Questions on Security Measures Taken at Nuclear Facilities in Other Countries

Question 1: Several press reports have stated that French and Canadian authorities have decided to place anti-aircraft weaponry at some or all of their nuclear facilities. What does the NRC recommend regarding taking the same measures in the U.S.? Does the NRC feel that the actions taken by France and Canada are unnecessary? Why is it that National Guard units are currently deployed at some plants and not at others? Shouldn't there be a uniform national policy on this matter - particularly in periods of heightened alert?

Answer:

We are not aware of any deployment of anti-aircraft weaponry at Canadian nuclear facilities. We understand that France deployed anti-aircraft weaponry at only one civilian nuclear facility, its reprocessing plant at La Hague. There is no similar commercial facility in the United States. We are not aware whether the French air defense missiles remain in place.

The NRC sees no need to deploy anti-aircraft weaponry at any commercial nuclear facilities in the United States. After consultation with the Department of Defense, the Office of Homeland Security, and the Federal Aviation Administration, the Commission believes that there would be enormous command and control problems and a large potential for unintended consequences and collateral damage if such weaponry were deployed. The Commission believes that the proper way to deal with the potential hijacking of large commercial aircraft by suicidal terrorists is through the measures on airline security now well underway.

On September 26, 2001, the Chairman sent a letter to the Governors of those States which have sensitive commercial nuclear facilities. The purpose of the letter was to explain the actions taken by the NRC and its licensees to augment security after September 11 and to note limitations on licensee capabilities to deal with beyond design basis threats. The letter noted that as the security situation unfolds, State resources might be needed to supplement licensees' capabilities. However, the Commission did not request such supplementation. The Commission believes that the individual Governors, working in consultation with their security advisors and federal law enforcement authorities, can best determine where to deploy National Guard assets to protect critical infrastructure.

Question 2: In your October 16, 2001 letter to me, you stated that "The Commission believes that the baseline security level at U.S. commercial nuclear reactors is very high compared with most other nations" and that "We are aware of no other regulator who systematically carries out security inspections involving force-on-force exercises." Has the Commission considered expanding its international programs with foreign nuclear facilities, particularly in light of the recent warning by the International Atomic Energy Agency (IAEA) regarding the heightened threat to nuclear facilities worldwide? If not, why not. If so, what are you planning?

Answer:

As stated in the earlier letter, we are aware of no other regulator who systematically carries out security inspections involving force-on-force exercises. If a foreign nation wanted the benefit of our expertise in this area, we would be pleased to provide it, as resources permitted. However, there have been no such requests.

Under the Physical Protection Convention, it is an individual nation's responsibility to design its physical protection and safeguards system. The NRC would be reluctant to attempt to force our specific model on other nations. Nonetheless, the NRC and other agencies have been working with the IAEA as it designs activities related to the terrorist threat.

Question 3: In your October 16, 2001 letter to me, you stated that the Swiss nuclear authorities have required that "nuclear power stations shall be protected against the consequences of an airplane crash" and that these guidelines are intended to insure that in the event of an airplane crash, "the radiation exposure to the public shall not exceed the limits specified."

Question 3.a. What design features have been required as a result of these guidelines?

Answer:

The Swiss design requirements for protection against a serious aircraft crash are contained in Guidance HSK-R-102 "Design Criteria for the Protection of Safety Equipment in Nuclear Power Stations against the consequences of Airplane Crash." These criteria were largely motivated by the large number of NATO F-104's which were crashing during the 1970s.

The design against military and civilian airplanes is to be based upon the following assumptions:

- Impact of a military airplane (essentially an F-104) of mass 20 tonnes and velocity 774km/hr with a circular impact area of 7 square meters.
- Crash occurs from any direction. If buildings and terrain rule out an impact perpendicular to the surface of the building, then the most unfavorable impact angle is used.
- Simultaneous impact of airplane wreckage on the power station site.
- As a consequence of the crash there is a fire of airplane fuel. The most important features required are reinforced concrete with a wall thickness, in the reactor building, of more than 1 meter. In addition, spatial separation of redundant or diverse safety devices is required.

Question 3.b. Is the Commission aware of any other nations that have similar requirements? Please compare the Swiss and any similar requirements in other nations, to the Commission's requirements for domestic licensees with respect to the protection of nuclear power plants against airline crashes.

Answer:

Germany and possibly other European countries also require nuclear containment structures to withstand the crash of certain types of military and commercial aircraft. The major reason that European countries such as Switzerland and Germany have required deterministic design features for protection from aircraft impacts is the significantly higher traffic densities of both military and commercial aircraft and crash rates. For example, the June 1982 Argonne report entitled "Evaluation of Aircraft Crash Hazards Analyses for Nuclear Power Plants" indicates that in some parts of Europe, exposure to potential aircraft crashes is higher than in the U.S. by as much as a factor of 25. This led to a probabilistically based decision to provide structural protection against aircraft impacts.

The likelihood of an airplane accidentally crashing onto a reactor site in the U.S. is typically much lower than in Europe. Therefore, deterministic protection requirements are imposed only when the likelihood of a crash is found to be unacceptably high. Hence, although the technical basis is similar in the U.S. and Europe, the specific requirements differ due to dissimilar exposures to aircraft hazards.

