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Nuclear Challenges

BEYOND DESIGN BASIS: THE FUKASHIMA NUCLEAR IMPACT

The Fukushima nuclear facilities, a 6 unit nuclear reactor complex owned and operated by Tepco (Tokyo Electric Power Company, were damaged in a magnitude 9.0 earthquake on March 11 (Japan time). The quake was centered offshore of the Sendai region, which contains the capital Tokyo. The plant was designed for a magnitude 8.2 earthquake. An 8.9 magnitude quake is approximately 7 times greater than what the plant was designed (e.g., 8.2). Serious secondary effects followed including a beyond design basis tsunami and numerous significant aftershocks. The 3 operating reactors were shutdown automatically and within seconds. Cooling systems were placed in operation to remove the residual heat (e.g., est. heat load of about 3% of the heat load under normal operating conditions). The earthquake resulted in the loss of normal offsite power to the plant. As designed, emergency diesel generators (EDGs) started and powered station emergency cooling systems. About 1 hour later, the station was struck by an estimated 48 foot tsunami, which is larger than design basis. The tsunami destroyed the backup EDGs leaving only emergency battery power to cool the core for 8 hours in accordance with abnormal and emergency operating procedures. Offsite power could not be restored and efforts to connect portable generators were initially unsuccessful. After the batteries were depleted, residual heat, which could not be removed resulted in increased reactor temperatures and a decrease in reactor water levels; eventually uncovering and overheating the core. Hydrogen produced from metal-water reactions in the reactor created increased pressure with an explosive atmosphere. Operators attempted to vent the reactor to relieve steam pressure (and hydrogen) into primary containment (drywell). These efforts caused primary containment temperatures and pressures to increase. Operators vented the primary containment to control containment pressure and hydrogen levels. Venting was required to protect the primary containment from failure. Primary Containment Venting was initially established through a filtered path through duct work in the secondary containment to an elevated release point on the

Inside this issue:

Japan nuclear plant event: A comment, a thought, and a prayer

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By Ernest J. Harkness For PlanPhilly ; March 19, 2011—The current situation at the Fukushima-Daiichi Nuclear plant in Japan is a tragic and serious situation. The news media is providing significant and in some cases continuous coverage of the event. With all the information, and sometime conflicting information, it is hard to understand what is actually going on and how dire the situation. I have spent my career operating nuclear power plants and still provide consulting services in the form of operational safety reviews and assessments. The following comments are some thoughts that may help PlanPhilly readers understand the current and potential future situation. The design of the Japanese plants are Boiling Wa-

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refuel floor (on top of the reactor building). A hydrogen detonation subsequently occurred while venting secondary containment.

The station deployed portable generators and utilized a portable pump to inject sea water into the reactor and primary containment. Primary containment was successfully flooded to cool the reactor vessel and any debris that might have been introduced into the primary containment. Boric acid was added to the seawater used for injection. (NOTE that boric acid is used to capture neutrons, arrest the fission reaction and speed up the cooling down of the core. Boron also reduces the release of iodine by buffering the containment water pH). The station declared the equivalent of General Emergency event at Unit 1. Subsequent evacuation of the public was performed within 20 km (13 miles) of plant (approximately 200,000 people evacuated). A similar hydrogen detonation subsequently occurred at Unit 3 on Sunday, March 14th (Japan time). At that time, it was thought that primary containment remained intact for Unit's 1 and 3, however there was considerable damage to the secondary containment (reactor building).

Initial reports stated that the highest recorded radiation level at the Fukushima Daiichi site was 155.7 millirem/hr and was reduced to 4.4 millirem/hr after flooding containment . The NRC's radiation dose limit for the public is 100 millirem/yr. Authorities distributed potassium-iodide tablets to protect the public from potential health effects of radioactive isotopes of iodine that could potentially be released. This is quickly absorbed by the thyroid gland and its presence prevents the uptake of iodine-131 into the thyroid.

