



XA04N2815

INIS-XA-N--243

Progress in the

U.S. Nuclear

Utility Industry

1979-1989

March 28, 1979 changed the course of the commercial U.S. nuclear utility industry. An accident at Three Mile Island Nuclear Station Unit 2 in Middletown, Pennsylvania damaged the reactor's fuel core, as well as the industry's reputation and confidence.

In the months after the event, the president of the United States, the nuclear industry, the public, government regulators and the media sought answers to many questions. Among the most important were, how and why did the accident happen? The President's Commission on the Accident at TMI, the Kemeny Commission, was formed to address these questions.

Four major causes were identified by the commission:

- o inadequate or inappropriate operator training
- o mechanical problems and faulty instrumentation
- o poor control room design
- o communication failures at the facility and in information exchange within the industry

Of even greater importance was another question: How could another such accident be prevented? A look at the industry's progress in the 10 years since the TMI accident shows this question has been vigorously addressed and that corrective actions have been taken.

What Has Changed in 10 Years?

The last decade has not been an unbroken line of progress in restoring confidence in commercial nuclear power. Other operational and management problems, though not as severe as at TMI, have occurred and attracted widespread attention. Controversy surrounding the start-up of the Seabrook and Shoreham plants and long-term shutdowns of several other plants have detracted from the industry's standing and have acted as a rallying point for anti-nuclear activists.

The 1986 accident at the Chernobyl nuclear plant in the Soviet Union was a major setback, although it was soon widely recognized that U.S. commercial reactors are of quite different design than Chernobyl-type reactors. Despite these problems, the

commercial nuclear power industry has persevered, and improvements have been achieved on an industrywide basis.

Today, cleanup at the damaged TMI-2 reactor nears completion; TMI-1 is operating successfully. Utility organizations support and provide guidance on operations, training, regulatory matters and other critical issues.

Nuclear plant personnel are learning from the mistakes and experiences of their counterparts. And above all, utilities have made quantifiable major advances in virtually every area--control room design, plant and personnel performance, training and qualification, self-regulation, emergency response, maintenance and radiation protection, to name a few. The nuclear utility industry in 1989 is not the nuclear utility industry of 1979.

The Industry Addresses Kemeny Commission Recommendations

Two weeks after the TMI accident, President Carter established the Kemeny Commission to study and investigate the event and make recommendations for industry improvement, among them:

- o The commission said there must be systematic gathering and analysis of operating experience at all nuclear plants and a network to rapidly spread that information throughout the industry worldwide.
- o The commission recommended establishment of accredited training institutions for plant personnel, as well as ongoing training to maintain knowledge and skills.
- o The commission stressed management responsibility at all levels must be achieved consistently across the industry.

The industry also took swift action after the accident to prevent a recurrence. Within days of the event, the Electric Power Research Institute set up the Nuclear Safety Analysis Center to perform a complete analysis of the TMI event. (The Electric Power Research Institute, established in 1973, is involved in research and development efforts to improve electrical supply and nuclear plant safety and economics.)

A major step was the formation in October 1979 of the Institute of Nuclear Power Operations, whose programs address

each of the major Kemeny Commission recommendations aimed at the industry. The Institute's mission is to promote the highest levels of safety and reliability--to promote excellence--in the operation of nuclear electric generating plants. All 54 U.S. electric utility companies with nuclear plant construction or operating licenses are members of INPO, as are many major plant designers and international nuclear organizations.

The Kemeny Commission's report endorsed INPO, as did the administration. "The President's Response to the Recommendations of the President's Commission on the Accident at Three Mile Island," a report issued December 7, 1979, put its support behind the new organization and urged both the Nuclear Regulatory Commission and the Department of Energy to cooperate fully with the Institute.

Industry Has Exceeded Kemeny Recommendations

In the years since the TMI accident, the commercial U.S. nuclear utility industry has not only met applicable Kemeny Commission recommendations, it has progressed beyond them in improving operations at its nuclear power plants. Much of this has been accomplished via INPO's cornerstone programs: plant and corporate evaluations, training and accreditation, events analysis and information exchange, and assistance efforts.

