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IMPROVEMENTS TO THE UNITED STATES NUCLEAR REGULATORY COMMISSION'S OPERATING EXPERIENCE PROGRAM

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Improving Nuclear Safety Through Operating Experience Feedback
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The subject of this Conference, improving nuclear safety through the use of operating experience, is one of fundamental importance to the U.S. Nuclear Regulatory Commission. Thus, I am especially pleased to join you for this conference.

Operational safety performance is a keystone of the NRC's regulatory framework. It has a long reach, extending into areas such as maintenance, engineering, and security, as well as into operations. It can also be seen as both originating from, and feeding back to, a plant's design. The importance of this area at the NRC derives from our overall Strategic Objective to:

> ***Enable the use and management of radioactive materials and nuclear fuels for beneficial civilian purposes in a manner that protects public health and safety and the environment, promotes the security of our nation, and provides for regulatory actions that are open, effective, efficient, realistic, and timely.***

To accomplish that Objective, we identified six key Strategies to assure safety, one of which is to:

> ***Evaluate and utilize domestic and international operational experience and events to enhance decision-making.***

This strategy not only enhances our decision-making process, but is also a fundamental component of knowledge management – meaning the process by which the NRC enables the transfer of knowledge and lessons learned from current regulators to a generation of newly hired regulators.

In international documents, this strategy may be expressed somewhat differently, but the underlying message is always fundamentally the same:

Learn from your experiences and those of others.

For example, the IAEA expresses it as ". . . actively promote feedback on the lessons learned from past experience" (Ref. 1). An NEA document, adopting a prior IAEA position, adds as one aspect of regulatory effectiveness, "Strives for continuous improvements in . . . performance" and emphasizes the use of a "learning organization" model (Ref. 2). The recently published NEA guidelines on regulatory use of nuclear operating experience quite appropriately note the need for a vigorous operating experience program, stating that "serious accidents are almost always preceded by less serious precursor events and that by taking actions to prevent recurrence of similar events, one is thereby reducing the probability of serious accidents." (Ref. 3)

This learning should not be confined to lessons only from the nuclear industry. Nuclear regulatory agencies should also learn from experiences in other industries and organizations that have a strong focus on safety, such as the transportation industry and space flight programs. But the question of just how a regulatory agency can optimize the process of gathering, analyzing, and using operational experiences to help ensure nuclear safety is certainly a complex issue worthy of examination at this conference.

The use of operating experience has long been a part of the NRC's activities (and those of its predecessor, the Atomic Energy Commission), and the agency's programs have been shaped by several past events.

In the late 1970s, the NRC was primarily focused on the licensing of new plants and the inspection of plant construction and commissioning. At that time, only one headquarters division and one branch in each of the five regional offices focused on operating reactors. Such limited resources did not enable any systematic method for evaluating the growing volume of licensee-reported event information. In addition, licensees themselves did not have the resources to systematically evaluate operating experience, nor at that time was any industry group available, such as the Institute of Nuclear Power Operations (INPO) or the World Association of Nuclear Operators (WANO), to perform such a function.

According to NRC historian Sam Walker's book titled *Three Mile Island*, the Kemeny Commission report on Three Mile Island (TMI) noted that while equipment failures contributed significantly to the emergency, "insufficient consideration of the human element had converted minor equipment malfunctions into a severe accident." The Kemeny Commission also noted that the licensee "failed to acquire enough information about safety problems, failed to analyze adequately what information they did acquire, or failed to act on that information." In particular, it pointed out that neither the licensee nor the NRC had assimilated or communicated information from an earlier precursor event in 1977 at Davis-Besse that was similar to what later occurred at TMI. During the

Davis-Besse event, the operators acted appropriately to stop the escape of coolant. Sam Walker, in reviewing the Kemeny report, notes that:

> Neither Babcock and Wilcox nor the NRC had taken effective action to draw lessons from Davis-Besse or provide warnings to other plant owners that "could have prevented the accident" at TMI.

Walker also notes that the Kemeny report referenced a 1977 report by a TVA engineer and consultant to the NRC's Advisory Committee on Reactor Safeguards that analyzed a situation very similar to the TMI event. Both Babcock and Wilcox and the NRC received drafts of the engineer's report, but "they had not found it urgent enough or convincing enough to pursue."