Over 300 after shocks have occurred since the initial quake and continues to challenge station response. Internal Accident Recovery Phases included four elements; 1.Energy heat rejection and control, (e.g., Open feed & bleed which would cool/vent radioactive steam and initiate closed Residual Heat Removal Operation), 2.Gas release control/mitigation (i.e., use of containments, filtration and liquid release intended containment and mitigation of 10+ Millions Of Gallons of Highly Radioactive Water in Basements), 3. Purification of liquids, and 4. contamination control management (e.g., Contain/package, Store/transport, & Dispose).

As of this writing, Tepco acknowledges that a fuel meltdown occurred at three of the plant's six reactors in the early hours of the crisis, something experts had been suggesting for weeks. "Even though we have confirmed that the nuclear core melted soon after the accident, our three- to six-month timeline will not

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Reuters

TEPCO

Catalysts for Dramatic Changes in Nuclear Safety & Security

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Remarks for The Honorable Gregory B. Jaczko, Chairman U.S. Nuclear Regulatory Commission at American Association for the Advancement of Science (AAAS), Washington, D.C., May 6, 2011

A few key events that have served as catalysts for dramatic changes in the way we approach nuclear safety and security. These important events do not suggest that the NRC's regulatory environment remained static in the intervening years between them. Far from it. While the safety and security focus of the agency has never wavered, the way we go about meeting that mission has necessarily responded to new research, information, and experience. But these events were paradigm-shifting, as they precipitated some of the most dramatic developments in our understanding of nuclear technology and its risks, as well as how we address those challenges.

Browns Ferry Fire—The first of these events was the Browns Ferry Fire in 1975, a mere two months after the NRC's creation as an independent regulatory agency. This serious incident fundamentally transformed how we viewed fire safety. Whereas it was before seen as primarily an insurance concern or an industrial hazard, it was properly understood after Browns Ferry as an important nuclear safety issue.
The circumstances that led to the Browns Ferry Fire suggest how little we understood the potential risks of fire to reactor safety at that time. The incident started when a plant employee, using a candle to search for air leaks, accidentally set a temporary cable penetration seal on fire. This practice was used in coal-fired power plants as a common method for checking for leaks around the main condenser seals, and it was carried over to the nuclear industry. The idea behind this practice was that, if the flame of the candle flickered, then that suggested the presence of an air leak. That seems reasonable as far as it goes. It begs the question, however, of how it ever became an accepted practice to routinely bring an open flame into rooms filled with electrical cables. It reflected to an extent an ethos that viewed fire safety as a matter for insurance underwriters rather than nuclear safety regulators. It will probably not surprise you to learn, as a result, that fires at nuclear power plants were not considered all that uncommon back then. It may surprise you to learn, however, that one of the preferred methods for plant personnel to extinguish fires that they ignited in the temporary cable penetration seals was by beating them out with their flashlights. This all seems astonishing from today's perspective, but that was the reality in the early days of commercial nuclear power. Much progress has been made since then to enhance fire safety at nuclear power plants. In the aftermath of the Browns Ferry fire, the NRC instituted a number of changes to ensure that licensees more effectively prevented fires from breaking out in the first place and could mitigate their potential consequences if they did happen. At a more fundamental level, this event raised key questions about how we evaluate risk, not just related to fire protection, but across the spectrum of potential accidents at a nuclear power plant. How do we determine the potential likelihood of accidents in the first place? How do we assess the potential consequences of different types of accidents? And how do we account for the inevitable limitations and uncertainties in our information? By crystallizing the importance of these types of questions, the Browns Ferry Fire contributed to the development and incorporation of modern risk analysis into the NRC's nuclear safety program. This long-term trend toward risk-informed regulation has been borne out across a number of important safety issues over the last 35 years, especially in the area of fire protection. At this time, nearly half of operating reactor licensees are moving forward with implementing a risk-informed approach that will allow them to deploy more effective approaches for fire safety that are tailored to the specific circumstances of their facilities. Because of developments like this one, it is no exaggeration to say that the NRC is a world leader among regulators in using modern risk tools.