Questions from November 19, 2001 Letter

Questions on the Security of Spent Fuel Casks Related to the October 16, 2001 Response of the NRC

Question 1: In your October 16 response, you stated that "the capacity of spent fuel dry storage casks to withstand a fire for extended time, such as 24 hours, has not been analyzed, given the very low probability that firefighting personnel would be unable to respond within 24 hours." Firefighters responded in far less than 24 hours to the fires that resulted at the Pentagon and World Trade Center, but they took far longer to extinguish these fires because of the amount of jet-fuel and other debris involved. If such a fire, fed by more than 20,000 gallons of jet-fuel, also involved the dispersal of highly radioactive materials, this could hinder firefighters' ability to immediately contain the fire. In fact, it took almost 200 firefighters 4.5 hours to extinguish the more than 30 fires started after the Chernobyl reactor exploded, except for the graphite core fire, which took more than 9 days to extinguish - after most of the radioactive materials had been released into the environment. [Given the risks involved and the record at the World Trade Center [and Chernobyl], don't you think you should perform a worst-case analysis involving a long-duration fire at a spent fuel storage cask facility, rather than just assuming that such a fire could never occur? If not, why not?

Answer:

The NRC does not believe that comparison of fires that could occur at spent fuel storage facilities, to the fires that occurred at the World Trade Center, the Pentagon, and Chernobyl, provides much meaningful information, because a spent fuel storage facility would not have the additional flammable material to fuel a long-duration fire, as did the other fires mentioned.

As a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation will be a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs and will include a detailed analysis of the consequences resulting from a plane crashing into a spent fuel storage facility.

Question 2: Your October 16 response restates earlier NRC claims that a worst-case analysis of aircraft impact indicates that the jet-fuel would burn off in a matter of minutes. You conclude that therefore, "a spent fuel storage cask would not be expected to be appreciably affected by a fire." However, as I pointed out in my September 21 letter, this analysis was based on an assumption that there would only be 200 gallons of fuel involved, not more than 20,000 gallons as is typically contained in a 757 or 767. Please clarify you response. Exactly how much fuel did your worse-case analysis assume would be present in fire? If the amount is not typical of the amount carried by a fully-fueled large commercial aircraft, please redo your worst-case analysis and provide it to me, indicating as well whether the results will necessitate additional security measures at spent fuel storage facilities.

Answer:

The duration of a fire is highly dependent on the velocity and trajectory of a plane crash, as well as the amount of flammable materials at the crash site. The greater the velocity of the plane crash, the shorter the duration of the fire. This is due to the fuel spreading across a large area, rapidly atomizing and igniting. To estimate an upper bound for a potential fire duration, one can consider a plane traveling at very low velocity where the fuel would remain close to the crash target. On December 23, 1983, at the Anchorage International Airport, AK, while on takeoff, a DC10 collided with a parked aircraft. For this event, the amount of fuel was considerably greater than from one aircraft. The DC10 aircraft, alone, was fully loaded with approximately 36,600 gallons of fuel. The fire was extinguished within two and a half hours. The speed of impact was 168 feet per second. For a larger velocity impact, the fuel would have dispersed and burned significantly faster.

To assess the impact of a dry cask under an engulfing jet fuel fire, the staff performed an analysis of a seven-hour fire duration. The results from the analysis did not lead to fuel failure nor cask failure.

Question 3: In your October 16 response, you stated that "Even if a spent fuel cask were impacted and penetrated by a commercial aircraft, the resultant effects could never be equivalent to a Chernobyl-style accident because the amount of radioactive material contained within the cask is orders of magnitude less than in an operating reactor, and the mechanisms for dispersal are fewer than were present during the Chernobyl accident." However, a November 2, 2001 report in the New York Times cites a September 2000 NRC report, that "suggests that breaching a cask used to store spent fuel would create a lethal radiation dose in area many times larger than that caused by a 10-kiloton nuclear weapon." The New York Times report also states the "other experts note the spent fuel pools can contain 20 to 30 times as much radioactive material as the reactor core does....A draft study by the National Council on Radiation Protection and Measurements discussed the risk of shipping spent fuel and calculated that breaching a cask could produce a lethal radiation dose in an area of 2,700 square kilometers. In comparison the study said a 10-kiloton nuclear blast would produce those doses in 47 square kilometers.

Question 3.a. Please explain the apparent discrepancy between your October 16, 2001 statement regarding the consequences of an aircraft impact on a spent fuel cask with those reportedly made in the September 2000 NRC report and the draft NCRP report. Please additionally provide a copy of the September 2000 NRC report.

Answer:

The staff reviewed the November 2, 2001 New York Times article that referenced a September 2000 report which "suggests that breaching a cask used to store spent fuel would create a lethal radiation dose in an area many times larger than caused by a 10 kiloton nuclear weapon." The staff contacted Matthew L. Wald, the author of that New York Times report, who indicated that the referenced information about radiation dose was from a draft National Council on Radiation Protection and Measurements (NCRP) document (not from an NRC report). The draft report has now been published as NCRP Report No. 138, "Management of Terrorist Events involving Radioactive Materials," issued October 24, 2001. The staff reviewed NCRP Report No. 138 and noted the quoted information from the draft report was not incorporated into the final report. The Commission believes that the calculations cited in the draft were incorrect.

