Appendix I

Radiological Accidents

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Radiological Accidents

The information below summarizes the review of existing information on accidents at decommissioning nuclear power facilities using the DECON or SAFSTOR option. The ENTOMB option was not included in this review because of the lack of available information; however, accidents would likely be similar to the DECON option during preparation of the facility for entombment. The purpose of this review was to determine the potential accidents that could occur at nuclear power facilities that have permanently ceased operations. When available, the potential offsite doses from these accidents were analyzed to determine which accidents could have the greatest offsite impact. This appendix provides an assessment of the activities conducted during decommissioning and determines whether accidents of greater consequence may occur during those activities.

As indicated in the Introduction to this Supplement, although the staff relies on the Commission's Waste Confidence Proceeding Finding, which states, in part, that there is, "reasonable assurance that, if necessary, spent fuel generated in any reactor can be stored safely and without significant impact for at least 30 yrs beyond the licensed life for operation...of that reactor at its spent fuel storage basin..." (54 Federal Register 39767),[a] the staff has elected to include in this Supplement a discussion of potential accidents related to the storage and maintenance of fuel in a spent fuel pool.

Three sources of information were reviewed to obtain a list of potential accidents and their consequences: (1) U.S. Nuclear Regulatory Commission (NRC) research efforts, including NUREGs, NUREG/CRs, and the 1988 GEIS (NRC 1988), (2) industry-related publications and documents, and (3) licensing-basis documents for the individual plants, such as post-shutdown decommissioning activity reports (PSDARs), decommissioning plans, final safety analysis reports (FSARs) or FSAR-equivalent documents, or environmental reports (ERs) developed by the licensee. A list of documents used for this analysis is provided in Section I.5. Included as

(a) The Commission reaffirmed this finding of insignificant environmental impacts in 1999. This finding is codified in the Commission's regulations in 10 CFR 51.23(a).

well were environmental assessments (EAs), environmental impact statements (EISs), safety evaluations, or emergency exemptions that were written by NRC. Twenty of the 22 plants listed in Chapter 3 were included in the analysis, which was completed in late 1999. Zion, Units 1 and 2, the most recent plants to permanently cease operations, were not included.

I.1 Potential Accidents Considered During Decommissioning

Table I-1 contains a list of the accidents that were considered for both pressurized water reactors (PWRs) and boiling water reactors (BWRs) during decommissioning in early studies on safety and the cost of decommissioning PWRs and BWRs (Smith et al. 1978 and Oak et al. 1980, respectively). Both documents also considered several other types of accidents that were determined to be either of low probability or to result in very small releases, as shown in Table I-2. These accidents are listed along with a brief description or discussion of the accidents, as given in Smith et al. (1978) and Oak et al. (1980). The discussion in this section does not evaluate whether the accidents described in Smith et al. (1978) or Oak et al. (1980) should still be considered appropriate to the decommissioning process. As a result of improvements in the technology used for decommissioning, several of the accidents listed in Table I-2 may now be considered to be of a much lower probability or, at the least, to result in much-reduced consequences. Table I-3 provides a comprehensive list of accidents of potential accidents at facilities undergoing decommissioning, including HTGRs and FBRs.

The 1988 GEIS (NRC 1988) also considered accidents that could potentially occur during decommissioning. The list of postulated accidents was developed from the lists given in Smith et al. (1978) and Oak et al. (1980). However, not all accidents contained in these two documents were included in the 1988 GEIS, as shown by the footnote in Table I-1.

The staff conducted a study of spent fuel pool accident risk at decommissioning nuclear power facilities to support development of a risk-informed technical basis for reviewing exemption requests and a regulatory framework for integrated rulemaking (NRC 2001). Earlier analyses in NUREG/CR-4982, *Severe Accidents in Spent Fuel Pools in Support of Generic Issue 82*, (Sailor et al. 1987) and NUREG/CR-6451, *A Safety and Regulatory Assessment of Generic BWR and PWR Permanently Shutdown Nuclear Power Plants* (Travis et al. 1997) included a limited analysis of the offsite consequences of a severe spent fuel pool 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 spent fuel pool accidents. The external event initiators included:

- seismic events (earthquakes)
- aircraft crashes
- tornadoes and high winds

Table I-1. Summary of Accidents for PWR and BWR Plants Undergoing Decommissioning Operations[a]

Pressurized Water Reactors	Boiling Water Reactors
Explosion of liquid propane gas leaked from a front-end loader – Explosion ruptures filters and prefilters in the purge exhaust filter banks in containment.	**Explosion of liquid propane gas leaked from a front-end loader** – Used to load concrete rubble in the reactor building. Assumed to occur in building ventilation ductwork and to cause failure of filters and blowers as well as to release radioactive contamination that is deposited on the high-efficiency particulate air (HEPA) filters and in the ductwork.
Explosion of oxyacetylene during segmentation of the reactor pressure vessel – Postulated during segmenting of the reactor pressure vessel in the reactor cavity. Explosion is sufficient to cause failure of the HEPA filter in the contamination control envelope.	**Oxyacetylene explosion** – During use of oxyacetylene cutting torch to remove the activated portion of the reactor vessel in air before segmenting the removed sections under water.
Explosion and/or fire in the ion exchange resin – Explosive release of an ion exchange column in a nuclear waste facility.	--
Detonation of Unused Explosives in the Reactor Cavity[b] – A charge used to scarf the bioshield is detonated when the water spray is turned off, and the blasting mat and contamination control envelope are not in place.	**Detonation of unused explosives** – Assumes that a charge positioned to remove the sacrificial shield explodes when the water sprays are off and the contamination control envelope has been removed.
Fire in contaminated sweeping compound[b] – Sweeping compound is composed of sawdust treated with oil or other additives to enhance pickup of contamination. Postulated to catch fire spontaneously. Contains contamination from the floor surfaces.	**Contaminated sweeping compound fire** – Sweeping compound is composed of sawdust treated with oil or other additives to enhance collection of loose surface contamination. A fire is postulated to occur in used sweeping compound contaminated with radioactive material.
Gross leak during *in situ* decontamination – Leak of 10 times the magnitude of the routine *in situ* decontamination leak for 30 minutes.	**Gross leak during loop chemical decontamination** – A massive failure of reactor piping during loop chemical decontamination is assumed to be low. This accident involves a gross leak about 10 times larger than the spray lead. A total of 1% of the liquid in the system is assumed to be made airborne.
Segmentation of reactor coolant system (RCS) piping with unremoved contamination – Released to the reactor containment building since no contamination-control envelope is assumed to be used.	–

Table I-1. (contd)