Three Mile Island—The second of these seminal events was the Three Mile Island accident in 1979. As the most serious accident in the history of the U.S. nuclear industry, this event precipitated changes to nuclear safety in this country in scope and magnitude that are difficult to overstate. Specific changes included an overhaul of our approach to emergency management, the development of systematic approaches to evaluating operational experience, a continued shift toward risk-informed regulation, a significant expansion of the agency's resident inspector program, and a statutory reorganization of the NRC Commission structure. I could discuss any of these important issues at some length today. They are all significant changes that helped strengthen the safety of the Nation's nuclear power plants and made the NRC a stronger, more effective regulator. But I'll instead focus on another issue that I did not mention, though one that is perhaps the most important insight we took away from Three Mile Island. That is the central role of people in ensuring plant safety. In fact, the Presidential Commission on Three Mile Island

CATALYSTS FOR DRAMATIC CHANGES IN NUCLEAR SAFETY & SECURITY

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concluded that the “equipment was sufficiently good that, except for human failures, the major accident at Three Mile Island would have been a minor incident.” The operators at Three Mile Island, however, did not have the necessary training or the clear operating procedures that might have enabled them to mitigate rather than exacerbate the situation. Although the plant equipment was functioning properly, they at times did not trust or understand the admittedly complex and confusing information that the plant equipment was providing them. Before the Three Mile Island accident, if you asked nuclear power plant operators or regulators the first word that came to mind when they heard phrase “nuclear safety,” they would have likely responded with the word “engineering” or “equipment.” And with good reason, since prior to the accident, the overwhelming focus of the NRC and the nuclear industry was on the role of nuclear plant hardware in preventing accidents. The Three Mile Island accident changed that. The world of nuclear safety was no longer the same, and the new world was one in which people’s attitudes and actions—in the form of operator errors, management deficiencies, and complacency—posed the greatest threats to plant safety. In the words of the Presidential Commission, the NRC and the industry had “failed to recognize sufficiently [sic] that the human beings who manage and operate the plants constitute an important safety system.” This simple yet important insight led to dramatic changes, including an increased focus on human performance and the consequent revamping of training and staffing requirements for operators. Even today, more than 30 years later, the central importance of people to plant safety continues to resonate throughout the NRC and the nuclear industry. That is evidenced by the NRC’s continued focus on human performance, but also by our increased focus in recent years on the role of safety culture in ensuring the safe and secure operation of nuclear facilities. That grows out of the recognition that the best training isn’t enough on its own to ensure safety if workers don’t view safety as an overriding priority above other considerations.

September 11, 2001—The third major event that I will discuss briefly today is the September 11, 2001, terrorist attacks. Although not a nuclear event like the other two I have discussed today, the 9/11 Commission Report detailed the extent to which our adversaries had contemplated potential attacks against the Nation’s nuclear facilities. In the aftermath of the September 11th attacks, the NRC took aggressive actions aimed at ensuring the immediate security of the Nation’s nuclear facilities and materials in light of our enhanced understanding of the threat environment. Those actions included requirements for operating reactors to implement mitigative measures to address the potential consequences of large fires and explosives. Changes were also made to the NRC organization itself, with the creation of a separate office within the agency focused on security and incident response. The long-term effect of September 11th, however, extends far beyond the specific steps we took in the immediate aftermath of the attacks to strengthen nuclear security. By keeping us focused on the ever-evolving and highly dynamic nature of the threat environment, it has left an enduring imprint on our approach to nuclear security. In the years since September 11th, we have expanded our security work in areas beyond our traditional nonproliferation focus. Of course, our nonproliferation activities remain related to safeguarding nuclear materials, and dual-use technologies remain a critical part of our mission. It’s safe to say, however, that over the past decade the NRC has expanded its efforts in other areas, most notably source security and cyber security, which were not as prevalent a decade ago. While these issues are high priorities today, we never forget the central lesson of September 11th—that new issues with different and complex challenges can always emerge.

