

Testimony for the Record
Robert F. Willard, President and Chief Executive Officer
Institute of Nuclear Power Operations
U.S. Senate Committee on Environment and Public Works
November 13, 2019

An excerpt from the Convention on Nuclear Safety Report:

The Role of the Institute of Nuclear Power Operations in Supporting the
United States Commercial Nuclear Power Industry's Focus on Nuclear
Safety

GENERAL DISTRIBUTION: Copyright © 2019 by the Institute of Nuclear Power Operations. Not for sale or for commercial use. All other rights reserved.

NOTICE: This information was prepared in connection with work sponsored by the Institute of Nuclear Power Operations (INPO). Neither INPO, INPO members, INPO participants, nor any person acting on the behalf of them (a) makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this document, or that the use of any information, apparatus, method, or process disclosed in this document may not infringe on privately owned rights, or (b) assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this document.

1. Executive Summary

The U.S. nuclear power industry established the Institute of Nuclear Power Operations (INPO or “the Institute”) in 1979 after the event at the Three Mile Island Nuclear Station to promote the highest levels of safety and reliability—to *promote excellence*—in plant operation. INPO is a nongovernmental corporation that operates on a not-for-profit basis. Under United States tax law, the company is classified as a charitable organization that “relieves the burden of government.”

Since its inception, all utility organizations that have direct responsibility and legal authority to operate or construct commercial nuclear plants in the United States have maintained continuous membership in INPO, which currently has 22 members. In addition, many utility organizations that jointly own U.S. nuclear power plants are associate members. A number of major U.S. and international suppliers also voluntarily participate in the Institute’s activities and programs

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

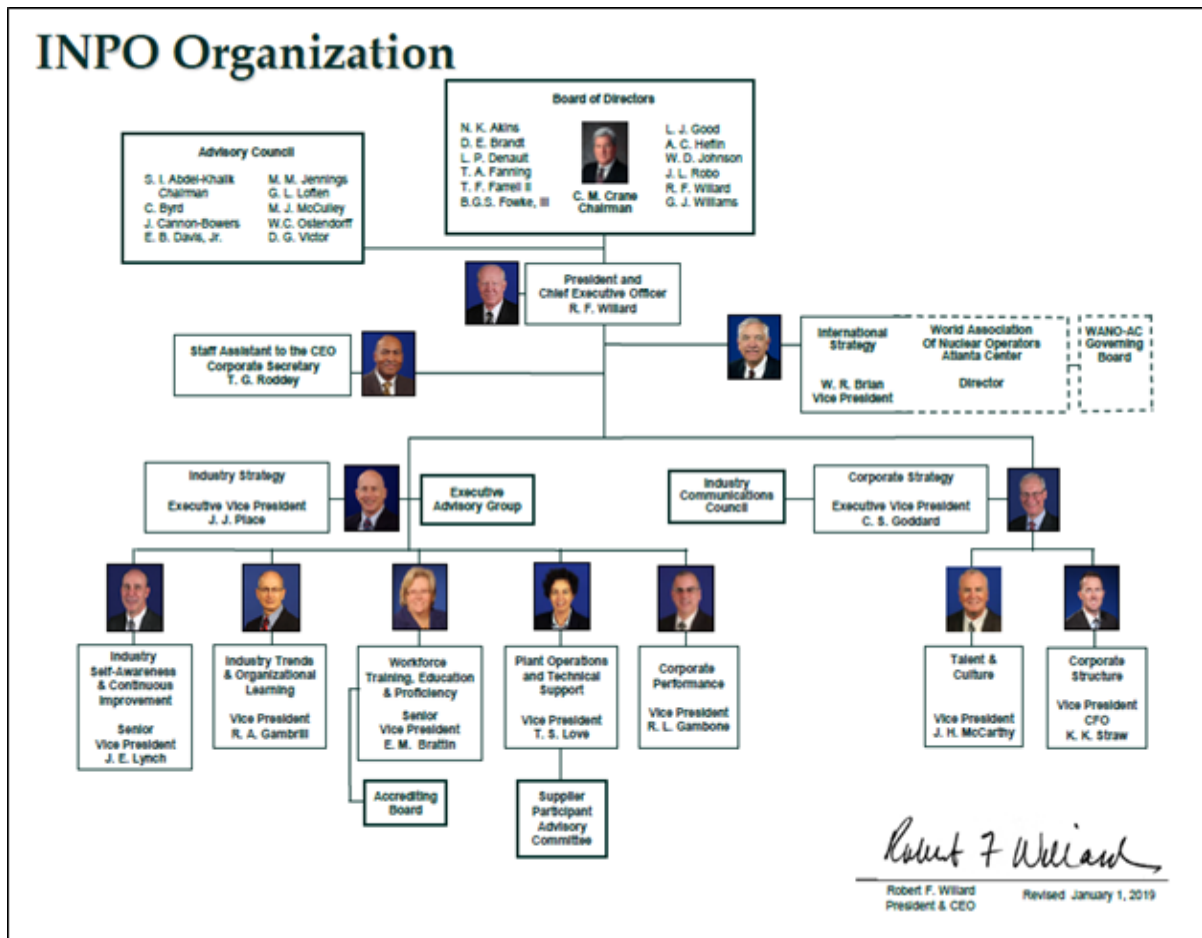
The nuclear industry’s commitment to go beyond regulatory compliance and continually strive for excellence, with INPO’s support, has resulted in substantial performance improvements over the past 40 years. At the end of 2018, the U.S. nuclear industry was performing at its highest levels ever. Today, the median industry capacity factor is above 93 percent, most plants experience no automatic scrams in a year, there have been no significant operational events since June 2017, and collective radiation dose and industrial accident rates are both lower by a factor of 7 when compared with the rates of the 1980s industry. A focus for INPO going forward will be to help the industry sustain these high levels of performance.

Despite record levels of U.S. industry performance, challenges persist that warrant additional focus by the industry and INPO. For example, while the number of lower performing plants in the industry has significantly decreased, several remain, and others have not fully recovered to top-level performance. Progress has been made in reducing the number of consequential events in operations, maintenance, and engineering; however, more work is needed to further reduce errors in these areas that affect plant reliability. The number of plants operating with fuel defects has held steady over the last several years, and more emphasis is needed on reducing foreign material in primary systems in order to minimize the number of fuel failures. INPO is working closely with industry stakeholders to close these remaining performance gaps.

Numerous actions were taken in response to lessons learned from the March 2011 earthquake and tsunami in Japan that led to the consequential accident at Tokyo Electric Power Company's Fukushima Dai-ichi nuclear power plant. INPO conducts periodic reviews to ensure sustainability of those actions and to evaluate each member station's ability to respond to extreme external events.

2. Organization and Governance

In many ways, INPO's organizational structure is similar to that of a typical U.S. corporation. A board of directors, composed of the INPO Chief Executive Officer (CEO) and 12 Chief Executives from INPO's member organizations, provides oversight of the Institute's operations and activities. The Institute's bylaws specify that at least two directors must have recent experience in the direct supervision of a nuclear power station. In addition, at least one director must represent a publicly-held utility. The president and CEO of the Institute, normally a single individual, is elected by, and reports to, the INPO Board of Directors. A chart depicting INPO's organization is presented below



Because the INPO board is made up of utility executives, the industry believes that having support from an advisory council of distinguished individuals, mainly from outside the

nuclear generation industry, to provide diversity of experience and thought is important. The INPO Advisory Council of 9 to 15 professionals selected from outside INPO membership meets periodically to review the Institute's activities and to provide advice to both INPO management and the Board on its objectives and methods. Advisory Council members include prominent educators, scientists, engineers, business executives, and experts in organizational effectiveness, human relations, and finance.