Question 3.b. Is the statement that a spent fuel pool can contain 20 to 30 times as much radioactive material as an operating reactor true? Please provide a list of each operating reactor and each spent nuclear fuel pool, indicating for each how much radioactive material is contained within. Should this information be nonpublic, please advise your staff to make appropriate arrangements with my staff for transmittal and safekeeping of these documents.

Answer:

Typically, spent fuel pools contain a greater number of spent fuel assemblies than the number of fuel assemblies in the reactor. However, spent fuel that has been removed from the reactor for a significant period of time generates less decay heat than recently used fuel and has had a significant portion of the radioactive fission products decay. The NRC does not require reactor licensees to report regularly the inventories of their spent fuel pools. However, information from 1998 is available and is provided in the attached table. It lists the number of fuel assemblies in operating reactors and their spent fuel pools. Changes to the 1998 information can be expected as additional fuel has been used and some facilities have received NRC approval to increase the capacity of their spent fuel pools.

APPENDIX A

SPENT FUEL POOL/FULL CORE OFFLOAD CAPABILITY - As of November 1998

(Number of fuel assemblies)

(Attachment to Answer 3.b)

CLOSEST CITY/TOWN	PLANT NAME	FUEL IN CORE	AVAILABLE SPENT FUEL POOL CAPACITY	FUEL IN SPENT FUEL POOL	REMAINING SPENT FUEL POOL CAPACITY
RUSSELLVILLE AR	Arkansas 1	177	968	818	150
	Arkansas 2	177	988	701	287
MCCANDLESS PA	Beaver Valley 1	157	1627	756	871
	Beaver Valley 2	157	1088	392	696
JOILET IL	Braidwood 1	193	2870	1054	1816
	Braidwood 2	193	*	*	*
DECATOR AL	Browns Ferry 1	764	3471	1864	1607
	Browns Ferry 2	764	3471	2116	1355
	Browns Ferry 3	764	3471	1588	1879
SOUTHPORT NC	Brunswick 1	560	1767	984	783
	Brunswick 2	560	1767	1020	747
ROCKFORD IL	Byron 1	193	2781	1278	1503
	Byron 2	193	*	*	*
FULTON, MO	Callaway	193	1340	829	511
ANNAPOLIS, MD	Calvert Cliffs 1	217	1830	1362	468
	Calvert Cliffs 2	217	*	*	*
ROCK HILLS SC	Catawba 1	193	1418	705	622
	Catawba 2	193	1418	686	695
CLINTON, IL	Clinton	624	2515	1124	1381
GLENN ROSE TX	Comanche Peak 1	193	556	765	526
	Comanche Peak 2	193	735	*	*
NEBRASKA CITY, NE	Cooper	548	2366	1340	1026
CRYSTAL RIVER, FL	Crystal River 3	177	1357	680	677
TOLEDO, OH	Davis-Besse	177	718	601	117
BENTON HARBOR MI	D.C. Cook 1	193	3613	2015	1598
	D.C. Cook 2	193	*	*	*
SAN LUIS OBISPO CA	Diablo Canyon 1	193	1324	640	684
	Diablo Canyon 2	193	1317	660	657
MORRIS IL	Dresden 2	724	3537	2562	975
	Dresden 3	724	3536	2380	1156
CEDAR RAPIDS, IA	Duane Arnold	368	2411	1648	763
DOTHAN, AL	Farley 1	157	1407	662	527
	Farley 2	157	1407	593	641

Enclosure 1

	PLANT NAME	FUEL IN CORE	AVAILABLE SPENT FUEL POOL CAPACITY	FUEL IN SPENT FUEL POOL	REMAINING SPENT FUEL POOL CAPACITY
TOLEDO, OH	Fermi 2	764	2383	1296	1087
OSWEGO, NY	FitzPatrick	560	2797	2080	717
OMAHA, NE	Fort Calhoun	133	1083	706	377
ROCHESTER, NY	Ginna	121	1879	879	435
VICKSBURG, MS	Grand Gulf 1	800	4348	2488	1860
BAXLEY, GA	Hatch 1	560	5946	4884	1062
	Hatch 2	560	*	*	*
WILMINGTON, DE	Hope Creek	764	4006	1708	2298
NEW YORK, NY	Indian Point 2	193	1374	917	457
	Indian Point 3	193	1345	672	655
GREEN BAY, WI	Kewaunee	121	990	780	210
OTTAWA, IL	LaSalle 1	764	7932	3076	4852
	LaSalle 2	764	*	*	*
PHILADELPHIA, PA	Limerick 1	764	2832	1701	1131
	Limerick 2	764	3921	1893	2028
CHARLOTTE, NC	McGuire 1	193	1351	871	480
	McGuire 2	193	1425	1039	386
NEW LONDON CT	Millstone 2	217	1306	868	423
	Millstone 3	193	756	416	340
MINNEAPOLIS, MN	Monticello	484	2209	1094	1115
OSWEGO, NY	Nine Mile Point 1	532	2776	2200	576
	Nine Mile Point 2	764	4049	1400	2649
RICHMOND, VA	North Anna 1	157	1737	1505	169
	North Anna 2	157	*	*	*
GREENVILLE, SC	Oconee 1	177	1312	1094	218
	Oconee 2	177	1312	1094	218
	Oconee 3	177	825	552	273
TOMS RIVER, NJ	Oyster Creek	560	2645	2420	180
SOUTH HAVEN, MI	Palisades	204	771	657	101
PHOENIX, AZ	Palo Verde 1	241	1205	648	557
	Palo Verde 2	241	1205	644	561
	Palo Verde 3	241	1205	664	541
LANCASTER, PA	Peach Bottom 2	764	3819	2720	1099
	Peach Bottom 3	764	3819	2777	1042
PAINESVILLE, OH	Perry 1	748	4020	1504	2516