This May 6, 2011 photo released by Tokyo Electric Power Co. shows the reactor buildings of Unit 1, left, and 2 at the crippled Fukushima Dai-ichi nuclear power plant in Okuma, Fukushima Prefecture, northeastern Japan. (AP Photo/

Japan - I hope that this discussion has demonstrated how our nuclear safety and security mission requires us to evolve in response to new information and experience. Among the most important in the history of nuclear power, these events served to transform in fairly fundamental ways how we understand the nature of nuclear safety and security, and what we need to do in order to protect the public. The recent events in Japan have potentially raised new concerns and the possibility that our understanding of nuclear safety may further evolve, based on what we learn from those events. While we don’t have the information yet to definitively say what those lessons may be, we have the responsibility to the American people to conduct a comprehensive safety review to determine whether there are lessons and what they are. I can assure you that this safety review will be systematic and methodical and will be conducted with the appropriate sense of urgency. I expect there will be lessons learned and changes made as a result. To conduct this review, the Commission has established a senior-level task force

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to help us determine whether there are areas for the agency to make improvements to our regulatory system based on lessons learned from the events in Japan. The task force review will be conducted in a short-term and a longer term timeframe. The short-term, 90-day review has already begun and will identify potential or preliminary near-term operational or regulatory issues. A longer term review will begin as soon as we have sufficient information from Japan and will be completed in six months from the beginning of the evaluation. During this longer term review, we expect to be able to engage key stakeholders in a way that the time constraints of the short-term review do not allow. Both the 90-day and final reports will be made publicly available. I understand the urgency that many feel to move quickly on this safety review. It is important, however, that we take the time to fully understand the situation in Japan, identify the full range of questions that we need to answer, and develop the appropriate responses. As the task force completes its initial review and the Commission begins to decide how to best move forward, I believe it is vital that stakeholders remain actively engaged throughout this process. With the benefit of the NRC staff's expert review and the dialogue with our stakeholders that will follow, I am confident we will take the actions necessary to ensure the continuing safety of the American people.

Conclusion - As we move forward with this review and other initiatives, I believe it's important that we always keep an open mind. We should never grow complacent, and we should always remain open to new information and experience that may challenge our existing assumptions and views. It's precisely that open and questioning attitude that enabled us to learn from Browns Ferry, Three Mile Island, and September 11th, and it's what will allow us to learn whatever lessons there may be from the events in Japan.

Japan nuclear plant event: A comment, a thought, and a prayer

(Cont. from p.1)

ter Reactors (BWR), which does not require generators to produce steam, instead steam is generated in the reactor vessel. The nuclear reaction heats water in the reactor vessel and the vapor from the water is passed through steam dryers to the turbines. This eliminates an additional fluid loop and provides some differences to other designs.

SEQUENCE OF EVENTS

This design is used around the world, including the U.S., and has a proven good operating record. A reactor of this design has three barriers to contain the nuclear fuel and decay products. The actual fuel tube (an approximate 3/8" tube that contains the Uranium Oxide fuel pellet), the primary coolant loop and reactor vessel, and the primary containment. The reactor building, in which the primary containment is housed, is sometimes called Secondary Containment and in U.S. plants this Secondary Containment is required by law for BWR type reactors. The Spent Fuel Pool is where expired fuel is stored until final disposition or recovery. The Spent Fuel Pool is normally a concrete structure housed in the Secondary Containment structure and is a robust structure made of cement and steel in the form of a pool with the fuel stored under at least 20 feet of water. Several units at Fukushima were off line and de-fueled at the time of the earthquake and three of the units were operating. The operating units shut down at the time of the earthquake. When a nuclear plant shuts down the chain reaction stops and the remaining heat is generated by the radioactive decay of the nuclear fission products. The problem at Fukushima initially was the systems used to remove the decay heat are not functioning due to various problems initiated by the tsunami and other complications. The main goal of the operators is to maintain cooling through installed cooling systems or addition of water to the Reactor Core and the Spent Fuel Pool. The Nuclear Energy Institute, a U.S. Industry Group, reports that as of 3/17/11 the operators are making progress and have stabilized cooling to the three reactors that were operating at the time of the event.

