To: Collins, NRR
Ref. G20010508

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Dr. William D. Travers
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

November 8, 2001

RE: 10 C.F.R Section 2.206 Petition for the Emergency Shutdown of Indian Point's Units 1 and 2

Dear Dr. Travers:

Pursuant to 10 C.F.R. Section 2.206, the Pace Environmental Litigation Clinic, Inc., representing the Riverkeeper Inc., Petitioner in this matter, hereby submits to the Nuclear Regulatory Commission, a petition requesting that the Commission institute a proceeding to suspend, modify, or revoke the operating licenses for Indian Point's Unit 1 and 2. This request is based on a new, site specific, hazardous condition, which represents a substantial safety and health issue not previously considered in the licensing or design basis threat of the Indian Point facility, specifically the threat of a terrorist attack. The condition Petitioner identifies precludes the continued safe operation of the Indian Point facility.

Please note that we have previously transmitted of fax copy of this petition as a courtesy, which did not include exhibits contained within this submission.

Sincerely,

William J. Dubanevich, Legal Intern
Pace Environmental Clinic, Inc.

Template: EDO-001

E-RIDS: EDO-01

Before the
UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, D.C. 20555

In the Matter of:	:	TO: EXECUTIVE DIRECTOR FOR OPERATIONS
	:	
ENTERGY CORPORATION	:	
(Indian Point Nuclear Power Station,	:	Docket No. ______
Units No. 2 and 3; Facility Operating	:	
Licenses DPR-26 and DPR-64)	:	
		November 8, 2001

RIVERKEEPER, INC., et al,
Petitioners

SECTION 2.206 REQUEST FOR EMERGENCY SHUTDOWN OF INDIAN POINT UNITS 2 AND 3

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Before the
UNITED STATES NUCLEAR REGULATORY COMMISSION
Washington, D.C. 20555

In the Matter of:	:	TO: EXECUTIVE DIRECTOR FOR OPERATIONS
	:	
ENTERGY CORPORATION	:	
(Indian Point Nuclear Power Station,	:	Docket No. _______
Units No. 2 and 3; Facility Operating	:	
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RIVERKEEPER, INC., et al,
Petitioners

SECTION 2.206 REQUEST FOR EMERGENCY SHUTDOWN

OF INDIAN POINT UNITS 2 AND 3

I. Request for Action

Riverkeeper, Inc. and the individual and organizational petitioners identified on the attached page (collectively, "Petitioners") hereby respectfully request, pursuant to 10 CFR §§ 2.206 and 2.202, that the United States Nuclear Regulatory Commission take the following immediate actions:

1. Order the Indian Point licensee to suspend operations, revoke the operating license, or adopt other measures resulting in a temporary shutdown of Indian Point Unit 2 and Unit 3, as per 10 CFR § 2.202, and order the licensee to conduct a full review of the facility's vulnerabilities, security measures and evacuation plans.

2. Require the licensee to provide information, as contemplated by 10 CFR § 2.204(a), documenting the existing and readily attainable security measures which provide the Indian Point facility with protection against land, water, and airborne terrorist attacks. Such information should provide, at a minimum, sufficient basis for the Commission to determine that physical barriers, intrusion alarms, and other measures are in place or may be easily constructed, and are sufficient to meet realistically expected threats.

3. Immediately modify the licensee's operating license for Units 2 and 3 to mandate, at minimum, the following security measures sufficient to protect the facility as required by 10 CFR § 73.55:

a. obtainment of a permanent no-fly zone from the Federal Aviation Administration in the air space within 10 nautical miles of the Indian Point facility;

b. a defense and security system sufficient to protect and defend the no-fly zone;

c. a defense and security system sufficient to protect the entire facility, including the containment and spent fuel storage buildings, control room and electricity equipment, from a land or water based terrorist attack. The security review described above should contemplate retaining these measures on a permanent basis, and/or discuss reasonable alternatives of equal efficacy.

4. Order the revision of licensee's Emergency Response Plan and Westchester County's Radiological Emergency Response Plan in order to account and prepare for possible terrorist attacks. These reviews must contemplate not only realistic and catastrophic effects of a terrorist attack on the Indian Point facility, but a comprehensive response to multiple attacks in the region which may impair the efficient evacuation of the area. Examples of such attacks include destruction of the Tappan Zee Bridge, loss of power to passenger railroads, and other events which deny use of necessary infrastructure.

5. If, after conducting a full review of the facility's vulnerabilities, security measures and evacuation plans, the NRC cannot sufficiently ensure the security of the Indian Point facility against terrorist threats, the Commission should take prompt action to permanently retire the facility.

6. Separate and apart from the above, the Commission must order the Indian Point licensee to undertake the immediate conversion of the current spent fuel storage technology from a water cooled system to a dry cask system in a bunkered structure in order to reduce the long-term risk associated with potential exothermic oxidation within the existing spent fuel storage facility.

As explained more fully below, the Indian Point facilities' containment structures, reactor vessels, spent fuel storage areas, control rooms, and electrical switching equipment are all vulnerable to terrorist attack. Indian Point, located in Westchester County, New York, is not currently equipped to defend itself, nor the 20 million people who reside and work within a 50 mile radius of the plant, against an attack of the scale, sophistication, and coordination demonstrated on September 11, 2001. A successful attack on these structures would have a catastrophic effect on the region's human population, environment, and economy. Based on this threat, Petitioners are requesting, among other things, that the United States Nuclear Regulatory Commission suspend the operating licenses for all units until such time as the licensee can demonstrate that the facility is protected against plausible attack scenarios.

II. The Interests of Petitioners

Petitioner Riverkeeper, Inc. is a not-for-profit organization whose mission is to protect the environmental, recreational and commercial integrity of the Hudson River, and to safeguard New York City's and Westchester County's drinking water supply. Petitioners together and independently state that they are personally affected and aggrieved by the continued operation of Indian Point without the specific security measures identified in this request.

Section 2.206(a) of Title 10, CFR, states that "[a]ny person may file a request to institute a proceeding pursuant to § 2.202 to modify, suspend, or revoke a license, or for any other action as may be proper." Riverkeeper, Inc. hereby submits this petition identifying the threat of a terrorist attack on the Indian Point facility as a new, site-specific, hazardous condition that is larger and more dangerous than previously considered in the licensing and the design basis threat of Indian Point Units 2 and 3.

III. Critical New Information Constituting the Basis for This Request.

A. The Indian Point Facility is a Plausible Target of Future Terrorist Actions.

The United States is currently facing a heightened state of security related to the recent terrorist attacks against infrastructure targets in New York City and Washington D.C. As political, judicial, and military operations against suspected terrorist organizations continue, civilian and military establishments within the United States remain plausible targets of future terrorist attack. New York City remains a primary terrorist target, as evidenced by the growing number of Anthrax cases in that city and its environs. As New York City is a terrorist target, so too are nearby industrial facilities that, if compromised, could cause devastation to the populace, environment, and economy. No other facility in the country, let alone in New York, poses as great a risk to as great a number of people as the Indian Point nuclear power plant. Among the factors making the Indian Point facility a plausible target for a terrorist attack is the facility's proximity to:

- A population density of approximately 20 million people within 50 miles of the facility;[1]

[1] According to year 2000 U.S. Census Bureau data, 19,086,634 people live within the twenty-six counties that are within 50 miles of Indian Point, *available at* http://www.census.gov/index.html.

- Major financial centers in New York City that are essential to the functioning of the U.S. economy, (the greater New York City metropolitan area has the 14th largest economy in the world and the greatest economy of any metropolitan region in the nation);[2]
- The Croton, West Branch and Kensico reservoirs which supply and store nearly all of Westchester County's and most of New York City's drinking water; and
- Major air, sea, rail, and highway transportation systems that are vital to the regional and national economy.

B. Actual Threats Against Nuclear Power Plants Have Been Documented.

The imminent threat of a terrorist attack on a nuclear power plant is evidenced in news and in government statements. On November 3, 2001, Daniel Rubin reported in his article, *Nuclear Terrorism Threat Growing*: "[t]he vulnerability of power plants moved to center stage after last Sunday, when Canadian authorities monitored a phone call from an alleged al-Qaida member to Afghanistan. Two targets, he said, would be attacked this week 'down south,' including an unnamed nuclear facility."[3]

Shortly following the attacks on September 11, 2001 the Three Mile Island nuclear power plant received a "credible threat" on October 17, prompting officials to shut down two nearby airports and dispatch military aircraft to protect the facility.[4]

On November 1, 2001, Mohamed ElBaradei, Director General of the International Atomic Energy Agency (IAEA) warned that there is "the potential of terrorists targeting nuclear facilities."[5] Mr. ElBaradei also stated that the "safety and security of nuclear material is a legitimate concern of all States" and that "[t]he willingness of terrorists to commit suicide to

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[2] *See* The United States Conference of Mayors, *If U.S. City/County Metro Economies Were Nations, at* http://www.usmayors.org/citiesdrivetheeconomy/chart2_decade.pdf (last visited Nov. 7, 2001) (rankings based on gross domestic and metropolitan product 2000). Attached as Exhibit 1.

[3] Daniel Rubin, *Nuclear Terrorism Threat Growing*, KNIGHT RIDDER FOREIGN SERVICE (November 3, 2001) *available at* www.nci.org/01/11f/3-5.htm. Attached as Exhibit 2.

[4] CNN, *Threat at Three Mile Island Closes Airports*, October 18, 2001, *available at* www.cnn.com/2001/us/10/18/gen.three.mile.island/index.htm. Attached as Exhibit 3.

[5] International Atomic Energy Agency, *Calculating the New Global Nuclear Terrorism Threat* (November 1, 2001) *available at* www.iaea.org/worldatom/Press/P_release/2001/nt_Pressrelease.shtml. Attached as Exhibit 4.

achieve their evil makes the nuclear terrorism threat far more likely than it was before September 11."[6]

On November 1, 2001, the Washington Post reported: "Nancy Savage, an FBI agent in Eugene, Ore., who is president of the FBI Agents Association, said the biggest concerns for investigators include airports, power plants and other key infrastructure points."[7]

On July 4, 2001, the New York Times reported that an Algerian man, Ahmed Ressam, convicted of attempting to carry out a terrorist attack in Los Angeles, testified that he was trained in an Afghanistan camp run by Osama bin Laden and received training in how to blow up "the infrastructure of a country."[8] Ressam described how he was among 50 to 100 men at the camp who were being trained in "urban warfare."[9] Ressam stated that power plants were targets as they were labeled "enemies' installations."[10]

On October 21, 2001, the Sunday London Times reported that the FBI is studying a report that the four terrorists who seized Flight 93, which crashed near Pittsburgh, may have been targeting a nuclear power plant.[11] Most recently, the Federal Aviation Administration established a no-fly zone around nuclear power plants.[12] On October 30, 2001, the Washington Post reported on an interview with a jailed disciple of Osama bin Laden who said there are "more important places, like atomic plants and reactors" that may have been more appropriate targets than the World Trade Center.[13]

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[6] *Id.*

[7] Eric Pianin and Dan Eggen, *Preparations Stepped Up For Possible New Attacks*, WASHINGTON POST (November 1, 2001), *available at* www.washingtonpost.com/wp-dyn/articles/A20995-2001Oct.31.html. Attached as Exhibit 5.

[8] Lara Mansnerus and Judith Miller, *Terrorist Details His Training in Afghanistan*, N.Y. TIMES (July 4, 2001), *available at* www.nci.org/01/07/04-nyt-terrorist_afg.htm. Attached as Exhibit 6.

[9] *Id.*

[10] *Id.*

[11] Nicholas Rufford, David Leppard and Paul Eddy, *Nuclear Mystery: Crashed Plane's Target May Have Been Reactor,* SUNDAY TIMES (London, UK) (October 21, 2001), *available at* www.sunday-times.co.uk/news/pages/sti/2001/10/21/stiusausa02018.html. Attached as Exhibit 7.

[12] CNN, *FAA Restricts Flights Near World Series, Nuclear Plants* (October 30, 2001), *available at* http://edition.cnn.com/2001/us/10/30/gen.attack.on.terror. Attached as Exhibit 8.

[13] William Branigin, *In Afghan Jail, a Terrorist Who Won't Surrender,* WASHINGTON POST (October 30, 2001), *available at* www.washingtonpost.com/wp-dyn/articles/A8758-2001Oct29.html. Attached as Exhibit 9.

The NRC acknowledges the threat against nuclear power plants, as evidenced by the agency's move to shut down its website within weeks after the September 11 attacks. NRC's website is back up but with limited access to sensitive information, raising the question of whether terrorists already have downloaded and made use of information that has since been removed from the website. The United States remains on high alert in anticipation of additional terrorist attacks. As this petition was being written, the U.S. Justice Department announced it had credible information that another round of terrorism is imminent. In response to this renewed threat, the Governor of the State of New York, George Pataki, dispatched additional National Guard reservists to the state's nuclear power facilities. However, the strained resources of the state and the National Guard cannot ensure sustained adequate protection from terrorist attacks.

C. Indian Point Is Currently Vulnerable to Catastrophic Terrorist Attack.

1. While Operational, Indian Point Is Unnecessarily Vulnerable.

a. Risks from Takeover of or Damage to Control Rooms

As long as the facility remains operational, the control rooms are a likely and vulnerable target for terrorist attack. Seizure or disability of the control rooms would dramatically increase the potential for the intentional or accidental destruction of the reactor core. A terrorist attack on the control rooms of the Indian Point facility would cause a loss of control of Units 2 and 3. Disruption of the off-site power supplied to Indian Point or an on-site cutoff of power directly to the control room could render the control room inoperable. Back-up diesel generators are also vulnerable and sometimes unreliable. An on-site fire affecting the control room could render the control inoperable or ineffective, as technicians would be forced to leave or die. A properly functioning control room and control staff is necessary to ensure safe operation of an active reactor core. Absent proper control of plant operations, the risk of a reactor core melt-down or spent fuel storage incident rises precipitously.

b. Breach of Operating Reactors Creates Greater Danger of Catastrophic Contamination.

As discussed below, the reactor containment walls were not designed to withstand the accidental or intentional crash of fuel laden jetliners. The incidents of September 11, 2001, have introduced the likelihood that such a aircraft may be used against high-risk infrastructure facilities. The dangers posed by a breach of the containment domes of Indian Point Units 2 and 3 would be reduced by a cold shut down of these reactors. In particular, de-powering the reactors would reduce a potential release of high-risk radio-nucleides, thereby lowering long-term impacts such as childhood thyroid cancers of the type encountered in the wake of the Chernobyl accident.

c. Operational Facility Creates Multiple Vulnerable Points in Plant Security.

Because the reactors at Indian Point are operational, the licensee must extend full security measures to ensure protection of the control rooms and to guard against strikes that threaten the structural stability of the containment domes. While shutting down the reactors will not remove the need for such security, the reduction in threat would allow the licensee to focus its protective efforts on the more critical areas of the facility, especially the spent fuel storage area. The licensee would be able to shift some security personnel away from low risk areas, concentrating resources where they are most valuable and most likely to protect effectively against the deadliest attack.

d. Indian Point and NRC Personnel and Resources Confront Dual Challenges When Ensuring Security At Operational Facility.

Currently, employees at Indian Point must ensure both the safe and stable generation of power and create a heightened security environment. Simultaneously, NRC personnel are tasked with overseeing the ordinary operations of the plant while also ensuring that nuclear plants like Indian Point are protected against foreseeable threats. Resources of both the agency and the licensee have been stretched thin by this double-tasking.

On September 21, 2001, for example, the NRC announced that it was "working around the clock to ensure adequate protection of nuclear power plants and nuclear fuel facilities," and had directed the Staff to review NRC security regulations and procedures.[14] NRC also reports that it has advised all nuclear power plant licensees to maintain a state of the "highest level of

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[14] NRC, Press Release No. 01-112, *NRC Reacts to Terrorist Attacks* (September 21, 2001). Attached as Exhibit 10.

security." In addition, the NRC conceded that nuclear power plants are not designed to withstand to withstand crashes by large aircraft.[15]

The Commission's efforts in this regard highlight the credibility of the threats faced by nuclear power plants, particularly Indian Point. The necessity for round the clock operations, even figuratively, demonstrates the levels of staff time and resource commitments necessary to meet currently foreseeable threats. Closing down reactor operations will reduce these expenditures, simplifying daily operations at Indian Point, thereby reducing the chances of an accident while allowing both the Commission and licensee to prioritize security measures.

e. Shutting Down Indian Point's Reactors Creates A More Secure Environment

Security of spent fuel has never been demonstrated at Indian Point. A provisional shut down of the plant is needed to allow the licensee and NRC to test critical security provisions for this facility. "Business as usual" operation of Indian Point provides no incentive for the plant's owner and NRC to remedy this long overlooked vulnerability.

2. Vulnerability of the Spent Fuel Storage Facility

Terrorist action against the spent fuel storage facility could result in a catastrophic failure of the containment system. NRC has never established that the Indian Point spent fuel storage facility is secure against foreseeable attacks. Likewise, the Commission cannot be certain that the structure of the storage facility is sufficiently sound to preclude the possibility of a spent fuel fire in the event of an airborne, land, or water based assault.

NRC has not properly evaluated the consequences of terrorist attack on the spent fuel storage area. In a study conducted by the NRC in October 2000, it stated that:

> "the risk analysis in this study did not evaluate the potential consequences of a sabotage event that could directly cause off-site fission product dispersion, for example, a vehicle bomb driven into or otherwise significantly damaging the SFP [Spent Fuel Pool], even after a zirconium fire was no longer possible."[16]

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[15] *Id.*

[16] NRC Report October, 2000 at 4-15. Attached as Exhibit 11.

A likely result of an aircraft crashing into a spent fuel storage facility, or of a truck bomb explosion similar to that which destroyed the Alfred E. Murrow Federal Building, would be a precipitous loss of cooling water in the spent fuel pools. During the course of normal operation, the presence of cooling water reduces heat produced by the decaying fuel rods and minimizes the potential for fire in the fuel cladding. In the absence of cooling water, adequate air circulation through the spent fuel storage racks is necessary to prevent such a fire. Partial dewatering of the storage pools will block this air flow, especially if the racks are damaged or obstructed by falling debris or the force of an explosion.

A reduction of cooling water in the spent fuel pools could lead to a catastrophic release of radiation. As the water in the fuel pool is reduced the remaining water will heat up and evaporate. This could expose the zirconium cladding which surround the spent fuel rods to oxygen and steam, resulting in an exothermic reaction that will lead to a spent fuel rod assembly fire. This event would release deadly amounts of radiological material and toxic fumes. The NRC October 2000 report stated:

> This reaction of zirconium and air, or zirconium and steam is exothermic (i.e., produces heat). The energy released from the reaction, combined with the fuel's decay energy, can cause the reaction to become self-sustaining and ignite the zirconium. The increase in heat from the oxidation reaction can also raise the temperature in adjacent fuel assemblies and propagate the oxidation reaction. The zirconium fire would result in a significant release of the spent fuel fission products which would be dispersed from the reactor site in the thermal plume from the zirconium fire. Consequence assessments have shown that a zirconium fire could have significant latent health effects and resulted (sic) in number of early fatalities.[17]

A Department of Energy report indicates that such a fire would release considerable amounts of cesium-137, an isotope that accounted for most of the offsite radiation exposure from the 1986 Chernobyl accident.[18] Another report, authored by NRC, concludes that, in the event of a pool fire approximately 100 percent of the pool's inventory of cesium would be released to the atmosphere.[19]

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[17] NRC Report October, 2000 at 3-1 (internal citation omitted).

[18] *See* US Department of Energy, Health and Environmental Consequences of the Chernobyl Nuclear Power Plant Accident, DOE/ER-0332 (Washington, DC: DOE. June 1987).

[19] *See* V L Sailor et al, Severe Accidents in Spent Fuel Pools in Support of Generic Safety Issue 82, NUREG/CR-4982 (Washington, DC: NRC, July 1987).

The emission of radioactive particles from a spent fuel pool accident would lead to horrific consequences. The NRC study stated that human fatalities within the first year of such an event "can be as large as for a severe reactor accident even if fuel has decayed several years."[20] The radioactive fallout from this type of release could also make tens of thousands of acres of land uninhabitable.

An uncontrolled fuel rod fire in one pool could quickly cause fires in other pools where water loss is occurring. In the October 2000 report, the NRC stated that "[i]f the fuel handler fails to respond to the alarm or is unsuccessful in extinguishing the fire within the first 20 minutes, the staff assumes that the SSP cooling system will be significantly damaged and cannot be repaired."[21]

In addressing catastrophic events such as an earthquake, the report stated that the spent fuel pools "are also subject to unpredictable changes as a result of the severe seismic, cask drop and possibly other dynamic events which could rapidly drain the pool." A terrorist attack is one such dynamic event.

The spent fuel storage buildings at Indian Point are not capable of withstanding a terrorist attack. The roofs are "made partly out of pretty insubstantial metal, like sheet metal," according to the Nuclear Energy Institute.[22] This construction, coupled with relatively thin walls, is insufficient to protect against large vehicles or medium sized aircraft. The storage facilities are highly vulnerable to a ground-based attack of only several individuals or to a car and/or truck bomb. Compromise of the storage facility could pose an immediate health threat to workers and residents within close proximity of the Indian Point facility since radiation levels in the spent fuel storage facility can be five times higher than radiation levels in the containment area.[23]

The spent fuel storage area is highly vulnerable to an air attack and mitigation and control of damage from such an attack is highly improbable. An NRC report stated that an aircraft crashing into the spent fuel storage area could seriously affect the "structural integrity of the

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[20] *See* NRC Report October, 2000 at 3-34.

[21] *See* NRC Report October, 2000 at 3-16.

[22] *See* Vibeke Laroi, *Spent Nuclear Fuel Pools Seem Vulnerable To Attack*, REUTERS (Nov. 4, 2001).

[23] Based on calculations assuming that there are 15 times as many cores in the spent fuel storage area than in the containment area.

spent fuel pool or the availability of nearby support systems, such as power supplies, heat exchanges, or water makeup sources, and may also affect recovery actions."[24] The NRC study goes on to estimate that "1 of 2 aircrafts are large enough to penetrate a five foot thick reinforced concrete wall. The conditional probability that a large aircraft crashing penetrate a 5-foot-thick reinforced concrete wall is taken as 0.45."[25]

This probability is based on the occurrence of catastrophic damage to the spent fuel pool where "the pool is so damaged that it rapidly drains and cannot be refilled from either onsite or offsite resources."[26] Such an impact could cause a catastrophic event. The report estimates that a worse case scenario radiation release from a spent fuel rod fire will cause a 4.3 percent increase in early fatalities among those who are late to evacuate the one mile perimeter.[27] The individual risk of latent cancer fatalities from a worse case scenario release would be 8.42% higher.[28]

3. Design Basis Threat of the Indian Point Facility

The design basis threat did not consider the possibility of an intentional terrorist attack from the air or water, or a suicide attack from any front. The NRC has acknowledged that the Indian Point facility was not designed to withstand an attack by a fuel-laden, wide body jet. NRC spokesman, Neil Sheehan, stated "[w]e have not done the analysis, so we are not going to guarantee that a plane couldn't breach the containment."[29] The NRC news release of September 21, 2001 (No. 01-112), reads "the NRC did not specifically contemplate attacks by aircraft such as Boeing 757s or 767s and nuclear plants were not designed to withstand such crashes. Detailed engineering analysis of a large airline crash has not yet been performed."[30] Victor Dricks, NRC

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[24] NRC Report October, 2000 at 3-23.

[25] *Id.* at 3-23.

[26] *Id.* at 3-23.

[27] *Id.* at 3-29.

[28] *Id.*

[29] Roger Witherspoon, *Indian Point Chief: Plant Safe From Possible Attack*, JOURNAL NEWS (October 20, 2001), *available at* www.thejournalnews.com/newsroom/102001/20entergy.html. Attached as Exhibit 12.

[30] NRC Press Release, *NRC Reacts to Terrorist Attacks*, September 21, 2001.

spokesperson, stated that: "No one considered the possibility of suicide hijackers steering a large aircraft into a nuclear plant." [31]

In 1982, the U.S. Energy Department's Argonne National Laboratory performed a study that detailed the probable damage a jetliner could cause on the concrete containment walls protecting the reactors. While this study only addressed an accidental crash, it focused on the force of an impact into the primary containment wall and interior structure of a nuclear reactor. The report estimated that, if just one percent of a jetliner's fuel ignited after impact, an explosion inside the already damaged reactor building would occur generating a force equivalent to 1,000 pounds of dynamite.[32] The more fuel, the worse the explosion. The report stated that the ignition of fuel "could lead to a rather violent explosion and impose upon the primary containment relatively severe loads."[33]

The report added that U.S. nuclear regulators might have underestimated the potential damage from such explosions. The report also mentioned that "the breaching of some of the plant's concrete barriers may often be tantamount to a release of radioactivity." The report also stated that "[I]t appears that fire and explosion hazards have been treated with much less care than the direct aircraft impact. Therefore, the claim that these fire/explosion effects do not represent a threat to nuclear power plant facilities has not been clearly demonstrated."[34]

4. Defending the Indian Point Facility Against a Terrorist Attack

Security forces at nuclear power plants have repeatedly failed to repel mock terrorist attackers. In NRC recognized drills intended to test the ability of plants to defend against land based terrorist attacks, the nuclear industry has repeatedly failed to stop mock terrorist assaults from reaching the secure area of the plant and wreaking simulated damage that would, in a real situation, result in a core meltdown. The NRC reveals that 33 of the 68 facilities failed to repel

[31] Vibeke Laroi, *Nuclear Plant Scare Adds to U.S. Security Jitters*, REUTERS (October 18, 2001). Attached as Exhibit 13.

[32] U.S. Energy Department's Argonne National Laboratory Study, 1982.

[33] Id.

[34] Id.

small groups of mock intruders whose weapons, explosives, and tactics are severely limited.[35] In response to this problem, Paul Leventhal, founder of the Nuclear Control Institute,[36] stated:

> The security guards at half the nuclear power plants in the United States have failed to repel mock terrorist attacks against safety systems designed to prevent a reactor meltdown. These are so-called "force-on-force" exercises supervised by the Nuclear Regulatory Commission. The NRC refuses to take enforcement action in response to the failures, and is in the process of weakening the rules of the game in response to industry complaints. Sabotage of nuclear power plants may be the greatest domestic vulnerability in the United States today. This is the time to strengthen, not weaken, nuclear regulation.[37]

Despite Entergy's (the licensee of the Indian Point facility) assurances that it will be able to adequately protect against a terrorist attack, the reality of protection seems dubious.

5. Security And Safety Violations by Indian Point Licensee

It is clear from Entergy's history of violations that their claims of having sufficient security and the ability to protect the facility against a terrorist attack need to be called into question. Entergy has a demonstrably poor security record. As recently as August 2000, Entergy was sanctioned by the NRC for failure to maintain adequate physical protection of the Waterford 3 facility in Killona, Louisiana.[38] As a result of an October 1999 inspection by NRC staff, the NRC issued an order modifying Entergy's operating license in order to "assure that corrective actions are effectively implemented over the long term...and are necessary for [Entergy] to maintain compliance with 10 CFR 73.55[a]."[39] The NRC order explained that "[b]ased on the conduct of tabletop exercises, weaknesses were identified with the Licensee's capabilities to respond adequately to a design basis threat intrusion."[40]

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[35] Douglas Pasternak, *A Nuclear Nightmare*, U.S. WORLD & NEWS REPORT (September 17, 2001), *available at* www.nci.org/01/09/09-3.htm. Attached as Exhibit 14.

[36] The Nuclear Control Institute (NCI) is a non-partisan and non-profit Washington, D.C. based, independent research and advocacy center specializing in problems of nuclear proliferation.

[37] Paul L. Leventhal, Commencement Address to the Class of 2001 at Franklin & Marshall College (May 13, 2001). Attached as Exhibit 15.

[38] NRC Enforcement Action EA-00-093, dated August 4, 2000.

[39] *Id.* at 1 (regulation entitled "Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage").

[40] *Id.* at 5.

In addition to this enforcement order, Entergy has been subject to several enforcement actions for inadequate physical protection at its other facilities. Such violations include knowingly providing false information to an NRC inspector concerning a failure to provide adequate escorts to visitors inside the vital area.[41] Entergy has also been cited for numerous other violations related to safety.[42]

Last year, Indian Point 2 became the first nuclear plant in the nation to be given a "red" designation, giving it the highest risk assessment in the nation. The NRC gave the plant its worst rating because of the operators failure to detect flaws in a steam generator tube before a radiation leak in February 2000.[43]

6. History of Emergency Preparedness Problems at the Indian Point Facility

The Indian Point facility has long history of safety problems related to the ability to respond to emergency situations. In Inside NRC, 2000, the Commission reported that a NRC Region One Automated Inspection Team (AIT) found emergency response problems at Indian Point. The report stated that the

> [e]mergency response data system, which links the site with the NRC's operations center, was in-operable for the first several hours of the event due to pre-existing equipment problems. The utility was slow to activate emergency facilities; beepers used to notify emergency response personnel; phone number contacts were outdated and confusion exists about who responded when, some responders entered Indian Point's site from a back gate to Indian point Three and their arrival and whereabouts were not noted.[44]

D. Impacts of a Terrorist Attack on Indian Point's Unit Two and Unit Three

A successful attack on either of Indian Point's reactors or spent fuel storage facilities would likely result in a massive release of radioactive materials into the surrounding towns and counties, quite possibly reaching into and contaminating New York City. Such a release would

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[41] Independent Action IA 96-052 against Richard M. Gracin, Security Shift Supervisor, dated December 19, 1996.

[42] History of NRC violations: NRC OE EA 96-274 $50,000 fine - maintenance violation; NRC OE EA 96-025 $50,000 fine - safety system violations; NRC OE EA 95-076 unauthorized people gaining unescorted access to secure areas ; NRC OE EA 94-161 unauthorized access to felons; NRC OE EA 94-105 $112,000 fine - safety violation penalty; NRC OE EA 93-071 $112,500 fine - violation of physical security and safety problems.

[43] *See* Shawn Cohen, *NRC Flags ConEd With Red Tag For Indian Point*, THE JOURNAL NEWS (November, 21, 2000). Attached as Exhibit 16.

[44] *See* NRC, *Inside NRC, 2000.*

cause hundreds of immediate fatalities close to the site and 100,000 or more latent cancer deaths farther downwind of the plant.[45] Further, a major release would probably contaminate the drinking water supply for New York City and Westchester County, devastate the area's ecology, and render portions of the New York metropolitan area uninhabitable.

1. Illness and Fatality Data

A study performed by NRC estimates that a terrorist attack on the Indian Point Unit 2 reactor that leads to a meltdown would cause "46,000 Peak Early Fatalities, 141,000 Peak Early Injuries, [and] 13,000 Peak Deaths from cancer."[46] A meltdown of the Indian Point Unit 3 reactors would cause "50,000 Peak Early Fatalities, 167,000 Peak Early Injuries, [and] 14,000 Peak Deaths from cancer."[47]

Loss of life and long-term illnesses will be exacerbated by the near-impossibility of evacuating the 22 million people who live within the 50 mile radius surrounding Indian Point. Following the 1979 accident at Three Mile Island, then Director of NRC's Office of State Programs testified that a similar accident at Indian Point would have had far more drastic consequences:

> Everybody says what a terrible situation we had at Three Mile Island, and I agree, but can you imagine what it would have been if it had been at Indian Point? It would have calamitous. You would have had dozens, hundred of people killed perhaps trying to get out of the place, because the roads are, you know, they're North-South roads basically and...there are narrow old bridges, one of the oldest bridges across the Hudson, the Bear Mountain Bridge, is a two-lane bridge...It's just a ridiculous place.[48]

2. Economic Loss Data

This same NRC study reveals that a terrorist attack on the Indian Point Unit 2 or 3 reactors that leads to a meltdown would cause $274 billion (1982 dollars) in property damage,[49]

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[45] Sandia Labs, NRC, Calculation of Reactor Accident Consequences (1982) ("CRAC-2 Report"). (We understand that the NRC has a more recent model or code for performing these estimates. We encourage the Commission to update these figures.)

[46] *Id.*

[47] *Id.*

[48] *At Indian Pt., A History of Nuclear Power, Problems And Controversy*, N.Y. TIMES (May 6, 1983). Attached as Exhibit 17.

[49] Sandia Labs, NRC, Calculation of Reactor Accident Consequences (1982).

and $314 billion (1982 dollars) in property damage respectively.[50] In terms of 2000 dollars, property damage from a Unit 2 meltdown would be estimated conservatively at $500.5 billion, and property damage from a Unit 2 meltdown would be estimated conservatively at $573.5 billion -- figures based solely on inflation without factoring the substantial rise in metropolitan area real estate values.[51] Data from the New York State Office of Real Property Services show that property values in Westchester County, and NY state in general, have increased four-fold since 1982.[52] Compounding this economic disaster would be the tremendous loss of both personal and corporate equity, and the loss resulting from uninsured and unrecoverable defaults on mortgage loans resulting from property loss.

An economic loss of this magnitude for the City of New York would have devastating consequences on our nation's entire economy.

3. Environmental Consequences

The potential dispersal of radiological contaminants into the water, atmosphere, and on land, would cause extensive and irreversible environmental damage. The dispersal of radiological contaminants is dependent on their physical and chemical properties. Some particles would be suspended or dissolved in water, contaminating drinking water supplies. The consumption of these suspended particles would adversely affect the health of aquatic life. Some radioactive isotopes are known to bio-accumulate in the tissues and organs of wildlife, thereby leading to systemic contamination of the food chain and further injury to humans. As some of the radioactive particles fall out of suspension and settle, river and reservoir beds would become contaminated. Furthermore a radioactively contaminated Hudson River would lose its recreational and commercial value as it would be unnavigable, unswimmable, and unfishable.

Particles that remain airborne would be respirable by humans and wildlife causing latent carcinogenic, mutagenic and teratogenic effects. Particles that settle out of the air would contaminate plant life and lands, causing lasting damage to entire ecosystems.

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[50] *Id.*

[51] *See* The Inflation Calculator, available at http://www.westegg.com/inflation/ (based on increases in the Consumer Price Index) (last visited Nov. 7, 2001).

[52] *See* New York State Office of Real Property Services, *Exemptions From Real Property Taxation In New York State* (1982 & 1999 reports), *available at* http://www.orps.state.ny.us/.

E. Westchester County's Radiological Emergency Preparedness Plan (REPP)

Westchester County's Radiological Emergency Preparedness Plan (REPP) was last revised in May of 2000 and does not address the site-specific, hazardous conditions of a sabotage event or a terrorist attack at the Indian Point facility. Moreover, the REPP does not address the likelihood of a meltdown event, a spent fuel storage area release, or a spent fuel assembly fire.

The REPP is flawed because it is based on erroneous assumptions. Therefore, REPP is inadequate in providing protection to the public. The assumptions in the REPP preclude the occurrence of an intentional act of terrorism or sabotage, a meltdown event involving Units Two or Three, the radiological release from the spent fuel storage area, a spent fuel rod fire, or the possibility of an explosion at the Indian Point facility.[53] A particularly disturbing assumption is that the effect of an accident "would almost certainly be contained within the reactor containment building. Nonetheless, an accidental release of radioactive materials to the off-site environment remains a remote possibility."[54] In the event of an accident, the REPP only considers the potential release of radioactive iodine, xenon, and krypton gases.[55] The REPP, by omission, ignores the release of cesium, stontium-90, plutonium and other radiological and toxic contaminants that will be released from a meltdown scenario, compromise of the spent fuel pools, or a spent fuel assembly fire.[56]

The inadequacies of emergency response at the Indian Point facility were known and considered decades ago, however no action was taken to resolve response problems. Robert Ryan, previous Director of NRC's Office of State Programs, said in a sworn statement after Three Mile Island, "it is insane to have a three-unit reactor on the Hudson River in Westchester County, 40 miles from Times Square, 20 miles from the Bronx" and that the emergency response

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[53] Indian Point Radiological Emergency Preparedness Plan for Westchester County, Revision May, 2000, at I-3.

[54] *Id.* at I-3, I-4.

[55] *Id.* at I-4.

[56] *Id.*

plan for serious accidents at the facility was a "nightmare."[57] Given the imminent threat of a terrorist attack on the Indian Point facility Mr. Ryan's statement is doubly true today.

Based on the inherent inadequacies of the REPP and its preclusion of the new site-specific, hazardous condition posed by a terrorist threat, the REPP needs to be revoked. In the interim, the Indian Point facility should be temporarily shut down until a realistic REPP can be developed, implemented, and tested.

F. Economic Impact of Actions Requested

The temporary shutdown of the Indian Point facility during the fall, winter, and spring will not have a significant impact on the supply and cost of electricity to consumers. The Indian Point reactors generate only five percent of the electricity in New York State. During the fall, winter, and spring months, there is a surplus of generating capacity in New York State. The potential costs increase to consumers from a temporary shutdown of Indian Point will be approximately 1/10 of one cent per kilowatt-hour. This is a small price to pay in comparison to the potential loss of life, environmental damage and economic loss that could result from terrorist attack at the Indian Point facility.

IV. The NRC Has Broad Discretionary Powers to Order and Implement Petitioner's Requests.

Pursuant to 10 CFR § 2.202(a) the Commission has authority to "institute a proceeding to modify, suspend or revoke a license or to take such actions as may be proper." In upholding its duty to protect the public, environment, and property, the NRC has broad discretionary powers to grant Petitioners' requests.

Section 161(b) of the Atomic Energy Act empowers the Commission to "establish rule[s], regulation[s], or order[s]" to "protect health or to minimize danger to life or property."[58] The NRC's authority to protect the public

> ...cannot be read simply to permit the Commission to provide adequate protection; another section of the Act "requires" the Commission to do that much.

[57] *At Indian Pt., A History of Nuclear Power, Problems And Controversy*, N.Y. TIMES (May 6, 1983). Attached as Exhibit 17.

[58] 42 U.S.C. § 2201(b), (i).

> We therefore must view section 161 as a grant of authority to the Commission to provide a measure of safety above and beyond what is "adequate." The exercise of this authority is entirely discretionary. If the Commission wishes to do so, it may order power plants already satisfying the standard of adequate protection to take additional safety precautions.[59]

In addition, the Code of Federal Regulations, in Title 10, Sections 2.200, 2.204, 2.206, and 73.55, as well as other authority, authorizes the NRC to take the specific actions requested herein.

V. The Actions Requested Are Necessary and Appropriate to Protect the Safety of the Twenty Million People Living in the Vicinity of Indian Point.

Petitioners have properly "set forth the facts that constitute the basis for [this] request" pursuant to 10 CFR § 2.206, and have properly identified "the potentially hazardous conditions" as required by 10 CFR § 2.202(a)(1), specifically the threat of a terrorist attack on the Indian Point facility. The NRC should take immediate action in response to Petitioners' request.

The threat of terrorism on a scale of the September 11th attacks, and including assaults from the air or water, has not been previously considered in the licensing and/or design basis threat of the Indian Point facility, therefore, this request is proper and demands NRC's immediate attention and action. The Atomic Energy Act "commands the NRC to ensure that any use or production of nuclear materials 'provide[s] adequate protection to the health or safety of the public.'"[60] As of September 11, 2001, this duty has taken on a new dimension: the protection of the public from threat of a major radiological release resulting from a terrorist attack. Given that NRC's "paramount responsibility [is] protection of the public health and safety and the environment,"[61] the NRC should immediately order the actions requested herein and more fully articulated below.

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[59] *Union of Concerned Scientists v. NRC*, 824 F.2d 108, 110 (D.C. Cir. 1987).

[60] *Shoreham-Wading River Cent. Sch. Dist. v. U.S. NRC*, 931 F.2d 102, 106 (D.C. Cir. 1991) (*citing* 42 U.S.C. § 2232(a)).

[61] Conference Report at 47, 1982 U.S. Code Cong. & Admin.News at 3617.

A. The NRC Should Order An Immediate, Temporary Suspension of Operations at Indian Point Units Two and Three, and Conduct a Full Review of The Facilities' Vulnerabilities, Security Measures and Evacuation Plans.

Title 10, Section 2.202 of the Code of Federal Regulations authorizes the NRC to "modify, suspend, or revoke a license, or [take] any other action as may be proper."[62] The NRC should immediately order the Indian Point licensee to suspend operations, revoke the operating license, or adopt other measures resulting in a temporary shutdown of Indian Point Unit Two and Unit Three, as per 10 CFR § 2.202, and to conduct a full review of the facility's vulnerabilities, security measures and evacuation plans for the following reasons:

First, as explained above, as an operating facility, Indian Point is unnecessarily vulnerable to risks from takeover of or damage to control rooms. As long as the facility remains operational, the control rooms are a likely and vulnerable target for terrorist attack. Seizure or disability of the control rooms would dramatically increase the potential for the intentional or accidental destruction of the reactor core.

Second, because the reactor containment walls were not designed to withstand the accidental or intentional crash of fuel Laden jetliners, a breach of operating reactors creates a significantly greater danger of catastrophic contamination. The danger of a potential release of high-risk radio-nucleides would be reduced by a temporary de-powering and cold shut down of these reactors.

Third, the operating facility creates multiple vulnerable points in plant security. While shutting down the reactors will not remove the need for security, the reduction in threat would allow the licensee to focus its protective efforts on the more critical areas of the facility, especially the spent fuel storage area, thereby concentrating resources where they are most valuable and most likely to effectively protect against the deadliest attack.

Fourth, Indian Point and NRC personnel and resources confront dual challenges when ensuring security at an operational facility. Currently, employees at Indian Point must ensure both the safe and stable generation of power and create a heightened security environment. Simultaneously, NRC personnel are tasked with overseeing the ordinary operations of the plant – which is the only nuclear plant in the nation with a D rating (multiple/repetitive degraded

[62] 10 C.F.R. § 2.202.

cornerstone) from the NRC – while also ensuring protection against foreseeable threats. Resources of both the agency and the licensee are stretched thin by this double-tasking.

Finally, shutting down Indian Point's reactors creates a more secure environment. Spent fuel security has never been demonstrated at Indian Point. A provisional shut down of the plant is needed to allow the licensee and the NRC to test critical security provisions for this facility. "Business as usual" operation of Indian Point provides no incentive for the plant's owner and the NRC to remedy this long overlooked vulnerability.

For all of these reasons, an immediate, temporary shutdown of the operating reactors at Indian Point Units Two and Three is necessary and prudent.

B. The NRC Should Require the Licensee to Provide Information Documenting That Existing Security Measures Are Sufficient Against Plausible Threats of Terrorist Attacks.

Title 10, Section 2.204(a) of the Code of Federal Regulations authorizes the NRC to demand information from a licensee. The NRC should immediately demand that Entergy provide information documenting the existing and readily attainable security measures which provide the Indian Point facility with protection against land, water, and airborne terrorist attacks. Such information must provide, at a minimum, sufficient basis for the Commission to determine that physical barriers, intrusion alarms, and other measures are in place or may be easily constructed to meet plausible threats, for the following reasons:

Actual threats against nuclear power plants have been documented and the Indian Point facility is a plausible target of future terrorist actions. However, as explained above, the design-basis threat for Indian Point did not consider the possibility of an intentional terrorist attack from the air or water, or a suicide attack from any front. Security forces at nuclear power plants have repeatedly failed to repel mock terrorist attackers. Moreover, Indian Point has a long history of safety problems related to the ability to respond to emergency situations. Entergy, the new owner and licensee of Indian Point, has a demonstrably poor security record and it is clear from Entergy's history of violations that its ability to protect the facility against a terrorist attack is questionable at best.

Because a terrorist attack was not considered in the plant's design basis threat, because mock attacks at nuclear plants are rarely thwarted by security forces, and because this facility and its operator have notoriously poor security histories, the NRC should immediately demand all information necessary to determine whether Indian Point is, or can be secured against a land-, air- or water-based terrorist attack.

C. The NRC Should Immediately Modify The Operating License For Units Two And Three To Mandate, At Minimum, Security Measures Sufficient To Protect The Facility as Required by 10 CFR § 73.55.

As explained above, a successful attack on either of Indian Point's reactors or spent fuel storage facilities would likely result in a massive release of radioactive materials into the surrounding towns and counties, quite possibly reaching into and contaminating New York City. Such a release would cause hundreds of immediate fatalities close to the site and 100,000 or more latent cancer deaths farther downwind of the plant. Further, a major release would probably contaminate the drinking water supply for New York City and Westchester County, devastate the area's ecology, and render portions of the New York metropolitan area uninhabitable.

Faced with this catastrophic threat, the NRC should, at a minimum, take action to obtain the following security measures:

1. a permanent no-fly zone within 10 nautical miles of the Indian Point facility;
2. a defense and security system sufficient to protect and defend the no-fly zone; and
3. a defense and security system sufficient to protect the entire facility, including the containment and spent fuel storage buildings, control room and electricity equipment, from a land- or water-based terrorist attack.

These measures are necessary to comply with the requirements of 10 CFR § 73.55 regarding physical protection of licensed activities in nuclear power reactors against radiological sabotage.

D. The NRC Should Order the Revision of Entergy's Emergency Response Plan and Westchester County's Radiological Emergency Response Plan in Order to Account for Critical New Information and Prepare for Possible Terrorist Attacks.

The NRC should order the revision of Entergy's Emergency Response Plan and Westchester County's Radiological Emergency Response Plan in order to account and prepare for possible terrorist attacks. These reviews must contemplate not only realistic and catastrophic effects of a terrorist attack on the Indian Point facility, but a comprehensive response to multiple attacks in the region which may impair the efficient evacuation of the area. Examples of such attacks include destruction or blockage of the Tappan Zee Bridge, loss of power to passenger railroads, and other events which deny use of necessary infrastructure.

Westchester County's Radiological Emergency Preparedness Plan (REPP) was last revised in May of 2000 and does not address the site-specific, hazardous conditions of a sabotage event or a terrorist attack at the Indian Point facility. [63] Moreover, the REPP does not address the likelihood of class 9 event, a spent fuel storage area release, or a spent fuel assembly fire. The REPP is flawed as it is based on erroneous assumptions, therefore, REPP must be considered inadequate in providing protection to the public. The assumptions in the REPP preclude the occurrence of an intentional act of terrorism or sabotage, a class nine event involving Units Two or Three, the radiological release from the spent fuel storage area, a spent fuel rod fire, or the possibility of an explosion at the Indian Point facility.[64]

The inadequacies of emergency response at the Indian Point facility were known and considered decades ago, however no action was taken to resolve response problems. Based on the inherent inadequacies of the REPP and its preclusion of the new site-specific, hazardous condition posed by a terrorist threat, the REPP must be revised.