- o The industry established its own means of evaluating performance at U.S. nuclear plants through INPO. Teams of experienced INPO staff, augmented by experts from similar plants, perform regular evaluations of every U.S. nuclear station to ensure each plant is operated and maintained according to industry standards of excellence.
- o The industry created a formal, centralized program through which event information is reported, analyzed and disseminated. Detailed information on foreign and domestic nuclear plant events is reviewed by a staff of experts at INPO. Significant lessons learned from these events are quickly transmitted through an information exchange program that links all U.S. plants;

implementation of these lessons is followed up on during INPO evaluations. An electronic messaging system that rapidly disseminates this information nationwide and to many other countries is part of this program, as well.

Accreditation and Academy Foster Training Progress

Nowhere is industry progress more evident and dramatic than in training. Early on, nuclear executives recognized the need for improved, uniform training at nuclear utilities nationwide, a need reinforced by the Kemeny Commission. The utilities also realized a need for formal training of all key craftsman and technical positions, not just for licensed control room operators.

In 1982, an accreditation process was established through INPO to address these needs:

- o Each utility conducts an extensive analysis of its training programs based on industrywide objectives and criteria, then makes any corrections needed and sends a self-evaluation report to INPO.
- o An accreditation team made up of training experts from INPO and the industry then visits the plant to assess training programs and provide recommendations for improvement.
- o Once the utility responds to these recommendations, a panel of the independent National Nuclear Accrediting Board meets with the utility to determine whether the programs meet accreditation objectives and criteria. The accrediting board, made up of eminent Americans from various fields, awards accreditation or defers it until upgrades are achieved. The charter for the board requires that the majority of a decision-making panel be from outside the nuclear utility industry.

The National Academy for Nuclear Training, the type of training institution recommended by the Kemeny Commission, was established under the auspices of INPO to further strengthen the U.S. nuclear utility industry's training efforts.

The National Academy is comprised of three elements:

- o the training activities, resources and facilities of the nuclear utility industry
- o the National Nuclear Accrediting Board
- o INPO training and accreditation activities

Each plant site with accredited training programs is a branch of the National Academy. Utilities must have all training programs accredited at each of their operating nuclear plants to become members of the National Academy. At the end of 1988, 72 plants were branches, and 50 utilities were members.

Industry Meets Training Milestones

In the years since accreditation and the National Academy have been established, the industry has met many training milestones. Training programs at all plants that loaded fuel by the end of 1984 had achieved accreditation by mid 1988, and plants that loaded fuel in 1985 and beyond committed to having their training programs ready for accreditation within two years of fuel load. The industry works equally hard to keep high training program quality ongoing by renewing accreditation every four years.

As a result of all the above efforts, training facilities and staffs in the U.S. industry since TMI have been revolutionized.

- o Training is now provided for all key craftsman and technician positions. At the time of the TMI accident, formal training was conducted at many utilities only for licensed control room operators. Classroom lectures make up but a fraction of modern nuclear plant training; on-the-job, performance-based training using the latest, most sophisticated techniques in realistic laboratories and in the plant itself provides practical, hands-on experience for trainees.
- o In 1979, 460,000 square feet of space across the industry were dedicated to training facilities; today, that number is over three million--a 568 percent increase.

- o More professionals are conducting training today--over an eightfold increase since 1979. These staff members, who have years of plant experience and are carefully selected from the operational and educational fields, are responsible for training the entire nuclear work force.
- o Five- or six-shift personnel rotations are now the norm in most plants, compared with three or four shifts 10 years ago. The extra shifts help alleviate excessive hours worked and provide ample opportunity for training; one shift is usually in training at each plant, showing the industry's ongoing commitment.
- o Control room simulators, replicas of control room facilities, are used to train operators to handle routine as well as unexpected events. In 1979, 12 of these simulators were in use. By 1988, 71 were operating; 14 more are scheduled for operation in the next several years.