Pressurized Water Reactors	Boiling Water Reactors
Loss of contamination control envelope during oxyacetylene cutting of the reactor vessel shell – Molten metal particles penetrate the plastic sheet walls. Release lasts 5 minutes.	**Contamination control envelope rupture** – During oxyacetylene cutting. Molten metal particles penetrate the plastic sheet walls and increase leakage into the reactor building. Assumed to occur during the removal of the reactor vessel. Assumed large leak occurs for 1 hour of cutting before it is detected.
Pressure surge damage to filters during blasting of activated concrete bioshield[(b)]	**Filter damage from blasting surges** – During removal of activated concrete in the sacrificial shield.
Loss of blasting mat during removal of activated concrete[(b)] – Protective blasting mat is lost during blasting, and confinement barriers could be breached.	--
Temporary loss of local airborne contamination control during blasting[(a)] – A contamination control envelope is required in the reactor containment building during the explosive removal of the contaminated concrete in the biological shield. Loss of fine fog spray and contamination control increases the dust made airborne.	--
Loss of integrity of portable filtered ventilation enclosure during segmentation of the steam generators[(b)] – Substantial breach occurs and is readily apparent. Segmenting is promptly terminated. Air flow continues for 10 minutes.	--
Vacuum bag rupture – Metal shards rupture the filter bag and puncture the vacuum cleaner, releasing all the collected material into the air.	**Vacuum filter-bag rupture** – From metal shard, releasing all collected material to the reactor building.
Fire involving contaminated clothing or combustible waste[(b)] – Assumed 1 m^3 (35 ft^3) of combustible waste (absorbent materials such as rags or paper wipes).	**Combustible waste fire** – Assumed 1 m^3 (35 ft^3) of combustible waste (absorbent materials such as rags or paper wipes).
Accidental cutting of contaminated piping – Caused by human error. Assumed pipe is 25 cm (10 in.) or smaller.	--
Accidental spraying of concentrated contamination with the high-pressure spray – Postulated to be in the thermal insulation that has hidden a slow leak for a number of years. Results in an airborne release.	--
Accidental break of contaminated piping during inspection[(b)] – Occurs during SAFSTOR in reactor building. Pipe is weakened by corrosion and becomes damaged by incidental jostling or hitting of pipe. Assumed not to have been decontaminated *in situ.* Ventilation system is not operating.	--

Table I-1. (contd)

Pressurized Water Reactors	Boiling Water Reactors
Minor accidents with closed van	**Minor transportation accident** – Truck collision or overturn with waste containers that may rupture, or a collision and overturn with a minor fire (½ hour or less) involving one Type A waste container.
Moderate accidents with closed van	--
Severe accidents with closed van	**Severe transportation accidents** – Truck collision or overturn and a major fire (1 hour or longer) involving 40 Type A waste containers.

(a) All accidents listed are from Smith et al. (1978) and Oak et al. (1980).
(b) These accidents were not included in the 1988 GEIS (NRC 1988).

- compression or buckling of stored assemblies from the impact of a dropped heavy load (such as a fuel cask)

- loss of neutron absorber plates that separate the stored assemblies.

The results of the staff's analysis is presented in Section I.2.

The accidents and malfunctions considered in licensing documents were divided into subgroupings within five main categories:

- fuel-related accidents, which center around the storage of fuel in the spent fuel pool

- other radiological, non-fuel-related accidents, which include onsite accidents related to decontamination or dismantlement activities (e.g., material-handling accidents or accidental cutting of contaminated piping), or storage activities (e.g., fires or ruptures of liquid waste tanks)

- external events, which include aircraft crashes, floods, tornadoes and extreme winds, earthquakes, volcanic activity, forest fires, lightning storms, freezing, and intruder events

- offsite events, which consist solely of transportation accidents that occur offsite

- hazardous, nonradiological, chemical-related accidents, with the potential for injury to the offsite public either directly from the accident, or as a result of further actions initiated by the accident.

Table I-3 contains the list of accidents as described in the licensing documentation for each of the 20 plants reviewed. The accidents are organized under the five category headings shown

Table I-2. Accidents Considered but Not Evaluated in Smith et al. (1978) and Oak et al. (1980)

Pressurized Water Reactors	Boiling Water Reactors
Accidents involving fuel – Extensively studied and considered in other references. Not unique to or amplified by decommissioning.	--
Temporary loss of local airborne containment control during jackhammer scarfing of concrete surfaces – Manual operation, so the loss of local airborne containment is readily apparent to operator. Operation is suspended before significant release occurs.	--
Dropping of contaminated concrete rubble – Causing fine particles to become suspended in air. Quantity of such material is assumed to be small since most of the readily suspendible particles are removed during routine operations.	--
Dropping a concrete slab during placement in onsite retrievable waste storage – Precast concrete slab used for top shield and sealing surface is dropped 6 m (20 ft) while it is being placed. Surface particles become airborne, but do not increase routine release significantly and are not considered further in this study.	--
--	**Ion-exchange resin accidents** – Assumes no danger of combustion. Handling accidents appear likely, but would lead to little airborne release because of liquid nature of wastes involved.
Temporary loss of services, such as water, power, or airflow – Constitutes a lesser hazard for airborne releases than other postulated accidents.	**Loss of services, such as water supply, electrical power, or air flow** – Constitutes a lesser magnitude release than other postulated accidents, so no further analysis was made.
Natural phenomena – Reference PWR is designed to withstand effects of natural phenomena. It is assumed that this structural integrity is preserved during decommissioning as long as required for safety. These are low-probability events, e.g., floods, earthquakes, tornadoes, and high winds.	**Natural phenomena** – Reference BWR is designed to withstand the most severe natural phenomena recorded for the site with appropriate margins for uncertainties. Events are of low probability, and impact is less than the impacts calculated for operating BWRs. Includes floods, earthquakes, tornadoes, and high winds.
Aircraft crashes – Probability is low, risk is not escalated by dismantlement operations.	**Aircraft crashes** – Probability is low and risk of damage is low and not escalated by dismantlement operations.
--	**Man-caused events** – Covers wide spectrum of magnitude, ranging from releases induced by casual trespassers to releases induced by armed terrorists. Detailed analysis beyond scope of study.