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[63] Indian Point Radiological Emergency Preparedness Plan for Westchester County, Revision May, 2000.

[64] Id. at I-3, I-4.

E. The NRC Should Order The Licensee To Undertake The Immediate Conversion of the Current Spent Fuel Storage Technology From A Water Cooled System To A Dry Cask System.

As explained above, terrorist action against the spent fuel storage facility could result in a catastrophic failure of the containment system. NRC has never established that the Indian Point spent fuel storage facility is secure against foreseeable attacks, nor can it be certain that the structure of the storage facility is sufficiently sound to preclude the possibility of a spent fuel fire in the event of an airborne, land, or water based assault. A likely result of an aircraft crashing into a spent fuel storage facility or of a truck bomb explosion would be a precipitous loss of cooling water in the spent fuel pools.

A reduction of cooling water in the spent fuel pools could lead to a catastrophic release of radiation. As the water in the fuel pool is reduced the remaining water will heat up and evaporate. This could expose the zirconium cladding which surrounds the spent fuel rods to oxygen and steam, resulting in an exothermic reaction that will lead to a spent fuel rod assembly fire. This event would release deadly amounts of radiological material and toxic fumes leading to horrific consequences. Fallout from this type of release could make tens of thousands of acres of land uninhabitable. The spent fuel storage buildings at Indian Point are not capable of withstanding a terrorist attack. The spent fuel storage area is highly vulnerable to an air attack and mitigation and control of damage from such an attack is highly improbable.

However, an alternative is available that would greatly reduce, or even eliminate, the risk of a pool fire. Specifically, the fuel could be stored dry, in robust steel casks that are cooled by natural circulation of air, and each cask could be surrounded by an earth-and-gravel berm, with substantial spacing between the casks.[65] This storage arrangement would withstand a wide variety of determined acts of malice.[66] The design basis for this storage arrangement could include a requirement, among other things, that the impact of a large, fuel-Laden aircraft on the storage facility would not lead to a release of radioactive material from more than one cask.[67] A

[65] Telephone conversation with Ed Lyman, Nuclear Physicist at Nuclear Control Institute (Nov. 6, 2001).

[66] Id.

[67] Id.

fuel storage facility constructed with such a design basis would not only be able to withstand or limit the consequences of a wide variety of acts of malice, but would also exhibit a very low probability of experiencing a substantial release of radioactive material due to events other than acts of malice.[68]

Consequently, pursuant to its power under 10 CFR § 2.202 to modify licenses or take other appropriate action, the NRC should order Entergy to undertake the immediate conversion of the current spent fuel storage technology from a water cooled system to a dry cask system.

CONCLUSION

The NRC is confronted with a new challenge: how to protect the nation's most densely populated area and the environment from the threat of a terrorist attack on the Indian Point facility. While this may be a challenging and daunting task, the NRC must react quickly and in a determined manner. The temporary shutdown of the Indian Point facility will significantly reduce the potential catastrophic consequences if it experiences a terrorist attack. As the potential harm resulting from such an attack is reduced, the Indian Point facility becomes less of an attractive target to terrorists. Therefore, the temporary shutdown and increased protection of the Indian Point facility is the most logical action to be taken to protect public health and minimize danger to life.

The NRC should order Entergy and local municipalities to review and update their emergency response plans in consideration and response to a terrorist threat since: (1) the threat of a large, highly coordinated terrorist attack has not been previously considered in the licensing or the design basis threat of the Indian Point facility; (2) it also has not been considered in the development of Indian Point's emergency response plan; and (3) it has not been considered in the Radiological Emergency Response Plans developed by local municipalities. If Entergy and/or any municipality determines that it is infeasible to develop a Emergency Response Plan or a Radiological Emergency Preparedness Plan to meet this new threat, then the NRC should order the shutdown of the Indian Point facility until the new site-specific, hazardous condition is abated.

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[68] Id.

Petitioners' requests are for reasonable and achievable measures that should be supported and implemented by the NRC. This is the only way NRC may uphold its congressional mandate to protect the lives, the environment and the property of the people of New York State.

Finally, in accordance with the Commission's petition guidance, Petitioners request a technical review meeting with the Petition Review Board (the "PRB"), including representatives of the Commission's Office of Nuclear Regulatory Research responsible for the Indian Point licenses at the earliest possible time and before any action is taken on this Petition.

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The Following Organizations and Individuals Join In the Foregoing Petition by Riverkeeper, Inc.

Nuclear Control Institute
STAR Foundation
Waterkeeper Alliance
Hudson River Sloop Clearwater

Eliot Engel, U.S. Congress (D)
Maurice Hinchey, U.S. Congress (D)
Jerrold Nadler, U.S. Congress (D)

Eric Schneiderman, NY State Senate (D)
Thomas Morahan, NY State Senator (R)
Suzi Oppenheimer, NY State Senate (D)
Richard Brodsky, NY State Assembly (D)
Samuel Colman, NY State Assembly (D)
Alexander Gromack, NY State Assembly (D)
Naomi Matusow, NY State Assembly (D)
Amy Paulin, NY State Assembly (D)
Ronald C. Tocci, NY State Assembly (D)

Stanley Michels, NY City Council (D)
Jim Gennaro, NY City Council (D)

Scott Vanderhoef, Rockland County Executive (R)
Tom Abinanti, Westchester County Board of Legislators (D)
George Latimer, Westchester County Board of Legislators (D)
Vincent Tamagna, Putnam County Board of Legislators (R)
Sam Oliverio, Putnam County Board of Legislators (D)
Harriet Cornell, Rockland County Board of Legislators (D)

Paul Feiner, Town Supervisor, Greenburgh (D)
Greenburgh Town Board
Charles Holbrook, Town Supervisor, Clarkstown (D)
John Dinin, Town Supervisor, Bedford (R)
Christopher P. St. Lawrence, Town Supervisor, Ramapo (D)

1

If U.S. City/County Metro Economies Were Nations

World Rankings on Gross Domestic and Metropolitan Product 2000 (U.S. Billions, Current)

THE UNITED STATES CONFERENCE OF MAYORS

Rank	Nation or Metro Area	GP 2000
1	United States	9,963.00
2	Japan	4,614.00
3	Germany	1,873.00
4	United Kingdom	1,410.00
5	France	1,286.00
6	China	1,104.00
7	Italy	1,074.00
8	Canada	699.00
9	Brazil	595.00
10	Mexico	578.00
11	Spain	557.00
12	India	510.00
13	Korea, South	480.00
14	New York, NY	437.80
15	Australia	428.00
16	Los Angeles-Long Beach, CA	363.70
17	Netherlands	360.00
18	Chicago, IL	332.80
19	Taiwan	323.00
20	Argentina	284.00
21	Russia	247.00
22	Switzerland	241.30
23	Boston, MA	238.80
24	Belgium	227.00
25	Sweden	224.10
26	Turkey	217.60
27	Washington, DC-MD-VA-WV	217.00
28	Austria	184.90
29	Philadelphia, PA-NJ	182.40
30	Houston, TX	177.50
31	Hong Kong	164.80
32	Atlanta, GA	164.20
33	Norway	164.00
34	Poland	163.00
35	Dallas, TX	160.00
36	Denmark	158.00
37	Detroit, MI	156.30
38	Indonesia	147.80
39	Saudi Arabia	145.30
40	South Africa	132.30
41	Orange County, CA	130.00
42	Thailand	128.20
43	Minneapolis-St. Paul, MN-WI	121.30
44	Finland	118.00
45	Seattle-Bellevue-Everett, WA	115.90
46	Phoenix-Mesa, AZ	114.20
47	Greece	110.90
48	Israel	108.00
49	SanFrancisco, CA	107.30
50	Nassau-Suffolk, NY	106.80
51	San Diego, CA	104.60
52	Venezuela	102.90
53	Portugal	100.50
54	Newark, NJ	96.30
55	Baltimore, MD	96.20
56	Ireland	95.10
57	Singapore	93.70
58	Oakland, CA	92.10
59	Egypt	91.50
60	Denver, CO	91.10
61	Colombia	90.00
62	St. Louis, MO-IL	89.60
63	Malaysia	88.80
64	SanJose, CA	85.40
65	Riverside-San Bernardino, CA	84.10
66	Tampa-StPetersb-Clwater, FL	82.20
67	Cleveland-Lorain-Elyria, OH	80.80
68	Pittsburgh, PA	80.70
69	Philippines	78.00
70	New Haven-BrPt-Stamford-Danbury-Waterbury, CT	76.80
71	Chile	73.00
72	Miami, FL	71.80
73	Portland-Vancouver, OR-WA	71.50
74	Iran	67.10
75	Puerto Rico	66.30
76	Kansas City, MO-KS	64.80
77	Hartford, CT	64.30
78	Middlesex-Somerset-Hunterdon, NJ	63.60
79	Sacramento, CA	63.10
80	Fort Worth-Arlington, TX	63.00
81	Pakistan	62.70
82	Peru	62.70
83	Charlotte-Gastonia-Rock Hill, NC-SC	61.30
84	Columbus, OH	60.70
85	United Arab	60.70
86	Orlando, FL	59.50
87	Cincinnati, OH-KY-IN	59.40
88	Bergen-Passaic, NJ	59.30
89	Indianapolis, IN	57.70
90	Nigeria	54.90
91	Milwaukee-Waukesha, WI	54.80
92	Las Vegas, NV-AZ	54.60
93	San Antonio, TX	53.70
94	Algeria	52.80
95	New Zealand	52.10
96	Norfolk-Virginia Beach-Newport News, VA-NC	51.70
97	Czech	50.80
98	Austin-San Marcos, TX	48.20
99	Buffalo-Niagara Falls, NY	47.80
100	Hungary	47.40
101	Fort Lauderdale, FL	46.70
102	New Orleans, LA	46.50
103	Salt Lake City-Ogden, UT	46.40
104	Greensboro-Winston-Salem-HighPoint, NC	46.30
105	Rochester, NY	45.70
106	Richmond-Petersburg, VA	45.70
107	Nashville, TN	45.20
108	Raleigh-Durham-Chapel Hill, NC	44.30
109	Jacksonville, FL	43.00
110	GrRapids-Muskegon-Holland, MI	42.30
111	Memphis, TN-AR-MS	38.90
112	Louisville, KY-IN	38.70
113	Bangladesh	38.50
114	Kuwait	38.05
115	Albany-Schenectady-Troy, NY	37.80
116	Syria	35.53
117	Morocco	34.80
118	West Palm Beach-Boca Raton, FL	33.20
119	Honolulu, HI	33.00
120	Monmouth-Ocean, NJ	33.00
121	Romania	33.00
122	Providence-Warwick, RI	32.50
123	Oklahoma City, OK	32.30
124	Birmingham, AL	32.00
125	Ukraine	31.70
126	Wilmington-Newark, DE	31.40
127	Dayton-Springfield, OH	31.20
128	Vietnam	30.60
129	Manchester-Nashua, NH	30.20
130	Syracuse, NY	30.10
131	Greenville-Spartanburg-Anderson, SC	29.90
132	Jersey City, NJ	28.10
133	Harrisburg-Lebanon-Carlisle, PA	27.10
134	Fresno, CA	26.30
135	Omaha, NE-IA	26.20
136	Tulsa, OK	25.70
137	Albuquerque, NM	25.60
138	Iraq	25.50
139	Ventura, CA	24.50
140	Tucson, AZ	22.90
141	Akron, OH	21.90
142	Knoxville, TN	21.50
143	Toledo, OH	21.20
144	Springfield, MA	20.90
145	Allentown-Bethlehem-Easton, PA	20.60
146	Scranton-Wilkes-Barre-Hazelton, PA	20.60
147	Santa Rosa, CA	20.50
148	Uruguay	20.49
149	Baton Rouge, LA	20.40
150	Slovakia	20.20
151	Tunisia	19.96
152	Dominican Republic	19.67
153	Des Moines, IA	19.10
154	Ann Arbor, MI	19.10
155	Columbia, SC	19.10
156	Guatemala	19.05
157	Tacoma, WA	19.00
158	Croatia (Hrvatska)	19.00
159	Bakersfield, CA	18.90
160	Oman	18.82
161	Fort Wayne, IN	18.60
162	El Paso, TX	18.60
163	Trenton, NJ	18.50
164	Slovenia	18.47
165	Little Rock-North Little Rock, AR	18.40
166	Madison, WI	18.40
167	Lafayette, LA	18.20
168	Kazakhstan	18.20
169	Luxembourg	18.10
170	Lexington, KY	17.80
171	Colorado Springs, CO	17.80
172	Wichita, KS	17.50

City/County Metro Areas

Nations

Source: DRI • WEFA

2

Nuclear terrorism threat growing

BY DANIEL RUBIN Knight Ridder Foreign Service

VIENNA, Austria -- After a month of dealing with anthrax fears, counterterrorism experts have their eyes on an even more ominous threat: a crude but effective nuclear attack.

U.S. intelligence and law enforcement officials say they have no evidence that Osama bin Laden's al-Qaida network or any other terrorist group has built, bought or stolen a nuclear weapon.

Terrorists, they say, are more likely to make a "dirty" bomb by mixing radioactive material with a conventional explosive or to attack a nuclear reactor with a truck bomb, plane or boat.

The vulnerability of power plants moved to center stage after last Sunday, when Canadian authorities monitored a phone call from an alleged al-Qaida member to Afghanistan. Two targets, he said, would be attacked this week "down south," including an unnamed nuclear facility.

"We now see nuclear terrorism to be a real possibility," said Mohamed El Baradei, director of the International Atomic Energy Agency, who Friday addressed a special U.N. session on nuclear terrorism here.

The agency is calling for international standards to protect radioactive materials from falling into the hands of extremists.

U.S. officials are concerned that two Pakistani nuclear scientists arrested by Pakistan might have given the al-Qaida network instructions how to build a dirty bomb with radioactive waste or enriched uranium, which associates of bin Laden reportedly have sought to acquire.

The most probable terrorist device could contain radioactive materials easily stolen from U.S. hospitals, research labs and industrial sites, said George Bunn, a professor at the Stanford University Center for International Security & Cooperation.

"If you explode a dirty bomb, you might not even kill anyone," he said, "but you would give everyone a real scare."

According to the Vienna-based IAEA, a watchdog agency that until Sept. 11 had focused on safety and keeping nuclear materials out of the hands of rogue nations, terrorists have never used a nuclear bomb, and bin Laden is not known to possess a nuclear capability.

Eighteen times since 1993, people have been found to be trafficking in highly enriched uranium or plutonium, the materials needed to make a nuclear bomb, the agency reported.

Less likely than dirty bombs, but far more devastating, would be attacks on nuclear reactors with truck bombs or planes, Bunn said.

In a recent Stanford survey of countries with peaceful nuclear programs, not one of the six respondents reported plans for dealing with truck bombs.

While nuclear power plants are built to withstand accidental crashes of small planes, a precision strike is another thing, Bunn said.

Another expert in nuclear terrorism, Matthew Bunn, an assistant director at Harvard's Kennedy School of Government, said he was most worried about "insiders" at nuclear facilities in Pakistan.

"It doesn't matter how many rings of men with guns you have around the place if an insider is working with terrorists," said Bunn, whose father is the Stanford professor.

He also voiced concerns about the loyalties of scientists in the former Soviet Union who live in 10 "nuclear cities" and earn the equivalent of $300 a month.

Asked which countries might unwillingly become unwitting sources for nuclear materials, he mentioned Yugoslavia, which he said has enough high-energy plutonium for a bomb, as well as Uzbekistan, Ukraine, Kazakstan and Latvia.

Many scientists at the conference have been warning about nuclear terrorism for years.

However, little money is spent on protecting against such threats, and the agency has no power to investigate the way nuclear materials are handled by the "nuclear weapons states" -- the United States, Russia, China, Great Britain and France.

And the other countries with nuclear capability -- Israel, India and Pakistan -- share little if any information.

"You cannot impose any safeguards on them," said Morten Maerli, a researcher with the Norwegian Institute of International Affairs. "This is a major problem."

The agency has called for an international approach to what has been largely the job of individual countries -- and one shrouded in secrecy by those protecting military operations.

The agency, with a $100 million annual budget, says it needs to spend an additional $30 million to $50 million a year shoring up the safety of nuclear materials.

"This is a threat we basically know how to fix," Matthew Bunn said. "It's a matter of writing a check."

3

CNN.com PRINTTHIS

Threat at Three Mile Island closes airports

HARRISBURG, Pennsylvania --The Three Mile Island nuclear power plant received a "credible threat" on Wednesday, prompting officials to shut down two nearby airports and dispatch military aircraft to protect the facility.

The plant was placed on a high state of alert as the FBI, state police and military planes scrambled to protect the facility.

Patrick von Keyserling, spokesman for the Dauphin County Emergency Management Agency, said the Nuclear Regulatory Commission got some kind of a threat against the nuclear facility and decided to restrict airspace in a 20mile radius around the Harrisburg International Airport as a precaution. He did not have details on the threat.

Nuclear Regulatory Commission spokeswoman Diane Screnci declined to discuss the type of threat, or how the agency received it. The commission told Three Mile Island about the threat between 6 p.m. and 7 p.m., and the airports were shut down about 9 p.m., she said.

Ralph DeSantis, a spokesman for Three Mile Island, confirmed the plant's high state of alert, but also declined to discuss the type of threat or the additional security measures. He said Three Mile Island was the only nuclear power plant threatened. Three Mile Island is located just outside Harrisburg, which is 35 miles northwest of Lancaster.

Since the Sept. 11 terrorist attacks, the power plant had already taken additional security measures, but Wednesday's alert tightened security further, DeSantis and Screnci said.

The Associated Press contributed to this report.

Find this article at:
http://www.cnn.com/2001/US/10/18/gen.three.mile.island/index.html

☐ Check the box to include the list of links referenced in the article.

4

■ **Press Release (1 November 2001)**

The head of the International Atomic Energy Agency (IAEA) says that the ruthlessness of the 11 September attacks has alerted the world to the potential of nuclear terrorism - making it "far more likely" that terrorists could target nuclear facilities, nuclear material and radioactive sources worldwide.

Experts from around the world are meeting at the IAEA on 29 October to 2 November at an international symposium on nuclear safeguards, verification, and security. A special session on 2 November focuses on the issue of combating nuclear terrorism.

"The willingness of terrorists to sacrifice their lives to achieve their evil aims creates a new dimension in the fight against terrorism," says Mohamed ElBaradei, IAEA Director General, whose Agency sets world standards for nuclear safety and security. "We are not just dealing with the possibility of governments diverting nuclear materials into clandestine weapons programs. Now we have been alerted to the potential of terrorists targeting nuclear facilities or using radioactive sources to incite panic, contaminate property, and even cause injury or death among civilian populations."

"An unconventional threat requires an unconventional response, and the whole world needs to join together and take responsibility for the security of nuclear material," says Mr. ElBaradei. "Because radiation knows no frontiers, States need to recognise that safety and security of nuclear material is a legitimate concern of all States. Countries must demonstrate, not only to their own populations, but to their neighbours and the world that strong security systems are in place. The willingness of terrorists to commit suicide to achieve their evil aims makes the nuclear terrorism threat far more likely than it was before September 11."

The IAEA, the UN nuclear watchdog agency based in Vienna, helps countries around the world to prevent, intercept and respond to terrorist acts and other nuclear safety and security incidents. It has the only international response system in place that would be in a position to immediately react to assist countries in case of a radiological emergency caused by a nuclear terrorist attack.

Although terrorists have never used a nuclear weapon, reports that some terrorist groups, particularly al-Qaeda, have attempted to acquire nuclear material is a cause of great concern.

According to the IAEA, since 1993, there have been 175 cases of trafficking in nuclear material and 201 cases of trafficking in other radioactive sources (medical, industrial). However, only 18 of these cases have actually involved small amounts of highly enriched uranium or plutonium, the material needed to produce a nuclear bomb. IAEA experts judge the quantities involved to be insufficient to construct a nuclear explosive device. "However, any such materials being in illicit commerce and conceivably accessible to terrorist groups is deeply troubling," says Mr. ElBaradei.

There has been a six-fold increase in nuclear material in peaceful programmes worldwide since 1970. According to IAEA figures, there are: 438 nuclear power reactors; 651 research reactors (of these 284 are in operation) and 250 fuel cycle plants around the world, including uranium mills and plants that convert, enrich store and reprocess nuclear material. Additionally, tens of thousands of radiation sources are used in medicine, industry, agriculture and research.

While the level of security at nuclear facilities is generally considered to be very high, security of medical and industrial radiation sources is disturbingly weak in some countries. "The controls on nuclear material and radioactive sources are uneven," says Mr. ElBaradei, "Security is as good as its weakest link and loose nuclear material in any country is a potential threat to the entire world."

The Risks Involved:

IAEA experts have evaluated the risks for nuclear terrorism in these three categories:

Nuclear facilities: IAEA experts believe the primary risks associated with nuclear facilities would involve the theft or diversion of nuclear material from the facility, or a physical attack or act of sabotage designed to cause an uncontrolled release of radioactivity to the surrounding environment.

From its inception, the nuclear industry has been keenly aware of the dangers of nuclear material falling into terrorist's hands. At all levels - operator, State and international - there is a complex infrastructure at work to ensure nuclear material is accounted for; safeguarded from diversion; and protected from theft and sabotage.

Billions of dollars per year are already being spent to protect and defend nuclear facilities. Indeed, no other industry in the world has such a sophisticated level of security. Nuclear facilities are protected by well-trained security forces and are extremely robust, designed to withstand, for example, earthquakes, tornado-force winds and accidental crashes of small aircraft. Although it is not automatic that any attack would result in a release of radioactivity, they are however industrial facilities and as such are not hardened to withstand acts of war.

The extent of damage that could be caused by the intentional crash of a large, fully fuelled jetliner into a nuclear reactor containment or other nuclear facilities is still a matter for analysis. Nuclear facility designs vary from country to country, so studies will have to take specific plant designs into account. "After September 11, we realized that nuclear facilities - like dams, refineries, chemical production facilities or skyscrapers - have their vulnerabilities," Mr. ElBaradei says. "There is no sanctuary anymore, no safety zone."

Countries around the world with nuclear facilities have heightened security since the 11 September attacks, and are conducting urgent analyses of their safety and security systems. The IAEA plans to strengthen and tailor its existing safety and security services to address the terrorism threat, by assisting countries in upgrading the security and safety of their nuclear facilities.

Nuclear Material: According to IAEA experts, terrorists obtaining nuclear weapons would be the most devastating scenario. "While we cannot exclude the possibility that terrorists could get hold of some nuclear material," says Mr. ElBaradei, "it is highly unlikely they could use it to manufacture and successfully detonate a nuclear bomb. Still, no scenario is impossible."

Beyond the difficulty for terrorists to obtain weapon usable material - scientists estimate that 25 kg of highly enriched uranium or 8 kg of plutonium wound be needed make a bomb - actually producing a nuclear weapon is far from a trivial exercise. Scientific expertise and access to sophisticated equipment would be required. However, when the Cold War ended, thousands of highly knowledgeable scientists and engineers previously involved in the Soviet Union's weapons programme were laid off or found their incomes drastically reduced. Another legacy of the Cold War are the disturbing reports, albeit unsubstantiated, of missing nuclear weapons.

Nuclear material has traditionally been subjected to extensive national protection measures. To prevent theft of nuclear material, nuclear facilities employ a range of protection measures, including site security forces, site access control, employee screening and co-ordination with local and national security authorities. In some States, national security forces provide back-up to facility security. The IAEA offers countries around the world assessments and advice on physical security. It also maintains a database on incidents of trafficking in nuclear material, although the IAEA considers the information States provide on incidents and on follow-up to be inadequate.

In non-nuclear weapon States, the IAEA carries out international safeguards to verify that nuclear material has not been diverted to non-peaceful uses. These safeguards, the verification tool entrusted to the IAEA in the 1970 Treaty on the Non-Proliferation of Nuclear Weapons (NPT), also play an important role in reducing the risk that terrorists could acquire nuclear material without detection. But when the NPT was drafted, nuclear terrorism was not perceived as a significant threat.

However, safeguards require that a state account for all its nuclear material material and serve as a "burglar alarm" against a terrorist. A well-designed system will also help to pinpoint the origin of missing material, identify individuals who had access to it, and facilitate recovery of the material.

The nuclear weapon programmes in the five Nuclear Weapon States - China, France, the Russian Federation, the United Kingdom and the United States, as well any that may exist in India, Pakistan and Israel, the three non-NPT countries known to have nuclear programmes - are not under the purview of IAEA safeguards. "Although I understand there is a high level of security for nuclear weapons," says Mr. ElBaradei, "I hope that all of these countries are urgently reviewing the safety and security of their nuclear weapons."

"There have been two nuclear shocks to the world already - the Chernobyl accident and the IAEA's discovery of Iraq's clandestine nuclear weapons programme," says Mr. ElBaradei. "It will be vital we do all in our power to prevent a third."

The IAEA plans to significantly expand its advisory services and help States upgrade protection of their nuclear materials.

Radioactive Sources: IAEA experts are concerned that terrorists could develop a crude radiological dispersal device using radioactive sources commonly used in every day life. The number of radioactive sources around the world is vast: those used in radiotherapy alone are in the order of ten thousand. Many more are used in industry; for example, to check for welding errors or cracks in buildings, pipelines and structures. They are also used for the preservation of food. There is a large number of unwanted radioactive sources, many of them abandoned, others being simply "orphaned" of any regulatory control.

Such a weapon, sometimes referred to as a "dirty bomb", could be made by shrouding conventional explosives around a source containing radioactive material, although handling the nuclear material could well be deadly.

"Security of radioactive materials has traditionally been relatively light," says Abel Gonzalez, the IAEA's Director of Radiation and Waste Safety. "There are few security precautions on radiotherapy equipment and a large source could be removed quite easily, especially if those involved have no regard for their own health. Moreover, in many countries, the regulatory oversight of radiation sources is weak. As a result, an undetermined number of radioactive sources has become orphaned of regulatory control and their location is unknown."

"Certainly, the effects of a dirty bomb would not be devastating in terms of human life," says Mr. Gonzalez. "But contamination in even small quantities could have major psychological and economic effects."

The accidental contamination of Goiânia, a major city in Brazil, with a medical radiation source exemplifies the potential for a terrorist group to wreak havoc on an urban centre. In September 1987, scrap scavengers broke into an abandoned radiological clinic and stole a highly radioactive caesium 137 source and moved it to a junkyard for sale as scrap. Workers broke open the encasement and cut up the 20-gram capsule of caesium 137 into pieces. The valuable-looking scrap was then distributed to friends and family of workers around the city. Fourteen people were overexposed, and 249 contaminated. Four subsequently died. More than 110,000 people had to be continuously monitored. To decontaminate the area, 125,000 drums and 1470 boxes were filled with contaminated clothing, furniture, dirt and other materials; 85 houses had to be destroyed.

"We are dealing with a totally new equation since September 11," Mr. Gonzalez said. "These terrorists demonstrated before our eyes their willingness to give up their lives. The deadliness of handling intensely radioactive material can no longer be seen as an effective deterrent."

* * *

The IAEA is proposing a number of new initiatives, including strengthening border monitoring, helping States search for and dispose of orphan sources and strengthening the capabilities of the IAEA Emergency Response Centre to react to radiological emergencies following a terrorist attack.

"September 11 presented us with a clear and present danger and a global threat that requires global action," says Mohamed ElBaradei. "Many of our programs go to the heart of combating nuclear terrorism, but we now have to actively reinforce safeguards, expand our systems for combating smuggling in nuclear material and upgrade our safety and security services."

"At a minimum," Mr. ElBaradei says, "national assessments of security infrastructure for all types of nuclear and radioactive material should be required. Countries will have something to gain from allowing international assessments to demonstrate to the world that they are keeping their nuclear material secure."

In the short term, the IAEA estimates that at least $30-$50 million annually will be needed to strengthen and expand its programs to meet this terrorist threat.

* * *

The International Atomic Energy Agency (IAEA), based in Vienna, has 132 Member States. It has 2200 employees and an annual budget of about $330 Million. The IAEA, a UN agency, serves as the world's intergovernmental forum for scientific and technical co-operation in peaceful uses of nuclear energy. It is also the international inspectorate for the application of nuclear verification **measures to ensure that nuclear programmes are peaceful.**

For further information, please contact Melissa Fleming, at (+43-1) 2600-21275; Mobile: (+43) 664-325 7376, E-mail: M.Fleming@iaea.org.

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Preparations Stepped Up For Possible New Attacks

Concern Focuses on Power Plants, Trucks, Ships, Bridges

By Eric Pianin and Dan Eggen
Washington Post Staff Writers
Thursday, November 1, 2001; Page A02

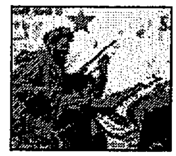
While authorities try to cope with the anthrax outbreak, federal and state officials are taking steps to prepare for a possible escalation of terrorism that experts say could include truck bombings and attacks on nuclear power plants as well as more hijackings.

Since the FBI issued its second national terrorism alert Monday, administration officials and congressional intelligence experts have studied myriad terrorist threats, including the outside possibility of the use of portable nuclear weapons. Steps taken by state and federal officials point, in particular, to concern about assaults on power plants and utilities, truck explosions in tunnels and on bridges, and attacks on ships carrying hazardous materials.

"If you're asking for a scenario of things that could go wrong, it's a mighty long list," said Rep. Porter J. Goss (R-Fla.), chairman of the House intelligence committee and a former CIA officer.

Yesterday, the governors of Arkansas, Louisiana and Mississippi ordered National Guard troops to strengthen security at nuclear facilities in their states, following a recommendation from Tom Ridge, the homeland security director, according to a spokesman for Entergy Corp. in Arkansas.

Latest texts and statements:



A multimedia-based, geographic guide to the war on terrorism. *(Flash 5 required)*

In a conference call Tuesday, Ridge advised governors throughout the country to take such precautions if they had not already done so, according to Phil Fisher, the Entergy spokesman. The Federal Aviation Administration this week temporarily barred private aircraft from approaching 86 sensitive nuclear sites, including power plants and waste storage facilities.

The Treasury Department's Bureau of Alcohol, Tobacco and Firearms, meanwhile, has begun intensive inspections of all 9,500 mining and construction companies and others licensed to use explosives across the country. New York Gov. George E. Pataki (R) said that more than 1,500 National Guard troops patrolling in and around New York City will be armed for the first time by week's end.

Federal and local officials also remain concerned about the possibility that terrorists would attack ships carrying propane and other fuels. The city of Boston went to court in an attempt to keep liquefied natural gas tankers out of Boston harbor, but a judge ruled against the city on Monday -- just hours before the FBI issued its alert -- saying officials had failed to demonstrate a sufficient threat.

President Bush yesterday defended his decision to put the country on national security alert, telling business leaders that the country was still under attack.

"I wanted our law enforcement officials to know we had some information that made it necessary for us to protect United States assets, to protect those areas that might be vulnerable. And that's exactly what's taking place today," Bush said.

"This is a very unusual period in American history, obviously. We've never been attacked like this before. We're still being attacked," he said.

The nation has been awash in special warnings and alerts since Sept. 11, many focused on the types of potential terrorist targets that have been used in previous attacks or identified as possibilities by intelligence officials.

One example is commercial trucks, which have been used by terrorists around the world as delivery vehicles for makeshift but effective bombs.

Osama bin Laden's al Qaeda terrorist network has been particularly fond of explosives packed into trucks or cars, using the method in the first attack on the World Trade Center in 1993 and on the coordinated 1998 assaults on U.S. embassies in Kenya and Tanzania. A homegrown U.S. terrorist, Timothy J. McVeigh, used a rental truck to deliver the bomb that destroyed the Alfred P. Murrah Federal Building in Oklahoma City in 1995.

Since the Sept. 11 terrorist attacks on New York and Washington, the FBI and the Department of Transportation have warned the trucking industry to watch for suspicious activity in connection with hazardous chemicals, including radioactive waste and other substances that can be used to create weapons of mass destruction.

State and federal authorities in the United States have dramatically stepped up roadside inspections of tractor-trailers, especially those carrying hazardous materials, and Canadian officials are now asking for two forms of identification from truckers crossing the border, according to the American Trucking Associations industry group.

"We've been on high alert since September 11, and there is more focus on overall security in the industry," said Mike Russell, a spokesman for the trucking group. "We're transitioning to focus as much on security as on highway safety."

The ATF has temporarily halted its other regular inspections to focus on 9,500 mining and construction firms, fireworks factories and other companies that hold federal explosives licenses. The ATF is particularly interested in identifying any missing stocks, and has devoted a quarter of its agents to the task, an ATF official said.

The ATF and the FBI are still investigating the discovery of C-4 plastic explosive, along with a highly explosive, 1,000-foot strand of detonator cord, in a Greyhound bus locker in Philadelphia earlier last month. Authorities have determined that the cord was manufactured for military use, and have found no connection so far to the terrorist network blamed for the Sept. 11 attacks.

Nancy Savage, an FBI agent in Eugene, Ore., who is president of the FBI Agents Association, said the biggest concerns for investigators include airports, power plants and other key infrastructure points.

"Everyone expects additional attacks," Savage said. "We don't think they're going to give up now. That's why we're at war: We don't think they plan to give up anytime soon."

The FBI was particularly concerned in the weeks after Sept. 11 about crop-duster airplanes, which are fixtures in rural areas but which also could be used as part of a chemical or biological attack.

The presumed ringleader of the Sept. 11 hijackers, Mohamed Atta, showed interest in crop-dusters and how much poison they could carry, and even tried unsuccessfully this year to secure a U.S. government loan to purchase one. In addition, one of the key suspects now in U.S. custody, Zacarias Moussaoui, had information about crop-dusters on a computer.

The discoveries prompted the FAA to twice ground crop-dusters, and agricultural spraying companies have been asked to lock their planes and take other precautions since resuming flights.

Attorney General John D. Ashcroft said yesterday that the threat level announced Monday has not abated.

"I wish I could turn the clock back to before September the 11th," Ashcroft said. "I wish that we didn't have to talk about threats, I wish we didn't have to make announcements about threats. But the facts are different."

Staff writer Peter Behr contributed to this report.

Latest Business News

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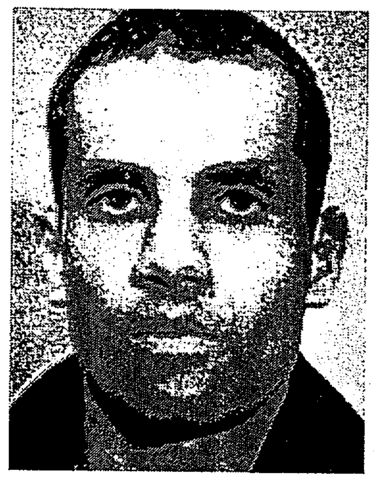
The New York Times

July 4, 2001

Terrorist Details His Training in Afghanistan

By LAURA MANSNERUS and JUDITH MILLER

An Algerian convicted of trying to carry out a terrorist attack in Los Angeles on the eve of the millennium celebration testified yesterday that he had received money and training at camps in Afghanistan that American officials say were run by Osama bin Laden.



The Associated Press
Ahmed Ressam testified on Tuesday against an Algerian former friend.

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Ahmed Ressam, the Algerian, described in detail his training in light arms, explosives, assassinations and techniques for blowing up "the infrastructure of a country." After more than six months of training in Afghanistan in 1998, Mr. Ressam testified, he returned to Canada with $12,000 in seed money to plot terrorist attacks against the United States, Islam's "biggest enemy."

In his testimony yesterday in Federal District Court in Manhattan, Mr. Ressam did not mention Mr. bin Laden, the Saudi exile charged with conducting a jihad, or holy war, against the United States and its allies.

But in describing the origins of his plan to set off a bomb at Los Angeles International Airport, he nonetheless confirmed the key outlines of the picture drawn by American intelligence of Mr. bin Laden's operations. He described a network of camps in which Algerians, Jordanians, Germans and others were trained and indoctrinated for terrorist missions around the world.

Mr. Ressam testified at the trial of Mokhtar Haouari, an Algerian accused of providing money and support for the plot to blow up the airport. In Los Angeles in April, Mr. Ressam was convicted of trying to bring explosives into the United States. He has since agreed to cooperate with prosecutors; his sentencing has been postponed to July 25.

Mr. Ressam's testimony, translated from Arabic by an interpreter, offered a rare insider's look at the design and attempted execution of a terrorist plot. His account depicted a decentralized structure in which militants were trained and given considerable latitude in selecting targets and missions.

In his testimony, Mr. Ressam said the camps were run by Abu Zubaida, the nom de guerre of a Palestinian whom American officials have identified as an important lieutenant to Mr. bin Laden.

American officials say Abu Zubaida reports directly to Mr. bin Laden and is in charge of recruiting for the camps. Mr. Ressam said Abu Zubaida arranged for his trip from Montreal to Afghanistan, providing him with Afghan clothes and an Afghan guide to take him from Pakistan to a camp called Khalden.

Mr. Ressam also described how, at the camps, he and others were made aware of orders to kill Americans that had been issued by Sheik Omar Abdel Rahman, the blind Egyptian cleric who was convicted in 1995 of conspiring to blow up the United Nations and other landmarks in the United States. He is now serving a life sentence in federal prison.

Mr. Ressam recounted how and why he selected the Los Angeles airport as a target and how he planned to rehearse and carry out the bombing. The plot went awry on Dec. 14, 1999, when a border guard in Port Angeles, Wash., questioned him in a routine check. Mr. Ressam, who does not speak English well, panicked and tried to flee. He was arrested and the authorities found more than 100 pounds of explosives in his car.

Mr. Ressam said he had planned the operation for more than a year but was forced to improvise when two other Algerians in his terrorist cell were detained in Britain and others then backed out. He said he selected the Los Angeles airport because he had passed through there on a flight from Pakistan.

Mr. Ressam testified that he wanted to test security at the airport by leaving a luggage cart with a bag unattended.

Mr. Ressam said he was trained at two camps in Afghanistan, Khalden and Darunta. Both have been identified by American officials as integral parts of al-Qaeda, a terrorist group founded by Mr. bin Laden that is an umbrella organization for anti-American militants around the world. There was no mention of al- Qaeda in the testimony yesterday, but Mr. Ressam was asked whether Abu Zubaida belonged to a "terrorist organization."

"Yes," he replied.

The United States has been pressing Afghanistan, most of which is ruled by the Taliban, to close down the camps and evict Mr. bin Laden. The Afghans have refused and American officials recently warned the Taliban that they would be held responsible for any attacks against the United States organized from their country.

A senior Bush administration official said Mr. Ressam's account "demonstrates that Afghanistan, in fact, has turned into the most threatening terrorist sanctuary in the world today."

Mr. Ressam said he was among 50 to 100 men at the camp in Afghanistan. He described his training in light weapons and explosives and instruction in "urban warfare." Among the possible targets among "enemies' installations," he said, were power plants, airports, railroads and large corporations.

Later, he said, he went to another camp for training in explosives, and returned to Canada with ingredients including hexamine, a booster used in bombs, and glycol. He said he bought other components in Vancouver and made his own timing devices.

When asked why he chose an airport as a target, he said, "An airport is sensitive politically and economically."

After Mr. Ressam had outlined his plan, he was asked if he realized that many civilians would die. "Yes, I would try to avoid that as much as possible," Mr. Ressam replied.

"But no matter how you did that, many would die," said Joseph F. Bianco, an assistant United States attorney.

"Yes," Mr. Ressam said.

Mr. Ressam is the star witness against Mr. Haouari, whom he met in Montreal through friends in a circle of Algerian émigrés. He agreed just a few weeks ago, as his sentencing date approached, to cooperate with the government.

Mr. Haouari is charged with providing money and support to Mr. Ressam, as well as bank fraud.

In testimony yesterday, Mr. Ressam, 34, began the story of a career that took him from a job in his father's coffee shop in Algeria to his arrest in 1999 with a cache of explosives in his rental car.

He described a life of petty crime in Montreal, where he arrived as an illegal immigrant in 1994 "to improve my life situation."

"I lived on welfare and theft," he said. He said Mr. Haouari was dealing in stolen checks and passports and sometimes worked with him.

Mr. Ressam said that when he returned to Montreal from Afghanistan, he had been assigned to work with several other Algerians from the camps on general instructions to meet in Canada, rob banks and use the money to finance "an operation in America."

When his comrades failed to arrive in Canada, he testified, he worked mostly on his own.

He said that at the time, he and Mr. Haouari were working on a plan for Mr. Ressam to open a shop as a way to get information for counterfeit credit cards. He had told Mr. Haouari about the terrorist training camp, he said, and Mr. Haouari expressed interest in going, too.

He testified however, that he did not give Mr. Haouari details of the plan or identify the target.

"No, no, for security reasons I didn't want to tell him," Mr. Ressam said.

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October 21 2001 TERRORISM

E-MAIL US


©
Mission aborted: the downed plane's flight path took it close to five nuclear plants
Photograph: Gary Tramontina

WAR ON TERRORISM

Next: West Bank killings set stage for showdown

NUCLEAR MYSTERY: Crashed plane's target may have been reactor

Nicholas Rufford, David Leppard and Paul Eddy


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THE hijackers who forced a fourth passenger jet to crash during the September 11 attacks in America may have been intending to use it to bomb a nuclear power station to cause a Chernobyl-type disaster.

The FBI is studying a report that the four terrorists who seized the plane may have been attempting to steer it towards a cluster of nuclear power stations on the east coast of America. The most likely target was Three Mile Island, site of America's most serious nuclear accident in 1979.

United Airlines flight 93 crashed into a field near the tiny town of Shanksville, in Pennsylvania, 90 minutes after taking off from Newark, New Jersey. All 44 passengers and crew on board died.

Until this weekend it had been assumed that the hijackers of the plane, a Boeing 757, were planning to fly it either to the presidential retreat at Camp David, or to Washington and crash it into the White House or the Congress and Senate buildings on Capitol Hill. But security officials have now revealed that within a week of the attacks, the FBI sent a report to MI5 saying that a "credible source" had said that the terrorists might have been planning to hit a nuclear plant.

Had it breached the plant's reactor vessel, such a strike could have caused an incident on the scale of the Chernobyl nuclear plant in Ukraine, which spread radioactive material over thousands of square miles in

1986.

US security sources say that Three Mile Island, which is part-owned by British Energy, was the subject of surveillance by some of the hijackers and their associates in the months before the terrorist attacks. One security official said: "Early on in the investigation we did receive a report from the FBI that the plane may have been heading for a nuclear power station. This was based on their analysis that Pittsburgh is near several power stations.

"There is some plausibility to this and we're not trying to dismiss it. But it may well be that nobody will ever know where the plane was going."

The "nuclear meltdown" assessment has not been independently confirmed but was taken seriously enough by the FBI to pass to European governments, including Britain and France.

The analysis is based on a study of flight 93's flight path and the fact that there are five nuclear power stations in the area. Experts say that the plane does not appear to have been hijacked until it was passing over West Virginia, some 200 miles beyond Washington. It then made a series of sharp turns before going into a steep descent. Aviation experts say that at this point there were three nuclear power stations between the plane and Washington and directly in its line of flight: Three Mile Island, Peach Bottom and Hope Creek.

Investigators cannot understand why the plane would have descended so early, unless its intended target was much nearer than Washington. The descent could have been an error by one of the hijackers, but if so, they cannot understand why the plane did not then climb again once control was regained.

America has since tightened security around nuclear stations and has taken steps to withdraw maps on the internet showing the location of nuclear plants. A French government minister said last week that fighters would shoot down aircraft heading for its nuclear plants. A missile defence system had been positioned at the Le Havre nuclear reprocessing plant.

In Britain, security around all nuclear sites has also been increased. David Blunkett, the home secretary, has given new powers to the 500-strong police force that guards the sites. Atomic Energy Authority police will be able to patrol an extra 13 civil nuclear sites, including Sizewell, Hinkley Point and Dungeness.

Engineering experts are divided over whether concrete containment shields around nuclear power stations could withstand a direct hit from a large passenger aircraft, especially one carrying 200,000lb of fuel, as was flight 93, enough to reach its destination of San Francisco.

The containment buildings generally have an outer structure, which for much of the dome is 3ft-thick concrete containing large amounts of reinforcing steel. Inside is a steel "lining" 1in-4in thick.

There are usually two more concrete walls close to the reactor, each 1ft thick and with reinforced steel bars. But these walls do not enclose the top of the reactor completely. The reactor vessel itself is about 4in-6in thick and made of high-carbon steel.

All reactors are designed to withstand impact by a light plane. Experts say it is unclear whether a larger modern jet loaded with fuel, deliberately flown at high speed, could break open the reactor vessel. The resultant fire could, however, cause enough damage to allow radioactive material into the air.

The drama aboard flight 93 as a small group of passengers tried to seize control of the plane from the hijackers during its final few minutes has become an emblem of American heroism during the events of September 11.

Delayed 40 minutes in taking off from Newark's congested airport, the plane was in the early stages of its journey when its passengers started hearing that other aircraft had been hijacked and at least one had flown into the twin towers of the World Trade Center.

Todd Beamer, one of the passengers, called an emergency operator on an onboard telephone after he and fellow passengers learnt of the first attack. He explained that flight 93 had also been hijacked. He said there were three hijackers - two with knives and one with what he thought was a bomb strapped to his waist. In fact, there were four, and by this time the fourth was almost certainly flying the plane.

Beamer, who was married with two young sons, told the operator: "We're going to do something. I know I'm not going to get out of this." He explained that some of passengers had decided to jump on the terrorist thought to have the bomb.

With the telephone left on, he could be heard saying: "Are you guys ready? Let's roll." The operator heard screams and a few minutes later the line went dead.

- The FBI is looking into whether another United Airlines flight, scheduled to leave Kennedy International Airport for San Francisco, was a target of hijackers on September 11. When the plane was grounded because of the attacks, four Middle Eastern-looking men refused to return to their seats and hurriedly left as soon as its doors opened.

Next page: West Bank killings set stage for showdown

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FAA restricts flights near World Series, nuclear plants

October 30, 2001 Posted: 10:41 p.m. EDT (0241 GMT)

(AP PHOTO)

President Bush throws out the ceremonial first pitch before Game 3 of the World Series at New York's Yankee Stadium.

WASHINGTON (CNN) -- Heeding the latest terrorist warning, the Federal Aviation Administration is temporarily restricting flights near the World Series games in New York and around nuclear sites.

