant safety and performance during the nearly three decades since the Three Mile Island event. The leaders who guided this industry over decades of challenge and change showed great 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.

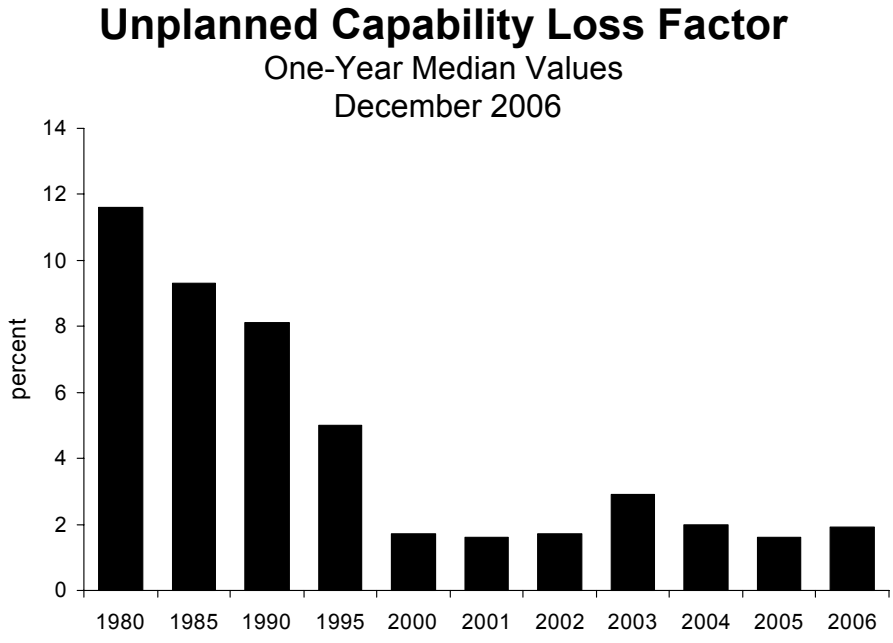
This insight and commitment to integrity has provided the foundation for a unique, sustained partnership between INPO and its members. INPO is pleased to serve as an essential element of an industry that has raised its standards and improved its performance in nearly every aspect of plant operation. 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.

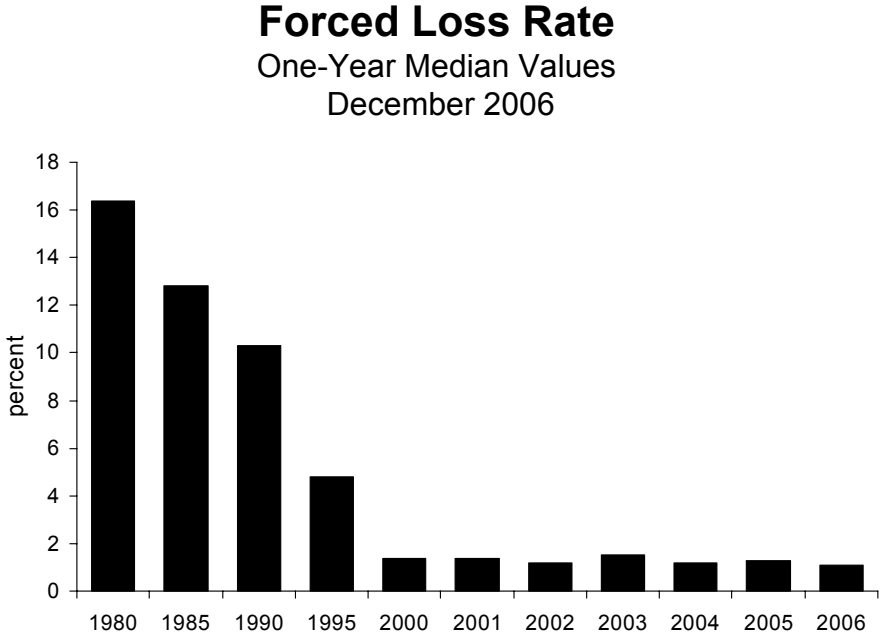
These challenges, while demanding, are not insurmountable. The U.S. commercial nuclear electric generating industry, in partnership with INPO, will continue the tradition of both sharing insight and acting with integrity, and in so doing, will continue on the shared journey to ever-higher levels of excellence.

