WRITTEN TESTIMONY
OF DALE E. KLEIN, CHAIRMAN
UNITED STATES NUCLEAR REGULATORY COMMISSION
TO THE
SENATE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS
SUBCOMMITTEE ON CLEAN AIR AND NUCLEAR SAFETY

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Mr. Chairman, Senator Vitter, and distinguished members of the Subcommittee, I want to thank you for inviting Commissioner Jaczko, Commissioner Lyons, Commissioner Svinicki and me to appear before you today to discuss the lessons learned from the Three Mile Island (TMI) Nuclear Power Plant accident 30 years ago.

My testimony will provide some historical background to explain what happened, address the U. S. Nuclear Regulatory Commission's (NRC) response and outline some of the major regulatory improvements implemented to enhance nuclear safety and security, and mention two significant challenges that still remain unresolved.

The March 28, 1979 accident remains the single most important event in the history of the NRC and the commercial nuclear power industry in the United States. The TMI crisis revealed weaknesses in the licensing and operation of nuclear plants and brought about critical improvements in assumptions, procedures, and priorities—both at the NRC and in industry.

One of the most important changes that has occurred over the last 30 years is an intensive focus on creating what we call a strong "safety culture"—both in industry and internally at the NRC. In addition to the specific changes made in direct response to the accident at Three Mile Island, I will discuss a number of broader steps the agency has taken to promote a work environment where management and employees are dedicated to putting safety and security first.

It is important to note that we have come a long way in the past 30 years in improving the regulatory oversight of nuclear power plants. But we must also continue to remember the past, to learn from where we have been, and to ensure that past mistakes are not repeated.

This hearing contributes to all of these goals; and I appreciate the Committee's interest in understanding the lessons that have been learned and implemented.

I assure you, the Commission has not forgotten about the TMI accident. In fact, some of the historical background I will outline is adapted from a recent paper by the NRC's historian, Dr. Samuel Walker, entitled "Three Mile Island after Thirty Years," which was developed as part of an effort to ensure that current and future NRC employees learn from what happened at TMI. Moreover, in 2004, Dr. Walker published ***Three Mile Island: A Nuclear Crisis in Historical Perspective*** as Volume 4 in a series of books on the history of nuclear regulation.

Because many current NRC employees are too young to remember what happened at TMI and/or were not working at NRC when the accident occurred, the Agency will hold a seminar tomorrow for these NRC employees. The seminar will include an explanation of the accident from a technical perspective, personal insights from an operator in the control room, and a discussion of the event from the point of view of the White House, State government, and the NRC. A number of presenters—including former Pennsylvania Governor Richard Thornburgh and former NRC director of the Office of Nuclear Reactor Regulation Harold Denton—are also participating in this hearing. Video-teleconferences have been arranged at all NRC locations to ensure that all NRC employees have an opportunity to benefit from this offering.

HISTORICAL BACKGROUND

Unit 2 of the Three Mile Island nuclear generating station was the newer of two reactors located on a sliver of land in the Susquehanna River about 10 miles southeast of Harrisburg, Pennsylvania. The accident was the result of a series of mechanical failures and operator errors that (researchers later determined) uncovered the reactor's core and melted about half of it. The immediate cause of the accident was a pressure relief valve that stuck open and allowed large volumes of water to escape from the reactor coolant system. The instrument

panel did not provide a clear picture of what was happening in the reactor, and the operators failed to recognize that the core was overheating. Although the plant's emergency core cooling systems began to work according to design, the operating crew, acting on the training they had received, decided to reduce the flow of emergency coolant to a trickle. By the time the operating crew recognized that the plant had suffered a loss-of-coolant-accident and flooded the core with coolant, the reactor had been irreparably damaged.