Critical reviews of the NRC immediately following the TMI accident in 1979 included NRC task forces to examine our analysis and evaluation activities. In response, NRC created the Office for Analysis & Evaluation of Operational Data, or AEOD, as an internal but independent office to collect operational data, to systematically analyze and evaluate these data, to feed back lessons to improve the safety of licensed operations, to assess the effectiveness of the agency-wide program, and to act as a focal point for interaction with outside organizations for data analysis and evaluation of operational experiences. At about the same time, U.S. industry also took action to create INPO, in part to provide an independent capability to evaluate operating experience and feed back lessons learned to licensees.

In 1999, as part of its initiative to streamline NRC's infrastructure, the agency implemented a significant strategic change and dissolved AEOD, transferring its core operating experience functions to two separate offices. The Office of Nuclear Reactor Regulation, or NRR, was assigned short-term operating experience functions and the Office of Nuclear Regulatory Research, or RES, was assigned long-term efforts. During this period, the agency continued to support evolutionary improvements to the systematic processes for collecting and evaluating operating experience and communicating the lessons learned to the NRC staff and the regulated industry.

The 2002 Davis-Besse reactor vessel head degradation incident was another significant event in the history of the NRC and forced another comprehensive re-evaluation of our key processes. An NRC inter-office task force in 2002 found substantial shortcomings in the agency's operating experience activities. Throughout the NRC, it was acknowledged that our operating experience programs needed reassessment. The shortcomings noted by the Davis-Besse task force were similar to those noted in the evaluations and reviews conducted after the TMI accident.

Davis-Besse was not the first U.S. nuclear plant to report reactor pressure vessel head wastage caused by boric acid-induced corrosion. Two previous events were at Turkey Point in March 1987 and at Salem in August 1987. Both of these events were documented in supplements to NRC Information Notice 86-108, "Degradation of Reactor Coolant System Pressure Boundary Resulting From Boric Acid Corrosion." These 1987 events and their lessons learned should have been pursued more aggressively by both industry and the NRC.

Furthermore, in the early 1990s, French PWR plant vessel head penetration nozzle cracking experience was generally regarded by NRC as not being directly applicable to U.S. PWR plants since, at that time, it had not yet appeared in the older U.S. plants. The French regulatory agency required programmatic changes as well as plant modifications for all affected plants following the identification of nozzle cracking at the Bugey plant. The French regulators were concerned with both catastrophic failure of nozzles from cracking and with RPV head wastage from boric acid-induced corrosion. At that time, the NRC staff did not fully appreciate the potential aggressiveness of the wastage or the importance that the French placed on this failure mode in formulating their response.

During 2004, the NRC staff developed a plan for implementing the task force recommendations and completed the framework and infrastructure for our revised operating experience program for reactors and launched it on January 1, 2005. The program established a centralized clearinghouse to systematically collect, communicate, and evaluate operating experience information and apply the lessons learned. It also makes significant use of information technology to make related information readily available to internal users and to the public.

A new database was created for managing all reported events, and a new Operating Experience Information Gateway Web site was launched that consolidates a large collection of individual databases and Web sources of information onto a single Web access page. We have also made it easier for the public to search operating experience in generic communications, event reports, and preliminary event notifications.

A new Web-based communication tool to promptly notify NRC staff members of new operating experience in their areas of expertise has been developed. This tool may also be used to examine emergent operating experience in selected areas. We have created teams of technical review groups to systematically and periodically assess operating experience in their specialized areas to identify trends and insights and to recommend actions. This program has gotten off to a successful start.