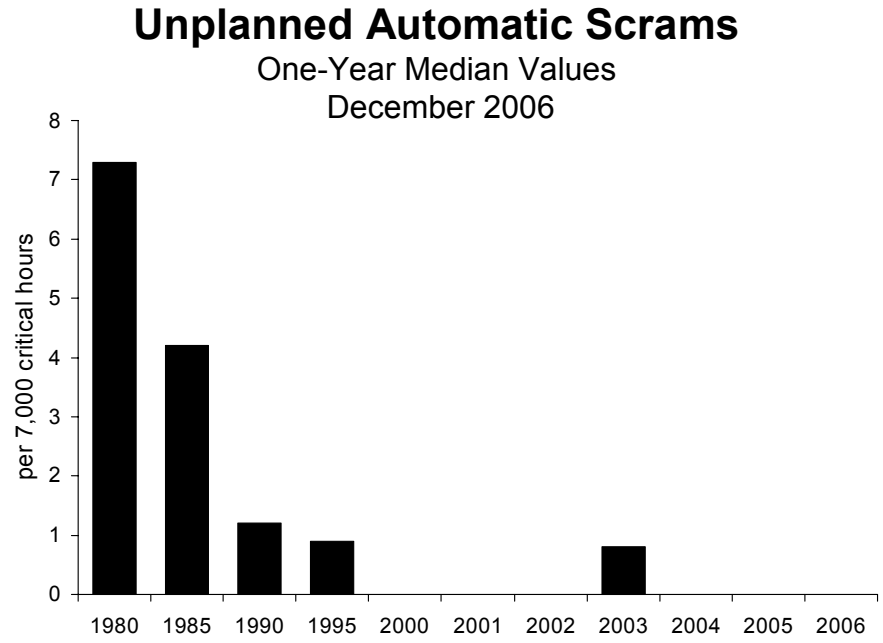
U.S. Nuclear Electric Industry Performance Indicator Graphs