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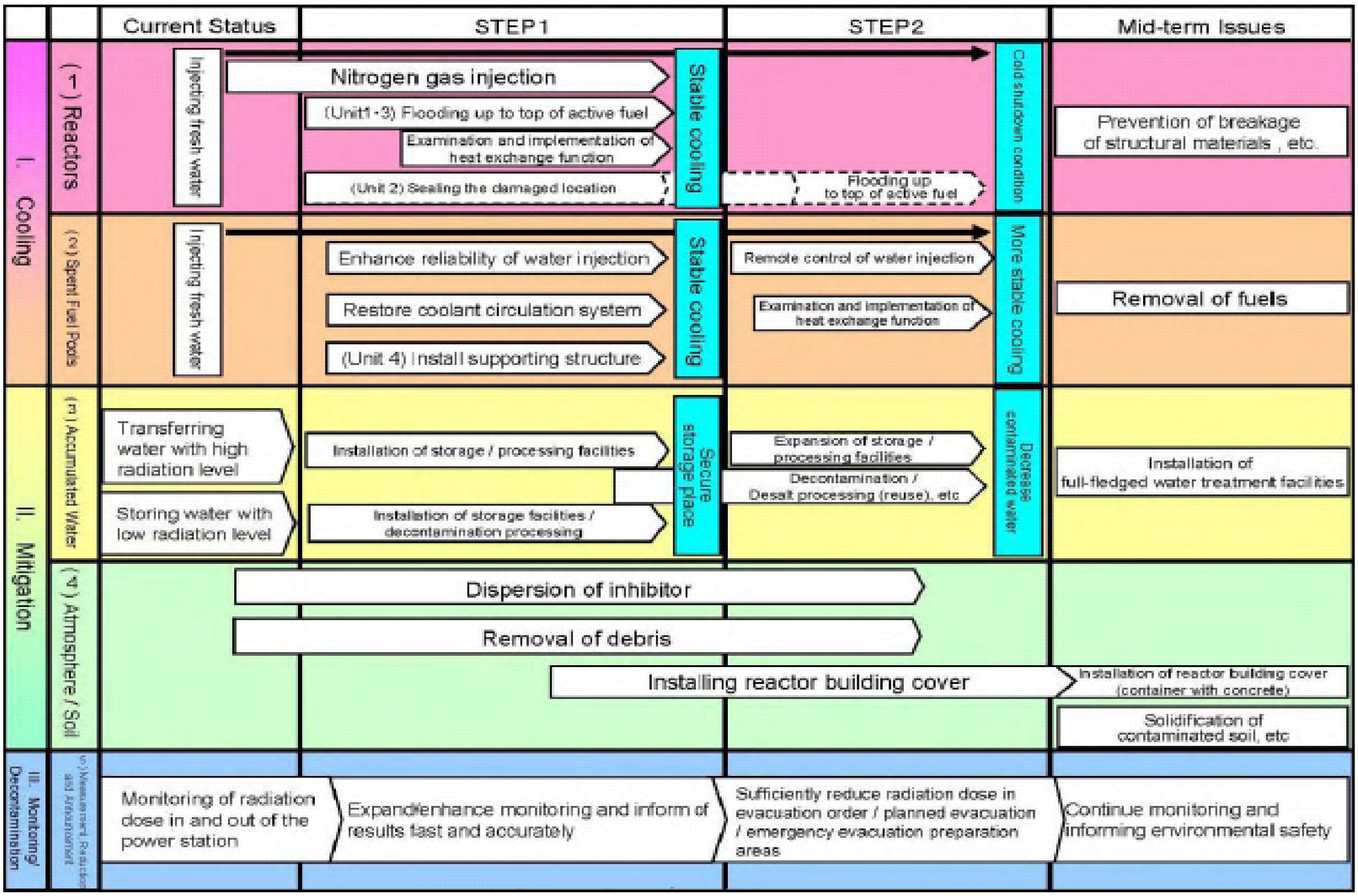
change, "Tepco's nuclear chief, Sakae Muto, said at a news conference on Tuesday, May 17, 2011.Tepco officials have stated that the initial 9.0 magnitude earthquake, not just the 50-foot high tsunami, may have damaged vital equipment needed to activate cooling systems either by back-up electricity or by workers who tried to open valves manually, including the hardened vent system. They concluded this based on a radiation alarm that alarmed at the Fukushima nuclear power plant before the tsunami hit on March 11, 2011. This suggested that contrary to earlier assumptions the reactors were damaged by the earthquake that spawned the wall of water. Note: The improved venting system at the Fukushima plant was first mandated for use in the United States in the late 1980s as part of a "safety enhancement program" for boiling-water reactors that used the Mark I containment system, which had been designed by General Electric in the 1960s. Between 1998 and 2001, Tepco followed suit at Fukushima Daiichi, where five of six reactors use the Mark I design. The venting system required an electrical supply to operate the valves, which was no longer available after the tsunami impacted the EDGs and battery power was lost after about 8 hours.