The restrictions over New York City prohibit any aircraft operating under visual flight rules from flying within 30 nautical miles of John F. Kennedy International Airport during World Series games. The ban is in effect from 6:45 p.m. until 2 a.m. ET and lasts until midnight, November 6.

Restrictions were even tighter during President Bush's appearance at Tuesday's game.

All aircraft flying below 3,000 feet were prohibited from approaching within three nautical miles of JFK airport from 7:05 p.m. until 7:15 p.m. ET, and from 10:30 p.m. until 10:45 p.m. ET.

The nuclear sites ban, which affects 80 facilities such as power plants and Energy Department areas, restricts aircraft flying below 18,000 feet from coming within a radius of 10 nautical miles of each facility.

The restrictions underscore Attorney General John Ashcroft's announcement Monday of "credible reports" that another major terrorist attack may be possible within the week.

"The FAA realizes these restrictions inconvenience general aviation pilots and airports," said FAA Administrator Jane Garvey in a press release. "As the FAA and other federal agencies continuously review measures to ensure national security, we look for the understanding and cooperation of the general aviation community."

"Pilots must make every effort ... to avoid these sensitive areas," said Phil Boyer, president of the Aircraft Owners and Pilots Association.

Elsewhere in Washington, officials said Tuesday that Bush's national security team wants the war in Afghanistan to continue during Ramadan, the Muslim holy period. Letting up on the assaults, said one official, would be interpreted "as a sign of flexibility in what the president himself has called a doctrine."

The president, officials said, would decide whether to press on during Ramadan, which begins about November 17.

The sentiment to continue strikes during Ramadan underscored Army Gen. Tommy Franks' assertion Tuesday that the allied coalition is committed "for as long as it takes" to oust the ruling Taliban and Osama bin Laden's al Qaeda network.

After meeting with Uzbekistan's president, Franks, commander of the U.S. military campaign in Afghanistan, dismissed suggestions that the U.S.-led military operation has bogged down in its fourth week. (Full story)

U.S. airplanes launched another round of airstrikes early Tuesday on the Taliban stronghold of Kandahar, with low-flying jets pounding targets around the southern Afghan city and Taliban forces returning antiaircraft fire.

CNN's Kamal Hyder reported Kandahar was quiet Tuesday night, but electricity was out to most of the city and there was no running water. (Full story)

Ashcroft warned Monday that there is a "credible" threat of new terrorist action in the United States in the coming days, and he told law enforcement agencies and the public to be on "highest alert."

The attorney general said intelligence sources had found nonspecific but "credible" information the nation could be the focus again for some sort of terrorist attack.

"We are dealing with an unknown; we are dealing without a lot of specific information," Homeland Security Director Tom Ridge told CNN on Tuesday. "But we also know since September 11 the environment is different, and America has to continue to be on guard."

Latest developments

• Homeland Security Director Tom Ridge said Tuesday that the security alert issued Monday by Attorney General John Ashcroft was a "reiteration" of the October 11 alarm sent to law enforcement agencies. Ashcroft warned that there is a "credible" threat of new terrorist action in the United States in the coming days, and he told law enforcement agencies and the public to be on "highest alert."

U.S. law enforcement is on high alert after officials warn of possible terrorist attacks. CNN's John King reports (October 30)

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• Despite the new threat of more terror attacks in the United States, President Bush plans to be at Yankee Stadium in New York on Tuesday night to throw out the first pitch in the third game of the World Series. (Full story)

• Transportation Secretary Norman Mineta announced Tuesday a new crackdown on security at U.S. airports, including more stringent passenger and bag searches. Mineta said there have been deficiencies in security screening since September 11, and the aviation industry must show improvement "right away." (Full story)

• American Airlines, the world's largest airline, announced Tuesday that it has secured the cockpits of its entire fleet of jet aircraft. American said the new locking devices prevent intruders from accessing the cockpit by securing it from the inside.

• Amid growing criticism of the U.S.-led military campaign, British Prime Minister Tony Blair appealed to the public Tuesday to remember the images of September 11. "Thousands of people were killed in cold blood in the worst terrorist attacks the world has ever seen," Blair said in a keynote speech. (Full story)

• An Egyptian-born man was charged Tuesday with conspiring with others to murder Northern Alliance leader Gen. Ahmad Shah Masood. The opposition leader was killed September 9 by suicide bombers posing as journalists. Yasser Al Siri, who has lived in Britain for eight years, was charged under Britain's anti-terrorism act. (Full story)

• Iraqi President Saddam Hussein warns that the U.S.-led war in Afghanistan could spread. Calling it a spark that may set "the world on fire," he called Tuesday on other countries to help defeat the United States. (Full story)

• Vice President Dick Cheney on Tuesday was placed again at an undisclosed, secure location, administration officials told CNN. They said Cheney -- who made public appearances Monday in New York-- was returned to the higher level of security through at least next week in response to the latest warning that Ashcroft announced.

• The United Nations refugee agency said Tuesday that thousands of Afghans continue to cross into Pakistan through unofficial entry points. At a briefing in Geneva, Switzerland, a U.N. spokesman said that more than 5,000 people

The Pentagon says progress is being made in the military campaign in Afghanistan. CNN's Jamie McIntyre reports (October 30)

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Will Americans continue to take alerts seriously if attacks don't follow?

Yes

No

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- Special Forces
- Military Desk: Big bombs, bad news for Taliban
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ANTHRAX ATTACKS

crossed into Pakistan's Northwest Frontier province last weekend.

• The U.N. special envoy to Afghanistan, Lakhdar Brahimi, was meeting Tuesday with Pakistan's President Pervez Musharraf and met with other top Pakistani officials Monday as part of the U.N.'s role in shaping a post-Taliban Afghanistan. Brahimi said the United Nations is considering a proposal by the Taliban ambassador in Pakistan to discuss the situation in Afghanistan.

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The Washington Post ONLINE

In Afghan Jail, a Terrorist Who Won't Surrender

Bin Laden Disciple Held by N. Alliance Would Attack U.S.

By William Branigin
Washington Post Staff Writer
Tuesday, October 30, 2001; Page A13

KHOJA MAKBUL, Afghanistan -- He sits cross-legged on a carpet, fixing his visitor intently with dark eyes behind thick, oversize glasses. With his flowing black beard, embroidered skullcap and beatific smile, the soft-spoken Pakistani still resembles the Islamic scholar he once was.

But, by his own account, Salahuddin Khaled is a dangerous man. The 27-year-old member of the hard-line Pakistani Muslim group Harkat ul-Mujaheddin is an ally of Afghanistan's ruling Taliban militia, a disciple of Osama bin Laden and a highly trained terrorist. After five years behind bars, he is the longest serving prisoner of war held by the opposition Northern Alliance. And there is a reason he is likely to continue to serve time in a single-story, mud-brick compound in the Panjshir Valley.

If released, he readily acknowledges, he would gladly carry out the kind of terrorist attacks that killed almost 5,000 people in the United States last month.

He talks of using atomic weapons against America, and wonders

AMERICA AT WAR
SPECIAL REPORT

(Reuters, Oct 30, 2001)

(The Washington Post, Oct 30, 2001)

(The Washington Post, Oct 30, 2001)

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whether the Sept. 11 attackers would have better served their cause by flying one of the hijacked planes into a nuclear power plant. "I don't know who did that action," Khaled says in halting English. "If Muslim organizations did that action, I agree, because America is their enemy. . . . They have to hurt America in its military, economic and political centers to make America leave its plans against Islam."

While it may never be possible to fully understand the passions and motives of someone such as Khaled, an interview with him at the Northern Alliance's Baharak Prison provides a glimpse into the mind of a terrorist. Never raising his voice, he explains in his rudimentary English and fluent Dari, the language of the Tajik ethnic group here, the reasons for his implacable hatred of the United States.

He occasionally expresses regret for the deaths of civilians in the Sept. 11 attacks and other operations against the United States. But he makes it clear that these casualties are secondary to the goal of punishing America for a long list of sins, headed by U.S. support for Israel.

He also makes it clear that he sees the United States as the main obstacle to establishing Islamic law in Afghanistan, across Central Asia and elsewhere around the world.

Khaled is among 21 foreigners and 306 Afghan Taliban members held at the Baharak Prison, which opened eight months ago in a desolate spot a couple of miles north of the village of Baharak. It is reached by leaving a dirt road cut into a mountainside, fording a shallow part of the Panjshir River and walking across a narrow metal bridge. The prison sits on a rocky spit of land that juts into a bend in the river and is bordered by barren, forbidding mountains that rise almost vertically from the riverbed.

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A multimedia-based, geographic guide to the war on terrorism. *(Flash 5 required)*

The fortress-like prison contains a row of dark cells facing a sunny interior courtyard. Each cell is about 12 feet wide by 28 feet long and crammed with more than 30 inmates. Shoes, bags of clothes and other belongings hang from the walls and from log beams in the ceiling.

The other foreign prisoners are from Burma, China, Yemen and Iraq, as well as Pakistan. Like Khaled, they joined extremist Muslim organizations that urged them to fight for the Taliban in its "holy war" in Afghanistan.

Abdul Jabar, 22, a Pakistani with a slight build and a sparse beard, studied at a veterinary college for two years before coming to Afghanistan in 1999. After three weeks of training, he was sent to the front to fight the Northern Alliance and was promptly captured.

Interviewed in a prison sitting room, he said he still believes in the Taliban cause, admires bin Laden and hates the U.S. government "because it helps Israel." He said he came to Afghanistan believing that he was going to be fighting Russians, but found himself facing only Muslim Afghans. (The Soviet Union withdrew its occupation forces from Afghanistan in 1989.) If he had known that, he said, "I would not fight. I would fight against Israel or in Kashmir or against America."

Would he carry out a suicide bombing? "If I know that [the target] is not Muslim but is Jewish or [of] another religion, I would immediately carry out this action," he said. But if he knew the target were Muslim, he would question the order.

Noor Mohammed Abdullah, 29, a Muslim from China, was also captured two years ago after barely a month in Afghanistan. He came here from a Pakistani Islamic school whose principal has close ties to the Taliban and told students they had an obligation to fight in Afghanistan, he said. He said he was told he would be fighting Russians and Americans.

Abdullah said he now realizes he made a mistake. If released, he would continue his religious studies and no longer fight the Northern Alliance, "because they are Muslim," he said.

Khaled has no such qualms.

"He will not change his ideas," said Abdul Qayyum, an Afghan with gray hair and pale blue eyes who is a deputy warden of the prison.

Another deputy warden, Farouk, said Khaled is the hardest of the hard-liners at Baharak, and probably the most dangerous man in the prison. "Any time he is free, he will work with Osama bin Laden and the Taliban," Farouk said.

Khaled has consistently expressed his radical views to all who will listen, seemingly unconcerned about the chilling effect his words have on any prospect of release or a prisoner exchange. It is as if softening his hard-line positions would be tantamount to renouncing his faith, Farouk said.

At one time, the Northern Alliance held 2,500 Taliban prisoners. Most have since been exchanged for alliance POWs.

In a study this year on foreign prisoners held by the Northern Alliance, Julie Sirrs, a former Afghan analyst for the Defense Intelligence Agency, reported that more non-Afghans are fighting in the country than ever before. She said the foreigners are more difficult to capture because they tend to be more motivated than Afghans on the Taliban side, "many of whom are conscripts."

Contrary to the popular perception, Sirrs said, only 43 percent of the 113 prisoners she interviewed identified themselves as *talibs*, or religious students. Most of the foreign fighters were recruited while working as shopkeepers, laborers, party activists and in other occupations. Only 30 percent of the Pakistanis identified themselves as Pashtuns, the ethnic group that dominates the Taliban.

Khaled said he was born in Baluchistan province, the son of an Islamic studies professor. He earned a degree in Islamic law from the Islamia University of Punjab, where friends recruited him into the fundamentalist Harkat ul-Mujaheddin, which has been implicated in the deaths of Americans and declared a terrorist organization by the U.S. government. Khaled arrived in Afghanistan in 1992 determined, he said, to "defend Muslims" at a time when Serbs were killing Muslims in Bosnia.

He said he underwent training for two years near Khost, south of the capital, Kabul, first in a Harkat camp. He later moved up to a camp for more advanced trainees that eventually was taken over by bin Laden, he said. There, 35 men received instruction in guerrilla tactics, bomb-making and "chemicals and poisons." He said the last instruction covered "poison gas and bombs," but he declined to go into details. He denied any knowledge of anthrax, the disease currently being spread in the United States by biological agents sent through the mail, and said its use was not taught while he was at the training center.

After bin Laden moved to Afghanistan in 1995, he occasionally visited the camp to give pep talks, said Khaled, who was serving as an instructor by then. Bin Laden would tell the trainees, "You should spill more sweat during training so you don't spill your blood during battle," Khaled recalled. He said bin Laden told the students they were "fighting against people who want to finish Islam" and that the U.S. government was an enemy of Muslims.

After his training, Khaled said he went to Kashmir to fight the Indian government, returning a year later to Afghanistan, where he linked up with the Taliban.

He was in command of 30 Harkat fighters when his unit was cut off by Northern Alliance soldiers near Jabal Saraj in October 1996. While his men escaped to Kabul, he said he held off his attackers for five hours, using an AK-47 assault rifle and the sharpshooting skills he acquired during his training. He said he killed more than 10 alliance fighters before he ran out of ammunition and surrendered.

Today, Khaled is as unapologetic about his support for the Taliban as he is about his hatred for America.

"If America didn't work against us, we would never take action against their cities," he said. "Our enemies are America and Israel, but we cannot fight against them face to face. We have to fight against them secretly to make them leave their plans and stop working against us."

Besides support for Israel, including $3 billion a year in aid, Khaled's catalogue of complaints against the United States includes the activities of the CIA, the presence of U.S. troops on "holy land" in Saudi Arabia since the Persian Gulf War (a major grievance of bin Laden), the U.S. intervention in Somalia, the bombing of Iraq, an airstrike against Libya, the dropping of atomic bombs on Japan during World War II and even Washington's rejection of the Kyoto treaty on global warming.

At one point, he launched into a stream of revisionist history, portraying the United States as the aggressor against Japan in World War II and justifying the attack on Pearl Harbor. Hawaii, he asserted, rightfully belonged to Japan.

Of the Sept. 11 attacks, Khaled said, "the target was not to kill civilian people, but [to cause] important hurt to the American government." There was no other way to achieve the goal, he said. "They had to do that action."

Would he participate in such a mission? "If my commander led me to an action like this, I would do it. If Osama bin Laden told me to do it, I would do it." He added, "I'm from Harkat, but I think that Osama bin Laden is also my leader."

He has no reservations about sacrificing himself in a suicide attack, he said, "because our target is very important, more important than my life." But he said he did not necessarily agree with the specific targets last month.

"In America, there are more important places, like atomic plants and reactors [that] they could attack," he said. "Not only atomic plants, but the CIA center, arms factories and the White House."

"America tries to say to the world that Muslim fundamentalist organizations [are] terrorist," Khaled said. "But we think the American government is terrorist."

He rejected the notion that the terrorist attacks last month were counterproductive, since they did not cause the United States to reconsider its policies but united Americans in a desire for revenge and brought an intervention in Afghanistan aimed at eliminating bin Laden and the Taliban.

"You will see, America will not be successful in [its] goals," Khaled said. The use of U.S. troops will eventually be necessary, he said, and "American ground forces wouldn't be able to fight against us. We're fighting the Americans on three front lines: in Afghanistan, in Pakistan and in the United States."

Even if bin Laden is killed, Khaled said, another leader will quickly take his place. And if the Taliban eventually is defeated, "we will do secret activities, secret action."

Does he mean more terrorist attacks?

Khaled smiled broadly. "That's right."

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NRC NEWS
U.S. NUCLEAR REGULATORY COMMISSION

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September 21, 2001

NRC REACTS TO TERRORIST ATTACKS

In light of the recent terrorist attacks, U.S. Nuclear Regulatory Commission officials and staff have been working around the clock to ensure adequate protection of nuclear power plants and nuclear fuel facilities. This has involved close coordination with the Federal Bureau of Investigation, other intelligence and law enforcement agencies, NRC licensees, and military, state and local authorities.

Immediately after the attacks, the NRC advised nuclear power plants to go to the highest level of security, which they promptly did. The NRC has advised its licensees to maintain heightened security. The agency continues to monitor the situation, and is prepared to make any adjustments to security measures as may be deemed appropriate.

In view of the recent unprecedented events, Chairman Richard A. Meserve, with the full support of the Commission, has directed the staff to review the NRC's security regulations and procedures.

A number of questions have come in from reporters and members of the public since the tragic events of September 11. The following questions and answers are offered in response:

Q: What would happen if a large commercial airliner was intentionally crashed into a nuclear power plant?

A:. Nuclear power plants have inherent capability to protect public health and safety through such features as robust containment buildings, redundant safety systems, and highly trained operators. They are among the most hardened structures in the country and are designed to withstand extreme events, such as hurricanes, tornadoes and earthquakes. In addition, all NRC licenses with significant radiological material have emergency response plans to enable the mitigation of impacts on the public in the event of a release. However, the NRC did not specifically contemplate attacks by aircraft such as Boeing 757s or 767s and nuclear power plants were not designed to withstand such crashes. Detailed engineering analyses of a large airliner crash have not yet been performed.

Q: What measures have the NRC and its power plant licensees taken in face of this potential threat?

A: Immediately after the attacks, the NRC advised licensees to go to the highest level of security, which all did promptly. The specific actions are understandably sensitive, but they generally included such things as increased patrols, augmented security forces and capabilities, additional security posts, heightened coordination with law enforcement and military authorities, and limited access of personnel and vehicles to the sites.

Q: What, precisely, did the NRC do in response to the attacks?

A: At 10 a.m. on September 11, the NRC activated its Emergency Operations Center in headquarters and assembled a team of top officials and specialists. The same was done in each of its four regional offices. In addition to communicating with its licensees about the need to go to the highest level of security, the NRC established communications with the FBI, the Department of Energy, and the Federal Emergency Management Agency, among others. NRC personnel were dispatched to the FBI's Strategic Information Operations Center. The NRC has also established close communications with nuclear regulators in Canada and Mexico.

Q:What would happen if a large aircraft should crash into a spent fuel dry storage cask?

A: The capacity of spent fuel dry storage casks to withstand a crash by a large commercial aircraft has not been analyzed. Nonetheless, storage casks are robust and must be capable of withstanding severe impacts, such as might occur during tornadoes, hurricanes or earthquakes. In the event that a cask were breached, any impacts would be localized. All spent fuel storage facilities have plans to respond to such an emergency, drawn up in consultation with local officials.

Q: What if a large aircraft crashed into a spent fuel transportation cask in a heavily populated area?

A: Again, the capacity of shipping casks to withstand such a crash has not been analyzed. However, they are designed to protect the public in severe transportation accidents. The cask must be able to withstand a 30-foot drop puncture test, exposure to a 30-minute fire at 1475 degrees Fahrenheit, and submersion under water for an extended period. Moreover, the location of loaded casks is not publicly disclosed and such a cask would present a small target to an aircraft .

If an airliner crashed into a cask, there could be some localized impacts. Regulations require special accident response training of those involved in shipping, as well as coordination with state, local and tribal emergency response personnel. In addition, redundant communications must be maintained during shipment with the transporter vehicle; this would facilitate emergency response, if necessary.

Q: Could such a crash into a nuclear power plant, or a storage or shipping cask trigger a nuclear explosion?

A: No.

Q: What are the consequences if an airliner crashed into a uranium fuel cycle facility?

A: Because of the nature of the material, there would likely be only minimal off-site radiological consequences. Some such facilities use chemicals similar to those found at many industrial facilities. In the event of a release, comprehensive emergency response procedures would be immediately implemented.

Q: Have nuclear power plants been subject to attack in the past?

A: There has never been an attack on a nuclear power plant. On very rare occasions there have been intrusions. For example, there was a 1993 car crash through the gates of Three Mile Island plant by an individual with a history of treatment for mental illness. Such intrusions have not resulted in harm to public health or safety.

Q: What are the normal security measures at commercial nuclear power plants.

A: Licensees are required to implement security programs that include well-armed civilian guard forces, physical barriers, detection systems, access controls, alarm stations, and detailed response strategies. NRC routinely inspects security measures as part of its normal reactor oversight process and periodically undertakes various exercises, including force-on-force exercises, so as to assure that any vulnerabilities are exposed and corrected .

Q: Is an attack using an airplane part of the NRC's design basis threat against which its licensees have to defend?

A: No. The NRC has been in close and continuing contact with law enforcement and the military regarding such a threat.

Q: What exactly is the so-called design basis threat?

A: The details of the design basis threat are classified, but it includes the characteristics of a possible sabotage attempt that NRC licensees are required to protect against. The agency continually assesses the adequacy of the design basis threat in consultation with local law enforcement and federal intelligence agencies.

Q:Is the NRC contemplating a modification of the design basis threat?

A: The agency will continue to coordinate with law enforcement and intelligence agencies to assess the implications of this new manifestation of terrorism. If the NRC determines that the design basis threat warrants revision, such changes would occur through a public rulemaking.

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11

Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants

October 2000

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Technical Study of Spent Fuel Pool Accidents at Decommissioning Plants

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EXECUTIVE SUMMARY

This report documents a study of spent fuel pool (SFP) accident risk at decommissioning nuclear power plants. The study was undertaken to support development of a risk-informed technical basis for reviewing exemption requests and a regulatory framework for integrated rulemaking.

The staff published a draft study in February 2000 for public comment and significant comments were received from the public and the Advisory Committee on Reactor Safeguards (ACRS). To address these comments the staff did further analyses and also added sensitivity studies on evacuation timing to assess the risk significance of relaxed offsite emergency preparedness requirements during decommissioning. The staff based its sensitivity assessment on the guidance in Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis." The staff's analyses and conclusions apply to decommissioning facilities with SFPs that meet the design and operational characteristics assumed in the risk analysis. These characteristics are identified in the study as industry decommissioning commitments (IDCs) and staff decommissioning assumptions (SDAs). Provisions for confirmation of these characteristics would need to be an integral part of rulemaking.

The results of the study indicate that the risk at SFPs is low and well within the Commission's Quantitative Health Objectives (QHOs). The risk is low because of the very low likelihood of a zirconium fire even though the consequences from a zirconium fire could be serious. The results are shown in Figures ES-1 and ES-2. Because of the importance of seismic events in the analysis, and the considerable uncertainty in seismic hazard estimates, the results are presented for both the Lawrence Livermore National Laboratory (LLNL) and the Electric Power Research Institute (EPRI) seismic hazard estimates. In addition, to address a concern raised by the ACRS, the results also include a sensitivity to a large ruthenium and fuel fines release fraction. As illustrated in the figures, the risk is well below the QHOs for both the individual risk of early fatality and the individual risk of latent cancer fatality.

The study includes use of a pool performance guideline (PPG) as an indicator of low risk at decommissioning facilities. The recommended PPG value for events leading to uncovery of the spent fuel was based on similarities in the consequences from a SFP zirconium fire to the consequences from a large early release event at an operating reactor. A value equal to the large early release frequency (LERF) criterion (1×10^{-5} per year) was recommended for the PPG. By maintaining the frequency of events leading to uncovery of the spent fuel at decommissioning facilities below the PPG, the risk from zirconium fires will be low and consistent with the guidance in RG 1.174 for allowing changes to the plant licensing basis that slightly increase risk. With one exception (the H.B. Robinson site) all Central and Eastern sites which implement the IDCs and SDAs would be expected to meet the PPG regardless of whether LLNL or EPRI seismic hazard estimates are assumed. The Robinson site would satisfy the PPG if the EPRI hazard estimate is applied but not if the LLNL hazard is used. Therefore, Western sites and Robinson would need to be considered on a site-specific basis because of important differences in seismically induced failure potential of the SFPs.

The appropriateness of the PPG was questioned by the ACRS in view of potential effects of the fission product ruthenium, the release of fuel fines, and the effects of revised plume parameters. The staff added sensitivity studies to its analyses to examine these issues. The consequences of a significant release of ruthenium and fuel fines were found to be notable, but not so important as to render inappropriate the staff's proposed PPG of $1x10^{-5}$ per year. The plume parameter sensitivities were found to be of lesser significance.

In its thermal-hydraulic analysis, documented in Appendix 1A, the staff concluded that it was not feasible, without numerous constraints, to establish a generic decay heat level (and therefore a decay time) beyond which a zirconium fire is physically impossible. Heat removal is very sensitive to these additional constraints, which involve factors such as fuel assembly geometry and SFP rack configuration. However, fuel assembly geometry and rack configuration are plant specific, and both are subject to unpredictable changes after an earthquake or cask drop that drains the pool. Therefore, since a non-negligible decay heat source lasts many years and since configurations ensuring sufficient air flow for cooling cannot be assured, the possibility of reaching the zirconium ignition temperature cannot be precluded on a generic basis.

The staff found that the event sequences important to risk at decommissioning plants are limited to large earthquakes and cask drop events. For emergency planning (EP) assessments this is an important difference relative to operating plants where typically a large number of different sequences make significant contributions to risk. Relaxation of offsite EP a few months after shutdown resulted in only a "small change" in risk, consistent with the guidance of RG 1.174. Figures ES-1 and ES-2 illustrate this finding. The change in risk due to relaxation of offsite EP is small because the overall risk is low, and because even under current EP requirements, EP was judged to have marginal impact on evacuation effectiveness in the severe earthquakes that dominate SFP risk. All other sequences including cask drops (for which emergency planning is expected to be more effective) are too low in likelihood to have a significant impact on risk. For comparison, at operating reactors additional risk-significant accidents for which EP is expected to provide dose savings are on the order of $1x10^{-5}$ per year, while for decommissioning facilities, the largest contributor for which EP would provide dose savings is about two orders of magnitude lower (cask drop sequence at $2x10^{-7}$ per year).[1] Other policy considerations beyond the scope of this technical study will need to be considered for EP requirement revisions and previous exemptions because a criteria of sufficient cooling to preclude a fire cannot be satisfied on a generic basis.

Insurance does not lend itself to a "small change in risk" analysis because insurance affects neither the probability nor the consequences of an event. As seen in figure ES-2, as long as a zirconium fire is possible, the long-term consequences of an SFP fire may be significant. These long-term consequences (and risk) decrease very slowly because cesium-137 has a half life of approximately 30 years. The thermal-hydraulic analysis indicates that when air flow has been restricted, such as might occur after a cask drop or major earthquake, the possibility of a fire lasts many years and a criterion of "sufficient cooling to preclude a fire" can not be defined on a

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[1]Consistent with PRA limitations and practice, contributions to risk from safeguards events are not included in these frequency estimates. EP might also provide dose savings in such events.

generic basis. Other policy considerations beyond the scope of this technical study will therefore need to be considered for insurance requirements.

The study also discusses implications for security provisions at decommissioning plants. For security, risk insights can be used to determine what targets are important to protect against sabotage. However, any revisions in security provisions should be constrained by an effectiveness assessment of the safeguards provisions against a design-basis threat. Because the possibility of a zirconium fire leading to a large fission product release cannot be ruled out even many years after final shutdown, the safeguards provisions at decommissioning plants should undergo further review. The results of this study may have implications on previous exemptions at decommissioning sites, devitalization of spent fuel pools at operating reactors and related regulatory activities.

The staff's risk analyses were complicated by a lack of data on severe-earthquake return frequencies, source term generation in an air environment, and SFP design variability. Although the staff believes that decommissioning rulemaking can proceed on the basis of the current assessment, more research may be useful to reduce uncertainties and to provide insights on operating reactor safety. In particular, the staff believes that research may be useful on source term generation in air, which could also be important to the risk of accidents at operating reactors during shutdowns, when the reactor coolant system and the primary containment may both be open.

In summary, the study finds that:

1. The risk at decommissioning plants is low and well within the Commission's safety goals. The risk is low because of the very low likelihood of a zirconium fire even though the consequences from a zirconium fire could be serious.

2. The overall low risk in conjunction with important differences in dominant sequences relative to operating reactors, results in a small change in risk at decommissioning plants if offsite emergency planning is relaxed. The change is consistent with staff guidelines for small increases in risk.

3. Insurance, security, and emergency planning requirement revisions need to be considered in light of other policy considerations, because a criterion of "sufficient cooling to preclude a fire" cannot be satisfied on a generic basis.

4. Research on source term generation in an air environment would be useful for reducing uncertainties.

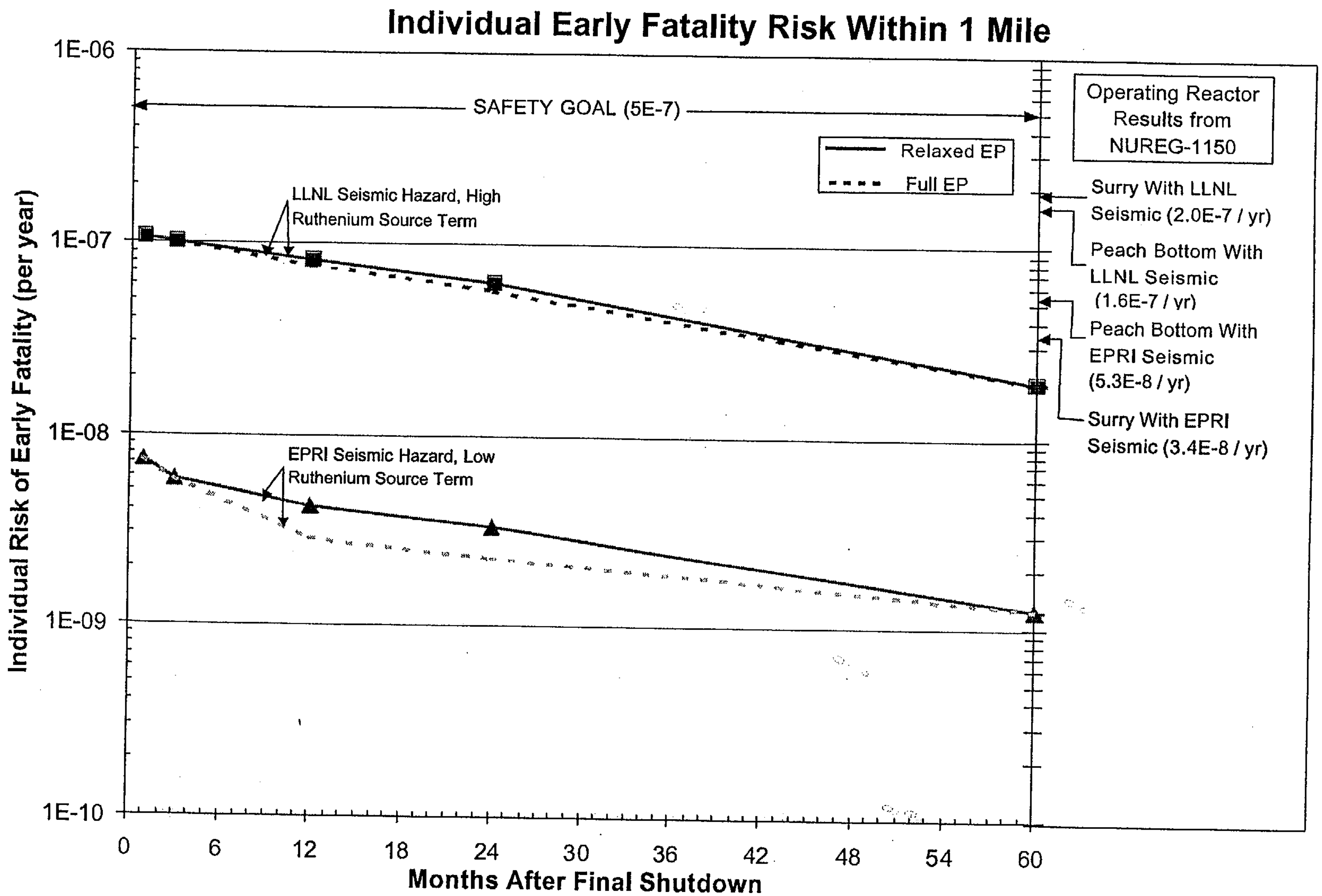
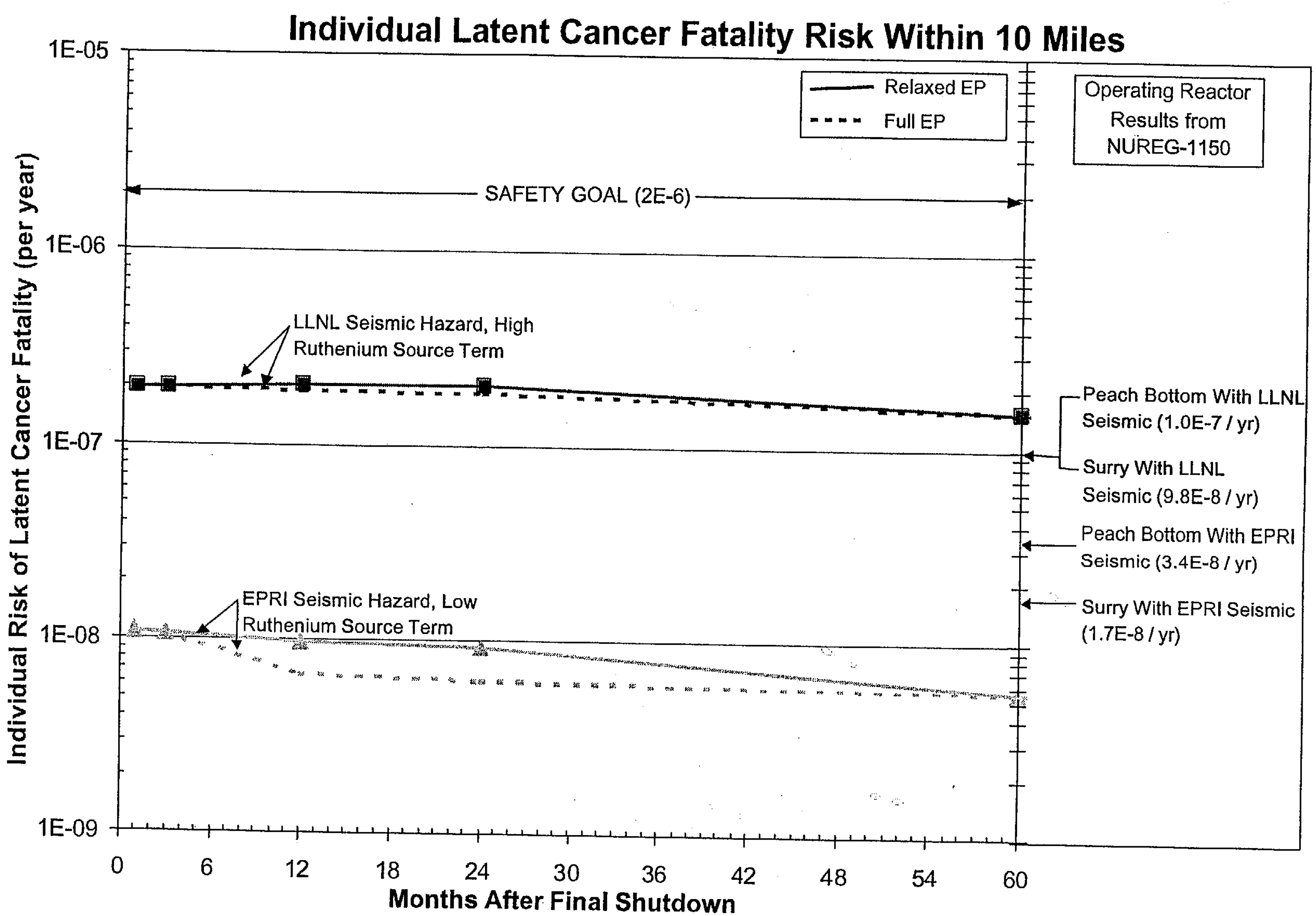

Individual Early Fatality Risk Within 1 Mile
1E-06
1E-07
1E-08
1E-09
1E-10
Individual Risk of Early Fatality (per year)
SAFETY GOAL (5E-7)
Relaxed EP
Full EP
Operating Reactor Results from NUREG-1150
LLNL Seismic Hazard, High Ruthenium Source Term
EPRI Seismic Hazard, Low Ruthenium Source Term
Surry With LLNL Seismic (2.0E-7 / yr)
Peach Bottom With LLNL Seismic (1.6E-7 / yr)
Peach Bottom With EPRI Seismic (5.3E-8 / yr)
Surry With EPRI Seismic (3.4E-8 / yr)
0
6
12
18
24
30
36
42
48
54
60
Months After Final Shutdown

Figure ES-1


Individual Latent Cancer Fatality Risk Within 10 Miles
Relaxed EP
Full EP
Operating Reactor Results from NUREG-1150
SAFETY GOAL (2E-6)
LLNL Seismic Hazard, High Ruthenium Source Term
EPRI Seismic Hazard, Low Ruthenium Source Term
Peach Bottom With LLNL Seismic (1.0E-7 / yr)
Surry With LLNL Seismic (9.8E-8 / yr)
Peach Bottom With EPRI Seismic (3.4E-8 / yr)
Surry With EPRI Seismic (1.7E-8 / yr)
Individual Risk of Latent Cancer Fatality (per year)
1E-05
1E-06
1E-07
1E-08
1E-09
0
6
12
18
24
30
36
42
48
54
60
Months After Final Shutdown

1.0 INTRODUCTION

Decommissioning plants have requested exemptions to certain regulations as a result of their permanently defueled condition. Although the current Part 50 regulatory requirements (developed for operating reactors) ensure safety at the decommissioning facility, some of these requirements may be excessive and not substantially contribute to public safety. Areas where regulatory relief has been requested in the past include exemptions from offsite emergency planning (EP), insurance, and safeguards requirements. Requests for consideration of changes in regulatory requirements are appropriate since the traditional accident sequences that dominate operating reactor risk are no longer applicable. For a defueled reactor in decommissioning status, public risk is predominantly from potential accidents involving spent fuel. Spent fuel can be stored in the spent fuel pool (SFP) for considerable periods of time, as remaining portions of the plant continue through decommissioning and disassembly. To date, exemptions have been requested and granted on a plant-specific basis. This has resulted in some inconsistency in the scope of evaluations and the acceptance criteria applied in processing the exemption requests.

To improve regulatory consistency and predictability, the NRC undertook this effort to improve the regulatory framework applicable to decommissioning plants. This framework utilized risk-informed approaches to identify the design and operational features necessary to ensure that risks to the public from these shutdown facilities are sufficiently small. This framework forms a technical foundation to be used as one input to developing regulatory changes, as well as a part of the basis for requesting and approving exemption requests until rulemaking is completed.

In support of this objective, the NRC staff has completed an assessment of SFP risks. This assessment utilized probabilistic risk assessment (PRA) methods and was developed from analytical studies in the areas of thermal hydraulics, reactivity, systems analysis, human reliability analysis, seismic and structural analysis, external hazards assessment, and offsite radiological consequences. The focus of the risk assessment was to identify potential severe accident scenarios at decommissioning plants and to estimate the likelihood and consequences of these scenarios. The staff also examined the offsite EP for decommissioning plants using an analysis strategy consistent with the principles of Regulatory Guide (RG) 1.174.

Preliminary versions of this study were issued for public comment and technical review in June 1999 and February 2000. Comments received from stakeholders and other technical reviewers have been considered in preparing this assessment. Quality assessment of the staff's preliminary analysis has been aided by a small panel of human reliability analysis (HRA) experts who evaluated the human performance analysis assumptions, methods and modeling. A broad quality review was carried out at the Idaho National Engineering and Environmental Laboratory (INEEL).

The study provides insights for the design and operation of SFP cooling and inventory makeup systems and practices and procedures necessary to ensure high levels of operator performance during off-normal conditions. The study concludes that, with the fulfillment of industry commitments and satisfaction of a number of important staff assumptions, the risks from SFPs can be sufficiently low to evaluate exemptions involving small changes to risk parameters and to contribute to the basis for related rulemaking.

As a measure of whether the risks from SFPs at decommissioning plants were sufficiently low to allow small changes to risk parameters, the concept of a pool performance guideline (PPG) was presented in the February 2000 study based on the principles of RG 1.174. In the study, the staff stated that consequences of an SFP fire are sufficiently severe that the RG 1.174 large early release frequency baseline of $1x10^{-5}$ per reactor year is an appropriate frequency guideline for a decommissioning plant SFP risk and a useful measure in combination with other factors such as accident progression timing, for assessing features, systems, and operator performance for a spent fuel pool in a decommissioning plant. Like the February 2000 study, this study uses the PPG of $1x10^{-5}$ per reactor year as the baseline frequency for a zirconium fire in the SFP.

The study is divided into three main parts. The first (Section 2) is a summary of the thermal-hydraulic analysis performed for SFPs at decommissioning plants. The second (Section 3) discusses how the principles of risk informed regulation are addressed by proposed changes. The third (Section 4) discusses the implications of the study for decommissioning regulatory requirements.

2.0 THERMAL-HYDRAULIC ANALYSES

Analyses were performed to evaluate the thermal-hydraulic characteristics of spent fuel stored in the spent fuel pools (SFPs) of decommissioning plants and determine the time available for plant operators to take actions to prevent a zirconium fire. These are discussed in Appendix 1A. The focus was the time available before fuel uncovery and the time available before the zirconium ignites after fuel uncovery. These times were utilized in performing the risk assessment discussed in Section 3.

To establish the times available before fuel uncovery, calculations were performed to determine the time to heat the SFP coolant to a point of boiling and then boil the coolant down to 3 feet above the top of the fuel. As can be seen in Table 2.1 below, the time available to take actions before any fuel uncovery is 100 hours or more for an SFP in which pressurized-water reactor (PWR) fuel has decayed at least 60 days.

Table 2.1 Time to Heatup and Boiloff SFP Inventory Down to 3 Feet Above Top of Fuel (60 GWD/MTU)

DECAY TIME	PWR	BWR
60 days	100 hours (>4 days)	145 hours (>6 days)
1 year	195 hours (>8 days)	253 hours (>10 days)
2 years	272 hours (>11 days)	337 hours (>14 days)
5 years	400 hours (>16 days)	459 hours (>19 days)
10 years	476 hours (>19 days)	532 hours (>22 days)

The analyses in Appendix 1A determined that the amount of time available (after complete fuel uncovery) before a zirconium fire depends on various factors, including decay heat rate, fuel burnup, fuel storage configuration, building ventilation rates and air flow paths, and fuel cladding oxidation rates. While the February 2000 study indicated that for the cases analyzed a required decay time of 5 years would preclude a zirconium fire, the revised analyses show that it is not feasible, without numerous constraints, to define a generic decay heat level (and therefore decay time) beyond which a zirconium fire is not physically possible. Heat removal is very sensitive to these constraints, and two of these constraints, fuel assembly geometry and spent fuel pool rack configuration, are plant specific. Both are also subject to unpredictable changes as a result of the severe seismic, cask drop, and possibly other dynamic events which could rapidly drain the pool. Therefore, since the decay heat source remains nonnegligible for many years and since configurations that ensure sufficient air flow[2] for cooling cannot be assured, a zirconium

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[2]Although a reduced air flow condition could reduce the oxygen levels to a point where a fire would not be possible, there is sufficient uncertainty in the available data as to when this level would be reached and if it could be maintained. It is not possible to predict when a zirconium fire would not occur because of a lack of oxygen. Blockage of the air flow around the fuel could be

fire cannot be precluded, although the likelihood may be reduced by accident management measures.

Figure 2.1 plots the heatup time air-cooled PWR and BWR fuel take to heat up from 30 °C to 900 °C versus time since reactor shutdown. The figure shows that after 4 years, PWR fuel could reach the point of fission product release in about 24 hours. Figure 2.2 shows the timing of the event by comparing the air-cooled calculations to an adiabatic heatup calculation for PWR fuel with a burnup of 60 GWD/MTU. The figure indicates an unrealistic result that until 2 years have passed the air-cooled heatup rates are faster than the adiabatic heatup rates. This is because the air-cooled case includes heat addition from oxidation while the adiabatic case does not. In the early years after shutdown, the additional heat source from oxidation at higher temperatures is high enough to offset any benefit from air cooling. This result is discussed further in Appendix 1A. The results using obstructed airflow (adiabatic heatup) show that at 5 years after shutdown, the release of fission products may occur approximately 24 hours after the accident.

In summary, 60 days after reactor shutdown for boildown type events, there is considerable time (>100 hours) to take action to preclude a fission product release or zirconium fire before uncovering the top of the fuel. However, if the fuel is uncovered, heatup to the zirconium ignition temperature during the first years after shutdown would take less than 10 hours even with unobstructed air flow. After 5 years, the heatup would take at least 24 hours even with obstructed air flow cases. Therefore, a zirconium fire would still be possible after 5 years for cases involving obstructed air flow and unsuccessful accident management measures. These results and how they affect SFP risk and decommissioning regulations are discussed in Sections 3 and 4 of this study.

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caused by collapsed structures and/or a partial draindown of the SFP coolant or by reconfiguration of the fuel assemblies during a seismic event or heavy load drop. A loss of SFP building ventilation could also preclude or inhibit effective cooling. As discussed in Appendix 1A, air flow blockage without any recovery actions could result in a near-adiabatic fuel heatup and a zirconium fire even after 5 years.