U.S. Nuclear Electric Industry Performance Indicator Graphs

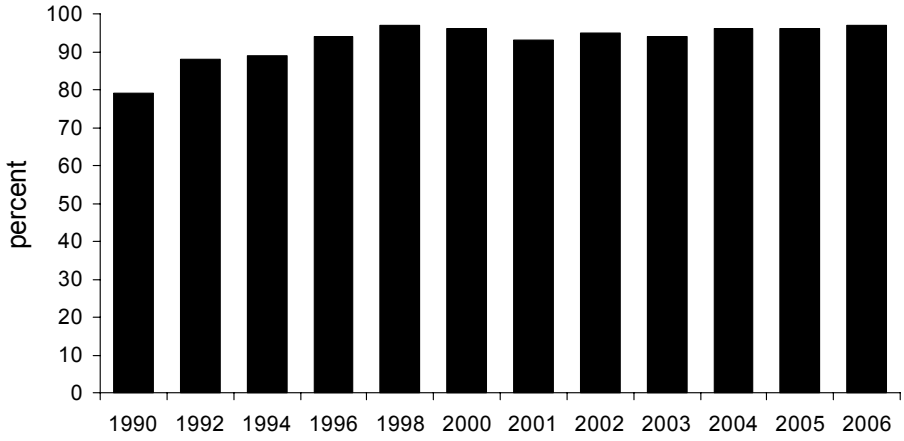




U.S. Nuclear Electric Industry Performance Indicator Graphs

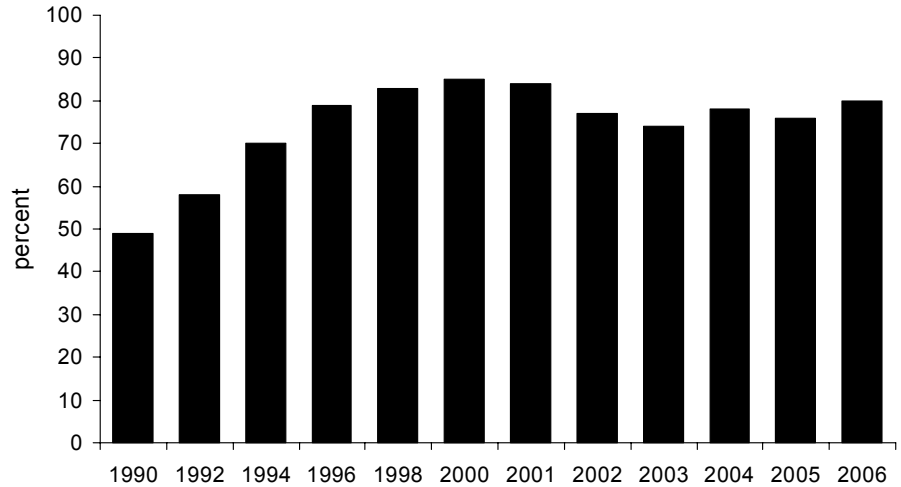
Safety System Performance

Percentage of Systems Achieving 2010 Industry Goal
December 2006



Fuel Reliability

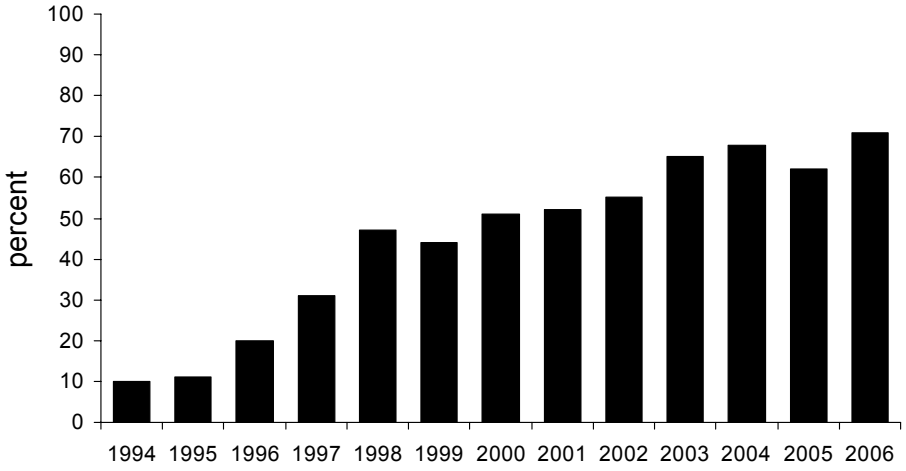
Percentage of Units Reporting Zero Defects
December 2006



U.S. Nuclear Electric Industry Performance Indicator Graphs

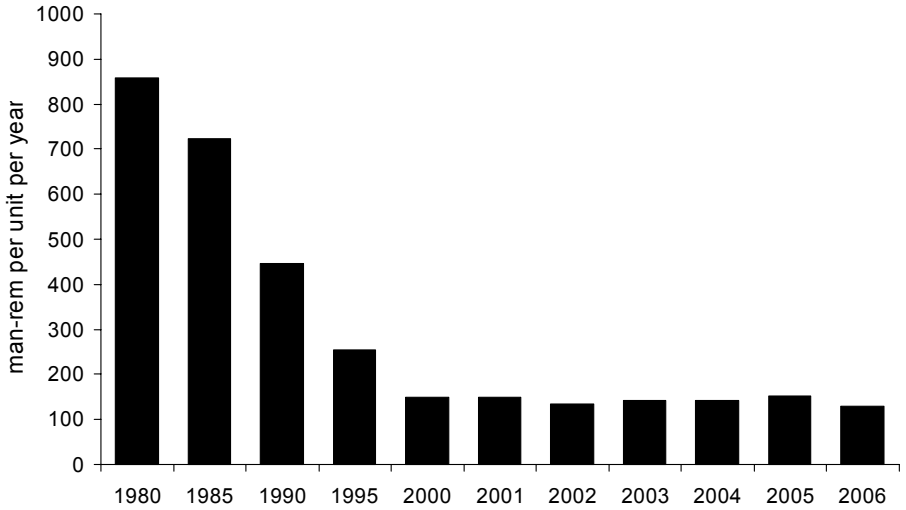
Chemistry Performance

Percentage of Units Achieving 2010 Industry Goal
December 2006



Collective Radiation Exposure (BWR)

One-Year Median Values
December 2006



U.S. Nuclear Electric Industry Performance Indicator Graphs