I would like to briefly discuss the basics of the operating experience program, known at NRC by the term “OpE”. As you can see on Slide 8, the first step in the process is collecting and storing OpE information. The OpE is then screened based on clearly defined guidance. Regardless of the screening decision, we always communicate OpE to various stakeholders. However, the level of communication will be dependent on the safety significance and generic applicability of the OpE. We also track and trend OpE information to identify generic issues. We review and evaluate “screened in” OpE to determine what actions should be taken. The reviewer recommends an application product to help apply the lessons learned from the OpE. An application product is synonymous with “taking action to address the issues.” These actions and products will always involve appropriate communication to internal stakeholders, and could additionally involve formally communicating to licensees and other stakeholders via Information Notices and Regulatory Issue Summaries, obtaining information from licensees in the form of a Bulletin or Generic Letter, or changing or influencing regulatory programs – licensing, oversight, incident response, or rulemaking.

This figure shows the various sources of OpE that are collected, how they are treated, and what the possible outcomes are. The left side shows the majority of OpE sources that are screened by the central clearinghouse. The middle displays the activities of the clearinghouse as shown in the process diagram. The right side shows the potential outcomes of the screening process. The main applications of OpE are generic communications, internal communications, and feedback to the inspection program. As you can see, several valuable sources of OpE are entered into the clearinghouse screening process where a decision for further evaluation is made.

There are several recent focus areas of the NRC's operating experience program for reactors:

● Today, we have a heightened sensitivity to passive component degradation, especially issues caused by extended power uprates (EPUs). Two examples of EPU issues have occurred at Quad Cities. Over the last few years, the licensee has experienced steam dryer cracking in various places. They have attributed this cracking due to the increased vibration and increased steam flow from the EPU. Quad Cities recently identified damage to their electromatic relief valves due to vibration. As you can see in the figure, there is a standing wave in the valve standpipe, and vortices are created when turbulent flow passes over a cavity. When the frequencies coincide, high amplitude pressure fluctuations occur. The licensee is developing a damper that will be used to reduce the pressure fluctuations. This is another example of how licensees continue to experience unexpected consequences of their EPUs.

● One other area of significance to operational safety is grid reliability. Since the August 2003 electrical grid blackout in North America, which resulted in loss of offsite power at a number of reactors, the agency has increased its attention in this area. Additional monitoring has been introduced, especially during high power demand situations like hot summers, to ensure licensees have prompt communication mechanisms and appropriate procedures with transmission operators to maintain the reliability of offsite power to the plant during routine operations or under possible upset conditions. This issue of grid reliability in the U.S. involves the joint regulatory oversight roles of the NRC (for the safety of the nuclear plants) and the U.S. Federal Energy Regulatory Commission (FERC) that regulates the development and use of the electrical grid (among other forms of bulk energy transfer). Because grid reliability can affect nuclear power plant (NPP) safety, and NPP generating capability (or loss thereof) can affect the stability and reliability of the grid, a symbiotic relationship exists between these technologies and therefore demands close coordination between the associated regulatory authorities. Other countries may have similar situations and perhaps together we could learn from each other.

● During 2004 through 2005, there have been eight service water (SW) silting/sanding events that occurred at U.S. NPPs. Several of these events occurred at plants that use rivers or ponds as the ultimate heat sink and are vulnerable to lowering water levels. A few licensees either didn't have adequate monitoring programs or failed to implement commitments to monitor for silt/sand. These events are of concern since silting/sanding of the SW system may result in a common cause failure of both SW trains. These pictures show the amount of sludge found in a service water pipe at a U.S. plant and what the pipe looked like after being cleaned.

● Since 1983, there have been 23 SW pump shaft and/or coupling failures. The SW pumps involved are of the vertical, deep-draft design. Recently, one plant operated a SW pump without performing any major maintenance until shaft failure occurred. Another plant periodically rebuilt the SW pumps; however, this licensee introduced a maintenance error which caused a subsequent coupling failure. The failure mechanisms of SW pumps include intergranular stress corrosion cracking misalignment, and corrosion. Over the years, several generic communications have been issued regarding service water component degradation.

● SW systems, with components often located in outdoor areas, are also susceptible to un-badged and unauthorized intruders, such as this poisonous copperhead snake found at a U.S. plant.