Table I-3. Comprehensive Accident List

Fuel-Related Accidents	Nuclear Plant
Cask or Heavy Load Handling Accident	
Cask drop into spent fuel pool	Haddam Neck
Spent fuel shipping cask drop in the spent fuel pool	Maine Yankee
Spent fuel cask drop	San Onofre, Unit 1
Shipping cask or heavy load drop in fuel element storage well	La Crosse
Heavy load drop (equivalent to spent fuel cask drop) into pool	Big Rock Point
Drop of heavy object (cask) into spent fuel pool	Indian Point, Unit 1
Heavy load drop (equivalent to spent fuel cask drop) into spent fuel pool	Humboldt Bay, Unit 3
Heavy load drop	Fort St. Vrain
Spent Fuel-Handling Accident	
Fuel assembly drop	Haddam Neck
Fuel-handling accident	Trojan
Fuel-handling accident	San Onofre, Unit 1
Fuel-handling accident	Rancho Seco
Spent fuel handling accident	Humboldt Bay, Unit 3
Spent fuel handling event	Yankee Rowe
Fuel-assembly handling accident in the spent fuel pool	Maine Yankee
Spent fuel handling accident in fuel element storage well	La Crosse
Loss of Spent Fuel Pool Cooling	
Loss of spent fuel pool cooling water (caused by loss of offsite power)	Big Rock Point
Loss of fuel pool cooling	Indian Point, Unit 1
Loss of spent fuel pool cooling water	Yankee Rowe
Loss of fuel element storage well cooling	La Crosse
Loss of prestressed concrete reactor vessel shielding water (after fuel has been removed)	Fort St. Vrain
Loss of spent fuel pool decay heat-removal capability	Maine Yankee
Loss of spent fuel decay heat-removal without concurrent spent fuel pool inventory loss	Trojan
Failure of auxiliary electrical systems related to fuel pool cooling	Dresden, Unit 1
Loss of offsite power; limited loss of spent fuel pool cooling	San Onofre, Unit 1
Nonmechanistic loss of cooling and airborne release	Humboldt Bay, Unit 3
Loss of Water from the Spent Fuel Pool	
Loss of spent fuel pool water level	Big Rock Point
Loss of spent fuel pool water (nonmechanistic; earthquake beyond design basis)	Haddam Neck
Loss of spent fuel pool water	Indian Point, Unit 1
Loss of spent fuel pool inventory (loss of heat sink or by inadvertent siphoning)	Maine Yankee
Loss of spent fuel pool water from pool rupture of unknown origin	Humboldt Bay, Unit 3
Loss of cooling water	Yankee Rowe
Fuel pool drain-down	Dresden, Unit 1
Fuel element storage well system pipe break	La Crosse
Loss of spent fuel pool decay heat-removal capability with concurrent spent fuel pool inventory loss	Trojan

Table I-3. (contd)

Fuel-Related Accidents (contd)	Nuclear Plant
Loss of Offsite Power	
Loss of offsite power (resulting in loss of spent fuel cooling)	Big Rock Point
Loss of offsite power (resulting in loss of water from the pool)	La Crosse
Loss of offsite power (resulting in loss of spent fuel pool cooling)	Rancho Seco
Loss of power	Fort St. Vrain
Temporary loss of offsite power (crane or hoist failure)	Trojan
100% Fuel Failure	
100% fuel failure	Indian Point, Unit 1
100% fuel failure	Shoreham
Simultaneous failure of fuel assemblies	Dresden, Unit 1
Criticality	
Inadvertent criticality (misplaced assembly in pool)	Maine Yankee
Criticality, stored spent fuel rearranged from seismic or other events	Humboldt Bay, Unit 3
Accidents Involving Radioactive Materials (Non-Fuel-Related)	
Decontamination-Related Accidents	
Spray release during in situ decontamination of systems	Saxton
Gross leak or accident during in situ decontamination (spray and liquid)	Trojan
Decontamination of liquid spill	Three Mile Island, Unit 2
Decontamination events	Yankee Rowe
Accidental spraying of concentrated contamination with high-pressure spray	Three Mile Island, Unit 2
Concentrated contamination spray	Three Mile Island, Unit 2
Radioactive Material (Non-fuel) Handling Accidents	
Waste container drop	Pathfinder
Waste container drop and rupture (containing activated concrete rubble)	Shoreham
Dropping of filters or packages of particulate material	Trojan
Dropping of contaminated components	Trojan
Dropping of concrete rubble	Fort St. Vrain
Dropping of concrete rubble	Trojan
Packaging events	Yankee Rowe
Materials-handling event	Yankee Rowe
Steam generator load drop inside containment	Trojan
Dropping the reactor pressure vessel	Pathfinder
Dropping steam generator primary module	Fort St. Vrain
Steam generator load drop outside of containment	Trojan
Dismantlement-Related Accidents	
Contamination release during accidental cutting of contaminated piping	Three Mile Island, Unit 2
Contamination release during accidental break of contaminated piping	Three Mile Island, Unit 2
Loss of engineering controls during dismantlement of reactor cavity	Big Rock Point
Contamination release during dismantlement of main coolant system loop	Yankee
Dismantlement of RCS and safety injection piping without or with loss of local engineering controls	Saxton

Table I-3. (contd)

Accidents Involving Radioactive Materials (Non-Fuel-Related) (contd)	Nuclear Plant
Absence of blasting mat during removal of activated concrete	Trojan
Loss of HEPA Filters	
Rupture of contamination-control envelope; release of contamination on HEPA filter	Shoreham
HEPA filter failure	Three Mile Island, Unit 2
Loss of integrity of portable filtered ventilation enclosure	Trojan
Pressure-surge damage to filters during blasting of activated concrete bioshield	Trojan
Temporary loss of local airborne contamination control during blasting	Trojan
Temporary loss of local airborne contamination control during scarfing of contaminated concrete surfaces with jackhammer	Trojan
Loss of contamination-control envelope during oxyacetylene cutting of the reactor-vessel shell	Trojan
Radioactive Gas Waste System Leaks	
Leaks and failures in radioactive waste gas system in radwaste decay tanks	Maine Yankee
Leak or failure in radioactive waste gas system	Trojan
Radioactive Liquid Waste Releases	
Liquid waste tanks rupture	Fermi, Unit 1
Storage tank rupture	Three Mile Island, Unit 2
Liquid waste storage vessel failure	Saxton
Postulated radioactive releases due to liquid tank failures	Trojan
Liquid radioactive tank release	Humboldt Bay, Unit 3
Liquid radioactive waste release to lake through cracks in building, earthquake-induced	Fermi, Unit 1
Rupture of spent fuel pool, contents released to bay	Humboldt Bay, Unit 3
Liquid waste discharge pumped to river without sampling	La Crosse
Leaks and failures in radioactive liquid waste system	Maine Yankee
Condensate storage tank contents pumped into ground during in-service leak test (actual event report)	Dresden, Unit 1
Containment Breach (Open Penetration to Containment)	
Containment vessel breach, subsequent loss of contents to air/water	Saxton
Open penetration – unfiltered pathway from containment	Three Mile Island, Unit 2
Spent Resin Accidents	
Spent resin handling accident (exothermic reaction during dewatering)	Haddam Neck
Dropped resin vessel during removal from containment building	Saxton
Low-level waste storage accident (resin liner drop)	Maine Yankee
Release of resins from makeup and purification demineralizer	Three Mile Island, Unit 2
Storage of spent resins	Big Rock Point
Explosion and/or fire in ion exchange resins	Trojan
Vacuum Filter Bag Ruptures	
Vacuum filter bag rupture during decontamination of spent fuel pool floor	Saxton
Vacuum filter bag rupture during cleaning of the Reactor Building floor	Shoreham
Vacuum canister failure	Three Mile Island, Unit 2

