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FINAL
ENVIRONMENTAL IMPACT STATEMENT

Decommissioning of the Shippingport Atomic Power Station

May 1982

U.S. Department of Energy
Assistant Secretary for Nuclear Energy,
Deputy Assistant Secretary for Nuclear Waste Management
and Fuel Cycle Programs,
Remedial Action Program Office

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FINAL ENVIRONMENTAL IMPACT STATEMENT

Decommissioning of the Shippingport Atomic Power Station
Beaver County, Pennsylvania

May 1982

Abstract

The U.S. Department of Energy proposes to decommission the Shippingport Atomic Power Station located at Shippingport, Pennsylvania. This environmental impact statement analyzes possible decommissioning alternatives, evaluates potential environmental impacts associated with each alternative, and presents cost estimates for each alternative. The Department's preferred decommissioning alternative is immediate dismantlement. Other alternatives include no action, safe storage followed by deferred dismantlement, and entombment. The environmental impacts that are evaluated include those associated with occupational radiation dose, public radiation dose, handling and transporting of radioactive wastes, resource commitments, and socioeconomic effects.

U.S. Department of Energy

SUMMARY

The U.S. Department of Energy (DOE) proposes to decommission the Shippingport Atomic Power Station located on the Ohio River at Shippingport, Pennsylvania. This environmental impact statement describes: 1) the preferred alternative (immediate dismantlement of the government-owned portion of the station), 2) other possible alternatives, and 3) the potential environmental consequences of the preferred and other alternatives.

The Shippingport Atomic Power Station was constructed during the mid-1950s as a joint project of the Federal Government and the Duquesne Light Company for the purpose of developing and demonstrating pressurized water reactor (PWR) technology and for the purpose of generating electricity. The station consists of a PWR currently rated at 72 MWe, a turbine-generator, and associated facilities. The reactor and steam generating portions of the station are owned by the DOE. The electrical generating portion of the station is owned by Duquesne Light.

The station achieved criticality in December 1957 and has been operated by Duquesne Light under supervision of the DOE Division of Naval Reactors since that time. The station has produced over 6.6 billion kilowatt hours of electricity from the time it began operation. Operation of the station resulted in 37 man-rem of occupational exposure in 1979.

The potential environmental impacts of the preferred alternative were calculated on the basis of engineering studies of Shippingport Station decommissioning methods and on a generic decommissioning study (NUREG/CR-0130) performed for the U.S. Nuclear Regulatory Commission (NRC). (E.9) Also, data and experience gained from actual decontamination, dismantling and decommissioning operations from such facilities as the Piqua Nuclear Power Facility, Hallam Nuclear Power Facility, BONUS, and the Elk River reactor were used. Based on these studies, the environmental consequences of the preferred alternative on decommissioning personnel and the general public are shown to be reasonable. DOE will comply with applicable standards and guidelines (DOE Order 5480.1A), as described in Section 1.1.2 and summarized below.

1. Potential radiation doses from the preferred alternative decommissioning operations are estimated to be:

   - Total occupational exposure, based on conservative worst-case analyses, is estimated to be 1275 man-rem. No worker will be exposed in excess of the DOE occupational exposure standard of 5 rem per year (DOE Order 5480.1A).

   - Total collective radiation dose to the general public is estimated to be 28 man-rem. Natural background in the Shippingport area is about 100 mrem per year to each person, or about 100,000 man-rem to the population of approximately 1 million residing within a 50-mile radius of the Shippingport Station.

2. The highest potential radiation (50-year accumulated) dose to a member of the general public from abnormal operational events (potential credible accidents) during immediate dismantlement could be 2.9 mrem. This person would receive about 5000 mrem from natural background during the same period.

3. Based on generic transportation studies of all radioactive waste shipments, the most severe credible offsite transportation accident could result in a 50-year accumulated radiation dose to the maximum-exposed individual of 25 rem to the lungs. The risk of such an accident is extremely small.

4. The principal nonradiological emission resulting from decommissioning operations will be from vehicle and fuel-driven equipment exhausts. These emissions will be far below all applicable standards, as discussed in Section 4.2.1.

The preferred alternative and other possible alternative actions are discussed in detail in Section 2.0 and are described briefly below. Tables S-1 and S-2 provide summary comparisons of the alternatives.

PREFERRED ALTERNATIVE - IMMEDIATE DISMANTLEMENT

Immediate dismantlement is the removal from the site, shortly after shutdown, of all fluids, piping, equipment, components, structures, and wastes

TABLE S-1. Summary of Estimates for Decommissioning Alternatives

	No Action, Continued Operation[a]	No Action, Continued Surveillance[a]	No Action, No Surveillance[a]	Immediate Dismantlement	Safe Storage/ Deferred Dismantlement	Entombment
Occupational Radiation Dose (man-rem)	37/yr	25/yr	0	1,275[b]	505[c]	617[d]
Occupational Health Effects	3.7×10^{-3} to 29.6×10^{-3} per year	2.5×10^{-3} to 20.0×10^{-3} per year	0	0.13 to 1.02[b]	0.05 to 0.40[c]	0.06 to 0.49[d]
Public Radiation Dose (man-rem)	<1/yr	0[e]	24 R/hr[f]	28[b]	21[c]	16[d]
Public Health Effects	1×10^{-4} to 8×10^{-4} per year	0[e]	(f)	2.8×10^{-3} to 22.4×10^{-3}[b]	2.1×10^{-3} to 16.8×10^{-3}[c]	1.6×10^{-3} to 12.8×10^{-3}[d]
Processed Liquid (kiloliters)	500/yr	0[g]	0[g]	2,934	2,767	2,767
Concentrates from Processed Liquids (m^3)[h]	30/yr	0[g]	0[g]	84	84	84
Radioactive Solid Waste Burial Volume (m^3)	233/yr	0[g]	0[g]	11,700	3,300	3,178
Cost (1979 $)	(i)	200,000/yr	0[j]	33,929,000[k]	44,412,000[k]	38,743,000[k]

(a) The terms of the contract between the DOE and Duquesne Light require the DOE to make the premises safe from a radiation standpoint at the end of the DOE's experimental program.
(b) Numbers are based on total project duration.
(c) Numbers are based on the active periods of preparation work for safe storage and the execution of deferred dismantlement.
(d) Numbers are based on the active periods of preparation work for entombment.
(e) The public dose will be zero unless fluids leak or the surveillance is breached.
(f) 24 R/hr is the dose rate near the pressure vessel, which would be fatal to one-half of the exposed persons after 10 hours.
(g) No materials are removed from the plant.
(h) One kiloliter equals one cubic meter.
(i) Capital costs of continued operation have not been determined.
(j) Costs of health effects resulting from unrestricted access to a radioactive facility could be quite high.
(k) Costs include a 25% contingency, but do not include any escalation to costs incurred after 1979.

TABLE S-2. Comparison of Shippingport Station Decommissioning Alternatives

Alternative	Potential Advantages	Potential Disadvantages	Potential Release of Radioactivity	Other Potential Environmental or Socioeconomic Effects
Immediate Dismantlement (preferred alternative)	Lowest cost of any action alternative. Quickest release of land for other uses. Immediate removal of radioactivity from the site.	About twice the occupational dose of the other action alternatives. Largest amount of radioactive waste to be transported.	Moderate potential for release during dismantling. Eliminates the potential for release of radioactivity from site after immediate dismantlement is complete.	Air pollutants from workers' vehicles will not add appreciably to the pollutants already present. Decommissioning work force is approximately the size of the operating work force and will be drawn from the greater Pittsburgh labor pool. Very little socioeconomic impact for any alternative. No threatened or endangered species are impacted by any alternative.
No Action - Continue Operation	Delays need for decommissioning. Continues power production.	Requires sale of plant to an electric utility and probably extensive modification to meet NRC licensing criteria. No utility has expressed interest.	Continued routine gaseous emissions. Small quantity of solid radioactive waste annually.	The costs of continued operation could be high because of the need to meet NRC licensing criteria. Site continues to be unavailable for other uses.
No Action - Continue Surveillance	Permits station shutdown and delays need for decommissioning.	Requires careful surveillance. Delays decommissioning while continuing surveillance costs. Results in higher final cost.	Moderate potential for release of radioactive material from deteriorating equipment.	Site continues to be unavailable for other uses.
No Action - No Surveillance	Permits station shutdown and delays need for decommissioning. No cost.	Unacceptable alternative because of very high potential for large releases of radioactivity and overexposure to trespassers.	Very high potential release of radioactive material from unattended station.	Site continues to be unavailable for other uses.
Safe Storage - Deferred Dismantlement	Lowest occupational radiation dose of any action alternative. Volume of solid radioactive waste almost as small as that from entombment. Smallest commitment of land area to radioactive waste disposal.	Highest cost of any action alternative. Requires surveillance for many decades.	Low potential for release of radioactivity during preparation for safe storage and during deferred dismantlement. Very low potential for release of radioactivity from station in safe storage. No potential for release of radioactivity from site after deferred dismantlement.	Site is unavailable for other uses for many decades.
Entombment	Intermediate occupational radiation dose. Smallest amount of solid radioactive waste to be transported.	Intermediate cost. Potential for failure of entombment structures due to water seepage and freeze-thaw cycles. Entombed area never becomes available for other uses **unless the entombed structure is eventually dismantled.**	Low potential for release of radioactivity during preparation for entombment. Moderate potential for release of radioactivity during entombment if water seeps into the structure and then seeps out again.	Entombed area never becomes available for other uses unless the entombed structure is eventually dismantled.

having radioactivity levels greater than those permitted for unrestricted use. Immediate dismantlement results in a lower cost than any other decommissioning alternative. It also results in the complete removal of radioactivity from the site within several years of station shutdown and provides early protection of the public by transferring the radioactive material to a waste disposal site. Immediate dismantlement results in about twice the total occupational exposure of the other decommissioning alternatives, but the exposure to each individual will be monitored in order to meet DOE standards and guidelines. The preferred alternative also results in slightly greater exposure to the public; however, this exposure does not represent a significant impact. Immediate dismantlement also results in a greater volume of radioactive waste than the other alternatives and more waste shipments, but it permits earlier removal of this waste from the Shippingport site to a waste disposal area.

NO ACTION - CONTINUED OPERATION

This alternative involves continuing operation of the station to produce electricity. Since the DOE has no continuing use for the station, further operation would require that a utility purchase the station from the Federal Government and obtain an operating license from the NRC. Since the station is over 20 years old, it is likely that extensive analyses and modifications would be necessary in order to meet current NRC requirements. These analyses and modifications, a new core, and the required license application and hearing process would probably not be cost effective. Neither Duquesne Light (owner of the site and the non-nuclear portion of the station) nor any other utility has indicated any interest in continuing the operation of the station.

NO ACTION - CONTINUED SURVEILLANCE

This alternative involves defueling and closing the station, and then continuing some monitoring, surveillance, and maintenance of important plant systems. Closing the station while continuing maintenance, monitoring, and surveillance would leave the station intact and permit some decay of ^{60}Co, but would delay the decision as to the station's eventual disposition. Such a delay would result in higher cost than the preferred alternative because the cost of routine surveillance and maintenance would have to be added to the ultimate decommissioning cost.

No assurance could be given that radioactive fluids would not eventually leak from tanks, valves, and piping; and little assurance could be given that a determined member of the public could not gain access to the station and to radioactive materials and high dose rate areas.

NO ACTION - NO SURVEILLANCE

This alternative involves defueling and closing the station and doing nothing further.

Closing the station and doing nothing further is not an acceptable alternative because the public would have direct access to radioactive water, equipment, and other material, as well as to high dose rate areas in the station. A substantial effort is required in order to assure that the radioactivity remaining in the station after defueling will constitute no hazard to the public. Finally, the agreement between the DOE and Duquesne Light requires that the DOE take action to "make the premises safe from a radiation standpoint" at the conclusion of the Federal Government's current test program.

SAFE STORAGE - DEFERRED DISMANTLEMENT

This alternative involves dismantlement of the facility after a storage period of several decades (98 years is assumed) during which time radioactive isotopes, particularly ^{60}Co, are allowed to decay. During preparation for safe storage, radioactive materials outside the safe storage boundaries are removed. Security, surveillance, maintenance, and radioactive monitoring are continued during the safe storage period. Safe storage followed by deferred dismantlement results in higher cost than immediate dismantlement and prohibits unrestricted use of the facility and site until deferred dismantlement is completed. Deferred dismantlement results in less occupational exposure and radioactive waste than the preferred alternative. Radiation exposure to the public is somewhat less than for the preferred alternative and does not represent a significant impact. The controlling factor in determining the length of safe storage is the decay of ^{60}Co, which has a half-life of 5.27 years. Studies have shown that initiating deferred dismantlement in about 98 years would allow manual cutting operations during decommissioning.

ENTOMBMENT

This alternative involves complete isolation of the radioactivity in the station from the environment of man by means of massive concrete and steel barriers until the radioactivity has decayed to innocuous levels. The pressure vessel cladding and internals may be removed before entombment or may be left within the entombed structure, depending upon the inventory of radioactivity. In the case of the Shippingport Station, the pressure vessel cladding and internals are assumed to be removed during the entombment period. Maintenance, surveillance, and occasional monitoring are required.

Entombment is intermediate between immediate dismantlement and safe storage followed by deferred dismantlement in cost and radiation dose, as well as in the amount of land committed to the disposal of radioactive waste, if the land area occupied by the entombed structure itself is included. Entombment may not be a viable alternative for decommissioning the Shippingport Station because of the low elevation of the containment building subbasement relative to the normal elevation of the Ohio River and because of the possibility of water seepage into the entombed structure and later seepage of contaminated water out of the structure. Operation and maintenance of the sump pumps would not allow complete closure and sealing of the facility. Many freeze-thaw cycles during the entombment period would tend to weaken the structure.

The principal environmental effects that will result from the decommissioning of the Shippingport Station are occupational radiation dose and commitment of land and other resources to the disposal of radioactive wastes. As discussed above, doses to the public for the action alternatives are so small that they do not represent a significant environmental impact.

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1.0 INTRODUCTION

The Shippingport Atomic Power Station (Shippingport Station) was constructed during the mid-1950s as a joint project of the Federal Government and the Duquesne Light Company (Duquesne Light) for the purpose of developing and demonstrating pressurized water reactor (PWR) technology and for the purpose of generating electricity. The station consists of a PWR currently rated at 72-MWe, a turbine-generator, and associated facilities. It is located on the south bank of the Ohio River at Shippingport, Beaver County, Pennsylvania, on land owned by Duquesne Light. The reactor and steam generating portions of the station are owned by the U.S. Department of Energy (DOE). The electrical generating portion of the station is owned by Duquesne Light. The station achieved criticality in December 1957 and has been operated by Duquesne Light under supervison of the DOE Division of Naval Reactors since that time. Duquesne Light pays DOE for the steam and markets the electricity produced by the generator. The Shippingport Station has produced over 6.6 billion kilowatt hours of electricity from the time it began operation in December 1957 through December 1980 from three cores of reactor fuel. The first two were PWR cores, and the present core is a light water breeder reactor (LWBR) core. The LWBR core was installed in 1977 for the purpose of demonstrating the thermal breeding principle in a light water reactor and is scheduled for shutdown, end-of-life testing, and removal in the mid-1980s.

1.1 PURPOSE OF AND NEED FOR ACTION

The proposed action is to decommission the government-owned portion of the Shippingport Atomic Power Station. After the current LWBR core test program is completed, DOE has no further test or demonstration programs planned for the reactor, and no utility has indicated a desire to continue operating the station for the production of electricity. Fuel will be removed from the reactor and shipped to the Idaho National Engineering Laboratory at Idaho Falls for proof-of-breeding analysis, thus making the station available for decommissioning. Because the reactor and its associated components will contain substantial amounts of radioactivity even after the fuel is removed, some action will be required to decommission the station, i.e., to place it in such a condition that the remaining radioactivity will pose no hazard to public safety or to the environment. Possible alternative actions, including the DOE's preferred alternative of immediate dismantlement, and their impacts are examined in this document. Other alternative actions examined here are no action, safe storage followed by deferred dismantlement, and entombment.

1.1.1 Agreement Between Duquesne Light and the Atomic Energy Commission

In 1954 the U.S. Atomic Energy Commission (AEC) leased 6 acres of land from Duquesne Light on which to build the nuclear portion of the Shippingport Station. The land area was later increased to 7 acres. The present lease agreement (No. E(36-1)-322) is between Duquesne Light and the Department of Energy. It requires DOE, upon expiration or termination of the lease, to "make the premises safe from a radiation standpoint" and conveys ownership to Duquesne Light of any buildings and equipment not removed from the site within 2 years after expiration or termination of the lease. The existing lease expires March 17, 1994, and may be terminated sooner by the Federal Government upon 6 months notice. Another agreement (Contract No. E(36-1)-292) covers the working relationship between DOE and Duquesne Light for construction and operation of the Shippingport Station. This contract requires DOE, upon expiration or termination of the contract, to "make the nuclear portion of the plant safe from a radiation standpoint."

1.1.2 Decommissioning Statutory and Regulatory Requirements

The Shippingport Station reactor facility is owned by the DOE and does not fall under the licensing purview of the U.S. Nuclear Regulatory Commission (NRC); thus there are no NRC license termination requirements that must be met in decommissioning the Shippingport Station. DOE will comply with all local, state, and federal regulations that do apply and will comply with DOE Order 5480.1A, "Environmental Protection, Safety, and Health Protection Program for DOE Operations." This order consists of chapters covering environmental protection, safety, and health protection standards; safety requirements for the packaging of radioactive materials; safety of nuclear facilities; radiation protection; prevention, control and abatement of environmental pollution;

and other standards for the safety and protection of workers and the public. Appropriate regulations and standards of other federal agencies and regulatory bodies are incorporated into DOE Order 5480.1A by reference.

Plans are being developed to assure that the quantity of radioactivity that will be released to the environment during decommissioning will be as low as reasonably achievable, and that radiation doses to decommissioning workers and to members of the public from decommissioning activities will also be as low as reasonably achievable, in accordance with DOE Order 5480.1A. NRC regulations 10 CFR 20 and 10 CFR 50, which pertain to these matters, are incorporated by reference into DOE Order 5480.1A.

Applicable requirements of the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) are discussed in Section 1.2. The requirements of the Department of Transportation (DOT) with respect to the packaging, labeling, and transporting of hazardous materials (radioactive wastes in this case) appear in Title 49 of the Code of Federal Regulations, Parts 170-189 (49 CFR 170-189). Incorporated by reference into 49 CFR 170-189 and into DOE Order 5480.1A are the regulations of the NRC appearing in 10 CFR 71 that govern the packaging and shipment of radioactive materials. Also applicable are the regulations of the Federal Aviation Administration appearing in 14 CFR 103 that govern the shipment of radioactive materials by air, and the regulations of the U.S. Coast Guard appearing in 46 CFR 146 and 149 that govern the shipment of radioactive materials by water. It is not planned, however, that any radioactive materials from Shippingport will be shipped by air.

Environmental Protection Agency (EPA) regulations governing radiation doses to the public and radioactive releases to the environment from uranium fuel cycle operations appear in 40 CFR 190. EPA regulations that are applicable include those on allowable concentrations of nonradioactive liquid discharges in 40 CFR 423 and those on nonradioactive particulate ambient air quality in 40 CFR 50.

Standards for residual radioactivity following decommissioning are under development (see Section A.4 of Appendix A). Pending promulgation by the

EPA and adoption by the DOE of these standards, the Shippingport Station will be decommissioned to the residual radioactivity standards of NRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors." (E.8) Pathway analyses will be carried out, as suggested in Reference 5 of Appendix A (NUREG-0613, "Residual Activity Limits for Decommissioning"), to assure that residual radioactivity in the soil meets standards current at the time.

A list of existing Federal permits and major state permits that will also apply in decommissioning the Shippingport Station is given in Appendix B. These permits will be terminated when decommissioning is completed. No additional permits are known to be required.

1.2 PURPOSE OF THIS EIS

The purpose of this EIS is to provide environmental information in order to assist the DOE in deciding which decommissioning alternative is most appropriate for the Shippingport Station. The EIS is prepared pursuant to NEPA and under the regulations of the CEQ (40 CFR Parts 1500-1508) and the guidelines of the DOE (45 FR 20694). Significant alternatives and environmental impacts are discussed.

1.2.1 EIS Format

The EIS includes sections on decommissioning alternatives, on the affected environment, and on environmental consequences. Decommissioning costs, radiation doses, radiological effects, radiation doses from postulated accidents, and other impacts are discussed. Metric units are used in the EIS when the quantity in question refers specifically to decommissioning the Shippingport Station. Quantities taken from older literature that do not refer specifically to decommissioning the Shippingport Station, such as distances, land areas, river elevations, and river flows, are left in the original units for clarity.

Throughout the EIS, use is made of existing material appearing in References 1 through 7, particularly Reference 2, Shippingport Atomic Power Station Decommissioning Assessment. The EISs on the LWBR program at the Shippingport Station (Reference 1) and on the radioactive waste management operations at

Savannah River and Hanford (References 5 and 6) are incorporated into this EIS by reference. Information used from these documents is appropriately referenced and is presented fully. Whenever possible, the information has been verified to assure that it is still current. The EISs incorporated by reference may be inspected in the libraries listed in Appendix C. The LWBR EIS (Reference 1) covers activities through the removal of spent fuel. This EIS covers activities associated with decommissioning that follow reactor shutdown and fuel removal.

Comments received on the draft EIS have been incorporated into this EIS along with DOE's responses. The responses can be found in Appendix E along with the full text of all comment letters. If the response to a comment involves a text change, a comment letter number [example: (E.4)] precedes the statement where the change occurred.