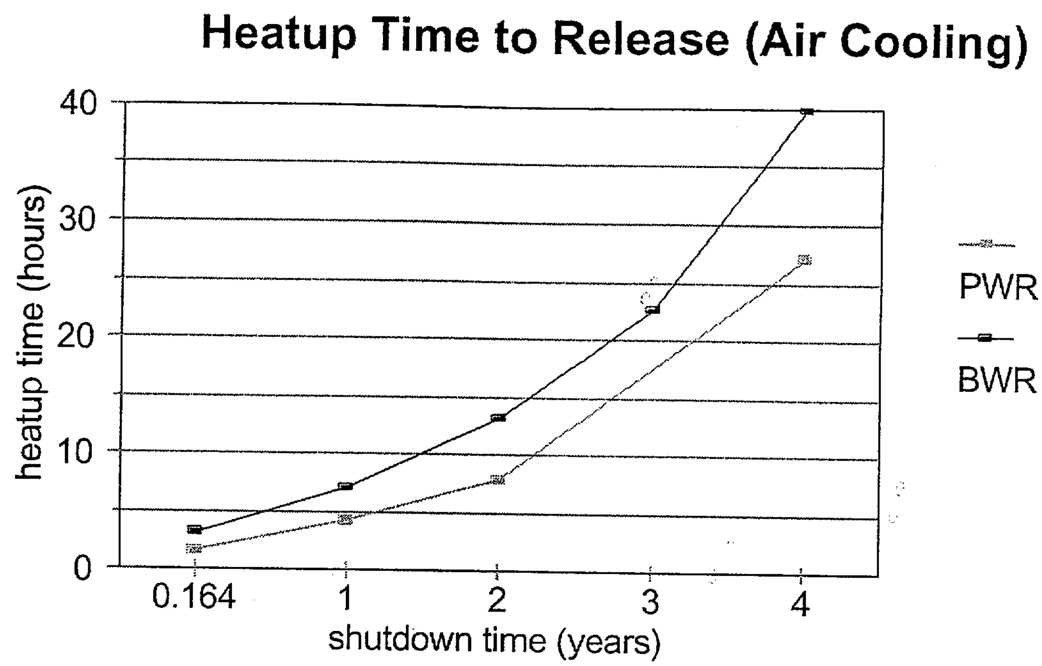

Figure 2.1 Heatup Time From 30 °C to 900 °C

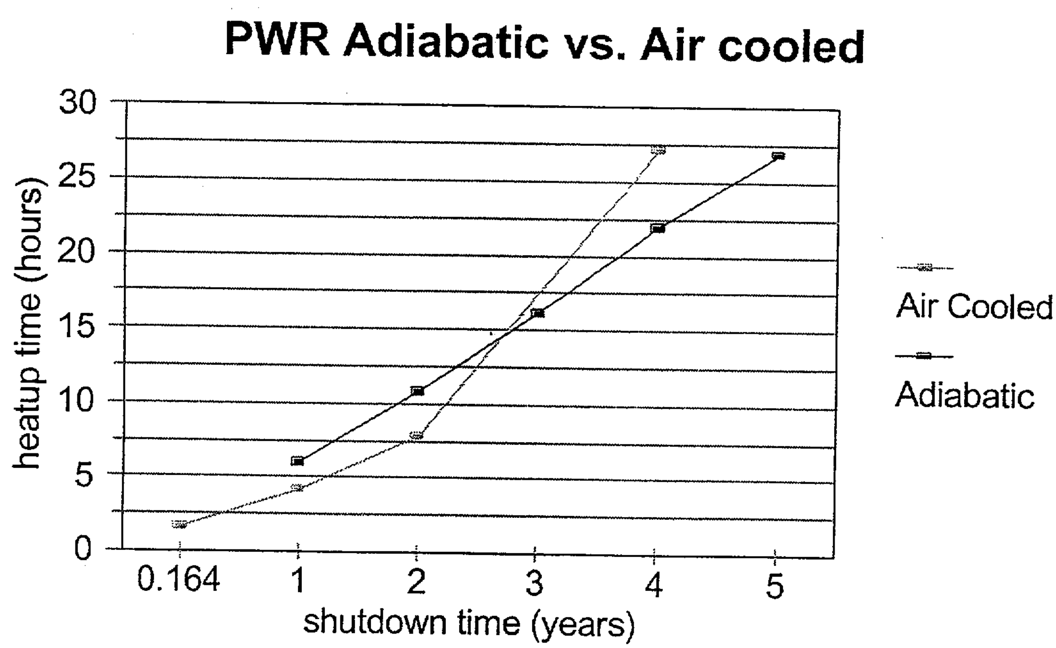

Figure 2.2 PWR Heatup Times for Air Cooling and Adiabatic Heatup

3.0 RISK ASSESSMENT OF SPENT FUEL POOLS AT DECOMMISSIONING PLANTS

The scenarios leading to significant offsite consequences at a decommissioning plant are different than at an operating plant. Once fuel is permanently removed from the reactor vessel, the primary public risk in a decommissioning facility is associated with the spent fuel pool (SFP). The spent fuel assemblies are retained in the SFP and submerged in water to cool the remaining decay heat and to shield the radioactive assemblies. The most severe accidents postulated for SFPs are associated with the loss of water from the pool.

Depending on the time since reactor shutdown, fuel burnup, and fuel rack configuration, there may be sufficient decay heat for the fuel clad to heat up, swell, and burst after a loss of pool water. The breach in the clad releases of radioactive gases present in the gap between the fuel and clad. This is called "a gap release" (see Appendix 1B). If the fuel continues to heat up, the zirconium clad will reach the point of rapid oxidation in air. This reaction of zirconium and air, or zirconium and steam is exothermic (i.e., produces heat). The energy released from the reaction, combined with the fuel's decay energy, can cause the reaction to become self-sustaining and ignite the zirconium. The increase in heat from the oxidation reaction can also raise the temperature in adjacent fuel assemblies and propagate the oxidation reaction. The zirconium fire would result in a significant release of the spent fuel fission products which would be dispersed from the reactor site in the thermal plume from the zirconium fire. Consequence assessments (Appendix 4) have shown that a zirconium fire could have significant latent health effects and resulted in a number of early fatalities. Gap releases from fuel from a reactor that has been shutdown more than a few months involve smaller quantities of radionuclides and, in the absence of a zirconium fire, would only be of concern onsite.

The staff conducted its risk evaluation to estimate the likelihood of accident scenarios that could result in loss of pool water and fuel heatup to the point of rapid oxidation. In addition to developing an assessment of the level of risk associated with SFPs at decommissioning plants, the staff's objective was to identify potential vulnerabilities and design and operational characteristics that would minimize these vulnerabilities. Finally, the staff assessed the effect of offsite emergency planning (i.e., evacuation) at selected sites using various risk metrics and the Commission's Safety Goals.

In support of the risk evaluation, the staff conducted a thermal-hydraulic assessment of the SFP for various scenarios involving loss of pool cooling and loss of inventory. These calculations provided information on heatup and boiloff rates for the pool and on heatup rates for the uncovered fuel assemblies and time to initiation of a zirconium fire (see Table 2.1 and Figures 2.1 and 2.2). The results of these calculations provided fundamental information on the timing of accident sequences, insights on the time available to recover from events, and time available to initiate offsite measures. This information was used in the risk assessment to support the human reliability analysis of the likelihood of refilling the SFP or cooling the fuel before a zirconium fire occurs.

For these calculations, the end state assumed for the accident sequences was the state at which the water level reached 3 feet from the top of the spent fuel. This simplification was used because of the lack of data and difficulty in modeling complex heat transfer mechanisms and chemical reactions in the fuel assemblies that are slowly being uncovered. As a result, the time available for fuel handler recovery from SFP events before initiation of a zirconium fire is underestimated. However, since recoverable events such as small loss of inventory or loss of power or pool cooling evolve very slowly, many days are generally available for recovery whether the end point of the analysis is uncovery of the top of the fuel or complete fuel uncovery. The extra time available (estimated to be in the tens of hours) as the water boils off would not impact the very high probabilities of fuel handler recovery from these events, given the industry decommissioning commitments (IDCs) and additional staff decommissioning assumptions (SDAs) discussed in Sections 3.2 through 4.[3] A summary of the thermal-hydraulic assessment is provided in Appendix 1A.

3.1 Basis and Findings of SFP Risk Assessment

To gather information on SFP design and operational characteristics for the preliminary risk assessment for the June 1999 draft study, the staff visited four decommissioning plants to ascertain what would be an appropriate model for decommissioning SFPs. The site visits confirmed that the as-operated SFP cooling systems were different from those in operation when the plants were in power operation. The operating plant pool cooling and makeup systems generally have been removed and replaced with portable, skid-mounted pumps and heat exchangers. In some cases there are redundant pumps. In most cases, physical separation, barrier protection, and emergency onsite power sources are no longer maintained. Modeling information for the PRA analysis was gathered from system walkdowns and discussions with the decommissioning plant staff. Since limited information was collected for the preliminary assessment on procedural and recovery activities and on the minimum configuration for a decommissioning plant, a number of assumptions and bounding conditions were in the June 1999 study. The preliminary results have been refined in this assessment, thanks to more detailed information from industry on SFP design and operating characteristics for a decommissioning plant and a number of IDCs that contribute to achieving low risk findings from SFP incidents. The revised results also reflect improvements in the PRA model since publication of the June 1999 and February 2000 studies.

The staff identified nine initiating event categories to investigate as part of the quantitative assessment on SFP risk:

1. Loss of offsite power from plant centered and grid-related events
2. Loss of offsite power from events initiated by severe weather
3. Internal fire
4. Loss of pool cooling
5. Loss of coolant inventory
6. Seismic event
7. Cask drop
8. Aircraft impact
9. Tornado missile

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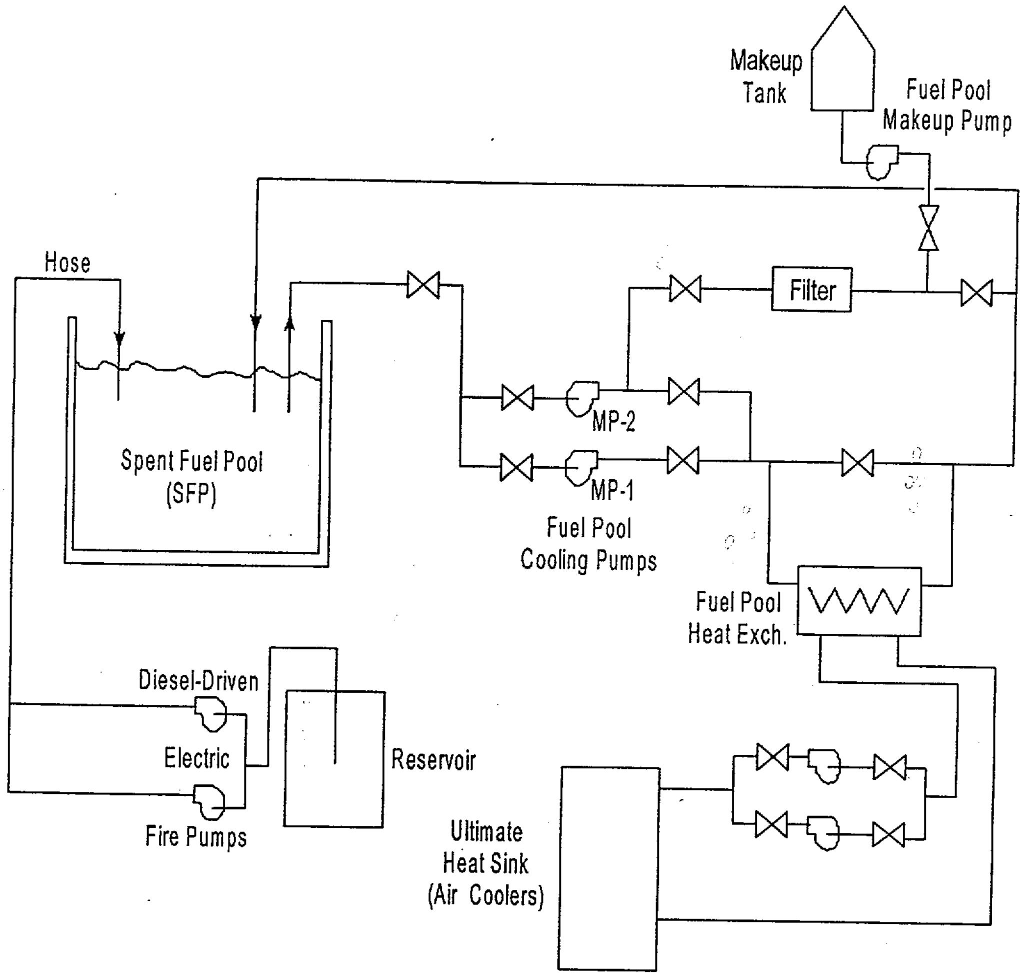
[3]The staff notes that the assumption that no recovery occurs once the water level reaches 3 feet above the fuel tends to obscure the distinction between two major types of accidents: slow boildown or draindown events and rapid draindown events. In both types of events, cooling would most likely be not by air but by water or steam. Also obscured is the effect of partial draindown events on event timing (addressed in Section 2).

In addition, a qualitative risk perspective was developed for inadvertent criticality in the SFP (see Section 3.6). The risk model, as developed by the staff and revised after a quality review by Idaho National Engineering & Environmental Laboratory (INEEL), is provided in Appendix 2A. Appendix 2A also includes the modeling details for the heavy load drop, aircraft impact, seismic, and tornado missile assessments. Input and comments from stakeholders were also utilized in updating the June 1999 and February 2000 risk models.

3.2 Characteristics of SFP Design and Operations for a Decommissioning Plant

Based on information gathered from the site visits and interactions with NEI and other stakeholders, the staff modeled the spent fuel pool cooling (SFPC) system (see Figure 3.1) as being located in the SFP area and consisting of motor-driven pumps, a heat exchanger, an ultimate heat sink, a makeup tank, a filtration system, and isolation valves. Coolant is drawn from the SFP by one of the two pumps, passed through the heat exchanger, and returned to the pool. One of the two pumps on the secondary side of the heat exchanger rejects the heat to the ultimate heat sink. A small amount of water is diverted to the filtration process and is returned into the discharge line. A manually operated makeup system (with a limited volumetric flow rate) supplements the small losses due to evaporation. During a prolonged loss of the SFPC system or a loss of inventory, inventory can be made up using the firewater system, if needed. Two firewater pumps, one motor-driven (electric) and one diesel-driven, provide firewater in the SFP area. There is a firewater hose station in the SFP area. The firewater pumps are in a separate structure.

Figure 3.1 Assumed Spent Fuel Pool Cooling System



Based upon information obtained during the site visits and discussions with decommissioning plant personnel during those visits, the staff also made the following assumptions that are believed to be representative of a typical decommissioning facility:

- The SFP cooling design, including instrumentation, is at least as capable as that assumed in the risk assessment. Licensees have at least one motor-driven and one diesel-driven fire pump capable of delivering inventory to the SFP (SDA #1, Table 4.2-2).
- The makeup capacity (with respect to volumetric flow) is assumed to be as follows:

Makeup pump:	20 – 30 gpm
Firewater pump:	100 – 200 gpm
Fire engine:	100 – 250 gpm (100 gpm, for hose: 1½-in., 250 gpm for 21/2-in. hose)

- For the larger loss-of-coolant-inventory accidents, water addition through the makeup pumps does not successfully mitigate the loss of the inventory event unless the location of inventory loss is isolated.

- The SFP fuel handlers perform walkdowns of the SFP area once per shift (8- to 12-hour shifts). A different crew member works the next shift. The SFP water is clear and the pool level is observable via a measuring stick in the pool to alert fuel handlers to level changes.

- Plants do not have drain paths in their SFPs that could lower the pool level (by draining, suction, or pumping) more that 15 feet below the normal pool operating level, and licensees must initiate recovery using offsite sources.

Based upon the results of the June 1999 preliminary risk analysis and the associated sensitivity cases, it became clear that many of the risk sequences were quite sensitive to the performance of the SFP operating staff in identifying and responding to off-normal conditions. This is because the remaining systems of the SFP are relatively simple, with manual rather than automatic initiation of backups or realignments. Therefore, in scenarios such as loss of cooling or inventory loss, the fuel handler's responses to diagnose the failures and bring any available resources (public or private) to bear is fundamental for ensuring that the fuel assemblies remain cooled and a zirconium fire is prevented.

As part of its technical evaluations, the staff assembled a small panel of experts[4] to identify the attributes necessary to achieving very high levels of human reliability for responding to potential accident scenarios in a decommissioning plant SFP. (These attributes and the human reliability analysis (HRA) methodology used are discussed in Section 3.2 of Appendix 2A.)

Upon considering the sensitivities identified in the staff's preliminary study and to reflect actual operating practices at decommissioning facilities, the nuclear industry, through NEI, made important commitments, which are reflected in the staff's updated risk assessment.

Industry Decommissioning Commitments (IDCs)

IDC #1 Cask drop analyses will be performed or single failure-proof cranes will be in use for handling of heavy loads (i.e., phase II of NUREG-0612 will be implemented).

IDC #2 Procedures and training of personnel will be in place to ensure that onsite and offsite resources can be brought to bear during an event.

IDC #3 Procedures will be in place to establish communication between onsite and offsite organizations during severe weather and seismic events.

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[4]Gareth Parry, U.S. NRC; Harold Blackman, INEEL; and Dennis Bley, Buttonwood Consulting.

IDC #4 An offsite resource plan will be developed which will include access to portable pumps and emergency power to supplement onsite resources. The plan would principally identify organizations or suppliers where offsite resources could be obtained in a timely manner.

IDC #5 Spent fuel pool instrumentation will include readouts and alarms in the control room (or where personnel are stationed) for spent fuel pool temperature, water level, and area radiation levels.

IDC #6 Spent fuel pool seals that could cause leakage leading to fuel uncovery in the event of seal failure shall be self limiting to leakage or otherwise engineered so that drainage cannot occur.

IDC #7 Procedures or administrative controls to reduce the likelihood of rapid draindown events will include (1) prohibitions on the use of pumps that lack adequate siphon protection or (2) controls for pump suction and discharge points. The functionality of anti-siphon devices will be periodically verified.

IDC #8 An onsite restoration plan will be in place to provide repair of the spent fuel pool cooling systems or to provide access for makeup water to the spent fuel pool. The plan will provide for remote alignment of the makeup source to the spent fuel pool without requiring entry to the refuel floor.

IDC #9 Procedures will be in place to control spent fuel pool operations that have the potential to rapidly decrease spent fuel pool inventory. These administrative controls may require additional operations or management review, management physical presence for designated operations or administrative limitations such as restrictions on heavy load movements.

IDC #10 Routine testing of the alternative fuel pool makeup system components will be performed and administrative controls for equipment out of service will be implemented to provide added assurance that the components would be available, if needed.

Additional important operational and design assumptions made by the staff in the risk estimates developed in this study are designated as SDAs and are discussed in later sections of this study.

3.3 Estimated Frequencies of Spent Fuel Uncovery and Assumptions That Influence the Results

Based upon the above design and operational features, IDCs, technical comments from stakeholders, and the input from the INEEL technical review, the staff's SFP risk model was updated. The updates have improved the estimated frequency calculations, but have not changed the need for the industry commitments or staff decommissioning assumptions. Absolute values of some sequences have decreased, but the overall insights from the risk assessment remain the same.

3.3.1 Internal and External Initiator Frequency of Spent Fuel Pool Uncovery

The results for the initiators that were assessed quantitatively are shown in Table 3.1. This table gives the fuel uncovery frequency for each accident initiator. The frequencies are point estimates because point estimates were used for the input parameters. For the most part, these input parameter values are the mean values of the probability distributions that would be used in a calculation to propagate parameter uncertainty. Because the systems are very simple and needs little support, the point estimates therefore reasonably correlate to the mean values that would be obtained from a full propagation of parameter uncertainty. Due to the large margin between the loss of cooling and inventory sequence frequencies and the pool performance guideline, this propagation was judged to be unnecessary (see Section 5.1 of Appendix 2A for further discussion of uncertainties).

Both the EPRI and LLNL hazard estimates at reactor sites were developed as best estimates and are considered valid by the NRC. Furthermore, because both sets of curves are based upon expert opinion and extrapolation in the range of interest, there is no technical basis for excluding consideration of either set of estimates. The mean frequency shown does not consider Western U.S. sites (e.g., Diablo Canyon, San Onofre, and WNP-2).

The results in Table 3.1 show the estimated frequency of a zirconium fire of fuel that has a decay time of 1 year. In characterizing the risk of seismically-induced SFP accidents for the population of sites, the staff has displayed results based on both the LLNL and EPRI hazard estimates, and has used an accident frequency corresponding to the mean value for the respective distributions, i.e., a frequency of $2x10^{-6}$ per year to reflect the use of LLNL hazard estimates and a frequency of $2x10^{-7}$ per year to reflect use of the EPRI hazard estimates. Use of the mean value facilitates comparisons with the Commission's Safety Goals and QHOs. Fire frequencies for all initiators range from about $6x10^{-7}$ per year to about $2X10^{-6}$ per year (depending on the seismic hazard estimates used), with the dominant contribution being from a severe seismic event. Plant-specific frequency estimates in some cases could be as much as an order of magnitude higher or lower because of the seismic hazard at the plant site. The mean value bounds about 70 percent of the sites for either the LLNL or the EPRI cases. A more detailed characterization of the seismic risk is given in Section 3.5.1 and Appendix 2B. The frequency of a zirconium fire is dominated by seismic events when the seismic hazard frequency is based on the LLNL estimate. Cask drop and boildown sequences become important contributors when seismic hazard frequency is based on the EPRI estimate. As a result, even though the seismic event frequency based on the EPRI estimate is an order of magnitude lower than the LLNL estimate, only a factor of four reduction in total frequency is realized with the use of the EPRI estimate since the nonseismic sequences become more important. In Section 3.4.7 the staff discusses the expected fuel uncovery frequencies for fuel that has decayed a few months, 2 years, 5 years, and 10 years.

In conjunction with the frequency of the uncovery of the spent fuel, it is important to know the time it takes the fuel to heat up once it has been uncovered fully or partially. Figures 2.1 and 2.2 in Section 2 show the time needed with and without air circulation to heat up the fuel from 30 °C to 900 °C (the temperature at which zirconium oxidation is postulated to become runaway oxidation and at which fission products are expected to be expelled from the fuel and cladding).

The staff realizes that the volumetric rate of air flow that a fuel bundle receives during a loss of cooling event significantly influences the heatup of the bundle. To achieve sufficient long-term air cooling of uncovered spent fuel, two conditions must be met: (1) an air flow path through the bundles must exist, and (2) sufficient SFP building ventilation flow must be provided. The presence of more than about 1 foot of water in the SFP, as in a seismically induced SFP failure or the late states of a boildown sequence, would effectively block the air flow path. Seismically induced collapse of the SFP building into the SFP could have a similar effect. Loss of building ventilation would tend to increase fuel heatup rates and maximum fuel temperatures, as described in Appendix 1A.

Based on engineering judgment, we have partitioned the frequency of each sequence into two parts: where the bundles in the spent fuel pool area receive two building volumes of air per hour (high air flow) and where the bundles receives little or no air flow (low air flow). Table 3.2 provides this partition.

Table 3.1 Spent Fuel Pool Cooling Risk Analysis — Frequency of Fuel Uncovery (per year)

INITIATING EVENT	Frequency of Fuel Uncovery (EPRI hazard)	Frequency of Fuel Uncovery (LLNL hazard)
Seismic event [5]	$2x10^{-07}$	$2x10^{-06}$
Cask drop [6]	$2.0x10^{-07}$	same
Loss of offsite power[7] initiated by severe weather	$1.1x10^{-07}$	same
Loss of offsite power from plant centered and grid-related events	$2.9x10^{-08}$	same
Internal fire	$2.3x10^{-08}$	same
Loss of pool cooling	$1.4x10^{-08}$	same
Loss of coolant inventory	$3.0x10^{-09}$	same
Aircraft impact	$2.9x10^{-09}$	same
Tornado Missile	$<1.0x10^{-09}$	same
Total[8]	$5.8x10^{-07}$	$2.4x10^{-06}$

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[5]This value is the mean of the failure probabilities for Central and Eastern SFPs that satisfy the seismic checklist and includes seismically induced catastrophic failure of the pool (which dominates the results) and a small contribution from seismically induced failure of pool support systems.

[6]For a single-failure-proof system without a load drop analysis. The staff assumed that facilities that chose the option in NUREG-0612 have a non-single-failure-proof system and implemented their load drop analysis including taking mitigative actions to assure a high confidence that the risk of catastrophic failure was less than or equivalent to that of a single-failure-proof system.

[7]The estimate is based upon the time available for human response when the fuel has decayed 1 year. After only a few months of decay, these estimates are not expected to increase significantly. Furthermore, for longer periods of decay, no significant change in the estimated frequency is expected because the fuel handler success rates are already so high after 1 year of decay.

[8]Consistent with PRA limitations and practice, contributions to risk from safeguards events are not included in these frequency estimates. EP might also provide dose savings in such events.

Table 3.2 Spent Fuel Pool Cooling Risk Analysis — Frequency Partition for Air Flow

SEQUENCES	% HIGH AIR FLOW	% LOW AIR FLOW (ADIABATIC)
Seismic	30%	70%
Heavy load drop	50%	50%
Loss of offsite power, severe weather	90%	10%

In Table 3.2 for seismic sequences, we have assumed that 30 percent of the time the building will turn over two building volumes of air per hour (high air flow) and 70 percent of the time the individual fuel bundle of concern will receive little or no air cooling. These percentages are based on discussions with staff structural engineers, who believe that, at accelerations in excess of 1.2 g spectral acceleration (which is greater than three times the safe shutdown earthquake (SSE) for many reactor sites east of the Rocky Mountains), there is a high likelihood of building damage that blocks air flow. For heavy load drop sequences, the staff assumed a 50 percent partition for the high air flow case. This is based on considering both damage to fuel bundles due to a heavy load drop that renders bundles uncoolable and the alternative possibility that the drop damages the building structure in a way that blocks some spent fuel bundles. For loss of offsite power events caused by severe weather, the staff assumed a 90 percent partition for the high airflow case. This is based on a staff assumption that openings in the SFP building (e.g., doors and roof hatches) are large enough that, if forced circulation is lost, natural circulation cooling will provide at least two building volume of air per hour to the SFP. This assumption may need to be confirmed on a plant-specific basis. The staff did not partition the rest of the sequences in Table 3.2, since their absolute value and contribution to the overall zirconium fire frequency are so low.

The frequency partitioning shows that a large portion of the seismic and heavy load drop sequences have low air flow. This partitioning did not consider the possibility that the air flow path is blocked by residual water in the SFP. When the potential for flow blockage by residual water is considered, an even greater portion of the events would result in no (or low) air flow. Fuel heatup calculations in Section 2 show that for the first several years after shutdown, the fuel heatup time (e.g., time to reach 900 °C) for the adiabatic and air-cooled cases is comparable. Thus, the effects of partitioning are negligible for this period. Because SFP and SFP building fragilities and failure modes are plant-specific, and the heatup time for the adiabatic and air-cooled cases differ only slightly, the staff did not consider the partitioning in estimating the frequency of SFP fires. Whether or not a spent fuel bundle receives high air flow or low air flow fuel uncovery does not change our insights into the risk associated with operation of SFPs.

3.3.2 Important Assumptions

As discussed in more detail in Appendix 2A, the results of the risk analysis depend on assumptions about the design and operational characteristics of the SFP facility. The following inputs can significantly influence the results:

- The modeled system configuration is described in Section 3.2. The assumed availability of a diesel-driven fire pump is an important factor in the conclusion that fuel uncovery frequency is low for the loss of offsite power initiating events and the internal fire initiating event. The assumption of the availability of a redundant fuel pool cooling pump is not as important since the modeling of the recovery of the failed system includes repair of the failed pump as well as the startup of the redundant pump. Finally, multiple sources of makeup water are assumed for the fire pumps. This lessens the possible dependencies between initiating events (e.g., severe weather, high winds, or earthquakes) and the availability of makeup water supply (e.g., the fragility of the fire water supply tank).

- Plants have no drain paths in their SFPs that could lower the pool level (by draining, suction, or pumping) more that 15 feet below the normal pool operating level, and licensees must initiate recovery using offsite sources.

- Openings in the SFP building (e.g., doors and roof hatches) are large enough that, if forced circulation is lost, natural circulation cooling will provide at least two building volumes of air per hour to the SFP. Procedures exist to implement natural circulation.

- Credit is taken for the industry/NEI commitments as described in Section 3.2. Without this credit, the risk is estimated to be more than an order of magnitude higher. Specifically —

  - IDC #1 is credited for lowering the risk from cask drop accidents.

  - IDCs #2, 3, 4, and 8 are credited for the high probability of recovery from loss of cooling scenarios (including events initiated by loss of power or fire) and loss of inventory scenarios. To take full credit for these commitments, additional assumptions have been made about how these commitments will be implemented. Procedures and training are assume to give explicit guidance on the capability of the fuel pool makeup system and on when it becomes essential to supplement with alternate higher volume sources. Procedures and training are assumed to give sufficiently clear guidance on early preparation for using the alternate makeup sources. Walkdowns are assumed once per shift and the fuel handlers are assumed to document their observations in a log. The last assumption compensates for potential failures of the instrumentation monitoring the status of the pool.

  - IDC #5 is credited for the high probability of early identification and diagnosis (from the control room) of loss of cooling or loss of inventory.

  - IDCs #6, 7, and 9 are credited with lowering the initiating event frequency for the loss of inventory event from historical levels. In addition, these commitments are used to justify the assumption that a large noncatastrophic leak rate is limited to approximately 60 gpm and the assumption that the leak is self-limiting after a drop in level of 15 feet. These assumptions may be nonconservative on a plant-specific basis depending on SFP configuration and commitments for configuration control.

- IDC #10 is credited for the equipment availabilities and relibilities used in the analysis. In addition, if there are administrative procedures to control the out-of-service duration for the diesel fire pump, the relatively high unavailability for this pump (0.18) could be lowered.

- Initiating event frequencies for loss of cooling, loss of inventory, and loss of offsite power are based on generic data. In addition, the probability of power recovery is also based on generic information. Site-specific differences will proportionately affect the risk from these initiating events.

The various initiating event categories are discussed below. The staff's qualitative risk insights on the potential for SFP criticality are discussed in Section 3.6.

3.4 Internal Event Scenarios Leading to Fuel Uncovery

This section describes the events associated with internal event initiators. More details are given in Appendix 2A.

3.4.1 Loss of Cooling

The loss of cooling initiating event may be caused by the failure of pumps or valves, by piping failures, by an ineffective heat sink (e.g., loss of heat exchangers), or by a local loss of power (e.g., electrical connections). Although it may not be directly applicable because of design differences in decommissioning plants, operational data from NUREG-1275, Volume 12 (Ref. 3), shows that the frequency of loss of SFP cooling events in which temperature increases more than 20 °F is on the order of two to three events per 1000 reactor years. The data also shows that was the loss of cooling lasted less than 1 hour. Only three events exceeded 24 hours: the longest was 32 hours. In four events the temperature increase exceeded 20 °F, the largest increase being 50 °F.

The calculated fuel uncovery frequency for this initiating event is 1.4×10^{-8} per year. Indications of a loss of pool cooling available to fuel handlers include control room alarms and indicators, local temperature measurements, increasing area temperature and humidity, and low pool water level from boiloff. For a fuel uncovery, the plant fuel handlers must fail to recover the cooling system (either fail to notice the loss of cooling indications or fail to repair or restore the cooling system). In addition, the fuel handlers must fail to provide makeup cooling using other onsite sources (e.g., fire pumps) or offsite sources (e.g., a fire brigade). A long time is available for these recovery actions. In the case of 1-year-old fuel (i.e., fuel that was in the reactor when it was shutdown 1 year ago), approximately 195 hours is available for a PWR and 253 hours for a BWR before the water level drops to within 3 feet of the spent fuel. If the fuel most recently offloaded is only 2 months out of the reactor, the time available is still long (100–150 hours), and the likelihood of fuel handler success is still very high. These heatup and boiloff times are about double those reported by the staff before a correction in the staff's heat load assumptions. Because the uncovery frequency is already very low (on the order of 1 in 1 million per year) both absolutely and relative to other initiators, and because the quantification of human reliability analysis values for such extended periods of recovery is beyond the state-of-the-art, the staff did not attempt to recalculate the expected uncovery frequency. For 2-year-old, 5-year-old, and 10-year-old fuel, much longer periods are available than at 1 year (see Table 2.1).

A careful and thorough adherence to IDCs #2, #5, #8, and #10 is crucial to establishing and maintaining the low frequency. In addition, however, the assumption that walkdowns are performed on a regular basis (once per shift) is important to compensate for potential failures of the instrumentation monitoring the status of the pool. The analysis has also assumed that the procedures and/or training give explicit guidance on the capability of the fuel pool makeup system and on when it becomes essential to supplement with alternative higher volume sources. The analysis also assumes that the procedures and training give sufficiently clear guidance on early preparation for using the alternative makeup sources.

There have been two recent events involving a loss of cooling at SFPs. The first, at Browns Ferry Unit 3 occurring in December 1998, involved a temperature increase of approximately 25 °F over a 2-day period. This event, caused by the short cycling of cooling water through a stuck-open check valve, was not detected by the control room indicators because of a design flaw in the indicators. In the second event, at the Duane Arnold Unit 1 in January 2000, the SFP temperature increased by 40 to 50 °F. The incident, which was undetected for approximately 2½ days, was caused by operator failure to restore the SFP cooling system heat sink after maintenance activities. The plant had no alarm for high fuel pool temperature, although there are temperature indicators in the control room. Since the conditional probability of fuel uncovery is low given a loss of cooling initiating event, the addition of these two recent events to the database will not affect the conclusion that the risk from these events is low. However, the recent events illustrate the importance of industry commitments, particularly IDC #5 which requires temperature instrumentation and alarms in the control room. In addition, the staff assumptions that walkdowns are performed on a regular basis (once per shift), with the fuel handler documenting the observations in a log, and the assumption that control room instrumentation that monitors SFP temperature and water level directly measures the parameters involved are important for keeping the risk low, since the walkdowns compensate for potential failures of the control room instrumentation and direct measurement precludes failures such as occurred at Browns Ferry.

Even with the above referenced industry commitments, the additional need for walkdowns to be performed at least once per shift and the specific need for direct indication of level and temperature had to be assumed in order to arrive at the low accident frequency calculated for this scenario. These additional assumptions are identified by the staff as staff decommissioning assumptions (SDAs) #2 and #3. SDA #2 assumes the existence of explicit procedures and fuel handler training to provide guidance on the capability and availability of inventory makeup sources and the time available to utilize these sources.

SDA #2 Walkdowns of SFP systems are performed at least once per shift by the fuel handlers. Procedures are in place to give the fuel handlers guidance on the capability and availability of onsite and offsite inventory makeup sources and on the time available to utilize these sources for various loss of cooling or inventory events.

SDA #3 Control room instrumentation that monitors SFP temperature and water level directly measures the parameters involved. Level instrumentation provides alarms for calling in offsite resources and for declaring a general emergency.

3.4.2 Loss of Coolant Inventory

This initiator includes loss of coolant inventory resulting from configuration control errors, siphoning, piping failures, and gate and seal failures. Operational data in NUREG-1275, Volume 12, shows that the frequency of loss of inventory events in which a level decrease of more than 1 foot occurred is less than one event per 100 reactor years. Most of these events are as a result of fuel handler errors and are recoverable. Many of the events are not applicable in a decommissioning facility.

NUREG-1275 shows that, except for one event that lasted 72 hours, no events lasted more than 24 hours. Eight events resulted in a level decrease of between 1 and 5 feet, and another two events resulted in an inventory loss of between 5 and 10 feet.

Using the information from NUREG-1275, it can be estimated that 6 percent of the loss of inventory events will be large enough and/or long enough to require that isolating the loss if the only system available for makeup is the SFP makeup system. For the other 94 percent of the cases, operation of the makeup pump is sufficient to prevent fuel uncovery.

The calculated fuel uncovery frequency for loss of inventory events is 3.0×10^{-9} per year. The uncovery frequency is low primarily due to the assumption that loss of inventory can drain the pool only so far. Once that level is reached, additional inventory loss must come from pool heatup and boiloff. Fuel uncovery occurs if plant fuel handlers fail to initiate inventory makeup either by use of onsite sources such as the fire pumps or offsite sources such as the local fire department. In the case of a large leak, isolation of the leak would also be necessary if the makeup pumps are used. The time available for fuel handler action is considerable, and even in the case of a large leak, it is estimated that 40 hours will be available. Fuel handlers are alerted to a loss of inventory condition by control room alarms and indicators, by the visibly dropping water level in the pool, by the accumulation of water in unexpected locations, and by local alarms (radiation alarms, building sump high level alarms, etc.).

As with the loss of pool cooling, the frequency of fuel uncovery is calculated to be very low. Again, a careful and thorough adherence to IDCs #2, #5, #8, and #10 is crucial to establishing the low frequency. In addition, the assumptions that walkdowns (see SDA #2 above) are performed on a regular basis (once per shift) and that instrumentation directly measures temperature and level are important to compensate for potential failures of the instrumentation monitoring the status of the pool. The assumption that the procedures and/or training give explicit guidance on the capability of the fuel pool makeup system lowers the expected probability of fuel handler human errors, and the assumption that fuel handlers will supplement SFP makeup at appropriate times from alternative higher volume sources lowers the estimated frequency of failure of the fuel handler to mitigate the loss of coolant inventory. IDCs #6, #7, and #9 are also credited with lowering the initiating event frequency.

Even with these industry commitments, the staff had to assume the drop in pool inventory due to loss of inventory events is limited in order to arrive at the low accident frequency calculated for this scenario. This additional assumption is identified by the staff as SDA #4.

SDA #4 The licensee has determined that the SFP has no drain paths that could lower the pool level (by draining, suction, or pumping) more than 15 feet below the normal pool operating level and that the licensee initiates recovery using offsite sources.

3.4.3 Loss of Offsite Power from Plant-Centered and Grid Related Events

A loss of offsite power from plant-centered events typically involves hardware failures, design deficiencies, human errors (in maintenance and switching), localized weather-induced faults (e.g., lightning), or combinations. Grid-related offsite power events are caused by problems in the offsite power grid. With the loss of offsite power (onsite power is lost too, since the staff assumes no diesel generator is available to pick up the necessary electrical loads), there is no effective way of removing heat from the SFP. If power is not restored in time, the pool will heatup and boiloff inventory until the fuel is uncovered. The diesel-driven fire pump is available to provide inventory makeup. If the diesel-driven pump fails, and if offsite power is not recovered promply, recovery using offsite fire engines is a possibility. Recovery times are the same as for loss of cooling (discussed in Section 3.4.1).

Even after recovering offsite power, the fuel handlers have to restart the fuel pool cooling pumps. Failure to do this or failure of the equipment to restart will necessitate other fuel handler recovery actions. Again, considerable time is available.

The calculated fuel uncovery frequency for this sequence of events is 2.9×10^{-8} per year. This frequency is very low and, as with loss of pool cooling and loss of inventory, is based on adherence to IDCs #2, #5, #8, and #10. In addition, regular plant walkdowns, clear and explicit procedures, fuel handler training (SDA #2), and the direct measurement of level and temperature in the SFP (SDA #3) are assumed as documented.

3.4.4 Loss of Offsite Power from Severe Weather Events

This event represents the loss of SFP cooling because of a loss of offsite power from severe weather-related events (hurricanes, snow and wind, ice, wind and salt, wind, and one tornado event). Because of the potential for severe localized damage, tornadoes are analyzed separately in Appendix 2E. The analysis is summarized in Section 3.5.3 of this study.

Until offsite power is recovered, the electrical pumps are unavailable and the diesel-driven fire pump is available only for makeup. Recovery of offsite power after severe weather events is assumed to be less probable than after grid-related and plant-centered events. In addition, it is more difficult for offsite help to reach the site.

The calculated fuel uncovery frequency for this event is 1.1×10^{-7} per year. As in the previous cases, this estimate was based on IDCs #2, #5, #8, #10 and on assumptions documented in SDA #2 and SDA #3. In addition, IDC #3, the commitment to have procedures in place for communications between onsite and offsite organizations during severe weather, is also important in the analysis for increasing the likelihood that offsite organization can respond effectively.

3.4.5 Internal Fire

This event tree models the loss of SFP cooling caused by internal fires. The staff assumed that there is no automatic fire suppression system for the SFP cooling area. The fuel handler may initially attempt to manually suppress the fire if the fuel handler responds to the control room or local area alarms. If the fuel handler fails to respond to the alarm or is unsuccessful in extinguishing the fire within the first 20 minutes, the staff assumes that the SFP cooling system will be significantly damaged and cannot be repaired. Once the inventory level drops below the SFP cooling system suction level, the fuel handlers have about 85 hours to provide some sort of alternative makeup, either by using the site firewater system or by calling upon offsite resources. The staff assumes that the fire damages the plant power supply system and the electrical firewater pump is not available.

The calculated fuel uncovery frequency for this event is 2.3×10^{-8} per year. As in the previous cases, this estimate was based on IDCs #2, #5, #8, and #10 and on SDA #2 and SDA #3. In addition, IDC #3, the commitment to have procedures in place for communications between onsite and offsite organizations during severe weather, is also important in the analysis for increasing the likelihood that offsite organizations can respond effectively to a fire event because the availability of offsite resources increases the likelihood of recovery.

3.4.6 Heavy Load Drops

The staff investigated the frequency of a heavy load drop in or near the SFP and the potential damage to the pool from such a drop. The previous assessment done for resolution of Generic Issue 82 (in NUREG/CR-4982 (Ref. 4)) only considered the possibility of a heavy load drop on the pool wall. The assessment conducted for this study identifies other failure modes, such as the collapse of the pool floor, as also credible for some sites. Details of the heavy load assessment are given in Appendix 2C. The analysis exclusively considered drops severe enough to catastrophically damage the SFP so that pool inventory would be lost rapidly and it would be impossible to refill the pool using onsite or offsite resources. There is no possibility of mitigating the damage, only preventing it. The staff has not attempted to partition the initiator into events where there is full rapid draindown and events where there is rapid, but partial draindown. The staff assumes a catastrophic heavy load drop (creating a large leakage path in the pool) would lead directly to a zirconium fire. The time from the load drop until a fire varies depending on fuel age, burn up, and configuration. The dose rates in the pool area before any zirconium fire are tens of thousands of rem per hour, making any recovery actions (such as temporary large inventory addition) very difficult.

Based on discussions with staff structural engineers, it is assumed that only spent fuel casks are heavy enough to catastrophically damage the pool if dropped. The staff assumes a very low likelihood that other heavy loads will be moved over the SFP and that if one of these lighter loads over the SFP is dropped, it is unlikely to cause catastrophic damage to the pool.

For a non-single-failure-proof load handling system, the drop frequency of a heavy load drop is estimated, based on NUREG-0612 information, to have a mean value of 3.4×10^{-4} per year. The number of heavy load lifts was based on the NEI estimate of 100 spent fuel shipping cask lifts per year, which probably is an overestimate. For plants with a single-failure-proof load handling system or plants conforming to the NUREG-0612 guidelines, the drop frequency is estimated to have a mean value of 9.6×10^{-6} per year, again for 100 heavy load lifts per year but using data from U.S. Navy crane experience. Once the load is dropped, the analysis must then consider whether the drop significantly damages the SFP.

When estimating the failure frequency of the pool floor and pool wall, the staff assumes that heavy loads travel near or over the pool approximately 13 percent of the total path lift length (the path lift length is the distance from where the load is lifted to where it is placed on the pool floor). The staff also assumes that the critical path (the fraction of total path the load is lifted high enough above the pool to damage the structure in a drop) is approximately 16 percent. The staff estimates the catastrophic failure rate from heavy load drops to have a mean value of 2.1×10^{-5} per year for a non-single-failure-proof system relying on electrical interlocks, fuel handling system reliability, and safe load path procedures. The staff estimates the catastrophic failure rate from heavy load drops to have a mean value of 2×10^{-7} per year for a single-failure-proof system. The staff assumes that licensees that chose the non-single-failure-proof system option in NUREG-0612 performed appropriate analyses and took mitigative actions to reduce the expected frequency of catastrophic damage to the same range as for facilities with a single-failure-proof system.

NEI has made a commitment (IDC #1) for the nuclear industry that future decommissioning plants will comply with Phases I and II of the NUREG-0612 guidelines. Consistent with this industry commitment, the additional assurance of a well-performed and implemented load drop analysis, including mitigative actions, is assumed in order to arrive at an accident frequency for non-single-failure-proof systems that is comparable to the frequency for single-failure-proof systems.

SDA #5 Load Drop consequence analyses will be performed for facilities with non-single-failure-proof systems. The analyses and any mitigative actions necessary to preclude catastrophic damage to the SFP that would lead to a rapid pool draining should be performed with sufficient rigor to demonstrate that there is high confidence in the facility's ability to withstand a heavy load drop.

Although this study focuses on the risk associated with wet storage of spent fuel during decommissioning, the staff has been alert to any implications for the storage of spent fuel during power operation. With regard to power operation, the resolution of Generic Issue (GI) 82, "Beyond Design Basis Accidents in Spent Fuel Pools," and other studies of operating reactor SFPs concluded that existing requirements for operating reactor SFPs are sufficient. In developing the risk assessment for decommissioning plants, the staff evaluated the additional issue of a drop of a cask on the SFP floor rather than just on a SFP wall. As noted above, because the industry has committed to Phase II of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants, Resolution of Generic Technical Activity A-36," this is not a concern for decommissioning reactors.

Operating reactors are not required to implement Phase II of NUREG-0612. The risk for SFPs at operating plants is limited by a lower expected frequency of heavy load lifts then at decommissioning plants. Nonetheless, this issue will be further examined as part of the Office of Nuclear Regulatory Research's prioritization of Generic Safety Issue 186, "Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants," which was accepted in May 1999.

3.4.7 Spent Fuel Pool Uncovery Frequency at Times Other Than 1 Year After Shutdown

The staff has considered how changes in recovery time available to fuel handlers at 2 months, 2 years, 5 years, and 10 years after shutdown (see Table 2.1) change the insights or bottom-line numerical results from the risk assessment . The different recovery times primarily affect the human reliability analysis (HRA) results and insights. Even at 2 months after shutdown, the HRA failure estimates are small and are dominated by institutional factors (e.g., training, quality of procedures, staffing). It is therefore expected that the total fuel uncovery frequency at 2 months will continue to be dominated by the seismic contribution. At periods beyond 1 year, the increased recovery time (from a very long time to an even longer time) lowers the uncertainty that these HRA estimates really are very small, but the increased time has not translated into significant changes in the bottom-line numerical estimates because quantification of the effect of such extensions on organizational problems is beyond the state-of-the-art.

3.5 Beyond Design Basis Spent Fuel Pool Accident Scenarios (External Events)

In the following sections, the staff explains how each of the external event initiators was modeled, discusses the frequency of fuel uncovery associated with the initiator, and describes the most important insights regarding risk reduction strategies for each initiator.

3.5.1 Seismic Events

The staff performed a simplified seismic risk analysis in its June 1999 preliminary draft risk assessment to gain initial insights on seismic contribution to SFP risk. The analysis indicated that seismic events could not be dismissed on the basis of a simplified bounding approach. The additional efforts by the staff to evaluate the seismic risk to SFPs are addressed here and in Appendix 2B.