INPO ensures that the industry actively participates in its programs and initiatives. Representatives from member utilities serve on an Executive Advisory Group, an Academy Council (assisting INPO's National Academy of Nuclear Training), and the Industry Communications Council. The Executive Advisory Group, composed of chief nuclear officers of all the member organizations, advises INPO management in nuclear technical areas as well as INPO operations. The Academy Council provides advice in the areas of training, accreditation, and human performance. The Industry Communications Council advises on the effectiveness of communication of INPO programs and activities. Frequently, INPO establishes ad hoc industry groups to provide input on specific initiatives.

Six core characteristics enable INPO's self-regulation model to be effective in fostering the highest standards of safety and reliability at U.S. nuclear power plants:

- **CEO engagement:** A fundamental element in founding INPO was the personal involvement and support of member CEOs. Today, that same level of support and involvement remains fundamental to INPO's continued impact on the industry.
- **Nuclear safety:** INPO's mission of promoting the highest levels of safety and reliability—*to promote excellence*—in the operation of commercial nuclear power plants has not wavered. Nuclear safety is at the forefront of every INPO activity. Additionally, the distinction between excellence and regulatory compliance is foundational to continuous improvement in nuclear safety and reliability.
- **Broad industry support:** The nuclear industry was involved in developing standards of excellence and is committed to meeting those standards. The industry accepts that as part of the self-regulation model, its nuclear stations are subject to onsite evaluations that involve participation by industry peers. The evaluations are intrusive, comprehensive, and performance based. The industry also supports and participates in self-regulation through involvement in advisory groups, industry task forces, and working groups, and by loaning employees to INPO. Through such involvement, participants gain firsthand experience and knowledge on improvement opportunities at their own sites and increase their understanding of INPO's role and the importance of self-regulation across the industry.
- **Accountability:** INPO's formal process of evaluations and assessments provides a basis for continuous industry improvement that includes peer pressure and the identification and targeting of plants that require special assistance to help improve performance in key areas. Furthermore, utility insurance rates are impacted as a consequence of INPO evaluation results.
- **Independence:** Although INPO is part of the nuclear power industry, it remains independent. The Institute establishes high industry standards and distinguishes

clearly between its evaluative role and other collaborative interactions and activities with its members.

- Confidentiality: INPO and its member utilities recognize that for continued success, it is essential that the nuclear industry maintain a healthy environment for peer review and self-improvement. Candid interactions with utility staff, which are central to the evaluation and monitoring processes, are predicated on the assurance the information will be used privately and constructively. Misuse of information contained in INPO reports by individuals outside the utility would have a detrimental effect on INPO's ability to obtain information and to identify needed improvements.

The Institute is committed to a long-term strategic design that outlines the ways and means by which it will fulfill its mission through 2023. The strategic design takes into account the current state, the desired end state, and potential barriers in shaping desired outcomes in three separate but interrelated areas: INPO's corporate responsibilities, U.S. nuclear industry performance, and international nuclear industry performance. Defined within its strategic design are priorities and measurable outcomes that guide the application of INPO's limited resources.

INPO's Corporate Strategy

INPO is guided in its corporate responsibilities by the strategic bases for shaping U.S. and international industry performance, together with the traditional corporate tasks of developing its workforce and maintaining and enhancing the infrastructure needed to support the way INPO does business:

- INPO is committed to developing and maintaining a diverse workforce and attracting top-performing employees whose talents match Institute and industry needs.
- Understanding that a strong culture has a powerful influence on behaviors and performance, the Institute strives to instill a culture that emphasizes integrity, accountability, and high performance. It also ensures employees are equipped with the necessary sensitivities and flexibility to navigate cultural differences encountered both domestically and internationally.
- INPO employs a matrixed organizational structure whereby its staff supports crossfunctional initiatives. This requires an internal work environment that is stable, complete, unambiguous, and consistent across the organization, while maintaining the flexibility and scalability to adapt to changing needs.

INPO's U.S. Industry Strategy

In pursuit of nuclear safety, reliability, and operational excellence, INPO sets performance standards for the industry. It then measures industry performance against those standards and facilitates performance improvement through education and training, widespread sharing of best practices, lessons learned, and assistance. Finally, when it must, INPO exercises the self-regulatory authority granted by its member utilities.

INPO's industry-facing strategy currently addresses five areas that challenge continuing improvement and sustainment of high levels of performance:

- **Self-awareness and continuous improvement.** Fundamental attributes of high-performing industries include self-awareness and the capability to continuously improve. Industry management must be proactive, intrusive, and knowledgeable to reduce recurring or long-duration shutdowns, as well as recognize the presence of key risk factors that can lead to significant events. It is vital that a high level of awareness is maintained regarding worker proficiency and that training be applied to mitigate proficiency shortfalls and to minimize human error. The more that leaders are educated, trained, developed, and committed to knowing their plants and adapting to inevitable variances in performance, the less susceptible the nuclear industry will be to unanticipated, negative outcomes.
- **Industry trends and organizational learning.** An operating experience culture is paramount to ensuring that the nuclear industry remains alert to adverse safety and reliability trends. In embracing lessons learned, operating experience must become pervasive and central to management and worker decisionmaking. Achieving long-term performance goals requires that management recognizes the merits of operating experience and transfers its lessons down to the worker level.
- **Workforce training, education, and proficiency.** Considering the vital importance of a knowledgeable workforce to nuclear safety, training must be of the highest quality to ensure industry needs are met. This requires an integrated approach to sourcing, educating, training, and qualifying workers. A broad array of management, leadership, and training approaches is necessary to help sustain worker proficiency and minimize human error. Leaders must prepare the workforce to adapt to changing conditions, including changes in site performance, to ensure the right management and leadership mix, along with the right qualifications, are in the right place at the right time.
- **Corporate performance.** Nuclear plants perform best when they are aligned with and receptive to oversight and support from a high performing corporate organization. In contrast, ineffective and misaligned corporate-plant engagement usually results, over time, in substandard plant performance and creates irregularities across fleets of nuclear stations. Similarly, a low performing plant will be impeded in its efforts to improve absent a strong corporate function. In addition, a low performing plant can adversely impact the effectiveness of corporate and the performance of other fleet stations. For the nuclear industry to achieve consistent, exemplary performance, utility corporate organizations must be uniformly high performing.
- **Fully recover low performers.** Corporate and site leadership are pivotal for recovering from low performance and in achieving workforce alignment and a culture of sustainability. They must have an unwavering focus on finding and fixing problems by being intrusive and engaged while managing challenges and distractions. Management teams will be better equipped to lead recoveries by developing the applicable leadership skills in advance of such circumstances and by preidentifying the means to augment leadership capability or capacity shortfalls.

International Industry Strategy

Internationally, INPO leverages the World Association of Nuclear Operators (WANO) to influence the worldwide nuclear industry to improve nuclear safety and allow U.S. operators to benefit from worldwide operating experience.

- As a WANO member, INPO participates in peer reviews, member support missions, and other WANO activities worldwide and brings international participants to participate in similar INPO activities at U.S. stations.
- INPO serves as the collection point for U.S. nuclear station performance data and operating event information and shares this information with WANO, and, likewise, INPO receives international event information and disseminates it to the U.S. nuclear industry.
- Leveraging WANO's global reach, INPO liberally shares its intellectual property throughout the international industry.
- Through WANO, INPO provides services and products to support safe and reliable startup of new units by existing operators and new entrants. This includes a high level of engagement during construction and initial startup to instill superior standards among new entrants.
- INPO associates with and facilitates improvement of like-minded organizations, such as other national-level self-regulators, the IAEA and the NEA, so that synergies in operational safety approaches may be realized.

