

Happy Days for Nuclear Power?

The first license to construct a new nuclear power plant in the U.S. in 34 years was granted by the Nuclear Regulatory Commission on Feb. 9. Has the elusive nuclear renaissance finally begun?

By Kennedy Maize

There was justification in early February for the U.S. nuclear industry to be humming the famous Depression-era song "Happy Days Are Here Again."

Feb. 9, 2012, in Washington's Maryland suburbs was a bright but chilly day following a quick blast of cold Canadian air and a dusting of snow that stuck on lawns and fields but not roads. At noon, the U.S. Nuclear Regulatory Commission (NRC) voted 4-1 to approve a combined construction and operating license for Southern Co.'s two new units at its existing Vogtle nuclear station in Georgia (Figures 1 and 2). It marked the first new construction license for a nuclear plant since Jan. 27, 1978, when Carolina Power & Light won a construction license for its Shearon Harris Unit 1 in central North Carolina.

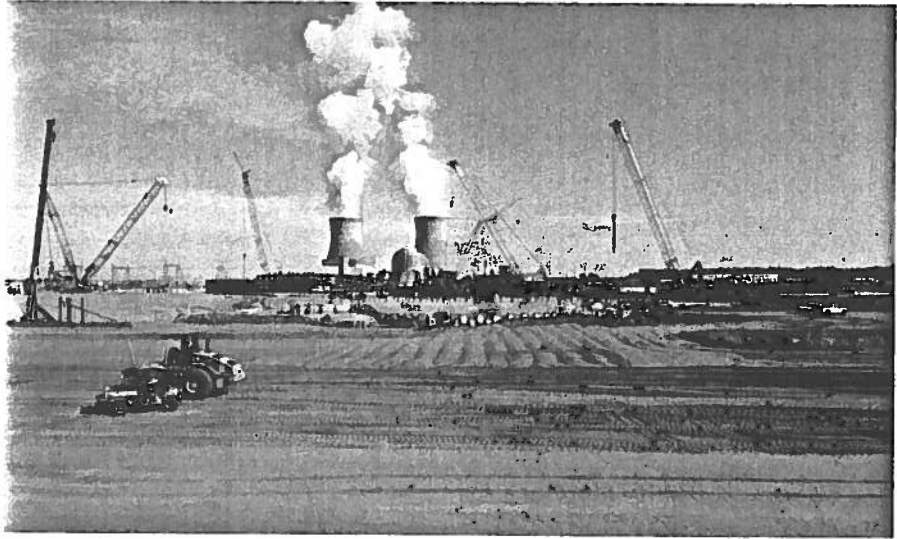
That February moment was sweet. The industry's long nuclear nightmare appeared to be over. The long-depleted project pipeline was getting an injection. The NRC was expected to soon approve a license for another new two-unit project, in South Carolina.

Industry Insiders Meet

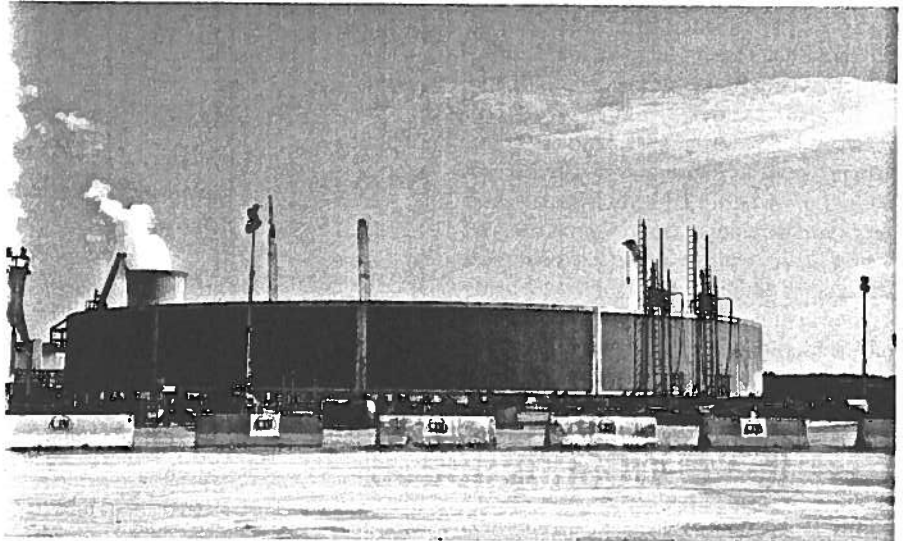
Across a busy Rockville Pike from the NRC at a swanky Marriott hotel, Platts was holding its 8th Annual Nuclear Energy conference Feb. 9 to 10. Despite the NRC action, there was a slightly bittersweet aftertaste that colored the Platts gabfest. The version of the Happy Days song that seemed most appropriate for the nuclear business that day was Barbra Streisand's slow-tempo, ironic, and somewhat somber 1960s version, not the ebullient 1929 original that became the theme song for Franklin Delano Roosevelt's successful campaign for president in 1932. Depressing the nuclear buoyancy was the nightmare of Fukushima.