SFP structures at nuclear power plants should be seismically robust. They are constructed of thick, reinforced concrete walls and slabs lined with stainless steel liners 1/8 to 1/4 inch thick.[9] Pool walls are about 5 feet thick and the pool floor slabs are around 4 feet thick. The overall pool dimensions are typically about 50 feet long by 40 feet wide and 55 to 60 feet high. In boiling-water reactor (BWR) plants, the pool structures are located in the reactor building at an elevation several stories above the ground. In pressurized-water reactor (PWR) plants, the SFP structures are outside the containment structure and supported on the ground or partially embedded in the ground. The location and supporting arrangement of the pool structures affect

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[9]Except at Dresden Unit 1 and Indian Point Unit 1, have no liner plates. The plants were permanently shut down more than 20 years ago and no safety significant degradation of the concrete pool structure has been reported.

their capacity to withstand seismic ground motion beyond their design basis. The dimensions of the pool structure are generally derived from radiation shielding considerations rather than seismic demand needs. Spent fuel structures at nuclear power plants are able to withstand loads substantially beyond those for which they were designed.

To evaluate the risk from a seismic event at an SFP, one needs to know both the likelihood of seismic ground motion at various acceleration levels (i.e., seismic hazard) and the conditional probability that a structure, system, or component (SSC) will fail at a given acceleration level (i.e., the fragility of the SSC). These can be convolved mathematically to arrive at the likelihood that the SFP will fail from a seismic event. In evaluating the effect of seismic events on SFPs, it became apparent that although information was available on seismic hazard for nuclear power plant sites, the staff did not have fragility analyses of the pools, nor generally did licensees. The staff recognized that many of the SFPs and the buildings housing them were designed by different architect-engineers. Additionally, the pools were built to different standards as the rules changed over the years.

To compensate for the lack of knowledge of the capacity of the SFPs, the staff proposed the use of a seismic checklist during stakeholder interactions, and in a letter dated August 18, 1999, NEI proposed a checklist that could be used to show an SFP would retain its structural integrity at a peak spectral acceleration of about 1.2 g. This value was chosen, in part, because existing databases that could be used in conjunction with the checklist only go up to 1.2 g peak spectral acceleration. The checklist was reviewed and enhanced by the staff (see Appendix 2B). The checklist includes elements to assure there are no weaknesses in the design or construction or any service-induced degradation of the pools that would make them vulnerable to failure during earthquake ground motions that exceed their design-basis ground motion but are less than the 1.2 g peak spectral acceleration. The staff used a simplified, but slightly conservative method to estimate the annual probability of a zirconium fire due to seismic events and site-specific seismic hazard estimates (see Appendix 2B, Attachment 2). These calculations resulted in a range of frequencies from less than 1×10^{-8} per year to over 1×10^{-5} per year, depending on the site and the seismic estimates used.

Figures 3.2 and 3.3 show the estimated annual probabilities of a zirconium fire from a seismic event in ascending order. Figure 3.2 shows the results of convolving the site-specific LLNL seismic hazard estimates (from NUREG-1488, "Revised Livermore Seismic Hazard Estimates for 69 Nuclear Power Plant Sites East of the Rocky Mountains," P. Sobel, October 1993) with the generic SFP fragility analysis, and Figure 3.3 shows the results of convolving the EPRI site-specific seismic hazard estimates (Ref. 10) in a similar manner.[10] Note that the order of the sites differs somewhat In the EPRI and LLNL estimates. These figures show that for the zirconium fire frequencies using the LLNL estimates, the annual probabilities for most site clusters just above 1×10^{-6} per year. The mean failure probability for the sites analyzed by LLNL is about 2×10^{-6} per year. This value bounds 70 percent of the sites using the LLNL curves. For the EPRI curve, the mean value of the pool failure frequency is about 2×10^{-7} per year. In

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[10] At higher accelerations, especially for plant sites east of the Rocky Mountains, there is great modeling uncertainty about the ground motions, return periods, and the possibility of cutoff. There is virtually no data at these acceleration levels.

considering these two different sets of hazard estimates, the NRC has found that both sets are reasonable and equally valid.

By passing the checklist, the SFP will be assured a high confidence with low probability of failure (HCLPF)[11] of at least 1.2 g peak spectral acceleration. The performance of the seismic checklist is identified by the staff as SDA #6.

SDA #6 Each decommissioning plant will successfully complete the seismic checklist provided in Appendix 2B to this study. If the checklist cannot be successfully completed, the decommissioning plant will perform a plant specific seismic risk assessment of the SFP and demonstrate that SFP seismically induced structural failure and rapid loss of inventory is less than the generic bounding estimates provided in this study ($<1 \times 10^{-5}$ per year including non-seismic events).

For many sites (particularly PWRs because their SFPs are closer to ground level or embedded and the motion is therefore less amplified), the plant-specific risk may be considerably lower. There are only two plant-specific SFP fragility analyses of which the staff is aware, and these were used in the analyses performed to help confirm the generic seismic capacities assumed for SFPs.

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[11]The HCLPF value is defined as the peak seismic acceleration at which there is 95 percent confidence that less than 5 percent of the time the structure, system, or component will fail.

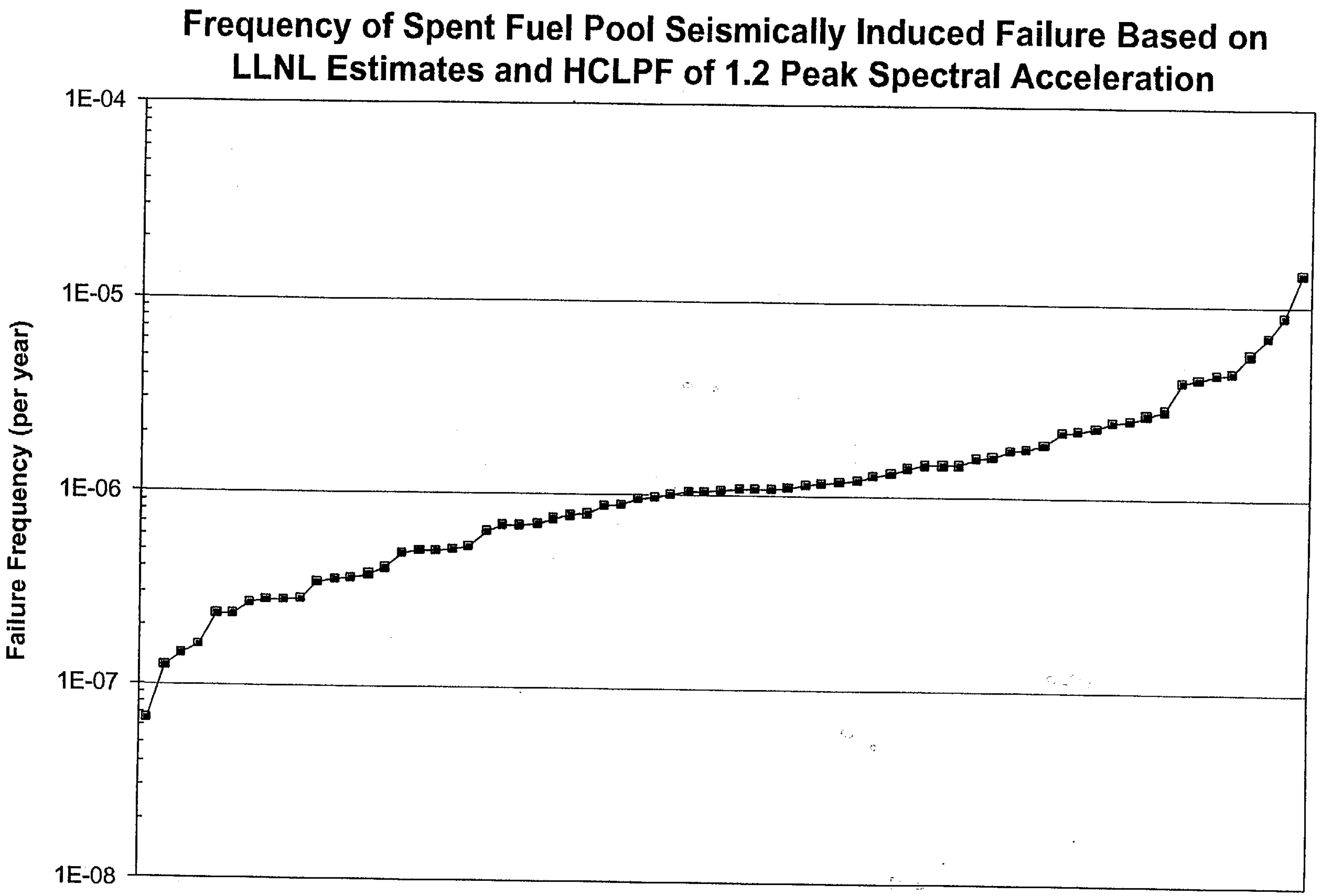
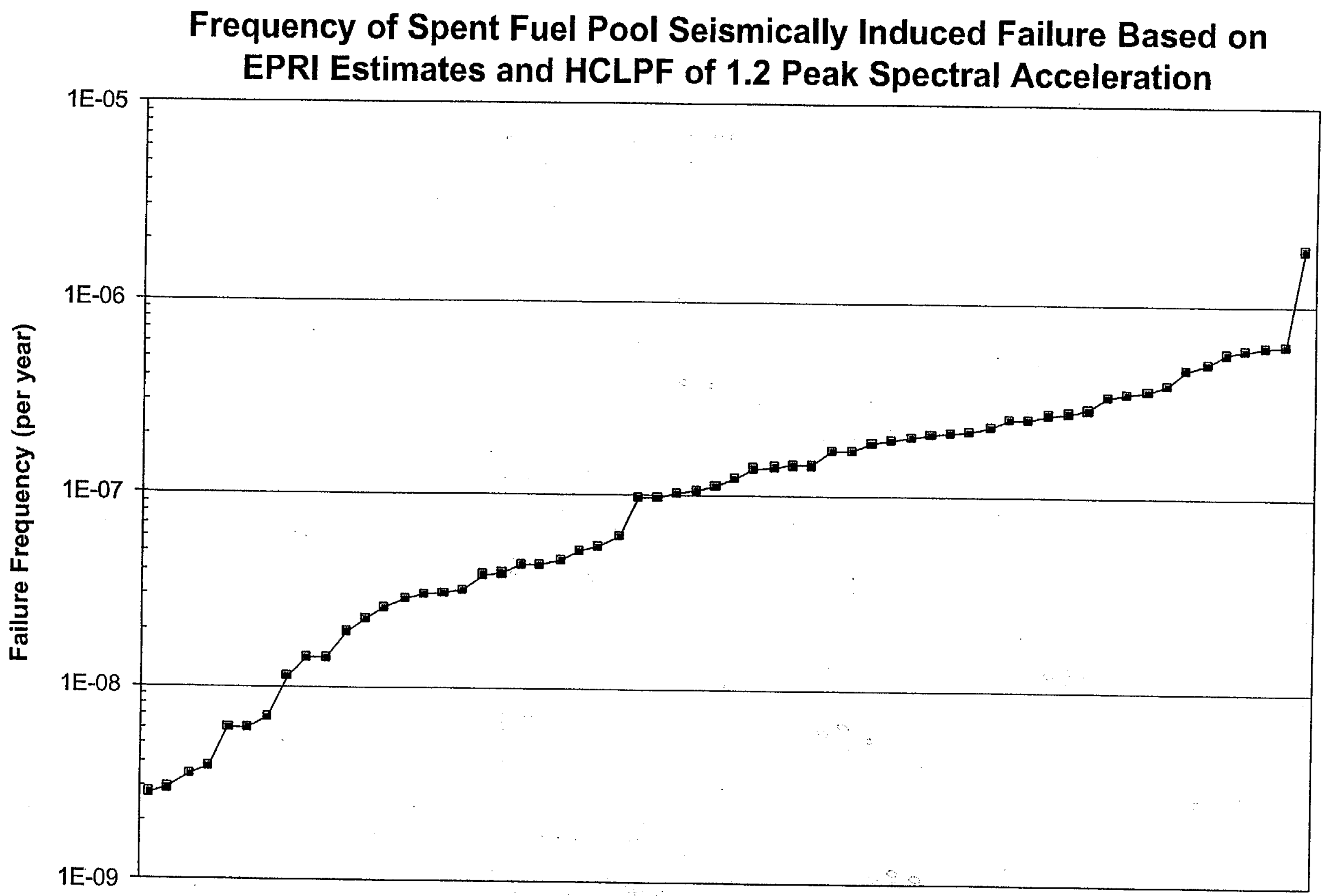

Frequency of Spent Fuel Pool Seismically Induced Failure Based on LLNL Estimates and HCLPF of 1.2 Peak Spectral Acceleration
Failure Frequency (per year)
1E-04
1E-05
1E-06
1E-07
1E-08

Figure 3.2



Frequency of Spent Fuel Pool Seismically Induced Failure Based on EPRI Estimates and HCLPF of 1.2 Peak Spectral Acceleration
1E-05
1E-06
1E-07
1E-08
1E-09
Failure Frequency (per year)

Figure 3.3

3.5.2 Aircraft Crashes

The staff evaluated the likelihood that an aircraft crashing into a nuclear power plant site would seriously damage the spent fuel pool or its support systems (details are in Appendix 2D). The generic data provided in DOE-STD-3014-96 (Ref. 6) was used to assess the likelihood of an aircraft crash into or near a decommissioning spent fuel pool. Aircraft damage can affect the structural integrity of the spent fuel pool or the availability of nearby support systems, such as power supplies, heat exchangers, or water makeup sources, and may also affect recovery actions. There are two approaches to evaluating the likelihood of an aircraft crash into a structure. The first is the point target model, which uses the area (length times width) of the target to determine the likelihood that an aircraft will strike the target. The aircraft itself does not have real dimensions in this model. In the second approach, the DOE model modifies the point target approach to account for the wing span and the skidding of the aircraft after it hits the ground by including the additional area the aircraft could cover. The DOE model also takes into account the plane's glide path by introducing the height of the structure into the equation, which effectively increases the area of the target.

In estimating the frequency of catastrophic PWR spent fuel pool damage from an aircraft crash (i.e., the pool is so damaged that it rapidly drains and cannot be refilled from either onsite or offsite resources), the staff uses the point target area model and assumes a direct hit on a 100 x 50 foot spent fuel pool. Based on studies in NUREG/CR-5042, "Evaluation of External Hazards to Nuclear Power Plants in the United States," it is estimated that 1 of 2 aircrafts are large enough to penetrate a 5-foot-thick reinforced concrete wall. The conditional probability that a large aircraft crash will penetrate a 5-foot-thick reinforced concrete wall is taken as 0.45 (interpolated from NUREG/CR-5042). It is further estimated that 1 of 2 crashes damage the spent fuel pool enough to uncover the stored fuel (for example, 50 percent of the time the location of the damage is above the height of the stored fuel). The estimated range of catastrophic damage to the spent fuel pool resulting in uncovery of the spent fuel is 1.3×10^{-11} to 6.0×10^{-8} per year. The mean value is estimated to be 4.1×10^{-9} per year. The frequency of catastrophic BWR spent fuel pool damage resulting from a direct hit by a large aircraft is estimated to be the same as for a PWR. Mark-I and Mark-II secondary containments generally do not appear to have any significant structures that might reduce the likelihood of aircraft penetration, although a crash into 1 of 4 sides of a BWR secondary containment may be less likely to penetrate because other structures are in the way of the aircraft. Mark-III secondary containments may reduce the likelihood of penetration somewhat, since the spent fuel pool may be protected on one side by additional structures. If instead of a direct hit, the aircraft skids into the pool or a wing clips the pool, catastrophic damage may not occur. The staff estimates that skidding aircraft are negligible contributors to the frequency of fuel uncovery resulting from catastrophic damage to the pool because skidding decreases the impact velocity. The estimated frequencies of aircraft-induced catastrophic spent fuel pool failure are bounded by other initiators.

The staff estimated the frequency of significant damage to spent fuel pool support systems (e.g., power supply, heat exchanger, makeup water supply) for three different situations. The first case is based on the DOE model including the glide path and the wing and skid area and assumes a structure 400 x 200 x 30 feet (i.e., the large building housing the support systems) with a conditional probability of 0.01 that one of these systems is hit (the critical system occupies a 30 x 30 x 30 foot cube within the large building). This model accounts for damage from the aircraft (including, for example, being clipped by a wing). The estimated frequency range for significant damage to the support systems is 1.0×10^{-10} to 1.0×10^{-6} per year. The mean value is estimated to be 7.0×10^{-8} per year. The second case estimates the value for the loss of a support system (power supply, heat exchanger or makeup water supply). Based on the DOE model including the glide path and the wing and skid area this case assumes a 10 x 10 x 10 foot structure (i.e., the support systems are housed in a small building). The estimated frequency of support system damage ranges from 1.1×10^{-9} to 1.1×10^{-5} per year, with the mean estimated to be 7.3×10^{-7} per year. The third case uses the point model for this 10x10 structure, and the estimated value range is 2.4×10^{-12} to 1.1×10^{-8} per year, with the mean estimated to be 7.4×10^{-10} per year. Depending on the model used and the target structure size, the mean value for an aircraft damaging a support system is 7×10^{-7} per year or less. This is not the estimated frequency of fuel uncovery or a zirconium fire caused by damage to the support systems, since the frequency estimate does not include recovery, either on site or off site. As an initiator of failure of a support system leading to fuel uncovery and a zirconium fire, an aircraft crash is bounded by other more probable events. Recovery of the support system will reduce the likelihood of spent fuel uncovery.

Overall, the likelihood of significant spent fuel pool damage from aircraft crashes is bounded by other more likely catastrophic spent fuel pool failure and loss of cooling modes.

3.5.3 Tornadoes and High Winds

The staff performed a risk evaluation of tornado threats to spent fuel pools (details are in Appendix 2E). The staff assumed that very severe tornadoes (F4 to F5 tornadoes on the Fujita scale) would be required to cause catastrophic damage to a PWR or BWR spent fuel pool. These tornados have wind speeds that result in damage characterized as "devastating" or "incredible." The staff then looked at the frequency of such tornadoes and the conditional probability that if such a tornado hit the site, it would seriously damage the spent fuel pool. To do this the staff examined the frequency and intensity of tornadoes the continental United States, using the methods described in NUREG/CR-2944 (Ref. 7). The frequency of an F4 to F5 tornado is estimated to be 5.6×10^{-7} per year for the Central United States, with a U.S. average value of 2.2×10^{-7} per year.

The staff then considered what level of damage an F4 or F5 tornado could do to a spent fuel pool. Based on the buildings housing the spent fuel pools and the thickness of the spent fuel pools themselves, the conditional probability of catastrophic failure given a tornado missile is very low. Hence, the overall frequency of catastrophic pool failure caused by a tornado is extremely low (i.e., the calculated frequency of such an event is less than 1×10^{-9} per year).

It was assumed that an F2 to F5 tornado would be required to significantly damage SFP support systems (e.g., power supply, cooling pumps, heat exchanger, or makeup water supply). These tornados have wind speeds that result in damage characterized as "significant," "severe," or "worse." The frequency of an F2 to F5 tornado is estimated to be 1.5×10^{-5} per year for the Central United States, with a U.S. average value of 6.1×10^{-6} per year. This is not the estimated frequency of fuel uncovery or a zirconium fire caused by damage to the support systems, since the frequency estimate does not include recovery, either on site or off site. As an initiator of failure of a support system leading to fuel uncovery and a zirconium fire, a tornado is bounded by other more probable events. Recovery of the support system(s) will reduce the likelihood of spent fuel uncovery.

Missiles generated by high winds (for example, straight winds or hurricanes) are not as powerful as those generated by tornados. Therefore high winds are estimated to have a negligible impact on the frequency of catastrophic failure of the SFP resulting in fuel uncovery. Long-term loss of offsite power due to straight winds is evaluated in Section 3.4.4.

The staff estimated the frequency of significant damage to SFP support systems from straight-line winds to be very low. Damage was assumed to be caused by building collapse. Based on the construction requirements for secondary containments, the staff believes that the buildings containing BWR spent fuel pools are sufficiently robust that straight line winds will not challenge the integrity of the building. The staff assumes buildings covering PWR spent fuel pools have a concrete foundation that extends part way up the side of the building. The exterior of the rest of the building has a steel frame covered by corrugated steel siding. The PWR spent fuel buildings are assumed to be constructed to American National Standards Institute (ANSI) or American Society of Civil Engineers (ASCE) standards. Based on these assumptions, the staff believes that straight-line winds will cause buildings housing PWR spent fuel pools to fail at a frequency of 1×10^{-3} per year or less. This failure rate for support systems is subsumed in the initiating event frequency for loss of offsite power from severe weather events. The event tree for this initiator takes into account the time available for recovery of spent fuel pool cooling (approximately 195 hours for 1-year old PWR fuel and 253 hours for 1-year-old BWR fuel).

3.6 Criticality in Spent Fuel Pool

In Appendix 3, the staff performed an evaluation of the potential scenarios that could lead to criticality and identified those that are credible.

In this section the staff gives its qualitative assessment of risk due to criticality in the SFP, concluding that, with the additional assumptions, the potential risk from SFP criticality is small.

Appendix 3 references the NRC staff report "Assessment of the Potential for Criticality in Decommissioned Spent Fuel Pools." The assessment identified two credible scenarios listed below:

(1) A compression or buckling of the stored assemblies from the impact of a dropped heavy load (such as a fuel cask) could result in a more optimum geometry (closer spacing) and thus create the potential for criticality. Compression is not a problem for high-density PWR or BWR racks because they have sufficient fixed neutron absorber plates to mitigate any reactivity increase, nor is it a problem for low-density PWR racks if soluble boron is credited. But compression of a low-density BWR rack could lead to a criticality since BWR racks contain no soluble or solid neutron-absorbing material. This is not a surprising result since low-density BWR fuel racks use geometry and fuel spacing as the primary means of maintaining subcriticality. High-density racks rely on both fixed neutron absorbers and geometry to control reactivity. Low-density racks rely solely upon geometry for reactivity control. In addition, all PWR pools are borated, whereas BWR pools contain no soluble

neutron-absorbing material. If BWR pools were borated, criticality would not be possible during a low-density rack compression event.

(2) If the stored assemblies are separated by neutron absorber plates (e.g., Boral or Boraflex), loss of these plates could result in a potential for criticality for BWR pools. For PWR pools, the soluble boron in the fuel pool water is sufficient to maintain subcriticality. The absorber plates are generally enclosed by cover plates (stainless steel or aluminum alloy). The tolerances of cover plates tend to prevent any appreciable fragmentation and movement of the enclosed absorber material. The total loss of the welded cover plate is not considered feasible.

Boraflex has been found to degrade in spent fuel pools because of gamma radiation and exposure to the wet pool environment. For this reason, the NRC issued Generic Letter 96-04 on Boraflex degradation in spent fuel storage racks to all holders of operating licenses. Each addressee that uses Boraflex was requested to assess the capability of the Boraflex to maintain a 5-percent subcriticality margin and to submit to the NRC proposed actions to monitor the margin or confirm that this 5 percent margin can be maintained for the lifetime of the storage racks. Many licensees subsequently replaced the Boraflex racks in their pools or reanalyzed the criticality aspects of their pools, assuming no reactivity credit for Boraflex.

Other potential criticality events, such as events involving loose pellets or the impact of water (adding neutron moderation) during personnel actions in response to accidents, were discounted because the basic physics and neutronic properties of the racks and fuel would prevent criticality conditions from being reached with any credible likelihood. For example, without moderation fuel at current enrichment limits (no greater than 5 wt% U-235) cannot achieve criticality, no matter what the configuration. If it is assumed that the pool water is lost, a reflooding of the storage racks with unborated water may occur during personnel actions. However, both PWR and BWR storage racks are designed to remain subcritical if moderated by unborated water in the normal configuration. Thus, the only potential credible scenarios are the two scenarios described above, which involve crushing of fuel assemblies in low-density racks or degradation of Boraflex over long periods in time. These conclusions assume present light-water uranium oxide reactor fuel designs. Alternative fuel designs, such as mixed oxide (MOX) fuels will have to be reassessed to ensure that additional vulnerabilities for pool criticality do not exist.

To gain qualitative insights on credible criticality events, the staff considered the sequences of events that must occur. For scenario 1, a heavy load drop into a low-density racked BWR pool, compressing the assemblies would be required. From its analysis of the heavy load drop documented in Appendix 2C, the staff has determined the likelihood of a heavy load drop from a single failure-proof crane to have a mean frequency of approximately 9.6×10^{-6} per year, assuming 100 cask movements per year at the decommissioning facility. From the load path analysis done in Appendix 2C, the staff estimates that the load is over or near the pool approximately 13 percent of the movement path length, depending on the plant's layout. The additional frequency reduction in the appendix to account for the fraction of time that the heavy load is lifted high enough to damage the pool liner is not applicable here because the fuel assemblies can be crushed by a smaller impact velocity than required to need to crush the pool liner. Therefore, the staff estimates that the potential initiating frequency for crushing is approximately $1.2X10^{-6}$ per year (based upon 100 lifts per year). The criticality calculations in Appendix 3 show that even if the low-density BWR assemblies were crushed by a transfer cask, it is "highly unlikely" that a configuration would be produced that would result in a severe reactivity event, such as a steam explosion that could damage and drain the spent fuel pool. The staff judges the chances of such a criticality event to be well below 1 chance in 100 even if the transfer cask drops directly onto the assemblies. This would put the significant criticality likelihood well below $1X10^{-8}$ per year.

Deformation of the low-density BWR racks by the dropped transfer cask was shown to most likely not result in any criticality events. However, if some mode of criticality was to be induced by the dropped transfer cask, it would likely be a small return to power for a very localized region, rather than the severe response discussed in the paragraph above. This type of event would have essentially no offsite (or onsite) consequences since the heat of the reaction would be removed by localized boiling in the pool, and water would shield the site operating staff. The reaction could be terminated with relative ease by the addition of boron to the pool. Therefore, the staff believes that qualitative (as well as some quantitative) assessment of scenario 1 demonstrates that it poses no significant risk to the public from SFP operation while the fuel remains stored in the pool.

With respect to scenario 2 (the gradual degradation of the Boraflex absorber material in high-density storage racks), there is currently insufficient data to quantify the likelihood of criticality due to the degradation. However, the current programs in place at operating plants to assess the condition of the Boraflex and take remedial action if necessary provide sufficient confidence that pool reactivity requirements will be satisfied. In order to meet the RG 1.174 safety principle of maintaining sufficient safety margins, the staff judges that continuation of such programs into the decommissioning phase should be considered at all plants until all high-density racks are removed from the SFP. As such, SDA #7 should be considered in future regulatory activities associated with SFP requirements. This additional assumption is identified as SDA #7.

SDA #7 Licensees will maintain a program to provide surveillance and monitoring of Boraflex in high-density spent fuel racks until such time as spent fuel is no longer stored in these high-density racks.

Based upon the above conclusions and the staff decommissioning assumption, the staff believes that qualitative risk insights demonstrate conclusively that SFP criticality poses no meaningful risk to the public.

3.7 Consequences and Risks of SFP Accidents

This section assesses the consequences and risks associated with SFP accidents. The consequences are assessed in Section 3.7.1. Results are provided for both early evacuation and late evacuation cases[12] to address the impact of evacuation on consequences, and for two

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[12] Early evacuation is initiated and completed before the SFP release. Late evacuation is not completed before release.

different source terms to show the impact of source term uncertainties on results. In Section 3.7.2, the severe accident consequences for either the early or late evacuation cases are assigned to each of the major types of SFP accidents, as appropriate, and then combined with the respective event frequencies to provide a scoping estimate of SFP risks. The risks of SFP accidents are shown to meet the Commission's safety goals. The impact of changes in EP regulations on these risk measures is discussed later in Section 4.

3.7.1 Consequences of SFP Accidents

Earlier analyses in NUREG/CR-4982, "Severe Accidents in Spent Fuel Pools in Support of Generic Issue 82," and NUREG/CR-6451, "A Safety and Regulatory Assessment of Generic BWR and PWR Permanently Shutdown Nuclear Power Plants," included a limited analysis of the offsite consequences of a severe SFP accident occurring up to 90 days after the last discharge of spent fuel into the SFP. The analysis showed that the consequences of an SFP accident could be comparable to those for a severe reactor accident. As part of its effort to develop generic, risk-informed requirements for decommissioning, the staff performed a further analysis of the offsite radiological consequences of beyond-design-basis SFP accidents. Varying the evaluation and other modeling assumptions, the staff performed an initial set of calculations to extend the earlier analyses to SFP accidents occurring 1 year after plant shutdown and to supplement the earlier analyses with additional sensitivity studies. The results of these calculations were documented in the February 2000 study, and are provided in Appendix 4.

Subsequently, the ACRS raised issues with the source term and plume modeling for SFP accidents. In particular, the ACRS believed that the ruthenium and fuel fines releases were too low and the plume was too narrow. To address these issues, the staff performed additional sensitivity studies, as documented in Appendix 4A of this study.

To provide insight into the impact on results of decay times shorter or longer than 1 year, additional consequence calculations were performed using fission product inventories at 30 and 90 days and 2, 5, and 10 years after final shutdown. The results of these consequence calculations were used as the basis for assessing the risk from SFP accidents. These results are summarized in Tables 3.7-1 and 3.7-2 for several key consequence measures, and are described in more detail in Appendix 4B. These consequences are conditional upon the occurrence of an accident that results in an SFP fire, i.e., the consequences are on a "per event" rather than a "per year," basis and do not account for the probability of the event.

These calculations were based on the Surry site, although the SFP accident consequences could be greater at higher population sites, the quantitative health objectives used in comparisons to the Commission's Safety Goals (see Section 3.7.3) represent risk to the average individual within 1 mile and 10 miles of the plant, and should be relatively insensitive to the site specific population.

Table 3.7-1 Consequences of an SFP Accident With a High Ruthenium Source Term (per event)

Time After Shutdown	Mean Consequences for High Ruthenium Source Term (Surry population, 95% evacuation)			
	Early Fatalities	Societal Dose (p-rem within 50 miles)	Individual Risk* of Early Fatality (within 1mile)	Individual Risk* of Latent Cancer Fatality (within 10 miles)
Late Evacuation				
30 days	192	2.37×10^{7}	4.43×10^{-2}	8.24×10^{-2}
90 days	162	2.25×10^{7}	4.19×10^{-2}	8.20×10^{-2}
1 year	77	1.93×10^{7}	3.46×10^{-2}	8.49×10^{-2}
2 years	19	1.69×10^{7}	2.57×10^{-2}	8.42×10^{-2}
5 years	1	1.45×10^{7}	8.96×10^{-2}	7.08×10^{-2}
10 years	-	1.34×10^{7}	4.68×10^{-2}	6.39×10^{-2}
Early Evacuation				
30 days	7	1.35×10^{7}	2.01×10^{-3}	4.79×10^{-3}
90 days	4	1.29×10^{7}	1.87×10^{-3}	4.77×10^{-3}
1 year	1	1.12×10^{7}	1.50×10^{-3}	4.33×10^{-3}
2 years	-	9.93×10^{6}	1.12×10^{-3}	3.70×10^{-3}
5 years	-	8.69×10^{6}	3.99×10^{-4}	2.93×10^{-3}
10 years	-	8.13×10^{6}	2.05×10^{-4}	2.64×10^{-3}

* Conditional on event - Total frequency for all events is shown in Table 3.1 as less than 3×10^{-6} per year.

Table 3.7-2 Consequences of an SFP Accident With a Low Ruthenium Source Term (per event)

Time After Shutdown	Mean Consequences for Low Ruthenium Source Term (Surry population, 95% evacuation)			
	Early Fatalities	Societal Dose (p-rem within 50 miles)	Individual Risk* of Early Fatality (within 1mile)	Individual Risk* of Latent Cancer Fatality (within 10 miles)
Late Evacuation				
30 days	2	5.58×10^6	1.27×10^{-2}	1.88×10^{-2}
90 days	1	5.43×10^6	9.86×10^{-3}	1.82×10^{-2}
1 year	1	5.28×10^6	7.13×10^{-3}	1.68×10^{-2}
2 years	-	5.12×10^6	5.64×10^{-3}	1.58×10^{-2}
5 years	-	4.90×10^6	3.18×10^{-3}	1.43×10^{-2}
10 years	-	4.72×10^6	1.63×10^{-3}	1.29×10^{-2}
Early Evacuation				
30 days	-	4.12×10^6	8.36×10^{-4}	9.92×10^{-4}
90 days	-	4.02×10^6	6.83×10^{-4}	9.62×10^{-4}
1 year	-	3.95×10^6	5.44×10^{-4}	9.09×10^{-4}
2 years	-	3.87×10^6	4.41×10^{-4}	8.71×10^{-4}
5 years	-	3.77×10^6	2.54×10^{-4}	8.14×10^{-4}
10 years	-	3.69×10^6	1.47×10^{-4}	7.70×10^{-4}

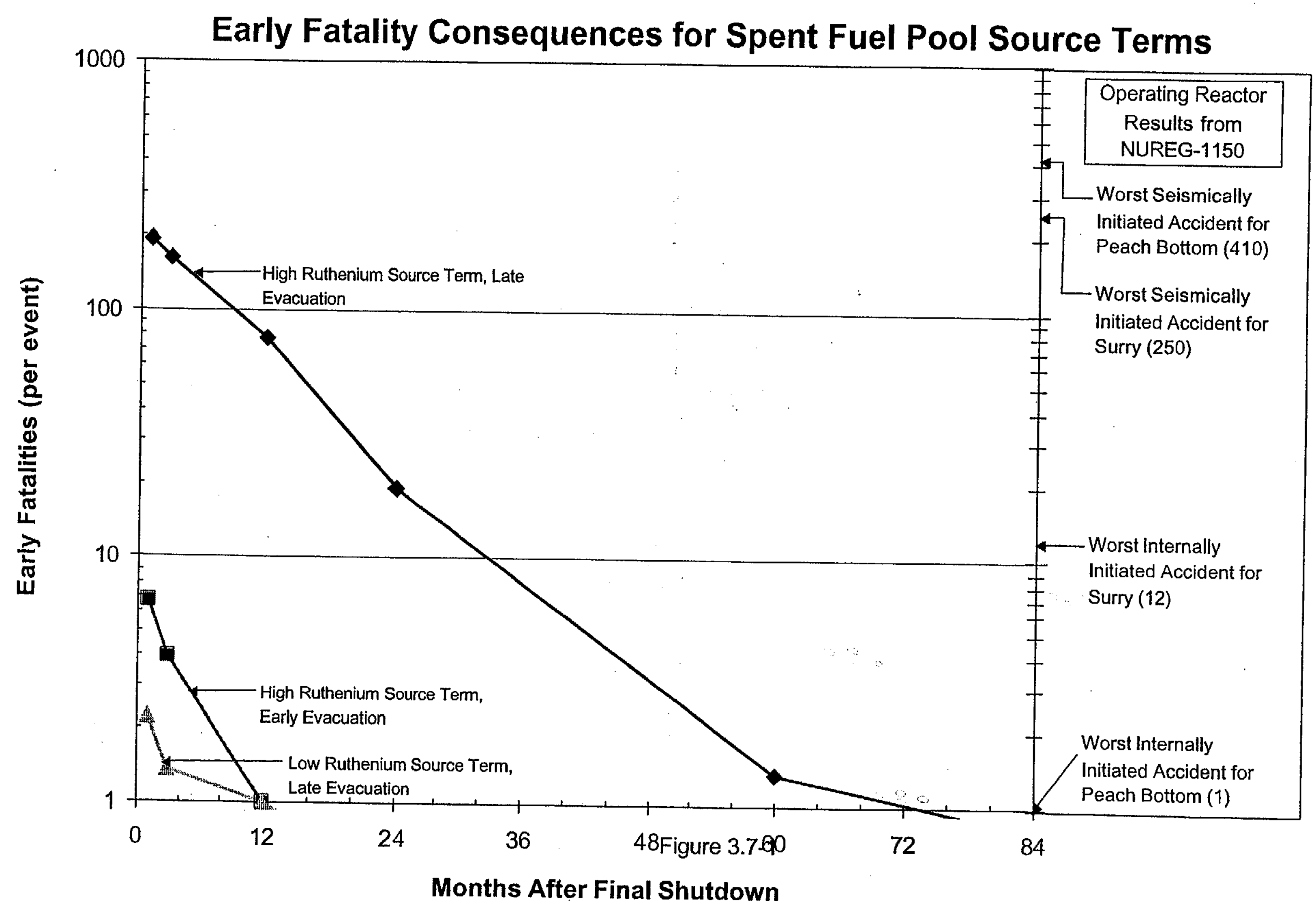
* Conditional on event - Total frequency for all events is shown in Table 3.1 as less than 3×10^{-6} per year.

The consequences in Table 3.7-1 are based on the upper bound source term described in Appendix 4B. With the exception of ruthenium and fuel fines, the release fractions are from NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants" (Ref. 1), and include the ex-vessel and late in-vessel phase releases. The ruthenium release fraction is for a volatile fission product in an oxidic (rather than metallic) form. This is consistent with the experimental data reported in Reference 8. The source term is considered to be bounding for several reasons. First, rubbling of the spent fuel after heatup to about 2500 °K is expected to limit the potential for ruthenium release to a value less than that for volatile fission products. Second, following the Chernobyl accident, ruthenium in the environment was found to be in the metallic form (Ref. 2). Metallic ruthenium (Ru-106) has about a factor of 50 lower dose conversion factor (rem per Curie inhaled) than the oxidic ruthenium assumed in the Melcor Accident Consequence Code System (MACCS) calculations. Finally, the fuel fines release fraction is that from the Chernobyl accident (Ref. 3). This is considered to be bounding because the Chernobyl accident involved more extreme conditions (i.e., two explosions followed by a prolonged graphite fire) than an SFP accident. In subsequent discussions, this source term is referred to as the high ruthenium source term.

The consequences obtained using the source term in NUREG-1465 (which treats ruthenium as a less volatile fission product) in conjunction with SFP fission product inventories are provided in Table 3.7-2 for comparison. In subsequent discussions, this source term is referred to as the low ruthenium source term.

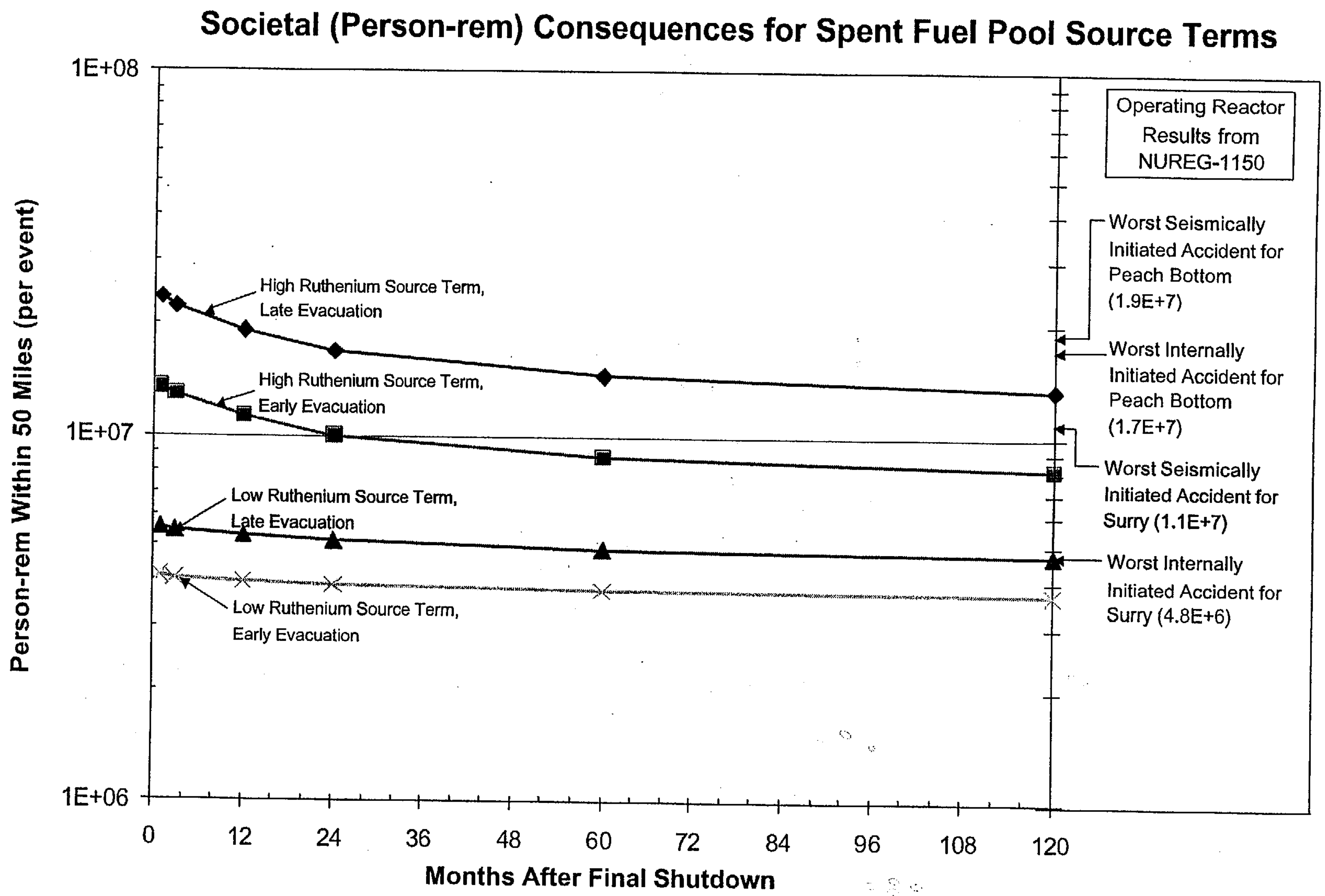
The consequence calculations for both the high and low ruthenium source terms assume that all of the fuel assemblies discharged in the final core off-load and the previous 10 refueling outages participate in the SFP fire. These assemblies are equivalent to about 3.5 reactor cores. Approximately 85 percent of all the ruthenium in the pool is in the last core off-loaded since the ruthenium-106 half-life is about 1 year. For cesium-137, with a 30-year half-life, the inventory decays very slowly and is abundant in all of the batches considered. The staff assumed that the number of fuel assemblies participating in the SFP fire remains constant and did not consider the possibility that fewer assemblies might be involved in an SFP fire in later years because of substantially lower decay heat in the older assemblies. Based on the limited analyses performed to date, fire propagation is expected to be limited to less than two full cores 1 year after shutdown (see Appendix 1A). Thus, the assumption that 3.5 cores participate adds some conservatism to the calculation of long-terms effects associated with cesium, but is not important with regard to the effects of ruthenium.

The results for early fatality and societal dose (person-rem) consequences for an SFP accident are graphed in Figures 3.7-1 and 3.7-2. The early fatality plots are truncated at a value of one early fatality since fractions of a fatality are not meaningful. Since no early fatalities were predicted for the low ruthenium source term with early evacuation, a curve is not shown for that case in Figure 3.7-1. Because latent cancer fatalities are directly proportional to societal dose through a dose-to-cancer-risk conversion factor within the MACCS2 consequence code (Ref. 9), results for latent cancer fatalities are not displayed separately.



Early Fatality Consequences for Spent Fuel Pool Source Terms
Early Fatalities (per event)
1000
100
10
1
0
12
24
36
48
60
72
84
Months After Final Shutdown
High Ruthenium Source Term, Late Evacuation
High Ruthenium Source Term, Early Evacuation
Low Ruthenium Source Term, Late Evacuation
Operating Reactor Results from NUREG-1150
Worst Seismically Initiated Accident for Peach Bottom (410)
Worst Seismically Initiated Accident for Surry (250)
Worst Internally Initiated Accident for Surry (12)
Worst Internally Initiated Accident for Peach Bottom (1)

Figure 3.7-1



Societal (Person-rem) Consequences for Spent Fuel Pool Source Terms
1E+08
1E+07
1E+06
Person-rem Within 50 Miles (per event)
0
12
24
36
48
60
72
84
96
108
120
Months After Final Shutdown
High Ruthenium Source Term, Late Evacuation
High Ruthenium Source Term, Early Evacuation
Low Ruthenium Source Term, Late Evacuation
Low Ruthenium Source Term, Early Evacuation
Operating Reactor Results from NUREG-1150
Worst Seismically Initiated Accident for Peach Bottom (1.9E+7)
Worst Internally Initiated Accident for Peach Bottom (1.7E+7)
Worst Seismically Initiated Accident for Surry (1.1E+7)
Worst Internally Initiated Accident for Surry (4.8E+6)

Figure 3.7-2

Consequence estimates are also included on Figures 3.7-1 and 3.7-2 for the two operating reactors for which risk results for both internal and seismic events are available in NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," and the supporting NUREG/CR-4551 reports, "Evaluation of Severe Accident Risks: Surry Unit 1" and "Evaluation of Severe Accident Risks: Peach Bottom, Unit 2." The values shown are for the reactor accident source terms that produced the greatest number of early fatalities (Figure 3.7-1) or the greatest societal dose and latent cancer fatalities (Figure 3.7-2). Results are displayed separately for internally and seismically initiated accidents and indicate that for these plants, reactor accident consequences for seismically initiated events are substantially higher than those for internally initiated events. Although the consequences for the high ruthenium source term diminish more quickly than for the low ruthenium source term, these curves do not converge because of the long half-lives of the fuel fines in the high ruthenium source term.

An examination of Figure 3.7-1 indicates the following:

- Early fatality consequences for spent fuel pool accidents can be as large as for a severe reactor accident even if the fuel has decayed several years. This is attributable to the significant health effect of ruthenium, and the ruthenium-106 half-life of about 1 year. There is also an important but lesser contribution from cesium.
- A large ruthenium release fraction is important to consequences, but not more important than the consequences of a reactor accident large early release.
- The effect of early evacuation (if possible) is to offset the effect of a large ruthenium release fraction. This effect is comparable to that for reactor accidents.
- For the low ruthenium source term, no early fatality is expected after 1 year decay even with late evacuation.

For the longer term consequences Figure 3.7-2 indicates:

- Long-term consequences remain significant as long as a fire is possible. These consequences are due primarily to the effect of cesium-137, which remains abundant even in significantly older fuel because of its long (30-year) half-life. Ruthenium and evacuation have notable long-term consequences but do not change the conclusion.

3.7.2 Risk Modeling for SFP Accidents

The quantitative assessment of risk involves combining the estimated frequencies of severe accident sequences with their corresponding offsite consequences. In this section, severe accident consequences reported in Tables 3.7-1 and 3.7-2 are assigned to each of the major types of events that lead to uncovery of the spent fuel, and then combined with the respective event frequencies to provide a scoping estimate of SFP risks.

