Environmental Defense Institute

News on Environmental Health and Safety Issues

April 2011 **Volume 22 Number 3**

Comparing Chernobyl Disaster to an ATR Accident

In previous issues of this newsletter, EDI presented documented evidence gained through the Freedom of Information Act of the serious public hazard the Advanced Test Reactor (ATR) poses in the event of an accident. [1] In this issue, EDI will put this hazard into a context of other major nuclear reactor events so the numbers can have substantive meaning.

Although the Three-Mile Island (TMI) nuclear reactor melt-down so far remains the worst U.S. commercial accident, little is known about how much radiation was released because the radiation monitoring instruments pegged off-scale. What is known about TMI - is between 12 and 24 curies of radioactive iodine were released. It is crucial to remember that TMI had a sealed concrete containment dome that prevented much of the radiation from catastrophic release to the atmosphere. [2] The ATR does not have any credible radiation containment because it is housed in an ordinary steel sheathed industrial building built – along with the reactor - in the 1960s.

The Department of Energy/Idaho National Laboratory (INL) SL-1 reactor explosion – that killed three operators - is the worst U.S. non-commercial accident. These TMI/SL-1 radioactive releases are significant and have continuing health impacts on surrounding residents, but pale in comparison to Chernobyl and potential ATR releases. Recent statements by Japanese officials are acknowledging that the radioactive releases from the Fukushima reactors may exceed Chernobyl; however, emission data is still being compiled.

Environmental Defense Institute presents –below- documented data that compares these two events and show how the Chernobyl nuclear reactor disaster compares to a potential ATR accident. Moreover, DOE's ATR is a self-regulated nuclear reactor. This means neither the Nuclear Regulatory Commission nor the congressionally mandated Defense Nuclear Facility Safety Board is exercising jurisdiction over ATR's operations. No outside independent oversight and no accountability with catastrophic consequences, spell a disaster waiting to happen. Moreover – thanks to Congress – DOE is indemnified from damage/injury claims resulting from accidents at any of its nuclear facilities. The legal term is "sovereign immunity." [3]

The Environmental Protection Agency (EPA) and the Idaho Department of Environmental Quality have jurisdiction over INL/ATR operations, however fail to take any regulatory action other than minor hazardous materials violations. Based on Centers for Disease Control's final INL report these releases between 1952 and 1992 were **10,848,480 curies**. [4] This past radiation imposed on the deliberately non-informed public is unconscionable. Current radiation burden on INL and nuclear bomb downwinders must not be increased with an additional potential catastrophic ATR accident.

"The Chernobyl disaster triggered the release of substantial amounts of radiation into the atmosphere in the form of both particle and gaseous radioisotopes, and is the most significant unintentional release of radiation into the environment to date. It has been suggested that the Chernobyl disaster released as much as 400 times the radioactive contamination of the Atomic bombings of Hiroshima and Nagasaki. The radioactivity released at Chernobyl tended to be more long lived than that released by a bomb detonation hence it is not possible to draw a simple comparison between the two events." [5]

According to Robert Alvarez's review; The World Association of Nuclear Operators (WANO) provided an estimate for the total quantity of various radionuclides released at Chernobyl at 100 million curies. And 2.5 million curies Cesium-137 were estimated to have been released at Chernobyl. [6]

DOE's 2000 Environmental Impact Statement states: "

[1] See EDI website for previous Newsletters and a complete analysis of the Freedom of Information Act documents released by the U.S. District Court of Wyoming in Keep Yellowstone Nuclear Free, Environmental Defense Institute and David McCoy v. U.S. Department of Energy, in U.S. District Court for the District of Wyoming (06-CV-205-D).All available at; http://environmental-defense-institute.org/publications

[2] TMI operators did intentionally, gradually over time, release large amounts of radioactive gases to prevent an explosion, and contaminated water to the Susquehanna River. See video documentary "Three Mile Island Revisited."

[3] The fallout victim's from the nuclear bomb tests at the Nevada Test Site class action suit was denied based on "sovereign immunity of the U.S.federal government.

[4] Final Report; Identification and Prioritization of Radionuclide Releases from the Idaho National Engineering Laboratory; Centers for Disease Control and Prevention; Department of Health and Human Services; October 8, 2002; Risk Assessment Corporation, page 53. This report is part of CDC's INEEL Dose Reconstruction Project.