The initial response to the accident by Federal and State authorities was hesitant and uncertain, largely because no one could confidently assess the condition of the reactor or estimate the risk of releasing significant amounts of radiation to the environment. Thus, decision makers and their technical advisers were faced with having to make crucial decisions with only fragmentary information at their disposal. The most important—and the most excruciating—dilemma was whether to order an evacuation of the area surrounding the plant. On the one hand, if the containment vessel leaked, and the walls of the containment building that surrounded the reactor were breached, radioactive material would be released into the environment. On the other hand, Governor Thornburgh was acutely aware that ordering a large-scale evacuation also presented serious risks of panic and injury.

The greatest source of concern was a hydrogen bubble that formed in the reactor vessel, the large container that held the reactor core. At first, experts feared that the bubble could inhibit efforts to cool the core and bring it to a safe shutdown condition. However, another issue soon arose. Scientists, engineers, and government officials began to worry that the bubble, over time, might become flammable or even explosive. Some believe that in a worst case scenario, a burn or explosion could rupture the pressure vessel. If this occurred, it would increase by uncomfortable proportions the chances of a breach of the containment building, the last line of defense against a release of radiation. Eventually, it became clear that the bubble was not as significant a problem as originally thought. The absence of free oxygen

in the pressure vessel prevented the bubble from reaching a flammable or explosive condition. But this was not obvious immediately, and it took time to arrive at this conclusion.

The resolution of the bubble question ended the acute phase of the TMI crisis. However, the accident vividly demonstrated a series of unsettling problems that demanded immediate attention. Internally, the NRC undertook a number of investigations and instituted a Special Inquiry to review and report on the accident. The results of this inquiry, known as the Rogovin Report, described what happened and why, assessed the actions of the utility and NRC personnel before and during the accident, and identified deficiencies in the regulatory regime and areas where further investigation might be warranted. The NRC promptly took action to correct the deficiencies that the accident had revealed in key areas, including operator training, instrumentation, communications, evaluation of operating data, and emergency planning.

In addition to the reforms the NRC adopted based on internal findings, the Agency responded to a series of recommendations made by the President's Commission on the Accident at TMI. President Carter established the Commission on April 11, 1979, and named John G. Kemeny, President of Dartmouth College, as its Chairman. The White House deliberately avoided placing anyone on the panel that was associated with strong pro- or anti-nuclear views. The Kemeny Commission held a series of public hearings, took more than 150 depositions, and collected a vast body of documentary evidence. Findings were presented to President Carter on October 30, 1979, and released to the public the following day. The completed study consisted of a 179-page overview and nine volumes of task force reports that totaled more than 2,200 pages.

The central feature of the Kemeny Commission report was a list of 44 recommendations that the panel deemed of "vital importance" for reducing and managing the risks of nuclear power. The Kemeny panel broke down its proposed reforms into seven broad categories: the NRC, the utility and its suppliers, training of operating personnel, technical assessment, worker

and public health and safety, emergency planning and response, and the public's right to information. Dr. Walker's pamphlet, which I mentioned earlier, is attached to this testimony and provides a detailed discussion of the Kemeny Commission recommendations, so I will not repeat them here. I think it is sufficient to note that they were comprehensive and wide-ranging.

The NRC's response to the Kemeny Commission's recommendations, as well as its own internal investigation, led to important improvements in regulatory approaches and performance. An obvious example was the increased emphasis on human factors, which reflected the Kemeny Commission's conclusion that the "fundamental problems" at TMI were "people-related problems and not equipment problems." In 1989, the NRC published a report, "The Status of Recommendations of the President's Commission on the Accident at Three Mile Island: A Ten-Year Review," that described its response to each of the 44 recommendations of the Kemeny Commission over a period of ten years.

REMEMBERING TMI IN A CHANGING REGULATORY ENVIRONMENT

During the three decades since the TMI accident, the focus of nuclear regulation has shifted in accordance with changes in the nuclear industry. In 1979, the licensing of new plants was one of the NRC's most important and visible activities. By the mid-1980s, however, most of the plants that had been under review at the time of the accident had either been awarded operating licenses or had been cancelled. The NRC received no new applications for construction permits, the first phase of what was then a two-step licensing process, after 1978. As a result, the licensing of plants ceased to be a major function and the NRC focused primarily on regulation and oversight of the operation of existing plants.