Table I-3. (contd)

Accidents Involving Radioactive Materials (Non-Fuel-Related) (contd)	Nuclear Plant
Loss of Electric Power	
Loss of offsite power	Yankee Rowe
Loss of offsite power	Trojan
Loss of electric power with unknown scenario	Pathfinder
Loss of offsite power affecting HEPA filters, etc.	Saxton
Loss of Compressed Air	
Temporary loss of compressed air	Trojan
Loss of compressed air	Yankee Rowe
Fire	
Fire	Dresden, Unit 1
Fire	San Onofre, Unit 1
Fire	Fort St. Vrain
Fire	Indian Point, Unit 1
Fire events (primarily those that could impact SFP cooling)	Big Rock Point
Fire inside of containment	Three Mile Island, Unit 2
Fire inside stairwell	Three Mile Island, Unit 2
Fire in D-rings	Three Mile Island, Unit 2
Fire in reactor building or fuel handling building	Pathfinder
Fire in boiler building	Pathfinder
Fire in storage facilities	Yankee Rowe
Fire in intermodel container of waste	Yankee Rowe
Fire in combustible waste stored in yard	Saxton
Fire in low-level radioactive waste storage building	Trojan
Combustible waste fire in 208-L (55-gal) drum container	Shoreham
Contaminated clothing or combustible waste fire	Trojan
Contaminated sweeping compound fire (sawdust with oil and other additives, used to enhance collection of loose surface contaminants)	Shoreham
Fire or other catastrophic event, initiator for residual sodium release	Fermi, Unit 1
Explosion	
Explosion of liquid propane gas leaked from front-end loader in containment	Trojan
Liquid propane gas explosion on front-end loader	Shoreham
Liquid propane gas explosion caused by an accidental leak on front-end loader used in containment building	Saxton
Oxyacetylene explosion in the containment building while cutting reactor coolant system piping and release of HEPA filter contents within portable enclosure	Saxton
Oxyacetylene explosion and release of HEPA filter contents	Shoreham
Explosion of oxyacetylene during segmenting of reactor vessel shell	Trojan
Explosion event inside vapor container	Yankee Rowe
Explosion inside area warehouse	Yankee Rowe
Explosion of large fuel-oil storage tanks	Humboldt Bay, Unit 3
Detonation of unused explosives in reactor cavity	Trojan
Sodium interaction with water caused by water inflow through a crack in a tank	Fermi, Unit 1

Table I-3. (contd)

Accidents Involving Radioactive Materials (Non-Fuel-Related) (contd)	Nuclear **Plant**
Onsite Transportation Accidents	
Onsite transportation accident	Yankee Rowe
Accidents Initiated in External Events	
Aircraft Crashes	
Aircraft hazards	Big Rock Point
Aircraft crashes	Trojan
Aircraft impact	Yankee Rowe
Floods	
Flood	San Onofre, Unit 1
Flood	Yankee Rowe
Flood	Pathfinder
Flooding	Saxton
External flooding	Big Rock Point
External flooding	Trojan
Site flooding	Dresden, Unit 1
Site flooding	Indian Point, Unit 1
Site flooding	Peach Bottom, Unit 1
Flood, seiches, and tsunamis	Shoreham
Low Water	
Probable minimum water level, from negative lake surge or sieche	Big Rock Point
Wind	
Tornadoes and extreme winds	Pathfinder
Tornadoes and extreme winds	Trojan
Tornadoes and extreme wind	Yankee Rowe
Tornadoes and extreme wind	Saxton
Tornadoes and wind	Big Rock Point
Wind and tornadoes	La Crosse
Wind and tornado missiles	San Onofre, Unit 1
Tornados and hurricanes	Shoreham
Natural disaster, tornado	Fort St. Vrain
Earthquakes	
Earthquake	Big Rock Point
Earthquake	Indian Point, Unit 1
Earthquake	Pathfinder
Earthquake	Trojan
Earthquake	Saxton
Earthquake	San Onofre, Unit 1
Earthquake	Shoreham
Earthquakes	Yankee Rowe
Seismic events	Dresden, Unit 1
Seismic event	La Crosse

Table I-3. (contd)

Accidents Initiated in External Events (contd)	Nuclear Plant
Volcanoes	
Volcanic activity	Trojan
Lightning	
Lightning	Trojan
Lightning	Saxton
Lightning	Yankee Rowe
Forest Fire	
Forest fires	Yankee Rowe
Forest or brush fire	Saxton
Freezing Temperatures	
Freezing temperatures, loss of plant heating	Big Rock Point
Freezing temperatures (actual accident)	Dresden, Unit 1
Physical Security	
Intruder event	Saxton
Physical security breach	Shoreham
Physical security breach	Pathfinder
Offsite Transportation-Related Accidents	
Offsite transportation accident	Shoreham
Offsite transportation accident	Yankee Rowe
Transportation accident	Three Mile Island, Unit 2
Truck carrying radwaste – fire	Pathfinder
Truck and two intermodel containers, transportation accident with fire	Saxton
Reactor pressure vessel railroad accident and fire	Pathfinder
Reactor pressure vessel in the river during transportation by rail	Pathfinder
Offsite radiological event (shipment of radioactive materials)	Saxton
Hazardous Nonradiological Chemical Events	
Toxic chemical event (initiation for material handling event)	Saxton
Toxic chemical event	Trojan
Chemical combustion (from sodium-water interaction) and dispersal	Fermi, Unit 1
Toxic chemical event, initiator for fuel-handling event	Trojan

above and under subgroup headings that describe a specific type of accident, e.g.,“cask or heavy load handling accidents” or “spent resin accidents.” Each of the plants described the accidents they evaluated in a specific way, which may or may not be identical to the subgroup headings. For example, Big Rock Point considered a “loss of spent fuel pool cooling,” while the Trojan Nuclear Plant described a similar accident as a “loss of spent fuel decay heat removal without concurrent spent fuel pool inventory loss.” The exact descriptions given by the plants were used when available. In some cases, however, a short description was not available, and it was necessary to paraphrase or summarize from a longer discussion of the accident.