[5] Wikipedia; "Chernobyl Disaster Effects," citing International Commission for Radiation Protection (ICRP), and 53 other sources. Herein after referred to Wikipedia. http://en.wikipedia.org/wiki/chernobly_disaster_effects

[6] http://www.world-nuclear.org/info/chernobyl/info07.html

The radiological analysis of the large-break loss-of-coolant accident shows that an ATR core inventory of 1.11 giga-curies [1.11 billion curies] at reactor scram conditions releases an available source term [radioactive releases fractions] of 175 mega-curies [175 million]." ATR core inventories of all radioactive iodine species is 57,000,000 curies. [7]

DOE's 2004 ATR Safety Analysis Report (SAR-153) "Source terms used in the large break LOCA [loss-of-coolant-accident] radiological analysis for Iodine scram inventory is 80,290,000 curies, with available source term 4,256,000 curies." [8]

Radiation exposure standards; in the below exposure table, it must be kept in mind what the U.S. radiation standards are currently. Updated EPA Title 40 Protection of Environment (40 CFR 61.92 Standard) states: "Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive **in any year** an effective dose equivalent [whole body] of **10 mrem/yr [0.01 rem/yr]."**

The variation of radiation doses in the below table is due to different DOE documents cited and different ATR accident scenarios analyzed by DOE. The Chernobyl radiation doses to children are a crucial component because researchers know all-to-well that children – especially infants – are more impacted due to the fact that they are still growing and body cell division is much higher than adults. The bottom line is that all of these ATR accident exposure doses are all greater than the Chernobyl releases.

The ATR spent fuel canal contains recently irradiated fuel that would melt if the water drains. It is outside confinement and there's no fission product scrubbing or hold up. ATR reactor and canal accidents are addressed in the Preliminary Risk Assessment (PRA). It essentially doubled the doses to the offsite population even though more iodine would have decayed away from canal fuel. DOE's Emergency Management Assessment acknowledges the "ATR Canal drain, loss-of-coolant water caused by breach of canal wall or floor…dose at 30meters is 7,380,000 rem to downwind [Total Effective Dose Equivalent] TEDE Estimates for 95% worst case meteorology." [9]

Chernobyl Doses Compared to Potential ATR Accident Doses

Exposure – Doses *	**Chernobyl within 30 km [10]**	**ATR Accident [11]**
Internal Inhaled (adult public)	3-150 mSv = 15 rem	13.2 rem [12] 96 rem [13]
Internal Inhaled (public child)	10-700 mSv = 70 rem	Not available
Thyroid Inhaled (adult public)	20-1000 mSv = 100 rem	323.0 rem [14] 185.0 rem [15]
Thyroid Inhaled (child public)	20-6000 mSv = 600 rem	Not available
Ingested (adults public)	3-180 mSv = 18 rem	Not available
Ingested (children public)	20-1,300 mSv = 130 rem	Not available
Worker	16.5 rem	7,380,000 rem [16]
Worker (thyroid)	Not available	8,030,000 rem [17]

***** For conversion units' sieverts (Sv) to rems; one sievert = 100 rem

DOE's own previous Environmental Impact Statement on NASA's plutonium-238 production states: **the ATR released 1,802 curies in 2000 and 1,180 curies in 2003 to the atmosphere.** [18] On average that is about 1,491 curies/year; so over an eight year period 2000 through 2009 (given ATR's continuous operation) about 13,419 curies may have been released to the air. These high emissions from ATR suggest liquid waste is first sent to the

[7] Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, U.S. Department of Energy, December 2000, DOE/EIS-0310, page I-6 and I-7.

[8] Chapter 15.12 – Severe Accident Analysis – Upgraded Final Safety Analysis Report for the Advanced Test Reactor, page 15.12-22, 8/1004, Department of Energy.

[9] Emergency Management Hazards Assessment for Reactor Technology Complex (HAD-3), page 142, Appendix A-1.

[10] Wikipedia Foundation, Inc. is a non-profit organization.

[11] 2004 Chapter 15 Severe Accident Analysis – Upgraded Final Safety Analysis Report for the Advanced Test Reactor (SAR), herein after referred as SAR; And Emergency Management Hazards Assessments for Reactor Technology Complex (HAD-3, 2004) herein after referred to as HAD-3. These reports contain dose data for various accident scenarios. For a complete analysis see; http://environmental-defense-institute.org/publications

[12] SAR, page 15.8-10; Total Effective Dose Equivalent (whole body dose), at off-site low population zone. See Endnote # V .

[13] HAD-3, page 129; Based on a source term rate of 5.0 E+6 R/hr; at 500 meters (1,640 feet) 2 rem/hour (96 rem at 48 hours); also see page 139 for 48 hour dose rate for ATR loss-of-coolant accident downwind total effective dose equivalent. See Endnote # III at the newsletter end.