The Agency's wide-ranging improvements in ensuring higher standards of nuclear safety and security over the past thirty years include personnel training, internal processes and procedures, infrastructure and planning, technological upgrades, oversight and risk

assessment methodologies, and safety culture expectations. In fact, discussing in detail every specific improvement—such as requiring two NRC resident inspectors at every nuclear power plant site, or the massive overhaul and modernization of our Incident Response Center—would be too extensive for this testimony.

Allow me, however, to list some of the key changes:

- Upgrading and strengthening of plant design and equipment requirements. This includes piping systems, auxiliary feedwater systems, containment building isolation, reliability of individual components (pressure relief valves and electrical circuit breakers), fire protection, and the ability of plants to shut down automatically;
- Identifying human performance as a critical part of plant safety, enhancing and simplifying emergency operating (or accident) procedures, revamping operator training and staffing requirements, followed by improved instrumentation and controls for operating the plant, and establishment of site-specific simulators which has allowed extensive "what-if" training for licensed operators;
- Improving instruction to avoid the confusing signals that plagued operations during the accident;
- Enhancing emergency preparedness to include immediate NRC notification requirements for plant events and an NRC operations center staffed 24 hours a day with access to plant status data. Drills and response plans are now tested by licensees several times a year, and State and local agencies participate in drills with the Federal Emergency Management Agency and NRC;
- Establishing a program to integrate NRC observations, findings, and conclusions about licensee performance and management effectiveness into a periodic, public report;
- Performing regular analysis of plant performance by senior NRC managers who identify those plants needing additional regulatory attention;

- Expanding NRC's resident inspector program – first authorized in 1977 – whereby at least two inspectors live nearby and work exclusively at each plant in the U.S. to provide daily surveillance of licensee adherence to NRC regulations;
- Expanding performance-oriented as well as safety-oriented inspections, and the use of risk assessment to identify vulnerabilities of any plant to severe accidents;
- Strengthening and reorganization of enforcement as a separate office within the NRC;
- The installing of additional equipment by licensees to mitigate accident conditions, and monitor radiation levels and plant status;
- Employing major initiatives by licensees in early identification of important safety-related problems, and in collecting and assessing relevant data so lessons of experience can be shared and quickly acted upon;
- Expanding NRC's international activities to share enhanced knowledge of nuclear safety with other countries in a number of important technical areas.

Although it is not an element of the NRC's work, I would be remiss if I did not mention one other critical improvement: the establishment of the Institute of Nuclear Power Operations (INPO), the industry's organization which promotes excellence in the safety and operating performance of nuclear power plants around the country by sharing data and best practices.

SECURITY IMPROVEMENTS

Of course, one key change in the regulatory environment for nuclear power since 1979 had nothing to do with Three Mile Island. The terrorist attacks on the World Trade Center and the Pentagon on September 11, 2001, brought about a thorough reassessment of the security of nuclear plants.

Since 9/11 the NRC has required many security enhancements at licensed power reactors and other nuclear facilities. Our licensees now have increased patrols, stronger and

more capable security forces, additional physical barriers, greater standoff distances for vehicle checks, more restrictive site access controls, enhanced emergency preparedness and response plans, enhanced coordination with law enforcement authorities, and many other heightened security measures.

In addition, on a voluntary basis, licensees report suspicious activities occurring at or near their facilities. Also, NRC intelligence analysts screen Intelligence Community threat reporting on a daily basis, looking for threats to NRC licensed facilities and materials as well as for changes in the general threat environment that could affect the security posture at the facilities we license. This information is analyzed within the context of other threat data and is shared with DHS and the Federal Bureau of Investigation (FBI).