Performance Improved Across the Board

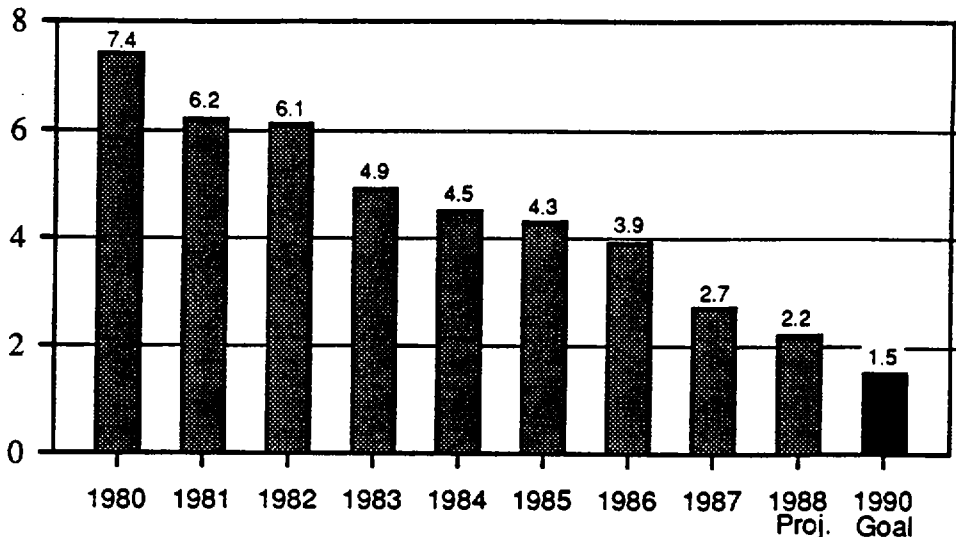
The industry's training accomplishments over the past 10 years are among its most noteworthy achievements. But performance is the bottom line, and industry efforts are geared above all toward its improvement.

In 1981, the industry began developing a performance indicator program through INPO to provide quantitative measures of progress made in key areas. Not only do the performance indicators allow utilities to gauge their plants' improvements, they also allow the industry as a whole to measure its progress. In addition, the indicators foster healthy competition among utilities and plants, a thoroughly American quality that inevitably results in better performance.

By 1986, each U.S. utility with an operating unit had set 1990 goals for these performance indicators; the individual goals were used to develop an overall industry goal. Already, several of the 1990 goals have been met or surpassed, proof of the industry's ongoing commitment to top-notch performance.

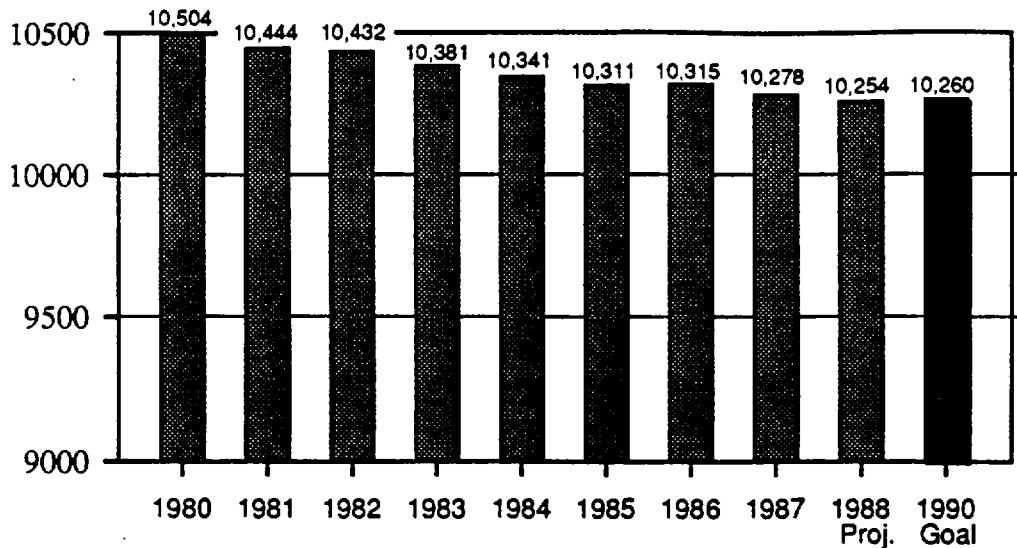
In many areas, progress is already impressive.

- o Since 1980, the number of unplanned automatic shutdowns while the reactor is critical has been reduced by more than 70 percent. As these shutdowns, which challenge safety systems, typically cost over \$500,000 per day each in replacement power, this represents not only a measure of improved safety, but a huge savings for utilities and their customers, as well. This improvement also attests to the results of industry efforts in training, maintenance and management attention to detail.