[14] HAD-3, page 148; "At INL boundary – 48 hours; Committed Effective Dose. See Endnote # IV below.

[15] SAR, page 15.8-10; "The dose calculated for 100% core melt considers release of 64% of the source term in the first day and remainder over the next 10 days; the total dose is 185 rem thyroid and 13.2 rem EDE (whole body**)** at the LPZ [low population zone]." See Endnote # V below.

[16] HAD-3, pages 32 and 34. "Downwind dose at 30 meters; 7.38 E+6 Total Effective Dose Equivalent; 9.00 E+7 Committed Effective Dose, in rems." See Endnote # VI below.

[17] HAD-3, page 148; Committed Effective Dose; 8.03 E+6 rem at 30 meters.

[18] DOE/EIS-0287 pg. 4-30; DOE/DEIS-0373D, pg 3-26.

ATR cooling towers w/o treatment and the precipitates are then pumped to INTEC evaporators or the percolation ponds. This represents a significant hazard to INL workers and the downwind public, and violation of regulatory limits (Radioactive Emission Standard 40 CFR 61.92 cited above). Where are the EPA/ID state regulators?

DOE's Advanced Test Reactor (ATR) radioactive potential release in the event of a "large break loss-of-coolant-accident "scram inventory" (emergency shutdown) for radioactive iodine at 80,290,000 curies and Cesium at 57,570,000 curies. [19] DOE claims that none of the cesium and only 5.3% of the radioactive iodine would be released in an accident.

INL Nuclear Waste Vulnerabilities

An independent international panel of distinguished nuclear experts lead by Robert Alvarez issued a report called "Reducing the hazards from stored spent power-reactor fuel in the United States." [20] This lengthy technical report outlines the inherent vulnerabilities of existing commercial and DOE reactor fuel storage operations to catastrophic failure from system malfunctions and terrorist attacks. This hazard looming over the heads of Americans has spurred national attention. [21]

The report notes: "Because of the unavailability of off-site storage for spent power-reactor fuel, the [Nuclear Regulatory Commission] NRC has allowed high-density storage of spent fuel in pools originally designed to hold much smaller inventories. As a result, virtually all U.S. spent-fuel pools have been re-racked to hold spent-fuel assemblies at **densities that approach those in reactor cores**.

"In order to prevent the spent fuel from going critical, the fuel assemblies are partitioned off from each other in metal boxes whose walls contain neutron-absorbing boron. It has been known for more than two decades that in case of a loss of water in the pool, convective air cooling would be relatively ineffective in such a 'dense-packed' pool.

"Spent fuel recently discharged from a reactor could heat up relatively rapidly to temperatures at which the zircaloy [sic] fuel cladding could catch fire and the fuel's volatile fission products, including 30-year half-life cesium-137, would be released. The fire could well spread to older spent fuel. The long-term contamination consequences of such an event could be significantly worse than those from the [Russian] 1986 reactor meltdown at Chernobyl." [Emphasis added]

DOE made a programmatic policy decision in 1995 to consolidate its inventory of aluminum-clad spent nuclear fuel (SNF) at its Savannah River Site in South Carolina, and its zirconium and stainless steel-clad spent fuel at the Idaho National Laboratory (INL). This "centralization" plan resulted in an INL SNF inventory of 2,742 metric tons of heavy metal that includes 78 metric tons of zirconium clad fuel. [22] This inventory may be significantly understated on zirconium SNF since the Navy's inventory at INL is classified. [23]

In an effort to understate the amount of Spent Nuclear Fuel (SNF) waste, DOE developed a questionable way to account for its inventory by now showing it as metric tons heavy metal (MTHM) which only includes the estimated weight of the uranium/plutonium portion of the SNF and eliminating the total weight of the waste.

According to DOE's website; "Through the National Environmental Policy Act, a decision was made in 1995 to consolidate DOE-owned SNF at existing DOE sites that have the skills, facilities, and technologies to best handle the fuel. Based on the decisions from the associated environmental impact statement, DOE will temporarily store its SNF at the Hanford Site in Washington, the Idaho National Laboratory (INL) in Idaho, and the Savannah River Site (SRS) in South Carolina until a repository is completed. The Hanford Site will retain most of its current inventory of SNF. The remaining DOE SNF will be consolidated at either the INL or SRS, depending on the type of fuel.

"[Environmental Management] EM is currently managing approximately 2400 metric tons of heavy metal (MTHM) of SNF at the three sites: approximately 2100 MTHM at RL; about 30 MTHM at SRS and about 260 MTHM at INL.

