NUCLEAR ENERGY LEADERSHIP

Lessons Learned From U.S. Operators

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Contents

Preface

With the disastrous events at Japan's Fukushima Daiichi station on March 11, 2011, the safety and viability of nuclear power again came to the forefront of the public dialogue. The record earthquake and tsunami destroyed towns and took thousands of lives, flooded the Daiichi nuclear units, and wiped out power supplies and the backup diesel generators designed to cool the reactor and the stored used nuclear fuel. If good can come from terrible loss, then Fukushima may ultimately bring clarity to the global risks of nuclear energy—and how to minimize them.

While fossil-derived energy has fueled extraordinary growth in much of the world's economy, the full cost of burning fossil fuels is increasingly realized in terms of its environmental impact and the loss of human life. When the Macondo well operated by BP and Transocean started blowing millions of gallons of oil into the Gulf of Mexico on April 20, 2010, the explosion killed 11 men, destroyed countless Gulf creatures and plant life, and severely damaged the regional coastal economy. Although this disaster was one of many deadly ocean drilling blowouts, refinery explosions, and coal mining accidents in recent years, it garnered the public's attention regarding the costs of a fossil energy–hungry economy.

Many countries have relied on nuclear power as a key part of their energy portfolios and, like the United States, plan to continue using nuclear generation into the future. Other countries are in the process of building a number of new nuclear power plants. Nuclear power has become more attractive over the years because of its negligible carbon impact. Nuclear power is also locally generated, and so it does not need to be imported. But nuclear power plants are very expensive to build and extremely challenging to run well. Fortunately, there are many nuclear operators who have figured out how to run nuclear power plants with exceptional safety and reliability.

This book is not a polemic on the complicated history of nuclear energy or on the policies shaping the future of nuclear power. Nor is it a technical manual on how to run a nuclear power plant. *Nuclear Energy Leadership: Lessons Learned from U.S. Operators* is a discussion of how to lead and manage power plant organizations in order to achieve and maintain the highest possible levels of safety and production simultaneously. This book is based on the hundreds of observations, thousands of interviews and assessments, and essential lessons learned over a period of nearly 15 years

of immersion in the nuclear power industry. It is a tribute to those leaders and managers who make the commitment every day with hope that others, whether running nuclear power plants or other high-risk operations, will learn from the effort.

CHAPTER 1 State of U.S. Nuclear Energy

The United States' commercial nuclear power industry has steadily improved its safety, production, and financial performance over the past 30 years to become the safest, most reliable, and lowest-cost electricity generator.[1] U.S. nuclear power has made an industry-wide transformation since March of 1979 when a series of events at the Three Mile Island (TMI) nuclear power plant near Middletown, Pennsylvania, resulted in a partial reactor core meltdown and a public much more concerned about nuclear plant safety. The disastrous incidents at the Daiichi nuclear power plant in Fukushima, Japan, in March 2011 subsequent to the Great East Japan Earthquake and Tsunami have awakened the public's anxieties about nuclear power. Yet the Fukushima disaster comes at a time when U.S. nuclear power plants have become the safest industrial working environments worldwide and overall plant performance is at an all-time high:

- Nuclear stations' total industrial safety accident rate has been at or below 0.21 accidents per 200,000 worker-hours since 2001 (fig. 1–1).[2]
- Nuclear generating *unit capability*, the percentage of time the plant is online and producing electricity, has been at or above 91% since 2001 (fig. 1–2).[3]
- Nuclear electricity production costs were 2.14¢ per kilowatt-hour (kWh) in 2010 and have hovered around 2¢/kWh beginning in 2001 (fig. 1–3).[4]

Japan's record earthquake and tsunami and the resulting accident at the Fukushima Daiichi nuclear power plant had a powerful impact on the views of nuclear energy worldwide. Before elaborating on the merits of effective nuclear energy operators and how to learn from the best practices of the industry, it is important to review the events surrounding the Fukushima disaster and discuss the impact on the U.S. nuclear energy industry.

Future of U.S. Nuclear Power

Commercial nuclear power continues to be a significant source of electricity in the United States, providing approximately 20% of the nation's electricity every year since 1990. As a result of its high reliability and low production cost, nuclear power is more intensive than all other sources. While nuclear power is only one-tenth of the total U.S. electricity generation capacity, nuclear plants generate one-fifth of the electricity used—because most nuclear plants run continuously to provide baseline megawatts to the grid and to get the best use out of their nuclear fuel (fig. 1–4).[16]