● NRC has also been very active in assessing external events arising from natural phenomena due to domestic and international operating experiences involving the Asian tsunami and the recent hurricanes named Katrina, Rita, and Wilma**.** Previously, NRC created a lessons learned task force to review implementation of lessons learned from Hurricane Andrew and to identify further improvements from the 2005 hurricanes. Hurricane Andrew was a Category 5 hurricane, which is the strongest category, that directly hit Turkey Point in 1992. Several lessons were learned from that event including the need for more reliable communications and for more interaction with the Federal Emergency Management Agency (FEMA) prior to plant restart. The task force also identified several lessons from the 2005 hurricanes and made several recommendations to the NRC. The top priority recommendations were to develop an NRC procedure for hurricane response, to ensure better accountability for inspectors that are dispatched to the site, and to improve the attention given to materials licensees during significant natural events. The task force also recommended that the NRC improve the diversity and reliability of agency communications during an event. The lessons learned task force report is available to the public.

There are a few other OpE areas that the NRC continues to focus on.

● Gas intrusion or voiding in safety systems continue to be a concern at some PWRs, notably the Indian Point and Palo Verde plants. At Indian Point, engineering analysis determined that, based on the large amount of gas vented from a safety injection pump, the pump was inoperable. The cause of the event was back-leakage of safety injection accumulator water through the system and subsequent gas collection within the safety injection pump casing. We take every one of these events seriously. Development of a Generic Letter to obtain information from domestic licensees on the subject has been approved and is underway.

● Significant design and design control issues in existing plants continue to appear, although they appear to be decreasing in frequency. One recent example was a degraded condition identified at the Kewaunee plant involving the potential loss of safety-related systems as a result of postulated flooding in the turbine building. This issue was rated as Level 2 in the International Nuclear Event Scale (INES) and was reported to the IAEA. A similar condition has also been identified at the Surry plant as well, and an Information Notice has been issued.

● Shutdown and low power events, such as loss-of-shutdown-cooling events, continue to be tracked by the OpE program. For example, last year Waterford was draining the reactor cooling system to install steam generator nozzle dams, when the operators accidentally formed a vacuum in the system because vent valves had not been opened as required. This condition created steam vapor and gas bubbles which passed through the low-pressure safety injection pumps. A month later, Waterford also experienced an event where a void was transferred to the reactor vessel. The licensee root cause evaluation preliminarily determined that the shutdown cooling flow created a venturi effect which sucked air from the safety injection tank and transported the air into the top of the reactor vessel.

These are some of the areas where events and degraded conditions of actual or potential risk significance have been recently observed. For these and other areas, the agency is increasing its attention by applying the operating experience lessons learned, insights, and observations. Such applications include timely and effective internal and external communication of the relevant operating experience through briefings, Web postings, the development of generic communications, and other communication mechanisms depending on significance and generic applicability. Additional inspections are performed as necessary for events and degraded conditions of safety significance.

Even more broadly, an insight we gained from the Davis-Besse head degradation event was that NRC needed a better process to institutionalize significant lessons. To address this, we have started developing an agency-wide corrective action program to better capture, track, and document the significant lessons that must be institutionalized and that must remain understood and be carefully evaluated by future generations of NRC staff.

Whether it is explaining a significant problem or explaining why something is NOT a significant problem, communicating openly and effectively with our public has always been an NRC goal. Sometimes this can be very challenging. One example is our operating experience with events involving the inadvertent release of tritium to the environment. Controlled tritium releases to the environment, such as through plant circulating water systems, occur routinely as part of normal plant operations and are normally within safe and prescribed regulatory limits. Any inadvertent spill of water containing tritium must be stopped and analyzed radiologically. So far, in such cases there have been no adverse health impacts to the public. But the public reaction can nevertheless be very strong.

A recent U.S. example involves spills of tritiated plant circulating water at the Braidwood Nuclear Plant in 1996, 1998, and 2000. These circulating water spills were on the order of 0.25 to 3 million gallons each and affected areas both within and outside of the plant boundary. Tritium from these spills was detected in a couple of near-surface locations at levels exceeding the U.S. Environmental Protection Agency drinking water standard. However, extensive testing by the licensee, independently verified by NRC and state authorities, has shown that tritium in the local drinking water wells remained at background levels or no more than about 10% of the federal standard. However, both the U.S. nuclear industry and the NRC are conducting separate task force reviews to determine lessons learned.