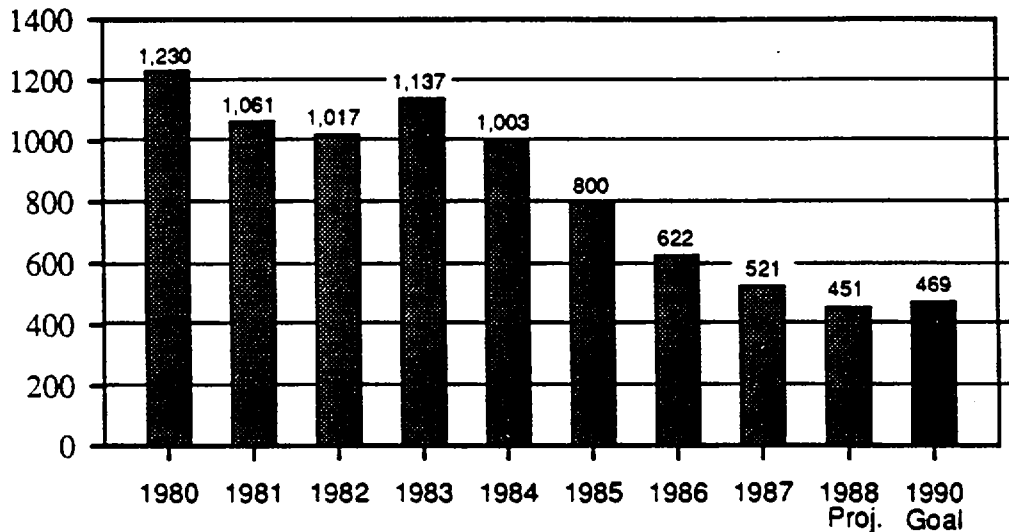
Unplanned Automatic Scrams While Critical (per unit)

- o The decrease in gross heat rate, or the number of Btu of energy to produce a kilowatt-hour of electricity, since 1980 represents a gain of more than 2 percent in overall plant efficiency--a savings of about \$400 million each year for the industry. Gross heat rate improvements reflect emphasis on thermal efficiency in design and operation, including attention to detail in plant maintenance and equipment performance. In effect, the plant must be "well tuned" to achieve optimum heat rate. When this is the case, abnormalities are more easily recognized, and safety is enhanced. In 1988, the industry bettered the 1990 goal for gross heat rate.



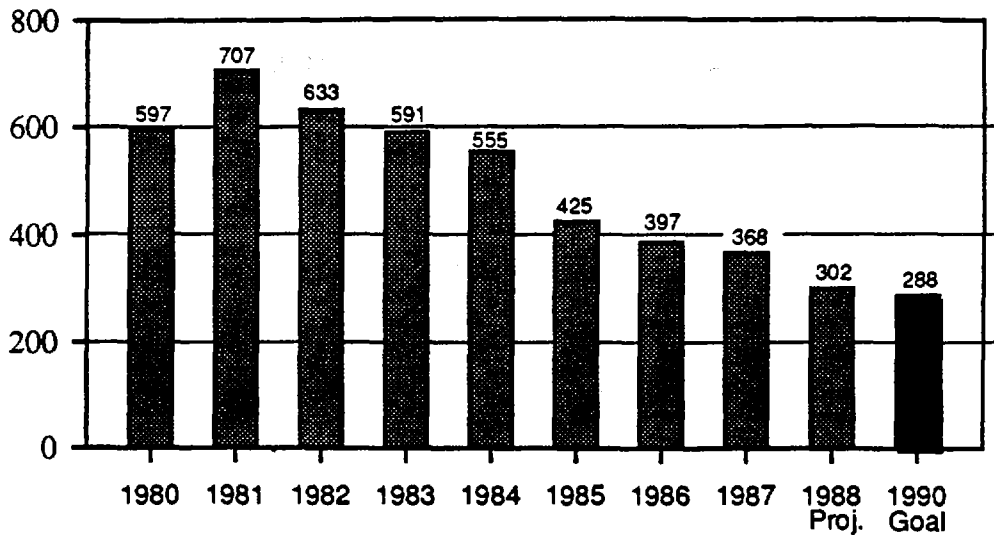
Gross Heat Rate (Btu per kilowatt-hour)

- o Collective radiation exposure to plant workers has decreased 61 percent since 1980, showing radiological protection programs are minimizing collective and individual exposures. The industry has also greatly reduced the number of contaminated areas in plants, which makes plant inspection and maintenance easier.