The SFP accidents discussed in Section 3 can be broadly classified as either boildown or rapid draindown sequences. Rapid draindown sequences are further divided into seismically- and non-seismically-initiated events. In assigning consequences to each of these events, the staff considered whether protective measures to evacuate the population around the site could be effectively implemented before fission product release. This included consideration of the effectiveness of offsite notification, the delay between event initiation and fission product release (dependent on time after shutdown), the time required to initiate and complete an evacuation, and the impact that a relaxation in current emergency planning requirements might have on these factors. As a result of this assessment, consequences were assigned based on either the early evacuation case or late evacuation case.

The frequency and consequence modeling is briefly described below for each type of SFP accident. The resulting risk estimates for each sequence (in terms of early fatalities and societal dose per year) are presented in Figures 3.7-3 through 3.7-6 and discussed in Section 3.7.3.

Boil Down Sequences

Boil down sequences (including loss of inventory events) and their associated frequencies are listed in Table 3.7-3. These sequences involve heatup of the pool to boiling followed by gradual reduction in pool level until the spent fuel is eventually uncovered. This process would take over 100 hours at 60 days, and substantially longer at later times as shown in Table 2.1. The long delay provides sufficient time for licensee staff to effectively intervene in the large majority of these events, and results in very low frequencies of fuel uncovery. For those events that proceed to fuel uncovery, fuel heatup will continue until either steady-state conditions are achieved or cladding oxidation occurs. All boil down sequences that uncover spent fuel were assumed to result in an SFP fire. Loss of inventory events are classified as boil down events since the time to uncover the fuel will be in excess of 24 hours (as described in Section 4.5.4.1 of Appendix 2A) and will provide ample time for licensee to take corrective measures.

Table 3.7-3 Frequency of Boil Down Events Leading to Spent Fuel Uncovery (for times greater than 60 days after shutdown)

Initiating Event	Frequency (per year)
Loss of offsite power—severe weather	1.1×10^{-7}
Loss of offsite power—plant-centered and grid-related events	2.9×10^{-8}
Internal fire	2.3×10^{-8}
Loss of pool cooling	1.4×10^{-8}
Loss of coolant inventory	3.0×10^{-9}
Total	1.8×10^{-7}

The failure paths leading to a zirconium fire involve failure to acquire offsite resources to makeup pool inventory, despite the large amount of time available for recovery in the boildown event. For sequences involving loss of offsite power due to severe weather, the weather is assumed to drain regional resources or limit access to the facility. The staff reasoned that if it is difficult for offsite resources to reach the facility or if regional resources are engaged in other efforts, then it would also be unlikely that the population in the area would be effectively notified and/or evacuated under these conditions. For sequences other than loss of off-site power due to severe weather, the dominant reason that recovery is not provided in the failure paths is a general breakdown in the overall facility organization. The failure to acquire offsite resources also implies a failure to contact regional authorities and declare an emergency when the SFP level drops below the proceduralized limit in these sequences. Accordingly, the consequences for boildown sequences are based on results for the late evacuation case (Tables 3.7-1 and 3.7-2). This same reasoning is applied for cases with and without EP relaxations and for all times after shutdown. The net effect is that EP, as well as relaxations in EP, do not impact the risk associated with those boildown sequences that proceed to spent fuel uncovery.

Rapid Draindown Due to Seismic Events

Given the robust structural design of SFPs, it is expected that a seismic event with peak spectral acceleration several times larger than the safe shutdown earthquake (SSE) would be required to produce catastrophic failure of the structure. The estimated frequency of events of this magnitude differs greatly among experts and is driven by modeling uncertainties. The estimated frequency of seismic events sufficiently large to result in structural failure of the SFP is given in Table 3.7-4 and is based on the LLNL and EPRI seismic hazard estimates.

Both the LLNL and EPRI hazard estimates were developed as best estimates and are considered valid by the NRC. Furthermore, because both sets of curves are based upon data extrapolation and expert opinion, there is no technical basis for excluding consideration of either set.

Using the LLNL hazard estimates, a return frequency equivalent to the pool performance guideline ($1x10^{-5}$ per year) for a 1.2g peak spectral acceleration (PSA) ground motion bounds all but four sites (one Central and Eastern and three Western U.S. sites). The frequency for the remaining sites falls in the range of less than $7x10^{-8}$ per year to $9x10^{-6}$ per year. The majority (45 sites) have hazard estimates (for a 1.2 PSA ground motion) near $1x10^{-6}$ per year and 20 sites fall below $6x10^{-7}$ per year. The mean value for the population of plants is approximately $2x10^{-6}$ per year.

If EPRI hazard estimates were used, only one site would have an estimate that exceeds $1x10^{-6}$ per year (excluding Western sites).[13] Ten sites are near $5x10^{-7}$ per year, and the remaining 49 sites analyzed by EPRI have estimates less than $3x10^{-7}$ per year, with half of these sites (25 sites) estimated at less than $7x10^{-8}$ per year. The mean value for the population of plants is approximately $2x10^{-7}$ per year.

In characterizing the risk of seismically induced SFP accidents for the population of sites, the staff has displayed results based on both the LLNL and the EPRI hazard estimates, and has used an accident frequency corresponding to the mean value for the respective distributions,

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[13]EPRI seismic estimates were not developed for all sites east of the Rocky Mountains. Six sites have LLNL but no EPRI hazard estimates.

i.e., a frequency of 2×10^{-6} per year to reflect the use of the LLNL hazard estimates and a frequency of 2×10^{-7} per year to reflect use of the EPRI hazard estimates. Use of the mean value facilitates comparisons with the Commission's quantitative safety goals and quantitative health objectives (QHOs). About 70 percent of the sites are bounded using the mean value.

Table 3.7-4 Mean Frequency of Rapid Draindown Due to Seismic Events

Source of Hazard Estimate	Frequency (per year)
LLNL	2×10^{-6}
EPRI	2×10^{-7}

Likely SFP failure modes and locations are discussed in Attachment 2 to Appendix 2B. The conclusion is that drainage of the pool would be fairly rapid and a small amount of water is likely to remain in the pool, with post-seismic-failure, water depths ranging from about zero to about 4 feet depending upon the critical failure mode. For purposes of consequence assessment, all seismically initiated sequences were assumed to result in a rapid draindown followed by an SFP fire, regardless of the SFP failure mode and location, which are plant-specific.

The SFP risk estimates are strongly dependent on the assumptions about the effectiveness of emergency evacuation in seismic events, since these events dominate the SFP fire frequency. In NUREG-1150, evacuation in seismic events was treated in either of two ways, depending on the peak ground acceleration (PGA) of the earthquake:

- For low PGA earthquakes, the population was assumed to evacuate; however, the evacuation was assumed to start later and proceed more slowly than evacuation for internally initiated events.
- For high PGA earthquakes, it was reasoned that there would be no effective evacuation and that many structures would be uninhabitable.

Since the seismic contribution to SFP fire frequency is driven by events with ground motion several times larger than the SSE, the reasoning that there would be no effective evacuation was adopted in developing the seismic contribution to the risk. This is consistent with the expert opinion provided in Attachment 2 to Appendix 2B about the expected level of collateral damage within the emergency planning zone in a seismic event large enough to cause the SFP failure. Specifically, for ground motion levels that correspond to SFP failure in the Central and Eastern United States, it is expected that electrical power would be lost and more than half of the bridges and buildings (including those housing communication systems and emergency response equipment) would be unsafe even for temporary use within at least 10 miles of the plant. This approach is also consistent with previous Commission rulings on San Onofre and Diablo Canyon in which the Commission found that for those risk-dominant earthquakes that cause very severe damage to both the plant and the offsite area, emergency response would have marginal benefit because of offsite damage.

The consequences for seismic sequences are therefore based on results for the late evacuation cases in Tables 3.7-1 and 3.7-2. The same reasoning is applied for cases with and without EP relaxations and for all times after shutdown. The net effect is that EP, as well as relaxations in EP, do not impact the risk associated with seismic events that result in SFP failure. A sensitivity study was also done to explore the impact on risk if the seismic event only partially degrades the emergency response (see Section 4.2.1).

Rapid Draindown Due to Non-Seismic Events

Non-seismically-initiated events leading to rapid draindown are listed in Table 3.7-5. These events are dominated by cask drop accidents, with the next highest contributor nearly two orders of magnitude lower.

Table 3.7-5Frequency of Rapid Draindown Spent Fuel Uncovery Due to Nonseismic Events

Initiating Event	Frequency (per year)
Cask drop	2.0×10^{-7}
Aircraft impact	2.9×10^{-9}
Tornado missile	$<1.0 \times 10^{-9}$
Total	2.0×10^{-7}

Cask drop accidents that lead to catastrophic failure of the SFP include accidents in which the load is dropped either on the pool floor or on or near the pool wall. Load drops on the pool floor are more likely to result in complete draindown of the pool and create an air flow path through the fuel assemblies. Load drops on the pool wall would likely result in residual water in the pool, which would obstruct air flow. For purposes of consequence assessment, all cask drop accidents leading to fuel uncovery were assumed to result in a rapid draindown followed by an SFP fire.

Depending upon the pool failure mode and location, the fuel could be air cooled, or heatup could be close to adiabatic as a result of air flow blockage. As discussed in Appendix 1A for either adiabatic or air flow conditions (at 60 GWD/MTU burnup), the time of fission product release would be about 4 hours for a PWR and 8 hours for a BWR for accidents initiated 1 year following shutdown. For cases with air cooling, close to 1 day is available after 3 years decay. Even with adiabatic heatup, 1 day is available after 5 years of decay. At 60 days after shutdown, fission product release could begin as early as 2 hours after fuel uncovery. The actual time would depend on reactor type, fuel burnup, fuel rack structure, and other plant-specific parameters, as discussed in Appendix 1A. The fuel handlers would be immediately aware of a cask drop accident. It is expected that with procedures that specify the SFP water level at which an emergency is to be declared, the proper offsite authorities would be promptly informed.

For the case in which current EP requirements are retained, it was assumed that cask drop accidents occurring 1 or more years following shutdown would afford sufficient time to implement protective measures before fission products were released. This is consistent with the evacuation time estimates in the NUREG-1150 study for Surry, which assumed a 1.5 hour delay time and a 4 mile per hour evacuation speed. Thus the consequences at less than 1 year following shutdown are based on late evacuation, and the consequences at 1 year and beyond are based on early evacuation when full EP requirements are retained.

Relaxations in EP requirements are expected to result in additional delays in initiation and implementation of protective measures relative to the case in which current EP requirements are retained. If offsite preplanning requirements were to be relaxed, as many as 10 to 15 hours may be required at some sites to initiate an evacuation. Based on either air-cooled or adiabatic heatup rates for the reference pool, the minimum time to fission product release following a load drop that catastrophically damages the pool is about 8–9 hours for PWR pools and about 15 hours for BWR pools 2 years following shutdown (see Appendix 1A). These release times increase significantly by 5 years following shutdown (i.e., greater than 24 hours even with adiabatic heatup rates). For the case in which current EP requirements are relaxed, the consequences within the first 2 years following shutdown are based on late evacuation, and the consequences at 5 years and after are based on the early evacuation results reported in Tables 3.7-1 and 3.7-2.

3.7.3 Risk Results

The frequency and consequences for each SFP accident were combined to provide a scoping estimate of the risk of SFP accidents. The frequency of each event was based on the estimated value at 1 year following shutdown as described above, and was assumed to remain constant over time. In reality, the frequency would vary with time, and could be higher or lower than the 1-year estimate, as a result of plant configuration changes described in Section 3.1 (e.g., replacement of operating plant pool cooling and makeup systems with skid-mounted systems) and reductions in decay heat levels (which would impact human reliability estimates). However, as described in Section 3.4.7, these impacts are not expected to change the insights from the risk assessment for decay times greater than 60 days.

Figures 3.7-3 and 3.7-4 show the total early fatality risk and societal risk as a function of time after final shutdown. Companion curves are provided based on both the LLNL and the EPRI seismic hazard studies since both studies are considered equally valid. The SFP risk results are shown in these figures for both the high ruthenium source term and a fuel burnup of 60 GWD/MTU. Also shown are the corresponding mean risk measures for two operating plants, Surry and Peach Bottom,[14] for which risk results for both internal and seismic events are given in NUREG-1150.

[14] The LLNL seismic risk results reported in NUREG-1150 are based on a 1989 version of the LLNL hazard estimates. An update of these estimates performed in 1993 resulted in a factor of 10 reduction in the LLNL mean hazard for Peach Bottom and a smaller reduction for Surry. To provide a more meaningful comparison, the LLNL seismic risk results for Peach Bottom reported in NUREG-1150 have been reduced by a factor of 10. The results for Surry and the EPRI seismic risk results are not affected by this adjustment.

Figures 3.7-5 and 3.7-6 show the risk contribution from cask drop events, which are the only events modeled that are significantly impacted by EP. For the case in which current EP requirements are retained, the consequences at 1 year and beyond are based on early evacuation (the lower, solid curve). For the case in which current EP requirements are relaxed, the consequences within the first 2 years following shutdown are based on late evacuation (the upper, solid curve), and the consequences at 5 years and beyond are based on early evacuation, as discussed in Section 3.7.2.

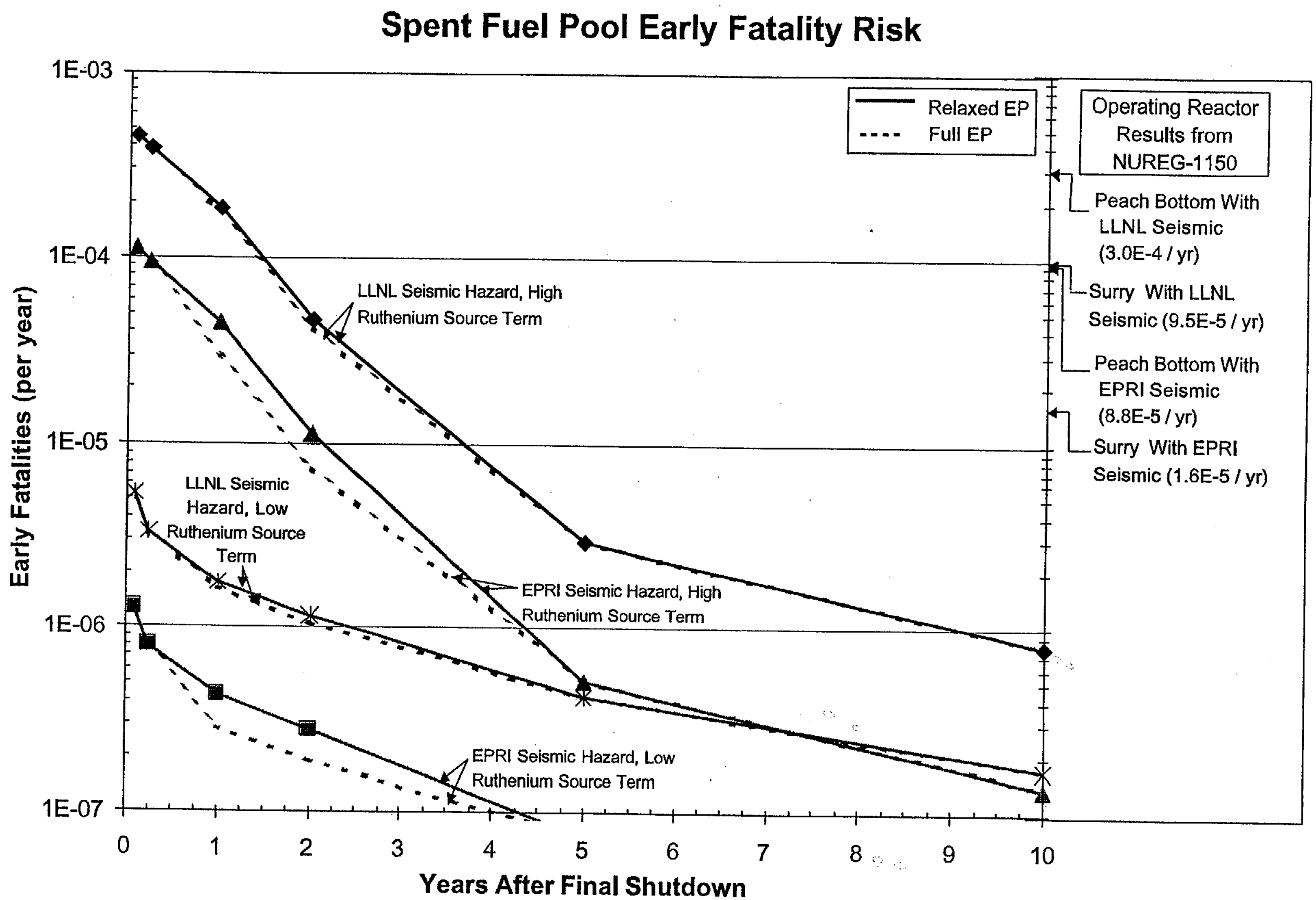
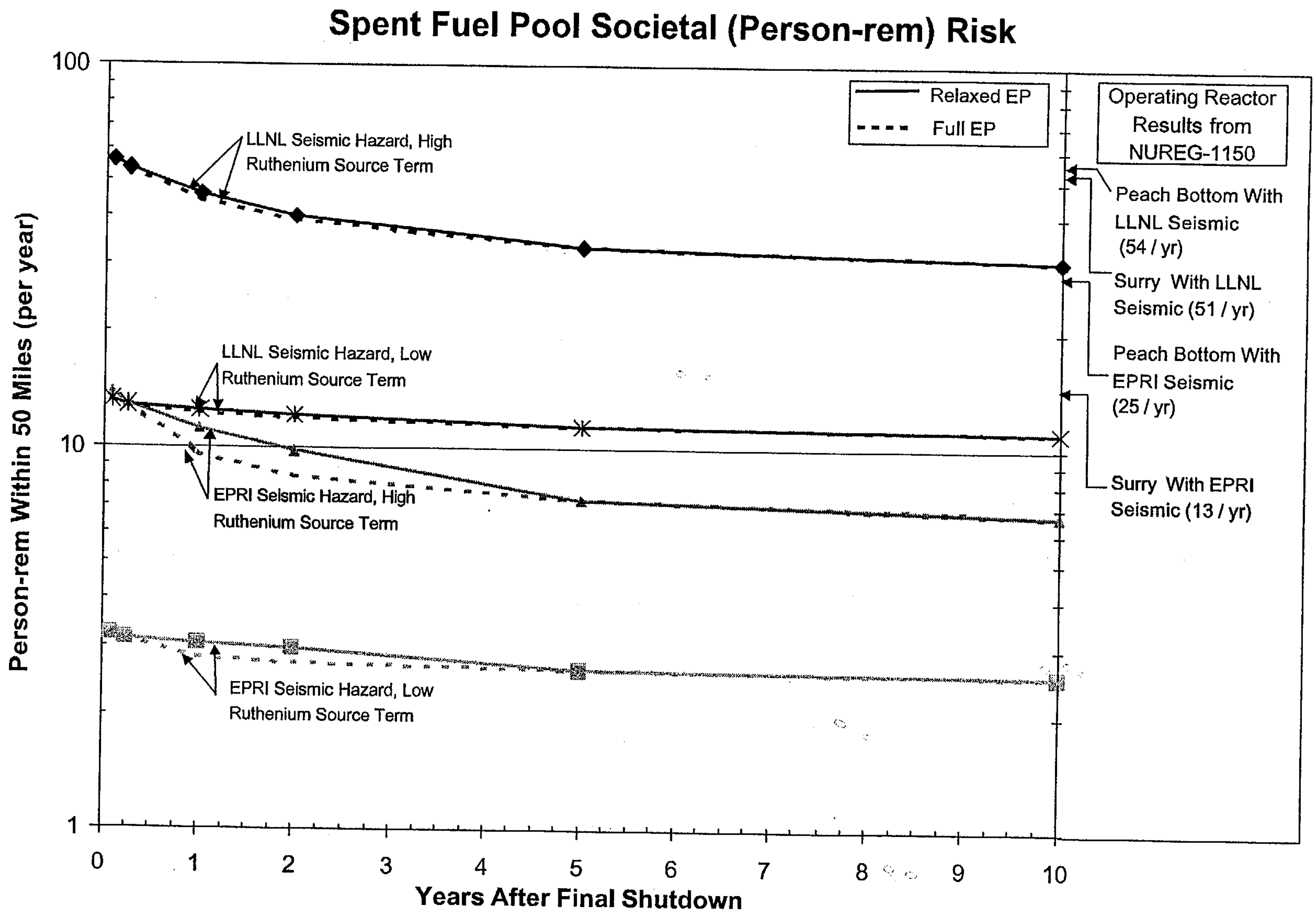

Spent Fuel Pool Early Fatality Risk
1E-03
1E-04
1E-05
1E-06
1E-07
Early Fatalities (per year)
Relaxed EP
Full EP
Operating Reactor Results from NUREG-1150
Peach Bottom With LLNL Seismic (3.0E-4 / yr)
Surry With LLNL Seismic (9.5E-5 / yr)
Peach Bottom With EPRI Seismic (8.8E-5 / yr)
Surry With EPRI Seismic (1.6E-5 / yr)
LLNL Seismic Hazard, High Ruthenium Source Term
LLNL Seismic Hazard, Low Ruthenium Source Term
EPRI Seismic Hazard, High Ruthenium Source Term
EPRI Seismic Hazard, Low Ruthenium Source Term
0
1
2
3
4
5
6
7
8
9
10
Years After Final Shutdown

Figure 3.7-3



Spent Fuel Pool Societal (Person-rem) Risk
Person-rem Within 50 Miles (per year)
Years After Final Shutdown
100
10
1
0
1
2
3
4
5
6
7
8
9
10
Relaxed EP
Full EP
Operating Reactor Results from NUREG-1150
LLNL Seismic Hazard, High Ruthenium Source Term
LLNL Seismic Hazard, Low Ruthenium Source Term
EPRI Seismic Hazard, High Ruthenium Source Term
EPRI Seismic Hazard, Low Ruthenium Source Term
Peach Bottom With LLNL Seismic (54 / yr)
Surry With LLNL Seismic (51 / yr)
Peach Bottom With EPRI Seismic (25 / yr)
Surry With EPRI Seismic (13 / yr)

Figure 3.7-4

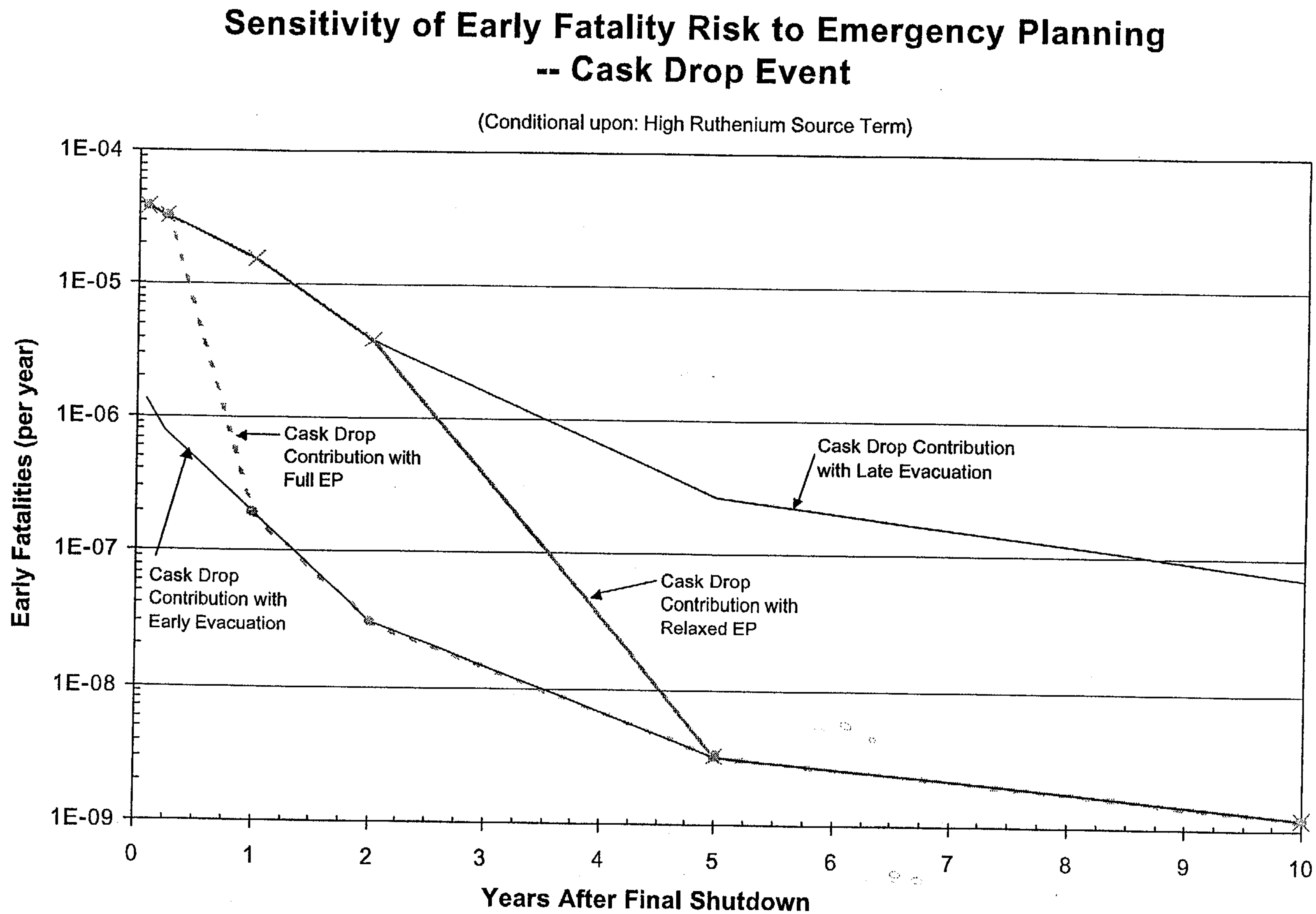
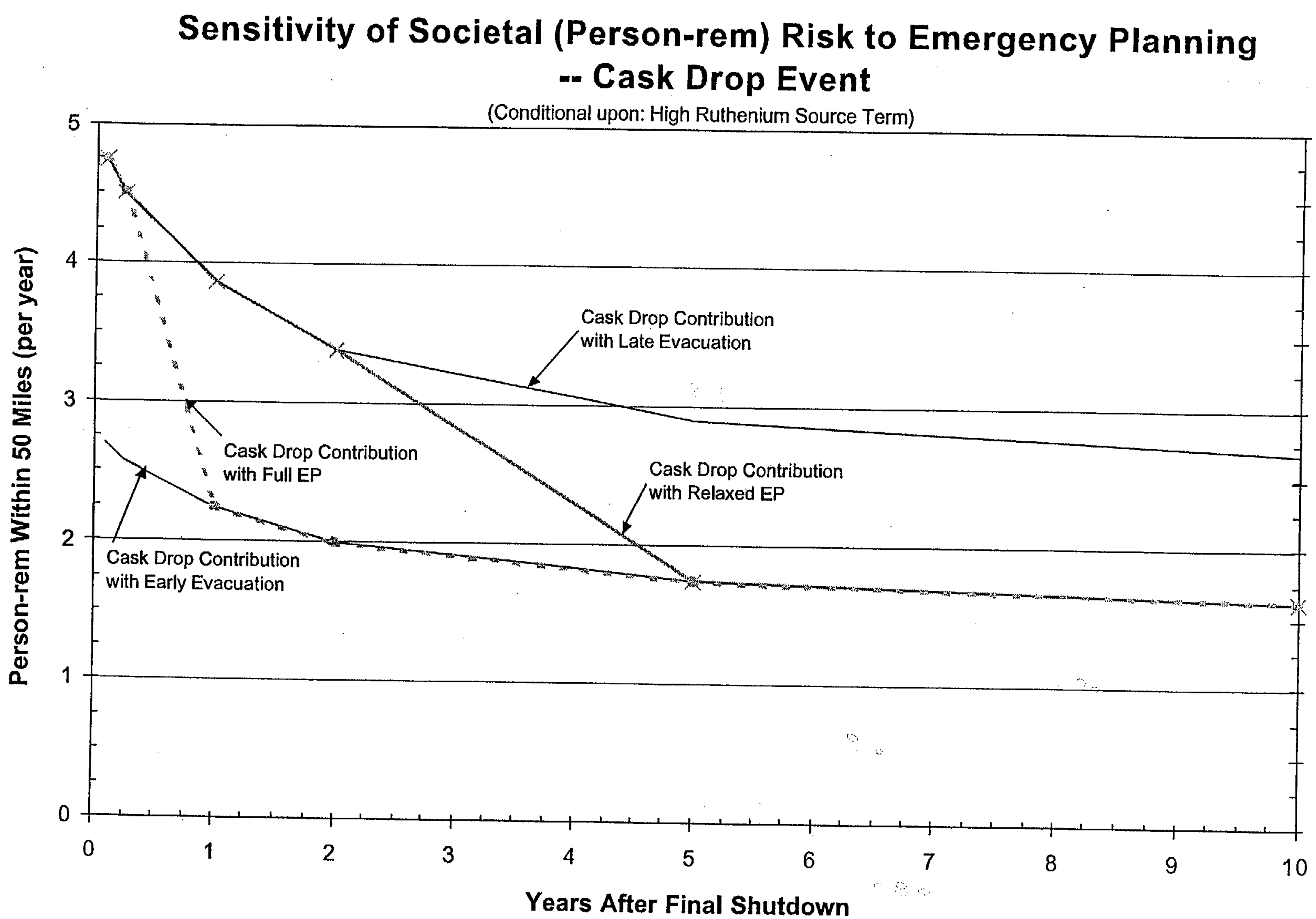

Sensitivity of Early Fatality Risk to Emergency Planning
-- Cask Drop Event
(Conditional upon: High Ruthenium Source Term)
1E-04
1E-05
1E-06
1E-07
1E-08
1E-09
Early Fatalities (per year)
0
1
2
3
4
5
6
7
8
9
10
Years After Final Shutdown
Cask Drop Contribution with Full EP
Cask Drop Contribution with Late Evacuation
Cask Drop Contribution with Early Evacuation
Cask Drop Contribution with Relaxed EP

Figure 3.7-5



Sensitivity of Societal (Person-rem) Risk to Emergency Planning -- Cask Drop Event
(Conditional upon: High Ruthenium Source Term)
Person-rem Within 50 Miles (per year)
5
4
3
2
1
0
Cask Drop Contribution with Late Evacuation
Cask Drop Contribution with Full EP
Cask Drop Contribution with Relaxed EP
Cask Drop Contribution with Early Evacuation
0
1
2
3
4
5
6
7
8
9
10
Years After Final Shutdown

Figure 3.7-6

On high ruthenium source term, The staff concludes:

- For the first 1 to 2 years following shutdown, the early fatality risk for an SFP fire is low, but may be comparable to that for a severe accident in an operating reactor (based on the two operating reactors considered). At 5 years following shutdown, the early fatality risk for SFP accidents is approximately two orders of magnitude lower than at shutdown. This is attributable to the effect of ruthenium, which decays to negligible amounts at 5 years.

- Societal risk for an SFP fire may be comparable to that for a severe accident in an operating reactor, but does not exhibit a substantial reduction with time because of the slower decay of fission products and the interdiction modeling assumptions that drive long-term doses.

- Of the SFP accidents assessed, only the cask drop accident is affected by changes to EP requirements. However, these changes do not substantially impact the total risk because the frequency of cask drop accidents is very low. As discussed previously, changes to EP requirements affect only the risk from cask drop accidents in the time period between 1 and 5 years.

- These observations are valid regardless of whether seismic event frequencies are based on the LLNL or the EPRI seismic hazard study.

About the low ruthenium source term the staff concludes:

- Use of the low ruthenium source term reduces early fatality risk by about a factor of 100 (relative to the high ruthenium source term) within the first 1 to 2 years and by about a factor of 10 at 5 years and after.

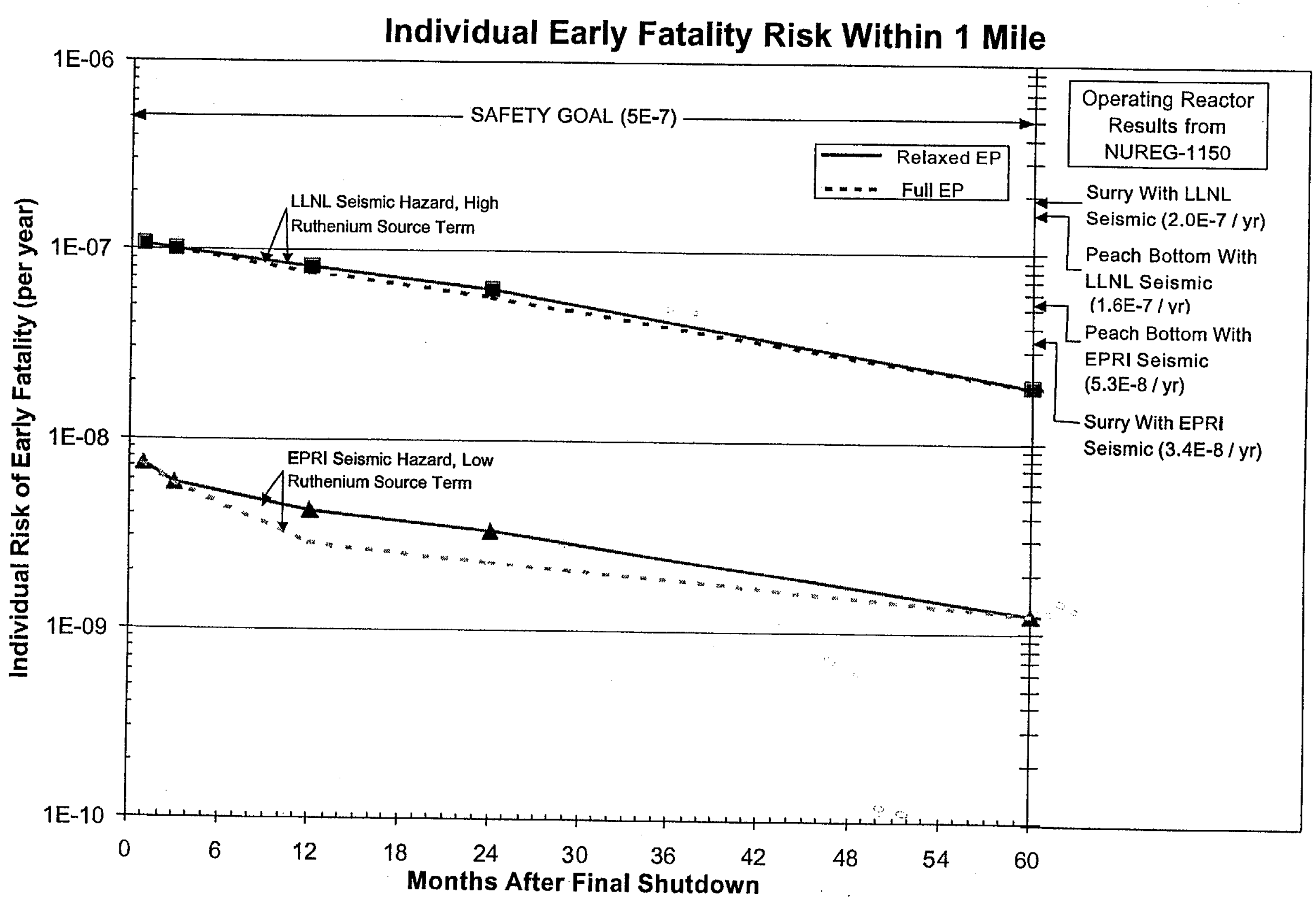
- With the low ruthenium source term, the early fatality risk for SFP accidents is about an order of magnitude lower than the corresponding values for a reactor accident shortly following shutdown and about two orders of magnitude lower at 2 years following shutdown. (In making these comparisons it is important to compare the SFP risks based on a particular seismic hazard estimate, e.g., EPRI, with reactor accident risks based on the same hazard estimate.)

- With the low ruthenium source term, the societal risk for SFP accidents is also about an order of magnitude lower than the corresponding values for a reactor accident shortly following shutdown, but does not exhibit a substantial reduction with time because of the slower decay of fission products and the interdiction modeling assumptions (discussed in Appendix 4) that drive long-term doses. Substantial reductions would only occur after about 5 years, when sufficient time appears to be available to initiate unplanned accident management recovery actions.

- As with the high ruthenium source term, changes to EP requirements affect the cask drop accident, and do not substantially impact the total risk due to the low frequency of cask drop accidents.

- These observations are valid regardless of whether seismic event frequencies are based on the LLNL or the EPRI seismic hazard estimates.

Figures 3.7-7 and 3.7-8 show the risk measures relevant to the Commission's safety goal policy statement, specifically, the individual risk of early fatality (to an individual within 1 mile of the site) and the individual risk of latent cancer fatality (to an individual within 10 miles of the site). The upper curves are based on the LLNL seismic hazard curves and the high ruthenium source term, and the lower curves are based on the EPRI hazard curves and the low ruthenium source term. Accordingly, these results may be viewed as a representative range of risk results for spent fuel pools uncovery given the conservative assumption that all SFP accidents result in a fire.



Individual Early Fatality Risk Within 1 Mile
1E-06
1E-07
1E-08
1E-09
1E-10
Individual Risk of Early Fatality (per year)
SAFETY GOAL (5E-7)
Relaxed EP
Full EP
Operating Reactor Results from NUREG-1150
LLNL Seismic Hazard, High Ruthenium Source Term
EPRI Seismic Hazard, Low Ruthenium Source Term
Surry With LLNL Seismic (2.0E-7 / yr)
Peach Bottom With LLNL Seismic (1.6E-7 / yr)
Peach Bottom With EPRI Seismic (5.3E-8 / yr)
Surry With EPRI Seismic (3.4E-8 / yr)
0
6
12
18
24
30
36
42
48
54
60
Months After Final Shutdown

Figure 3.7-7

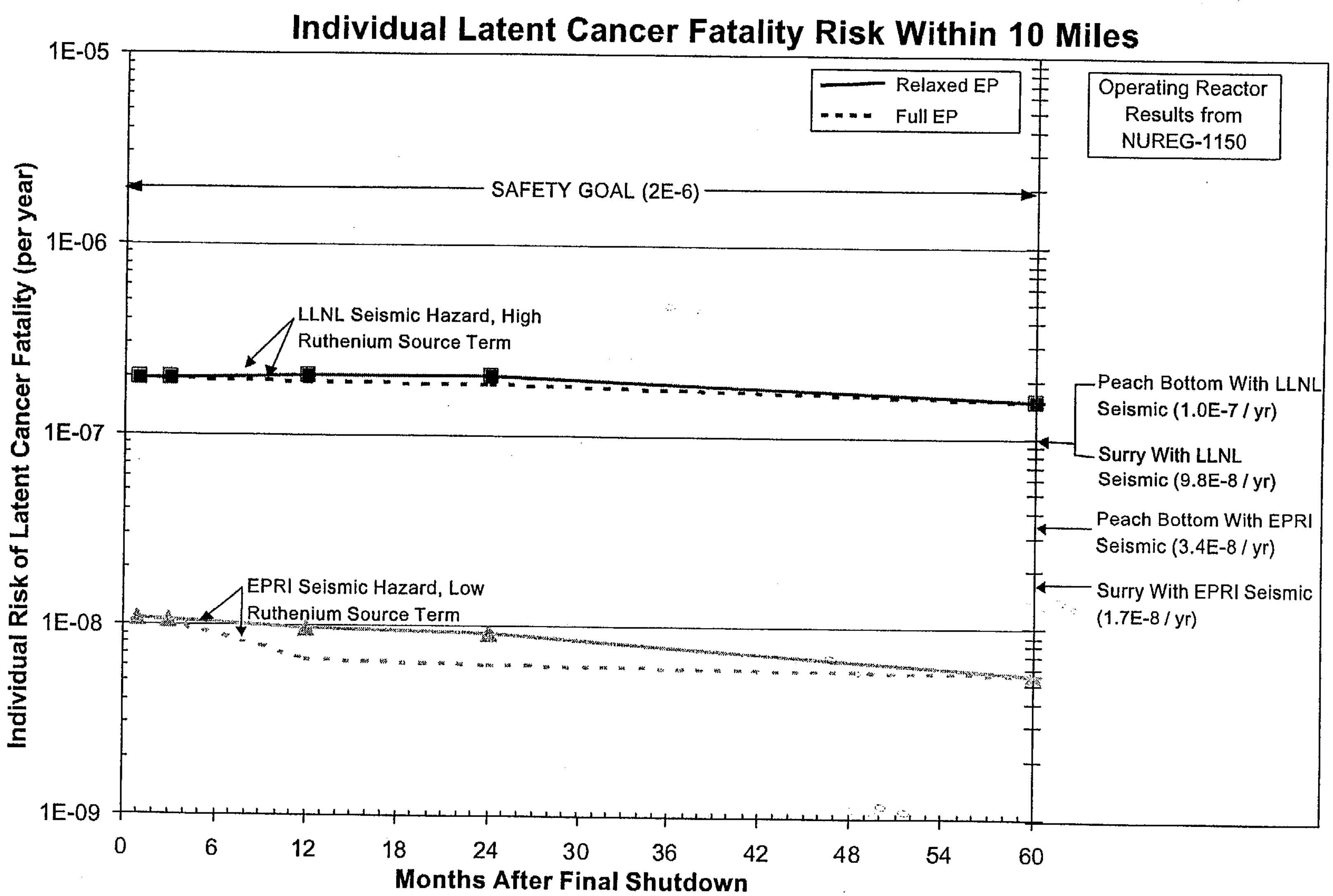

Individual Latent Cancer Fatality Risk Within 10 Miles
1E-05
1E-06
1E-07
1E-08
1E-09
Individual Risk of Latent Cancer Fatality (per year)
Relaxed EP
Full EP
Operating Reactor Results from NUREG-1150
SAFETY GOAL (2E-6)
LLNL Seismic Hazard, High Ruthenium Source Term
EPRI Seismic Hazard, Low Ruthenium Source Term
Peach Bottom With LLNL Seismic (1.0E-7 / yr)
Surry With LLNL Seismic (9.8E-8 / yr)
Peach Bottom With EPRI Seismic (3.4E-8 / yr)
Surry With EPRI Seismic (1.7E-8 / yr)
0
6
12
18
24
30
36
42
48
54
60
Months After Final Shutdown

Figure 3.7-8

The individual early fatality risk for an SFP accident is about one to two orders of magnitude lower than the Commission's safety goal, depending on assumptions about the SFP accident source term and seismic hazard. For the upper curve (corresponding to use of the mean of the LLNL seismic hazard estimates and the high ruthenium source term), the risks are about a decade lower than the safety goal. For the lower curve (corresponding to use of the mean of the EPRI seismic hazard estimates and the low ruthenium source term) the risks are about 2 decades lower than the safety goal. The individual early fatality risk for an SFP accident decreases with time and is about a factor of 5 lower at 5 years following shutdown (relative to the value at 30 days).

Similarly, the individual latent cancer fatality risk for an SFP accident is about one to two orders of magnitude lower than the Commission's safety goal, depending on assumptions about the SFP accident source term and seismic hazard. For the upper curve (corresponding to use of the mean of the LLNL seismic hazard estimates and the high ruthenium source term), the risks are about a decade lower than the safety goal. For the lower curve (corresponding to use of the mean of the EPRI seismic hazard estimates and the low ruthenium source term), the risks are about 2 decades lower than the safety goal. The individual latent cancer fatality risk for an SFP accident are not substantially reduced with time because of the slower decay of fission products and the interdiction modeling assumptions that drive long-term doses.

Changes to EP requirements, as modeled, do not substantially impact the margin between SFP risk and the safety goals because of the low frequency of events for which EP would be effective.

4.0 IMPLICATIONS OF SPENT FUEL POOL (SFP) RISK FOR REGULATORY REQUIREMENTS

The primary purpose of this study is to provide risk insights to support possible revisions to regulatory requirements for decommissioning plants. Section 4.1 below describes the safety principles of Regulatory Guide (RG) 1.174 as they apply to an SFP, and examines the design, operational, and regulatory elements that are important in ensuring that the risk from an SFP continues to meet these principles. This technical assessment explores possible implications for EP requirements, but the same technical information also provides risk insights to inform regulatory decisions on changes in insurance, safeguards, staffing and training, backfit, and other requirements for decommissioning plants. Section 4.2 examines the implications of the technical results for these regulatory decisions, and how future regulatory activity might reflect commitments and assumptions. The implications of safeguards events are not included in this evaluation.

4.1 Risk-Informed Decision Making

In 1995, the NRC published its PRA policy statement (Ref. 1), which stated that the use of PRA technology should be increased in all regulatory matters to the extent supported by the state-of-the-art of the methods. Subsequent to issuance of the PRA policy statement, the agency published RG 1.174, which contained general guidance for application of PRA insights to the regulation of nuclear reactors. The regulatory framework proposed in this study for decommissioning plants is based on the risk-informed decision-making process described in RG 1.174 (Ref. 2). Although the focus of RG 1.174 is decision making regarding changes to the licensing basis of an operating plant, the same risk-informed philosophy can be applied generically as part of the evaluation of potential exemptions or changes to current regulatory requirements for decommissioning plants.

RG 1.174 articulates the following safety principles, which can be applied in evaluating regulatory changes for decommissioning plants:

- The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change, i.e., a "specific exemption" under 10 CFR 50.12 or a "petition for rulemaking" under 10 CFR 2.802.
- When proposed changes result in an increase in core damage frequency and/or risk, the increases should be small and consistent with the intent of the Commission's safety goal policy statement.
- The proposed change is consistent with the defense-in-depth philosophy.
- The proposed change maintains sufficient safety margins.
- The impact of the proposed change should be monitored using performance measurement strategies.

A discussion of each of these safety principles and how they would continue to be satisfied at a decommissioning plant is provided in the sections that follow. Since the application of this study specifically relates to exemptions to a rule or a rule change for decommissioning plants, a discussion of the first principle regarding current regulations is not necessary nor is it provided.

4.1.1 Increases in Risk

RG 1.174 states that when proposed changes result in an increase in core damage frequency and/or risk, the increases should be small and consistent with the intent of the Commission's safety goal policy statement.