Financial and Human Resources

The 2019 operating budget for INPO of \$108 million is primarily funded through member dues. Dues are approved annually by the INPO Board of Directors and are assessed based on the number of each member's nuclear plant sites and units.

INPO's permanent staff of about 330 full time employees is augmented extensively by industry professionals who serve as loaned employees or international liaison engineers on assignments of 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 INPO employees serve in loaned assignments to member organizations primarily for professional development. The total number of both permanent and loaned employees at INPO is approximately 400.

INPO resources and capabilities are further enhanced by the extensive use of U.S. and international utility peers and executive industry advisers. These peers participate in a wide range of short-term activities, including performance monitoring, evaluation, and accreditation teams that visit nuclear plants. Peers enhance the effectiveness of the INPO teams by offering varied perspectives and by providing additional current experience. The peers benefit from learning other ways to conduct business that can be shared with their

stations. In 2018, the industry provided INPO with nearly 900 peers for short-term assignments.

3. INPO's Role within the Federal Regulatory Framework

The Federal Government regulates the nuclear utility industry in the United States, as it does other industries that could affect the health and safety of the public. This regulatory function is based principally on the Atomic Energy Act of 1954, as amended, and is carried out by the NRC. In 1979, following the accident at Three Mile Island, the President of the United States appointed a commission to investigate the accident. The Kemeny Commission, as it came to be known, 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 POs&Cs based on standards of excellence would effectively bring improvements. In the broadest sense, the ultimate goals of the NRC and INPO are the same in that both organizations strive to protect the public by promoting safe and reliable plant operations; therefore, some important areas of nuclear power plant operations are reviewed by both organizations. 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. INPO recognized that it would have to work closely with the NRC while not becoming or appearing to become an extension of, or an adviser 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 covering 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. Although the two roles—evaluator and regulator—may appear similar, they differ in some ways. The industry and INPO jointly develop numerous POs&Cs. INPO then conducts regular, extensive, and intrusive evaluations to determine how well they are being met. These POs&Cs are broad statements of conditions reflecting an excellent level of overall plant performance—often exceeding regulatory requirements. These POs&Cs, 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. Although INPO interactions with an individual member remain private between that member and INPO, stations are encouraged to make their INPO plant evaluation 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 the following information on programs and activities at the Institute:

- copies of selected generic documents
- access to other pertinent information, such as the INPO Consolidated Event System (ICES) 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, thus benefiting INPO members while enabling both the NRC and INPO to maintain or strengthen the 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 on the handling of items that are potentially reportable to the NRC. The Institute'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 the utility has not already done so.

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 POs&Cs and other industry standards of excellence. This effort also includes the achievement and maintenance of accredited 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, continuous performance monitoring, and events analysis programs.

Nuclear operators are explicitly responsible for complying with the terms and conditions of their operating license and the applicable rules and regulations. The licensee is ultimately responsible for the safety of its activities and the safeguarding of nuclear facilities and materials used in operation. These regulatory tenets remain foundational to INPO's relationship with its members.

The INPO Board of Directors approved a special procedure that provides guidance if a member does not respond to INPO programs, if it is unwilling or unable to take action to resolve a significant safety issue, has persistent shortfalls in performance, or if the accreditation for its training programs has been put on probation or withdrawn by the National Nuclear Accrediting Board. The procedure specifies that INPO and the member

utility's management team work to resolve any contentious issues, using a graduated approach of increasing accountability. Specific options for accountability include interactions between INPO's CEO and the member's CEO and, if necessary, the member's board of directors. If the member continues to be unresponsive, its INPO membership may be suspended. While this option has never been necessary, such action would significantly affect the utility's continued operation, including limiting its ability to obtain insurance.

Members are expected to participate fully 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 programs.

In return, the industry expects INPO to provide members with results from evaluation, continuous performance monitoring, accreditation, and review visits, including written reports and an overall numerical assessment that characterizes performance relative to standards of excellence. The industry expects INPO to follow up on corrective actions by a member and to verify that the member has implemented the actions.

INPO and its members clearly understand that all parties must maintain the confidentiality of the Institute's reports and related information, and that members must not distribute this information external to their utility. INPO also expects members and participants to use information provided by the Institute to improve nuclear operations and not for other purposes (to gain commercial advantage, for example). Members are to avoid including INPO or INPO documents in litigation.

INPO members that are also members of the collective insurance organization Nuclear Electric Insurance Limited have authorized and instructed the Institute to make available to Nuclear Electric Insurance Limited copies of its evaluation reports and other data. Nuclear Electric Insurance Limited reviews these reports and data for issues that could affect the insurability of its members.

INPO POs&Cs are written with input from, and with the support of, the industry. However, they are written without regard to utility-specific constraints or agreements, such as labor agreements. INPO expects each member to resolve any impediments to the implementation of the POs&Cs that may be imposed by outside organizations.

INPO does not engage in public, media, or legislative activities to promote nuclear power, as such activities could be seen to 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. nuclear industry, including electricity deregulation and increasing marketplace pressures, the industry has reaffirmed INPO's mission and methods. Even with U.S. utilities now in competition in certain geographical areas, these plant operators clearly understand the need to continue sharing pertinent operational information to continuously strengthen safety and reliability. Nuclear utility owners believe that this cooperation is fundamental to the industry's continued success.

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

INPO facilitates the sharing of industry information by including participation of industry peers in nearly all of the Institute's programs—plant evaluations, training and accreditation, analysis and information exchange, continuous performance monitoring and plant recovery. INPO communicates and shares information through a variety of methods, including the secure Nuclear Network® member Web site, written guidelines, and other publications.

Although the industry and INPO recognize that the rapid and complete sharing of information important to nuclear safety is essential, both entities clearly understand that certain information is private and 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 Culture

The U.S. nuclear industry believes that a strong safety culture is central to excellence in nuclear plant operations, due to the special and unique nature of nuclear technology and the associated hazards—radioactive byproducts, concentration of energy in the reactor core, and decay heat. Within INPO itself, the elements, activities and behaviors that are essential to a strong safety culture are embedded in everything that the Institute has been doing since its establishment 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.

In 2012, INPO distributed a report entitled, "Traits of a Healthy Nuclear Safety Culture." This document was developed through a collaborative effort of the U. S. and international nuclear operating communities, and representatives from the NRC, the public, and INPO staff. The report replaced the INPO report "Principles for a Strong Nuclear Safety Culture," issued in November 2004.

In April 2013, two addenda were developed and distributed in support of the nuclear safety culture traits. Addendum I is titled "Behaviors and Actions that Support a Healthy Nuclear Safety Culture." It includes the behaviors and examples found in the "Traits of a Healthy Nuclear Safety Culture," but sorted by organizational level and attribute. Addendum II is titled "Cross-References for Traits of a Healthy Nuclear Safety Culture." It cross-references the traits to the INPO principles document, NRC safety culture components, and IAEA safety culture characteristics.

INPO activities reinforce the primary obligation of the operating organization's leadership to establish and foster a healthy safety culture, to periodically assess safety culture, to address

shortfalls in an open and candid fashion, and to ensure that everyone from the boardroom to the shop floor understands his or her role in safety culture.

As part of its focus on safety, the industry uses INPO evaluations and other activities to identify and help correct early signs of decline in the safety culture at any plant or utility. Furthermore, 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. INPO expects each evaluation team to review the 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. The INPO evaluation team discusses aspects of a plant's safety culture with the CEO of the utility at each evaluation exit briefing.