BWR PLANTS

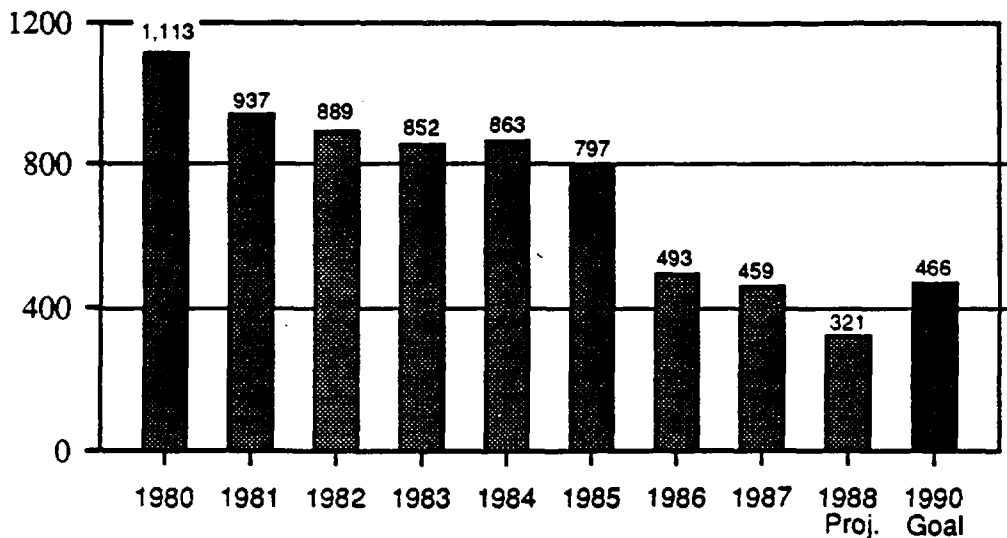
Collective Radiation Exposure (in man-rem per unit)



PWR PLANTS

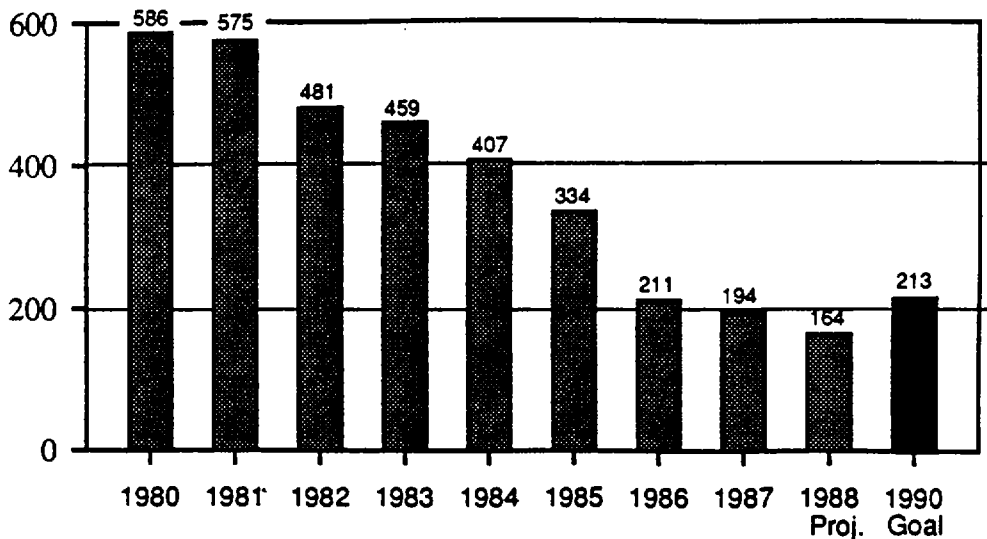
Collective Radiation Exposure (in man-rem per unit)

- o The volume of low-level solid radioactive waste has been reduced by 75 percent. The reduction results from good maintenance and management control programs. Minimizing radioactive waste production has both economical and ecological benefits, reducing storage, transportation and disposal needs. Maintaining the current level of progress in this area saves about \$100 million annually. The industry surpassed the 1990 goals for this indicator in 1987.