The inspectors' access and use of OpE has increased over the last few years. Through our internal OpE Gateway, inspectors can search for several different OpE data sources including event reports, inspection findings, generic communications, international events, and others. One of the most useful tools for inspectors is our cross-reference between inspection procedures and generic communications. For each of our inspection procedures under the baseline inspection program, hyperlinks to several relevant generic communications have been provided to allow the inspectors to better prepare for their inspections.

Inspectors also receive targeted OpE information through our internal OpE forum. Our OpE staff sends out event summaries with links to relevant OpE for inspectors and technical staff to use in their work. This information is saved on our internal website to allow any staff to review it in the future for applicability to their current activities.

Our regional offices utilize their morning conference call to discuss OpE and present relevant OpE to the inspection staff. This OpE may be from another region or from an international event that applies to U.S. plants. This allows inspectors to increase the use of OpE in their daily activities.

In addition, NRC's use of, and participation in, international operating experience forums is systematic and extensive. These experiences, such as those received through the Incident Reporting System, or IRS, and the INES, jointly developed by IAEA and NEA, are now a formal element of the NRC's operational experience screening process and are available on our internal Web site. NRC has been participating in the INES since 1993 and has fully participated in the initiative since 2001. All daily events are screened and rated, and those events that are rated Level 2 or higher are reported to IAEA.

NRC has also participated since the early 1980s in the IRS for the efficient exchange of operating experience. In addition to posting Generic Communications on our public Web site, NRC also submits all Generic Communications pertaining to reactor operating experience to IAEA on a quarterly basis.

Internally, the INES events and IRS reports from the international community are systematically screened and evaluated for applicability to U.S. plants. In 2005, a number of international events reported from these and other sources have been disseminated to appropriate NRC staff. A few of these events have been identified for detailed evaluation and potential applicability to our domestic reactors. For example, the circumferential break of the essential service water pipe at Vandellos-2 (Spain) while operating at rated power and the vibration issue found in French low-pressure safety injection and containment spray pumps are currently under staff evaluation. NRC also exchanges operating experience with individual countries and the international community through routine interfaces, meetings, conferences, and agreements.

After the first year of implementing the revised OpE program, the NRC has had several successes. Over 1000 specific OpE items were screened, of which about 100 were subject to more detailed screening by technical staff. Over 100 OpE communications, which are posted on the internal Web site, were sent to various technical staff. Thirty OpE issues were fully evaluated and dispositioned. Sixty-six Generic Communications such as information notices, generic letters and others were issued to notify licensees of issues and request information. As I mentioned earlier, we also created 30 technical groups to periodically review OpE and identify issues or trends. When I visit operating plants, I always ask about their use of OpE reports. So far, I have found every plant to be carefully evaluating and using this information on a regular basis.

Even with our current successes, we expect to face significant challenges in the future. We need to continue to stress the importance of sharing OpE and applying the lessons learned amongst regulators and the nuclear industry. This sharing of information needs to occur both domestically and internationally. As we move forward, we will also need to obtain OpE related to new reactor construction and operation that we can apply domestically.

In addition, many operating experience sources are made available to the pubic and accessible by domestic and international stakeholders through the NRC public Web site and the agency's document management system which can be accessed through our Electronic Reading Room (http://www.nrc.gov/reading-rm.html).

In conclusion, NRC's management and use of operating experience have evolved over many years. We intend to maintain continued strong vigilance in collecting and using operating experience across related industries and across international borders. To further assure success, the Commission has specifically requested periodic updates from the staff on the agency's progress in developing a rigorous corrective action program to institutionalize the lessons we learn from our experience. And, as I noted at the beginning of my talk, this is one of the key strategies of the Commission for success in our mission.

Throughout our three decades of operation, the NRC has continued to learn from operating experience. However, we clearly must continue to improve in this key area. International sharing and use of operating experience continues to play a critical supporting role in the safety of nuclear power plants worldwide.

Endnotes

1. IAEA-TECDOC-1090, Quality Assurance within Regulatory Bodies, 1999, para. 392

2. OECD/NEA, Improving Nuclear Regulatory Effectiveness, 2001, pg 11