Categorizing accidents is not a straightforward process. Frequently, an initiating event causes more than one type of accident. For example, the loss of electric power could cause the loss of spent fuel cooling, resulting in the potential for fuel failure and subsequent offsite release. The same loss of electric power could result in a crane or hoist failure, resulting in a heavy object being dropped either into the spent fuel pool with subsequent failure of fuel cladding, or in a highly contaminated object other than fuel being dropped onto an unyielding surface, causing the release of contamination. The same loss of electric power could affect the ventilation system and result in the loss of high-efficiency particulate air filter (HEPA) filtration and subsequent release of contamination. Alternatively, a single accident could be caused by multiple types of initiating events. For example, the loss of spent fuel pool coolant could be caused by the loss of offsite power, a break in a pipe (resulting from cutting the wrong pipe), or an external event (such as damage to the pipes from freezing or rupture of the pool during an earthquake) causing the release of the water. Because an effort was made to categorize the accidents as they were described by the licensing documents for each plant, a "loss of offsite power accident" may be the same thing as a "loss of spent fuel cooling accident." In some cases, a single plant would analyze both the loss of offsite power and the loss of spent fuel pool cooling as separate accidents, whereas they both concluded with the same result.

All accidents identified by licensees were included in Table I-3, even if they were just considered without a detailed discussion or analysis of the consequences. A number of accidents were initially considered, but were determined without further analysis to fall under one of the following categories:

- an accident that is not possible or probable – For example, a licensee might consider an aircraft impact as an accident, but state in their documentation that the probability of occurrence is low and, therefore, the accident is not analyzed further.

- an accident may occur, but not result in any type of consequence – For example, during consideration of a flood, the licensee might state that "flooding events do not result in significant radiological release; therefore, public health and safety are not adversely affected," or in the case of a material-handling event, make a statement such as, "compliance with management programs and quality assurance plan ensure that the probability of occurrence and the consequences do not significantly affect the public health and safety."

- an accident may occur, but mitigative actions can be taken before any radioactive material is released offsite – For example, during consideration of a seismic event, a statement is made that the facility was designed to accommodate the initiating event, and no damage resulting in a release would occur.

- an accident may occur, but with minimal offsite dose consequences – For example, loss of cooling for a spent fuel pool where the fuel has cooled to a level that would not result in the release of activity for a number of days and where mitigative actions could be taken to ensure that there would be no release of radioactive materials.

Although these accidents were not analyzed in depth, they were considered and, therefore, are included in Table I-3.

Most licensees did not describe the entire scenario that would cause the accident. For example, most documents that discussed the analysis of the release of liquid radioactive waste did not provide an indication of the event that caused the rupture of a liquid waste tank or storage tank. Therefore, it was a simple decision to place this accident in the group of "Liquid Radwaste Releases." However, some licensees did provide a complete scenario, such as a description that the tanks located in the basement were assumed to have been cracked during an earthquake, allowing fluid to leak into the earth and then into an aquifer, finally settling in a nearby lake. This accident could have been grouped by the initiating event (an earthquake) or the consequence (a release of liquid radioactive waste). In such cases, the initiators (or the consequences) are also shown in Table I-3.

In other cases, the accident could easily be placed under more than one heading. For example, one licensee (Trojan Nuclear Plant) analyzed an explosion and/or fire in the ion exchange resins. This accident could have been included under "Explosions," "Fires," or "Spent Resin Accidents." In this case, the last choice was selected. Another example would be the "oxyacetylene explosion and release of HEPA filter contents," which was analyzed by the licensees for the Saxton, Shoreham, and Trojan Nuclear Plants. This accident could have been included under either "Explosions" or "Loss of HEPA filters." In this case, the first choice was selected.

In some cases, the descriptions provide much more information regarding the accident than they do in other cases. For instance, under the heading "Fire," five of the licensees did not give any more detailed description other than they were analyzing a "fire" or "fire events." Other licensees described the location of the fire (inside stairwells, inside boiler buildings, etc.), and the remainder discussed the items that were combusted (contaminated clothing or waste, or contaminated sweeping compound).

Some of the descriptions of the accidents did not give any details regarding the scenario that resulted in offsite dose consequences. These accidents were described as nonmechanistic, i.e., they had no associated scenarios or initiators. For example, three licensees evaluated the simultaneous failure of 100% of the fuel assemblies in the spent fuel pool but gave no reason for the simultaneous failure.

The fuel-related accidents centered around the storage of the spent fuel in the spent fuel pool. The most common fuel-related accidents analyzed include the loss of spent fuel pool cooling (10 facilities), the loss of water in the spent fuel pool (9 facilities), cask or heavy handling

(8 facilities), and the spent fuel handling (8 facilities). The accidents listed under "Loss of Offsite Power Accidents" also result in the loss of cooling, the loss of water from the pool, or a handling accident.

The non-fuel-related accidents center around decontamination, dismantlement, or storage-type activities. Decontamination-related activities include *in situ* decontamination and rupture of vacuum-filter bags. Accidents from these activities could include fires that occur in contaminated clothing or sweeping compounds. Dismantlement-related activities include accidental cutting or breaking of contaminated piping or breaching of containment, loss of HEPA filters during cutting or blasting operations, and material-handling accidents, such as dropping of contaminated components, concrete rubble, or spent resins. Dismantlement activities also include the potential for explosions either from front-end loaders or while using oxyacetylene during dismantlement activities. Storage-type activities include storage of non-fuel wastes that could result in liquid waste tank ruptures and explosive gas buildup in ion exchange resins. There is also the potential for fires in buildings or in waste stored inside the facility.

The most common non-fuel-related accidents that involved radioactive material were the fires (20 total accidents from 12 different plants). A fire may be one of the more important accidents to consider for a plant in decommissioning because of the large loading of combustible material resulting from the amount of low-level radioactive waste in the form of wipes, clothing, etc. Fire events included generic listings of "fire," specific listings of locations where the fire might occur (in the boiler building or low-level waste storage buildings) or the material the fire involves (contaminated clothing or contaminated sweeping compounds).

The second most common non-fuel-related accident related to the handling of radioactive (non-fuel) material such as waste containers, filters, concrete rubble, contaminated components, or larger items such as reactor pressure vessels or steam generators (13 accidents identified from 5 separate plants). The third most common radiation-related (non-fuel) accident was from explosions, which comprise 11 accidents from 5 separate plants. These accidents included explosion of liquid propane gas from front-end loaders being used for dismantlement activities and oxyacetylene explosions during dismantlement, which released HEPA filter contents, or during the reactor vessel shell. The fourth most common non-fuel-related accident is the release of liquid radioactive waste from storage tanks. The majority of these accidents resulted from the rupture or failure of a tank storing liquid radioactive waste. However, one of the postulated accidents occurs during the inadvertent pumping or transfer of the liquid radioactive waste to the river without sampling. Another of the postulated accidents in this group was the rupture of the spent fuel pool, with the contents released to a nearby body of water. This accident looked at the offsite dose consequences of the contaminated water being released to the environment and did not consider the resultant effect on the spent fuel remaining in the now-drained pool (considered a separate accident).