	PLANT NAME	FUEL IN CORE	AVAILABLE SPENT FUEL POOL CAPACITY	FUEL IN SPENT FUEL POOL	REMAINING SPENT FUEL POOL CAPACITY
PLYMOUTH, MA	Pilgrim	580	3859	1974	1885
MANITOWOC WI	Point Beach 1	121	1502	1347	155
	Point Beach 2	121	*	*	*
MINNEAPOLIS MN	Prairie Island 1	121	1386	1237	125
	Prairie Island 2	121	*	*	*
MOLINE IL	Quad Cities 1	724	3657	1933	1724
	Quad Cities 2	724	3897	2943	954
BATON ROUGE, LA	River Bend	624	2680	1400	1280
FLORENCE, SC	Robinson	157	544	302	242
WILMINGTON DE	Salem 1	193	1632	772	850
	Salem 2	193	1632	584	1038
SAN CLEMENTE CA	San Onofre 2	217	1542	870	672
	San Onofre 3	217	1542	918	624
PORTSMOUTH, NH	Seabrook	193	1236	376	860
CHATANOOGA TN	Sequoyah 1	193	2091	1295	796
	Sequoyah 2	193	*	*	
RALEIGH, NC	Shearon Harris 1 (accepts spent fuel from other units)	157	4184	720 PWR and 1841 BWR	336 PWR and 557 BWR
BAY CITY TX	South Texas 1	193	1969	428	1529
	South Texas 2	193	1969	400	1556
FT. PIERCE FL	St. Lucie 1	217	1706	1128	578
	St. Lucie 2	217	1076	692	384
COLUMBIA, SC	Summer	157	1276	637	567
NEWPORT NEWS VA	Surry 1	157	1044	854	190
	Surry 2	157	*	*	*
BERWICK PA	Susquehanna 1	764	2840	2655	None
	Susquehanna 2	764	2840	1762	823
HARRISBURG, PA	Three Mile Island	177	1338	755	583
MIAMI FL	Turkey Point 3	157	1395	808	587
	Turkey Point 4	157	1389	770	619
BATTLEBORO, VT	Vermont Yankee	368	2863	2331	532
AUGUSTA GA	Vogtle 1	193	1475	1081	2392
	Vogtle 2	193	1998	*	*
RICHLAND, WA	WNP 2	764	2654	1703	951
NEW ORLEANS, LA	Waterford 3	217	2398	700	1698
SPRING CITY, TN	Watts Bar 1	193	1612	80	1530
BURLINGTON, KS	Wolf Creek	193	1327	664	663

* Single values given for multiple units using common fuel storage facility.

Question 3.c. Is the statement reportedly contained within the September 2000 NRC report that "suggests that breaching a cask used to store spent fuel would create a lethal radiation dose in an area many times larger than that caused by a 10-kiloton nuclear weapon" true? If so, how is this consistent with your statement in your October 16 response that the only consequence of such an event that you could not exclude is "localized impacts?" Would you consider a radiation release equivalent to that of a 10-kiloton nuclear bomb to be a "localized" event?

Answer:

Please see response to question 3.a. above.

Questions Related to Emergency Preparedness Regulations At Decommissioning Nuclear Power Plants Storing Fuel in Spent Fuel Pools

Question 1: Prior to September 11, 2001, were all spent fuel and dry cask storage areas protected by: a) permanent or temporary personal and vehicle barriers, and, b) armed guards? Are such areas currently so protected? If not, aren't they vulnerable to either attacks by terrorists on foot or by truck bombs?

Answer:

NRC regulations do not require dry cask storage areas be protected by armed guards or vehicle barriers. A watchman is required with the ability to contact and have the local law enforcement agencies respond immediately to an event. Spent fuel located at operating nuclear power plants is protected by armed guards and vehicle barriers. Prior to September 11, 2001, the requirement for vehicle barriers and armed responders varied for non-operating nuclear power plants. After September 11, 2001, the NRC issued an advisory to recommend vehicle barriers and armed responders at non-operating nuclear power plants. The NRC issued Confirmatory Actions Letters (CALs) to decommissioning reactors confirming that these licensees would take measures associated with four issues. Although the details are sensitive, the issues include 1) vehicle threat, 2) offsite communications, 3) offsite response commitments, and 4) onsite/offsite response force.

As a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation will be a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs and will include the potential consequences of terrorist attacks at spent nuclear fuel storage sites.

Question 2: Can either hand-placed or truck-delivered explosives penetrate either a pool or cask? What could happen if explosives or heat-producing material were placed next to the fuel in an emptied pool or in a breached dry cask?

Answer:

There is a possibility that, with enough explosives, both a spent fuel pool or spent fuel dry cask can be penetrated. The damage and possible material released is scenario dependent. Even if the pool or cask were penetrated, measures in place should provide adequate protection of public health and safety.

As a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation is a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs and includes the potential consequences of terrorist attacks using various explosives or heat-producing devices on spent pools and spent nuclear fuel dry casks at spent nuclear fuel storage sites.