The staff has evaluated the risks associated with SFP accidents and the impacts of potential changes to regulatory requirements for decommissioning plants relative to applicable regulatory guidance. Guidance on acceptable levels of (total) risk to the public from nuclear power plant operation is provided in the Commission's safety goal policy statement (Ref. 3). Additional guidance on the acceptable levels of risk increase from a change to the plant licensing basis is provided in RG 1.174. The guidance contained in these documents is summarized below and used in this study to evaluate the risks associated with SFP accidents and the impacts of potential changes to regulatory requirements for decommissioning plants.

SFP Risk Relative to the Safety Goal Policy Statement

The "Policy Statement on Safety Goals for the Operation of Nuclear Power Plants," issued in 1986, establishes goals that broadly define an acceptable level of radiological risk to the public as a result of nuclear power plant operation. These goals are used generically to assess the adequacy of current requirements and potential changes to the requirements. The Commission established two qualitative safety goals that are supported by two quantitative objectives for use in the regulatory decision-making process. The qualitative safety goals stipulate the following:

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.

- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

The following quantitative health objectives (QHOs) are used in determining achievement of the safety goals:

- The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of 1 percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.

- The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of 1 percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

These QHOs have been translated into two numerical objectives as follows:

- The individual risk of a prompt fatality from all "other accidents to which members of the U.S. population are generally exposed," such as fatal automobile accidents, is about $5x10^{-4}$ per year. One-tenth of 1 percent of this figure implies that the individual risk of prompt fatality from a reactor accident should be less than $5x10^{-7}$ per reactor year.

- "The sum of cancer fatality risks resulting from all other causes" for an individual is taken to be the cancer fatality rate in the U.S. which is about 1 in 500 or $2x10^{-3}$ per year. One-tenth of 1 percent of this risk means that the risk of cancer to the population in the area near a nuclear power plant due to its operation should be limited to $2x10^{-6}$ per reactor year.

Although the policy statement and related numerical objectives were developed to address the risk associated with power operation, the QHOs provide a convenient benchmark for SFP evaluations. Accordingly, the staff has compared the estimated risks associated with SFP accidents to the QHOs.

The risks associated with SFP accidents compare favorably with the QHOs. The comparisons, presented in Section 3.7.3, show that a typical site that conforms with the IDCs and SDAs would meet the QHOs by one to two orders of magnitude a few months following shutdown and by greater margins later. The risk comparisons provided in Appendix 4C show that SFP facilities maintained at or below the recommended pool performance guideline (PPG) of $1X10^{-5}$ per year, would continue to meet the QHO even with a severe SFP source term. With the exception of H.B. Robinson (using the LLNL seismic hazard estimates and generic fragilities), all Central and Eastern U.S. plants which satisfy the IDCs and SDAs (and pass the seismic checklist) will meet the PPG. Western plants (including San Onofre, Diablo Canyon, and WNP-2) were not included in the LLNL or EPRI seismic hazard studies and need to demonstrate compliance with the PPG on a plant-specific basis.

Risk Increases Relative to Regulatory Guide 1.174

The guidelines in RG 1.174 pertain to the core damage frequency (CDF) and large early release frequency (LERF). For both CDF and LERF, RG 1.174 contains guidance on acceptable values for the changes that can be allowed due to regulatory decisions as a function of the baseline frequencies. For example, if the baseline CDF for a plant is below $1x10^{-4}$ per year, plant changes can be approved that increase CDF by up to $1x10^{-5}$ per year. If the baseline LERF is less than $1x10^{-5}$ per year, plant changes can be approved which increase LERF by up to $1x10^{-6}$ per year.

For decommissioning plants, the risk is primarily due to the possibility of a zirconium fire involving the spent fuel cladding. The consequences of such an event do not equate directly to either a core damage accident or a large early release as modeled for an operating reactor. Zirconium fires in SFPs have the potential for significant long-term consequences because multiple cores may be involved; the relevant cladding and fuel degradation mechanisms could lead to increased releases of certain isotopes (e.g., short-lived isotopes such as iodine will have decayed, but the release of long-lived isotopes such as ruthenium could be increased due to air-fuel reactions); and there is no containment surrounding the SFP to mitigate the consequences. On the other hand, after about 2 years, the consequences are different than from a large early release because the postulated accidents progress more slowly, allowing time for protective actions to be taken to significantly reduce early fatalities (and to a lesser extent latent fatalities). In effect, an SFP fire would result in a "large" release, but this release would not generally be considered "early" due to the significant time delay before fission products are released.

In spite of the differences relative to an operating reactor large early release event and the differences in isotopic makeup, the consequence calculations performed by the staff and discussed in Section 3.7 show that SFP fires could have health effects comparable to those of a severe reactor accident. These calculations considered the effects of different source terms and evacuation assumptions on offsite consequences. Since an SFP fire scenario would involve a direct release to the environment with significant consequences, the staff has decided that the RG 1.174 guidance concerning LERF can be applied to the issue of SFP risks for decommissioning plants.

The LERF guidance is applied in two ways in this study:

(1) Because the changes in EP requirements affect not the frequency of events involving a large early release (i.e., the SFP fire frequency) but the consequences of these releases, the allowable increase in LERF in RG 1.174 is translated into an allowable increase in key risk measures. The estimated risk increases associated with changes in EP requirements are then compared to the allowable increases inferred from RG 1.174. These comparisons are presented in Appendix 4D.

(2) The RG 1.174 guidance is used to establish a PPG. The PPG provides a threshold for controlling the risk from a decommissioning SFP. By maintaining the frequency of events leading to uncovery of the spent fuel at a value less than the recommended PPG value of $1x10^{-5}$ per year, zirconium fires will remain highly unlikely, the risk will continue to meet the Commission's QHOs, and changes to the plant SFP licensing basis that result in very small increase in risk may be permitted consistent with the logic in RG 1.174. A licensee would need to assure that the frequency of events leading to uncovery of the spent fuel would be less than the PPG in order to consider the risk-informed changes in a rule for decommissioning plants. With the exception of those plants mentioned above, this assurance could be provided by conforming with the IDCs and SDAs listed in Tables 4.2-1 and -2. The use of the LERF guidance ($1x10^{-5}$ per year frequency of fuel uncovery) was questioned by the ACRS because of concerns related to SFP source terms and accident consequences. The rationale for the PPG is presented in Appendix 4C.

The risk increases associated with relaxations in EP requirements compare favorably with the guidance contained in RG 1.174 (see Table 4 of Appendix 4D). Relaxation of EP requirements would result in an increase of about $1.5x10^{-5}$ early fatalities per year and 2 person-rem per year for the Surry analysis, the first is about a factor of 15 and the second a factor of 5 below the allowable increase inferred from the RG 1.174 LERF criteria. The increase in the QHO risk measures is also substantially lower than that allowed in RG 1.174. Since the SFP fire frequency assumed in these comparisons is about a factor of 4 lower than the PPG of 1×10^{-5} per year, an SFP facility operating nominally at the PPG would have a smaller margin to the allowable risk limits for the reference plant but would still be at or below these limits.

As discussed in Section 3.7, the basis for these results is that EP is of marginal benefit in large earthquakes because of offsite damage. However, as described in Appendix 4D, even with unrealistically optimistic assumptions about the effectiveness of EP in seismic events (i.e., assuming full and relaxed EP results in early and late evacuation, respectively, and using the LLNL seismic hazard frequency and the high ruthenium source term), the change in risk is small and the QHOs continue to be met with adequate margin.

Measures to Assure Risk Increases Remain Small

The analysis in Section 3 explicitly examines the risk impact of specific design and operational characteristics. This analysis credits the industry decommissioning commitments (IDCs) proposed by NEI in a letter to the NRC dated November 12, 1999 (Ref. 4) and several additional staff decommissioning assumptions (SDAs) identified through the staff's risk assessment and the staff's evaluation of the RG 1.174 safety principles for decommissioning plants. The IDCs and SDAs are summarized in Tables 4.2-1 and 4.2-2.

The low numerical risk results shown in Section 3 and Appendix 2 are predicated on the IDCs and SDAs being fulfilled. Specifically,

- IDC #5 and SDAs #2 and #3 provide assurance of timely operator response for a broad range of operational events.
- The low likelihood of pool failure due to heavy load drop is dependent on design and procedural controls for handling of heavy loads (IDC #1 and #9 and SDA #5).
- The low baseline frequency for a seismically initiated zirconium fire is predicated upon implementation of the seismic checklist shown in Appendix 5 (SDA #6).
- The low likelihood of loss of cooling is dependent upon procedures and training (IDC #2) and instrumentation (IDC #5 and SDA #3).
- The low likelihood of loss of inventory is dependent upon design provisions (IDC #6) and procedures and controls (IDC #7) to limit leakage.
- The high probability that the operators will identify and recover from a loss of cooling or a loss of inventory event is dependent upon procedures and training for effective use of onsite and offsite resources (IDCs #2 through #4, IDC #8, and SDA #3) and SFP instrumentation (IDC #5 and SDA #3).
- The low likelihood criticality issues is dependent on continuation of programs to assess the condition of Boraflex absorber material (SDA #7).
- Applicability of the staff's generic risk assessment to a specific facility is assured by SDA #1.

With regard to SFP risks and risk increases associated with EP relaxations, the staff concludes:

- An SFP facility that conforms with the IDCs and SDAs would meet the QHOs by one to two orders of magnitude shortly after shutdown and with greater margins at later times.

- The risk increase associated with relaxations in EP requirements is very small, even under assumptions that maximize the effectiveness of emergency preparedness in seismic events (i.e., assigning consequences for the "full EP" case based on early evacuation and consequences for the "relaxed EP" case based on late evacuation), and the QHOs continue to be met with adequate margin.

- Continued conformance with IDCs and SDAs provides reasonable assurance that the SFP risk and risk increases associated with regulatory changes would remain small.

4.1.2 Defense-in-Depth

RG 1.174 states that the proposed change should be consistent with the defense-in-depth philosophy.

In accordance with the Commission white paper on risk-informed regulation (March 11, 1999), "Defense-in-depth is an element of the NRC's Safety Philosophy that employs successive compensatory measures to prevent accidents or mitigate damage if a malfunction, accident, or naturally caused event occurs at a nuclear facility. The defense-in-depth philosophy ensures that safety will not be wholly dependent on any single element of the design, construction, maintenance, or operation of a nuclear facility. The net effect of incorporating defense-in-depth into design, construction, maintenance and operation is that the facility or system in question tends to be more tolerant of failures and external challenges." Therefore, application of defense-in-depth could mean in part that there is more than one source of cooling water or that pump make-up can be provided by both electric as well as direct-drive diesel pumps. Additionally, defense-in-depth can mean that even if a serious outcome (such as fuel damage) occurs, there is further protection, such as containment for operating plants to prevent radionuclide releases to the environment and emergency response measures to provide dose savings to the public.

The defense-in-depth philosophy applies to the operation of the SFP in a decommissioning plant. The philosophy also applies to the potential regulatory changes contemplated for decommissioning plants. Implementation of defense-in-depth for SFPs is different than for nuclear reactors because the hazards are different. The robust structural design of a fuel pool, coupled with the simple nature of the pool support systems, goes far toward preventing accidents associated with loss of water inventory or pool heat removal. Additionally, because the essentially quiescent (low-temperature, low-pressure) initial state of the SFP and the long time available for taking corrective action associated with most release scenarios provide significant safety margin, a containment structure is not considered necessary as an additional barrier to provide an adequate level of protection to the public. Likewise, the slow evolution of most SFP accident scenarios allows for reasonable human recovery actions to respond to system failures, and provides sufficient time to allow for the implementation of protective actions.

The staff's risk assessment demonstrates that the risk from a decommissioning plant SFP accident is small if IDCs and additional SDAs are implemented as assumed in the risk study. Due to the different nature of an SFP accident versus an accident in an operating reactor with respect to system design capability and event timing, the defense-in-depth function of reactor containment is not required. However, the staff has found that defense-in-depth in the form of accident prevention measures and an appropriate level of emergency planning can limit risk and provide dose savings for as long as a zirconium fire is possible.

Defense-in-depth for accident prevention and mitigation is provided by licensee conformance with the IDCs and SDAs, as discussed previously. Defense-in-depth for consequence mitigation should continue to be provided by retaining requirements for an appropriate level of EP in consideration of the amount of time available before fission product release in specific events.

For the purpose of the analysis in this study, when referring to relaxation of offsite EP, the study assumed conditions that would be similar to those at sites in decommissioning that have already received exemptions from some EP requirements. For instance, licensees may no longer be required: to have a formalized emergency planning zone (EPZ); to have an emergency operations facility (EOF), technical support center (TSC), or operations support center (OSC); to promptly notify the public using a siren system, tone alert radios, or National Weather Service radios; or to conduct biennial full-participation exercises. The analyses in the study were simplified to focus on conditions which assumed evacuation occurred either early or late.

It is understood that EP involves more than just evacuation considerations. In the analysis of the study, it was assumed that the decommissioning licensee would still be required to notify offsite authorities, characterize the releases, and make protective action recommendations; have a means of notifying offsite organizations and providing information to the public; and hold onsite biennial exercises and semiannual drills.

The assessments conducted for this study show that, 60 days after final shutdown, recovery and mitigation times of more than 100 hours are available before release occurs, except for the most severe events. These times appear to be sufficient to permit offsite protective actions to be implemented on an ad hoc basis, if necessary, without the full compliment of regulatory requirements associated with operating reactors. The staff notes that potential relaxation of EP requirements for decommissioning plants could be phased in such that the relaxation would not result in an immediate lapse of all offsite emergency response capabilities following final shutdown, but would more likely result in early elimination of some capabilities (e.g., sirens) and more gradual relaxation of certain other capabilities (e.g., pre-planning of evacuations and communications), with a transition towards longer ad hoc response times over several years due to such factors as attrition of experienced personnel. Shortly after final shutdown, when SFP heatup rates and risks are greatest, response capabilities are expected to be largely intact and comparable to those for full EP. These capabilities could be expected to diminish over time, resulting in longer ad hoc response times. However, continued fission product decay in the spent fuel will result in longer times to release, providing additional time during which emergency response measures could be implemented.

Only during the first several years and in the most severe events, such as severe seismic events, heavy load drops, and other dynamic events, that cause the pool to fail, would the accident progress so rapidly that emergency response measures might not be implemented in a timely manner. The staff's risk study indicates that the frequency of such events is dominated by earthquakes with a magnitude several times the safe shutdown earthquake (SSE). As discussed in Section 3.7.2, for ground motion levels that correspond to SFP failure, emergency planning would have marginal benefit because of extensive collateral damage to infrastructure (e.g., power, communications, buildings, roads, and bridges). Emergency response action would likely require substantial ad hoc action regardless of pre-planned actions in these events.

The next largest contribution is from cask drop sequences. The frequency of such events is low in the staff's risk study ($2x10^{-7}$ per year) due to implementation of IDCs and SDAs concerning movement of heavy loads. Relaxations in EP requirements could result in some increase in the risk associated with these events for a limited time following shutdown (1 to 5 years in the staff's analysis). However, the increase is a small fraction of the total risk from SFPs, as shown in Section 3.7. For the remaining SFP accidents that were analyzed and lead to SFP fires (e.g., boildown sequences due to organizational failures), current emergency planning was assumed to be ineffective or the frequencies of accidents, (e.g., aircraft impact) would be at least an order of magnitude lower than for the cask drop accident. Thus, mitigation of these events would not be risk significant.

With regard to defense-in-depth, the staff concludes:

- Defense-in-depth for accident prevention and mitigation is provided by the robust design of the SFP, the simple nature of pool support systems, and the long time available for taking corrective action in response to system failures.
- The substantial amount of time available for ad hoc offsite emergency response should provide some level of defense-in-depth for consequence mitigation in SFP accidents.
- In the large seismic events that dominate SFP risk, pre-planning for radiological accidents would have marginal benefit due to extensive collateral damage offsite. Accordingly, relaxations in EP requirements are not expected to substantially alter the outcome from such a large seismic event.
- There can be a tradeoff between the formality with which the elements of emergency planning (procedures, training, performance of exercises) are treated and the increasing safety margin as the fuel ages and the time available to respond gets longer.

4.1.3 Safety Margins

RG 1.174 states that the proposed change should maintain sufficient safety margins.

As discussed in Section 2, the safety margins associated with fuel in the SFP are much greater than those associated with an operating reactor due to the low heat removal requirements and long time frames available for recovery from off-normal events. Due to these larger margins, the staff judges that the skid-mounted and other dedicated SFP cooling and inventory systems in place provide adequate margins for accident prevention. Additionally, the presence of soluble boron or Boraflex provides additional assurance of margin with respect to shutdown reactivity.

The risk results provided in Section 3.6.3 show that a typical site that conforms with the IDCs and SDAs would meet the Commission's QHOs by one to two orders of magnitude, depending on assumptions about the SFP source term and seismic hazard frequency. The risk comparisons provided in Appendix 4C show that SFP facilities maintained at or below the recommended PPG of $1x10^{-5}$ per year would continue to meet the QHOs for even the most severe source term.

The estimated risk increases associated with the EP relaxations are also well below the allowable increases developed from the RG 1.174 LERF criteria. As discussed in Section 4.2.1 and Appendix 4D, the increases in risk from the EP relaxation would be about a factor of 10 below the maximum allowable increases developed from RG 1.174. Since the SFP fire frequency assumed in the RG 1.174 comparisons is about a factor of 4 lower than the PPG of $1x10^{-5}$ per year, a plant operating nominally at the PPG would have a smaller margin to the allowable risk limits for the reference plant but would still be at or below the limits.

The results of a sensitivity case in Appendix 4D indicate that even with assumptions that maximize the effectiveness of EP in seismic events, the change in risk associated with relaxation of the requirements for radiological preplanning is still relatively small. The increases in early fatalities and individual early fatality risk remain below the maximum allowable for each risk measure. Population dose and individual latent cancer fatality risk are about a factor of 2 higher than the allowable value inferred from RG 1.174. This increase in individual latent cancer risk represents about 9 percent of the QHO; thus, considerable margin to the QHO would still remain.

The evacuation effectiveness assumed for "full EP" in the sensitivity case is unrealistic for high ground motion earthquakes, and the risk increase associated with the EP relaxations is expected to be closer to the baseline value. Also, the risk reduction estimates are based on the LLNL seismic hazard frequencies and the high ruthenium source term, and would be substantially lower if either the EPRI seismic hazard frequencies or the low ruthenium source term were used. The above comparisons are based on the risk levels 1 year after shutdown but would also be valid several months following shutdown. Use of either the EPRI seismic hazard frequencies or the low ruthenium source term would reduce each of the risk measures by about a factor of 10, to values well below the RG 1.174 guidelines and the QHOs. The risk impact will decrease even further in later years due to reduced consequences as fission products decay.

The study concludes that relaxation of certain EP requirements can be considered for decommissioning plants in which conformance with the IDCs and SDAs provides reasonable assurance that sufficient margins to the safety goals will be maintained.

4.1.4 Implementation and Monitoring Program

RG 1.174 states that the impact of the proposed change should be monitored using performance measurement strategies. RG 1.174 further states that an implementation and monitoring plan should be developed to ensure that the engineering evaluation conducted to examine the impact of the proposed changes continues to reflect the actual reliability and availability of SSCs that have been evaluated. This will ensure that the conclusions that have been drawn will remain valid.

Applying this guideline for the SFP risk evaluation results in identification of four primary areas for performance monitoring: (1) the performance and reliability of SFP cooling and associated power and inventory makeup systems, (2) the Boraflex condition for high-density fuel racks, (3) crane operation and load path control for cask movements, and (4) onsite emergency response capabilities. The following monitoring should continue after decommissioning in order to assure SFP risk remains low:

- Performance and reliability monitoring of the SFP systems, heat removal, AC power, and inventory should comply with the provisions of the Maintenance Rule (10 CFR 50.65).

- The current monitoring programs identified in licensee's responses to Generic Letter 96-04 (Ref. 2) with respect to monitoring of the Boraflex absorber material should be maintained by decommissioning plants until all fuel is removed from the SFP. This staff assumption is stated in SDA #7 (see Table 4.1-2).

- Heavy load activities and load paths should be monitored and controlled by the licensee in accordance with IDC #1 (see Table 4.1-1).

- Licensees should continue to provide a level of onsite capabilities to assure prompt notification of offsite authorities, characterization of potential releases, development of protective action recommendations, and communication with the public. These capabilities should be monitored by holding periodic onsite exercises and drills.

The staff concludes that continued compliance with the Maintenance Rule, the IDCs, and the SDAs, together with some level of EP, provides a reasonable level of monitoring of SFP safety.

Table 4.1-1 Industry Decommissioning Commitments (IDCs)

IDC No.	Industry commitments
1	Cask drop analyses will be performed or single failure-proof cranes will be in use for handling of heavy loads (i.e., phase II of NUREG-0612 will be implemented).
2	Procedures and training of personnel will be in place to ensure that onsite and offsite resources can be brought to bear during an event.
3	Procedures will be in place to establish communication between onsite and offsite organizations during severe weather and seismic events.
4	An offsite resource plan will be developed which will include access to portable pumps and emergency power to supplement onsite resources. The plan would principally identify organizations or suppliers where offsite resources could be obtained in a timely manner.
5	SFP instrumentation will include readouts and alarms in the control room (or where personnel are stationed) for SFP temperature, water level, and area radiation levels.
6	SFP seals that could cause leakage leading to fuel uncovery in the event of seal failure shall be self limiting to leakage or otherwise engineered so that drainage cannot occur.
7	Procedures or administrative controls to reduce the likelihood of rapid draindown events will include (1) prohibitions on the use of pumps that lack adequate siphon protection or (2) controls for pump suction and discharge points. The functionality of anti-siphon devices will be periodically verified.
8	An onsite restoration plan will be in place to provide repair of the SFP cooling systems or to provide access for makeup water to the SFP. The plan will provide for remote alignment of the makeup source to the SFP without requiring entry to the refuel floor.
9	Procedures will be in place to control SFP operations that have the potential to rapidly decrease SFP inventory. These administrative controls may require additional operations or management review, management physical presence for designated operations or administrative limitations such as restrictions on heavy load movements
10	Routine testing of the alternative fuel pool makeup system components will be performed and administrative controls for equipment out of service will be implemented to provide added assurance that the components would be available, if needed.

Table 4.1-2 Staff Decommissioning Assumptions (SDAs)

SDA No.	Staff Assumptions
1	Licensee's SFP cooling design will be at least as capable as that assumed in the risk assessment, including instrumentation. Licensees will have at least one motor-driven and one diesel-driven fire pump capable of delivering inventory to the SFP.
2	Walk-downs of SFP systems will be performed at least once per shift by the operators. Procedures will be developed for and employed by the operators to provide guidance on the capability and availability of onsite and offsite inventory makeup sources and time available to initiate these sources for various loss of cooling or inventory events.
3	Control room instrumentation that monitors SFP temperature and water level will directly measure the parameters involved. Level instrumentation will provide alarms at levels associated with calling in offsite resources and with declaring a general emergency.
4	Licensee determines that there are no drain paths in the SFP that could lower the pool level (by draining, suction, or pumping) more than 15 feet below the normal pool operating level and that licensee must initiate recovery using offsite sources.
5	Load Drop consequence analyses will be performed for facilities with non-single failure-proof systems. The analyses and any mitigative actions necessary to preclude catastrophic damage to the SFP that would lead to a rapid pool draining would be sufficient to demonstrate that there is high confidence in the facilities ability to withstand a heavy load drop.
6	Each decommissioning plant will successfully complete the seismic checklist provided in Appendix2B to this study. If the checklist cannot be successfully completed, the decommissioning plant will perform a plant specific seismic risk assessment of the SFP and demonstrate that SFP seismically induced structural failure and rapid loss of inventory is less than the generic bounding estimates provided in this study ($<1x10^{-5}$ per year including non-seismic events).
7	Licensees will maintain a program to provide surveillance and monitoring of Boraflex in high-density spent fuel racks until such time as spent fuel is no longer stored in these high-density racks.

4.2 Implications for Regulatory Requirements for Emergency Preparedness, Security, and Insurance

The industry and other stakeholders have expressed interest in knowing the relevance of the results of this study to decisions on specific regulatory requirements. These decisions could be made in response to plant-specific exemption requests or as part of the integrated rulemaking for decommissioning plants. Such decisions can be facilitated by a risk-informed examination of both the deterministic and probabilistic aspects of decommissioning. Three examples of such regulatory decisions are presented in this section: regulatory requirements for emergency preparedness, security, and insurance.

4.2.1 Emergency Preparedness

The requirements for emergency preparedness are contained in 10 CFR 50.47 (Ref. 5) and Appendix E to 10 CFR Part 50 (Ref. 6). Further guidance on the basis for EP requirements is contained in NUREG-0396 (Ref. 7) and NUREG-0654/FEMA-REP-1 (Ref. 8). The task force of NRC and Environmental Protection Agency (EPA) representatives formed to address the planning bases for emergency preparedness concluded that the overall objective of EP is to provide dose savings (and in some cases immediate life saving) for a spectrum of accidents that could produce offsite doses in excess of predetermined protective action guides (PAGs).

In the past, the NRC staff has typically granted exemptions from offsite emergency planning requirements for decommissioning plants that could demonstrate that they were beyond the period in which a zirconium fire could occur. The rationale for those decisions was that, in the absence of a zirconium fire, there were no decommissioning plant scenarios for which the consequences justify the imposition of an offsite EP requirement. The results of this technical study confirm that the frequency of events leading to SFP fires is very low (ranging from about 4×10^{-7} at sites where seismic events are a minimal contributor to less than 1×10^{-5} per year at sites where seismic events dominate SFP risk and no plant-specific seismic analyses need to be performed), and that the subset of events in which EP can produce significant dose savings is even smaller (about 2×10^{-7} per year). However, the staff concludes that the possibility an SFP accident will lead to a large fission product release cannot be ruled out even many years after final shutdown, since several SFP accidents could involve either blockage of the air cooling path (e.g., due to partial draining of the SFP) or inadequate air circulation within the SFP building, resulting in near-adiabatic heatup of the spent fuel. The impact of this new information on previously granted exemptions is being evaluated by the staff. Large seismic events that fail the SFP are the dominant contributor to these failure modes. Emergency planning would be of marginal benefit in reducing the risk of such events due to its impairment by offsite damage. The next largest contributor, cask drop accidents, is about an order of magnitude lower in frequency. In the first few years following final shutdown (when time to fission product release is less than about 10 hours), EP could provide some dose savings, but does not substantially impact risk due to the low frequency of these events. Finally, although large releases from the SFP would remain possible for these failure modes, the time available before release would be in excess of 24 hours 5 years after final shutdown and sufficient to support implementation of protective measures on an ad hoc basis.

In some cases, emergency preparedness exemptions have also been granted to plants which were still in the window of vulnerability for zirconium fire. In these cases, the justification was that enough time had elapsed since shutdown so that the evolution of a zirconium fire accident would evolve slowly enough to allow mitigative measures and, if necessary, offsite protective actions to be implemented without preplanning. The staff believes that the technical analysis discussed in Section 3 and the decision criteria laid out in Section 4.1 provides information on how such exemption requests could be viewed in the future. In addition, this information bears on the need for, and the extent of, emergency preparedness requirements in the integrated rulemaking. In consideration of the study's conclusion that air cooling may not always be available for some event sequences, the basis for some previous exemptions may need to be reconsidered.

The consequence analysis presented in Appendix 4 indicates that the offsite consequences of a zirconium fire may be comparable to those from operating reactor postulated severe accidents. Further, the analysis indicates that timely evacuation, implemented through either pre-planned or ad hoc measures, can significantly reduce the number of early fatalities due to a zirconium fire. The results in Section 3.7.3 indicate that early fatality and societal risk for an SFP fire may be comparable to that for an operating reactor, and that the risk is one to two orders of magnitude lower than the Commission's safety goal. The results in Appendix 4D show that even with the most optimistic assumptions about the effectiveness of EP in large seismic events, the increase in risk associated with relaxations in EP requirements is small and the QHOs continue to be met. Thus, the risk assessment provides some basis for reductions in EP requirements for decommissioning plants. With respect to the potential for pool criticality, the staff's assessment discussed in Section 3 and Appendix 3 indicates that credible scenarios for criticality are highly unlikely and are further precluded by the assumption of Boraflex monitoring programs. Additionally, even if a criticality event did occur, it would not have offsite consequences. Therefore, the conclusions regarding possible reductions in EP program requirements are not affected.

In Section 4.1, the safety principles of RG 1.174 are applied to assess whether changes to emergency preparedness requirements are appropriate. Notwithstanding the low risk associated with SFP accidents, the safety principles in RG 1.174 dictate that defense-in-depth be considered. As discussed previously, emergency preparedness provides defense-in-depth. However, because of the considerable time available to initiate protective actions, in most SFP accidents (and the low frequency of events in which sufficient time is not available to implement protective actions on an ad hoc basis), the level of formal emergency plans needed for rapid initiation and implementation of offsite protective actions can be evaluated. The principle emergency planning measures needed for SFP events is the means for identifying the event and notifying of State and local emergency response officials.

4.2.2 Security

Currently licensees that have permanently shut down reactor operations and have off-loaded the spent fuel into the SFP are still required to meet all the security requirements for operating reactors in 10 CFR 73.55 (Ref. 9). This level of security requires a site with a permanently shutdown reactor to provide security protection at the same level as for an operating reactor site. The industry has asked the NRC to consider whether the risk of radiological release from decommissioning plants due to sabotage is low enough to justify modification of safeguards requirements for SFPs at decommissioning plants.

In the past, decommissioning licensees have requested exemptions from specific regulations in 10 CFR 73.55 on the basis of the reduced number of target sets susceptible to sabotage attacks and the consequent reduced hazard to public health and safety. Limited exemptions have been granted on this basis. The risk analysis in this study does not refute the reduced target set argument; however, the analysis does not support the assertion of a lesser hazard to public health and safety, given the possible consequences of sabotage-induced uncovery of fuel in the SFP when a zirconium fire potential exists. Further, the risk analysis in this study did not evaluate the potential consequences of a sabotage event that could directly cause offsite fission product dispersion, for example, a vehicle bomb driven into or otherwise significantly damaging the SFP, even after a zirconium fire was no longer possible. However, this study supports a regulatory framework that relieves licensees from selected requirements in 10 CFR 73.55 on the basis of target set reduction when all fuel has been placed in the SFP.

As a result of the conclusions from this study, the bases for previous exemptions for defueled facilities, the devitalization of the spent fuel pool at operating reactors, and certain concerns at ISFSIs may need to be reconsidered. This is due to differences in the findings relative to the specific periods of time historically used for the devitalization of spent fuel pools at operating reactors and certain operational concerns and potential vulnerabilities at decommissioning sites.

The risk estimates contained in this study are based on accidents initiated by random equipment failures, human errors, or external events. PRA practitioners have developed and used dependable methods for estimating the frequency of such random events. By contrast, this analysis and PRA analyses in general do not include events due to sabotage. No established method exists for estimating the likelihood of a sabotage event. Nor is there a method for analyzing the effect of security provisions on that likelihood. Security regulations are designed and structured to prevent sabotage on the assumption that the design-basis threat could occur at commercial nuclear power plants without assessing the actual probability or consequences.

The technical information contained in this study shows that the consequences of a zirconium fire would be high. Moreover, the risk analysis could be used effectively to help determining priorities for, and details of, the security capability at a plant. However, no information in the analysis bears on the level of security necessary to limit the risk from sabotage events. Those decisions will continue to be made by a analytical assessment of the level of threat and the difficulty of protecting a specific facility.

4.2.3 Insurance

In accordance with 10 CFR Part 140 (Ref. 10), each 10 CFR Part 50 licensee is required to maintain public liability coverage in the form of primary and secondary financial protection. This coverage is required to be in place from the time unirradiated fuel is brought onto the facility site until all of the radioactive material has been removed form the site, unless the Commission terminates the Part 50 license or otherwise modifies the financial protection requirements under Part 140. On March 17, 1999, the staff proposed to the Commission that insurance indemnity requirements for permanently shutdown reactors be developed in an integrated, risk-informed effort along with emergency preparedness and security requirements. In the past, licensees have been granted exemptions from financial protection requirements on the basis of deterministic analyses that indicate that a zirconium fire could no longer occur.

In the staff requirements memorandum (SRM) for SECY-93-127 (Ref. 11), the Commission suggested that withdrawal of secondary financial protection insurance coverage be allowed after the requisite minimum spent fuel cooling period had elapsed. Further, the Commission directed the staff to determine more precisely the appropriate spent fuel cooling period after plant shutdown. While insurance does not lend itself to a "small change in risk" analysis because insurance affects neither the probability nor the consequences of an event, the NRC staff has considered whether the risk analysis in this study justifies relief from this requirement for a decommissioning plant while it is vulnerable to zirconium fires. The risk analysis in the February 2000 study identified a generic window of vulnerability for an SFP fire until about 5 years after shutdown. The analysis in this study, however, indicates that a zirconium fire cannot be precluded on a generic basis even after 5 years decay. This is because a spent fuel configuration necessary to assure air cooling cannot be assured following a severe earthquake or cask drop event that drains the pool. Since a criteria of "sufficient cooling to preclude a fire" cannot be met and the long-term consequences could be significant (e.g., the long-term consequences (and risk) decrease very slowly because cesium-137 has a half life of approximately 30 years), the staff will need to consider alternative criteria if changes to insurance requirements are to be pursued.

5.0 SUMMARY AND CONCLUSIONS

This study documents an evaluation of spent fuel pool (SFP) accident risk at decommissioning plants. The study was undertaken to develop a risk-informed technical basis for reviewing exemption requests and a regulatory framework for integrated rulemaking. The staff tried to actively involve the public and industry representatives throughout the study. The staff held a series of public meetings with stakeholders during and after the preparation of a preliminary study (published in June 1999 at the request of the Nuclear Energy Institute (NEI)).

The staff published a draft study in February 2000 for public comment and significant comments were received from the public and the Advisory Committee on Reactor Safeguards (ACRS). To address these comments the staff did further analyses and also added sensitivity studies on evacuation timing to assess the risk significance of relaxed offsite emergency preparedness requirements during decommissioning. The staff based its sensitivity assessment on the guidance in Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis." The staff's analyses and conclusions apply to decommissioning facilities with SFPs that meet the design and operational characteristics assumed in the risk analysis. These characteristics are identified in the study as industry decommissioning commitments (IDCs) and staff decommissioning assumptions (SDAs). Provisions for confirmation of these characteristics would need to be an integral part of rulemaking.

The results of the study indicate that the risk at SFPs is low and well within the Commission's Quantitative Health Objectives (QHOs). The risk is low because of the very low likelihood of a zirconium fire even though the consequences from a zirconium fire could be serious. Because of the importance of seismic events in the analysis, and the considerable uncertainty in seismic hazard estimates, the results are presented for both the Lawrence Livermore National Laboratory (LLNL) and the Electric Power Research Institute (EPRI) seismic hazard estimates. In addition, to address a concern raised by the ACRS, the results also include a sensitivity to a large ruthenium and fuel fines release fraction. The results indicate that the risk is well below the QHOs for both the individual risk of early fatality and the individual risk of latent cancer fatality.

The study includes use of a pool performance guideline (PPG) as an indicator of low risk at decommissioning facilities. The recommended PPG value for events leading to uncovery of the spent fuel was based on similarities in the consequences from a SFP zirconium fire to the consequences from a large early release event at an operating reactor. A value equal to the large early release frequency (LERF) criterion (1×10^{-5} per year) was recommended for the PPG. By maintaining the frequency of events leading to uncovery of the spent fuel at decommissioning facilities below the PPG, the risk from zirconium fires will be low and consistent with the guidance in RG 1.174 for allowing changes to the plant licensing basis that slightly increase risk. With one exception (the H.B. Robinson site) all Central and Eastern sites which implement the IDCs and SDAs would be expected to meet the PPG regardless of whether LLNL or EPRI seismic hazard estimates are assumed. The Robinson site would satisfy the PPG if the EPRI hazard estimate is applied but not if the LLNL hazard is used. Therefore, Western sites and Robinson would need to be considered on a site-specific basis because of important differences in seismically induced failure potential of the SFPs.

The appropriateness of the PPG was questioned by the ACRS in view of potential effects of the fission product ruthenium, the release of fuel fines, and the effects of revised plume parameters. The staff added sensitivity studies to its analyses to examine these issues. The consequences of a significant release of ruthenium and fuel fines were found to be notable, but not so important as to render inappropriate the staff's proposed PPG of 1×10^{-5} per year. The plume parameter sensitivities were found to be of lesser significance.

In its thermal-hydraulic analysis the staff concluded that it was not feasible, without numerous constraints, to establish a generic decay heat level (and therefore a decay time) beyond which a zirconium fire is physically impossible. Heat removal is very sensitive to these additional constraints, which involve factors such as fuel assembly geometry and SFP rack configuration. However, fuel assembly geometry and rack configuration are plant specific, and both are subject to unpredictable changes after an earthquake or cask drop that drains the pool. Therefore, since a non-negligible decay heat source lasts many years and since configurations ensuring sufficient air flow for cooling cannot be assured, the possibility of reaching the zirconium ignition temperature cannot be precluded on a generic basis.

The staff found that the event sequences important to risk at decommissioning plants are limited to large earthquakes and cask drop events. For emergency planning (EP) assessments this is an important difference relative to operating plants where typically a large number of different sequences make significant contributions to risk. Relaxation of offsite EP a few months after shutdown resulted in only a "small change" in risk, consistent with the guidance of RG 1.174. The change in risk due to relaxation of offsite EP is small because the overall risk is low, and because even under current EP requirements, EP was judged to have marginal impact on evacuation effectiveness in the severe earthquakes that dominate SFP risk. All other sequences including cask drops (for which emergency planning is expected to be more effective) are too low in likelihood to have a significant impact on risk. For comparison, at operating reactors additional risk-significant accidents for which EP is expected to provide dose savings are on the order of 1×10^{-5} per year, while for decommissioning facilities, the largest contributor for which EP would provide dose savings is about two orders of magnitude lower (cask drop sequence at 2×10^{-7} per year). Other policy considerations beyond the scope of this technical study will need to be considered for EP requirement revisions and previous exemptions because a criteria of sufficient cooling to preclude a fire cannot be satisfied on a generic basis.

Insurance does not lend itself to a "small change in risk" analysis because insurance affects neither the probability nor the consequences of an event. The study found that as long as a zirconium fire is possible, the long-term consequences of an SFP fire may be significant. These long-term consequences (and risk) decrease very slowly because cesium-137 has a half life of approximately 30 years. The thermal-hydraulic analysis indicates that when air flow has been restricted, such as might occur after a cask drop or major earthquake, the possibility of a fire lasts many years and a criterion of "sufficient cooling to preclude a fire" can not be defined on a generic basis. Other policy considerations beyond the scope of this technical study will therefore need to be considered for insurance requirements.

The study also discusses implications for security provisions at decommissioning plants. For security, risk insights can be used to determine what targets are important to protect against sabotage. However, any revisions in security provisions should be constrained by an effectiveness assessment of the safeguards provisions against a design-basis threat. Because the possibility of a zirconium fire leading to a large fission product release cannot be ruled out even many years after final shutdown, the safeguards provisions at decommissioning plants should undergo further review. The results of this study may have implications on previous exemptions at decommissioning sites, devitalization of spent fuel pools at operating reactors and related regulatory activities.

The staff's risk analyses were complicated by a lack of data on severe-earthquake return frequencies, source term generation in an air environment, and SFP design variability. Although the staff believes that decommissioning rulemaking can proceed on the basis of the current assessment, more research may be useful to reduce uncertainties and to provide insights on operating reactor safety. In particular, the staff believes that research may be useful on source term generation in air, which could also be important to the risk of accidents at operating reactors during shutdowns, when the reactor coolant system and the primary containment may both be open.

In summary, the study finds that:

1. The risk at decommissioning plants is low and well within the Commission's safety goals. The risk is low because of the very low likelihood of a zirconium fire even though the consequences from a zirconium fire could be serious.

2. The overall low risk in conjunction with important differences in dominant sequences relative to operating reactors, results in a small change in risk at decommissioning plants if offsite emergency planning is relaxed. The change is consistent with staff guidelines for small increases in risk.

3. Insurance, security, and EP requirement revisions need to be considered in light of other policy considerations because a criterion of "sufficient cooling to preclude a fire" cannot be satisfied on a generic basis.

4. Research on source term generation in an air environment would be useful for reducing uncertainties.

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7.0 ACRONYMS

ACRS	Advisory Committee on Reactor Safeguards
ANSI	American National Standard Institute
ANS	American Nuclear Society
ASB	NRC Auxiliary Systems Branch (Plant Systems Branch)
atm	atmosphere
BNL	Brookhaven National Laboratory
BTP	branch technical position
BWR	boiling-water reactor
CFD	computational fluid dynamics
CFM	cubic feet per minute
CFR	*U.S. Code of Federal Regulations*
DOE	Department of Energy
DSP	decommissioning status plant
ECCS	emergency core cooling system
EOF	emergency operations facility
EP	emergency plan
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
ET	event tree
FFU	frequency of fuel uncovery
FT	fault tree
gpm	gallon(s) per minute
GI	generic issue
GWD	gigawatt-day
HCLPF	high confidence in low probability of failure
HRA	human reliability analysis
HVAC	heating, ventilation, and air conditioning
IDC	industry decommissioning commitment
INEEL	Idaho National Engineering and Environmental Laboratory
ISFSI	independent spent fuel pool installation
kW	kilowatt
LERF	large early release frequency
LLNL	Lawrence Livermore National Laboratory
LOSP	loss of offsite power
LWR	light-water reactor

MR	Maintenance Rule
MW	megawatt
MWD	megawatt-day
MTU	metric ton uranium
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
NRR	NRC Office of Nuclear Reactor Regulation
OSC	operations support center
POE	probability of exceedance
POF	probability of failure
PPG	pool performance guideline
PRA	probabilistic risk assessment
PWR	pressurized-water reactor
QA	quality assurance
QHO	quantitative health objective
RES	NRC Office of Regulatory Research
RG	regulatory guide
SDA	staff decommissioning assumption
SF	spent fuel
SFP	spent fuel pool
SFPC	spent fuel pool cooling system
SFPCC	spent fuel pool cooling and cleaning system
SHARP	Spent Fuel Heatup Analytical Response Program
SNL	Sandia National Laboratory
SRM	staff requirements memorandum
SRP	standard review plan
SSC	systems, structures, and components
SSE	safe shutdown earthquake
TS	technical specification
TSC	technical support center
UKAEA	United Kingdom Atomic Energy Authority
WIPP	waste isolation pilot plant

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TheJournalNews.com
The online information source for Westchester, Rockland and Putnam

NEWS

Saturday October 20

Environment

Indian Point chief: Plant safe from possible attack

By ROGER WITHERSPOON
THE JOURNAL NEWS
(Original publication: Oct. 20, 2001)

If a wide-bodied jet were to fly into one of Indian Point's two nuclear power plants, it is unlikely the crash would cause enough damage to trigger a nuclear catastrophe, the chief executive of the company that owns the plants said yesterday.

Mike Kansler, head of Entergy Nuclear Northeast, said that the plants' massive, concrete containment buildings and internal barriers should prevent a major incident. But he acknowledged that there is no evidence to substantiate that belief.

"People are worrying about a plane crashing through," Kansler said during a meeting with The Journal News Editorial Board. "While it is true they were not specifically designed, and we have not done the calculations to say that these plants could specifically withstand a 767 or 747 hitting it, our belief is because of the robustness of the design, the way they were built, the way the reactors were placed in the building, we believe the plant could survive such an incident."

He added that there are several barriers within the containment buildings protecting the nuclear reactor and its 30 tons of fuel. A plane, he said, "may be able to penetrate the containment building, but not the rest."

Kansler said that in the wake of the Sept. 11 attacks on the World Trade Center, there was a public perception that the two nuclear plants at Indian Point, and their huge pools of spent nuclear fuel, were potential targets for a similar suicide attack.

Kansler said he did not believe the plants at Indian Point were a tempting terrorist target. In the worst case scenario, a serious accident at the plants in Buchanan could affect more than 20 million people within a 50-mile radius in New York, New Jersey, Connecticut, and Pennsylvania.

"They are not a preferred target," Kansler said. "A plane did fly down the Hudson River on its way to the World Trade Center. But the World

Trade Center is a much neater target for a plane to go after. It has much more of a public impact than a nuclear plant."

The U.S. Nuclear Regulatory Commission recently acknowledged that such plants were never designed to withstand an attack by a fuel-laden, wide-bodied jet.

"We have not done the analysis, so we are not going to guarantee that a plane of that nature couldn't breach the containment," NRC spokesman Neil Sheehan said yesterday. "We are quick to add that these are very hardened structures, they have a lot of systems in place to shut down the reactor in the event of an attack like that."

Kansler and other Entergy officials would not specify what security measures were in place at Indian Point, citing safety concerns. But they said the measures did take into account the possibility of an aerial attack. Kansler said he did not believe anti-aircraft missiles were the best way to protect plants, and questioned how it would be determined that a commercial airplane was headed toward the plants.

He and other company officials also said that the NRC and federal government also were responsible for helping to protect nuclear plants during times of war, whether officially declared or not.

Kansler said that if a plane crashed into one of the containment domes and did not cause a nuclear meltdown, "it is not going to have the devastation and disruptive impact that you get hitting the World Trade Center or hitting the Pentagon. And we believe the plant is viable and it could withstand such an attack."

The Coast Guard has been providing protection along the Hudson River since Sept. 11, and had announced its intention to end its patrols Monday. That decision prompted state and federal officials from Westchester to demand that the 24-hour surveillance continue. Gov. George Pataki, who visited Indian Point yesterday, announced that the Coast Guard would maintain its 24-hour patrols.

Kansler said he was not concerned about the presence or departure of the Coast Guard vessels.

"We can deal with a security threat, no matter what kind it is," he said.

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Energy and Environment Full Story

Nuclear plant scare adds to U.S. security jitters
Thursday, October 18, 2001 04:44 PM ET

By Vibeke Laroi

SAN FRANCISCO, (Reuters) - A security scare at the Three Mile Island power plant sent jitters through the U.S. nuclear power industry Thursday, driving

home the urgent need to rewrite outdated rules to met new threats following the Sept. 11 attacks.

Those attacks on the World Trade Center and Pentagon have opened up a previously unthinkable, possibility: using a big airliner to smash into a nuclear power station.

"No one considered the possibility of suicide hijackers steering a large aircraft into a nuclear plant," said Victor Dricks, a spokesman with the Nuclear Regulatory Commission (NRC), which oversees the nuclear industry.

"That was not considered ... a 'credible threat'. That's an act of war. Some

senarios that we previously did not consider credible may now need to be considered."