The licensees considered external events, including aircraft crashes into the facility's buildings, floods, low water levels, wind, earthquakes, volcanoes, lightning, forest fires, freezing temperatures, and physical security (intruder-initiated events). Earthquakes or seismic events (11 accidents from 10 plants), site flooding (10 accidents from 10 plants) and tornado or extreme wind (10 accidents from 9 plants) were the most commonly cited.

There is only one subgrouping of transportation-related accidents. Eight potential transportation-related accidents were discussed, ranging from transportation of low-level waste to transportation of large components, such as the reactor pressure vessel.

There were four accidents related to nonradiological, chemical releases that were found in the licensing-basis documentation. Three of the four accidents would result in an offsite release of toxic chemicals, and the fourth would result in a chemical event that would incapacitate the operator of a crane inside the plant, thus initiating a material-handling event.

I.2 Consequences of Potential Accidents

In addition to compiling a comprehensive list of accidents and malfunctions at permanently shutdown facilities, the potential offsite dose consequences were evaluated. The evaluation of dose consequences is necessary for understanding the risk to the public from these accidents. Compared to the potential consequences from an accident at an operating facility, most of the accident consequences for a permanently shutdown facility are small. This section addresses accident consequences both from the accidents obtained from NRC-sponsored research and the accidents found in the licensing documentation.

Table I-4 presents the highest doses in each of four categories of radiological accidents as obtained from licensing-basis documents. The highest doses result from postulated fuel-related accidents and radioactive-material-related accidents. All accidents that were reviewed used conservative assumptions to calculate the offsite dose. For example, some licensees analyzed accidents that considered the 100% failure of fuel by using assumptions that were non-mechanistic to determine the estimated dose.

Information obtained from licensing-basis documents for the fuel-related accidents showed that the highest doses were from the cask or heavy load handling accidents, the accidents that assumed a 100% fuel failure, and the spent fuel handling accidents. Although some of the licensing-basis documents gave calculated doses to the offsite population from the loss of water in the spent fuel pool (Maine Yankee, 2.3 mSv [0.23 rem]; Fort St. Vrain, 0.35 mSv [0.035 rem]) and from the loss of cooling capability to the spent fuel pool (Maine Yankee, 2.2E-5 mSv [0.002 mrem]), the majority of the documents stated that these accidents would result in no appreciable offsite dose because the accident could be mitigated before offsite-dose consequences could occur.

In addition to the licensing-basis documents reviewed, the staff's report *Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants* report (NRC 2001) provides an analysis of the consequences of the spent fuel pool accident risk. As discussed

Table I-4. Highest Offsite Doses Calculated for Postulated Accidents in Licensing-Basis Documents

Accident Description	Nuclear Plant	Offsite Whole-Body Dose, rem
Fuel-Related Accidents		
Cask drop into spent fuel pool	Haddam Neck	0.418
Loss of spent fuel pool inventory (loss of heat sink or by inadvertent siphoning)	Maine Yankee	0.23
Shipping cask or heavy load drop into fuel element storage well	La Crosse	0.186
Loss of prestressed concrete reactor vessel shielding water (after fuel has been removed)	Fort St. Vrain	0.035
100% fuel failure	Indian Point, Unit 1	0.027
Simultaneous failure of fuel assemblies	Dresden, Unit 1	0.016
Spent fuel handling accident	Humboldt Bay, Unit 3	0.013
Fuel-handling accident	Rancho Seco	0.01
Heavy load drop	Fort St. Vrain	0.007
Fuel assembly drop	Haddam Neck	0.0026
Radioactive Material-Related Accidents (Non-Fuel)		
Spent resin handling accident (exothermic reaction during dewatering)	Haddam Neck	0.96
Explosion inside vapor container	Yankee Rowe	0.44
Radioactive liquid waste system leaks and failure	Maine Yankee	0.23
Materials-handling event	Yankee Rowe	0.16
Fire	Fort St. Vrain	0.12
Fire in intermodal container of waste	Yankee Rowe	0.1
Fire in D-rings	Three Mile Island, Unit 2	0.049
Decontamination events	Yankee Rowe	0.039
Liquid radioactive waste released to lake through cracks in building (earthquake-induced)	Fermi, Unit 1	0.02364
Release of resins from makeup and purification demineralizer	Three Mile Island, Unit 2	0.02
External-Events Initiated Accidents		
Natural disaster, tornado	Fort St. Vrain	0.001
Physical security breach	Pathfinder	<0.000001
Offsite Transportation Accidents		
Reactor pressure vessel railroad accident and fire	Pathfinder	0.00014
Truck carrying radioactive waste – fire	Pathfinder	0.000005
Reactor pressure vessel drop into river during transportation by rail	Pathfinder	0.000001
Transportation accident	Three Mile Island, Unit 2	<0.000001
To convert from rem to sievert, multiply by 0.01.		

previously, earlier analyses in NUREG/CR-4982, *Severe Accidents in Spent Fuel Pools in Support of Generic Issue 82*, (Sailor et al. 1987) and NUREG/CR-6451, *A Safety and Regulatory Assessment of Generic BWR and PWR Permanently Shutdown Nuclear Power Plants* (Travis et al. 1997) included a limited analysis of the offsite consequences of a severe spent fuel pool accident occurring up to 90 days after the last discharge of spent fuel into the spent fuel pool. These analyses showed that the consequences of a spent fuel 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 spent fuel pool accidents using fission product inventories at 30 and 90 days and 2, 5, and 10 yrs. The results of the study indicate that the risk at spent fuel pools is low and well within the Commission's Quantitative Health Objectives. 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.

For the "Other Radioactive Material-Related" accidents (nonfuel), the accident subgroup with the highest estimated offsite dose was 0.96-rem total effective dose equivalent (TEDE) for a spent resin handling accident. The spent resin handling accident is only slightly below the U.S. Environmental Protection Agency's Protective Action Guide (PAGs). Other associated accident scenarios included handling accidents occurring during dewatering, releases from makeup and purification demineralizers, and the dropping of liners. Other categories with significant estimated doses include accidental releases of radioactive liquid wastes, radioactive material (nonfuel) handling accidents, explosions, and fires. However, there was a significant variation in doses within each subcategory. For example, for the radioactive liquid waste release accidents, the estimated doses range from a high of 2.3 mSv (0.23 rem) TEDE for a leak in the radioactive liquid waste system (Maine Yankee) to an estimate of "no dose" for the uncontrolled liquid waste discharge via a tank pumped directly to the river (Humboldt Bay 3).