1.2.2 Scoping Process

An early step in the EIS process is the publication in the Federal Register of a notice of intent (NOI) to prepare an EIS. The NOI announces the proposed action, i.e., the subject of the EIS; possible alternatives, including the agency's preferred alternative, if any; potential impacts to be evaluated in the EIS; and other pertinent information. The NOI also calls for comments on the scope of the EIS, including suggestions for other impacts and alternatives to be evaluated. The NOI on decommissioning the Shippingport Station was published in the Federal Register (45 FR 35414) on May 27, 1980. There were no substantive comments on the scope of the EIS in response to the NOI. Formal scoping meetings were not held.

REFERENCES

1. Final Environmental Statement, Light Water Breeder Reactor Program, U.S. Energy Research and Development Administration, ERDA 1541, June 1976.

2. Shippingport Atomic Power Station Decommissioning Assessment, Prepared for United Nuclear Industries, Inc., Richland, Washington, by Nuclear Energy Services, Danbury, Connecticut, June 1979.

3. R. I. Smith, G. J. Konzek and W. E. Kennedy, Jr., Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station, NUREG/CR-0130, Pacific Northwest Laboratory for U.S. Nuclear Regulatory Commission, June 1978.

4. R. I. Smith and L. M. Polentz, Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station, NUREG/CR-0130 Addendum, Pacific Northwest Laboratory for U.S. Nuclear Regulatory Commission, August 1979.

5. Final Environmental Impact Statement, Waste Management Operations, Savannah River Plant, U.S. Energy Research and Development Administration, ERDA-1537, September 1977.

6. Final Environmental Statement, Waste Management Operations, Hanford Reservation, U.S. Energy Research and Development Administration, ERDA-1538, December 1975.

7. Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes, U.S. Nuclear Regulatory Commission, NUREG-0170, December 1977.

2.0 DECOMMISSIONING ALTERNATIVES

At the completion of the LWBR core demonstration program, the Shippingport Atomic Power Station is scheduled to be retired. After reactor shutdown, end-of-life testing, and defueling, the DOE proposes to decommission the radioactive systems and structures at the station. This section discusses alternatives for decommissioning the radioactive systems and structures at the Shippingport Atomic Power Station. Possible alternatives are to take no action or to decommission the facility by one of the following alternatives: immediate dismantlement (DOE's preferred alternative), safe storage followed by deferred dismantlement, or entombment. Any option extending beyond March 17, 1994, will require renegotiation of the land lease between DOE and Duquesne Light.

No action means to continue operation of the station to produce electricity, to close the station while continuing existing maintenance and surveillance, or to close the station and do nothing further.

Immediate dismantlement means to remove all activated or contaminated equipment, components, liquids, and other material and to decontaminate or remove contaminated surfaces and structures sufficiently to permit release of the remaining structures for unrestricted use. All radioactive wastes are shipped to offsite disposal areas.

Safe storage means to remove all liquids and isolate the facility from public access for a number of decades to allow the decay of short-lived radionuclides, principally ^{60}Co, in order to reduce the radiation dose to dismantling workers. During the safe storage period, heating, ventilation, surveillance, fire protection, radiation monitoring, and environmental systems are kept in operation as appropriate. Maintenance is provided. Deferred dismantlement means to open the facility following the safe storage period, to remove all remaining activated and contaminated components, and to decontaminate or remove contaminated surfaces and structures so that any remaining structures can be released for unrestricted use.

Entombment means to remove all liquids and to seal the facility by means of massive steel and concrete barriers until the radioactivity within the structure has decayed to unrestricted release levels. Surveillance, monitoring and maintenance are required during the entombment period. Radioactive components and structures outside the entombed structure are dismantled and shipped to offsite disposal areas at the time the structure is entombed.

These decommissioning alternatives apply to an existing facility on an existing site, both of which are described in Section 3.0. Other areas that may be affected by the decommissioning of the Shippingport Station are also discussed in Section 3.0.

Decommissioning alternatives and major impacts are discussed in this section.

2.1 NO ACTION

Three options are available under the no action alternative: to continue operation of the station to produce electricity, to close the station while continuing existing maintenance and surveillance, or to close the station and do nothing further.

The Federal Government has no further plans for the facility at the conclusion of the LWBR program. Because the reactor is owned by the DOE, an operating license has never been required. If a utility were to take over the Shippingport Station, an NRC operating license would be required before the reactor could be operated for commercial purposes. Since the reactor is over 20 years old, it is likely that extensive analyses and modifications would be necessary to meet current NRC design requirements. Examples include analyses of the remaining thermal fatigue life of the steam supply system components, modification of the once-through cooling system, replacement of the LWBR core with a PWR core, and modifications of control equipment. These analyses, modifications, and the required license application and hearing process would probably not be cost effective. Also, electricity production from the 72-MWe Shippingport Station would not be of major significance in the immediate presence of the Bruce Mansfield and Beaver Valley plants, which have a combined capacity of 4280 MWe. No interest has been expressed by the Duquesne Light Company (owner of the site and the turbine-generator) in continuing the operation of the Shippingport Station. Continued operation of the Shippingport

Station would result in a continued annual collective radiation dose to operation and maintenance workers. This annual dose is approximately 37 man-rem at the present time. NRC data[1] show that the annual operating and maintenance dose increases with increasing age of the reactor. On the other hand, recent annual Shippingport and Beaver Valley Radiological Environmental Reports[2] indicate that there are no adverse effects on the environment as a result of activities at either plant and that radiological releases from both stations are below the limits of 10 CFR 20 and the applicable permits.

Following fuel removal, all of the Shippingport Station's systems and components could be left intact while continuing existing surveillance, maintenance, and monitoring. Liquids would not be removed (liquid removal is considered to be part of safe storage). Costs of 24-hour surveillance, full-time maintenance, and routine monitoring would amount to at least $200,000 annually. Occupational radiation doses would be as high as 25 man-rem per year, principally because of maintenance on the liquid handling systems. No assurance could be given that radioactive fluids would not eventually leak from tanks, valves, and piping; and little assurance could be given that a determined member of the public could not gain access to the station.

The option of shutting down the facility and doing nothing further following defueling is not feasible because of the radioactivity left inside the facility. The facility cannot be left open and unattended. While the annual costs would be zero, the potential environmental impacts would be unacceptable, because the public would have direct access to radioactive water, to radioactive equipment, and to high dose rate areas in the plant. These dose rates range from 750 mrem/hr near some contaminated piping up to 24 rem/hr near the pressure vessel. At 24 rem/hr, a 10-hour exposure would be lethal to approximately 50% of those exposed. A substantial effort is required in order to assure that the radioactivity remaining after defueling will constitute no hazard to the public.

Finally, the agreement between DOE and Duquesne Light requires that DOE take action to "make the premises safe from a radiation standpoint" (see Section 1.1.1).

2.2 IMMEDIATE DISMANTLEMENT

Immediate dismantlement is the removal from the site, within a few years after shutdown, of all fluids, piping, equipment, components, structures, and wastes having radioactivity levels greater than those permitted for unrestricted use of the property. Removal of the nuclear fuel, the blanket, and the reflector assemblies will have already been accomplished immediately after shutdown. Spent fuel removal (discussed in the LWBR EIS, Reference 3) is considered to be part of final reactor shutdown and not part of decommissioning. If the immediate dismantlement alternative is selected, present plans call for the dismantlement and removal of all DOE-owned equipment and all nonradioactive DOE-owned structures to 3 feet below grade.

The DOE-owned systems and structures to be removed in the immediate dismantlement of the Shippingport Station are listed below.[4]

DOE-Owned Systems and Components:

- Reactor Vessel and Internals
- Neutron Shield Tank
- Reactor Coolant Pumps, Steam Generators, and Pressurizer
- Instrumentation and Control System
- Reactor Coolant System Piping
- Reactor Plant Component Cooling-Water System
- Canal Water System
- Reactor Plant Gravity Drain System
- Fuel Handling and Storage Equipment
- Standby and DC Power Systems
- Pressurizing and Pressure Relief System
- Charging System
- Discharge and Vent System
- Purification System
- Sampling System
- Chemical Addition System
- Valve Operating System
- Delayed Loop Monitoring System

Nuclear Protection System
Movable Fuel Control System
Data Aquisition System
Operational Radiological System
Container Air Cooling System
Safety Injection System
Core Removal Cooling System
Main Steam (partial) System
Boiler Feed (partial) System
Heat Dissipation System
Auxiliary Service System
Reactor Plant Cooldown System
Chemical Shutdown System
Containment Atmosphere Cleanup System
Containment Isolation and Decay Heat Removal Systems
Radioactive Waste Processing System

DOE-Owned Structures:

Fuel Handling Building Structural Steel and Concrete
Reactor Chamber
Boiler Chambers
Auxiliary Chamber
Air Locks and Interconnections and Framing
Radioactive Waste Processing Building
Auxiliary Equipment Rooms 1A and 1B
Battery Enclosure
Core Vault Room
Contaminated Equipment Room
Mechanical Equipment Room 1A
Well Enclosures
Diesel Generator Pads
Clean Room
Decontamination Room
Auxiliary Control Room

Flywheel Generator Building
Laydown Building
(E.5) Demineralizer Building
Safety Injection System Pump House
Deep Well Pump House
Heat Dissipation Complex
Reactor Plant Service Building

2.2.1 Work Plan and Schedule

Dismantlement activities will begin with draining, decontamination, and removal of non-essential systems, and will continue to completion of the final radiation survey. A proposed schedule for immediate dismantlement tasks is given in Figure 2.2-1. This schedule is subject to change if detailed engineering studies reveal a more efficient sequence of activities. As shown in the figure, dismantlement would require about 5 years. Engineering studies are presently underway, and some peripheral dismantling activities could begin concurrently with defueling.

The radionuclide inventory in the plant is present either as neutron activation products in the reactor structural materials that were exposed to the neutron flux, as contamination deposited on the surfaces of the piping and equipment, or in spent resins and evaporator concentrates. The anticipated inventory of radioactivity in the Shippingport Station 2 years after final reactor shutdown, on the basis of 84,093 effective full power hours (EFPH), is given in Section 3.2.2.

The work plan and schedule described in this EIS specify segmentation of the reactor vessel, internals, and neutron shield tank, and shipment by truck to Savannah River. Radiation dose rates for dismantling these components are too high for contact work. Therefore, special remotely operated equipment will be used to cut up the reactor vessel internals, the reactor vessel, and the neutron shield tank. Special cutting devices such as arc saws or plasma-arc torches can be used for immediate dismantlement of the reactor vessel. The reactor vessel and its internals will probably be cut under water to provide radiation shielding and to minimize the release of contamination. Current

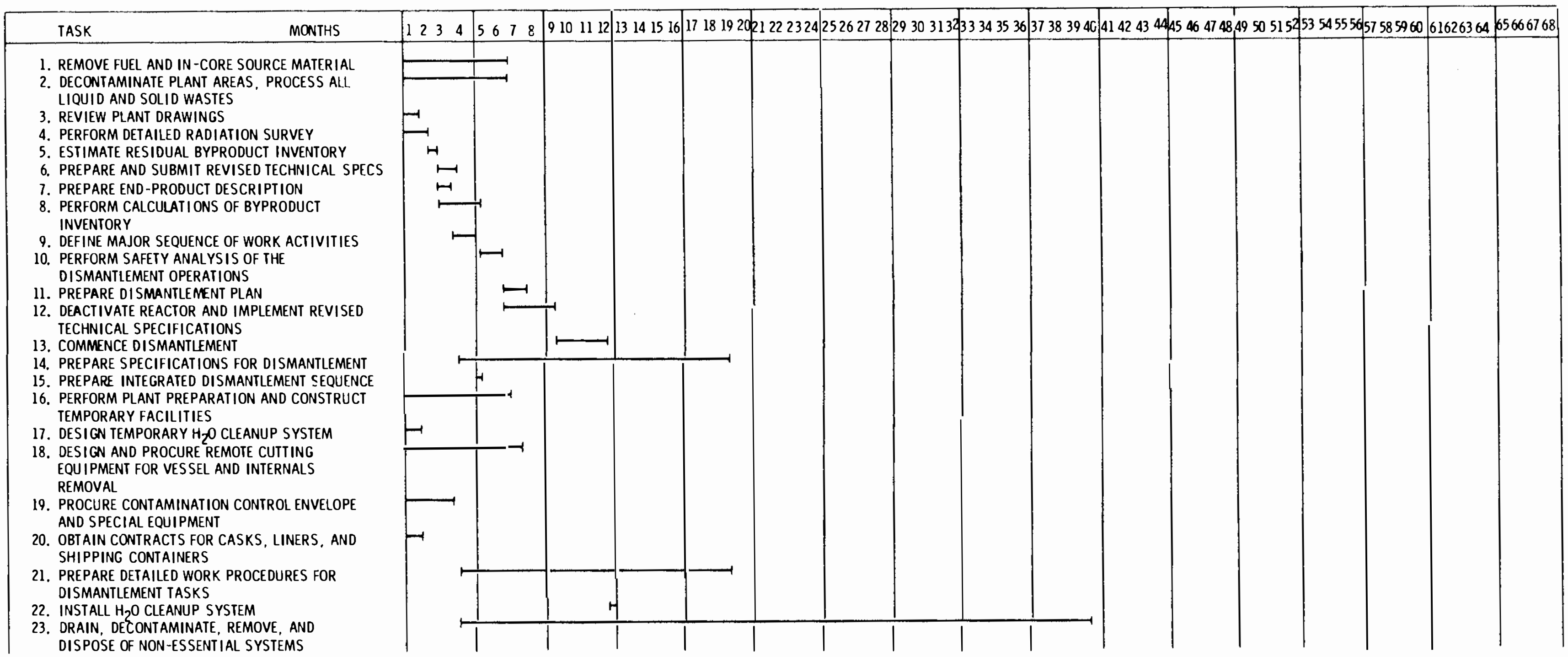

FIGURE 2.2-1. Immediate Dismantlement Tasks and Schedule (fuel removal is not part of decommissioning, but is shown here for the purpose of indicating coordination between decommissioning activities and fuel removal)

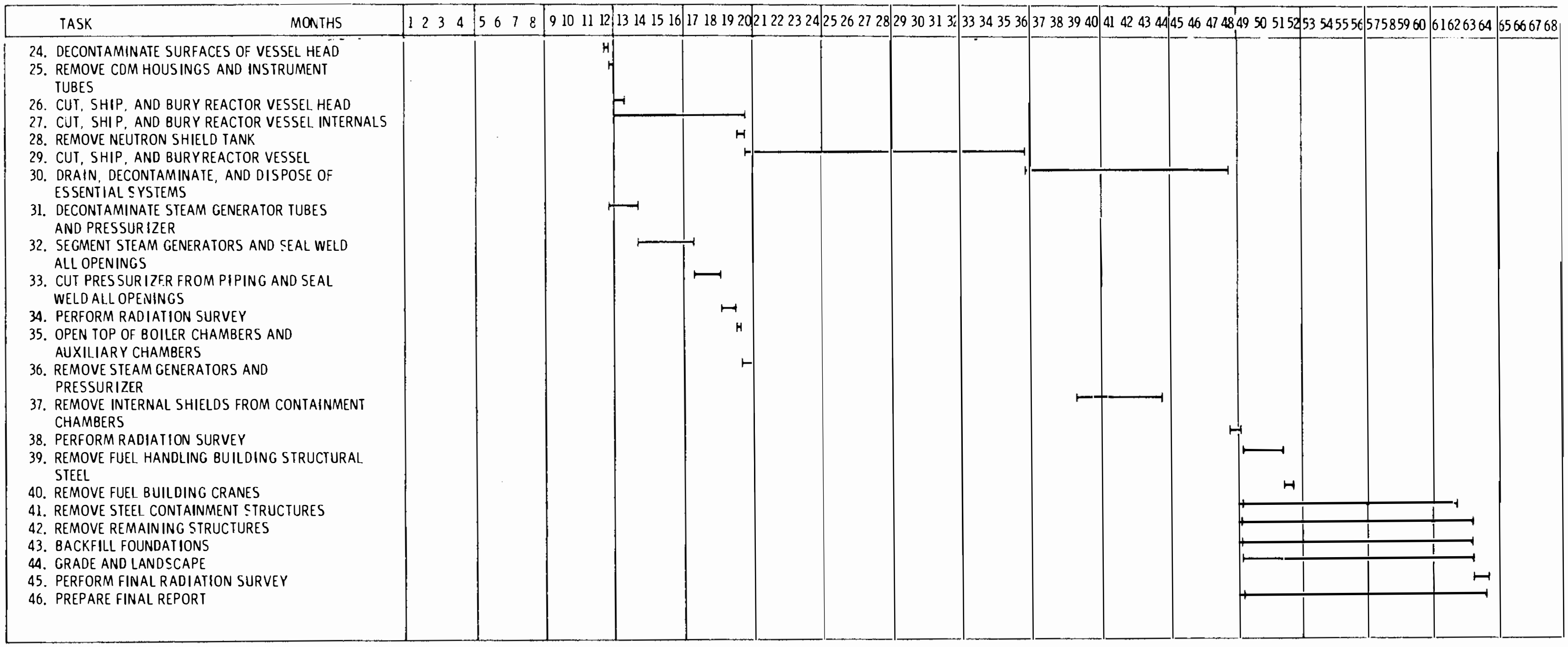

FIGURE 2.2-1. (contd)

engineering studies may show that the reactor vessel can be removed without segmenting it. In this case, it will be shipped intact together with appropriate shielding to a disposal site by barge (Section 2.2.5) or rail car (Section 2.2.6). Also, engineering studies may show that the internals, the reactor vessel, and the neutron shield tank can be shipped as one package to a disposal site by barge. In this case, the internals would be left in the vessel and the neutron shield tank would be filled with concrete to provide shielding.

Coolant piping and other systems and equipment will be decontaminated on a selective basis to reduce radiation dose rates to levels as low as reasonably achievable. Several techniques that have been demonstrated in the field are available for cutting and removing piping and equipment. Pneumatically operated power hack saws that can be strapped to pipe are capable of unattended operation, thus permitting the crew to cut other pipe simultaneously. More conventional oxyacetylene cutting torches can also be used for cutting pipe. Shaped charges can be used for explosive cutting of pipe and other components in relatively inaccessible locations.

Concrete floors and walls can be mechanically decontaminated by removing the contaminated surface layer (1 to 2 inches) using surface grinders, spallers, or pneumatic drills. Heavily reinforced, massive concrete structures can be broken up for removal by controlled blasting. Dust control is discussed in Section 4.2.1. It is possible, however, that the adoption of special procedures for concrete blasting will be required in order not to impact the adjacent Beaver Valley nuclear plants seismically.

2.2.2 Radiation Doses

The immediate dismantlement of the Shippingport Station will result in radiation doses to the dismantlement workers, to the transportation workers, and to the public. These doses are discussed in the following sections. Health effects of radiation doses and potential accidents during the decommissioning of the station that could have radiological consequences to the workers and to the public are discussed in Section 4.0. Potential health effects are included in Table 2.5-1.

2.2.2.1 Occupational Radiation Dose

Dose rates used in estimating the occupational radiation dose for immediate dismantlement are based on measured dose rates in the Shippingport Station. It is assumed, for purposes of calculation, that the occupational exposure occurs 2 years after reactor shutdown; accordingly, the dose rates are reduced by a factor of 0.768 corresponding to 2 years decay of ^{60}Co. A dose reduction factor is also included for the use of portable lead shielding in major activities such as pressure vessel cutting, but not for minor activities such as the removal of small components. No credit is taken for dose rate reduction as a result of system decontamination, except for decontamination of the demineralizers, steam generators, and pressurizer. All crew members are assumed to be present at the work site for the full time required to complete each task. These assumptions result in a very conservative estimate of the accumulated radiation dose. The estimated occupational dose for immediate dismantlement is 1275 man-rem. This dose may be compared to a maximum dose of 2500 man-rem if each of the 100 (average number) workers were to receive a maximum allowed dose of 5 rem per year (DOE Order 5480.1A) over a 5-year period. Details of this estimate are given in Table 2.2-1.

2.2.2.2 Public Radiation Dose

A public radiation dose results from transportation of the radioactive waste from the Shippingport site to the disposal site. It is assumed that the wastes will be hauled to DOE burial sites at either Hanford, Washington, or at Savannah River, South Carolina, 2380 and 715 miles from Shippingport, respectively. The dose estimate is based on transporting all solidified decontamination wastes, large quantity radioactive cask-contained material,[a] and low specific activity shipments according to DOT regulations. Calculation of the public radiation dose from transportation of radioactive waste to a disposal site is based on allowable surface dose rate standards and on the assumption

(a) Large quantity radioactive material and low specific activity material are defined in detail in 49 CFR 173. They are classifications of radioactive material defined for the purpose of specifying packaging and transport requirements. For example, low specific activity material must be packaged and transported in such a manner that the radiation dose rate at the surface of an exclusive-use closed transport vehicle is 200 millirem per hour or less, the dose rate 2 meters from the vehicle is 10 millirem per hour or less, and the dose rate in the cab is 2 millirem per hour or less.