7. Operations, Activities and Actions

In the execution of its strategic design, INPO conducts a broad spectrum of large-scale operations, such as plant evaluations and training accreditation visits, recurring activities, and one-time actions. Several of these are longstanding, cornerstone INPO efforts, including those described below.

a. Evaluation Programs

Members host regular INPO evaluations of their nuclear plants approximately every 2 years. The INPO evaluation teams periodically conduct additional review visits on corporate support and on other more specific areas of plant operation. During these evaluations and reviews, the INPO teams use standards of excellence based on the POs&Cs, their own experience, and their broad knowledge of industry best practices. This approach shares beneficial industry experience while promoting excellence in the operations, maintenance, and support of operating nuclear plants. Written POs&Cs guide the evaluation process and are the basis for identified areas for improvement. The evaluations focus on those issues that affect nuclear safety and plant reliability.

i. Plant Evaluations

Historically, teams of approximately 18 to 25 qualified and experienced individuals conduct evaluations of operating nuclear plants. In 2018, 34 plant evaluations or WANO peer reviews were conducted by INPO and integrated INPO/WANO-Atlanta Centre teams.

The scope of the evaluation includes the following functional areas:

- operations
- maintenance
- engineering
- radiological protection
- chemistry
- training
- emergency preparedness
- fire protection
- industrial safety

The teams also evaluate cross-functional performance areas (processes and behaviors that cross organizational boundaries) and address process integration and interfaces. The teams evaluate the following cross-functional areas:

- operational focus
- configuration management
- equipment reliability
- work management
- performance improvement (learning organization)
- organizational effectiveness (leadership, team effectiveness, management)

Teams also evaluate the following foundational areas:

- safety culture
- nuclear professionalism

As part of the process, an evaluation team looks at important aspects of a site's quality assurance and oversight programs to ensure that these programs provide confidence that the plant is satisfying the requirements for activities important to nuclear safety.

Team leaders provide a focal point for the evaluation of station management and leadership by concentrating on evaluating organizational effectiveness (leadership, teamwork, and management), safety culture, technical conscience, and nuclear oversight topics.

A key part of each evaluation includes the performance of operations and training personnel during simulator exercises. In addition, the evaluation includes, where practicable, observations of refueling outages, plant startups, shutdowns, major planned evolutions, and planned fire and emergency preparedness drills.

The industry also hosts WANO peer reviews conducted by the WANO-Atlanta Centre. These peer reviews are conducted at each U.S. station approximately every 4 years in place of an INPO plant evaluation. They use the same methodology and performance objectives as that of plant evaluations, but with teams that include international peers.

In June 2018, INPO began a more performance-based approach to evaluation team composition and conduct. The revision to the evaluation approach was based largely on the recognition of improved industry performance, increased confidence in INPO's ability to continuously monitor station performance, and that WANO peer reviews, with a full team complement, remain unchanged and are performed every 4 years.

The team size of INPO performance based evaluations is determined by station performance. A station with exemplary performance may have a base team consisting of six individuals. Stations with lower performance may have teams of 18 to 25 individuals. Base teams are composed of a team leader, organizational effectiveness team leader, INPO exit representative, and three industry peers, including one from the host station.

Guiding principles for the performance based evaluations include the following:

- The scope and composition of evaluations are dictated by performance.
- Operating crews are evaluated in abnormal and emergency conditions.
- Preevaluation observations are conducted during outages or other times when station workload is higher.
- WANO program requirements are fulfilled.
- Team scope and size are adjusted as needed during the evaluation process.
- An overall assessment of station performance is determined.
- The utility CEO is informed of results at an exit meeting.

In 2018, 13 performance-based evaluations, including two international reviews, were conducted. In 2019, of the 31 evaluations and peer reviews scheduled, 16 will be full WANO peer reviews, and 15 will be conducted using the new performance-based approach.

Following the first four performance-based evaluations, a comprehensive self-assessment was performed. While improvements were identified to this new approach, the conclusion was that the performance-based evaluations met the objectives for an INPO evaluation.

The evaluation team continues to provide the utility with formal reports of strengths and areas for improvement, and INPO continues to provide a numerical assessment following each evaluation. Stations are assessed from Category 1 (exemplary) to

Category 5, which is defined as the level of performance at which the margin to nuclear safety is substantially reduced. Such a process reflects the desire of utility CEOs and managers to know more precisely how their station's performance compares to the standards of excellence. This process is in accordance with INPO's responsibility to the individual CEO and to its members for identifying low-performing nuclear plants and for stimulating improvement in performance.

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

INPO technical department managers also provide an area performance summary in which they provide perspective on current performance in their area as compared with the industry. Each summary includes an articulation of the trend and the trajectory of performance.

Subjective team comments are often communicated to the member CEO during the evaluation exit meeting. The intent of these comments, which are often more intuitive, is to help the utility recognize and address potential issues before they adversely affect actual performance. Copies of the plant's evaluation report are distributed according to a policy approved by the Institute's Board of Directors.

The U.S. industry performance has risen to historically high levels of performance. Numerous improvements have been made in plant safety and reliability by addressing issues identified during evaluations, peer reviews, plant self-assessments and comparison and emulation among plants. The frequency of unplanned shutdowns has decreased markedly, and the reliability and availability of safety systems have improved measurably. The number of stations assessed in the lower categories has substantially declined.

Several U.S. nuclear stations have announced their intention to permanently shut down. As a result, in 2018 INPO began performing shutdown review visits. The objectives of these visits are to determine the readiness of plant personnel to safely shut down the plant and remove the nuclear fuel to its interim storage location. Two of these visits were conducted in 2018, and two are currently scheduled to take place in 2019.

ii. Corporate Evaluations

Member utilities that operate nuclear stations request that INPO conduct corporate evaluations at 6-year intervals. A followup review of corporate performance is conducted 2½ to 3 years following each corporate evaluation to verify progress on identified weaknesses. The evaluations reflect the important role of the corporate office, as well as corporate nuclear and nonnuclear leaders, in supporting safe and reliable nuclear operation. INPO conducted two corporate evaluations in 2018.

A tailored set of POs&Cs defines the scope of activities and the standards for corporate evaluations. The corporate evaluation focuses on the impact that the

corporation has on the safe operation of its nuclear plants. Areas typically evaluated include the following:

- organizational effectiveness, including leader and team behaviors, as well as the effectiveness of programs, processes, and the implementation of the utility's management model
- direction and standards for station operation, including the organizational alignment, communications, and accountability for strategic direction, business and 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 major components, such as steam generator and reactor vessel heads) and station upgrades to extract more power and efficiency
- integrated risk management
- performance of corporate functions, such as human resources, industrial relations, fuel management, supply chain management, and other areas 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. Because of responding to issues identified during corporate evaluations, stations often have refocused appropriate resources and leadership attention on improving station safety and reliability.

INPO provides ongoing oversight and assistance for nuclear corporate organizations between corporate evaluations. Oversight activities include frequent contact with senior corporate executives and corporate visits to observe safety board meetings and other corporate interactions to verify leadership direction, oversight, and engagement in the performance of the members' nuclear stations. Where appropriate to improve corporate performance, assistance is provided, including benchmarking of other high performing member corporate activities.

At the request of its members, INPO meets with utility boards of directors to provide an overview of plant and fleet performance when applicable. The boards use these briefings as an input to their assessment of operational, project, and enterprise risk.

iii. Other Review Visits

The industry also uses INPO to conduct review visits in selected industrywide problem areas to supplement the evaluation process. These visits are typically initiated by INPO, and the results of review visits may be used as an input to the evaluation process. The visits are designed as indepth 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 BWRs and 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 and fuel performance.

Similar to plant evaluations and peer reviews, review visits evaluate station performance against the INPO POs&Cs 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 that 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. The subsequent plant evaluation or WANO peer review team follows up on each of the recommendations requiring a response to ensure that 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.

The following sections discuss the details of selected review visit programs.