Disaster Plan Problems Found at U.S. Nuclear Plants

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Published: May 12, 2011 NY Times - The staff of the Nuclear Regulatory Commission acknowledged that the agency's current regulations and disaster plans did not give enough consideration to two factors that had greatly contributed to the continuing Fukushima Daiichi crisis in Japan: simultaneous problems at more than one reactor and a natural disaster that disrupts roads, electricity and other infrastructure surrounding a plant. The briefing was part of a review requested by the commissioners to evaluate the vulnerability of American reactors to severe natural disasters like the ones that hit the Japanese plant in March. Marty Virgilio, the dep-

Disaster Plan Problems Found at U.S. Nuclear Plants

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uty executive director of the agency, told the five commissioners that inspectors checked a sample of equipment at all 104 reactors and found problems at less than a third of them. The problems included pumps that would not start or, if they did, did not put out the required amount of water; equipment that was supposed to be set aside for emergencies but was being used in other parts of the plants; emergency equipment that would be needed in case of flood stored in places that could be flooded; and insufficient diesel on hand to run backup systems. Many of the emergency systems were put in place after the Sept. 11, 2001, terrorist attacks. Officials said the problems that had been found were addressed immediately but not everything had been inspected. Mr. Virgilio said he expected to have a fuller picture soon. He said an entire category of new procedures, called “severe accident mitigation guidelines,” had been adopted voluntarily by the nuclear industry and thus was not subject to commission rules.

R. William Borchardt, the commission’s chief staff official, said some of the preparations for severe accidents “don’t have the same kind of regulatory pedigree” as the equipment in the original plant design. The two-hour briefing given to the five-member commission was an early assessment, 30 days into a 90-day review being conducted by an N.R.C. task force. Charlie Miller, the staff member leading the effort, said the staff was considering “enhancements” to its disaster plans and procedures. But as laid out by the staff, some of the changes under consideration could be far-reaching. For example, the N.R.C. now looks at how well a plant’s design can handle a problem at just one reactor, even if there is more than one reactor at the site. “You have to take a step back and consider what would happen if you had multiple units affected by some ‘beyond design basis’ events,” Mr. Miller said.