TABLE 2.2-1. Estimated Occupational Dose for Immediate Dismantlement[a]

Dismantlement Task	Occupational Dose (man-rem)
Equipment Removal (System)	
Scarfing Concrete Surfaces in Decon Area	<1
Canal Water	1
Liquid Waste. Processing	362
Gaseous Waste Processing	<1
Solid Waste Processing	<1
Sampling	<1
Core Removal Cooling	2
Coolant Discharge and Vent	1
In-Core Instrumentation	<1
Decon Effluent	<1
Coolant Purification	119
Total for Equipment Removal	486
Piping Removal (Area)	
Canal Water Pump Area	<1
Monitored Waste Room	<1
Sampling Preparation Room	<1
A Auxiliary Equipment Room	<1
BD Purification Cubicle	2
AC Purification Cubicle	1
Auxiliary Chamber	1
Waste Disposal Yard	<1
Waste Disposal Basement	<1
B-Auxiliary Equipment Room	<1
Reactor Concrete Enclosure	<1
BD Enclosure	<1
AC Enclosure	1
B Boiler Area	<1
D Boiler Area	<1
Total for Piping Removal	7

TABLE 2.2-1. (contd)

Dismantlement Task	Occupational Dose (man-rem)
Reactor Coolant System Removal	
Loop A	
Heat Exchanger plus Steam Drum	93
Other Components	7
Total	100
Loop B	
Heat Exchanger plus Steam Drum	65
Other Components	7
Total	72
Loop C	
Heat Exchanger plus Steam Drum	47
Other Components	5
Total	52
Loop D	
Heat Exchanger plus Steam Drum	114
Other Components	6
Total	120
Pressurizer	82
Total for Reactor Coolant System Removal	426
Reactor Vessel and Internals Removal[b]	356
Total for Immediate Dismantlement	1,275

(a) From Table 5.11, Reference 4.
(b) Internals removal is based on measured Shippingport dose rate at the vessel flange with the vessel flooded to the flange elevation. Vessel removal is based on a calculated dose rate above a lead shielded work platform at the reactor chamber top with the vessel drained.

that the shipments to Savannah River and Hanford result in a nominal mileage of 1000 miles to Savannah River and 3000 miles to Hanford. The actual mileages vary according to the route selected (see Section 3.4). The estimated public radiation doses are 24 man-rem to drivers and 4 man-rem to the general public if all radioactive wastes are transported by truck to Savannah River, and 67 man-rem to drivers and 12 man-rem to the general public if all radioactive wastes are transported by truck to Hanford. Table 2.2-2 gives the estimated dose to the transportation workers and to the general public.

TABLE 2.2-2. Estimated Public Radiation Dose for Immediate Dismantlement from Truck Transport of Wastes[a]

No. of Shipments	Group	Dose (man-rem) Savannah River	Hanford
230	Drivers	24	67
	General Public	4	12
	Total	28	79

(a) From Table 5.14, Reference 4.

A public radiation dose also results from airborne releases from routine decommissioning activities (in addition to the dose from the transportation of radioactive wastes). Calculations for a much larger PWR (1175 MWe vs. 72 MWe, Reference 5, Section 11.2.1) show that the radiation dose to the public from these sources is trivial (1×10^{-4} man-rem total body first-year dose and 1×10^{-4} man-rem 50-year dose commitment). Thus, public radiation doses from routine airborne releases at Shippingport will also be trivial. It is to be noted that the calculations in Reference 5 were carried out with a wind rose and population distribution similar to the ones existing at Shippingport.

2.2.3 Waste Disposal

Decommissioning wastes from immediate dismantlement are both liquid and solid. These wastes are disposed of by means that minimize the impact on the environment. The sources and estimated volumes of radioactive wastes are discussed in this section.

2.2.3.1 Liquid Waste Disposal

Radioactive liquid wastes from the immediate dismantlement of the Shippingport Station are from two sources: 1) the existing liquid inventory in the piping, components, and fuel handling canal; and 2) water used in decontamination procedures. All radioactive liquids (approximately 297 Ci, see Section 3.2.2) will be filtered, dimineralized, and evaporated in the existing liquid waste processing system. All processed liquids released to the river will be analyzed before release to demonstrate that they are within the allowable discharge concentrations of 10 CFR 20, 40 CFR 423, DOE order 5480.1A, and the existing NPDES permit. Liquids that are not within the standards will be reprocessed until they are. (E.12) Liquid wastes will not be transported offsite.

(E.5) The estimated quantities of liquids and residues from immediate dismantlement are given in Table 2.2-3.

TABLE 2.2-3. Estimated Volumes of Liquids and Residues from Immediate Dismantlement[a]

Source	Volume (kiloliters)	Activity (curies)
Inventory at Shutdown[b]	2650	--[c]
Decontamination Fluids[d]	284	--
Spent Resins	59	207
Evaporator Concentrates	25	90

(a) See Table 5.13, Reference 4.
(b) Includes primary loop piping, steam generators, pressurizer, reactor vessel, canal crane lock, and deep pit and fuel storage area water.
(c) Radioactivity is removed in the liquid waste processing system and is included in the spent resins and evaporator concentrates estimates.
(d) Includes primary system water flushes and canal and selected building floor and wall washes.

2.2.3.2 Solid Waste Disposal

Solid radioactive materials that must be removed from the site during immediate dismantlement are of three types: neutron-activated material, contaminated material, and radioactive waste (liquid concentrates, combustibles, and other dry wastes). Most of the neutron-activated material will have to be shipped in shielded containers to meet the allowable surface dose rate limits for transport of radioactive materials. The bulk of the neutron-activated material (13,320 Ci) is contained in the metal in the pressure vessel and its internals. The inventory of radioactivity in activated concrete is probably less than 4 Ci (see Section 3.2.2). Contaminated material will be handled as low specific activity material,[a] as appropriate. Present plans call for solidification of spent ion exchange resins and evaporator concentrates with concrete in 208-liter (55-gallon) drums. A mobile solidification unit will be utilized for this purpose. Combustibles and other dry wastes will be compacted in 208-liter drums in the existing Shippingport waste compactor. Estimates of solid waste disposal requirements for immediate dismantlement are given below:

Total number of truck shipments	230
Number of shielded cask shipments by truck	83
Radioactive waste burial volume	11,700 m^3

The apparent discrepancy in density of shipments between immediate dismantlement and both safe storage followed by deferred dismantlement and entombment (Sections 2.3.3.2 and 2.4.3.2) is caused by the larger volume of less dense radioactive material that must be shipped during immediate dismantlement.

After the contaminated materials have been removed from the site, demolition of the buildings will generate approximately 14,500 m^3 of clean concrete rubble. (E.5) This rubble may be used to backfill below-grade building voids.

(a) Low specific activity material is defined in detail in 49 CFR 173. It is one of several classifications of radioactive material defined for the purpose of specifying packaging and transport requirements.

The rubble will then be covered by soil. (E.5) Non-radiological, non-hazardous waste should pose minimal environmental impact. These wastes will be disposed of as demolition wastes.

2.2.4 Costs of Immediate Dismantlement

The estimated cost of immediate dismantlement of the Shippingport Station is $33,929,000 in 1979 dollars. This estimate includes a 25% contingency allowance, but does not include any allowance for inflation, either to account for the work not beginning in 1979 or to account for the work extending over several years. This method of presenting the cost estimate allows useful comparisons to be made among the costs of immediate dismantlement, safe storage followed by deferred dismantlement, and entombment. Future cost estimates will reflect the effects of inflation. Details of the cost estimates for immediate dismantlement are given in Table 2.2-4. The costs shown are for dismantlement of the DOE-owned components and structures. Shipping and burial costs are based on disposal at Savannah River. Shipment to Hanford would add in the range of $4 to $5 million to the cost.

2.2.5 Barge Shipment of the Pressure Vessel

An alternative to segmenting the pressure vessel is to remove it in one piece and transport it by barge to either Savannah River or Hanford. If this option were chosen, the internals would be removed, segmented, and shipped separately, as before. (The feasibility of including the internals with the pressure vessel is currently being assessed. Handling and shipping of the pressure vessel would be the same, with or without the internals.) Openings to the pressure vessel would be sealed, the neutron shield would be filled with concrete, and the vessel would be lifted out of the steel reactor chamber and laid on its side on a bed of sand in the fuel canal. A high-capacity, portable overhead crane would have to be installed in the fuel handling building for this purpose. The pressure vessel, together with its concrete-filled neutron shield, would then be rigged for horizontal lifting and lifted onto a tracked or multi-wheeled transporter in the railbay of the fuel handling building for transport to the nearby Beaver Valley barge dock or to a temporary Shippingport moorage facility. The vessel would be placed on a barge by means of external rigging

TABLE 2.2-4. Estimated Costs of Immediate Dismantlement[a,b]

Decommissioning Activities	Decommissioning Cost ($ thousands)
Predecommissioning Period	
Review Plant Drawings	54.0
Perform Detailed Radiation Survey	25.5
Estimate Residual Byproduct Inventory	6.8
Prepare Revised Technical Specifications	22.5
Prepare End Product Description	5.4
Make Detailed Calculations of Byproduct Inventory	33.1
Define Major Sequence of Work Activities	7.2
Perform Safety Analysis of Dismantlement Operations	16.2
Prepare Dismantlement Plan	10.8
Deactivate Reactor and Implement Revised Technical Specifications	1.8
Project Management	18.9
Engineering QA	18.9
Utility Staff	3,926.3
Decommissioning Staff	137.3
Total Predecommissioning Cost	4,284.7
Dismantlement Period	
Prepare Activity Specifications for Dismantlement	1,114.2
Prepare Integrated Dismantlement Sequence	21.6
Prepare Plant and Install Temporary Facilities	331.8
Design Temporary H_2O Cleanup System	9.0
Procure Cutting Equipment for Vessel Internals Removal	1,047.0
Procure Contamination Control Envelope and Special Equipment	115.5

TABLE 2.2-4. (contd)

Decommissioning Activities	Decommissioning Cost ($ thousands)
Dismantlement Period (contd)	
Procure Cask Liners and Shipping Containers	9.0
Prepare Detailed Work Procedures	766.4
Install Temporary H_2O Cleanup System	34.3
Remove and Dispose of Nonessential Systems	1,114.3
Decontaminate Reactor Vessel Head	1.1
Cut, Load, Ship, and Bury CDM Housings and Instrument Tubes	5.1
Remove, Cut, and Dispose of Reactor Vessel Head	139.2
Cut, Ship, and Bury Vessel Internals	857.0
Remove Neutron Shield Tank	99.7
Cut, Ship, and Bury Reactor Vessel	795.1
Drain, Decontaminate, and Dispose of Essential Systems	1,416.8
Decontaminate Steam Generator Tubes and Pressurizer	158.8
Segment Steam Generators and Seal Openings	130.8
Cut Pressurizer from Piping and Seal Openings	9.2
Perform Radiation Survey	6.7
Open Top of Boiler and Auxiliary Chambers	0.9
Remove Steam Generators and Pressurizer	488.7
Remove Internal Shields from Containment Chambers	1,164.9
Perform Radiation Survey	6.7
Remove Fuel Handling Building Structural Steel	34.3
Remove Fuel Building Cranes	5.6
Remove Steel Containment Structures	167.4
Remove Remaining Structures	1,675.9

TABLE 2.2-4. (contd)

Decommissioning Activities	Decommissioning Cost ($ thousands)
Dismantlement Period (contd)	
Backfill Foundations	101.4
Grade and Landscape	8.9
Perform Final Radiation Survey	6.7
Prepare Final Dismantlement Report	27.0
Return Site to Unrestricted Use	1.8
Process Liquid and Solid Waste	84.7
Decommissioning Staff	6,665.5
Supplies	378.9
Heavy Equipment Rental	761.5
Security Force	696.4
Insurance (Nuclear and Property)	1,003.7
Engineering Consultants	777.6
Project Administration and QA	617.4
Total Dismantlement Work Activities Cost	22,858.5
Total Immediate Dismantlement Cost	27,143.2
Contingency (25%)	6,785.8
Total	33,929.0

(a) Based on Table 5.3, Reference 4.
(b) Notes: 1) All costs are in 1979 dollars. 2) Shipping and burial costs are based on disposal at Savannah River. 3) No salvage credit is taken. 4) Water flushes, high-pressure water lance, concrete scarfing, and manual scrubbing are the decontamination methods assumed to be used.

or by driving the transporter onto the barge, jacking up the vessel, and driving the transporter from underneath the vessel. The vessel would then be lowered to the barge, shielding would be put in place, and the vessel would be ready for transport to either Savannah River or Hanford. At Savannah River or Hanford, similar techniques would be used to unload the pressure vessel to transport it overland to the disposal site.

Removing and transporting the pressure vessel in one piece by barge would result in a cost reduction of about $200,000 for handling operations.[6] It would also shorten the immediate dismantlement schedule by about 11 months and reduce occupational radiation dose to immediate dismantlement workers by about 100 man-rem. Current estimates indicate that a cost reduction of as much as $450,000 per month would result from a shortened schedule because certain time-dependent costs would no longer accrue. Barge shipment would also reduce public radiation dose by about 6 man-rem for shipment to Savannah River and by about 16 man-rem for shipment to Hanford, if DOT regulations on allowable radiation dose rates are observed.

2.2.6 Train Shipment of the Pressure Vessel

A second alternative to segmenting the pressure vessel is to remove it in one piece and transport it by rail to either Savannah River or Hanford. In this scenario, the internals would be removed, segmented, and shipped separately as before. The neutron shield tank would also be removed, segmented, and shipped separately. A high-capacity, portable overhead crane would be installed within the fuel handling building and the pressure vessel would be lifted vertically into two half-cylindrical vessel shields which would be closed upon the pressure vessel and bolted to the vessel for rail transport. The vessel, with its shields, would then be lifted from the reactor chamber and laid on its side on a bed of sand in the fuel canal. From the fuel canal, the pressure vessel would be lifted to a shipping cradle in the rail bay and lifted onto the rail car for transport to either Savannah River or Hanford.

Removing and transporting the pressure vessel in one piece by rail would result in a cost reduction of about $400,000 for handling operations, an occupational dose reduction of about 60 man-rem, and a shortening of the schedule by about 9 months. As in the case of barge shipment, about $450,000 per month can be saved in the reduction of time-dependent costs. Train shipment of the intact pressure vessel would reduce public radiation dose by about 6 man-rem for shipment to Savannah River and by about 16 man-rem for shipment to Hanford, if DOT regulations on allowable radiation dose rates are observed.

2.3 SAFE STORAGE FOLLOWED BY DEFERRED DISMANTLEMENT

Safe storage is defined as those activities required to place and maintain a nuclear facility in such condition that risk from the facility to public safety is within acceptable bounds, and in such condition that the facility can be safely stored for as long as desired. Safe storage consists of a period of facility and site preparation followed by a period of continuing care that involves security, surveillance, monitoring, and maintenance. During preparation for safe storage all radioactive fluids are removed and processed and all radioactive materials outside the safe storage boundary are shipped offsite for disposal. At the end of the storage period, deferred dismantlement of the facility is started and all materials that still have radioactivity levels greater than those levels permitted for unrestricted use are removed and shipped to a disposal site. Successful completion of deferred dismantlement permits release of the facility for unrestricted use.

If safe storage followed by deferred dismantlement is the alternative chosen for decommissioning the Shippingport Station, it is planned to put the reactor facility in a hardened safe storage condition, which essentially entombs the facility for the storage period. The major difference between safe storage and entombment is that at the end of safe storage, the structure is reopened and any remaining radioactivity is removed. In the case of entombment, the entombed radioactivity is assumed to decay to unrestricted use levels during the structural lifetime of the facility. The entombed facility is not reopened to remove radioactivity.

2.3.1 Work Plan and Schedule

Preparation for safe storage will include disposing of all radioactive fluids and wastes and of some selected components. The highly radioactive reactor vessel and internals and the primary coolant system piping and components will be sealed within an entombment barrier to prevent unauthorized access during the storage period. Uncontaminated building structures surrounding the reactor will remain in place during the storage period.

The hardened safe storage and entombment boundaries for Shippingport consist primarily of reinforced concrete and steel containment structures. Top and side views of these boundaries are shown in Figures 2.3-1 and 2.3-2, respectively. Openings in the concrete boundary, such as hatches, passageways, and the fuel canal, will be covered with 2-ft-thick reinforced concrete slabs. Two passageways to airlocks will be locked closed, rather than concrete sealed, to permit access to the secured area for periodic inspections and maintenance. If one airlock fails to operate, persons trapped inside of the containment structure can leave through the other airlock. The eight hatches on top of the steel containment chambers and four of the six airlocks leading to the steel containment chambers will be seal-welded closed. The two unwelded airlock doors will be locked, and will be the only points of entry to the steel storage envelope.

The concrete boundary structure requires vertical reinforced concrete ribs to be placed between the steel containment chambers and their concrete enclosures. (E.4) These ribs will decrease the stresses in the concrete walls during possible flooding; they also will minimize movement of the steel chambers in the event of an earthquake.

Contaminated systems outside the storage boundary will be either decontaminated or removed for disposal in a controlled burial ground. The remaining systems will be modified to provide lighting, fire protection, and security during the storage period. Preparation for safe storage will be completed in about 31 months.

A proposed schedule for preparation for safe storage is given in Figure 2.3-3.

Security, surveillance, periodic inspections, radiation surveys, and maintenance of the storage boundary will be provided. A 98-year storage period would permit the radioactivity to decay to a level such that some material and equipment could be released to unrestricted use and that most other components could

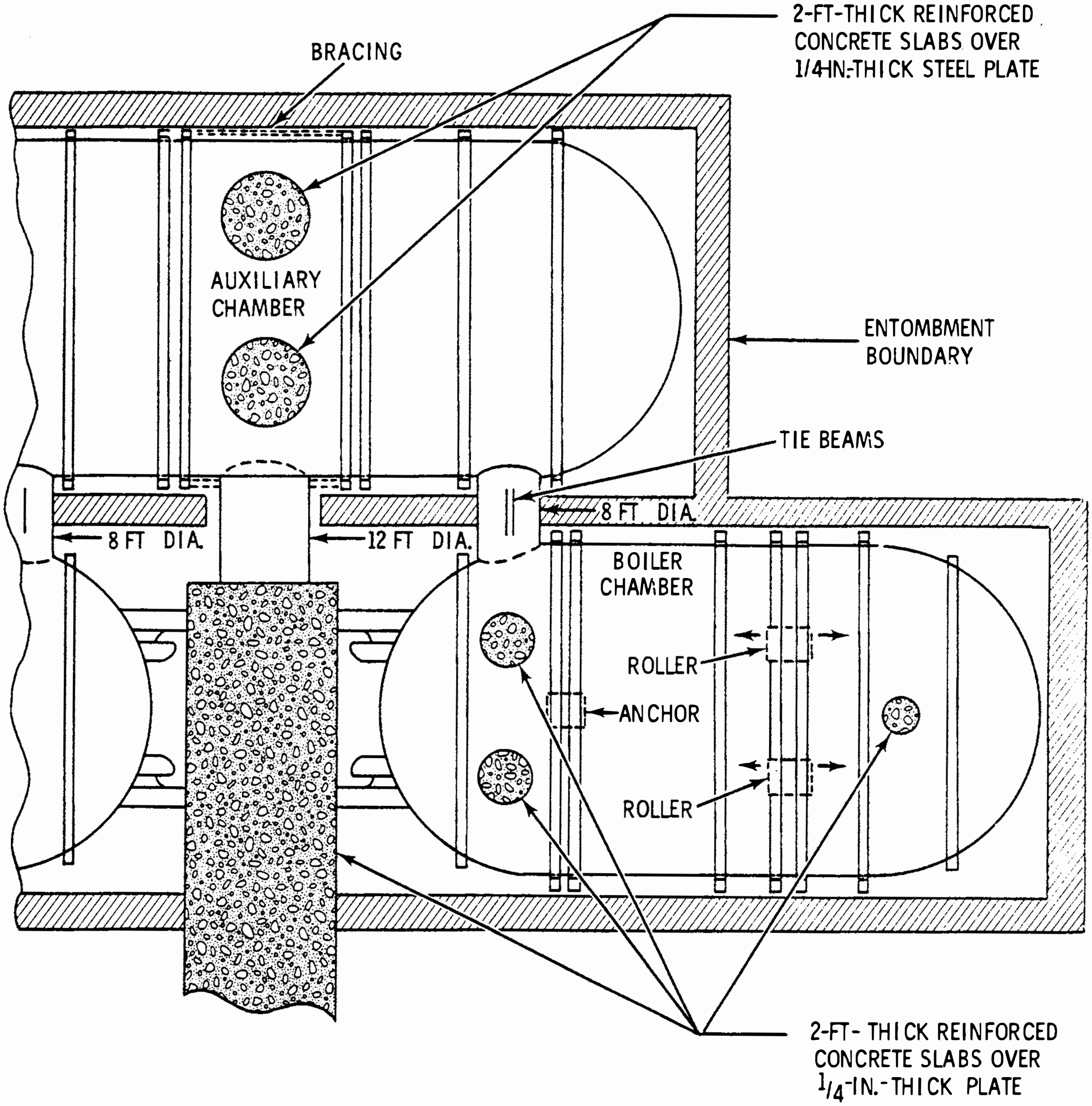

FIGURE 2.3-1. Partial Top View of Shippingport Hardened Safe Storage and Entombment Boundaries