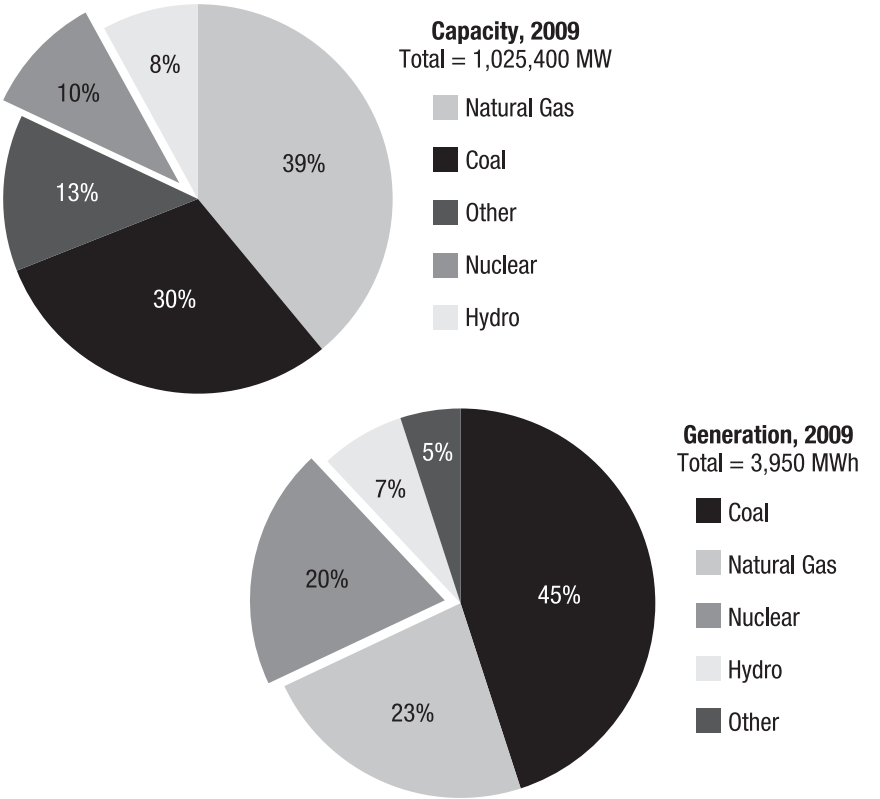

Fig. 1–4. U.S. electricity capacity and generation, 2009. Nuclear plants use more of their capacity to generate electricity than other plants. (Source: U.S. Energy Information Administration. 2012. *Electric Power Monthly*, July, table 1.1.)

- Industry evaluations (e.g., INPO evaluations)
- Operating experience
- QA/self-assessment/benchmarking/behavioral observations
- Employee concerns program
- Workforce issues, for example, grievance trends, potential SCWE claims, and hostile work environment claims
- Corrective action program evaluations
- Site performance trends[21]

The guidelines include a graded approach to nuclear safety culture assessment clarifying when to use a self-assessment, independent assessment, or a third-party assessment, and what the products and team makeup would entail. The information sources listed above are discussed as ways to identify early indications of potential problems, develop actions to address the issues, and evaluate the effectiveness of the actions. The site leadership team (ch. 11) is recognized as a critical force in monitoring and shaping the station's nuclear safety culture such that it is ultimately responsible for the site nuclear safety culture process.[22]

International Atomic Energy Agency

The International Atomic Energy Agency (IAEA) works to establish international nuclear energy safety norms and recognizes the importance of individual and organizational behavior in nuclear power safety. The IAEA approved the publication of safety standards in 1993, in which principle 3, leadership and management for safety, includes a definition and discussion of safety culture. According to the IAEA, safety culture includes the following:

- "Individual and collective commitment to safety on the part of the leadership, the management and personnel at all levels
- Accountability of organizations and of individuals at all levels for safety
- Measures to encourage a questioning and learning attitude and discourage complacency with regard to safety"[23]

Of note is a recent international effort to enhance previous safety culture definitions to make a more serviceable construct on a global scale. Nils Diaz

contribute to operational focus. Ultimately, the operation is the only reason the rest of the organization exists."[15]

Safety and Production Results

Operational focus promotes both safety and production simultaneously by creating an environment where all evolutions of the unit are controlled and the unit performs as expected. To create this environment, personnel have a low threshold for identifying, and appropriately managing, any potential threats to the safe operation of the unit. This also includes operationally focused behaviors by those working across the site, even those who have only an indirect impact on the unit. By having a high degree of rigor regarding potential impacts to reactor functioning, and prioritizing work that improves the monitoring and performance of the reactor, the unit is more likely to achieve its full capacity, barring any problems in the fuel itself. Threats that would potentially take the unit offline are diminished. Hence, an operationally focused organization is a high-performing organization. Figure 4–1 illustrates how practicing INPO's operational focus principles leads to safety and production results via a stable, predictable reactor.