Under current NRC regulations, a plant has to be able to defend itself against a small group of terrorists attacking from the ground with inside help.

As part of an ongoing comprehensive review of its regulations, the Washington-based NRC shut down its Web site to rethink its policy of posting

thousands of documents.

For each of the country's 103 nuclear power reactors, the NRC had put on its

Web site engineering drawings, photographs of the plants and detailed technical data describing the function of dozens of safety-related systems.

There were also aerial photographs of portions of sites, "which clearly

could
be of use to potential terrorists planning an aerial assault," Dricks said.

The NRC has decided to permanently cut from its Web site the latitudes and longitudes pinpointing the positions of all U.S. nuclear plants, he added.

THREATS

On Thursday, U.S. officials dismissed an unspecified threat to the Three Mile
Island nuclear power station as no longer credible, less than a day after putting the Pennsylvania plant on high alert and shutting two nearby airports.

The nation's 103 commercial reactors were already on heightened alert following the Sept. 11 attacks.

A few intrusions on nuclear plants have been reported, like in 1993 when a car, driven by an person with a history of mental illness, crashed through the outer gates of the Three Mile Island compound.

But a U.S. nuclear reactor has never been attacked.

The NRC says reactors, with their robust steel-enforced concrete containment

buildings and multiple safety systems, are, "among the most hardened structures in the country designed to withstand hurrianes, tornadoes and earthquakes.

"However, we could not rule out the possibility that a large aircraft like a

(Boeing) 767, fully loaded with fuel, deliberately crashed into a containment
building might not cause some structural damage that could release some radiation," Dricks said.

He added detailed engineering analyses of a large airliner crash on a nuclear
plant have not yet been performed.

But Paul Leventhal, president of watchdog group Nuclear Control Institute (NCI) warned that a Boeing 767 flown at full speed could penetrate a reactor

containment vessel, causing a meltdown and release of radiation.

"The consequences are so unthinkable that a successful attack has to be prevented at all costs," he told Reuters.

The NCI is calling on the government to immediately station National Guard soldiers and anti-aircraft weapons around each nuclear plant to boost their defense.

"We sent letters to the governors of 40 states, all of which have nuclear plants, urging them to establish close communication with the National Guard

within their borders in the event that they need assistance. So that's been left in their hands," Dricks said.

So far, New York and New Jersey have called up National Guard troops to protect the plants.

"We have taken steps to ensure the plants will be able to defend themselves against a wider variety of attacks ... and that includes attacks from the air
and water," Dricks said, without going into details.

The Federal Aviation Administration (FAA) has also issued an advisory to pilots urging them to stay away from nuclear plants, regardless of whether they are in their flight path.

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Nation & World 9/17/01

A nuclear nightmare

BY DOUGLAS PASTERNAK

He called it Project Worst Nightmare. And in the twisted mind of Donald Beauregard, commander of the 77th Regiment Militia in St. Petersburg, Fla., it surely was. Beauregard's plan was simple–disable the electric power grid feeding the nearby Crystal River nuclear power plant with explosives stolen from a National Guard armory. That would shut down the plant, blacking out St. Petersburg. This was no idle fantasy. When the cops finally caught up with him, Beauregard and his "strike team" had a 20-mm cannon, a .50-caliber machine gun, and a few pipe bombs primed to blow.

Beauregard might have succeeded if an informant hadn't tipped the police. He was prosecuted and clapped off to prison last year. But the FBI took Beauregard's plan seriously enough to incorporate it into a test it ran last May against the Palo Verde nuclear generating station in Arizona.

And here lies the rub. In the past decade, nearly half the nation's 103 power plants have failed mock terrorist attacks against them. The plants that failed, in other words, would not have stopped the Donald Beauregards of the world.

In the parlance of counterterrorism, nuclear power plants are among the world's most "hardened" targets. Barbed wire, surveillance cameras, motion sensors, armed response teams–all are designed to make the plants impenetrable to even the most determined saboteur. But interviews with current and former Nuclear Regula- tory Commission inspectors, security experts, and plant guards paint a very different picture. Often, security measures at nuclear plants don't work as they should or don't work at all. A re- view of recent incidents by *U.S. News* reveals numerous breakdowns in plant security, from criminals being granted access to sensitive areas to inadequate security that places vital equipment within easy reach of an attacker who never even enters the plant's perimeter.

Security experts say a terrorist is far more likely to attack a so-called soft target– such as a government building–than a nuclear power plant. Indeed, argues Lynnette Hendricks of the Nuclear Energy Institute, the nuclear power trade group: "We believe the plants are overly defended at a level that is not at all commensurate with the risk." But in light of attacks against fortified targets such as U.S. embassies, threats against nuclear plants are now considered very real. And concerns about security are likely to mount as the Bush administration calls for greater use of nuclear power. Last year, for instance, Japanese police arrested a man with seven pipe bombs who was planning to blow up a uranium processing plant. Last September, Ukrainian police arrested a group planning to sabotage the Chernobyl reactor. And in the United States, officials list at least 30 threats against nuclear plants since 1978. Most have been hoaxes, but in the mid-1980s, for instance, three of four power lines leading to the Palo Verde plant were sabotaged. And in 1989 four members of Earth First!, a radical environmental group, were charged with conspiring to disable three nuclear power plants in the Southwest.

Rating risks. Despite the threats and the documented security flaws, the nuclear industry has convinced the Nuclear Regulatory Commission–the federal agency that oversees nuclear power plants–that security at these sites would function better with less federal oversight. So starting this fall, the NRC will launch a pilot program allowing the power companies to design their own security exercises–a function formerly performed by federal terrorism experts. The industry says the new program will cost the plants less, yet allow for more frequent tests. But opponents, including many within the NRC, say the industry's track record has hardly earned it the right to looser regulation. In the past year alone, NRC inspectors have discovered alarms and video surveillance cameras that don't work, guards who can't operate their weapons, and guns that don't shoot. "I am very skeptical about the nuclear industry's ability to regulate itself," says Rep. Edward J. Markey, a vocal critic of nuclear security.

High on critics' lists of concerns is the failure rate in the NRC-run mock terrorist assaults–attacks that, if real, could have released radiation more lethal than the 1986 Chernobyl accident that resulted in an estimated 32,000 deaths. These exercises, called Operational Safeguards Response Evaluations, or OSREs, have been run by an outspoken former U.S. Navy SEAL captain named David Orrick. In a typical exercise, a team of three "terrorists" armed with small weapons and basic knowledge of how a plant works attempts to penetrate the facility. They evade or disable security equipment and destroy a set of targets in an effort to damage the plant's nuclear core, causing a radioactive release. In some cases, the mock terrorists make it all the way to the sensitive control room–even though they give plant operators ample advance notice of when they intend to strike.

Proponents of the NRC's mock attacks say they teach valuable lessons. In 1999, the Waterford 3 Nuclear Plant in Taft, La., failed a preliminary mock attack, but the plant's managers said that the exercise did not reflect the plant's true capability. So Orrick's team returned last year to conduct a more rigorous exercise against the plant. "We [the NRC team] just ate them alive," says one NRC inspector. The Waterford 3 site then hired more guards, improved training, and fortified physical barriers. They finally passed an NRC exercise last January. And in May, security guards easily apprehended a man with a history of mental illness who scaled a 10-foot, barbed-wire fence surrounding the site.

Still, critics charge that even the NRC's mock terrorist attacks do not reflect today's real-world scenarios. "There is nothing about protecting against a helicopter assault or a missile taking out one of our positions," says one plant security guard. Last September, for instance, an anti-nuclear demonstrator landed a motorized parafoil on the roof of a nuclear reactor in Bern, Switzerland, before being apprehended by security guards.

While nuclear plant operators design much of their security to prevent attacks from the outside, the record suggests that the greater danger lies within. "If somebody got a job as a janitor and got access to the plant, that's the real threat," says Erik Pakieser, former nuclear security officer at the Prairie Island nuclear generating plant in Minnesota. For instance, at the same time Donald Beauregard was cooking up his Project Worst Nightmare, a maintenance technician at the Crystal River site discovered that someone had intentional- ly disabled one of the plant's |emergency diesel generators. Some nuclear security experts also believe that sabotage should not have been ruled out so quickly as a possible cause of the 1979 accident at the Three Mile Island nuclear plant. Scientists at the Los Alamos National Laboratory found striking similarities between the incident and a computer-generated sabotage scenario they had run several months earlier.

Two decades later, critics remain troubled by the sorts of individuals who can gain access to a nuclear plant. In the early 1990s, a carpenter named Carl Drega got jobs at three nuclear power plants in the Northeast despite an arrest record and a job reference that described him as "volatile." Two months after Drega left the third plant, in 1997, he shot four people to death, including two state troopers, a judge, and a newspaper editor. An NRC investigation of the incident found that none of the three plants had violated their regulations by hiring him.

Easy access. Another insider, a computer programmer who once worked in the control room at the Maine Yankee nuclear power plant, goes to trial next year for murdering seven of his coworkers at a small Massachusetts technology company. Plant coworkers said the programmer, Michael McDermott, slept in a coffin and told a colleague he was sometimes so angry he felt like killing someone. In 1998, a worker at the Turkey Point nuclear plant in Florida had free access to critical areas of the plant for more than a month before officials learned of his 14 arrests. And at the Calvert Cliffs plant in Maryland, officials took eight months to learn that a worker was an illegal Mexican immigrant with fake identification papers and an arrest record. "Charles Manson could get access to a nuclear power plant," says former nuclear security officer Richard Kester.

But some experts worry that attackers can succeed even without getting inside. Classified reports from Sandia National Laboratories show that a well-placed truck bomb would not even have to enter a site's property to destroy vital equipment, leading to a possible release of radiation. In addition, experts say, the water-intake systems at some plants are particularly vulnerable to sabotage by either cutting off the water supply by clogging the intake valve or introducing volatile chemicals into the reactor's cooling system.

An even more accessible target may be spent nuclear material piling up at these plants. Large cooling pools inside reactor containment buildings were designed to store this fuel, but several years ago the pools began to fill up. Now, at many plants, the highly radioactive fuel is stored in cooling pools outside the containment building. "A lot of the spent nuclear fuel casks can be hit with a shoulder-fired missile by someone standing outside the fence," says Dave Lochbaum, nuclear safety engineer at the Union of Concerned Scientists. Yet at plants that are being decommissioned, the nuclear fuel is even less clos guarded. The Maine Yankee plant, which has stored 700 tons of spent fuel in outside cooling pools, has removed all of its vehi- cle barriers and received the NRC's permission to eliminate its armed guard force once the fuel is placed into dry casks.

The chairman of the NRC, Richard Meserve, says that no matter who runs the security drills, the plants remain among the world's most heavily guarded sites. And he says that the NRC mock attacks are expensive for both the commission to run and the plants to prepare for. "The reason we are making a big deal about this," says the Nuclear Energy Institute's Hendricks, is that the corrective actions resulting from these exercises " can have a tremendous impact" on a plant owner. "It can cost a million dollars to make these upgrades [of plant security]," she says. In any case, says Meserve, the new self-assessment pro- gram is only a trial: If it doesn't work, he says, it will be scrapped.

But the chorus of nuclear industry critics continues to grow. "The overall focus [at these sites] is not to protect the public but to get the NRC's blessing and ensure profits," says one nuclear security officer. Starting next week, the Waterford 3 plant, which had boosted security to pass the NRC's terrorist exercise, will begin to reduce its training programs and its guard force. "As soon as the NRC leaves," says one guard, "they downgrade security."

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Paul L. Leventhal, Class of '59
President, Nuclear Control Institute

Commencement Address to the Class of 2001
Franklin & Marshall College
Lancaster, PA
Sunday, May 13, 2001

It has been 42 years since I sat, as you are sitting, as a member of the graduating class of Franklin and Marshall College, looking up at the commencement speaker and thinking to myself, as you may well be thinking, "This guy is the last thing standing between me and my diploma."

With that in mind, let me tell you a story about Mario Cuomo, the former Governor of New York when he received his first invitation to speak at a graduation from his alma mater, St. John's University. He asked Father Flynn, the President of St. John's University how he should approach it. "Commencement speakers," said Father Flynn, "should think of themselves as the body at an old-fashioned Irish wake. They need you in order to have the party, but nobody expects you to say very much."

That's advice I intend to follow today, and I thank President Kneedler and the college trustees for giving me this opportunity to return to F & M and deliver my first graduation speech. And I will particularly cherish the Doctor of Laws degree I have just received. I am an ex-newspaperman who works in Washington and is always surrounded by lawyers. Now I outrank most of them.

At my graduation in 1959, I felt what many of you may be feeling today---above all, a magnificent and exultant sense of relief, but beneath it all, a persistent sense of confusion and trepidation about what lies ahead. Today marks your day of commencement, so let me help you put this glorious and conflicted moment of self esteem and self-doubt into perspective. Consider this the friendly shove that launches you on that proverbial journey of a thousand miles that begins with but a single step.

First, let me assure you that while that first step is a big one, you come well-equipped for the journey. I have grown to appreciate the remarkable education I received here at F & M, and I think over time, each of you will come to your own appreciation of what it is about this college that serves you so well over a lifetime. For me, it is an appreciation of Franklin & Marshall as, above all, a teaching school. Here there is a faculty of scholars who love to teach, and to reach the students they teach, and the impact these teachers had upon me was profound.

From Professor Vanderzell, in constitutional law, I learned of the

Farrell: Socrates Medalist

Lehman: Socrates Medalist

Tyndall: Socrates Medalist

overriding importance of the test of reasonableness, not only in assessing the political orientation of the Supreme Court at various periods in its history, but in evaluating the policies of the Executive Branch and the initiatives of Congress. The F & M Department of Government in those days had but three professors, extraordinary teachers all. We government majors used to joke about them being Philosopher Kings, the ruling elite from Plato's "The Republic." I owe a special debt to those three professors---John Vanderzell, Sid Wise and Dick Schier---because they disciplined my mind, taught me the values of social justice, stimulated my appetite for public affairs and--perhaps most important---got me used to unreasonable demands and hard work.

Which brings me back to the voyage upon which you are about to embark. What kind of trip will it be? You are embarking in an auspicious year.

The year 2001, thanks to the combined genius of screenwriter Arthur C. Clarke and director Stanley Kubrick, has a special meaning associated with human discovery and evolution. But while art often imitates life, life rarely lives up to the expectations of art. Mankind has not yet colonized the moon, much less sent an expedition of human beings to Saturn. Yet, the inscrutable complexities of this remarkable motion picture, especially its soaring finale of re-birth, somehow seem to be reflected in a technology-driven self-confidence that characterizes the human spirit we find in America today.

Compare this vision of 2001 with George Orwell's vision of 1984. To me and my F & M classmates in 1959, Orwell provided a disturbingly plausible version of what the future might hold. We had just lived through the political nightmare of McCarthyism and we were still living under the threat of nuclear war with the Soviet Union, a threat that was to reach its crescendo in the Cuban missile crisis three years later. Fortunately, 1984 came and went without a nuclear war, nor with an Orwellian Big Brother and his Thought Police displacing American democracy.

Yet, the question of whether American democracy is becoming dangerously dysfunctional has been the subject of a lively debate at F & M this year, with one visiting scholar warning that self-government is devolving into what he called "a process of socialization in which a political class tells us how to live." Today there is a growing sense of powerlessness in the face of Big Government, Big Money and the combining of the two into Big Power over our daily lives. More and more Americans are tuning out the politicians and the political process and are lasering in on making a good living and enjoying the good life. This pursuit of happiness, of course, is as American as apple pie, not to mention the Bill of Rights.

But these science- and political-fiction visions of the future are pertinent to the journey you begin today because, in truth, we have no way of predicting what the future will bring, or what our own role in shaping that future might be. Einstein once said, "Knowledge of what is does not open the door directly to what should be." But of one thing we can be quite sure. Whether we ultimately experience a great spiritual rebirth on the wings of technology, as envisioned in 2001, the movie, or a subjugation of the human spirit, as foreseen by Orwell, or a "return of the Stone Age on the wings of science," as Winston Churchill described the nuclear peril in 1946, depends not on some cosmic roll of the dice, but on a personal commitment by you to engage in the decisions by your government on which your future depends.

Be vigilant because, even in these seemingly good and peaceful times, there are dangers that are not widely understood and sometimes not easily seen, both at home and abroad. If we fail to recognize and reverse them, they could threaten our very survival. One such danger that I have been addressing in my work is the spread of nuclear weapons to additional nations and possibly even to terrorist groups. But when I set out 42 years ago as you are doing today, I had no way of knowing I would wind up, of all things, a nuclear non-proliferator.

I knew exactly what I wanted to do when I graduated from F & M. I wanted to be a journalist, and spent a decade in pursuit of this dream, most of it at Newsday as an investigative and political reporter. Journalism is a wonderful career because you never know what you might be covering next or where your work will lead. A classmate of mine at Columbia Graduate School of Journalism who was also a night copyboy with me at The New York Times was Joseph Lelyveld, now the Executive Editor of the Times. He recently told me, "What I've liked about this business from the start is that you can't see your path to the grave as clearly as you can in the more respectable professions."

I eventually came to feel, after covering politicians at the local, state and national levels, that a journalist was confined to being an observer, a commentator. The real challenge, I decided, was to get inside government and try to make it work. My big break came when the press secretary's job opened up in the office of a brainy, gutsy and workaholic United States Senator, Jacob Javits of New York, and he hired me to come to Washington. Javits was a liberal Republican. (In those days, "liberal Republican" was not an oxymoron!) I joined him in turbulent times at the start of the Nixon-Agnew Administration when Washington was under siege by anti-Vietnam War protesters. What a political learning experience that was!

By the way, perhaps the best piece of advice I ever got came from Javits, and I'd like to pass it on to you now. It was some years later when he was suffering the ravages of Lou Gehrig's disease. This disease destroys the body but leaves the brain intact. Sitting in a wheelchair and hooked to a respirator, Javits bid farewell to a reunion of his Senate staff "I leave you with four words," he whispered, which made us take notice because this Senator was famous for not being able to say anything in less than four thousand. And he said: "Demand excellence, take risks." Brilliant, I thought. Those words surely summed up his distinguished career, which began in poverty on New York's Lower East Side. And I have sought to apply them to my own work. And I say to you, if you demand excellence of yourself and those who may someday work for you, and you are prepared to take risks, you will probably reach where you are trying to go.

It's when I later went to work for a Democratic Senator, Abraham Ribicoff of Connecticut, that I had my first encounter with atomic energy. As an aide to a government operations subcommittee chaired by Ribicoff, I was assigned to handle a bill that came from the Nixon White House to reorganize the Atomic Energy Commission. We needed to transform the AEC into an all-energy agency capable of responding to challenges posed by the first Arab oil embargo of 1973. So, by chance of a bill referral, I was introduced to atomic energy.

For me, it was a baptism in fire, with no advanced warning, and it changed my life. This was the first time atomic energy legislation was assigned to a Congressional committee other than the then all-powerful Joint Committee on Atomic Energy, which had close ties with the nuclear industry and bureaucracy. But I saw a need to do things different from the way the Joint Committee wanted things done---in particular, to make a clean break between regulation and promotion of atomic energy. There was a need to eliminate conflicts of interest inside the AEC that compromised the safety and security of nuclear power plants. So, with support from Chairman Ribicoff, we overcame objections from the Joint Committee and crafted a new law that "fissioned" the AEC--split it into the present-day Nuclear Regulatory Commission and Department of Energy.

There were some eye-openers for me in the course of doing this work. I learned that plutonium, the essential material of nuclear weapons, is produced in civilian nuclear power plants as a byproduct of generating electricity with uranium fuel. The United States was planning to extract plutonium from the highly radioactive, self-protecting spent fuel of these plants. And we were going to give permission to other countries to remove plutonium from the uranium we exported to them for use in their plants. This atom bomb material was going to be "recycled" as fuel in civilian nuclear plants. But there was a big problem, and that was that the level of protection against thefts and diversions of civilian plutonium was far below protection of military plutonium. And there was another problem: Plutonium is so poisonous that if a speck of it the size of a pollen grain gets caught in the lung, it causes cancer.

Through domestic law and regulation, we stopped the plutonium business in the United States. Spent fuel from U.S. nuclear power plants is now supposed to be disposed of as waste inside a mountain in Nevada, without recovering plutonium. But export controls enacted in another law I worked on--the Nuclear Non-Proliferation Act of 1978--failed to stop extraction of plutonium from fuel the United States supplied to Europe and Japan. And the flow of nuclear technology and materials from industrial countries to the developing world has continued. As a result, there is now more plutonium in civilian hands than in all of the nuclear weapons in the world. And some of it has already been turned into bombs, as in India, Pakistan and North Korea, while others have used or are now using civilian nuclear programs as a cover for weapons programs. Of greatest immediate concern are Iran and Iraq, and Japan's neighbors are wondering why the Japanese are accumulating so much plutonium.

I founded the Nuclear Control Institute 20 years ago after the Reagan landslide cost me my Democratic Senate job, then with Gary Hart of Colorado. I had just finished codirecting the Senate's investigation of the Three Mile Island nuclear accident and became acutely aware of that ineffable combination of human fallibility and mechanical failure that makes nuclear plants vulnerable to accidents, and also sabotage. This institute now serves as a research and advocacy center where work can continue on reducing nuclear dangers, especially on preventing the further spread of nuclear weapons and raising effective barriers against nuclear terrorism.

So, what lessons can I share with you from my own journey since graduating from Franklin & Marshall College? The first is this: Be prepared to be surprised, just as I was surprised to become a nuclear specialist. You never know where your work will lead. If you have no clear career objective now, that's O.K. The important thing is to get a job, work hard at it, and see where it leads. If you know what you want to do, pursue that career passionately and see if it leads to where you want to go.

I ended up working in public affairs. You surely don't get rich laboring in the public interest, but it can be an enriching experience. At the same time, if you manage to be effective in taking on powerful political and industrial interests, the frustrations can run high and the going can get rough. For the large majority of you who will work in the private sector, you still have a responsibility to engage in public affairs. President Eisenhower, in his famous farewell, warned of "the acquisition of unwarranted influenceÉby the military-industrial complex." But he also declared that "only an alert and knowledgeable citizenry" can ensure "that security and liberty may prosper together."

Vigilance and tenacity are absolutely essential. In public affairs, it is distressing to find that there is a tendency for issues to come full circle, and to find yourself back where you started. I will offer a few examples from my field.

- Nearly 30 years after Congress established an independent nuclear regulator, there are complaints from Capitol Hill that the nuclear power industry is being crippled by over regulation. The agency is now being intimidated by budget cuts to be more compliant. It has begun a process of granting life extension to America's aging fleet of 104 power reactors even in the face of a rash of forced shut downs due to equipment failures caused by aging. It was a forced shut-down that triggered the Three Mile Island accident.

- In addition, the security guards at half the nuclear power plants in the United States have failed to repel mock terrorist attacks against safety systems designed to prevent a reactor meltdown. These are socalled "force-on-force" exercises supervised by the Nuclear Regulatory Commission. The NRC refuses to take enforcement action in response to the failures, and is in the process of weakening the rules of the game in response to industry complaints. Sabotage of nuclear power plants may be the greatest domestic vulnerability in the United States today. This is the time to strengthen, not weaken, nuclear regulation.

- Some 25 years after enactment of the Nuclear Non Proliferation Act, there is a push on Capitol Hill to lift sanctions against nuclear and military transfers to India and Pakistan despite their nuclear weapons tests of 1998. Both countries used civilian nuclear power programs as a cover for development of nuclear weapons. Other nations known to be or suspected of developing nuclear weapons, like Iraq, North Korea and Iran, will be watching closely to see if U.S. and international sanctions against proliferation are weakening.

- The 20-year ban on use of plutonium fuel in U.S. power reactors is now at risk. There is a U.S.-Russian plan to dispose of excess military plutonium from retired warheads by using it as fuel in power reactors in both countries, rather than dispose of it directly as waste. The plutonium fuel plan raises safety and security risks, especially in Russia. But the Bush Administration has just zeroed out funding for the alternative approach of combining the excess plutonium with highly radioactive waste for disposal in the mountain in Nevada along with civilian spent fuel. And now plutonium advocates on

Capitol Hill are even suggesting that the program for geological disposal of spent fuel was a mistake and want to emulate the highly uneconomic and extremely risky European and Japanese plutonium programs.

- It's been more than 20 years since construction began on a U.S. nuclear power plant, but the Bush Administration may announce next week a plan to encourage nuclear power plant construction in response to electricity shortages and global warming. This policy is flawed for three reasons. First, new nuclear plants could not be brought on line quickly enough to offset present shortages, which are caused primarily by lack of electrical transmission capacity, not production capacity. Second, these plants could not make a big dent in global warming because two-thirds of carbon-dioxide emissions, a major contributor to global warming, come from transport and other non-electric sources. Third, turning to the world stage, if carbon-free nuclear plants were used to replace coal plants worldwide, there would have to be a 10fold increase to 3,000 nuclear plants. That would reduce carbon emissions by only 20%, but plutonium commerce would expand enormously, to millions of kilograms a year.

To give you an idea of the weapons significance of millions of kilograms of plutonium, listen to Dr. Theodore Taylor, who was America's most creative atomic bomb designer in the 1950s and is a member of our Institute's board. "The bomb that destroyed Nagasaki," he said, "set off an instant of explosive energy equivalent to a pile of dynamite as big as the White House that was contained in a sphere of plutonium no bigger than a baseball." That was a first-generation atomic bomb, made with about 6 kilograms of plutonium, and it is a technological feat that is now within the grasp of radical states or terrorists, if they manage to get their hands on the plutonium.

Ultimately it comes down to a test of reasonableness. Is it reasonable to assume, over time, that millions of kilograms of plutonium can be sequestered down to the few kilograms needed for a bomb that can destroy a city? This question, in my view, must be answered before giving any further comfort to an industry that remains officially committed to using plutonium as a fuel---and surely before supporting an extension and expansion of that industry in response to electricity shortages and global warming.

Today, there is an historic opportunity to turn away from plutonium, by supporting development of nonnuclear energy strategies and by supporting nuclear arms control and disarmament. The question is, will we seize this opportunity, or will we squander it?

On our Institute's original Board was the late historian, Barbara Tuchman, who in her book The March of Folly gave a sobering description of a phenomenon, one repeated throughout recorded history, that drives nations to destruction. Folly, she wrote, was "pervasive persistence in a policy demonstrably unworkable or counterproductive." To qualify as folly, she said, it "must have been perceived as counter-productive in its own time, not merely by hindsight,É(and) a feasible alternative course of action must have been available."

But on this joyous day, let me close on an optimistic note. I would not be in the business I am in if I were not an optimist. I remain confident that our great nation will avoid the march of folly and steer the world clear of the slippery slope of nuclear proliferation. DeTocqueville, in observing democracy in a much younger America, wrote, "É(T)he great privilege enjoyed by the Americans is not only to be more enlightened than the other nations, but also to have the chance to make mistakes that can be retrieved."

I believe what deTocqueville said remains true to this day, and that an informed and engaged citizenry---led by you, the F & M graduates of 2001---will ensure that an enlightened America will endure and prevail.

Finally, let me say that I could not be in this business without the support and advice of my wife, Sharon Tanzer, the vicepresident of Nuclear Control Institute, who is here today with our sons, Ted and Josh, and without the further encouragement of my brother, Warren Leventhal, F & M Class of '53, and his wife Gloria, who are also here today.

To the Class of 2001, my congratulations to you all, for all the hard work that has brought you to this day of commencement--and for all your achievements in days to come. And on this Mother's Day, congratulations to the mothers, and the fathers, too, whom you have made so very proud.

Thank you and good luck to you all.

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In the news: Indian Point 2

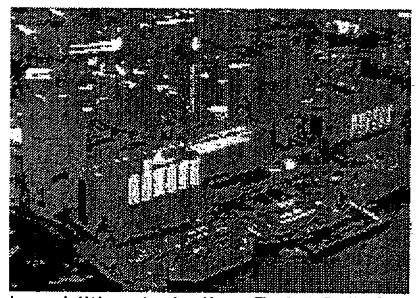
On Feb. 15, 2000, ConEdison's Indian Point 2 nuclear generating station in Buchanan sustained the most serious accident in its 26-year operating history.
This page includes key developments in the continuing story, as reported by The Journal News.

NRC flags ConEd with red tag for Indian Point

By SHAWN COHEN
The Journal News
(Original publication: 11/21/2000)

BUCHANAN — Indian Point 2 gained a dubious distinction yesterday when it became the first of the nation's 103 commercial nuclear power plants to be designated "red" — the highest risk assessment — by federal regulators for failing to detect flaws in a steam generator tube before the February radiation leak.

As a result of this violation, Consolidated Edison will face the Nuclear Regulatory Commission's highest level of scrutiny for at least a year. It will be required to open its doors to more frequent and thorough inspections, as well as pay for them. The NRC all but blamed Con Edison for the tube rupture, saying the utility should have detected corrosion during a 1997 inspection.



In addition to Indian Point 2 (left) the nuclear complex in Buchanan includes defunct Indian Point 1 (low dome in center) and Indian Point 3.

ConEd knew steam generators were defective

For more than 20 years, ConEd operated steam generators that it knew were defective. In fact, ConEd and other utilities had sued the manufacturer of the steam generators, and when the case was settled ConEd was given replacements.

But ConEd did not install the replacements until after a coolant pipe rupturned releasing radioactive water and steam. (Story published 2/18/2001)

"The (NRC) team concluded these failures resulted in tubes with flaws being left in service following the 1997 inspection until one of these tubes failed in February," the NRC said, adding that this "resulted in a significant reduction in safety margin during the plant's operating cycle."

The Feb. 15 emergency began when a steam generator tube cracked and began spewing radioactive water at a rate of 100 gallons a minute inside the plant. Con Edison declared the plant's first-ever emergency alert and quickly brought the leak under control. The plant, which is replacing its steam generators and hopes to reopen next month, has come under greater scrutiny since February.

During the spring, the NRC added Indian Point 2 to its "agency focus" list as part of a process designed to help the NRC keep an eye on troublesome plants. The utility is one of just two plants on the list. At the same time, the NRC established the color codes, ranging in severity from green to white to yellow to red, to assess specific plant problems.

In a preliminary report in August, the NRC categorized the 1997 inspection as a "red" violation of "high safety significance." It criticized Con Edison's testing methods, saying it could have noticed flaws, had it used an electrical probe properly and could have prevented the leak had it

Timeline

This timeline lists key events since the Indian Point accident, as reported in The Journal News on the dates shown. Click on any date to read a news story from our archives. Stories are listed chronologically; for the latest report, start at the of the timeline.

Feb. 16, 2000
For the first time in the 26-year history of the plant, ConEd declares an emergency at Indian Point 2 after a coolant pipe ruptures and spills radiocative water.

Feb. 17, 2000
The state of emergency is lifted and ConEd begins investigating the cause of the accident.

Feb. 19, 2000
A team of seven NRC inspectors are en route to Buchanan for an on-site review of ConEd's response to the accident.

Feb. 23, 2000
Westchester County officials voice skepticism about ConEd's preparedness for a nuclear accident.

March 1, 2000
Small amounts of radiation may have leaked into the air during the Feb. 15 incident, but the NRC said the levels were too low to be detected.

March 6, 2000
Ten years ago, ConEd said it would consider replacing the steam generators. March 15, 2000
ConEd tells the NRC that it plans to plug the leaky pipe and make other repairs, but won't replace the steam generator.

March 17, 2000
The NRC says the crack that

taken corrective actions.

Con Edison, which challenged this in September when it urged a "yellow" finding, raised objections again yesterday.

"As we have consistently said since February, our 1997 steam generator inspections used the most sophisticated technology and analysis at the time," said Con Edison spokesman Michael Clendenin.

"We submitted all required inspection documentation, which was reviewed and subsequently approved by the NRC. We believe all of our actions were thorough and prudent," Clendenin said.

But yesterday, the NRC stood firm. The red finding lasts a year and could be extended if Con Edison doesn't show signs of improvement, said Neil Sheehan, spokesman for the NRC Region 1.

"If they get several red findings against them, they could end up in a situation where we might shut them down," Sheehan said.

He noted that Con Edison received a "white" violation for its handling of a reactor shutdown in August 1999, during which an emergency diesel generator malfunctioned.

The NRC's inspector general has said the NRC itself was partly responsible for the 1997 inspection, because it failed to catch mistakes in the data. But the

caused the February leak might have been visible during a 1997 inspection of the plant.

March 25, 2000
Modifying an earlier report, the NRC says flaws discovered in a 1997 inspection could not have predicted the radiocative leak.

March 30, 2000
Federal regulators say ConEd responded properly and promptly to the emergency.

April 8, 2000
Public interest groups and nuclear watchdog organizations urge the NRC to require ConEd to replace the steam generators, not repair them.

May 2, 2000
ConEdison impurities in the water for causing the corrosion that led to the leak in the steam generator.

June 3, 2000
ConEd seeks permission to restart the plant with repaired steam generators, while promising to replace them by year-end.

June 7, 2000
The NRC's inspector general reveals an investigation into an agency decision to allow ConEd to forego a scheduled 1999 inspection of the steam generator.

June 21, 2000
An internal memo prepared by ConEd and obtained by The Journal News shows that the power plant was in turmoil in the hours following the accident.

Aug. 10, 2000
ConEdison scraps plans to repair the Indian Point steam generators, but will replace them instead.

Sept. 1, 2000

agency has placed sole blame on Con Edison.

Con Edison has announced it will sell its Indian Point 1 and 2 plants for $502 million to New Orleans-based Entergy Corp.

An inspector general's report says the NRC could have prevented the accident by more carefully scrutinizing a 1997 inspection report.

Sept. 1, 2000

Although President Clinton's new home is only 12 miles away, the Secret Service was not alerted about the incident.

Sept. 12, 2000

A key ConEd manager says "unwarranted pride" among plant operators contributed to the February accident.

Oct. 12, 2000

The NRC rejects a petition from nuclear safety advocates that would have made it more difficult for ConEd to reopen Indian Point 2.

Oct. 12, 2000

The NRC orders closer scrutiny of Indian Point 2.

ConEd's Indian Point 2 becomes the first of the nation's 103 private nuclear power plants to be adorned with a "red" tag -- the NRC's highest risk assessment.

Nov. 22, 2000

Groups that had been critical of ConEd and also criticized the NRC are praising the regulatory commission for its decision to red-tag the utility in the ongoing response to the February leak.

Dec. 11, 2000

Con Edison says it has completed repairs to the Indian Point 2 power plant, and is days away from restarting the reactor and generating electricity.

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The New York Times, May 6, 1983

The New York Times

May 6, 1983, Friday, Late City Final Edition

SECTION: Section B; Page 5, Column 1; Metropolitan Desk

LENGTH: 2335 words

HEADLINE: AT INDIAN PT., A HISTORY OF NUCLEAR **POWER,** PROBLEMS AND CONTROVERSY

BODY:
More than 30 years ago, in 1952, the Consolidated Edison Company began to study the possibility of using atomic energy to generate electricity. It became the first company to announce plans to build a commercial-sized atomic **power plant** without government subsidy.

Oct. 8, 1954. Con Edison announces the purchase of a 250-acre site in Buchanan, N.Y., on the east bank of the Hudson River 35 miles north of midtown Manhattan, to construct its atomic **power plant.** It says the **plant,** to be built in an area known as Indian Point, will cost $50 million to build.

May 4, 1956. The Atomic Energy Commission, the predecessor of today's Nuclear Regulatory Commission, grants Con Edison a construction permit. Major work on the **plant,** whose cost has risen to $121 million, starts in 1958. The **plant** - with a capacity of 275 megawatts, 59 percent from the heat of the reactor and 41 percent from a supplementary oil-fired superheater - is expected to provide enough **power** to fill the needs of a million homes.

Feb. 23, 1962. The Atomic Energy Commission, after finding that Con Edison has provided "reasonable assurance that the reactor could be operated so as not to endanger the health and safety of the public," authorizes a provisional 18-month license for its operation. The **plant,** still under construction, is designed to produce 1.79 billion kilowatt-hours of electrical energy a year at an operating cost of $25 million.

Sept. 16, 1962. The reactor, which would later become known as Indian Point 1, is to begin generating **power** today and and go into commercial operation next month. Its generating capacity is about a quarter of that of the average reactor that would be built two decades later.

Dec. 10, 1962. Con Edison applies for a permit to build another reactor, in Ravenswood, Queens. After public protests, the application is withdrawn on Jan. 6, 1964.

May 27, 1965. Seven United States Representatives from New York State accuse state officials of covering up fish kills in the Hudson River near the Indian Point **power plant.**

Nov. 23, 1965. Con Edison's directors approve plans to build a second nuclear reactor at Indian Point. Cost of construction is placed at $108 million. Gov. Nelson A. Rockefeller calls the move "of major importance to our state and its expanding atomic industry."

April 1967. Con Edison applies for permission to build a third nuclear **plant** at Indian Point. Permission is granted in August 1969, and construction begins shortly afterward.

May 13, 1970. The state charges Con Edison with serious violations of state conservation laws in the operation of its nuclear generating **plant** and asks that the **plant** be closed until "suitable methods" to protect the Hudson River can be developed. State seeks $5 million in damages for fish kills resulting from **plant's** operation.

June 30, 1970. Indian Point 1 is shut down because of defects in the stainless steel piping used to help keep the reactor cool. Meanwhile, the fish kills, caused by hot water being discharged into the Hudson River from the **plant's** cooling systems, have drawn protests from fishermen and have resulted in a $1.6 million fine from the state.

May 1972. The state levies $1.5 million in fines against Con Edison for a "massive" killing of fish in the Hudson River. The total fine is based on a civil penalty of $500 plus $10 for each fish killed.

Oct. 20, 1972. Con Edison withdraws an application to build nuclear **power** generating **plants** in Verplanck, near the Indian Point **plants.** One month later, the utility begins looking for sites away from the Hudson River to build generating **plants** after increasing pressures from environmentalists and others to preserve the Hudson River environment.

June 26, 1973. Indian Point 2 - which generates 873 megawatts, enough energy for almost 400,000 homes - goes into operation. September 1973. The commission rules that Con Edison must construct a "closed cycle" cooling system at its Indian Point **plants** that would prevent the release of the hot water into the Hudson and, therefore, avoid destruction of fish breeding grounds.

Dec. 1, 1973. Con Edison acknowledges that its new **power plant,** Indian Point 2, has significant problems. The acknowledgement comes after an accident on Nov. 13 forced it to shut down. Con Edison officials says the problems centered around a buckling and bulging of the steel liner in the reinforced concrete dome in which the nuclear **plant** is housed. At the time of the announcement, the other Con Edison nuclear **plant,** Indian Point 1, has been inoperable for more than a year.

Feb. 28, 1974. The State **Power** Authority announces plans to build a nuclear **power plant** along the Hudson River at either Athens or Cemeton, in Greene County, in 1982. The **plant,** along with another proposed, are needed, according to the state, to supply energy needs of the Metropolitan Transportation Authority. The **plants** are never built.

Sept. 18, 1974. The State Legislature votes to allow the **Power** Authority of the State of New York to take over Con Edison's Indian Point 3 **plant,** which is still under construction.

Oct. 14, 1974. Indian Point 1 is permanently shut down, 12 years after going into operation, because it lacks an emergency corecooling system, which the Nuclear Regulator Commission insists be added for continued operation. Techncially, the **plant** is retired but not decomissioned.

Dec. 30, 1975. Under pressure from Gov. Hugh Carey, Con Edison agrees to sell Indian Point 3 to the State **Power** Authority. The action disappoints environmentalists who hoped the sale could be blocked and eventually the **plant** closed down as a threat to the Hudson River and the adjacent Westchester County area.

Jan. 20, 1976. William N. Anders, chairman of the Nuclear Regulatory Commission, orders two separate investigations of two Indian Point reactors after **Robert** D. Pollard, the commission's project manager for Indian Point 3, questioned the safety of the **plants.** Mr. Pollard accused the commission of suppressing the existence of unresolved safety problems. On Jan. 13, Mr. Pollard resigned from the commission's staff, after four months on the job. After hearings in Washington, the N.R.C. decided to take no action.

Aug. 30, 1976. Indian Point 3 - with a capacity of 965 megawatts, 75 percent of which is used by government agencies, such as the Metropolitan Transportation Authority - goes into operation.

October 1979. An accident at the Three Mile Island **power plant** in Middletown, Pa., spurs a crescendo of criticism about the locations of several of the nation's 72 nuclear reactors and the emergency planning that has been conducted at virtually all of them. President Carter appoints appoints a commission to investigate the accident and to consider whether any of the nation's existing reactors should be shut down.

Nov. 18, 1979. **Robert Ryan,** the director of the Nuclear Regulatory Commission's Office of State Programs, testifies before the President's Commission on the Accident at Three Mile Island. He says the area around the Indian Point **plants** is one of the most populous of any containing nuclear **plants** and calls their construction there "**insane.**"

Dec. 18, 1979. The N.R.C. says that emergency evacuation plans for Indian Point are "lacking" "lacking" in key areas. The commission gives Con Edison and the State **Power** Authority two months to submit revisions.

Jan. 29, 1980. The two nuclear **plants** at Indian Point have been shut down for five months for refueling, maintenance and repairs, and the N.R.C. says safety improvements must be completed before they can resume operation. Eventually, Indian Point 2 resumes operation in early February and Indian Point 3 returns to service on Feb. 16.

Feb. 27, 1980. Con Edison accedes to the wishes of the N.R.C. and retires Indian Point 1 permanently. It had been inoperable since 1974. "It's the end of the beginning," says William J. Cahill, Jr., a Con Edison vice-president.

Oct. 17, 1980. A major water leak in a joint of a pipe carrying nonradioactive water deposits about 100,000 gallons of water in a containment building of Indian Point 2.

Oct. 24, 1980. The N.R.C. orders Indian Point 2 shut down until Con Edison determines how the leak went unnoticed. Five days later, the commission initiates an investigation to determine why Con Edison failed to notify the commission about the leak.

Dec. 10, 1980. The N.R.C. fines Con Edison $210,000 for the flooding that occurred at its Indian Point **plant** in October.

Jan. 7, 1981. The staff of the Public Service Commission says Con Edison should be forced to refund $43 million to its customers because of a "substantial likelihood" that "imprudent actions" by the utility caused the water leak that forced the **plant** to shut down. The money, which is eventually refunded to customers, represented extra fuel charges that were passed on to customers by Con Edison when it was forced to buy more expensive **power** to replace what would have been generated by the disabled **plant.**

Jan. 31, 1981. The State **Power** Authority shuts down Indian Point 3 because of malfunction in the **plant's** steam turbine section.

Meanwhile, officials from the four-county area within 10 miles of Indian Point testify at hearings in White Plains that an emergency evacuation plan presented by the utilities contains major flaws and urges that they not be approved by the N.R.C.

April 7, 1981. The technical staff of the N.R.C. says the Indian Point 2 nuclear reactor apparently suffered no damage from the flooding accident last October. The decision clears the way for the unit to be restarted. But one month later, Con Edison announces it has run into still another mechanical problem with Indian Point 2 and will not be able to put **plant** back in service until the end of May.

May 26, 1981. After the longest shutdown in its eight-year history, Indian Point 2 resumes service.

Dec. 11, 1981. Con Edison is fined $40,000 by the N.R.C. for not protecting workers from radiation at its Indian Point 2 **plant.**

Dec. 19, 1981. During 1981, Indian Point 2 has operated an average of only 11 days a month, according to Con Edison.

Feb. 27, 1982. A report by the Rand Corporation concludes that the cost of closing the Indian Point nuclear **power plants** has consistenly been underestimated and may be as high as $17.4 billion. If the **plant** were closed, the report says, electricity prices in New York City and Westchester County would increase substantially almost immediately.

March 3, 1982. Indian Point simulates a major accident to test emergency evacuation plans. Federal officials will later say that the drill was "generally good," although there were areas that need strengthening.

March 12, 1982. A plan to protect the nearly 300,000 people who live near Indian Point in case of a nuclear accident is said to be inadequate and may never be workable, according to some officials at the county, town and school-district level who would be responsible for carrying it out.

March 25, 1982. A leak and corrosion of steam generator tubes at the Indian Point 3 **power plant** forces the **plant** to close, and as of May 1983, it is still closed.

Aug. 2, 1982. The Nuclear Regulatory Commission threatens to close Indian Point unless flaws in the emergency evacuation plans for the area surrounding the **plant** are corrected within the next four months. The commission cites deficiencies in provisions for notifying residents in the area, for educating the public in advance about what to do, for making agreementrs with bus companies to provide emergency service and for limiting exposure of emergency workers to radiation.

Sept. 2, 1982. The chairman of a three-judge panel conducting hearings on safety of the two Indian Point **plant** resigns, saying the N.R.C. was not giving opponents of the **plant** a fair chance to state their case. The chairman, Administrative Law Judge Louis J. Carter, had been presiding at hearings ordered by the commission.

Dec. 17, 1982. The Federal Emergency Management Agency, the federal agency charged with evaluating preparedeness for an accident at Indian Point, says the emergency **plants** were "not feasible" because of significant deficiencies. The agency says it will decide whether to fine the utility operators, suspend the **plant's** operating licenses or take other action.

Dec. 22, 1982. The N.R.C. votes 3 to 2 to permit the Indian Point nuclear reactors to operate and to wait until an accident drill in March to determine whether deficiencies in emergency planning had been corrected. The **plants** had been under a Dec. 3 deadline to correct deficiencies found after a drill last March.

Jan. 31, 1983. Residents living within 10 miles of Indian Point **plants** indicate in a poll that they are confused about the evacuation plan and unlikely to follow it once informed.

Feb. 19, 1983. All but one of 75 warning sirens in the area surrounding Indian Point function well in a test. In a drill in March 1982, sirens malfunctioned and residents reported that they never heard a sound.

March 1, 1983. Testifying before a House subcommittee, John S. Dyson, head of the State **Power** Authority, says opponents of nuclear **power plants** "tend to be zealots who don't care in a sense what the answers are."

March 9, 1983. From bus drivers to county executives to the Lieutenant Governor, 2,000 people test their ability to respond to a major accident at the Indian Point **plants.** Watching closely are 55 Federal inspectors aznd one of the five members of Nuclear Regulatory Commission.

April 15, 1983. 7The Federal Emergency Management Agency issues a report based on the March drill that concludes the area around Indian Point is not prepared for a possible accident at the nuclear reactors, and the safety for the 288,000 people living in the area cannot be assured.

GRAPHIC: Illustrations: photos during history of Indian Point