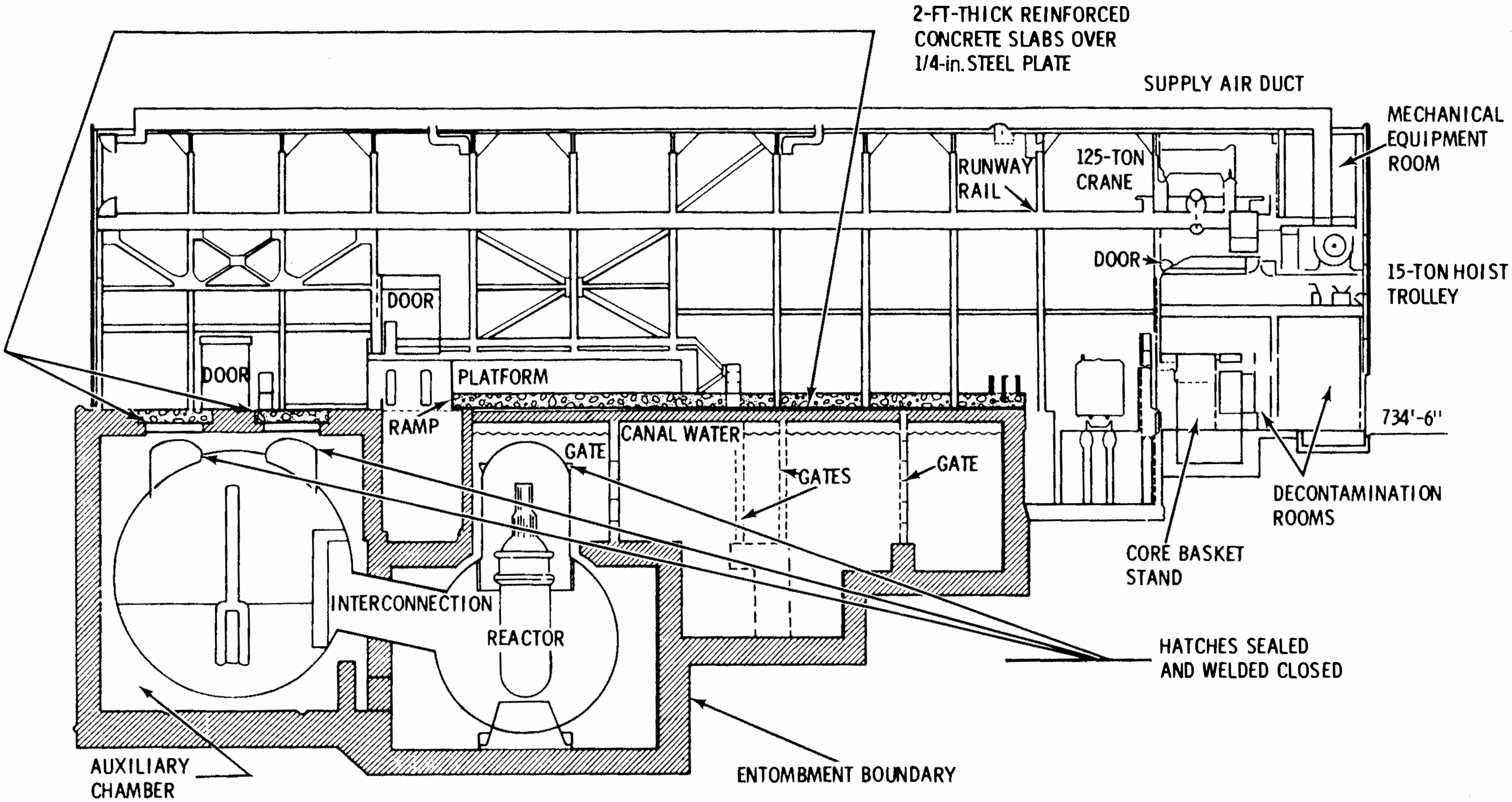

FIGURE 2.3-2. Side View of Shippingport Hardened Safe Storage and Entombment Boundaries

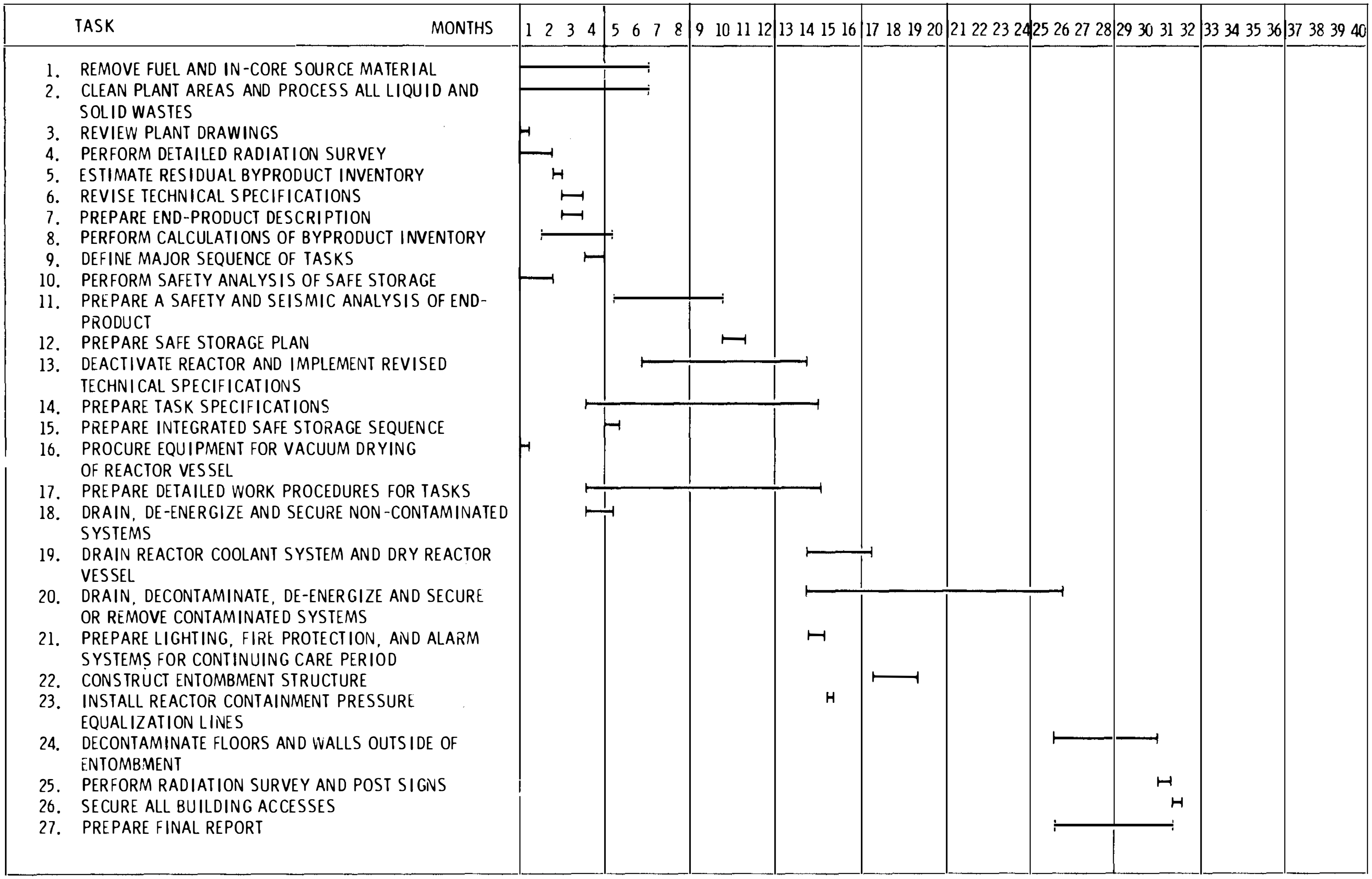

FIGURE 2.3-3. Preparation for Safe Storage Tasks and Schedule (fuel removal is not part of decommissioning, but is shown here for the purpose of indicating coordination between decommissioning activities and fuel removal)

be dismantled manually rather than remotely at an occupational dose rate not exceeding 300 millirem/hr. The neutron-activated reactor vessel and vessel internals would still have to be removed and shipped to a controlled burial ground for disposal, although less of the heavy shielding required for earlier shipment of the pressure vessel and its internals would now be required. A longer or a shorter safe storage period could be selected. The key factor is the dose rate from ^{60}Co, which decays with a half-life of 5.27 years.

Deferred dismantlement will start when the storage period ends. Since the radiation dose rates will be significantly lower than for immediate dismantlement, most originally contaminated piping and equipment will present little radiation hazard to the decommissioning workers, and the neutron-activated reactor vessel and internals will require less-sophisticated tooling for cutting and removal. A proposed schedule for deferred dismantlement is given in Figure 2.3-4.

2.3.2 Radiation Doses

Radiation doses to decommissioning workers, to transportation workers and to the public, are discussed in this section. Potential health effects are discussed in Section 4.0.

2.3.2.1 Occupational Radiation Dose

Occupational radiation doses will be received by the decommissioning workers during preparation for safe storage, during the storage period, and during deferred dismantlement. Dose rates used for estimating the occupational exposures are based on actual measurements taken at the Shippingport Station during reactor shutdown. The dose rates are corrected (reduced) to account for radioactive decay until the time the decommissioning work will be performed. Credit is not taken for dose rate reduction by decontamination. All workers in a crew are considered to be present at the work site during the time required to complete a task. The estimated occupational dose for safe storage followed by deferred dismantlement is 505 man-rem. A summary of the estimate is given in Table 2.3-1. Comparison of Table 2.3-1 with Table 2.2-1 shows that the reduction in radiation dose arises from a less thorough initial decontamination process which results in less contaminated liquid waste to process, and from decay of ^{60}Co in the reactor coolant system and in the pressure vessel and its internals during the safe storage period.

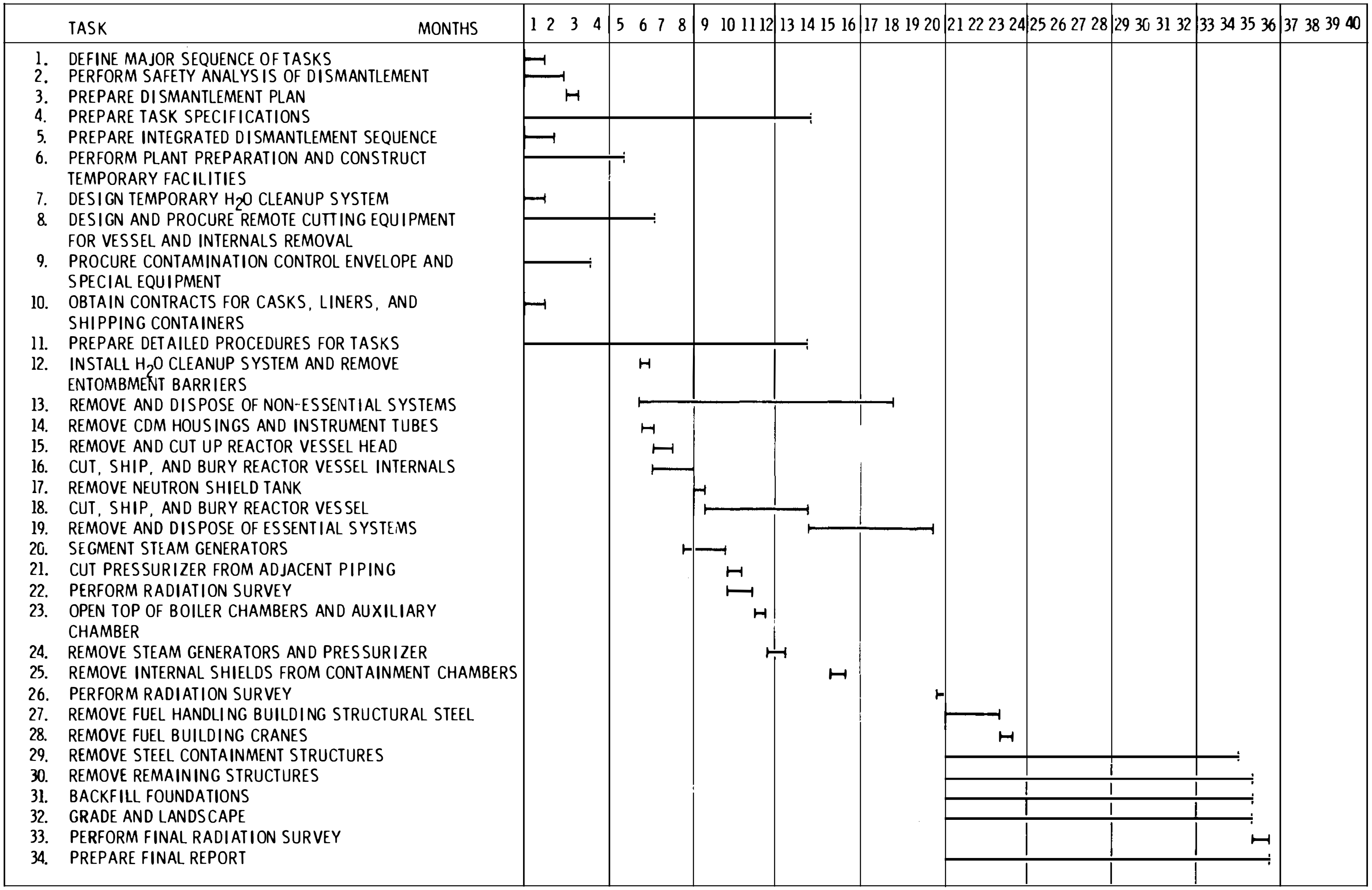

FIGURE 2.3-4. Deferred Dismantlement Tasks and Schedule

TABLE 2.3-1. Estimated Occupational Radiation Dose for Safe Storage Followed by Deferred Dismantlement[a,b]

Decommissioning Task	Dose (man-rem)
Equipment Removal	365
Piping Removal	2
Reactor Coolant System Removal	0
Reactor Vessel and Internals Removal	138
Total	505

(a) From Table 5.10, Reference 4.
(b) Facility is in safe storage for 98 years.

2.3.2.2 Public Radiation Dose

Estimates of the public radiation dose resulting from safe storage followed by deferred dismantlement of the Shippingport Station are based on the same assumptions as used for estimating public radiation dose from immediate dismantlement. Details of the estimated dose for transportation workers and the general public are given in Table 2.3-2.

TABLE 2.3-2. Estimated Public Radiation Dose for Safe Storage Followed by Deferred Dismantlement from Truck Transport of Wastes[a]

No. of Shipments	Group	Dose (man-rem) Savannah River	Hanford
181	Drivers	18	53
	General Public	3	9
	Total	21	62

(a) From Table 5.14, Reference 4.

2.3.3 Waste Disposal

Both liquid and solid radioactive wastes are generated during preparation for safe storage and during deferred dismantlement of the Shippingport Station. The sources and estimated volumes of these wastes are discussed in this section.

2.3.3.1 Liquid Waste Disposal

The inventory of radioactive liquids present at final shutdown of the Shippingport Station will be the same irrespective of the decommissioning alternative selected. For safe storage followed by deferred dismantlement, the volume of liquid waste from decontamination operations at the time of safe storage preparation will be less than the volume generated in immediate dismantlement, because, in safe storage, only loose contamination is removed. Reliance is placed on radioactive decay rather than on decontamination as a mechanism for reducing radiation dose to workers. (E.5) The estimated quantities of liquids and residues from safe storage followed by deferred dismantlement are given in Table 2.3-3.

TABLE 2.3-3. Estimated Volumes of Liquids and Residues from Safe Storage Followed by Deferred Dismantlement[a]

Source	Volume (kiloliters)	Activity (curies)
Inventory at Shutdown[b]	2650	--[c]
Decontamination Fluids[d]	117	--
Spent Resins	59	207
Evaporator Concentrates	25	90

(a) See Table 5.13, Reference 4.
(b) Includes primary loop piping, steam generators, pressurizer, reactor vessel, canal crane lock, and deep pit and fuel storage area water.
(c) Radioactivity is removed in the liquid waste processing system and is included in the spent resins and evaporator concentrates estimates.
(d) Includes primary system water flushes and canal and selected building floor and wall washes.

2.3.3.2 Solid Waste Disposal

Solid radioactive materials that have to be removed from the site during safe storage followed by deferred dismantlement are of the same three types as those for immediate dismantlement (neutron-activated material, contaminated material, and radioactive waste). During the preparation for safe storage, the bulk of the solid radioactive material removed will be radioactive waste (liquid concentrates, combustibles, and other dry wastes). Only the contaminated piping and equipment located outside the storage boundary will either be decontaminated or removed immediately for shipment to a burial ground. When deferred dismantlement is accomplished, the quantity of neutron-activated material will be reduced because of radioactive decay; therefore, more material can be reclaimed and less material will have to be sent to a burial ground than in the case of immediate dismantlement. As in the case of immediate dismantlement, spent ion exchange resins and evaporator concentrates will be solidified with concrete in 208-liter drums, and combustibles and other dry wastes will be compacted in 208-liter drums. Estimates of the volume of solid radioactive waste generated by safe storage followed by deferred dismantlement are given below:

Total number of truck shipments	181
Number of shielded cask shipments by truck	82
Radioactive waste burial volume	3,300 m^3

Demolition of the remaining non-radioactive structures will generate approximately 15,000 m^3 of clean concrete rubble. (E.5) The rubble may be used to backfill the below-grade building voids. Soil will be used to bring the level up to grade. (E.5) Non-radiological, non-hazardous wastes should pose minimal environmental impact. These wastes will be disposed of as demolition wastes.

2.3.4 Costs of Safe Storage Followed by Deferred Dismantlement

The estimated cost of safe storage for 98 years followed by deferred dismantlement of the Shippingport Station is $44,412,000 in 1979 dollars. This estimate includes a 25% contingency allowance, but does not include any allowance for inflation, either to account for the work not beginning in 1979 or to account for the work extending over 98 years. Details of the cost estimate are given in Table 2.3-4. Shipping and burial costs are based on disposal at Savannah River. Shipment to Hanford would add approximately $1.6 million to the cost.

TABLE 2.3-4. Estimated Costs of Safe Storage Followed by Deferred Dismantlement[a]

Decommissioning Activities	Decommissioning Cost ($ thousands)
Predecommissioning Period	
Review Plant Drawings	54.0
Perform Detailed Radiation Survey	25.5
Estimate Residual Byproduct Inventory	6.8
Prepare Revised Technical Specifications	22.5
Prepare End Product Description	5.4
Make Detailed Calculation of Byproduct Inventory	33.1
Define Major Sequence of Work Activities	5.4
Perform Safety Analysis of Decommissioning Operations	16.2
Prepare Safety Analysis of End Product	118.8
Prepare Decommissioning Plan	9.0
Deactivate Reactor and Implement Technical Specifications	1.8
Project Management	25.2
Quality Assurance	25.2
Utility Staff	3,926.3
Decommissioning Staff	137.3
Total Predecommissioning Cost	4,412.5
Preparation for Safe Storage Period	
Prepare Activity Specifications for Safe Storage	365.4
Prepare Integrated Safe Storage Sequence	16.2
Procure Equipment for Vacuum Drying Reactor Vessel	9.0
Prepare Detailed Work Procedures for Safe Storage	273.6
Drain, De-energize, and Secure Non-contaminated Systems	4.1
Drain Reactor Coolant System and Dry Reactor Vessel	5.0

TABLE 2.3-4. (contd)

Decommissioning Activities	Decommissioning Cost ($ thousands)
Preparation For Safe Storage Period (contd)	
Drain, Decontaminate, De-energize, and Secure or Remove Contaminated Systems	850.1
Prepare Lighting, Fire Protection, Ventilation, and Alarm Systems for Continuing Care Period	14.3
Construct Safe Storage Boundary Structure	297.6
Install Chamber Pressure Equalization Lines	7.1
Decontaminate Floors and Walls Outside Safe Storage Boundary	58.0
Prepare Safe Storage Report	9.0
Process Liquid and Solid Wastes	84.8
Decommissioning Staff	3,650.6
Health Physics Supplies	46.8
Decontamination Equipment	17.1
Equipment Rental	10.4
Security Force	465.4
Engineering Consultant	288.0
Quality Assurance	109.8
Project Administration	109.8
Insurance (Nuclear and Property)	671.9
Total Preparation for Safe Storage Cost	7,364.0
Storage Period	
Annual Cost	106.5
Total Storage Period Cost (98 Years)	10,437.0
Deferred Dismantlement Period	
Define Major Sequence of Work Activities	7.2
Perform Safety Analysis of Dismantlement Operations	16.2
Prepare Dismantlement Plan	10.8

TABLE 2.3-4. (contd)

Decommissioning Activities	Decommissioning Cost ($ thousands)
Deferred Dismantlement Period (contd)	
Prepare Activity Specifications for Dismantlement	1,080.0
Prepare Integrated Dismantlement Sequence	21.6
Prepare Plant and Temporary Facilities	331.8
Design Temporary H_2O Cleanup System	9.0
Procure Cutting Equipment for Vessel and Internals Removal	200.0
Procure Contamination Control Envelope and Special Equipment	115.5
Procure Cask Liners and Shipping Containers	9.0
Prepare Detailed Work Procedures for Dismantlement	766.3
Install Temporary H_2O Cleanup System and Remove Safe Storage Barriers	77.0
Remove and Dispose of Non-Essential Systems	725.0
Remove CDM Housings and Instrument Tubes	1.1
Remove, Cut, and Dispose of Reactor Vessel Head	9.3
Cut, Ship, and Bury Reactor Vessel Internals	268.1
Remove Neutron Shield Tank	43.2
Cut, Ship, and Bury Reactor Vessel	454.6
Remove and Dispose of Essential Systems	347.8
Segment Steam Generators	122.3
Cut Pressurizer from Piping	6.2
Perform Radiation Survey	6.7
Open Top of Boiler and Auxiliary Chambers	0.9
Remove Steam Generators and Pressurizer	23.8
Remove Internal Shields from Containment Chambers	235.6
Perform Radiation Survey	6.7
Remove Fuel Handling Building Structural Steel	34.3

TABLE 2.3-4. (contd)

Decommissioning Activities	Decommissioning Cost ($ thousands)
Deferred Dismantlement Period (contd)	
Remove Fuel Building Cranes	3.2
Remove Steel Containment Structures	160.4
Remove Remaining Structures	1,593.3
Backfill Foundations	101.4
Grade and Landscape	8.9
Perform Final Radiation Survey	6.7
Prepare Final Dismantlement Report	27.0
Return Site to Unrestricted Use	1.8
Decommissioning Staff	3,843.3
Health Physics Supplies	201.0
Heavy Equipment Rental	423.1
Security Force	237.6
Insurance (Nuclear and Property)	1,003.7
Engineering Consultants	432.0
Project Administration and Quality Assurance	343.0
Total Deferred Dismantlement Cost	13,316.4
Total for Safe Storage with Deferred Dismantlement	35,529.9
Contingency (25%)	8,882.5
Total	44,412.4

(a) Based on Table 5.4, Reference 4.
(b) 1) All costs are in 1979 dollars. 2) Shipping and burial costs are based on disposal at Savannah River. 3) No salvage credit is taken. 4) Water flushes, high pressure water lance, concrete scarfing and manual scrubbing are the decontamination methods assumed to be used.