"At INL, EM is planning to provide a SNF dry storage, packaging, and load-out capability. This capability would provide dry storage capacity for all SNF at INL and the ability to prepare and package the fuel into a "road ready" condition as well as to enable DOE to meet the Idaho Settlement Agreement dates of having all SNF in dry storage by 2023 and out of Idaho by 2035. INL also receives and stores SNF from domestic and foreign test and research reactors."

Robert Alvarez, one of the principal authors of the

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[19] Chapter 15.12 – Severe accident Analysis – Upgraded Final Safety Analysis Report for the Advanced Test Reactor, page 15.12-22, INEEL, 9/3/02, Rev. 7.

[20] *Science and Global Security,* Princeton University, written by Robert Alvarez, Jan Beyea, Klaus Janberg, Jungmin Kang, Ed Lyman, Allison Macfarlane, Gordon Thompson, and Frank N. von Hippel, 1/31/03.

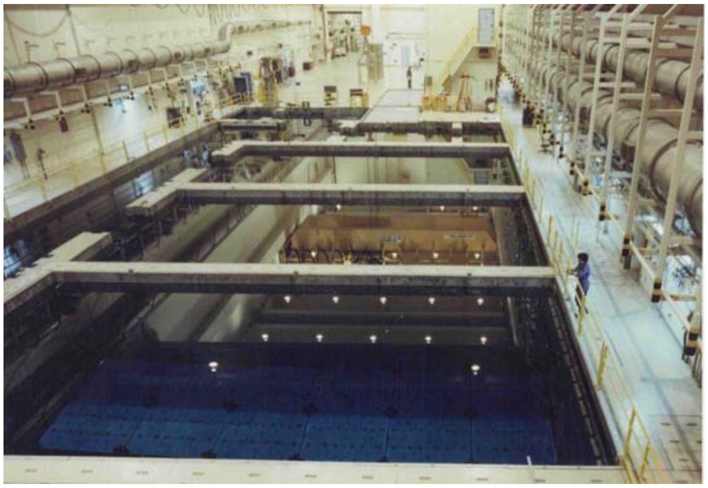
[21] *New York Times*, "Threats and Responses: Nuclear Plants: Study Warns Attack on Fuel Could Pose Serious Hazards," Matthew Wald, 1/30/03

[22] DOE Final Environmental Impact Statement, EIS-0203-F, Volume 1, Appendix B, page 3-7

[23] Idaho Chemical Processing Plans Spent Fuel and Waste Management Technology Development Plan, 4/24/92, US DOE Operations Office

independent hazards report, adds: "One concern about zirconium-clad SNF is that if the water drains enough to expose the fuel and the cladding heats up to somewhere between 600 to 1,000 degrees C, it will go exothermic. If the fuel is metal, then if it gets wet, it hydrides and also catches fire."

INL INTEC CPP-666 SNF Storage



The Navel Reactor Facility (NRF) at INL receives all Navel Nuclear Propulsion SNF and conducts destructive tests on nearly all Navy SNF (predominantly zirconium clad assemblies) that involve cutting the fuel mid-section to determine how well the fuel preformed in the Navy's ships and submarines. The NRF then transfers the SNF to INL/INTEC's Fluorinel and Fuel Storage Facility (CPP-666) for storage.

The salient point being is that the NRF zirconium reactor fuel cladding is compromised due to the destructive testing and therefore more vulnerable to storage coolant malfunctions. Moreover, the cuttings from NRF testing of zirconium clad fuel are a major problem because the Navy dumps these pyrophoric wastes in the INL burial ground at the Radioactive Waste Management Complex. According to an INL worker currently employed at the burial ground Pit-9 project, 18 tons of pyrophoric zirconium cuttings are interned in INL's dump. [24]

INL is in the process of consolidating current on/off-site SNF inventories to its INTEC (CPP-666) storage pools or to dry storage units. In order to make room for the additional SNF, CPP-666 is "re-racking" and condensing the SNF packing in the storage pool. This re-racking results in spacing nearly the same as in a reactor core, so any active cooling malfunction caused by systems failure or terrorist attacks presents a huge risk counted in days if active coolant systems and/or water level is not maintained.

Alvarez adds that, "The safe storage at CPP-666 depends very much on containing the risks of criticality. It's the exothermic reaction caused by very hot zirconium in a partially drained pool (about 75% is lost) that can ignite a potentially catastrophic fire."

INTEC has experienced dozens of power grid failures as well as backup power generator failures in the last decade. [25] DOE's own quasi-independent Defense Nuclear Facilities Safety Board has issued numerous critical reports in recent years identifying INL's deficient emergency power backup systems. [26] It is uncertain if current SNF storage or re-packing at CPP-666 requires active water cooling systems, if so, the operation's vulnerability is extremely problematic.