Operator Fundamentals Review Visits

In the fall of 2016, INPO identified an adverse trend in operator fundamental events. INPO initiated review visits to target sites that were contributing to the adverse industry performance in operator fundamentals. The purpose of these review visits was to observe operators in training and in-plant settings to determine if weaknesses existed in the execution of operator fundamentals. More than 20 Operator Fundamentals Review Visits were completed in 2017 and 2018. Combined with the industry's implementation of recommendations from an industry operating event report, these review visits have contributed to a reduced number of operator fundamental events and sustained improvement throughout 2018.

Pressurized-Water Reactor Materials Review Visits

INPO initiated review visits targeting the steam generator in 1996. In the early 1980s, steam generator tube leaks and ruptures contributed 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. The industry, through EPRI's Steam Generator Management Program, issued 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 that INPO help improve the prevention and detection of steam generator degradation by verifying correct and consistent implementation of industry guidance at individual stations and by evaluating steam generator management programs against standards of excellence. As a result, INPO established the Steam Generator Review Visit Program.

Subsequently, in 2003, a primary systems integrity review visit was launched in response to a number of notable events associated with leakage from PWR borated systems resulting in additional oversight by the NRC and INPO. In some cases, these leakage events resulted in corrosion and wastage of pressure-barrier components in the reactor coolant system. 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 indepth review visits focused on boric acid corrosion control and Alloy 600 degradation management, including dissimilar metal butt welds.

Industry performance has steadily improved in both steam generators and primary system integrity as evidenced by the lack of safety-significant events and events that contribute to lost generation. Utility programs addressing these areas are mature.

In 2012, the two programs were combined to form the PWR materials review visit to capture all aspects of the industry initiative codified in NEI 03-08, "Guideline for the Management of Materials Issues." This initiative encompasses the Steam Generator Review Visit Program, the Materials Reliability Program, and other programs directly dealing with primary system materials. While the review visit scope and team size is larger, the objective remains the same: ensure nuclear safety and plant reliability are not compromised because of weakness associated with the primary pressure boundary, including the steam generators. However, the focus on establishing effective station programs and capturing newly implemented industry guidance has been replaced with an emphasis on program implementation, capturing ongoing industry operating experience, and performing forward-looking trending to ensure material degradation is proactively managed.

In 2016, the scope of the PWR materials review visit was expanded to take an even broader look at materials degradation and included flow accelerated corrosion programs and buried pipe and tank integrity.

Boiling-Water Reactor Materials Review Visits

In 2001, INPO initiated BWR vessel and internals review visits 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 affect long-term health, including potential effects on fuel.

Overall industry performance improved, as evidenced by the lack of safety-significant events and events that contribute to lost generation.

In 2016, the scope of the BWR vessel and internals review visit was expanded to take an even broader look at materials degradation and included flow accelerated corrosion programs and buried pipe and tank integrity. In conjunction with this scope change, the name of the review visit is being changed to reflect the broader scope of the BWR materials review visit.

In 2018, the materials review visit at the corporate office was piloted where the programs were centralized at the utility to look at both BWRs and PWRs. This approach reduces the number of industry peers needed by approximately 18 per year and reduces the number of materials review visit trips from 12 per year to approximately 6 per year.

Alternating Current Power Source Reliability Review Visits

In 2014, INPO combined the transformer, switchyard and grid review visit program with the emergency diesel generator review visit program to support the industry focus area of ac power reliability. There are three to five loss of offsite power (LOOP) matrix reviews targeted per year prioritized on a performance basis. These reviews, termed ac power reliability review visits, integrate the scope of the transformer, switchyard and grid review visit program and the emergency diesel generator review visit program with additional focus on program and procedures relied on to prevent, detect, and mitigate LOOP and station blackout events. Team peer selection includes individuals with transmission system and emergency diesel expertise.

To ensure consistent monitoring of performance, ac power reliability will remain an industry focus area on evaluation teams through review of plant events. In addition, there has been an improving trend in fewer full and partial LOOP events in the industry. The new indicator developed to reflect ac power reliability for the industry and individual sites provides a mechanism to monitor performance. The metric combines LOOP events and emergency diesel generator performance and availability on a 2-year rolling average. Based on improved performance, the ac Power Reliability INPO focus area was transitioned to monitoring status in 2018.

INPO also actively partners with the North American Transmission Forum to develop common expectations and risk assessment tools for the switchyard and grid system interface. In 2014, INPO, the North American Transmission Forum, and EPRI began joint efforts focused on AC power reliability. In 2018, the first pilot review visit was completed that credited the North American Transmission Forum switchyard assist program review of site-specific switchyard programs. INPO is also engaged with EPRI in the industry Flexible Power Operations initiative for plants requested to accommodate renewable resource power contribution to grid load demand.

Main Generator Review Visits

The industry initiated main generator review visits in 2004 after the identification of an adverse trend involving failures of main generators and related support systems. The number of main generator failures that hindered power production, extended an outage, or both, 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. These review visits were suspended once industry performance improved and resources were shifted to emergent industry issues.

In 2016, INPO resumed monitoring main generator performance based on an increase in challenges to reliability of generator excitation and stator water cooling systems. Initially, main generator health was reviewed on plant evaluations. Teams focused on performance and condition monitoring to ensure that the generator is operating within design parameters and that monitoring is in place to detect early signs of equipment degradation. INPO personnel remain engaged in industry working groups and emergent plant issues related to main generator, turbine, and support systems.

Fuel Integrity Review Visits

INPO used fuel integrity review visits in 2017 and 2018 to gather detailed information regarding fuel integrity performance in the U.S. fleet. Specific sites that experienced a recent fuel failure were chosen, and plans were developed for a site review visit. A team composed of one INPO fuel specialist and two industry peers performed each of the site visits and collected information regarding the causes and corrective actions being taken by each station for its fuel rod failures. Recommendations to improve, and in some cases beneficial practices, are identified and documented in a report that is issued to the station for the results of the visit. Followup on the station response to those recommendations is also performed by INPO personnel.

In mid-2018, INPO issued an industry trend report communicating key causes, corrective action methods, and insights for fuel rod failures based on the results obtained from review visits. Providing this information to stations and utilities enabled all utilities to benefit from the operating experience of others. These review visits and trending by INPO are leading to further action with the nuclear industry to improve fuel integrity performance.

b. Training and Accreditation Programs

The U.S. commercial nuclear power 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 (“the Academy”) in 1985 to operate under the responsibility of INPO. 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.

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 of its operating plants achieve 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 are similar in content to the accreditation efforts of schools and universities and 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 are jointly developed with the industry and guide the accreditation process.

Unlike its 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 on accreditation. If training programs meet accreditation standards, the National Nuclear Accrediting Board awards or renews accreditation. If significant problems are identified, it 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 6 years. The National Nuclear Accrediting Board comprises training, education, and industry experts. It is convened and supported by INPO; however, it is independent in its decisionmaking authority. National Nuclear Accrediting Board members are selected from a pool of individuals from utilities, postsecondary education, nonnuclear industrial training, and NRC nominations. Each National Nuclear Accrediting Board consists of five sitting members, with a maximum of two utility representatives to ensure its independence from the nuclear industry.

The accreditation process is designed to ensure that a systematic process is used to develop and deliver the training. The process includes self-evaluations by members with assistance from INPO staff, onsite evaluations by teams of INPO and industry personnel, and decisions by the independent National Nuclear Accrediting Board. Members 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
- electrical maintenance personnel
- mechanical maintenance personnel
- chemistry technicians
- radiological protection technicians
- engineering support personnel

In 2015, the industry updated the accreditation objectives to better focus on the fundamental aspects of accredited training programs. In addition, a training evaluator was added to the plant evaluation process to provide a more distinct look at the linkage among knowledge, skill, and performance. Together, these changes are designed to provide a clearer picture of the health of station training programs and the impact on worker proficiency.