Another problem, staff members acknowledged, is that they have never paid much attention to the issues posed by handling an emergency when there is widespread damage to surrounding roads, power systems and communications links. In the past, the commission has explicitly rejected the notion that it should consider such combined events when reviewing a plant’s safety preparations. Simultaneous with the commission’s meeting, Representative Edward J. Markey, a Massachusetts Democrat, released a report arguing that a variety of other shortcomings existed at nuclear plants, including the frequent failure of emergency diesel generators, which are essential to plant safety if the power grid goes down. He also criticized the commission for not requiring plants to have a backup power source for spent fuel pools while the reactor is shut for maintenance or refueling. The Fukushima accident has cast new attention on spent fuel pools; the reason the United States government recommended that Americans stay 50 miles from the plant was damage to the spent fuel pool of Fukushima’s Unit 4, a reactor that was shut down before the March 11 earthquake and tsunami. Mr. Markey pointed out that in the last eight years, the commission had received 69 reports of inoperable diesel generators at 33 plants, with six of those generators out for more than a month. The diesels provide power for water pumps that allow removal of “decay heat,” the heat that fuel generates even after a reactor shuts down. The Fukushima plants shut down successfully but decay heat wrecked their cores.

The N.R.C. said it was aware of the reports. But on Wednesday, attention was called to that problem by the Institute of Nuclear Power Operations, an industry group formed after the Three Mile Island accident in 1979 to provide peer-to-peer safety reviews. That group said one of the few safety measures that was getting worse was the reliability of diesel generators. Mr. Markey also complained that the commission had allowed some plant operators to remove equipment that eliminates hydrogen produced by overheating fuel. In addition, there is no requirement for equipment to remove hydrogen in the rooms where spent fuel is stored; the building surrounding Fukushima Unit 4 was destroyed by the explosion of hydrogen that came from the spent fuel pool.

Commission officials said they were reviewing their previous decision to permit very heavy loading of the spent fuel pools. Thinning them out would reduce the amount of heat production that had to be dealt with in case of a severe accident, they said.

NUCLEAR: STILL THE BEST POWER FOR A GREAT FUTURE

By Llewellyn King . Published March 21, 2011 – 1:22 pm * For the Hearst-New York Times Syndicate

For 40 years I've written about nuclear power, defended it and believed, as I still do, that it offers the best sign-post to a great future, to what Churchill called the 'sunlit uplands' — in short, to utopia.
I regard electricity as one of mankind's great achievements, saving people from the menial, painful drudgery that marks daily existence without it. Growing up in Africa, I'd see men and women walking miles, many miles, barefoot across the savanna, looking for a few pieces of wood to burn for cooking and hot water.
Electricity, I've believed for these four decades, is assured for thousands of years through nuclear. With advanced breeder reactors and with the energy stored in weapons plutonium, it comes close to perpetual motion: So much energy from so little fuel. The alternative is to burn up the Earth, fossil fuel by fossil fuel, until we are searching, like the people of the African savanna, for something that is left to burn. Wind and solar are defined by their geography and limited by their scattered nature. Their place at the table is assured but not dominant. Industrial societies need large, centralized energy sources. Yet a nuclear tragedy of almost immeasurable proportions is unfolding in Japan. The sum of all the fears about nuclear is being realized. Hades and Poseidon have joined to cut nuclear down. Do disasters, like the Japanese nuclear one, really kill technologies? Mostly, obsolescence does that, but their demise can be accelerated by a last huge mishap.