Japan's Fukushima Reactors' meltdowns included hydrogen explosions at the co-located SNF waste storage pools resulting in massive radioactive releases to the air and sea. For more information go to: http://beyondnuclear.org

Three Mile Island Fuel Storage Modules at DOE Idaho Facility are Cracking

William Freebairn reports in Washington (Platts) 15 April 2011; "The US Department of Energy facility storing melted fuel from the Three Mile Island nuclear plant has not done enough to address crumbling concrete modules encasing the radioactive material, the US Nuclear Regulatory Commission said in a letter made public Friday.

The DOE facility at the Idaho National Laboratory holds the damaged fuel from unit 2 of the Three Mile Island Plant, which, in 1979, suffered a partial meltdown of the core, leading to the US' worst nuclear accident. The so-called spent fuel rubble is now contained in concrete storage modules located at an independent storage installation owned by DOE.

The concrete modules are "showing significant cracking and degradation," even though they were built in 1999 to last for 50 years, NRC said in the letter, which is dated April 7.

DOE has analyzed the structural integrity of the modules, which have walls two feet thick, and determined that the problem is getting progressively worse, NRC said.

[24] U.S. Department of Energy, Idaho Operations document IDO-14532, page 50

[25] See *Citizens Guide to INL* listing of reactor melt-downs and accidents, Environmental Defense Institute.

[26] See Defense Nuclear Facilities Safety Board reports on INL at; www.dnfsb.gov

Since the NRC inspection, DOE has identified funding to pay for repairs and will begin the work this construction season, meaning from the spring to the fall, spokeswoman Katinka Podmaniczky said in an email Friday."These cracks have no impact on the storage modules' ability to safely
store spent nuclear fuel," she said.

At the time of the inspection, it was not clear whether DOE had approved or scheduled measures to stabilize the degradation, NRC said in the letter. It asked DOE to provide the regulator with information about corrective measures, a schedule for their implementation and a plan for monitoring the effectiveness of actions taken.

The degradation of the modules was likely due to "water intrusion and the annual thawing and freezing cycle," NRC said in an inspection report attached to the letter. Chunks of concrete have fallen from areas of the modules and there are signs they are no longer water-tight, NRC said.

Cracking was first recognized in 2000 but considered to be "cosmetic," NRC said. In 2008, DOE recognized that continued cracking called into question the ability of the modules to protect the fuel canisters inside from natural phenomena and shield people from the radiation of the fuel.

A recent study determined that protective caps should be installed, damaged concrete replaced and a sealant applied, but those actions have not yet been taken, the NRC inspection report said. NRC licensed DOE's Idaho Operations office in 1999 to store the damaged fuel in dry shielded stainless steel canisters, which are loaded inside the reinforced concrete modules. The 30 dry shielded canisters at the site contain melted fuel from the Three Mile Island-2 reactor core. That unit, located in Pennsylvania, experienced the melting of about half the fuel in the core during an accident. The adjacent Three Mile Island-1 continues to operate.

The NRC inspectors concluded that the storage facility continues to meet standards, but the degradation of the modules is "a concern that will be tracked in the future," agency spokesman David McIntyre said in an email.

NRC also cited DOE in the inspection report for a "deviation from a[n] NRC commitment" because it deleted certain material from an emergency plan. NRC ordered the energy agency to respond within 30 days. The deviation was minor, Podmaniczky said.

William Freebairn, william_freebairn@platts.com. EDI thanks Peter Richards for posting this article.

New Mexico at Risk for Nuclear Meltdown

By David B. Mccoy

As we watch the explosions at nuclear reactors in faraway Japan, we may feel that nothing like this could happen here. But New Mexicans have two nuclear reactors in their backyard, both at Department of Energy’s Sandia National Laboratories. One of the nuclear reactors, the Annular Core Research Reactor (ACRR), is in a building that cannot be made safe should a large earthquake happen in Albuquerque. The reactor is located within the take-off and landing pattern used by both Kirtland Air Force Base and the Albuquerque International Sunport.

The ACRR reactor is decades old and has no containment that would keep its radiation from contaminating military personnel, their families and residents of Albuquerque. Ground rupture can occur at the location of the reactor that is in the southwest portion of Sandia Labs.

The Defense Nuclear Facilities Safety Board staff reviewed the ACRR reactor. They found the building and the ventilation system are not built to earthquake safety standards. The construction of the building cannot prevent a radioactive plume from escaping into the community.