The NRC vote, a pro-forma affirmation of action the NRC had already discussed and taken informally, came in the context of the catastrophe in Japan just 11 months earlier. NRC Chairman Gregory Jaczko made the connection clear both in his keynote address at the Platts conference and at the commission meeting where he dissent-

1. Long time coming. The NRC granted a combined construction and operating license for Southern Co.'s Vogtle Units 3 and 4 on Feb. 9, 2012. The construction site for the new Units 3 and 4 is shown with Units 1 and 2 visible in the background. *Courtesy: Southern Co.*



2. Reactor construction under way. Southern Co. received an Early Site Permit and Limited Work Authorization (LWA) from the NRC in August 2009. The LWA allowed safety-related construction at the site prior to receiving the combined construction and operating license. Shown is the assembly of the Unit 3 containment vessel lower ring. The photo was taken Jan. 30, 2012. *Courtesy: Southern Co.*



ed on the Vogtle license. Jaczko told Platts event attendees that the U.S. atomic power industry is at a crossroads, where it can fully understand and embrace the meaning

of the Fukushima disaster and move forward, or it can give only lip service to the lessons learned and go on with business as usual. Down one path, he said, is a vital,

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growing industry that enjoys public support; down the other is stagnation.

Three hours later, in his dissent, Jaczko detailed his position: "I cannot support issuing this license as if Fukushima had never happened," he said with no show of emotion. In written comments attached to the NRC order, he elaborated, "I simply cannot authorize issuance of these licenses without any binding obligation that these plants will have implemented the lessons learned from the Fukushima accident before they operate." (The sidebar offers a time line of events that led up to the Fukushima accident and looks at the disaster's ongoing impact.)

The other four commissioners respectfully disagreed, arguing that the lessons from Fukushima that the NRC staff has identified will be incorporated into operating procedures at Vogtle and across the industry, without the need to put the Southern Co. application on hold. Commissioner Kristine Svinicki said, "There is no amnesia, individually or collectively, regarding the events of March 11 and the ensuing accident at Fukushima."

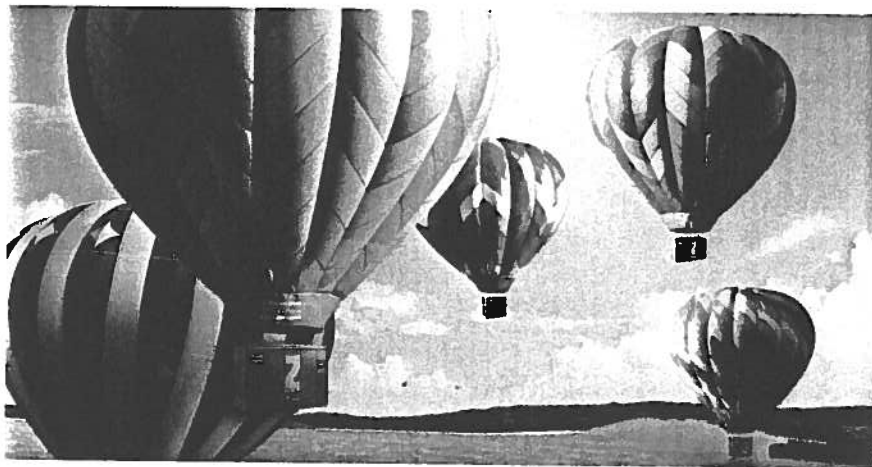
Given the turmoil that has characterized the NRC in recent months, including public complaints by the other commissioners about Jaczko's allegedly authoritarian and temperamental management style, the meeting was calm, not confrontational. Svinicki, frequently Jaczko's chief adversary, congratulated him on the "orderly manner" he displayed leading the years-long Vogtle proceeding.