Question 3: The SECY document states that revisions to the regulatory requirements for decommissioning nuclear power plants were initiated in the early 1990s because existing regulations "present a significant burden to decommissioning licensees without apparent commensurate safety benefits."

Question 3.a. Were the safety benefits of protecting decommissioning nuclear power plants from acts of radiological sabotage or theft explicitly considered when the decision was made to revise these regulations beginning in the early 1990s? Please provide copies of any analyses done on the impact of changing these regulations on the ability to protect decommissioning facilities against terrorist attacks.

Answer:

Each licensed nuclear power plant has a site-specific safeguards program that was initially approved by the staff to be in compliance with the applicable regulations in 10 CFR Parts 50 and 73. The regulations allow the licensee to make changes to the program without NRC review or approval so long as the changes do not decrease the program effectiveness. In addition, the regulations permit the licensee to seek changes to its safeguards program by requesting NRC approval of amendments to its license or exemptions to the regulations or both. Since there are no regulations that specifically address the safeguards for a nuclear power plant that permanently shuts down and enters into decommissioning, a decommissioning plant is still bound by the same safeguards requirements as when the plant was fully operational. Through exemptions, license amendments, and allowable programmatic change processes, the safeguards programs at currently decommissioning plants have been modified to a level that the staff judged to be appropriate based on site-specific requests and information from the licensees and reviews by the NRC staff at the time of the licensing action.

In order to provide certainty, consistency, and efficiency in regulating the safeguards programs at decommissioning plants, the staff has been studying potential regulatory changes focused specifically on understanding the threats and potential consequences at decommissioning plants. No regulatory changes have yet been implemented. The staff has been thoroughly and methodically studying the interrelationships between defined safeguards threats and the appropriate levels of emergency planning and insurance for decommissioning plants. In fact, SECY-01-0100 requested Commission policy guidance in the effort to integrate the relationship between insurance, emergency planning, and safeguards. Following the terrorist attacks on September 11, 2001, the staff withdrew this document and is reconsidering recommendations for decommissioning plants as part of the top-to-bottom review of its safeguards program.

Question 3.b. Were force-on-force exercises or other safety and security evaluations conducted at decommissioned facilities to verify that revising the regulations would pose no degradation in safety, compared to the old rules? If not, then on what basis was it determined that the pre-existing requirements did not provide commensurate safety benefits?

Answer:

No. A decommissioning plant is required to comply with 10 CFR 73.55. After entering decommissioning, licensees requested and received exemptions from specific requirements in 10 CFR 73.55. The staff's approval of these exemptions included consideration of public health and safety, offsite consequences, and the risk posed by radiological sabotage. On the basis of information that was available at the time, the staff believed that after a period of time following a final reactor shutdown, a large offsite radiological release, such as that caused by a zirconium fire, was no longer a reasonable possibility. NRC initiated reconsideration of the adequacy of safeguards requirements for decommissioning reactors following completion of the NRC's Technical Working Group report in late-2000 which noted that the risk at spent fuel pools was low and well within the Commission's quantitative health objectives; however, the results of this study were not able to preclude, on a generic basis, the possibility of reading the zirconium ignition temperature. The possibility is not zero; but it is very low.

Question 4: The SECY document states that "the only postulated scenario at a decommissioning plant that could result in a significant offsite radiological release is a beyond-design-basis event commonly referred to as a zirconium fire." Why were terrorist attacks at a decommissioning plant not "postulated scenarios?" Will the Commission revise its analysis of the scenarios in which a significant offsite radiological release could occur at a decommissioning plant in light of the events of September 11? If not, why not?

Answer:

Several events or conditions that lead to inadequate heat removal from the stored fuel would be necessary to initiate such a zirconium fire. The NRC quantified the probability of random equipment failures, human errors, and external events that could lead to inadequate cooling based upon extensive data and dependable methods for estimating the frequency of such random events. Radiological sabotage and terrorist attacks are deliberate acts, and, as such, their frequency cannot be similarly estimated.

Although insufficient intelligence information is available to reasonably quantify the likelihood of a zirconium fire resulting from a terrorist attack, the NRC assesses the probability of a terrorist attack against any licensed facility in a qualitative sense. In consultation with other federal agencies, the NRC uses a combination of actual security events and intelligence information to develop a threat profile, the design-basis threat. NRC licensees are required to establish and maintain a physical security program effective at preventing radiological sabotage attempted by this threat.

As a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation is a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs. Along with other physical security issues, the NRC is re-evaluating the design basis threat in light of the events of September 11, 2001.

Question 5: The document refers to a previous NRC publication, NUREG-1738, in which NRC staff "concluded that the risk from a spent fuel pool (SFP) zirconium fire at decommissioning plants is very low and well below the Commission's safety goals for operating reactors." The document describes the manner in which such a fire would take place as beginning with "a substantial loss of water from the spent fuel pool (SFP), uncovering the spent fuel. Uncovering the spent fuel could result in a heatup to the point where the fuel's zirconium cladding might begin to oxidize in a rapid, exothermic, self-sustaining reactor. The plume from such a zirconium fire could have significant offsite radiological consequences."

Question 5.a. Couldn't a terrorist start such a fire by draining the water from the spent fuel pool and then causing an explosion nearby? Why wasn't that considered?