A hot-cell facility that handles high-level radioactive waste is housed in the same unsafe building as the nuclear reactor. The potential for the increased danger from failure of the building's shared safety systems in the event of a strong earthquake has not been analyzed. Other Sandia buildings that are structurally weak could release a chemical cloud exposing many thousands of people to these toxic chemicals. This information can be found in the 1999 Sandia Environmental Impact Statement.

There are many earthquake faults under Kirtland AFB and Sandia Labs. The surrounding public has not been informed of any provisions for evacuation should there be a natural disaster. Dense housing tracts, freeways, military housing, day care centers and schools are located within and along the boundaries of Kirtland AFB where the nuclear reactors are housed.

By allowing the reactor and hot-cell operations in a building that cannot be made safe for earthquakes, Sandia is violating federal laws that require protection for the workers, public and environment (10 Code of Federal Regulations Section 830.204).

Seven years ago, the Defense Nuclear Safety Board found that unexamined dangers for fire hazards, an airplane crash and equipment operations existed for Sandia's nuclear facilities. The Safety Board pointed out that an explosion, fuel meltdown and unconfined release of radiation took place in Idaho in a reactor using the same design. The Safety Board still has made no recommendation to block approval for the operation of this nuclear reactor.

Sandia informed the Safety Board that it would not be feasible to modify the building structure and ventilation system to act as a safety class confinement system, because the building is a decades-old structure which does not meet earthquake safety criteria.

A Jan. 24, 2005, Sandia analysis, "The Path Ahead to Improve the Nuclear Safety Basis Process at Sandia National Laboratories," identified the root cause that "Sandia has failed to manage the nuclear safety basis program in a formal, systematic manner based on recognized management system standards." The report stated that, "Nuclear safety basis activities have been a low priority for Sandia senior management."

Due to a lack of responsible oversight, the public is at risk for exposure to radioactive and chemical accidents at Sandia. The Safety Board has no authority to enforce nuclear reactor safety standards. The Nuclear Regulatory Commission cannot regulate Department of Energy reactors. The Department of Energy allows operation of this reactor knowing it is housed in an unsafe building. In addition, DOE official Thomas D'Agostino informed the Safety Board that Sandia does not plan to upgrade the building that houses the nuclear reactor and the hot-cell facilities.

New Mexicans need to be aware that there is a vacuum in regulatory authority and accountability to prevent a potential nuclear accident in our backyard.

Dave McCoy is Executive Director, Citizen Action New Mexico; a nuclear watchdog group. McCoy is also a Board Member of EDI.

Preventing the Next Nuclear Meltdown

The Lessons of the Fukushima Disaster for U.S. Nuclear Policy

Victor Gilinsky reports 3/21/11; "By now everyone has seen the videos of explosions at Japan's crippled Fukushima Daiichi nuclear plant and the aerial photos of what looks like the result of a World War II bombing. The Fukushima accident has revived the long-dormant issue of nuclear safety, and these indelible images will no doubt accompany all future debates over nuclear energy. Lately, policy discussions have focused on expanding the role of nuclear power; they must now shift to making sure the existing nuclear plants, and especially the older ones, meet strict contemporary standards.

Of the 13 nuclear reactors along Japan's coast that were directly impacted by the earthquake and tsunami, it was the four oldest ones that failed completely. The more modern units sustained damage but rode out nature's onslaught, even if just barely, despite facing forces far greater than what they were designed to withstand. Postmortems will likely disclose that the older plants were designed to lower standards than more recent ones and were not adequately upgraded. Such findings will raise questions about older reactors elsewhere, including in the United States.

The operating Fukushima reactors shut down immediately upon sensing the March 11 earthquake, but radioactive fission products in the reactors' uranium fuel continued to generate heat after the shutdown and therefore required continuous cooling. But cooling was unavailable as the reactors lost all electric power, including from backup emergency diesel generators. Without adequate cooling, fuel temperatures rose to dangerous levels. The zirconium tubing surrounding the fuel reacted with hot steam to produce hydrogen, which mixed with air and exploded, destroying the surrounding structures.

As the heating continued, at least part of the fuel in the reactors likely melted and released radioactive material, some of which then escaped through the breached protective structures and spread into the surrounding air. The multiple failures of safety systems in the four reactors at Fukushima went beyond any emergency scenario the Tokyo Electric Power Company had ever envisioned, forcing it to improvise solutions, including using fire pumps filled with seawater to cool the reactors.

The United States needs firm government safety regulation because public and private incentives differ when it comes to nuclear power.