Fukushima Not Forgotten

All five of the NRC members appear to understand the significance of the challenge brought by the March 11, 2011, destruction of the Fukushima Daiichi nuclear power station in Japan. It was a \$40 billion act of a capricious nature, reminding everyone in the power industry that "low probability" decidedly does not mean "no probability." The specter of Fukushima was clearly part of the backdrop, from Jaczko's opening address at the Platts meeting to the vote at the commission to the final Platts session the following morning.

But it is not just a terrible accident in Japan that has tempered optimism in the nuclear business, despite the positive boost from the landmark Vogtle vote. The context for the nuclear industry today includes low growth in electricity demand, record and sustained low natural gas prices, uncertainty about nuclear waste, public policy preferences for renewable electricity generation, and an economy that may or may not be recovering from the worst

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Fukushima: The Death of Nuclear Power in Japan?

On March 11, 2011, a massive earthquake and an enormous 45-foot-high battering ram of water utterly destroyed three of the six General Electric boiling water reactors (BWRs) sharing a site in Japan's Fukushima prefecture on the island nation's west coast. The horrific, totally unexpected events produced vivid images of the plants literally blowing apart in consequence of the temblor and tsunami. They may also have spelled the end of atomic energy in Japan (Figure 3).

Unlike the 1986 Chernobyl explosion, the world learned of Fukushima as it was occurring, with blogs and tweets following the intimate details and stunning videos instantly showing up on YouTube (for example, see <http://tinyurl.com/7ddka2r>). The Japanese government, despite its insular nature, is still far more open than was the former Soviet Union. And if Japan had been inclined to cover up the events—and no doubt there were those in industry and government who were so inclined—modern technology rendered those instincts anachronistic and futile.

Accident Summary

The quake, the worst in Japan's earthquake-filled history, was far beyond the design basis of the six elderly GE boilers with (except for Unit 6) outmoded lightbulb-and-donut pressure suppression containments. The accompanying liquid assault from the sea produced one of the accident scenarios that keep nuclear safety experts pacing the floor at night. It's known as "station blackout," the complete loss of on-site and off-site

electric power necessary to keep cooling pumps and safety systems working during a loss-of-coolant accident.

The Fukushima plants didn't lack backup power. As with all modern nuclear plants, banks of large diesel generators—13 in all—were available to kick in automatically should the plant lose electricity from the grid. Backstopping those were ranks of batteries designed to provide enough standalone electricity to keep the plants safe until engineers could link up another source of power.

Hindsight, of course, often improves one's vision. Looking back on the accident from a year's distance reveals that the backup diesels were vulnerable to the tsunami's effects, the batteries were inadequate for the unimagined task they faced, and plant designers did not adequately address the risks of earthquake followed by a total inundation of immense force.

Unit 1 was the oldest of the Fukushima reactors, a 439-MW machine that went into commercial service in 1971. Next door, Units 2 and 3 were both 760-MW reactors; Unit 2 began generating electricity for the grid in 1974 and Unit 3 in 1976. Units 4 and 5 were also 760-MW BWRs; both began operating in 1978. The 1,067-MW Unit 6 went into service in 1979, the year of the Three Mile Island accident in the U.S. All were owned and operated by Tokyo Electric Power Co., one of the largest, most sophisticated utilities in the world, colloquially known as Tepco.

When the 9.0 magnitude earthquake hit at 14:46 Japan Standard Time (JST) on March 11,

2011, Units 1, 2, and 3 were operating normally. Unit 4 was shut down and held no fuel, while 5 and 6 were out of service for maintenance but were fully loaded with nuclear fuel. As reconstructed by Tepco and Japan's nuclear regulators, the Nuclear and Industrial Safety Agency (NISA), the three reactors scrambled, or automatically shut down, as they should have, when the earthquake hit. The plants lost their normal sources of power as the earthquake damaged the regional electric grid. Each unit had two back-up diesel generators, which kicked on, as designed.