The NRC also has significantly increased its ability to provide effective oversight of security at power reactor facilities. In 2000, NRC inspectors spent about 40 staff-weeks a year directly inspecting security. More recently, the NRC has been spending over 200 staff-weeks per year on security. In addition, the NRC now conducts much more realistic force-on-force exercises as part of its security inspection program, in which a highly trained mock adversary force simulates an attack on a facility. The transition to this enhanced force-on-force program occurred in November 2004. Since then, NRC has conducted more than 250 of these full-scale exercises and continues to work, using lessons learned, to make the exercises even more realistic. We also have required power plants to add more training and higher qualification standards for security personnel and to increase substantially the numbers of security personnel, among other measures. In our security efforts, the NRC coordinates extensively with the DHS, FBI, and other Federal entities in integrating nuclear security efforts into national security planning. Most recently, the Commission approved a rule that requires applicants for new power reactors to assess the ability of their reactor designs to avoid or mitigate the effects of a large commercial aircraft impact.

THE REMAINING CHALLENGES

The NRC still faces two significant challenges, one discrete and one ongoing. The discreet challenge is something that was recommended by the Kemeny Commission and yet remains partially unresolved to this day. At the time of the TMI accident, the NRC occupied several different office buildings, and the Kemeny Commission called for a consolidation of the Agency in the same location to improve communication and provide for a coordinated emergency response. This was largely accomplished when the NRC moved into adjacent buildings in Rockville, Maryland, between 1987 and 1994. But as the NRC has grown in size in recent years, the Agency has exceeded the capacity of the current two building headquarters complex and has acquired temporary office space in the Rockville area to accommodate this growth. I would like to thank Congress for supporting NRC's efforts to pursue a third building adjacent to the current White Flint complex so that we can accommodate our staff, shed temporary offices, and again have a consolidated headquarters.

The ongoing challenge is something that confronts every industry and every regulatory body concerned with safety: the danger of complacency. Before the TMI accident, reactor experts were confident that they had solved the most important reactor safety issues. This confidence and the complacency it fostered were shattered on the morning of March 28, 1979, by the combined forces of management weakness, limited operator training, inattention to human factors, and confusing instrumentation. In recent years, several identified operating deficiencies have underscored the continuing need for strong safety requirements and effective implementation. The most serious example was discovered at the Davis-Besse plant in Ohio in 2002. Both the licensee and the NRC failed to detect corrosion before it resulted in a large gap in the head of the pressure vessel. Although the problem did not result in a breach of the primary coolant system, it was the most serious safety issue since the Three Mile Island accident, and highlights the potential consequences of careless operating practices and flawed regulatory procedures.

To help guard against complacency, the NRC has been working to improve safety culture, throughout the industry and within the agency, for at least two decades.

- In 1989, in response to instances of operator inattentiveness and unprofessional behavior in the control room of some nuclear power plants, the Commission first published a policy statement to foster the development and maintenance of a safety culture at nuclear power plants.
- In 1996, in response to reports of management retaliation against licensee personnel for raising safety concerns, the Commission issued a policy statement affirming its expectation for NRC licensees to establish and maintain a safety-conscious work environment in which employees would feel free to raise concerns both to their own management and the NRC without fear of retaliation.
- In 2003, the Commission directed the staff to develop guidance that would identify best practices for establishing a safety-conscious work environment and to consider developing objective measures that could serve as indicators of possible problems with safety culture.
- In 2006, the agency enhanced the Reactor Oversight Process to, in part, implement lessons learned from the Davis-Besse incident.

The NRC has a vigorous, ongoing, conscientious commitment to maintaining a strong safety culture. Because it is something that requires constant attention, it is a subject I mention frequently in my speeches and remarks to the staff—including, most recently, my keynote address at the Agency's Regulatory Information Conference two weeks ago.

CONCLUSION

As the NRC evaluates the first applications for newly-ordered plants in three decades, the Agency can take pride in the improvements made since the crisis of 1979. However, the

Three Mile Island event remains a stark reminder of the need for strong performance, effective oversight, and unrelenting vigilance. As I said at the start of my testimony, it is important to note that we have come along way over the last 30 years. It is equally important that we continue to remember the past, to learn from where we have been, and to ensure that the mistakes of the past are not repeated.

Mr. Chairman and Members of the Committee, thank you for having me and my colleagues here today. I look forward to answering your questions.