Answer:

This study attempted to determine, on a generic basis, the time after shut-down that a zirconium fire could be precluded. The risk was determined to be very low; however, the results of this study were not able to preclude, on a generic basis, the possibility of reaching the zirconium ignition temperature due to the great number of uncertainties. The possibility is not zero; but it is very low. The study also made numerous simplifying conservative assumptions and did not model heat conduction. It has been strongly criticized by several stakeholders and has not been endorsed by the Commission. According to the study, for a given end configuration, the probability of the initiation of a zirconium fire after a major dynamic event decreases as the fuel's decay time increases. Although the NRC did not estimate the probability of a terrorist attack, the NRC considered the potential for sabotage in developing its conclusions regarding physical protection of decommissioning reactors. The results of the study are useful in identifying structures and systems that are important to protect, and the NRC is reevaluating what level of physical security is appropriate in the current threat environment.

Question 5.b. Will the NRC revise its estimation of the likelihood of such a fire in light of the events of September 11? If not, why not?

Answer:

As noted previously, as a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation is a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs. Along with other physical security issues, the NRC is re-evaluating the design basis threat in light of the events of September 11, 2001.

Question 6: The document states that "The study concluded that the possibility of a zirconium fire cannot be dismissed even many years after final reactor shutdown."

Question 6.a. Do you agree that this conclusion means that security at decommissioned plants must remain high at least until all the spent fuel is removed from the site? If not, why not?

Answer:

No. The staff approved security plans at decommissioning plants, in part, on the assumption that zirconium fires are not possible (see answer to question 3.b). Prior to the September 11, 2001, the staff requested direction from the Commission (SECY-01-0100, June 4, 2001) as to whether the possibility of a zirconium fire after a period of time following a final reactor shutdown increased the risk at decommissioning plants to a level that required reevaluation of the security plans. Although according to the 2000 study a zirconium fire could not be completely dismissed after many years of radioactive nuclide decay, for a given end configuration of the fuel and surrounding structures the probability of a fire decreases as the fuel's decay time increases. Additionally, the time between draining of the spent fuel pool and the possible initiation of a zirconium fire increases, which allows for the potential to regain physical control of the site and recover cooling. At some point, the scenario is no longer considered credible.

Subsequent to September 11, 2001, the staff recommended, and the Commission approved, the withdrawal of SECY-01-0100 to allow the staff to incorporate lessons learned from the events of September 11, 2001 and to determine whether any changes to the design basis threat would be necessary.

As a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation will be a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs.

While awaiting staff recommendations in this matter, the Commission issued advisories to licensees of decommissioning plants to enhance security beyond that required by their security plans. The enhanced security will remain in place until the Commission has determined otherwise.

Question 6.b. What steps has the NRC taken at decommissioned plants since September 11 to ensure that a terrorist attack on the spent fuel pool does not result in a fire and/or large release of radioactive materials? If no such steps have been taken, please justify.

Answer:

In consideration of the September 11, 2001, terrorist attacks against the United States, the NRC reviewed the security requirements for those licensee sites that are decommissioning and have permanently removed the fuel from the reactor and are now storing the fuel in the spent fuel pool. The NRC established guidelines for increased security measures at these facilities. Prior to issuing a confirmatory action letter (CAL) to the licensee at each such site, the NRC staff had discussions with each regarding actions the licensee should consider to protect against a variety of threats. Each licensee responded to these proposals as either planned actions or actions already taken in order to make the site more robust against the design basis threat. The confirmatory action letters contain information that cannot be disclosed to the general public. Therefore they have been separated from this enclosure to allow the information to be controlled and not be publicly released. Please see the response to Question 1 in Enclosure 2.

Question 7: A previous NRC ruling (SECY-93-127, "Financial Protection Required of Licensees of Large Nuclear Power Plants During Decommissioning," July 13, 1993) reduced certain insurance, emergency preparedness and safeguards requirements at decommissioned plants because the possibility of a zirconium fire resulting in a large release of radioactive materials had been ruled out. In light of the June 2001 finding that such an event cannot be ruled out, as well as in light of the highlighted risk that a terrorist could cause such an event, will the NRC reverse its 1993 decision to reduce certain insurance, emergency preparedness and safeguards requirements at these plants? If not, why not?

Answer:

In acting on SECY-93-127, the Commission established a policy that insurance at decommissioning plants could be reduced by demonstrating that air cooling of the spent fuel stored in the spent fuel pool was extremely unlikely to result in a zirconium fire. This policy was judged to be very conservative since the low likelihood of an event draining the spent fuel pool was coupled with the added assurance that demonstrated that the fire was very unlikely to occur even if the pool were drained. The policy was subsequently applied by the staff for exemptions reducing emergency planning and safeguards requirements at decommissioning plants. The thermal-hydraulic analyses used to confirm that the spent fuel would not reach the zirconium ignition temperature when air cooling did not account for all possible blockages or obstructions to the natural circulation air flow through the fuel assemblies. Therefore, because the event scenarios that are likely to result in drainage of a spent fuel pool are also likely to affect the cooling geometry and air flow around the fuel in indeterminate ways, the staff was not able to exclude the possibility of a zirconium fire under all scenarios on the basis of thermo-hydraulic analyses. The risk is not zero, but it is very low. NUREG-1738 simply observed that it is not feasible, without numerous constraints on the thermal-hydraulic analysis assumptions, to absolutely define a decay time beyond which zirconium fire is not physically possible. The frequency of event sequences (except terrorism/ sabotage) that would lead to drainage of the spent fuel pool are quantified in NUREG-1738. NUREG-1738 continues to support the staff's premise in its 1993 SECY paper which stated that the likelihood of event sequences that result in drainage of the spent fuel pool is very low. However, as noted in the response to question 5.a above, the probability of a terrorist attack or its likelihood of draining and altering the spent fuel geometry has not been determined. This does not mean that terrorism and sabotage were not considered by the staff. Decisions made by the staff to permit reductions in decommissioning plant insurance, emergency planning, and safeguards were based, in part, on expert judgment as to the vulnerability of the site specific spent fuel pools and the low likelihood of significant consequences from design basis threats.