The disaster at Three Mile Island in 1979 illustrates how quickly reactor fuel can reach melting temperatures if it is not cooled. There, half the reactor core melted in the first two hours of the accident. The melting stopped when an operator turned on emergency cooling, which had mistakenly been turned off. In fact, the active phase of the accident was over before regulators in Washington were informed. (I was the senior commissioner in charge of the Nuclear Regulatory Commission during the first day of the accident.) Altogether, as bad as it seemed at the time, the Three Mile Island accident was a far less serious event than the one at Fukushima. It is significant that we did not learn the degree of melting until several years later, when the reactor vessel's radioactivity had decayed sufficiently to open it. Similarly, the world will not learn what happened inside the Fukushima reactors for years, assuming things do not get worse.

The storage pools for radioactive spent fuel at Fukushima have also posed a threat. They contain more dangerous radioactive products than do the reactor vessels. One drained pool allowed spent fuel to heat up; similar overheating threatened an adjoining unit, and Japanese officials have been desperately trying -- using helicopters, fire pumps, and even riot police water cannons -- to keep the spent fuel rods under water. It appears that they have finally succeeded in reconnecting a power line to one of the reactors, which will help pump much-needed cooling water.

The reason for the frantic efforts to stabilize the reactors and spent fuel pools is that if the situation were to deteriorate further, molten and vaporized fuel could release dangerous radioactive fission products such as Cesium-137. If the radioactive materials are deposited in sufficient concentrations, they could make surrounding areas essentially uninhabitable. That is what happened around Chernobyl in Ukraine and even in parts of Belarus and Russia that were affected by the fallout. There, restrictions on use of contaminated land were not strictly enforced, but in a Western country or Japan, they would be -- at enormous economic cost. U.S. reactors typically store much more spent fuel than did the Fukushima plants, and a similar disaster here could therefore be devastating.

In the coming months, it will be necessary to conduct a thorough investigation involving both Japanese and international experts in order to help nuclear operators around the world absorb the lessons more effectively.

The United States should use the occasion to reexamine the safety of its operating nuclear reactors, especially the older ones. More than half of the United States? 104 reactors were licensed more than 30 years ago and constructed under safety codes less demanding than the ones applied to new reactors today. These older plants have been upgraded to some extent but not in any systematic manner. Their seismic analyses, for example, reflect old earthquake data that underestimated the degree of earth motion.

Approximately 20 U.S. boiling water reactors -- which boil water in their pressure vessels -- are essentially identical to the failed Fukushima reactors. Most U.S. 'pressurized water reactors' -- which do not generate steam in the reactor itself -- have formidable reinforced-concrete containment domes (although typically not as formidable as those in Europe). But nine of these pressurized reactors have smaller and weaker containment structures that rely on buckets of shaved ice to quench steam and thus reduce containment pressure in the event of an accident. Officials in Washington must take a hard look at these nine reactors -- four in North Carolina, three in Tennessee, and two in Michigan.

Unfortunately, U.S. regulators have been overly accommodating to the industry they supervise. The Nuclear Regulatory Commission has been handing out 20-year extensions to plants, whose original licenses were for 40 years. This includes the country's oldest operating plant, New Jersey's Oyster Creek, which went into operation in 1969 and now holds a license to operate until 2029. These extensions tend to be granted after NRC reviews that are heavily weighted toward accepting the validity of past technical conclusions. Rather than simply green-lighting old nuclear plants, officials need to reverse the burden of proof and examine more carefully whether past acceptances of old safety systems remain valid today.

The Obama administration's first reaction to the Fukushima accident was overly defensive. But U.S. President Barack Obama took a step in the right direction on March 17 by asking the NRC to undertake a comprehensive review of the safety of our domestic nuclear plants in light of the natural disaster that unfolded in Japan. There should be no illusions, however, about the likely result of this review.

The NRC regulation that covers safety upgrades (called 'backfits' in regulatory jargon) is strongly biased against any costly improvements. The last time the NRC launched such a review of the U.S. nuclear plants, in 1996, the industry mobilized then-Senator Pete Domenici (R-N.M.), who was the chairman of the NRC's appropriation subcommittee. Domenici promptly threatened a stunned NRC Chairperson Shirley Jackson with a deep budget cut unless she reversed her approach and made the agency more industry-friendly. Jackson did exactly that: she fired some of the top officials and toned down the NRC's criticism of industry. The staff got the message. Domenici brags about this episode in his 2004 book, A Brighter Tomorrow, and goes on to write that he has been very impressed with the NRC. So has the nuclear industry, which has always preferred self-regulation to government oversight.