The 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 enhances knowledge and skills to measurably improve plant performance. Such an approach to improving worker knowledge and skills contributes to high levels of safety and reliability in the nuclear industry. The role of training will continue to be vital in the coming years as many experienced workers retire and as new workers enter the workforce.

Although the accreditation process is independent of the NRC, the agency recognizes and endorses the process as a means for satisfying regulatory training requirements. In a report titled “Annual Report on the Effectiveness of Training in the Nuclear Industry,” the NRC 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 10 CFR [Part] 50 and 10 CFR [Part] 55 are being met.” In addition, the NRC assessment of the accreditation process indicates that continued accreditation remains a reliable indicator of a 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.

The 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, 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 February 2006, INPO launched the National Academy for Nuclear Training e-Learning (NANTeL) system. Using Web-based technologies that allow distance learning, NANTeL system training includes a variety of courses and proctored examinations. These include courses for plant access, radiation work, industrial

safety, maintenance, and engineering qualifications. The use of NANTeL increased over the last 2 years with the development of several industry standard courses, resulting in over 3 million individual courses completed over the last 2 years.

Examples of courses and seminars conducted are as follows:

- a nuclear education course for members of boards of directors in the nuclear industry
- reactor technology course for utility executives
- senior nuclear executive seminar
- senior nuclear plant management course
- nuclear operational risk course for managers
- operations shift manager seminar
- first-line leadership seminar
- next-level leadership seminar
- seminars for new department managers

INPO continues to work with the industry to develop and deliver training to address industry needs. For example, INPO recently revised the operations shift manager seminar to incorporate lessons and recommendations identified from industry operating experience.

c. Analysis and Information Exchange Programs

The analysis and information exchange programs help 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. INPO then analyzes and 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.

i. Events Analysis Program

INPO reviews and analyzes operating events from both domestic and international nuclear plants through the Operating Experience Program. The program is designed

to provide indepth analysis of nuclear operating experience and to apply the lessons learned across the industry. Events are screened, tagged, and analyzed for significance; those with generic applicability are disseminated to the industry in one or more of the following INPO Event Report (IER) levels:

- Level 1 IER—Level 1 IERs usually highlight an area of concern important to nuclear safety or plant reliability derived from several significant events but could also be based on a single significant event. Level 1 IER recommendations constitute a new industry standard of performance.
- Level 2 IER—A Level 2 IER highlight an area of concern that may or may not derive from significant events, but have high consequence to plant safety or operation.
- Level 3 IER—A Level 3 IER provides industrywide notification of significant or otherwise important events and associated lessons. Level 3 IERs do not contain recommendations.
- Level 4 IER—A Level 4 IER provides analysis of notable trends of equipment or human performance problems or other industrywide issues.

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 via the ICES. These entries enable a single station to multiply its experience base for identifying problems. This includes safety systems, which have similar components across many stations. A key to this success is the timeliness of reporting. A graded approach is used to prioritize event reports as follows:

- Prompt Reporting—A tentative record is created, shared and sent to INPO for initial screening within 6 INPO business days of the discovery of an event or condition.
- Early Reporting—A tentative record is created, shared and sent to INPO for initial screening within 30 days from discovery of the event.
- Normal Reporting—A complete, final and shared record is created and sent to INPO for screening within 90 days of the event or condition discovery.

Members are required to evaluate and take appropriate action on recommendations provided in Level 1 and Level 2 IERs. During onsite plant evaluations, INPO teams follow up on the effectiveness of each station's actions in response to the recommendations. Topics of Level 1 and Level 2 IERs in recent years include integrated risks to plant viability; weaknesses in operations leadership; team effectiveness, and fundamental behaviors; and weaknesses in maintenance technical skills affecting plant operations.

Members should review and take actions, as appropriate, on Level 3 and 4 IERs. INPO evaluates the effectiveness of utility programs in extracting and applying lessons learned from industrywide and internal station operating experience.

INPO maintains all operating experience reports on the secure member Web site. This information supports members in applying historical lessons learned as new issues are analyzed or activities planned. INPO also provides “just-in-time” 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. 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. These documents are organized in the following categories:

- **Tier One—Excellence Documents** - establish the standards that INPO members and participants are expected to meet. INPO evaluates station performance to the content of these documents. Examples of Tier One documents are as follows:

POs&Cs, which are common for INPO and WANO, are the standards of excellence for plant and corporate performance intended to promote excellence in the operation, maintenance, support and governance of commercial nuclear power plants. The standard is described in the performance or accreditation objective. Supporting criteria provide a breadth and depth to each objective. Member utilities strive to achieve objectives but do not need to meet each specific criterion in an objective to achieve excellence in an area. The POs&Cs support the achievement of the following set of operational excellence outcomes:

- sustainable, high-level plant performance
- sustainable, event-free operation
- avoidance of unplanned, long-duration shutdowns
- well-managed and understood safety, design, and operational margins
- high levels of plant worker safety
- a highly skilled, knowledgeable, and collaborative workforce

Principles describe fundamental attributes, traits and behaviors associated with important industry themes and issues. These principles are generally accepted or time-proven as essential to effective leadership, management

and performance of commercial nuclear power plants. In some instances, principles are developed to augment objectives and criteria. Principles may be incorporated into a subsequent revision of objectives and criteria or remain a standalone document for a long period.

Level 1 and 2 IERs provide recommendations for actions based on one or more significant industry events, an important industry issue, or an adverse trend. The reports analyze selected events, provide recommendations, and inform the industry of events for inclusion in the operating experience or corrective action program. Stations are expected to implement Level 1 recommendations and, if needed, to develop corrective actions for Level 2 recommendations. Detailed expectations for review and use of IER Level 1 and 2 documents are described in Operating Experience Program Description documents.

- **Tier Two—Supporting and Implementing Documents** - are intended to provide information to assist INPO members and participants in the pursuit of excellence. While it is expected that the intent of these documents be met, strict compliance is not required. Examples of Tier Two documents are as follows:

Level 3 IERs provide prompt notification of important events and reinforcement of related must-know operating experience lessons learned. Station lessons learned should be reviewed for development of internal corrective actions if they are applicable to the reviewing station. Detailed expectations for review and use of Level 3 IER documents are described in Operating Experience Program Description documents. IER Level 3 supplements and appendices are of equivalent pedigree to the parent IER.

Guidelines provide specific information and activities important to achieving standards of excellence as outlined in the related objectives and criteria. The documents provide added levels of guidance and detail considered necessary to implement objectives and criteria but stop short of prescribing specific methods or processes to use.

Process Descriptions reflect the experience gained from operating plants. The information provides a “road map” for how to perform the more advanced, complex and cross-functional activities at stations, which tend to be accomplished by a process. The “AP” annotation originally stood for “advanced plant”; however, the reference has gradually come to refer to “advanced process.” These are evolutionary documents that incorporate current best industry practices.

Operating Experience Program Descriptions provide an overview of the INPO-sponsored Operating Experience Program and the program expectations for INPO and INPO members.

- **Tier Three—Other Documents** – include those not addressed in Tier One or Tier Two of this hierarchy. Information in this tier provides reference or amplifying information for various topics to INPO members and participants

for their review and discretionary use. The information may be created by an organization other than INPO. Tier Three information varies greatly in format and style and may not be subjected to the strict document production quality controls required for Tier One and Tier Two documents. Examples of Tier Three documents are as follows:

Level 4 IERs provide analyses of notable trends of equipment or human performance problems or other industrywide issues intended to heighten industry awareness. Stations should use the information in these reports to determine plant vulnerabilities. Detailed expectations for review and use of IER Level 4 documents are described in Operating Experience Program Description documents. IER Level 4 supplements and appendixes are of equivalent pedigree to the parent IER.