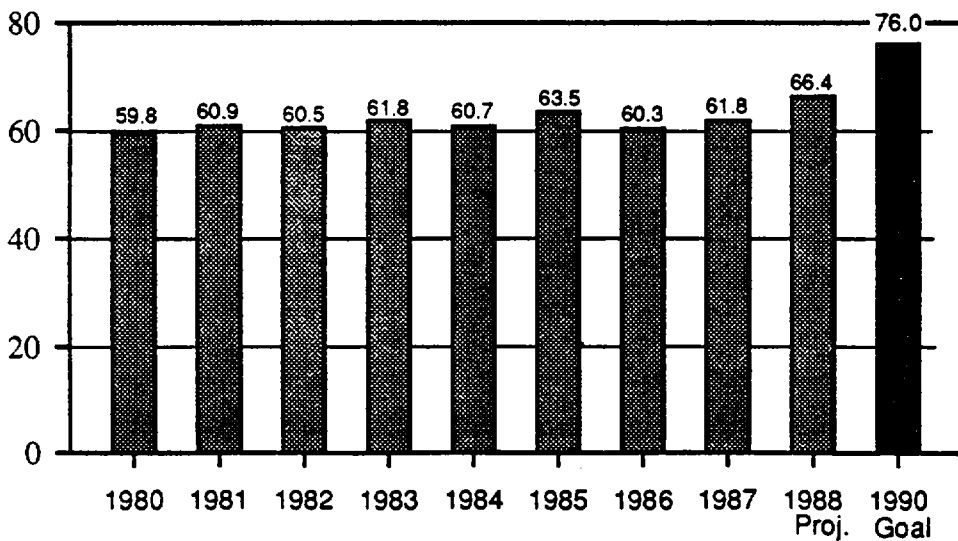
BWR PLANTS

Volume of Low-Level Solid Radioactive Waste (in cubic meters per unit)



PWR PLANTS
Volume of Low-Level Solid Radioactive Waste
 (in cubic meters per unit)

- o Average equivalent availability is on the rise. In recent years, industry averages for equivalent availability--the ratio of electricity a unit could have produced versus its capacity--have been affected by several plants in long-term shutdown. However, some of these plants have returned or are in the process of returning to operation. In 1987, equivalent availability was 61.8 percent; in 1988, that figure increased to 66.4 percent.



Equivalent Availability Factor (percent)

- o Utilities set a 1990 equivalent availability goal of 76 percent. Already, some 25 percent of U.S. units are meeting or surpassing the 1990 goal, operating at the level of the best-running plants throughout the world. For three-quarters of 1988, 47 percent of U.S. units were above the 1990 goal.

The NRC also tracks performance indicators through its ongoing plant inspection program. The NRC recently issued "Report to the U.S. Nuclear Regulatory Commission on Analysis and Evaluation of Operational Data," which corroborates the above conclusions.

The commission also noted a sizeable reduction in significant events--from 2.4 per reactor in 1985 to 0.8 in 1987. "A review of data from nuclear power plants operating in this country suggests that the overall operational safety of these facilities has improved," noted the paper.

World Association of Nuclear Operators to Promote High Standards Worldwide

The accident at TMI was a turning point for U.S. nuclear utilities, heightening the focus on operating nuclear power plants safely and reliably. In the past 10 years, noteworthy strides have been made by the industry, often through programs of INPO and other industry organizations. And ongoing progress is ensured through continuing communication of operating information.

The 1986 accident at Chernobyl pointed out the need for a similar approach on a worldwide basis. In October 1987, over 130 representatives from 29 countries operating nuclear power plants gathered at the International Nuclear Utility Executives Meeting in Paris to seek a history-making resolution. Discussion centered on the meeting's main objective: how to improve the exchange of nuclear safety information across the globe. As a means to that end, the World Association of Nuclear Operators, WANO, was conceived.

Since the Paris meeting, a foundation for WANO has been put in place. At an inaugural conference May 15-17, 1989 in Moscow, utility executives from all countries operating nuclear power plants are expected to approve and sign a charter formally establishing WANO. To a major degree, WANO is being modeled after INPO and after the initiative taken by the U.S. industry post-TMI.

Not only is WANO the type of international network recommended by the Kemeny Commission, it shows the industry's direction for the future and its progress in the past 10 years. U.S. nuclear utilities have gone from being relatively isolated, autonomous entities to a cohesive industry with common standards and goals. The accident at Three Mile Island showed that if one plant falls short in performance, all suffer. Likewise, if one plant excels and shares how it did so, all profit from that success.

In every area of nuclear power--training, plant and personnel performance, events analysis, information exchange--lessons learned and improvements made have strengthened the industry, enabling it to meet the challenges of today and tomorrow.