The external event accidents (aircraft crashes, forest fires, floods, freezing temperatures, low water levels, lightning, earthquakes, volcanoes, and extreme winds and tornadoes) were in all but one case determined by the licensee's analyses either to be of a very low probability of occurrence, to have no dose consequences, to have doses that were bounded by other accidents, or to have doses that were below the U.S. Environmental Protection Agency (EPA) PAGs (EPA 1991). Most of the time, it was indicated that the doses would be significantly less than the EPA PAGs. The one case where an offsite dose was calculated was a tornado event (Fort St. Vrain), which was estimated to result in a whole body, 2-hour dose of 0.0058 mSv (0.0058 rem) and an organ dose (lung) of 0.17 mSv (0.017 rem).

Doses from offsite transportation accidents were very small, ranging from a "no dose" estimate to an estimated 0.0014 mSv (0.00014 rem) for a reactor pressure vessel that was involved in a railroad accident (Pathfinder).

The accident consequences during decommissioning are somewhat time-dependent since some of the radionuclide inventory significantly decreases shortly following shutdown, and then continues to decrease at a slower rate during the entire decommissioning period. This is most pronounced for the fuel-related accidents since some of the radionuclides present in the fuel, such as iodine-131, have a significant impact on the severity of the dose, but have a short half-life and will decay to negligible amounts within a few months following shutdown.

I.3 Correlation of Activities with Potential Accidents During Decommissioning

Activities and hazards at reactor sites following permanent shutdown and defueling may be different from those routinely experienced at an operating reactor; however, there are similarities in decommissioning activities and the activities that take place during refueling and maintenance outages.

Table I-5 lists the activities that characterize the type of actions that are being taken at sites both in DECON and SAFSTOR and compares the activities to the accidents listed in Table I-3, "Comprehensive Accident List." This list of activities was obtained from documentation from the sites that have recently completed, or have recently started, the decommissioning process. The list is divided into activities performed during DECON and SAFSTOR. The decontamination and dismantlement activities were included for those sites that are in SAFSTOR but are performing incremental decontamination and dismantlement. Under DECON, the activities are categorized as having to do with construction; decontamination; contamination control; dismantlement; removal of the vessel, internals, and other large components and systems; radioactive waste management; spent fuel pool; soil remediation; and the final radiation survey. For activities that take place during SAFSTOR, activities are simply listed as taking place in preparation for or during SAFSTOR.

For each activity, an assessment was made to determine the accident type that might occur during that activity. In the right-hand column of Table I-5, an associated accident is given, using the subgroup heading used in Table I-3. If an activity was determined not to have the potential for an accident, then it is described as "no accident." From the comparison of activities to accidents, it was determined that there would be no accident of greater consequence than the accidents already identified.

Table I-5. Comparison of Activities and Accidents During DECON and SAFSTOR

Activities	Associated Accidents
DECON	
Construction and Establishment	
Possible establishment of site construction power site	No accident
Possible establishment of monitoring stations separate from the control room	No accident
Possible construction of independent spent fuel storage installation (ISFSI)	Cask or heavy load handling
Possible establishment of spent fuel pool cooling system that is independent of existing plant systems	Loss of spent fuel cooling
Possible construction of decommissioning support building and utilities	No accident
Possible establishment of radioanalytical facilities	No accident
Possible design and fabrication of special shielding and contamination-control envelopes	No accident
Possible establishment of radiological monitoring stations	No accident
In situ chemical decontamination of primary coolant system	Decontamination-related accidents
Decontamination of outside of large components, facility surfaces, components, and piping surfaces	Decontamination-related accidents
Vacuuming	Vacuum filter bag ruptures
Ultra-high-pressure water lancing	Decontamination-related accidents
Abrasive grit blasting	Decontamination-related accidents
Manual decontamination techniques (handwriting), wet mopping, scrubbing.	Decontamination-related accidents
Painting or applying coatings to stabilize contamination	No accident
Contamination Control	
Bag items to prohibit contamination spread	Fire
Dismantlement	
Remove contaminated piping and tubing - cut and install covers and plugs	Dismantlement-related accidents
Remove walls	Radioactive material (nonfuel) handling accidents
Demolish buildings	Radioactive material (nonfuel) handling accidents
Concrete removal with impact hammers, saw cutting, and diamond wire cutting	Radioactive material (nonfuel) handling accidents
Abrasive water jet cutting (scabbier) for concrete.	Decontamination-related accidents
CO_2 blasters for concrete	Decontamination-related accidents

Table I-5. (contd)

Activities	Associated Accidents
DECON (contd)	
Metal component dismantlement - saw cutting - power band saws - diamond wire saws - machining - mechanical shearing - manual disassembly - abrasive shell cutting - OD milling machines - torch cutting (thermal methods melt or vaporize surfaces of materials being cut)	Radioactive material (nonfuel) related accidents; dismantlement-related accidents
Rigging used to remove heavy or awkward sections	Radioactive material (nonfuel)
Small-diameter piping	related accidents; dismantlement-related accidents
Filings collected in catch basins and vacuumed, as needed	Radioactive material (nonfuel) related accidents; vacuum filter bag rupture
Removal of Reactor Pressure Vessel and Internals	
Piping and instrumentation lines cut; interferences removed	Radioactive material (nonfuel) related accidents; dismantlement-related accidents
Decontaminated, segmented, packaged, and shipped offsite – segmenting included underwater semi-automatic plasma arc and metal disintegration machining equipment	Decontamination-related accidents; radioactive material (nonfuel) related accidents; dismantlement-related accidents
Remove intact or segment	Radioactive material (nonfuel) related accidents; dismantlement-related accidents
Intact removal requires - opening in building - grouting of openings created by cutting operations - removal from containment and placement in lay down area - removal of internals - injection of grout into reactor vessel - installation of welded closure caps on all openings - installation of structural members, as necessary - potential welding around reactor vessel.	Radioactive material (nonfuel) related accidents; dismantlement-related accidents; containment breach accidents
Removal of Other Large Components (Steam Generators and Pressurize)	
Intact removal or partial segmentation	Dismantlement-related accidents; radioactive material (nonfuel) handling accidents

Table I-5. (contd)