Good Practices provide examples of effective methods for accomplishing elements of nuclear plant management and operation.

Manuals are collections of data or other information of wide usefulness to INPO members and participants. The documents provide a convenient collection of concepts, insights, and suggested activities of beneficial use to assist station personnel in understanding, implementing and performing a particular station function.

Reports provide descriptions and results of INPO or INPO-sponsored activities of broad interest to the industry, such as the following:

- information from INPO benchmarking
- information on cumulative analyses of industry events
- information to the industry that does not fall into a specific document type

INPO produces various other documents, 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.

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 INPO members and participants to meet and exchange information with their counterparts. In 2018, more than 3,400 industry personnel participated in more than 90 seminars, workshops, and technical working meetings at INPO.

iv. Nuclear Network[®] System

Nuclear Network[®] is an international electronic information exchange for sharing nuclear plant information. It is a major communication link for the Operating Experience Program and WANO event reporting system. The system transmits operating experience information and other nuclear technical information.

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 promptly informed of problems occurring at one station, allowing them to implement actions to prevent a similar occurrence.

v. Performance Data Collection and Trending

INPO operates and maintains a consolidated data entry system as a single process for the collection of 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. Plant data are then consolidated for trending and analysis purposes. Industrywide trends developed from the data are provided to members for a number of key operating plant performance indicators. Members use these data for comparison and emulation with other plants, in setting specific performance goals, and in monitoring and assessing the 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 factors, forced losses of generation, fuel reliability, collective radiation exposure, and industrial safety accidents.

Beginning in 1990, the industry has established long-term goals for each indicator on a 5-year interval.

vi. Equipment Performance Data

The industry reports equipment performance information to ICES, and member utilities use the data to identify and solve performance problems of plant equipment with the goal of enhancing plant safety and reliability. INPO also uses the information for performance trending to identify industrywide performance problems. The Institute also makes the data available to the NRC to support equipment performance reviews by the regulator.

vii. Operating Experience for New Plant Construction

In 2009, a means for collecting and distributing experience from construction problems was established through the Nuclear Network[®]. Nuclear Network[®] has long been the forum for rapid and secure communications and has hosted the industry's

operating experience program. The new plant construction program has a similar mission to that of the operating experience; however, it is tailored to the unique needs of utilities with construction projects.

viii. Plant Performance Indicator

In 2015, INPO created the Plant Performance Indicator, which is a statistical model that provides a numerical value that helps identify a station's current performance and that correlates to a station's assessment score. The Plant Performance Indicator provides an estimate of the current INPO assessment and WANO peer review scores on a quarterly basis. The Plant Performance Indicator is calculated for all plants using input from the Plant Information Center and other external sources. The Plant Performance Indicator also provides submodels of the most impactful functional and cross-functional areas and provides an estimate of their assessments as well.

While an actual assessment requires a team of evaluators to visit the station under evaluation, the Plant Performance Indicator relies upon station data, rather than direct observation to predict assessment scoring. Because it is based on data that are typically reported quarterly, the Plant Performance Indicator is valuable in that it is generally more current and is updated more frequently than evaluation or peer review team results, which occur approximately every 2 years.

ix. Other Analysis Activities

INPO analyzes industry operational data from a variety of sources—events, equipment failures, performance indicators, and regulatory reports—to detect trends in industry performance. INPO communicates the results of analyses and suggested actions to the industry. Subjects of recent analyses include common contributors to repeat and longstanding equipment problems, adverse trend in primary pump seal failures, adverse trend in debris-related nuclear fuel failures, and weaknesses in handling highly radioactive filters. Stations use this information to assess their performance and to identify improvements. In addition, individual plant performance data are analyzed, and the results are used to support other INPO activities, such as evaluations and assistance.

d. Comprehensive Performance Monitoring Program

In the second half of 2014, INPO established a performance monitoring program that uses all available data in combination with targeted, systematic assistance visits to develop an ongoing, comprehensive picture of plant performance between evaluations, such that timely and effective action can be taken to avoid declines. Preventing declines is part of an overall strategy to help the industry achieve a condition in which all stations operate at high levels of performance, meeting industry goals, with no significant events or long-duration shutdowns and no training program accreditation probationations.

A team of performance monitoring leaders continuously reviews and analyzes performance data of stations to identify subtle signs of decline. Additionally, a core team of assigned INPO subject matter experts continuously reviews and analyzes performance data pertaining to their specific functional areas. Performance is

collaboratively reviewed by all performance monitoring leaders twice a quarter. The INPO senior leadership team reviews and challenges on a quarterly basis the picture of performance presented by the performance monitoring leader. Each performance monitoring leader is responsible for monitoring approximately six stations that are grouped by fleet organizations. When signs of decline are identified, the performance monitoring leader works with station leaders and INPO leadership to develop an assistance plan to arrest the decline and improve performance.

The continuous performance monitoring program has been expanded to include corporate performance. Beginning in 2018, INPO's view of corporate performance is being evaluated and communicated quarterly through a performance summary report. Corporate continuous monitoring has highlighted gaps at several industry corporations that contributed to declines in plant performance. Although early in its implementation, corporate continuous performance monitoring, and its associated INPO and industry assistance, has improved performance at these corporations. Continuous monitoring for the non-U.S. corporations in WANO-Atlanta Centre will begin in 2019.

The methodology to achieve the comprehensive monitoring objective has three dimensions:

- **Monitor:** Monitoring leaders use all available data and information to characterize station and corporate performance. Integrating data with plant observations and insights from other touch points allows the performance monitoring leader to develop an integrated picture of station performance. Credible trigger points are used to identify small developing gaps that require attention. Station leaders receive an INPO Performance Summary Report (IPSR) twice each quarter, non-U.S. stations in the WANO-Atlanta Centre receive an updated IPSR every quarter and corporate leaders receive a Corporate IPSR once a quarter. The IPSR summarizes the current integrated picture of station performance from INPO's perspective.
- **Engage:** Monitoring leaders engage station leaders, primarily site vice presidents, to understand the station leader's awareness of performance issues and the effectiveness of corrective actions.
- **Intervene:** Intervention is required to shape performance improvement using a graded and specific approach. There are three levels of intervention: elevation for narrow shallow gaps; escalation for wider, deeper, or cross functional gaps; and special focus (described in the next sections). Targeted elevation or escalation plans are developed with the station leadership team to focus industry and INPO efforts to turn performance. In the case of a precipitous decline, the plant may be assigned to the plant performance recovery organization. Performance recovery uses additional tools and techniques that rely more on direct observations of station performance and more interactions with station leaders.

e. Member Support Missions

Between evaluations, a station can request and receive assistance in specific problem areas to help improve plant performance. Resources are provided using a graded approach that provides a higher priority to those plants that need greater performance

improvement. This support is targeted for specific technical concerns and for broader management and organizational issues. Although a station generally requests the areas of support, INPO may suggest support missions in a specific area to stimulate improvements.

INPO personnel and industry peers normally conduct such visits. For example, if a member requests support in some specific aspect of maintenance, INPO will include a peer from another plant that handles that aspect of maintenance particularly well. INPO provides written reports that detail the results of the visits to the requesting utility. In most cases, the member support mission visit includes actual methods and plans for improving performance as part of the assistance visit.

Effectiveness reviews performed by INPO approximately 6 months after member support missions show that the visits are highly valued by station management and contribute to improved performance.

f. Special Focus Program

There is a direct correlation between station performance and the likelihood of an event, such that very low performing stations typically experience consequential or even significant adverse operational events. To assist these stations improve performance, INPO created the highest level of member engagement in 2005, termed the Special Focus Program. Since the inception of the program, INPO and WANO-Atlanta Centre have worked together to create methods, tools, and training to sustainably recover performance at these stations. These methods include structured interactions with the site, utility executives, the utility CEO, and the utility Board of Directors. At INPO, a dedicated group of experienced experts is responsible for working with low performing stations directly and engaging the industry to support these stations.