About 50 minutes later, the stupendous wall of water hit the site, overwhelming the 19-foot seawall the company had put in place when the plant was designed and built to ward off a projected 18-foot wave. Water swept over the site, flooding the battery banks and emergency diesel generators. It all went bad, very bad, from that point on. The following chronology follows a detailed timeline published in November by the U.S.-based Institute for Nuclear Power Operations (Figure 4).

Accident Timeline

To condense the events considerably: All three units lost core cooling. The residual heat in the fuel resulted in a complete meltdown, liberating explosive hydrogen in the process. The hydrogen collected in the top of the reactor buildings. The hydrogen mixed with oxygen soon ignited and the units exploded, one after the other. Unit 1 was the first, at 15:36 JST March 12, as the sidewalls of the building blew apart, leaving an eerie, skeletal steel hulk standing. Some 4.5 hours later, the government ordered the utility to use fire trucks to pump seawater into the Unit 1 core in order to cool the glowing mass of fuel.

Events at Unit 3 followed a similar pattern. Loss of coolant exposed the core, which melted. A steam-zirconium reaction liberated hydrogen, which accumulated in the top of the reactor building. At 11:01 JST on March 14, Unit 3 exploded, a blast larger than that from Unit 1 and one felt some 40 miles away. The explosion injured six workers.

Around 6:00 JST March 15, workers heard a "loud noise" from Unit 2, shortly after a hydrogen explosion in Unit 4. Workers thought the noise from Unit 2 was also an explosion, although later, experts decided it was not. But the explosion in Unit 4 and the unknown event in Unit 2 led to even greater radiation levels on

3. Earthquake and tsunami damage. This satellite image shows damage to the Fukushima Daiichi Power Plant caused by an earthquake and tsunami. It was taken at 11:04 a.m. local time, March 13, 2011, 3 minutes after an explosion. *Courtesy: DigitalGlobe*



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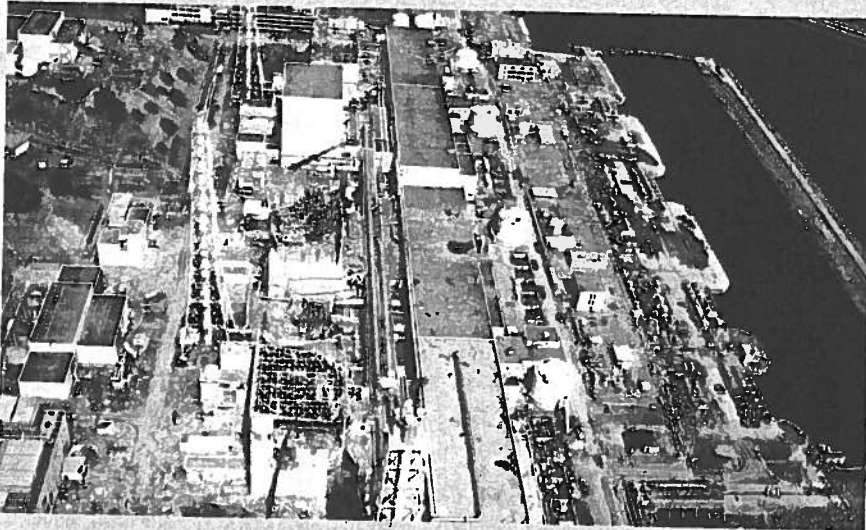
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4. Complete devastation. An unmanned drone took this aerial photo of the Fukushima Daiichi nuclear power plant on March 20, 2011. Unit 1 is at the top of the photo, Unit 4 is at the bottom. *Courtesy: Air Photo Service Co. Ltd., Japan*



site. Most workers on the site were evacuated, leaving only 70 to deal with events at the reactors. By this point it was abundantly clear that radiation was not confined to the reactor site.

The Fukushima prefecture government on March 11 ordered an evacuation of people within 2 kilometers (km) of the plant; some 1,800 individuals. Within hours, the central government expanded the evacuation zone to 3 km. By the next day the evacuation zone extended 20 km, then 30 km. By March 13, some 179,000 to 200,000 people had been ordered to evacuate. Many may never be able to return to their homes.