2.4 ENTOMBMENT

Entombment is the encasement of radioactive materials and components in a massive structure of concrete and steel. The structure must be sufficiently strong and long-lived to ensure retention of the radioactivity until it has decayed to levels that permit unrestricted use of the site. This requires that a very careful and complete inventory be taken of the radioactive material to be entombed in order to assure that it will decay to appropriate levels within the structural lifetime of the entombing facility. The structural lifetime of the entombing facility is estimated to be 200 years,[4] based on the effects of freeze-thaw cycles on concrete and on corrosion rates of the steel chambers inside the entombment boundary. A long period of continuing care, consisting of security, surveillance, and maintenance, follows the entombment of the radioactive materials and lasts until the radioactivity has decayed to levels that permit unrestricted use of the site. No access is available to the interior of the entombed structure and no utilities are available within the entombed structure. Thus, interior sump pumps are not available for use and there must be no possibility of ground water or flood water seeping into the structure, with the later possibility of contaminated water seeping out of the structure. The lowest level of the subbasement is 666 ft above sea level. The normal elevation of the Ohio River is 665 ft; the 2-year normal flood level is 675 ft; and the project design flood level is 705 ft. Seepage into the subbasement has been observed in the past.

2.4.1 Work Plan and Schedule

The entombment alternative for decommissioning the Shippingport Station is similar to the hardened safe storage alternative described in Section 2.3. The entombment structure is the same as the hardened safe storage boundary. An analysis shows that all of the radionuclides in the neutron-activated materials except ^{94}Nb and ^{59}Ni will decay sufficiently in 125 years to reduce the dose rate to 0.1 mrem/hr at 1 inch from the surface. The reactor internals and the reactor vessel stainless steel cladding will contain these long-lived radionuclides. To reduce the time until the entombed reactor could be released for unrestricted use, the pressure vessel internals and the pressure vessel cladding from 1.7 m above to 1.7 m below the beltline would have to be removed and shipped offsite to a controlled burial ground. The cost and dose estimates for entombment include removal of the pressure vessel internals and the pressure vessel cladding.

A proposed schedule for performing the entombment tasks is given in Figure 2.4-1. Entombment could be accomplished in about 42 months after shutdown.

2.4.2 Radiation Doses

The estimated radiation dose to decommissioning workers, the estimated radiation dose to transportation workers, and the estimated radiation dose to the general public are presented in this section. Potential health effects are discussed in Section 4.0.

2.4.2.1 Occupational Radiation Dose

The basis for the estimation of the occupational radiation dose for entombment is the same as the basis used for immediate dismantlement (see Section 2.2.2.1). For entombment the estimated occupational radiation dose is 617 man-rem. A summary of the estimate is given in Table 2.4-1. The reduction in radiation dose, as compared with immediate dismantlement, stems from a less thorough initial decontamination which results in less contaminated waste to process, and from the avoidance of having to remove the pressure vessel and the reactor coolant system.

2.4.2.2 Public Radiation Dose

Estimation of the public radiation dose from entombment of the Shippingport Station is based on the same assumptions as are used in the estimation of the public radiation dose from immediate dismantlement (see Section 2.2.2.2). Details of the public radiation dose estimate are given in Table 2.4-2.

2.4.3 Waste Disposal

Both liquid and solid radioactive wastes are generated in the entombment of the Shippingport Station. The sources and estimated volumes of these wastes are discussed in this section.

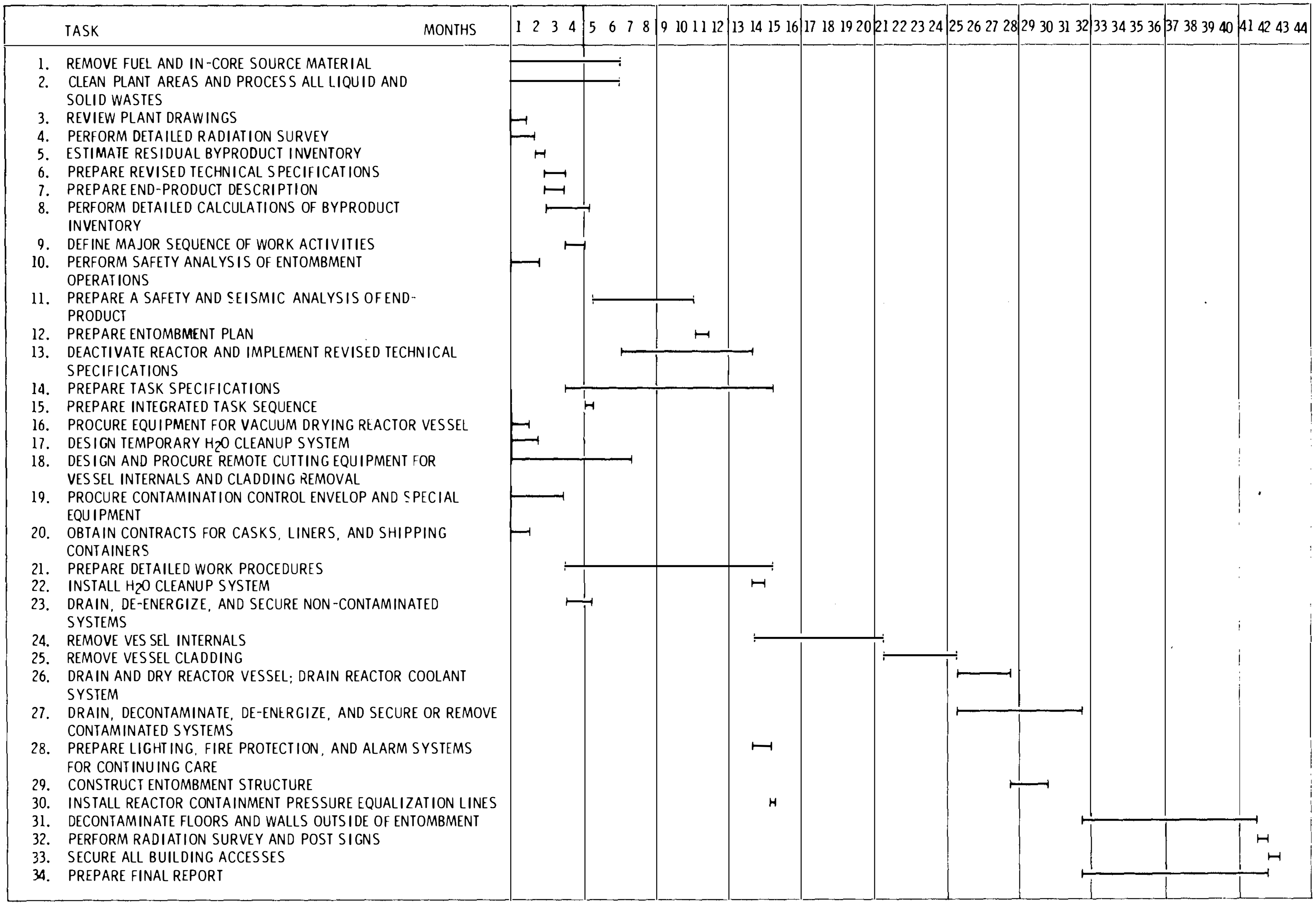

FIGURE 2.4-1. Entombment Tasks and Schedule (fuel removal is not part of decommissioning, but is shown here for the purpose of indicating coordination between decommissioning activities and fuel removal)

TABLE 2.4-1. Estimated Occupational Radiation Dose for Entombment

Decommissioning Task	Dose (man-rem)
Equipment Removal	365
Piping Removal	2
Reactor Vessel Internals Removal	88
Reactor Vessel Cladding Removal	162
Total	617

TABLE 2.4-2. Estimated Public Radiation Dose for Entombment from Truck Transport of Wastes[a]

No. of Shipments	Group	Dose (man-rem) Savannah River	Hanford
136	Drivers	14	40
	General Public	2	6
	Total	16	46

(a) From Table 5.14, Reference 4.

2.4.3.1 Liquid Waste Disposal

Although the inventory of radioactive liquid at reactor shutdown that must be disposed of will be the same as for immediate dismantlement, the volume of liquid waste generated by flushing and decontamination will be less than the volume from immediate dismantlement because, in entombment, only loose contamination is removed. (E.5) Table 2.4-3 gives the estimated quantities of liquids and residues processed during entombment of the reactor.

2.4.3.2 Solid Waste Disposal

Neutron-activated material, contaminated piping and equipment outside the entombment boundary, and radioactive waste (liquid concentrates, combustibles, and other dry wastes) will constitute the solid radioactive materials that must be removed from the site. The important neutron-activated material to be removed

TABLE 2.4-3. Estimated Volumes of Liquids and Residues from Entombment[a]

Source	Volume (kiloliters)	Activity (curies)
Inventory at Shutdown[b]	2650	--[c]
Decontamination Fluids[d]	117	--
Spent Resins	59	207
Evaporator Concentrates	25	90

(a) See Table 5.13, Reference 4.
(b) Includes primary loop piping, steam generators, pressurizer, reactor vessel, canal crane lock, and deep pit and fuel storage area water.
(c) Radioactivity is removed in the liquid waste processing system and is included in the spent resins and evaporator concentrates estimates.
(d) Includes primary system water flushes and canal selected building floor and wall washes.

consists of the reactor internals and cladding from the inside of the reactor vessel. Some contaminated material will be placed within the entombment structure rather than removed from the site. Spent ion exchange resins and evaporator concentrates will be solidified with concrete in 208-liter drums, and combustibles and other dry wastes will be compacted in 208-liter drums. The estimate of number of shipments and the volume of solid radioactive waste to be disposed of during entombment is:

Total number of truck shipments	136
Number of shielded cask shipments by truck	38
Radioactive waste burial volume	3,178 m^3

Entombment of the Shippingport Station does not include demolition of the structures and restoration of the site.

2.4.4 Costs of Entombment

The estimated cost for entombment and continuing care for 125 years of the Shippingport Station is $38,742,600 in 1979 dollars. This estimate includes a 25% contingency allowance, but does not include any allowance for inflation, either to account for the work not beginning in 1979 or to account for the work extending over 125 years. The estimate also does not include the demolition of the structures and grading and restoration of the site. Entombment, by definition, does not include removal of the entombed structure. Details of the cost estimated for entombment are given in Table 2.4-4. Shipping and burial costs are based on disposal at Savannah River. Shipment to Hanford would add approximately $1.7 million to the cost.

2.5 SUMMARY OF ALTERNATIVES

Three options are available under the no action alternative: 1) to continue operation of the station to produce electricity, 2) to defuel the reactor and close the station while continuing existing maintenance, monitoring, and surveillance, and 3) to defuel the reactor, close the station, and do nothing further (defueling is not considered to be part of decommissioning; it is considered to be the end of operation).

The DOE has no further plans for the Shippingport Station following completion of the LWBR program. Thus, continued operation would require that an electric utility purchase the station and obtain an NRC operating licence. The necessary analyses and modifications would probably not be cost effective. Also, the amount of electricity produced would not be significant compared with the electricity produced by the neighboring Beaver Valley and Bruce Mansfield plants. While no adverse radiation impacts on the environment have been observed from the operation of Shippingport, the annual operating and maintenance radiation dose can be expected to rise if the reactor continues to operate. Duquesne Light has no interest in purchasing the facility and making the required analyses and modifications in order to continue operating the station. Also, the contract between the DOE and Duquesne Light requires that the DOE make the premises safe from a radiation standpoint at the conclusion of the DOE's experimental program.

TABLE 2.4-4. Estimated Costs of Entombment[(a,b)]

Decommissioning Activities	Decommissioning Cost ($ thousands)
Predecommissioning Period	
Review Plant Drawings	54.0
Perform Detailed Radiation Survey	25.5
Estimate Residual Byproduct Inventory	6.8
Prepare Revised Technical Specifications	22.5
Prepare End Product Description	5.4
Make Detailed Calculation of Byproduct Inventory	33.1
Define Major Sequence of Work Activities	5.4
Perform Safety Analysis of Entombment Operations	16.2
Prepare Safety Analysis of the End Product	118.8
Prepare Decommissioning Plan	9.0
Deactivate Reactor and Implement Revised Technical Specifications	1.8
Project Management	25.2
Quality Assurance	25.2
Utility Staff	3,926.3
Decommissioning Staff	137.3
Total Predecommissioning Cost	4,412.5
Entombment Period	
Prepare Activity Specifications for Entombment	702.9
Prepare Integrated Entombment Sequence	16.2
Procure Equipment for Vacuum Drying the Reactor Vessel	9.0
Design Temporary H_2O Cleanup System	9.0
Procure Remote Cutting Equipment for Vessel Internals	1,047.0
Procure Contamination Control Envelope and Special Equipment	115.5
Procure Cask, Liners, and Shipping Containers	4.5
Prepare Detailed Work Procedures for Entombment	525.5
Install H_2O Cleanup System	34.3
Drain, De-energize, and Secure Non-Contaminated Systems	4.1
Remove Reactor Vessel Internals	857.0

TABLE 2.4-4. (contd)

Decommissioning Activities	Decommissioning Cost ($ thousands)
Entombment Period (contd)	
Remove Reactor Vessel Cladding	420.2
Drain Reactor Coolant System and Dry Reactor Vessel	4.9
Drain, Decontaminate, De-Energize and Secure or Remove Contaminated Systems	850.1
Prepare Lighting, Fire Protection, Ventilation, and Alarm Systems for Continuing Care Period	14.3
Construct Entombment Structure	297.6
Install Chamber Pressure Equalization Lines	7.1
Decontaminate Walls and Floors Outside Entombment	58.0
Prepare Final Report	9.0
Process Liquid and Solid Wastes	84.8
Decommissioning Staff	5,704.0
Health Physics Supplies	120.5
Decontamination Equipment	17.1
Equipment Rental	136.4
Security Force	538.0
Engineering Consultant	432.0
Quality Assurance	171.5
Project Administration	171.5
Insurance (Nuclear and Property)	907.1
Total Entombment Work Activities Cost	13,269.1
Continuing Care Period	
Annual Cost	106.5
Total Continuing Care Cost (125 Years)	13,312.5
Total Cost for Entombment and Continuing Care	30,994.1
Contingency (25%)	7,748.5
Total	38,742.6

(a) Based on Table 5.5, Reference 4.
(b) 1) All costs are in 1979 dollars. 2) Shipping and burial costs are based on disposal at Savannah River. 3) No salvage credit is taken. 4) Water flushes, high pressure water lance, concrete scarfing, and manual scrubbing are the decontamination methods assumed to be used.

Closing the station while continuing existing maintenance, monitoring, and surveillance is possible, but it merely postpones the inevitable decommissioning decision that must be made, at a cost of $200,000 per year and an occupational radiation dose of 25 man-rem per year. There is no assurance that security would not be breached or that the radioactive fluids would not leak.

To close the station and do nothing further would cost nothing but would expose the curious public to radioactive material and to radiation doses as high as 24 R/hr. Health consequences could be substantial.

Immediate dismantlement results in the highest radiation dose, the least cost, and the largest amount of land committed to the disposal of solid radioactive wastes. However, immediate dismantlement also results in the complete removal of radioactivity and the release of the facility and/or site for unrestricted use just a few years after the facility ceases operation.

Safe storage followed by deferred dismantlement results in less radiation dose and less land committed to the disposal of radioactive wastes than immediate dismantlement. It also costs more than immediate dismantlement and prohibits unrestricted use of the facility and site until deferred dismantlement is completed. The controlling factor in determining the length of safe storage is the decay of ^{60}Co, which has a half-life of 5.27 years. Other studies[7] have shown that deferred dismantlement could begin in less than 98 years and still result in a substantial dose reduction over immediate dismantlement.

Entombment is intermediate between immediate dismantlement and safe storage followed by deferred dismantlement in cost and radiation dose, as well as in the amount of land committed to the disposal of radioactive waste if the land area occupied by the entombed structure itself is included. Entombment may not be a viable alternative for decommissioning the Shippingport Station because of the low elevation of the containment building subbasement relative to the normal elevation of the Ohio River and the possibility of water seepage into the entombed structure. Operation and maintenance of the sump pumps would not allow complete closure and sealing of the facility. Also, many freeze-thaw cycles might tend to weaken the structure.

(E.5) Table 2.5-1 summarizes potential impacts and estimated costs for the decommissioning alternatives discussed in this section. The estimates are for truck shipment of radioactive wastes to Savannah River. Costs and radiation doses for alternate waste disposal sites (Hanford), and alternate methods of removing and transporting the pressure vessel are discussed in the text.

TABLE 2.5-1. Summary of Estimates for Decommissioning Alternatives

	No Action, Continued Operation[a]	No Action, Continued Surveillance[a]	No Action, No Surveillance[a]	Immediate Dismantlement	Safe Storage/ Deferred Dismantlement	Entombment
Occupational Radiation Dose (man-rem)	37/yr	25/yr	0	1,275[b]	505[c]	617[d]
Occupational Health Effects	3.7×10^{-3} to 29.6×10^{-3} per year	2.5×10^{-3} to 20.0×10^{-3} per year	0	0.13 to 1.02[b]	0.05 to 0.40[c]	0.06 to 0.49[d]
Public Radiation Dose (man-rem)	<1/yr	0[e]	24 R/hr[f]	28[b]	21[c]	16[d]
Public Health Effects	1×10^{-4} to 8×10^{-4} per year	0[e]	(f)	2.8×10^{-3} to 22.4×10^{-3}[b]	2.1×10^{-3} to 16.8×10^{-3}[c]	1.6×10^{-3} to 12.8×10^{-3}[d]
Processed Liquid (kiloliters)	500/yr	0[g]	0[g]	2,934	2,767	2,767
Concentrates from Processed Liquids (m^3)[h]	30/yr	0[g]	0[g]	84	84	84
Radioactive Solid Waste Burial Volume (m^3)	233/yr	0[g]	0[g]	11,700	3,300	3,178
Cost (1979 $)	(i)	200,000/yr	0[j]	33,929,000[k]	44,412,000[k]	38,743,000[k]

(a) The terms of the contract between the DOE and Duquesne Light require the DOE to make the premises safe from a radiation standpoint at the end of the DOE's experimental program.
(b) Numbers are based on total project duration.
(c) Numbers are based on the active periods of preparation work for safe storage and the execution of deferred dismantlement.
(d) Numbers are based on the active periods of preparation work for entombment.
(e) The public dose will be zero unless fluids leak or the surveillance is breached.
(f) 24 R/hr is the dose rate near the pressure vessel, which would be fatal to one-half of the exposed persons after 10 hours.
(g) No materials are removed from the plant.
(h) One kiloliter equals one cubic meter.
(i) Capital costs of continued operation have not been determined.
(j) Costs of health effects resulting from unrestricted access to a radioactive facility could be quite high.
(k) Costs include a 25% contingency, but do not include any escalation to costs incurred after 1979.

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3.0 AFFECTED ENVIRONMENT

The affected environment consists of the site on which the station is located, the station itself, the area surrounding the site that might be impacted by decommissioning operations, the transportation routes over which radioactive waste materials are to be carried, and the radioactive waste disposal areas. Characteristics of the affected environment discussed in this section include the geography, population, climate, and seismology of the Shippingport area; hydrology and water quality of the Ohio River; air quality of the Beaver Valley Air Basin; aquatic and terrestrial ecology of the area, including endangered and threatened species; and socio-economic characteristics. Characteristics of the Shippingport Station are discussed, including history, present operation, and radioactive inventory. Also described are potential waste disposal sites (Savannah River and Hanford) and potential transportation routes.

3.1 SITE AND SURROUNDING AREA DESCRIPTION

The Shippingport Station and the neighboring Beaver Valley Power Station are located on the south bank of the Ohio River in the Borough of Shippingport, Beaver County, Pennsylvania, on a 486.8-acre tract of land owned by the Duquesne Light Company (Reference 1, Section III). Beaver County is located in the extreme western part of Pennyslvania and borders the states of Ohio and West Virginia (Figure 3.1-1). The site lies in a valley which has a gradual slope extending from the river (elevation 665 feet above sea level) to an elevation of 1,160 feet along a ridge south of the Shippingport Station. Plant entrance level at the station is approximately 735 feet above sea level. The lowest level within the station is at an elevation of 666 feet.