Activities	Associated Accidents
DECON (contd)	
Cut piping attachments	Dismantlement-related accidents; radioactive material (nonfuel) handling accidents
Install temporary supports, cut hanger rods	
Decontaminate external surfaces	Decontamination-related accidents
Seal-weld openings	
Move vessels horizontally for lifting through removable hatch or new opening in concrete building	Radioactive material (nonfuel) related accidents
Grout if required or segment greater than class C (GTCC) components for storage with the spent fuel	Dismantlement-related accidents; radioactive material (fuel- and nonfuel-related accidents)
Reactor Coolant System	
Decontaminate, segment, and dispose of RCS and other larger-bore piping	Radioactive material (nonfuel) related accidents; dismantlement-related accidents
Remove and package asbestos insulation	Nonradioactive hazardous material accident
Remove turbine control oil	Fire
Remove nonradioactive materials, including fuel oil, lubricating oil, 1,1,1-tricholorethane, laboratory chemicals, lead, mercury, paint, battery acid, asbestos	Fire; nonradioactive hazardous material accidents
Radwaste Management	
Ship radioactive materials	Transportation accidents
Ship mixed wastes to approved disposal sites	Transportation accidents
Spent Fuel Pool	
Remove spent fuel and GTCC waste	Cask or heavy load handling accident; spent fuel pool handling accident
Decontaminate and dismantle spent fuel facility after all spent fuel has been removed	Decontamination-related accidents; dismantlement-related accidents; radioactive material (nonfuel) related accidents
Soil remediation	Radioactive material (non-fuel) related accidents
Final radiation survey	No accidents
SAFSTOR	
Preparation for SAFSTOR	
Assess functional requirements for all plant systems, structures, and components for all phases of decommissioning	None

Table I-5. (contd)

Activities	Associated Accidents
SAFSTOR (contd)	
Deactivate systems; dispose of nonessential structures and systems	Radioactive material (nonfuel) related accidents
Drain and flush plant systems	Decontamination-related accidents
Decontaminate, as necessary	Decontamination-related accidents
Either lay-up or isolate plant systems, structures, and components no longer required	No accidents
Remove filter elements and demineralizer resin beds	Spent resin accidents
Wet-mopping of clean areas	No accidents
Process, package, and ship liquid and solid radioactive waste generated during plant closure activities	Radioactive material (nonfuel) related accidents; radioactive liquid waste-release accidents; transportation accidents
Install permanent safety-related electrical power supply to spent fuel pool cooling system	Spent fuel pool cooling accidents
Establish a permanent reactor coolant system vent path (permanent passive venting of RCS to containment atmosphere)	Loss of HEPA filters
Establish a permanent containment vent path	Loss of HEPA filters
Removal of nitrogen gas cylinders	No accidents
Reconfigure the instrument/service air system	No accidents
Make electrical modifications required to de-energize equipment	No accidents
Remove dedicated safe-shutdown diesel and generator	No accidents
Perform an assessment of current radiological conditions	No accidents
SAFSTOR Activities and Tasks	
24-hour guard force	No accidents
Maintain environmental and radiation monitoring program	No accidents
Preventative and corrective maintenance on operating/functional plant systems, structures, and components	No accidents
Maintain structural integrity	No accidents
Process liquid radwaste	Radioactive liquid waste releases
Provide for safe spent fuel storage	Loss of spent fuel cooling accidents
Maintain security systems	No accidents
Maintain radwaste systems	Radioactive gas waste system leaks radioactive liquid waste releases
Maintain heating and ventilation, where necessary	No accidents
Maintain lighting, fire protection, heating, ventilation, and air conditioning, and alarm systems, as required	No accidents
Dispose of nonradioactive hazardous waste	No accidents
Remove unused equipment during SAFSTOR	No accidents
Operate and monitor required systems	No accidents
Limited decontamination of selected structures and systems	Decontamination accidents
Perform general inspections during annual containment entry	No accidents

I.4 References

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U.S. Nuclear Regulatory Commission. 2001. *Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants*. NUREG-1738, NRC, Washington, D.C.

I.5 Licensing Basis Documents

One of the sources of information used in this report was licensing basis documents. The sources of information listed below by nuclear facility were consulted. The documents that are listed have been docketed by the NRC and are publicly available. The docket numbers for the facilities are noted below next to the facility name.

The documents can be obtained one of three ways. First, by accessing the NRC's website the reader can obtain most of the Post-Shutdown Defueling Activities Reports (PSDARs) and License Termination Plans (LTPs) that are cited in this chapter. The address for the decommissioning page on the NRC's website is http://www.nrc.gov/OPA/reports/dcmmssng.htm.

Second, the documents can be obtained from the Public Electronic Reading Room, which provides access to the NRC's new records-management system of publicly available information the Agency wide Documents Access and Management System (ADAMS). Within this system you can access two libraries: the Publicly Available Records System, and that Public Legacy Library.

This system, which was implemented on October 12, 1999, marks a change in the previous practice where records were available only in paper or microfiche copies at either the main NRC Public Document Room in Washington, DC or at 86 local public document rooms at libraries near nuclear power plants and other regulated facilities throughout the United States. Access to the NRC Public Electronic Reading Room will now be possible from personal computers, including those located in most public libraries.

ADAMS is an electronic information system that allows access to NRC's publicly available documents via the Internet. It permits full text searching and the ability to view document images, download files, and print locally. It also provides a more timely release of information by the NRC and faster access to documents by the public, than before. The reader can obtain the documents cited in this Appendix by providing the facility name (e.g., Trojan) or the docket number cited for each facility as shown at the end of this section, and the name or date of the document.

ADAMS can be accessed via the Internet at the NRC's website using the following URL: http://www.nrc.gov/NRC/ADAMS/index.html. This site contains instructions for installing and running ADAMS as well as information on obtaining assistance during installation or use.

The Public Electronic Reading Room on the NRC Web site at <www.nrc.gov> allows the public to use the Internet to search for any of the records that NRC has already released to the public. This site uses NRC's Agency wide Documents Access and Management System (ADAMS) to search two electronic libraries: the Public Legacy Library and the Publicly Available Records System (PARS) Library. The Public Legacy Library currently has a selection of bibliographic descriptions and some full text files of NRC records released to the public prior to Fall 1999. Records in this library were copied from the NRC Bibliographic Retrieval System (BRS) and the Nuclear Document System (NUDOCS), the two systems previously used by the public to search for NRC records. Both BRS and NUDOCS will remain available for searching until all the records are in the Legacy Library. The other library, the Publicly Available Records System (PARS) Library, contains all NRC publicly available records released since Fall 1999. The records in the PARS Library are in, both, full text and image and the public can perform full text searches of the database, as well as view, download, and print the files from there.

Third, the NRC Public Document Room (PDR) at NRC Headquarters in Rockville, Maryland (One White Flint North, 20555 Rockville Pike, Washington DC 20555-0001 (1-800-397-4209), has a complete collection of over two million NRC documents released prior to the Fall of 1999 that are still retained as agency documents. The public may view documents at the PDR and there are reference librarians available to help in identifying, retrieving, organizing, and evaluating NRC documents from various resources and formats, including the Public Electronic Reading Room. Members of the public may also access the Electronic Reading Room libraries from computer terminals in the PDR. The PDR also provides reproduction services and, for a fee, the public can order copies of any of the records in the PDR, the Legacy, and the PARS libraries.

Big Rock Point (NRC Docket Number 50-155)

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