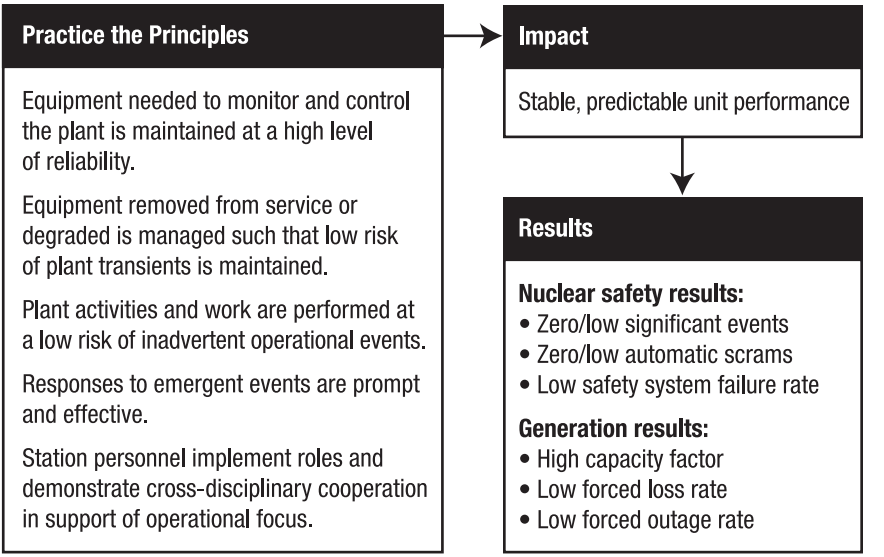

Fig. 4–1. Operational focus pathway to results in safety and production

the overall model for performance improvement, as well as details on the necessary components of a complete and effective program. The industry's model is considered a continuous cycle of problem prevention, detection, and correction (fig. 5–1).[11]

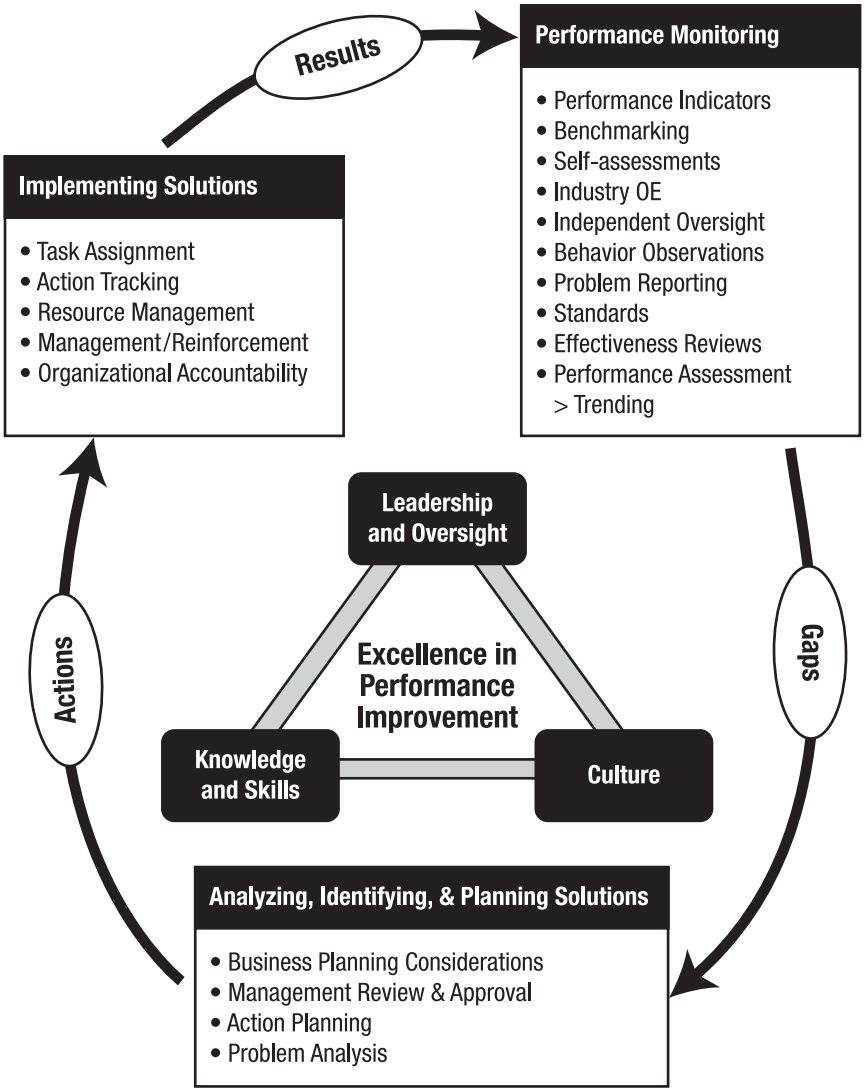

Fig. 5–1. INPO performance improvement model