The upper Ohio River Valley is one of the world's most heavily industrialized areas; however, the steep valley walls have provided a natural barrier to industrial expansion inland, so the countryside away from the river in the

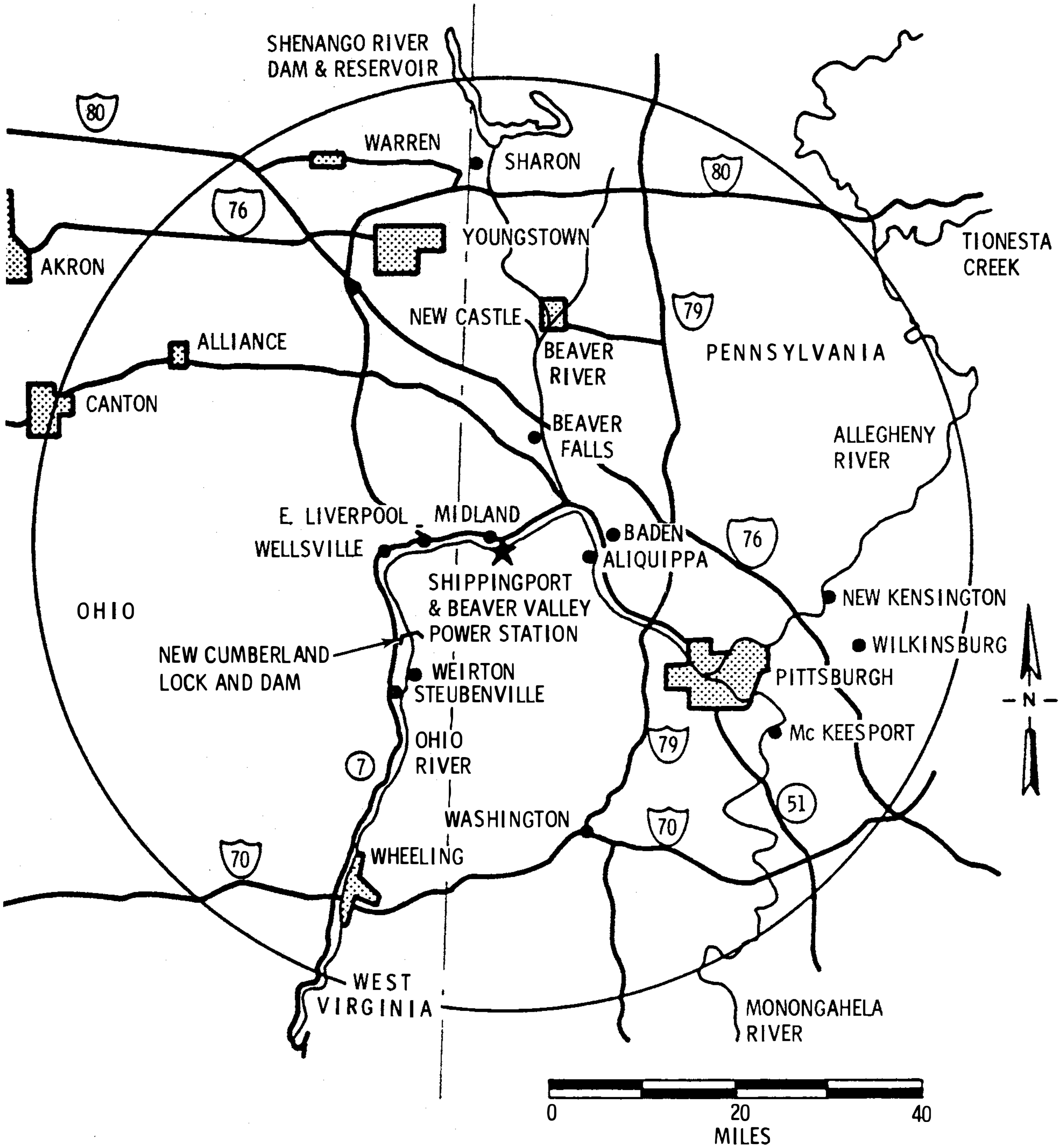

FIGURE 3.1-1. Map Showing Shippingport Site and 50-Mile Radius

vicinity of the Shippingport site is rural in character (Figures 3.1-2 and 3.1-3). Of the total land area in Beaver County (440 square miles), 48% is forest and 29% is crop and pasture land. Beaver County is considered a semi-agricultural area, but farming is not of great economic importance.

Figure 3.1-2 shows the Shippingport Station in relation to the Ohio River, the two immediately adjacent Beaver Valley nuclear plants (923 and 852 MWe), and the three Bruce Mansfield coal-fired plants (835 MWe each) approximately 1 mile away. All three of the Bruce Mansfield plants and one of the Beaver Valley plants are operating. Beaver Valley 2 is still under construction. The Shippingport Station is at the bottom of the picture. (See also Figure 3.2-1.)

Figure 3.1-3 shows the Shippingport Station in relation to the Beaver Valley plants and in relation to the wooded area to the south (upper portion of the picture).

Figure 3.1-4 shows the Shippingport Station in relation to the heavily industrialized area in Midland, Pennsylvania, across the Ohio River.

3.1.1 Population

Shippingport Borough has a population of 255.[2] Midland, Pennsylvania, a town with a population of 4300, is located approximately 1 mile northwest of the site on the Ohio River. East Liverpool, Ohio, with a population of 16,700, is located approximately 5 miles to the west; Weirton, West Virginia (population 24,700), is approximately 15 miles to the southwest; Steubenville, Ohio (population 26,400), is approximately 20 miles to the southwest; New Castle, Pennsylvania (population 33,600), is approximately 25 miles to the north; and the city of Pittsburgh, with a population of about 424,000, is located approximately 25 miles to the southeast. Other large cities between 25 and 50 miles of Shippingport include Youngstown, Ohio (population 115,000), Canton, Ohio (population 94,700), and Wheeling, West Virginia (population 43,100). Approximately one million people live within a 50-mile radius of Shippingport.

The population in the vicinity of the Shippingport Station and in the region as a whole has developed two distinct characteristics. The older, heavily industrialized settlements in the river valleys have been declining

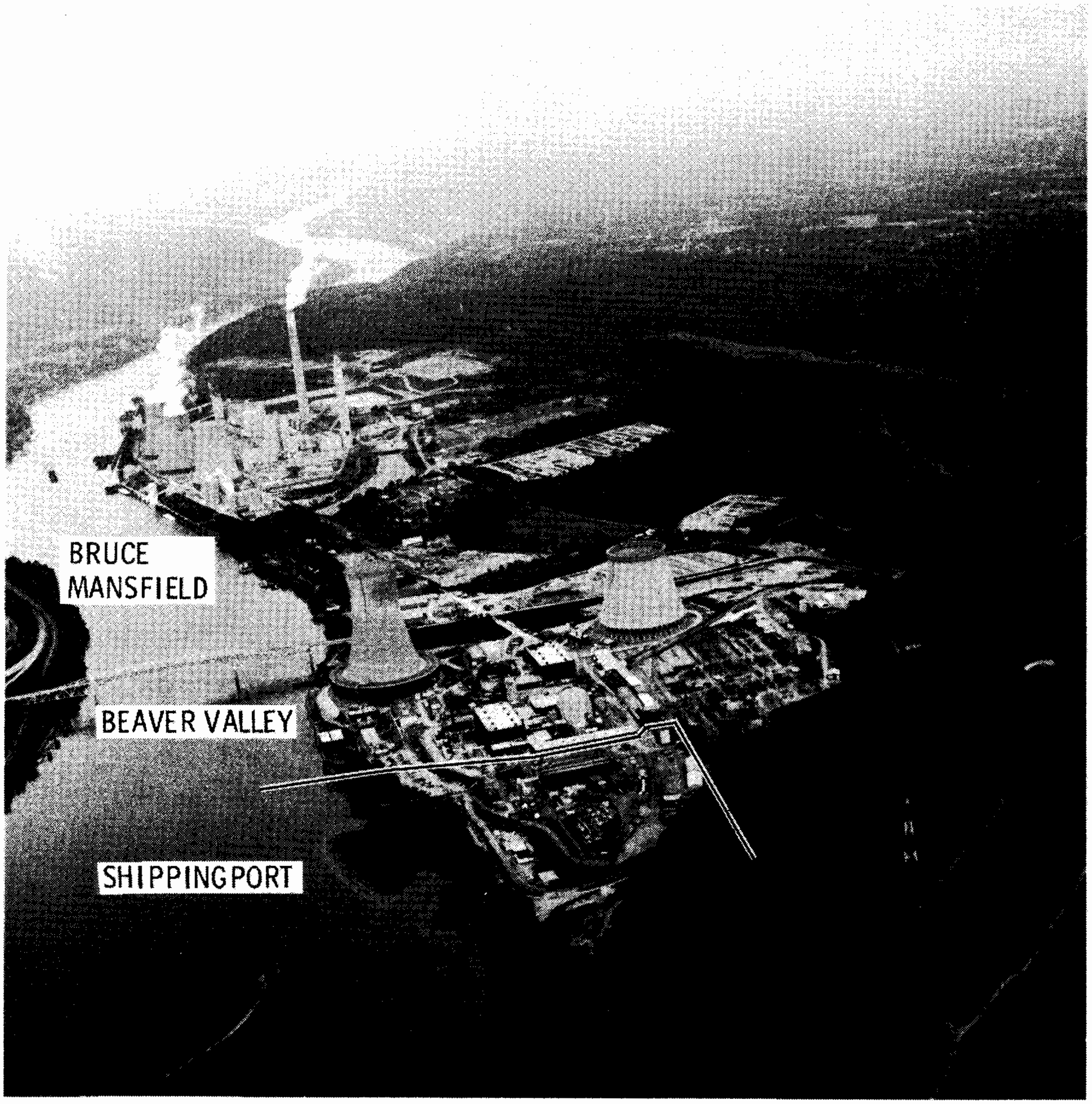

FIGURE 3.1-2. Shippingport Station Shown in Relation to the Two-Unit Beaver Valley Nuclear Plant and the Three-Unit Bruce Mansfield Coal-Fired Plant

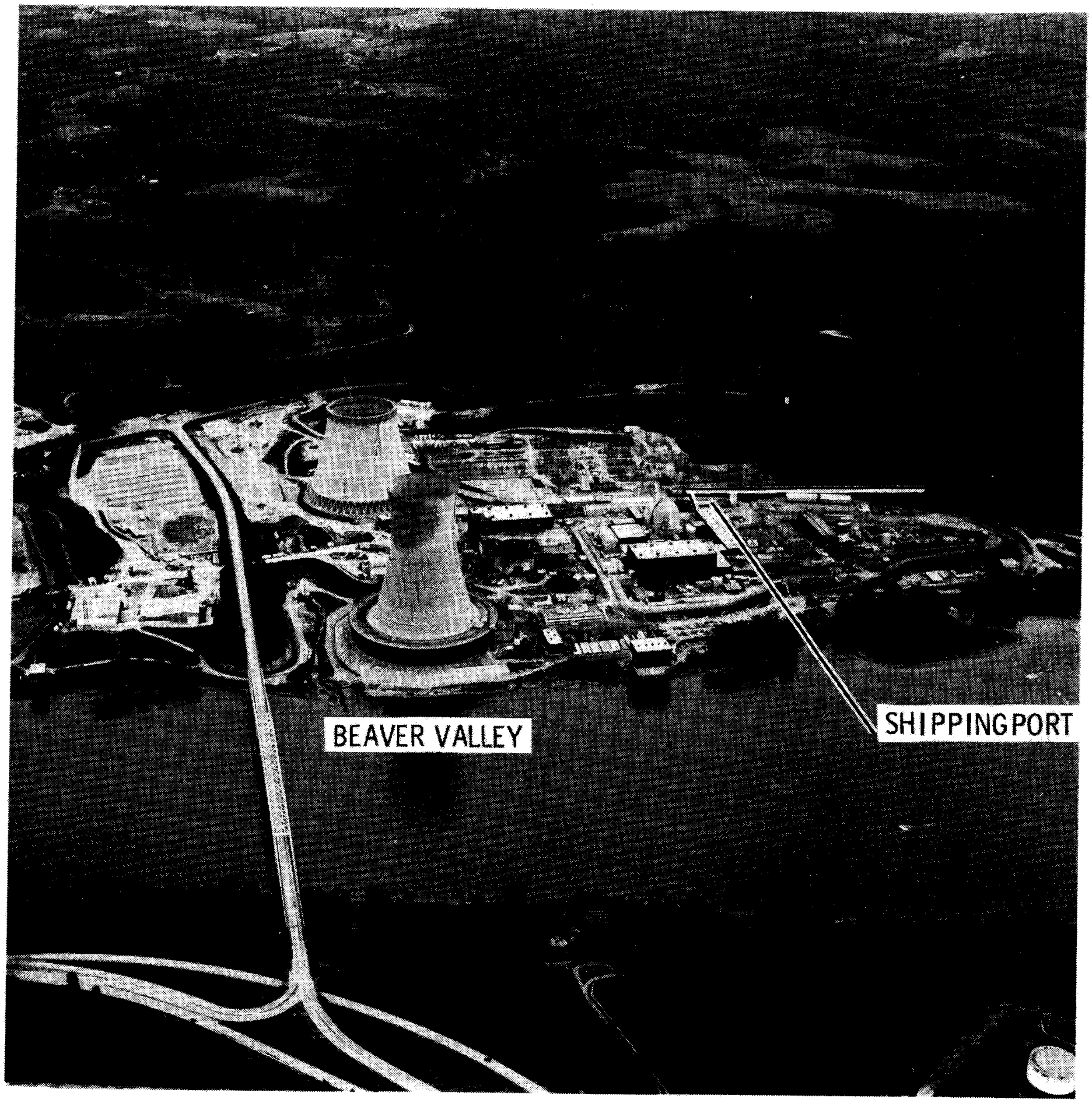

FIGURE 3.1-3. Shippingport Station and the Two-Unit Beaver Valley Nuclear Plant, Showing Forested Area to the South of the Ohio River

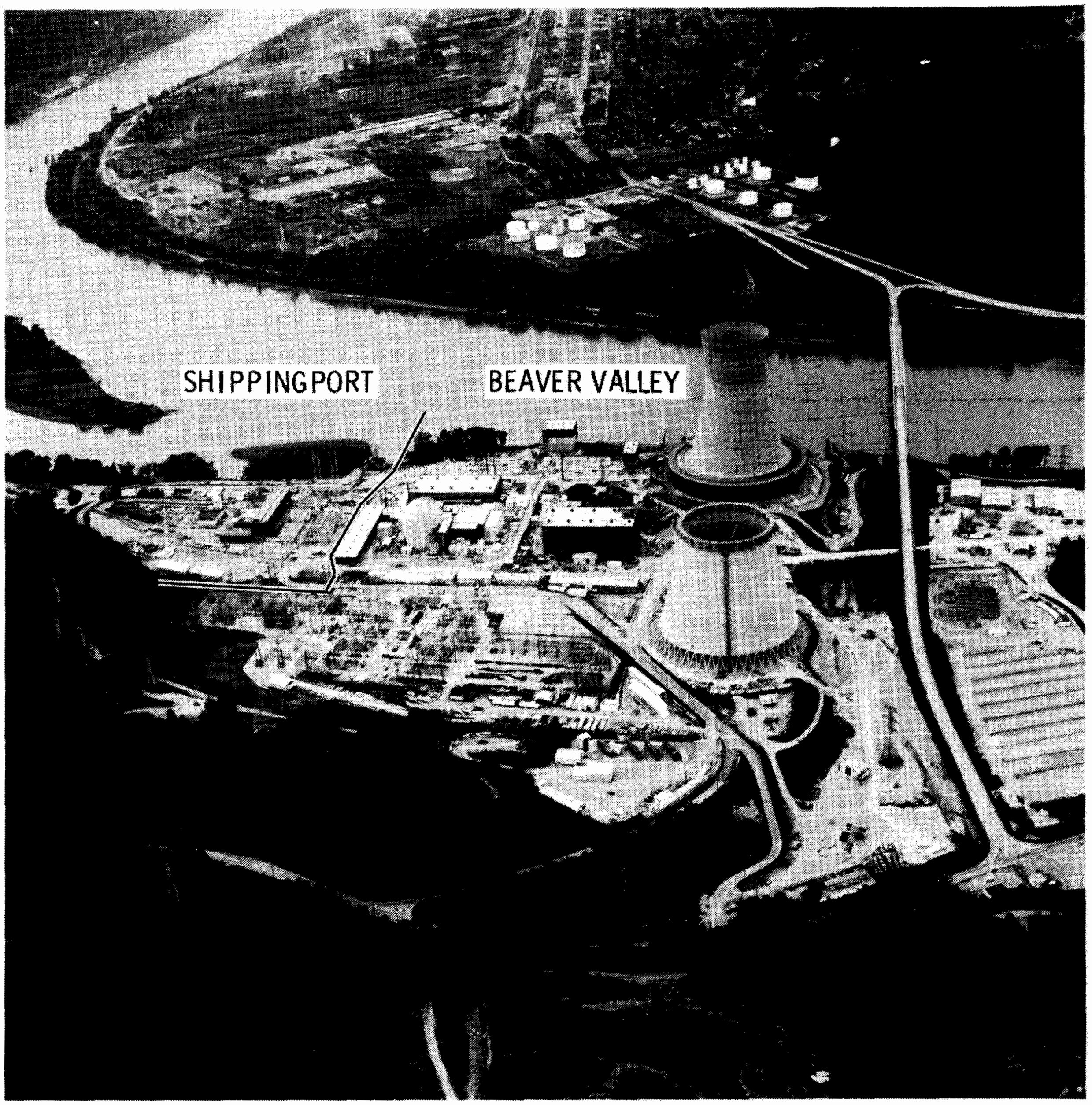

FIGURE 3.1-4. Shippingport Station and the Beaver Valley Nuclear Plant, Showing the Industrial Area at Midland, Pennsylvania, Across the Ohio River from Shippingport

in population, while the surrounding suburban areas have been gaining in population. Overall, the population of Beaver County decreased to 204,441 in 1980, from 208,413 in 1970.

3.1.2 Hydrology

The Ohio River is formed in Pittsburgh by the confluence of the Allegheny and Monongahela Rivers and flows for 931 miles to Cairo, Illinois, where it joins the Mississippi River. The Shippingport Station is located at Ohio River mile 34.8 on the New Cumberland Pool and is 19.4 river miles upstream from New Cumberland Lock and Dam (Figure 3.1-1). The river elevation of the Ohio River at the Shippingport site is determined by river flow and the operation of the downstream New Cumberland Dam gates. The dam maintains a river elevation of 664.5 feet at Shippingport, for a river flow range up to about 20,000 cfs.

Flood stage profiles have been developed by the U.S. Army Corps of Engineers for the Ohio River reach above the New Cumberland Dam at Shippingport (the New Cumberland Pool). These river level stages and recurrence frequencies are summarized below (Reference 1, p. III-30).

- Normal river level (controlled by downstream level) — Elevation 665 feet
- Normal flood level (recurrence frequency approximately 2 yr) — Elevation 675 feet
- Standard project design flood (recurrence frequency >1,000 yr) — Elevation 705 feet
- Probable maximum flood (recurrence frequency >100,000 yr) — Elevation 730 feet

Based on studies of flood data by the U.S. Army Corps of Engineers prior to plant design, the Shippingport Station was designed to be protected against high water to an elevation of 706 feet. This is 3 feet higher than the flood of 1936, the highest flood of record, and 1 foot above the currently defined standard project design flood.

Historical records on Ohio River floods date back 200 years and include floods occurring both before and after the construction of modern flood-control dams and reservoirs. The 1936 flood reached a record elevation of 703 feet (before flood control), while the more recent 1972 flood crested at an elevation of 694 feet.

3.1.3 Climate

The western portion of Pennsylvania in the vicinity of the Shippingport site lies on the western slope of the Allegheny Mountains. The site is about 90 miles southeast of Lake Erie and 340 miles west of the Atlantic coastline. Shippingport is also relatively near the Great Lakes-St.Lawrence storm track, so there are frequent periods of cloudiness and precipitation during the cooler part of the year. The warmer part of the year brings frequent periods of warm, humid weather. Average temperatures range from 29°F to 72°F throughout the year and extreme temperatures have ranged from -20°F to 103°F. These temperatures can be of importance in evaluating the effect of many freeze-thaw cycles on concrete weathering. The highest recorded windspeed is 58 mph from the west. Higher gusts are possible from tornados, which are infrequent in the area, and from hurricanes, which have always been observed to be in the process of final dissipation when they reach western Pennsylvania. Severe weather may be a factor in decommissioning the Shippingport Station if entombment is chosen as the decommissioning alternative, because of weather effects on the entombed structure.

Prevailing winds are from the northwest and from the south. Wind is from the northwest quadrant approximately 40% of the time and from the south quadrant approximately 30% of the time. Two large population centers (Pittsburgh to the southeast and Youngstown to the north-northwest) are in the direction of these winds.

3.1.4 Seismology

Historically, the area in which the Shippingport Station is located has had no significant seismic events. The nearest known fault lies approximately 60 miles to the southwest and has a course tangentially away from the station.

3.1.5 Air Quality

Air quality near Shippingport is monitored by the Pennsylvania Bureau of Air Quality Control.(3) The Bureau's closest monitoring station is at Midland, approximately 3 miles distant, where sulfur dioxide, ozone, total suspended particulate matter, and particulate fluoride and sulfate ions are routinely measured. The closest stations monitoring sulfur dioxide, nitrogen dioxide, carbon monoxide, and non-methane hydrocarbons are at Baden and Beaver Falls, both of which are approximately 11 miles distant. These three stations, together with nine others, are located in the Beaver Valley Air Basin. The Beaver Valley Air Basin extends approximately 20 miles along the Beaver River from Newcastle south to the Ohio River, approximately 10 miles south along the Ohio River from the mouth of the Beaver River to Aliquippa, and approximately 14 miles along the Ohio River from the Beaver River west to the West Virginia and Ohio borders (see Figure 3.1-1). Air quality data are reported both from individual stations and as air basin averages.