The United States needs firm government safety regulation because public and private incentives differ when it comes to nuclear power. The industry's economic interests generally dictate safe operation, but sometimes complacency sets in, or a company's management tries to cut corners. The safety performance of U.S. nuclear plants, as measured by the NRC, has in fact improved over the years. But doubts remain over how the NRC deals with outliers, such as Ohio's Davis-Besse, which had a close brush with a very serious accident in 2003 shortly after having received top grades from the NRC in all 18 safety categories shortly before.

U.S. nuclear regulators have been overly accommodating to the industry they supervise.

The Fukushima accident, especially because it happened in a wealthy industrialized country and involved plants of U.S. design, is a warning that should be heeded. Washington needs to reexamine not only U.S. reactors' safety systems but also the fundamentals of the U.S. approach to nuclear safety. That means looking at how the NRC balances the costs and benefits in deciding whether to require safety upgrades, and whether some of the most vulnerable plants should be operating at all.

The NRC has a highly skilled staff for dealing with day-to-day technical issues, but the agency has trouble confronting larger safety issues, especially those that threaten the prospects of commercial nuclear power or raise questions about its previous license approvals. The five appointed NRC commissioners currently monopolize all authority -- both state and federal -- over nuclear power plant safety. A state government cannot reject a nuclear facility within its borders on grounds of safety; only the NRC can do so.

In the wake of the Japanese nuclear crisis, it is time for Washington to reconsider this arrangement and allow states to decide for themselves."

Nuclear Official Laments That Spent Fuel Has Nowhere to Go

Hannah Northey, *E&E News* reporter posted 3/3/11 that; "Federal regulators yesterday said they are preparing spent nuclear fuel in Idaho to be shipped to a permanent storage facility -- even though they're not sure where that might be.

Adm. Kirkland Donald, deputy administrator for the National Nuclear Security Administration's (NNSA) Office of Naval Reactors, told a House subcommittee yesterday that the agency has prepared 38 containers of spent fuel from military operations in Idaho to be shipped to a national repository. NNSA is a semiautonomous agency within the Department of Energy that manages and maintains the country's nuclear weapons capabilities.

But since the federal government has quashed plans -- at least for now -- to use Yucca Mountain in Nevada as a permanent national repository, the spent nuclear fuel from nuclear-powered aircraft carriers and submarines is being stored temporarily at the Naval Reactors Facility at the Idaho National Laboratory.

"There's still a significant issue hanging out there about 'what are we going to do with this fuel, absent Yucca Mountain,'" Donald told the House Energy and Water Appropriations Subcommittee.

The subcommittee met to discuss President Obama's fiscal 2012 budget request, including $1.2 billion for the NNSA's naval reactors program, an increase of 7.8 percent over the fiscal 2011 request (*E&E News* PM, Feb. 28).

Part of the funding boost would be channeled to NNSA's spent fuel handling recapitalization project, which would replace the 50-year-old Expended Core Facility within the Naval Reactors Facility, which is used for performing research, inspection, examination and storage of naval spent nuclear fuel, according to the Idaho Department of Environmental Quality. NNSA says the facility's infrastructure is deteriorating and could eventually affect the Navy's ability to operate its nuclear-powered fleet and nuclear propulsion plants.

At the hearing, Donald expressed concern with a 2035 deadline to ship spent nuclear fuel out of Idaho, a date complicated by the lack of a permanent repository. The agreement forged among Idaho, the Navy and DOE in 1995 allows for only the interim storage of spent fuel over a 40-year period in Idaho. Under that agreement, DOE must treat all "high-level waste" at a facility in Idaho for final disposal elsewhere, with a target date of 2035, according to the Idaho Department of Environmental Quality.

NNSA is concerned with the 2035 timeline and "what it really meant from the beginning," because the agency does not want to leave Idaho and signed an addendum that "provided for a future beyond 2035," Donald said. But that addendum did not relieve the agency of its responsibility to prepare the spent fuel for ultimate disposal and the agency is moving it to dry storage into containers that are "road ready" to be shipped, he said.

"We will meet our obligations, absent the fact that I don't have anywhere to put it right now," Donald said. "The state has been remarkably patient with us and supportive of what it is we're doing. We as a nation have an obligation to come up with a final solution, and when that's ready we'll be ready to support it."

Rep. Mike Simpson (R-Idaho), a member of the House subcommittee, expressed doubt that the 2035 deadline was firm, adding that the true spirit of the agreement was to spur the Navy and DOE to find a permanent repository.

"To me the year 2035 ... I don't think it's written in stone, it is that the people of Idaho want to see progress for a permanent repository, and that to me is the important thing," Simpson said. NNSA official laments that spent fuel has nowhere to go."

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