Historically, it was common for 10 to 12 stations to be categorized as low performers and be designated as special focus plants. Some stations would improve performance enough to be removed from the program only to reenter as performance subsequently degraded. Other stations would linger at low performance levels and remain in the program for several years. As the program methods matured and expertise improved, the number of special focus stations decreased. As of January 2019, there are one U.S. domestic and one WANO-Atlanta Centre international station in the special focus program. Additionally, since 2013, no stations that have emerged from the program have reentered.

8. Relationship with World Association of Nuclear Operators

U.S. nuclear utilities are represented in WANO through INPO. As such, INPO coordinates the U.S. nuclear utilities' activities in WANO. INPO also operates the WANO-Atlanta Centre, one of the four WANO global regional centers under contract with WANO. The WANO-Atlanta Centre Governing Board appoints an INPO executive to serve as the Atlanta Centre director.

In addition to INPO, WANO-Atlanta Centre members include the following:

- Bruce Power (Canada)
- Centrala Nuclearelectrica (Romania)
- China Huaneng Group (China)
- Comisión Federal de Electricidad (Mexico)
- Emirates Nuclear Energy Corporation (United Arab Emirates)
- Eskom Holdings (South Africa)
- New Brunswick Power (Canada)
- Ontario Power Generation (Canada)
- State Power Investment Corporation (China)

WANO-Atlanta Centre operations and programs are very similar to INPO programs and include the following:

- WANO-Atlanta Centre teams of U.S. and international peers conduct reviews every 4 years at the request of INPO members to identify strengths and areas for improvement associated with nuclear safety and reliability. A WANO-Atlanta Centre peer review conducted at a U.S.-INPO member plant is performed in place of an INPO plant evaluation.
- U.S. nuclear utilities share their operating experience with INPO and WANO-Atlanta Centre, which is then passed to WANO. The operating experience sharing provides detailed descriptions of events and lessons learned to member utilities worldwide. International operating experience sent to WANO is entered into INPO databases and shared with the U.S. members.
- WANO-Atlanta Centre collects, trends, and disseminates performance indicator data to facilitate goal setting and performance trending and to encourage emulation of the best industry performance.
- WANO-Atlanta Centre conducts comprehensive continuous monitoring of its international stations in much the same way INPO conducts this function for the U.S. stations.
- WANO-Atlanta Centre conducts member support missions to allow direct sharing of plant operating experience and ideas for improvement.
- WANO-Atlanta Centre, with the support of INPO, designs professional and technical development courses, seminars, and workshops to enhance staff development and to share operating experience.

The U.S. nuclear power 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 the more than 355 units that are operated outside of the United States. INPO works to remain fully aware of trends in the global nuclear industry and continues to strengthen relationships in this area.

9. Industry Response to the Accident at Fukushima

A coordinated effort of EPRI, INPO, and NEI, in conjunction with senior utility executives, created a joint leadership model to respond to events at the Fukushima Dai-ichi nuclear energy facility. This model helped ensure that lessons learned were identified and well understood and that response actions were effectively coordinated and implemented throughout the industry.

The primary objective of the industry response has been to maintain and improve already high levels of operational safety and reliability, while applying the lessons from the Fukushima Dai-ichi nuclear accident to strengthen resilience against extreme external events. The U.S. nuclear industry has established strategic goals to maintain and provide, where necessary, added defense-in-depth for critical safety functions, such as reactor core cooling, spent fuel storage pool cooling, and containment integrity:

In addition to directly supporting the industry response strategy to the Fukushima accident, INPO issued several IERs providing recommendations for addressing lessons learned from Fukushima. In general, the recommendations were crafted to be compatible with and supportive of actions required by the NRC. Collectively, the IERs contained nearly 100 recommendations, subrecommendations, and actions. INPO has verified that the actions have been completed through a variety of review activities, including INPO evaluations and WANO peer reviews, Emergency Management Performance Evaluations and in-office document reviews. Sustainability of the actions will be reviewed during WANO peer reviews.

INPO developed training materials to assist utilities in preparing their organizations for beyond-design-basis events. These materials include case studies and instructor-led training focused on decisionmaking and decisionmaking under stress. The group also developed a guideline for establishing effective training for emergency response personnel. The guideline includes results of a job analysis that identified the needed knowledge and abilities required for each job function. In addition, an INPO Good Practice was issued in 2017 to support effective demonstration of diverse and flexible coping strategies.

The INPO emergency plan and emergency response facilities were upgraded in early 2013 and again in 2018 to better assist members in mobilizing the resources of the nuclear industry to provide assistance to a site experiencing an event. All INPO member utilities signed a mutual assistance agreement to provide resources during such an event if requested. INPO conducts quarterly drills, most involving the NEI and the EPRI, to practice response actions. Some are conducted in conjunction with utilities during their regularly scheduled emergency preparedness drills.

Diverse and Flexible Coping Strategies

NEI and INPO worked with the U.S. nuclear industry to develop a “Diverse and Flexible Coping Strategy,” or FLEX, which was endorsed by the NRC in August 2012. It provides a diverse and flexible means to prevent fuel damage while maintaining the containment function in beyond-design-basis external event conditions, resulting in an extended loss of ac power, and a loss of normal access to the ultimate heat sink.

The objective is to establish an indefinite coping capability by relying on installed equipment, onsite portable equipment, and prestaged offsite resources. The equipment ranges from diesel-driven pumps and electric generators to ventilation fans, hoses, fittings, cables and

communications gear. The new equipment is stored at strategic locations at the sites and protected to ensure that it can be used if other systems that comprise a facility's multilayered safety strategy are compromised. This flexible approach builds on existing safety systems to protect against unforeseen events.

The concept for offsite support is based on the assumption that onsite resources must be sufficient to cope for the first 24 hours. A standardized list of equipment connectors was developed to address interchangeability of the equipment. Each site is required to have one set of FLEX equipment onsite for each unit, plus one extra set. Therefore, each site becomes a potential source of FLEX equipment for any other industry site experiencing such an event. During an emergency event, a call to INPO or directly to the other site will activate mobilization of FLEX equipment.

In addition to support from other sites, there are two large response centers—one in Memphis, TN, and one in Phoenix, AZ—that are capable of delivering equipment to any U.S. site within 24 hours. The response centers are managed by a vendor, Strategic Alliance for FLEX Emergency Response. The Pooled Equipment Inventory Company joined forces with AREVA to create this new company to develop and manage the response center program. Each response center has five sets of FLEX equipment: four sets to support sites and one set out of service for maintenance. Each center also has additional equipment specified by a site in its site-specific response center mobilization manual.

10. Conclusion

The U.S. commercial nuclear industry has made substantial, sustained, and quantifiable improvements in plant safety and performance in the nearly 4 decades since the Three Mile Island accident. 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 with the creation of INPO. The industry members acknowledged that nuclear energy would remain a viable form of electric power generation only if utilities could ensure the highest levels of nuclear safety and reliability—*excellence*—in nuclear plant operation.

The U.S. industry commitment to improved performance 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. INPO does not take credit for this success, but it does take pride in its contributions to the industry it serves.

INPO also recognizes that the pursuit of excellence is a continuing journey. As the U.S. nuclear industry evolves and advances, it 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, although demanding, are not insurmountable. The U.S. commercial nuclear industry, in partnership with INPO, will continue its tradition of sharing and mutual support, conducting itself with utmost integrity and an unrelenting drive to excellent performance.