The Commonwealth of Pennsylvania has adopted all of the National Ambient Air Quality Standards as well as several standards of its own. (E.6) These standards are listed in Tables 3.1-1 and 3.1-2. Primary standards are those

TABLE 3.1-1. National Ambient Air Quality Standards (40 CFR 50)

Pollutant	Averaging Time	Primary Standard Levels	Secondary Standard Levels
Particulate Matter	Annual (geometric mean)	75 $\mu g/m^3$	60 $\mu g/m^3$
	24 hr[a]	260 $\mu g/m^3$	150 $\mu g/m^3$
Sulfur Oxides	Annual (arithmetic mean)	80 $\mu g/m^3$ (0.03 ppm)	--
	24 hr[a]	365 $\mu g/m^3$ (0.14 ppm)	--
	3 hr[a]	--	1300 $\mu g/m^3$ (0.5 ppm)
Carbon Monoxide	8 hr[a]	10 mg/m^3 (9 ppm)[b]	10 mg/m^3 (9 ppm)[b]
	1 hr[a]	40 mg/m^3 (35 ppm)	40 mg/m^3 (35 ppm)
Nitrogen Dioxide	Annual (arithmetic mean)	100 $\mu g/m^3$ (0.05 ppm)	100 $\mu g/m^3$ (0.05 ppm)
Ozone	1 hr[a]	235 $\mu g/m^3$ (0.12 ppm)	235 $\mu g/m^3$ (0.12 ppm)
Hydrocarbons (nonmethane)[c]	3 hr (6 to 9 a.m.)	160 $\mu g/m^3$ (0.24 ppm)	160 $\mu g/m^3$ (0.24 ppm)
Lead	3 mo.	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$

(a) Not to be exceeded more than once per year. For ozone, exceedances are determined by a method which utilizes the most recent three-year running average.
(b) EPA has proposed a reduction of the standard to 25 ppm (29 mg/m^3).
(c) A nonhealth-related standard used as a guide for ozone control.

TABLE 3.1-2. Pennsylvania Ambient Air Quality Standards

Pollutant	Averaging Time	Standard
Settleable Particulates	30 days	43 tons/mi^2-mo
	1 year	23 tons/mi^2-mo
Lead	30 days	5 μg/m^3
Beryllium	30 days	.01 μg/m^3
Sulfates	24 hours	30 μg/m^3
	30 days	10 μg/m^3
Fluorides	24 hours	5 μg/m^3
Hydrogen Sulfide	1 hour	0.1 ppm
	24 hours	0.005 ppm

deemed necessary to protect public health, and secondary standards are those deemed necessary to protect public welfare. There are no ambient air quality standards for radioactivity. Maximum concentrations of pollutants observed[3] in 1979 are listed in Table 3.1-3.

TABLE 3.1-3. Maximum Observed Concentrations of Air Pollutants at the Nearest Monitoring Station to Shippingport in 1979

Pollutant and Station	Concentration and Observation Time	Exceeds National Primary Standard	Exceeds National Secondary Standard	Exceeds State Standard
Total Suspended Particulates, Midland	192 μg/m^3 (24 hr)	No	Yes	(a)
Sulfates, Midland	28.3 μg/m^3 (24 hr)			No
	20.6 μg/m^3 (30 day)			Yes
Lead, Baden	1.15 μg/m^3 (30 day)			No
	1.07 μg/m^3 (90 day)	No	No	No
Fluorides, Midland	0.72 μg/m^3 (24 hr)			No
Settleable Particulate Matter, Midland	48 tons/mi^2 mo			Yes
Sulfur Dioxide, Midland	0.397 ppm (3 hr)		No	
	0.195 ppm (24 hr)	Yes		
Ozone, Midland	0.125 ppm (1 hr)	Yes	Yes	
Nitrogen Dioxide, Baden	0.418 ppm (1 hr)			
	0.068 ppm (24 hr)			
Carbon Monoxide, Baden	15.2 ppm (1 hr)	No	No	
	7.3 ppm (8 hr)	No	No	
Hydrocarbons, Baden	12.47 ppm (1 hr)			
	3.18 ppm (3 hr)	Yes	Yes	

(a) A blank indicates that no standard exists.

Air quality in the Beaver Valley Air Basin is dominated by heavy industrial activity in the area, including the Bruce Mansfield coal-fired plants, steel blast furnaces and rolling mills, and the fabricated metal products industry (see Figures 3.1-2 and 3.1-4).

The average total suspended particulate level was in violation of the primary annual standard in 1979 in the Beaver Valley Air Basin and at the Midland station. The 24-hour secondary standard was exceeded 7 times out of 61 observations at Midland and 61 times out of 515 observations in the basin. However, the annual average in the Beaver Valley Air Basin has shown substantial improvement since 1973, decreasing annually from a high of 127 $\mu g/m^3$ to 81 $\mu g/m^3$.

Thirty-day sulfate standards were exceeded each month in 1979 at Midland and in the entire Beaver Valley Air Basin. Twenty-four hour standards were not exceeded at Midland. The maximum monthly averages have varied and have shown only slight improvement from 1973 to 1979.

None of the lead or fluoride standards were exceeded in the Beaver Valley Air Basin in 1979.

Thirty-day and annual settleable particulate standards were exceeded at Midland in 1979, but not on the average in the Beaver Valley Air Basin.

Annual mean concentrations of SO_2 have increased in the Beaver Valley Air Basin since 1973, although the annual primary standard was just met at Midland in 1979 and the 24-hour primary standard was exceeded only once.

Maximum 1-hour ozone concentrations have improved slightly in the Beaver Valley Air Basin since 1973. At Midland the maximum 1-hour standard was exceeded three times in 1979.

Annual mean concentrations of NO_2 have decreased in the Beaver Valley Air Basin since 1973 and did not exceed the annual primary standard in 1979.

Annual mean concentrations of CO have not decreased in the Beaver Valley Air Basin since 1973, but no standard was violated in the basin in 1979.

Annual mean hydrocarbon concentrations have shown no trend in the Beaver Valley Air Basin since 1973, but violations of the daily 3-hour standard occur on about one-third of the days of the year.

(E.6) Discharges of non-radioactive materials into the air from decommissioning operations will not detectably change ambient air conditions (see Section 4.2.1). Discharges of radioactive materials from decommissioning will not exceed the limits of DOE Order 5480.1A (see Section 4.2.1).

3.1.6 Water Quality

Water quality of the Ohio River is monitored by the Ohio River Valley Water Sanitation Commission (ORSANCO).[4] ORSANCO carries out manual sampling and monitoring at 36 sites and operates a network of 22 automatic monitoring stations. Water quality standards are set by each state. Because discrepancies exist at state boundaries and where the Ohio River forms a common boundary between states, ORSANCO has recommended uniform water quality criteria. Unfortunately, not all affected states have adopted the ORSANCO-recommended criteria, so a complex situation exists. At Shippingport, standards adopted by Pennsylvania apply. Some of the more important Pennsylvania standards, including those that are exceeded at the East Liverpool, Ohio, monitoring site, are listed in Table 3.1-4. Criteria recommended by ORSANCO are also listed in Table 3.1-4.

Water quality in the New Cumberland Pool (i.e., in the Ohio River at Shippingport) is affected by acid mine drainage from the Allegheny and Monongahela Rivers, by industrial wastes and treated sewage from Pittsburgh, and by other industrial and municipal wastes discharged into the Ohio River between Pittsburgh and Shippingport. Substantial portions of the inorganic wastes are from the steel production and fabrication industries. Efforts of local, county, state, regional, and federal agencies have improved the water quality of the New Cumberland Pool over the past 20 years. In 1978 and 1979, 10 criteria recommended by ORSANCO were never exceeded at any ORSANCO monitoring site: un-ionized ammonia, arsenic, barium, chloride, hexavalent chromium, fluoride, nitrate and nitrite, selenium, silver, and dissolved solids.[4] However, at Shippingport, ORSANCO criteria for cyanide, mercury, lead, fecal coliform bacteria, and phenolics were exceeded during 1978 and 1979. Pennsylvania criteria were exceeded for iron, lead, manganese, and phenolics. Dissolved oxygen criteria are usually met at Shippingport.

TABLE 3.1-4. Important Ohio River Water Quality Standards at Shippingport

Constituent	Pennsylvania Standard	ORSANCO Recommended Standard
Cadmium (μg/ℓ)	--	10
Dissolved Oxygen (mg/ℓ)		
Daily Average	5.0	5.0
Minimum Allowable	4.0	4.0
Cyanide (μg/ℓ)	25	25
Free Cyanide (μg/ℓ)	5	--
Fecal Coliform Bacteria (monthly geometric mean)		
Recreation (count/100 mℓ)	200	200
Water Supply (count/100 mℓ)	2,000	2,000
Iron (μg/ℓ)	1,500	--
Dissolved Iron (μg/ℓ)	300	--
Lead (μg/ℓ)	50	50
Maganese (μg/ℓ)	1,000	--
Mercury (μg/ℓ)	2	0.2
pH	6 to 9	6 to 9
Phenolics (μg/ℓ)	5	10

Discharges into the Ohio River from decommissioning activities will not exceed the concentration limits of 10 CFR 20 and DOE Order 5480.1A for radioactive effluents or 40 CFR 423 for non-radioactive effluents (see Section 4.2.2). The conditions of the existing National Pollution Discharge Elimination System (NPDES) permit will be met (see Appendix B).

3.1.7 Aquatic and Terrestrial Ecology

The ecology of the Shippingport area is discussed in Section III.A.5 of Reference 1. Decommissioning will not require the clearing of any land at Shippingport, nor will it require the appropriation and discharge of water in volumes equivalent to those presently used in cooling the reactor. Thus the impact on the ecology of the area from decommissioning activities, and after decommissioning is completed, will be less than the impact of building and operating the station. No endangered or threatened species are known to be affected by decommissioning activities (see Section 4.2.3 and Appendix D).

No land not already dedicated to the disposal of radioactive wastes will be required at Savannah River or at Hanford (see Section 4.6.4).

3.1.7.1 Aquatic Ecology

The aquatic ecology of the Ohio River at Shippingport (New Cumberland Pool) reflects the condition of the water (Section 3.1.6). Counts of fecal coliform bacteria are often high, rendering the water quality marginal for water sports such as swimming and water skiing. Zooplankton found in the New Cumberland Pool include species associated both with polluted and clean water. The New Cumberland Pool supports only a sparse benthic community, and the species that do exist are tolerant to pollution.

Fish native to the Ohio River include muskellunge, walleye, sauger, and spotted bass. These fish prefer clean water and thus were generally not found 10 years ago in the New Cumberland Pool. They were replaced by species more tolerant to pollution, including carp, emerald shiner, sand shiner, blunt-nose minnow, and channel catfish. Improving conditions on the upper Ohio River in the later 1970s have resulted in the reappearance of sauger and walleye.[4].

3.1.7.2 Terrestrial Ecology

The Beaver Valley Power Station, Units 1 and 2, and the Shippingport Station occupy less than 25% of the 486.8-acre Shippingport site. Much of this site, except the northeast corner where the power stations are located, has been left in its native, undeveloped state. The area to the west of the stations is a forested community typical of many lands in western Pennsylvania.

Approximately 50% of the site is covered by deciduous forest, including maple, oak, cherry, black locust, elm, and dogwood trees. Another 20% of the site is occupied by transmission line rights-of-way, which are in turn occupied by shorter trees, shrubs, and herbs.

Over 200 species of birds have been identified in the region. These are predominantly small woodland birds, including woodpeckers, cardinals, chickadees, and goatsuckers. The undeveloped lands of the site offer suitable nesting habitats for these species. Marsh and aquatic species have been observed, including mallard ducks, red-winged blackbirds, and belted kingfishers.

Snakes, frogs, salamanders, and the eastern box turtle occur on the site.

Over twenty-five species of mammals are known to occur on the site, including rabbits, squirrels, woodchucks, whitetail deer, oppossums, raccoons, foxes, muskrats, beavers, weasels, moles, shrews, bats, rats, and mice.

3.1.7.3 Endangered and Threatened Species

Endangered and threatened wildlife and plants are listed in 50 CFR 17. Those occurring in Pennsylvania are listed in Appendix D. No endangered or threatened species are known to exist at Shippingport or in the immediate vicinity, except for occasional transient species.[5]

3.1.8 Socioeconomic Environment

The socioeconomic environment of the Shippingport area is dominated by the steel and power industries, by the large cities of Pittsburgh and Youngstown, and by a population of approximately one million people living within a 50-mile radius. The presence (or absence) of the small labor force of approximately 180 (maximum) needed to decommission the Shippingport Station will have little effect on the socioeconomic environment of the area (see Section 4.5).

3.2 SHIPPINGPORT STATION

The Shippingport Atomic Power Station was constructed in the mid-1950s as a joint project of the U.S. Government and the Duquesne Light Company on land owned by Duquesne Light. The nuclear reactor portion of the station is owned by the DOE and the turbine-generator portion of the plant is owned by Duquesne Light. The reactor portion of the station has been operated since 1957 by Duquesne Light under supervision of the DOE's Division of Naval Reactors. The reactor is currently operating with a light water breeder reactor (LWBR) core.

3.2.1 Plant Description and History of Operation

The Shippingport Station consists of a PWR currently rated at 72 MWe, a turbine-generator for generating electricity, a radwaste building, and other facilities appropriate to the operation of the station as a test reactor and as a power-producing facility. Shippingport Station structures are shown in Figure 3.2-1. Aerial views of the station in relation to the Beaver Valley nuclear plants, to the Bruce Mansfield coal-fired plants, and to the surrounding area are shown in Figures 3.1-2, 3.1-3, and 3.1-4.

Since construction, the reactor has been operated for DOE (formerly the Atomic Energy Commission) primarily to investigate the technical, practical, and evolutionary considerations involved in the use of nuclear energy for the production of electricity for commercial use.

During its history, the Shippingport Station has operated with two light water cooled, seed-blanket, PWR cores, and with the present LWBR core. The primary coolant system of the Shippingport Station contains four coolant loops, a pressurizer, and associated valves and piping. Including the associated secondary steam-producing circuit, this design concept is essentially that used by all commercial PWRs in this country (Figure 3.2-2).

The two boiler chambers, located on either side of the central reactor chamber, are divided into two shielded compartments, as shown in Figure 3.2-3. Loops 1A and 1C, separated by a concrete shield wall, are located in one chamber; loops 1B and 1D are similarly located in the other chamber. Shielding around each loop compartment is designed to permit personnel to enter the compartment of a shut down loop while the rest of the plant is operating at three-loop power capability.

PWR Core 1 began operation in December 1957 with a design electrical power output of 68 MWe gross. It underwent three partial refuelings (seed replacements) before suspending power operations in 1964. The plant was then modified to permit operation of PWR Core 2 with a design electrical power output rating of 150 MWe gross. Core 2 was developed to demonstrate higher core performance than Core 1 in terms of power density, power rating, and core lifetime. This core began operation on April 30, 1965, was partially refueled in 1969, and was shut down in February 1974 following failure of the turbine-generator. Defueling operations were then begun in preparation for LWBR core installation in 1977. Heat over 100 MWe from PWR Core 2 was dumped to a heat dissipation system in order not to exceed the turbine-generator capacity of 100 MWe.

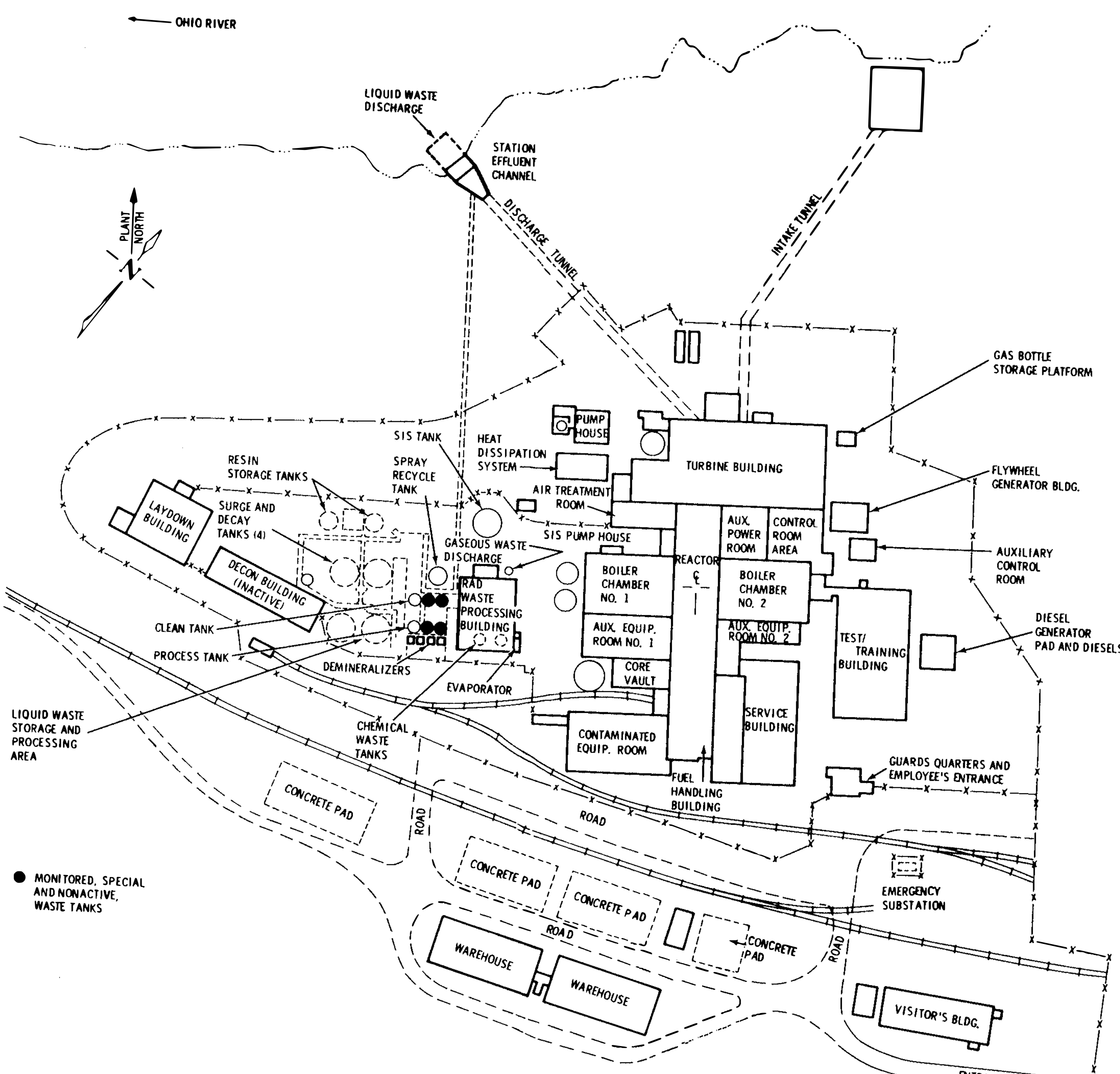

FIGURE 3.2-1. Shippingport Station Site Plan

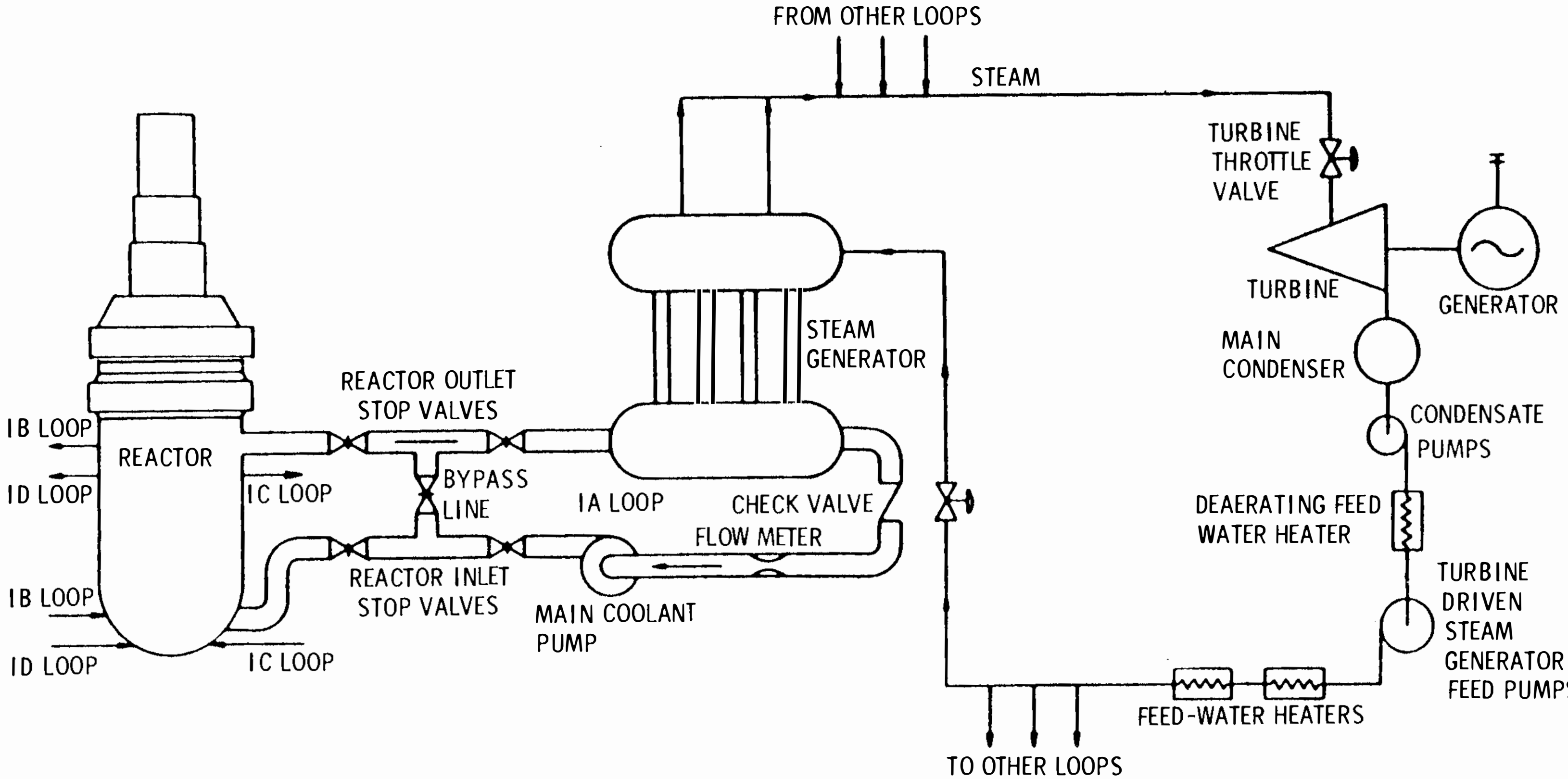

FIGURE 3.2-2. Shippingport Station Operating Cycle with LWBR Core (The portion of the station on the left of the figure, including the reactor and steam generators, is owned by the DOE. The portion on the right, including the turbine-generator and the condenser, is owned by Duquesne Light.)