A cascade of failures characterized the accident, and Tepco spent much of the rest of the year working to stabilize the site. Conditions of intense radioactivity limited the time workers could spend on and around the site: Extensive damage made recovery and cleanup difficult. It was months before the government and Tepco acknowledged that the fuel had actually melted down.

This was similar to what occurred at Three Mile Island, where the utility consistently underestimated the damage to the reactor fuel. Indeed, *The Economist* observed that Fukushima was “a bit like three Three Mile Islands in a row, with added damage in the spent-fuel stores.”

Accident Update

Last December, Japan declared that the Fukushima nuclear reactor site was finally stable, which could lead to the return of some 80,000 evacuees and allow the utility to begin dis-

mantling and decommissioning the wrecked plant. But that claim may have been premature. Reuters reported in February that Tepco had uncovered a leak of slightly radioactive water inside the containment of Unit 4, which was largely undamaged during the March accident. The 8 metric tons (8.5 cubic meters) of leaked water did not get outside the reactor and will be drained into storage, the wire service reported.

Not long after that, Tepco reported that temperatures in the crippled Unit 2 have been rising, although they are still below the 93C that defines “cold shutdown.” The rising temperatures suggest the possibility of re-criticality. Bloomberg quoted Tetsue Ito, head of the Atomic Energy Research Institute at Kinki University, as saying, “It was too early to say the plant is safe in December. They declared cold shutdown even though nobody is sure about the location of melted fuel.”

At its peak, Japan had 54 operating nuclear units, supplying some 30% of the country’s electricity. Japan had a reputation as one of the safest, most careful nuclear power regimes in the world.

At this writing, only three units are operating in Japan; those are scheduled to come out of service soon. As you read this, Japan may not be getting any power at all from its once-proud, now-humbled nuclear enterprise. That enterprise now faces intense opposition in a country that justifiably has mixed emotions about the power of the atom. Many observers predict that none of Japan’s nuclear units will ever operate again.

contraction since “Happy Days Are Here Again” made its debut in 1929.

Chip Pardee of Exelon Generation told the Platts meeting that he recalled being at similar events in 2007 when his job was “to get up before a group of people and talk about the advantages of nuclear power.” That was an easy task at the time. Today, five years later, he said, “It’s not impossible, but it is more difficult.” Five years ago, he noted, the talk was about the security of nuclear plants in the face of terrorist threats; today, it’s about nuclear accidents. Five years ago, the environmental concern was greenhouse gases; today, it is nuclear waste.

Westinghouse’s Jim Ferland commented that Fukushima “has pushed out ‘new build’” as a current topic and moved it into the future, although the NRC vote gave his company a major victory.

The heart of the Vogtle project is the Westinghouse AP1000 advanced reactor, which won NRC approval Dec. 30, after years of review and multiple redesigns. Four projects using the AP1000 reactor—the two approved in February and the two planned for Scana Corp.’s application, which will likely face the NRC next—are on the stage in the U.S.; four are under construction in China. “It would help a lot if we can bring those in on schedule and under budget,” Ferland said with ironic understatement.

Five years ago, the phrase “nuclear renaissance” was on the lips of many in the industry, as the NRC geared up to license as many as two dozen new units. Art Lembo of URS recalled that one of the pressing questions then, “when we were on the doorstep of renaissance,” was whether the industry could find the skilled people it needed to support that endeavor. Today, those plant numbers have been dramatically reduced; meeting the demand for human resources is no longer daunting.

Marvin Fertel, a realist who heads the Nuclear Energy Institute, the industry’s Washington lobby, told the *Wall Street Journal* after the NRC Vogtle vote that the Southern Co. plants in Georgia and Scana’s planned South Carolina units are probably the only new nuclear plants that will get built in the U.S. before 2020. Ultimately, Fertel said he believes that the prospects for nuclear power will rebound. “The long-term fundamentals haven’t changed,” he told the newspaper. One can almost hear the words in his head: “Let us sing a song of cheer again.” ■

—Kennedy Maize is a *POWER* contributing editor and executive editor of *MANAGING POWER*.