As a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation is a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs.

Question 8: The document found that the risk of a zirconium fire was dominated by the likelihood that a major earthquake would occur. However, the likelihood of sabotage was not even considered. Why would an analysis of any event that could result in a large release of radioactive material not even attempt to consider sabotage? Will the NRC redo this and other analyses of events that could result in a large release of radioactive materials in light of the events of September 11? If not, why not?

Answer:

As stated in previous responses, the staff's accident risk study for decommissioning plant spent fuel pools, NUREG-1738, did not attempt to quantify the likelihood of sabotage. Ideally, the probability of sabotage should be included in the overall zirconium fire initiating frequency. However, risk studies do not calculate the risk from sabotage because the available information is inadequate for estimating the frequency of such deliberate events. This by no means implies that sabotage and terrorism are not considered in determining the appropriate safeguards programs for each decommissioning plant. The study provides information about what systems and structures need to be protected to preclude radiological sabotage at a decommissioning plant. The relative likelihood and extent of sabotage threat to NRC licensees is qualitatively evaluated based on a comprehensive assessment of the domestic and international threat environment. Expert judgment is then used in developing deterministic criteria and attributes of the physical protection systems at the decommissioning plants.

Question 9: The document states that "regulatory changes for insurance or offsite emergency preparedness would be premised on the assumption that the level of safeguards maintained at a decommissioning plant would provide high assurance that the likelihood of a zirconium fire due to sabotage is very low." Was this assumption based on the results of Operational Safeguards and Response Evaluation exercises at decommissioned plants to determine whether a terrorist would be able to succeed in starting a zirconium fire? If so, please list the number of decommissioned plants that have undergone such exercises, the name of the security company contracted to the licensee, the results of such exercises, as well as the number of decommissioned plants at which potential vulnerabilities were identified. If no, then on what possible basis was the assumption made?

Answer:

The "assumption that the level of safeguards maintained at a decommissioning plant would provide high assurance that the likelihood of a zirconium fire due to sabotage is very low" was not based on Operational Safeguards and Response Evaluation (OSRE) exercises conducted at decommissioning sites. OSREs have been conducted at operating nuclear power reactor sites to assess the ability of the site security force to defend against the design basis threat. Decommissioning licensees are still required to meet the security requirements in §73.55. However, licensees have requested amendments to, and/or exemptions from, specific regulations due to the overall reduction in the numbers of target sets that remain and likely consequences at the time of the licensing action. The NRC technical staff conducted site-specific reviews for each of these sites to determine the adequacy of the proposed changes. A letter and safety evaluation report describing each proposed change were forwarded to each licensee.

A number of decommissioning sites also provided reports written by their contractor, Sandia National Laboratories, addressing the potential damage to the spent fuel pool in accordance with the design basis threat as stated in 10 CFR 73.1(a). In order to verify the results of the licensees' reports, the NRC contracted with the Corps of Engineers to provide an independent analysis of the spent fuel pool to withstand a vehicle bomb detonated in close proximity to the pool. In addition, a recent policy options paper, SECY-01-0100, attempted to define the safeguards protection goals and performance standards for decommissioning reactor sites with an end result being a new specific set of regulations for decommissioning sites through rulemaking. The staff determined that these implemented goals and standards would result in high assurance that a sabotage event resulting in a radiological release would be very low. As a result of the events of September 11, the staff recommended, and the Commission approved, withdrawal of this paper to allow the staff an opportunity to incorporate any lessons learned and provide a new recommendation to the Commission.

Question 10: The SECY document recommends that because of the severe consequences of a zirconium fire, the Commission's Safety Goal policy statement, which currently applies only to operating reactors, also apply to decommissioned plants until spent fuel is removed from the spent fuel pools. Has this recommendation been adopted? If not, why not, especially in light of the events of September 11?

Answer:

On September 11, 2001, the Commission was still considering the staff's recommendation that the safety goal policy statement apply to decommissioning plants storing spent fuel in the spent fuel pool. As a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation will be a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs. The staff recommended, and the Commission approved, withdrawal of this paper to allow the staff an opportunity to incorporate any lessons learned and provide a new recommendation to the Commission. Although the staff believes that including spent fuel pool storage into the safety goal policy statement is an important long-term decision, there are no anticipated near-term regulatory actions where the change to the safety goal policy statement would need to be adopted.

Question 11: The report stated that it would be difficult for the Commission to utilize probabilistic risk assessment techniques to evaluate the risk of a sabotage event, stating that Intelligence Agencies do not use these techniques either. Does this conclusion mean that the NRC will just ignore the risk of a zirconium fire being caused by sabotage entirely, as the document suggests?