While the Hindenburg disaster at Lakehurst, N.J., in 1937 didn't end lighter-than-air aircraft for passenger travel, it drew the curtains: Fixed-wing airplanes were doing a better job. The Concorde supersonic jet didn't leave the skies because of a fatal accident at Paris-Charles De Gaulle Airport in 2000, but it did make the Concorde's planned retirement immediate.
Conversely, Titanic's sinking in 1912 didn't put an end to ocean liners: They got safer. Throughout the 19th century boilers were constantly blowing up, not the least on the stern-wheelers plying the Mississippi. Boats kept working and the technology — primarily safety valves — got better. Bad technologies are replaced by safer ones and good ones with flaws were improved upon.
That is the history of boats, cars, planes and, yes, resoundingly yes, of nuclear power.
After the Three Mile Island disaster in 1979, a new word, **"passive,"** began to dominate reactor design and construction, but maybe too late for the General Electric Mark 1 boiling water reactors ordered so long ago. Passive, as it sounds, is a design in which cooling pumps are not as important. The idea is to depend more on gravity feeds and convective cooling. These are featured in newer designs, and there has been some back-fitting. Things were moving in the right direction, but not fast enough.
The story of the reactors at the Fukushima Daiichi site is a story of success and failure. They were designed 40 years ago to meet what in advanced design is known as a "maximum" credible accident. That was, in that location, an earthquake of a magnitude which had never occurred there. Excluded from this calculation of credible — i.e. it could happen — was the tsunami.
That exceeded the imagination of catastrophe to that point in time. Within the credible design envelope, the plants performed flawlessly, just as they were supposed to: The plants shut down; the emergency cooling pumps started up in fractions of a second; and when they failed, batteries took over. The problem was the tsunami destroyed the diesel generators, and the whole sequence of disaster began.
The opponents of nuclear power — and they have been pathological in opposition for more than 40 years — have their footwear on and are ready to dance on the grave of nuclear. They might want to unlace and take a seat: **Nuclear power does not have an alternative.**
Big demand for new energy (ideally carbon-free energy) around the globe, and especially in India and China, can't be satisfied without nuclear. Abundance of natural gas in the United States already has reduced the demand for new nuclear reactors to four or five plants. We'll be OK for a while. **--**

NWI

NWI News Board

- Abdul Ragab, & Bill Cheever continued to assist Monticello in preparation for their upcoming EPU outage in the design engineering and project management areas. Marv Engen is supporting EPU design activities at Prairie Island.
- Terry Johnson and Mike Gettle have joined the Entergy Indian Point Oversight team supporting the current NO/QA observation activities.
- Ernie Harkness continues to support Entergy's Nuclear Safety Review Board.
- Sam Newton supported McGuire Station's OR RCA
- Bill McNeill provided support of an Operations Training assessment at Robinson Plant.
- Tim Bostwick continues to lend his CAP expertise and insights to a new client at Robinson nuclear plant.
- Bill Lindsey supported Robinson Operations Training Dept.
- Frank Tsakeres assisted the DC Cook site team in preparations for the Operations Training programs Accrediting board as well as the Robinson plant in recovery activities.
- Dan Slater continues to assist APS's Palo Verde procedure development upgrades.
- Paul Kirker has traveled across the US to assist Entergy's Grand Gulf plant in Operations oversight activities.
- Rick Westcott has joined the NWI team providing causal analysis expertise for Callaway station and oversight support at Palisades power plant. Rick is assisting Ft. Calhoun's Ops Training Dept. as well.
- Roger Armitage provided training recovery causal analysis support for the Callaway station Maintenance and Technical training.
- Richard Miller assisted Robinson plant and is supporting CAP activities at PPL's Susquehanna Plant.

Thank You

We wish to express special thanks to the following clients for making NWI a preferred consulting company.

- **AEP's D.C. Cook Nuclear Power Plant**
- **APS's Palo Verde Nuclear Station**
- **Exelon Nuclear Partners**
- **Entergy (IPEC, Grand Gulf, Palisaides)**
- **Xcel Energy's Monticello, Prairie Island**

Nuclear Generating Plants

- **Duke's McGuire Plant**
- **Progress Energy's Robinson Plant**
- **PP&L's Susquehanna Steam Electric Station**
- **Ameren's Callaway Nuclear Station**
- **OPPD's Ft. Calhoun**

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