Answer:

No. Since the Commission has not quantified the possibility of a sabotage event, the risk of a zirconium fire has not been quantified for all initiating events. The Commission has calculated the risk of a zirconium fire for other initiating events besides radiological sabotage. The Commission has qualitatively assessed physical security risks by considering the threat environment, plant specific designs and target sets, vulnerabilities, program attributes, prescribed design basis threat characteristics, and consequences.

The staff is developing a qualitative assessment of risk resulting from radiological sabotage scenarios based on the events of September 11, 2001. The Commission will use the information from the quantitative and qualitative assessments of risk to develop an agency policy on what constitutes an acceptable security plan for decommissioning plants. It is believed that the measures in place provide adequate protection of public health and safety.

Question 12: The document recommends a safeguards protection goal for decommissioning nuclear power plants that "consists of a design criterion of protecting against radiological sabotage by the design basis threat and a performance standard of preventing spent fuel sabotage that could cause radiation exposure to an individual at the nearest controlled area boundary from exceeding the dose specified in 10 CFR 72.106 (5 rem at a minimum of 100 meters)." Has the Commission adopted this recommendation? If so, will it be overseen through the use of Operational Safeguards Response Evaluation exercises, and if not, how will you know the safeguards protection goal is being achieved? If the Commission has not adopted this recommendation, why not?

Answer:

No. The Commission has not adopted this recommendation for security plans at decommissioning plants. The staff had recommended a decommissioning plant safeguards protection goal for protecting against radiological sabotage. However, as a result of the events of September 11, 2001, the staff recommended, and the Commission approved, withdrawal of this paper to allow the staff an opportunity to reconsider the earlier recommendation and provide a new recommendation to the Commission.

Question 13: The document recommends that "insurance requirements be substantially reduced shortly after a reactor permanently shuts down and enters into decommissioning. These licensees would not be required to participate in the secondary retrospective rating pool and primary insurance coverage would be reduced to about $100 million. In addition, onsite property damage insurance would not be required 60 days after permanent shutdown." This recommendation was made on the assumptions that a zirconium fire was not possible and that acts of sabotage would be prevented. Does NRC plan to reduce insurance at decommissioning plants now that it is clear that the possibility of a zirconium fire cannot ever be ruled out, and in light of the events of September 11? If so, please fully justify the decision.

Answer:

The insurance reduction policy recommendation in SECY-01-0100 was based on the very low likelihood of a zirconium fire in conjunction with the high assurance that the safeguards program would provide adequate protection against radiological sabotage. As a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation will be a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs and will include a consideration of the appropriate insurance reduction policies at decommissioning plants.

Question 14: Has the NRC ever conducted an analysis of how much a large scale release of radioactive materials due to a zirconium fire would cost, including the costs of decontamination and addressing health impacts of such an event on the surrounding community? If so, what is the cost of a worst-case scenario? If not, how can the Commission make an informed decision as to how much insurance coverage a decommissioned plant should have?

Answer:

Several outdated studies of the costs associated with a zirconium fire have been previously conducted (NUREG-1563 and NUREG/CR-6451). The staff's insurance policy recommendation included in SECY-01-0100 was made based on the very low probability of a zirconium fire.

Question 15: The document recommends that offsite Emergency Preparedness be incrementally reduced and eventually eliminated after a reactor permanently shuts down. Did this recommendation take into consideration the risk of a terrorist attack on the facility? Since the risk exists that a terrorist could start a zirconium fire by merely draining the spent fuel coolant, why would emergency preparedness be reduced before all the spent fuel was removed from the site? How does this recommendation make sense in light of the other recommendation that the Commission's Safety Goal policy statement, which currently applies only to operating reactors, also apply to decommissioned plants until the spent fuel is removed from the spent fuel pools?

Answer:

The risk of a natural or technological event creating a zirconium fire is very low, but the risk of a terrorist attack has not been quantified.

The physics of the zirconium fire provides a basis for reductions in the EP program. An accident at an operating reactor could begin the evolution of a radioactive source term in as little as 30 minutes. Although the spent fuel configuration necessary for a zirconium fire is very unlikely, even if it occurred, the zirconium fire cannot start until the fuel heats up. The heat up rate is related to the how long the spent fuel has decayed. When the fuel is 5 years old, it would take at least 24 hours to achieve a zirconium fire under the worst conditions. The EP program necessary to respond to the potential for a radioactive source term in 30 minutes is much more extensive than the program necessary to respond to the potential for a radioactive source term in 24 hours.

The staff opinion in SECY-01-0100 is that maintenance of a level of offsite EP is a prudent measure in conformance with the Commission's policy statements regarding defense-in-depth. While risk numbers alone may justify more rapid reductions, uncertainties and defense-in-depth considerations would suggest that some level of EP be maintained until sufficient decay has occurred to allow ad hoc mitigative and protective measures.

As a result of the terrorist attacks of September 11, 2001, the Chairman directed the staff to thoroughly reevaluate the NRC's safeguards and physical security programs. This reevaluation will be a top-to-bottom analysis involving all aspects of the Agency's safeguards and physical security programs. Also, the staff recommended, and the Commission approved, withdrawal of this and other SECY papers to allow the staff an opportunity to incorporate lessons learned and provide a new recommendation to the Commission.