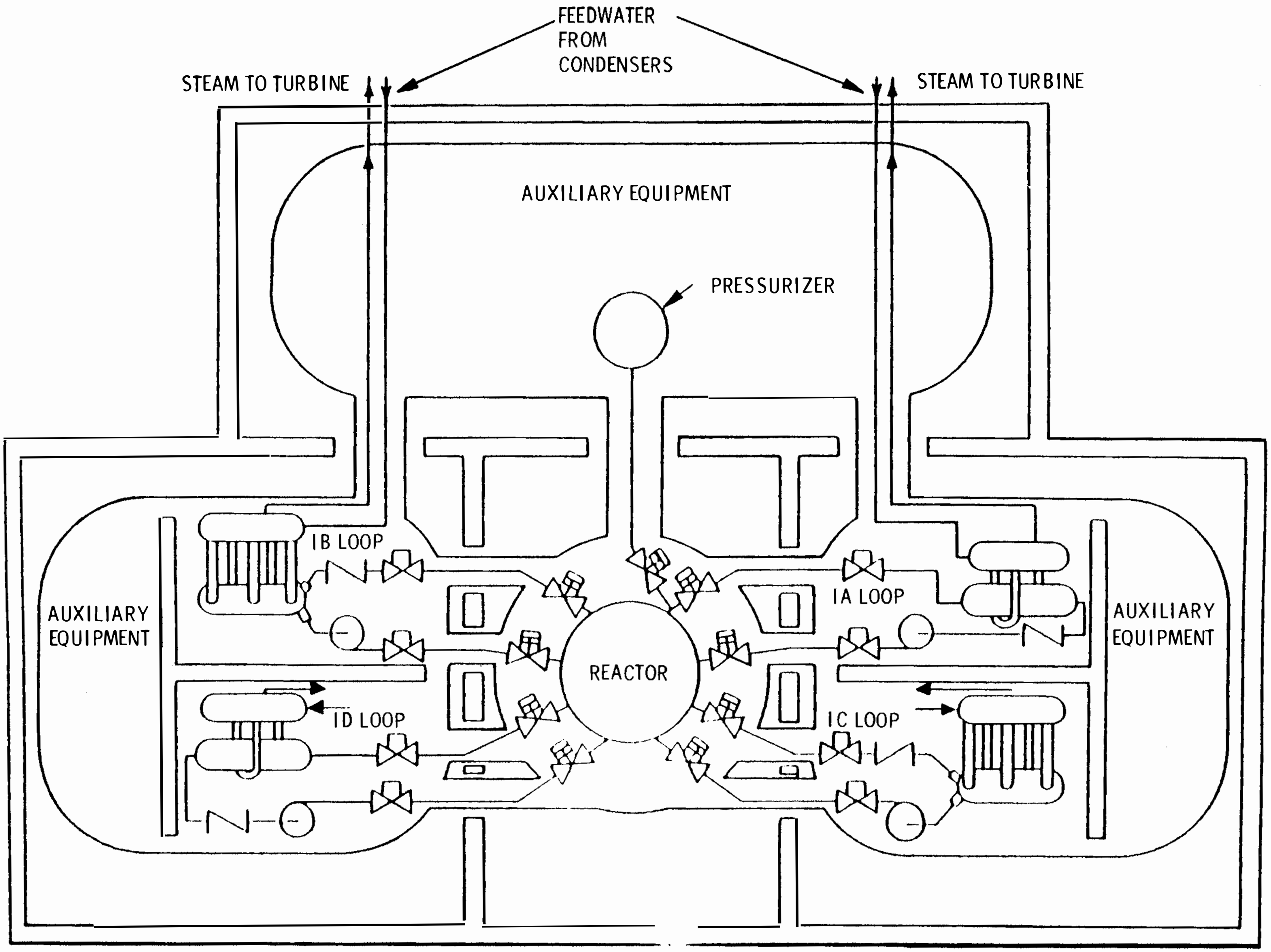

FIGURE 3.2-3. Schematic of the Primary System of the Shippingport Station

The LWBR core is designed to create new fissile uranium-233 from the interaction of fertile thorium-232 with neutrons from the fission of uranium-233. Thorium-232 and uranium-233 were the original components of the LWBR fuel elements. The station reactor plant system accommodated the LWBR core with only minor modifications. Additional plant modifications have been undertaken voluntarily to meet upgraded criteria in NRC regulatory guides and in 10 CFR 50, Appendix A (design criteria that have evolved since original construction). These additional modifications dealt principally with the engineered safety system that is provided to mitigate the consequences of postulated accidents.

Routine operation of the station produces 72 MWe of electrical power, requires once-through cooling water in the amount of 621,000 kiloliters per day, and produces approximately 233 m^3 of solid radioactive waste each year. The 130 workers receive a collective radiation dose of approximately 37 man-rem per year. Liquid and gaseous releases are routinely monitored and do not exceed the limits in 10 CFR 20 or in the applicable State of Pennsylvania permits.

3.2.2 Inventory of Radioactivity

An estimate of the inventory of radioactivity contained in the station after the fuel has been removed is necessary to determine the requirements for radioactive waste packaging, shipping, and disposal, as well as to determine the optimum length of time for radioactive decay during safe storage. A knowledge of the inventory is also useful in calculating occupational radiation dose rates to be expected from various decommissioning activities. Some of these dose rates can be measured now, but most are more conveniently calculated from the inventory because of the complicating presence of the reactor fuel.

The inventory of radioactivity consists of neutron activation products in the pressure vessel and its internals, neutron activation products in the neutron shield, contaminants in the reactor plant fluids, contaminants in the reactor plant fluid systems and radwaste systems, and, to a lesser extent, neutron activation products in concrete and in the metal reactor chamber container. The most recent estimate of the activation of the pressure vessel and its internals is based on 84,093 effective full power hours (EFPH) of reactor operation (27,781 hr for PWR Core 1, 23,812 hr for PWR Core 2, and 32,500 hr estimated for the LWBR Core). This estimate is given in Table 3.2-1 for a time of 2 years after shutdown when vessel-removal activities would begin. The total curie content is approximately 13,320 curies.

TABLE 3.2-1. Estimated Radioactivity in Curies of Shippingport Reactor Vessel and Internals at 2 Years After Reactor Shutdown

Component	^{14}C	^{55}Fe	^{60}Co	^{59}Ni	^{63}Ni	^{79}Se	^{94}Nb	^{93}Mo	^{99}Tc	^{121}Sn	^{125}Sb	Total
Bottom Plate		16.24	124.7	0.362	55.61							196.9
Seal and Reflector Support Ring		2.501	6.344	0.060	8.266							17.16
Filler Units	0.063	1,936	1,820	0.901	124.9		0.006					3,882
Upper Core Barrel	0.001	67.93	48.38	0.120	15.42		0.003					131.9
Lower Core Barrel	0.225	1,861	1,277	0.802	111.2		0.004	0.001			0.203	3,250
Thermal Shield	0.413	1,217	3,029	1.980	256.4	0.001	0.014	0.004	0.001	0.001	0.166	4,505
Vessel Cladding	0.030	66.18	168.7	0.161	20.36						0.008	255.4
Pressure Vessel		717.5	147.4	0.003	0.392			0.047	0.012			865.4
Neutron Shield Tank		193.0	22.50	0.001	0.091							215.6
Totals	0.732	6,077	6,644	4.390	592.6	0.001	0.027	0.052	0.013	0.001	0.377	13,319

Cooling and radwaste system contaminants consist of corrosion products from the pressure vessel and its internals and, to a lesser extent, fission products and transuranics from natural constituents of the fuel cladding and possibly from fuel rods containing cladding defects. The internal surface radioactive contamination (crud) in piping and components is deposited primarily in the reactor coolant system but is also introduced to auxiliary systems via purification and liquid waste disposal systems. Based on reactor coolant sample data for three sampling periods,[6] the typical relative coolant activity 120 hours after sampling is shown in Table 3.2-2. Total absolute crud activity is estimated to be approximately 20 curies. This amount can be further reduced by effective decontamination procedures. It is not likely, however, that decontamination of piping and components will reduce radiation dose to the extent that radiation protection procedures may be abandoned during either immediate or deferred dismantlement. It is evident that the primary contaminants deposited on internal surfaces will be ^{58}Co, ^{60}Co, and ^{59}Fe. ^{58}Co and ^{60}Co are expected to be the controlling isotopes (over 85 percent of the activity) with respect to gamma dose to the workers during early cooling and radwaste

TABLE 3.2-2. Relative Reactor Coolant Inventory 120 Hours after Sampling[a,b]

Activity	Percent of Gross Crud Activity, Sample Date: Nov. 77	May 78	Nov. 78	Average % of Gross Crud Activity
^{58}Co	34.6	50.6	51.1	45.4
^{60}Co	44.3	45.7	36.1	42.0
^{51}Cr	3.0	0.4	0.0	1.1
^{54}Mn	1.7	2.6	0.2	2.2
^{59}Fe	10.5	5.7	2.6	6.3
^{95}Zr	0.4	0.2	0.4	0.3
Total	94.5	105.2	90.4	97.3

(a) Data from Reference 6.
(b) Total activity is estimated to be approximately 20 Ci.

system removal. Radioactive contaminants in the fluids will be removed by the existing evaporation and ion exchange systems. After final processing of radioactive fluids, 90 Ci of activity are expected to remain in evaporator concentrates and 207 Ci are expected to remain in spent resins, including existing spent resins. Curie content of the activated shielding concrete has not yet been determined. It will probably be shown to be less than 4 Ci (see Section 7.3 of Reference 7). Curie content of the reactor chamber container will probably also be small.

At the time of decommissioning, the inventory, or total curies of each isotope in the station, must be determined again to identify the type and quantity of radioactivity for shipping and burial purposes.

3.3 WASTE DISPOSAL AREAS

Present plans call for disposal of radioactive wastes at a federally owned radioactive waste disposal site at Savannah River, South Carolina, or at Hanford, Washington. These sites are approximately 715 and 2380 highway miles, respectively, from Shippingport. The affected environments and the environmental impacts of radioactive waste disposal activities at Savannah River and Hanford are discussed in References 8 and 9, respectively. The affected environments are summarized here in Sections 3.3.1 and 3.3.2, and the environmental impacts are discussed in Section 4. Nonradioactive hazardous wastes will be disposed of at appropriate sites near Shippingport (see Section 3.3.3).

3.3.1 Savannah River

The Savannah River Plant was established in the early 1950s as a nuclear material production facility for the Federal Government. The site covers about 300 square miles on the north side of the Savannah River and has located on it three nuclear production reactors (two others are not presently in service), two chemical separation plants, tank farms for liquid radioactive waste storage, burial grounds for solid radioactive waste disposal, a fuel and target fabrication area, and a heavy water production and recovery facility.

The climate is warm and wet, with an average rainfall of 47 inches. The water table under the solid radioactive waste burial ground averages 45 feet below the surface. Rainwater can migrate downward through the burial ground and then laterally to surface water. Migration time to the nearest stream is calculated to be approximately 70 years. The probability of hurricanes, tornadoes, and earthquakes is moderate, but the probability of these events affecting solid waste disposal activities is low, because radioactive solid wastes are covered with soil when placed in the burial ground.

In 1972 the entire Savannah River Plant was designated as a National Environmental Research Park. Over 90% of the site is covered by pine and hardwood forests; however, the burial grounds have been deforested. Animal life is abundant in habitats that range from infertile dry hilltops to continually flooded swamps. Endangered species known to occur at Savannah River (see Appendix D) are the red-cockaded woodpecker (generally associated with over-mature pine forest habitat) and the American alligator (generally associated with river/wetland habitat). The burial ground area does not provide breeding or nesting habitat for these two species. A biological assessment is presently underway for the entire Savannah River Plant in order to determine the effect of plant activities on these and other species. This assessment is being conducted by the DOE in cooperation with the Asheville, North Carolina, office of the U.S. Fish and Wildlife Service.

An area of 195 acres (79 ha) has been established as a radioactive solid waste burial ground at Savannah River. As of January 1980, approximately 78 acres (32 ha) remained available for disposal purposes.[10] No land not already dedicated to the disposal of radioactive wastes would be required at Savannah River for the disposal of Shippingport radioactive wastes, even if all the Shippingport radioactive wastes were sent to Savannah River.

3.3.2 Hanford

The Hanford site was established in the early 1940s for the purpose of producing plutonium for the Federal Government. The site covers about 570 square miles in southeastern Washington, and is bounded on the north and east by the Columbia River. Facilities located on the site include one operating plutonium production reactor (eight others are no longer in service), the Fast Flux Test Facility, fuel reprocessing facilities, tank farms for liquid radioactive waste storage, burial grounds for disposal of low-level radioactive wastes, fuel fabrication facilities, and a research and development facility. Part of the site has been leased for the construction of three commercial power reactors. A 120 square mile area in the western portion of the site is dedicated to the Arid Land Ecology Reserve.

The semi-arid climate is hot in summer and cool in winter. The average rainfall is less than 7 inches per year. The water table beneath the solid radioactive waste disposal area is 150 to 300 feet below the surface. The probability of tornadoes and earthquakes is low; although moderate to high winds occur annually. Solid wastes are covered with soil each day, or more often, in order to reduce the probability of winds affecting the disposal activities.

Vegetation on the site consists typically of sage brush, Russian thistle, and grasses. A few mule deer exist at Hanford. Other animals include the cottontail rabbit, the Great Basin pocket mouse, and the chukar partridge. The only endangered and threatened species found on the Hanford Reservation is the bald eagle. It is not found, however, at the burial ground site (see Appendix D).

An area of 42 acres (17 ha) has been used[10] for the disposal of radioactive wastes on the Hanford site. Many more acres are available for radioactive waste disposal at Hanford, if necessary, because of the large size of the site and the relative homogeneity and semi-arid character of the environment. More than adequate space is available for the disposal of low-level radioactive wastes from Shippingport.

At both Savannah River and Hanford, disposal of radioactive waste from Shippingport will be in accordance with DOE policy at the time of disposal.

3.3.3 Nonradioactive Hazardous Waste Disposal Sites

Hazardous waste may also be radioactive (borated water, decontamination acids, asbestos pipe insulation) and will either be treated in the station's liquid radioactive waste handling system or will be handled as solid radioactive waste. Nonradioactive hazardous waste can be disposed of in nearby hazardous waste disposal sites upon approval of the Bureau of Solid Waste Management of the Pennsylvania Department of Environmental Resources. Two such disposal sites are the Mill Service Company site near Bulgar, Pennsylvania, and the Industrial Waste Division of CENCO site near Darlington, Pennsylvania. (E.5) Other less hazardous waste, including low concentrations of asbestos and demolition (non-radiological, non-hazardous) wastes, may be buried in sanitary landfills such as the Browning Ferris Industries landfill in Imperial, Pennsylvania, near the Pittsburgh airport and the Kelly Run Company landfill on Route 51, near the Allegheny and Westmoreland county line. Disposal of this waste is also subject to the approval of the Pennsylvania Bureau of Solid Waste Management.

3.4 TRANSPORTATION ROUTES

Radioactive waste will be transported by truck to the federally owned radioactive waste disposal sites at Hanford or Savannah River, along direct, interstate highway routes in accordance with DOT regulations (49 CFR 170-189). Two possible truck routes to each facility are shown on Figure 3.4-1.

One feasible route to Hanford follows Interstate Highway I-76 north to Cleveland, then I-80-90 west through Toledo to Chicago. It then follows I-90 to Ritzville, Washington, and from Ritzville on state highways to Hanford. The

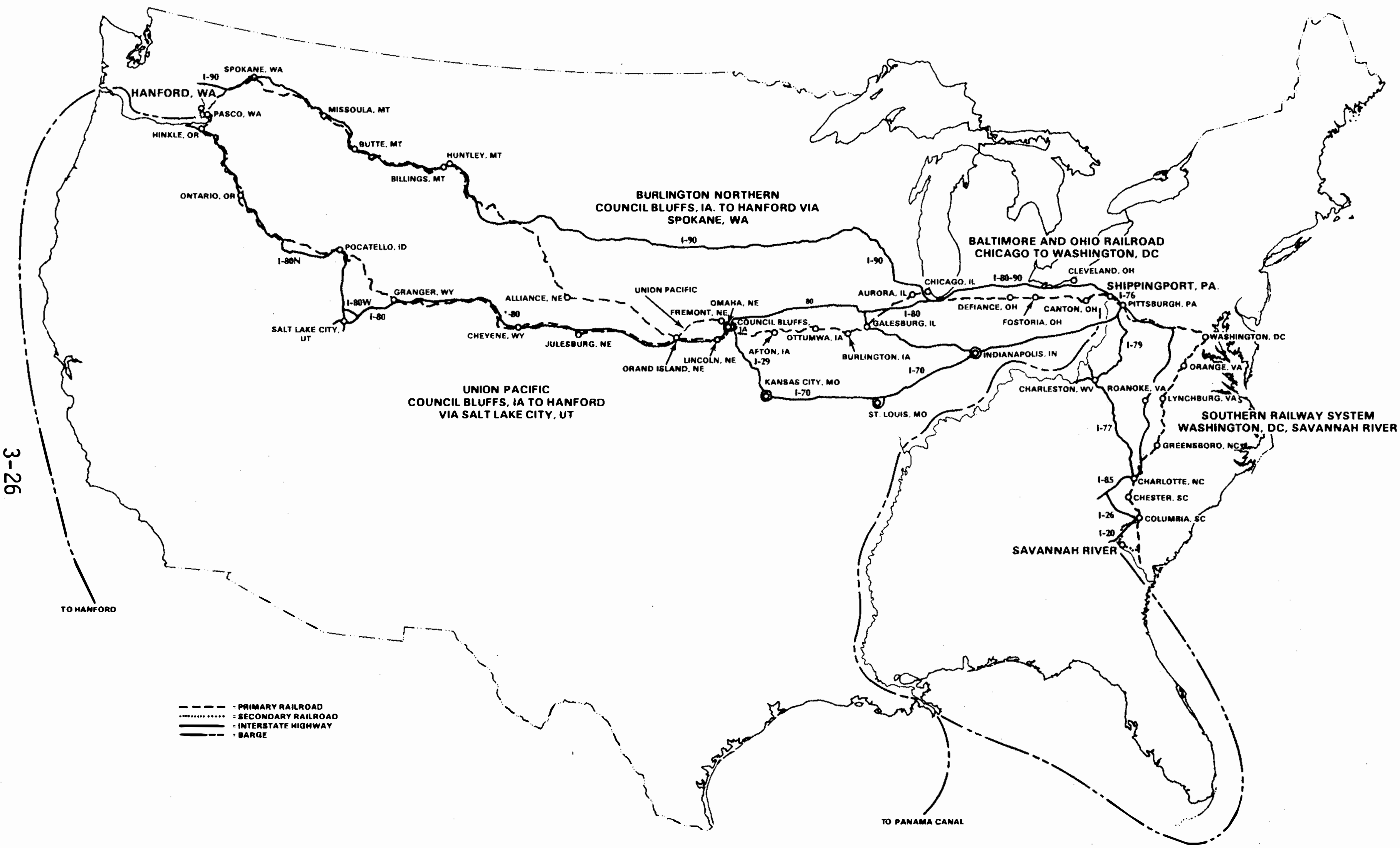

FIGURE 3.4-1. Potential Highwy, Barge and Rail Routes for Transporting Shippingport Decommissioning Wastes to Savannah River and Hanford

distance by this route is about 2,380 miles. An alternative route to Hanford takes I-76 and I-79 south to I-70; then I-70 west to Indianapolis, Indiana; I-74 west to Salt Lake City, Utah; north on I-80N to Hinkle, Oregon, and state highway routes to Hanford. This route avoids major cities except for Pittsburgh, and the total mileage is 2,620 miles.

Cross connections between these two routes exist at several points: at Chicago, Illinois, on I-55; at Des Moines, Iowa, on I-35; at Omaha, Nebraska, on I-29; at Cheyenne, Wyoming, on I-25 and at Pocatello, Idaho, on I-15.

A feasible truck route to Savannah River takes I-76 south to Pittsburgh; I-79 to Charlotte, North Carolina; I-85 and I-26 south to Columbia, South Carolina; I-20 south to Augusta, Georgia, and then on state highways to Savannah River. The distance of this route is about 715 miles. An alternative route to Savannah River takes I-76 south to Pittsburgh; I-70 and I-81 south to Roanoke, Virginia, then state highways to Charlotte and I-85 and I-26 south to Columbia, I-20 to Augusta and state highways to Savannah River. The distance of this route is about 750 miles.

Barge shipment is possible for the reactor vessel if it can be removed in one piece and be adequately shielded. Loading facilities at Beaver Valley would be used or new facilities would be built or assembled at Shippingport. At both Savannah River and Hanford, overland transport from the existing barge dock to the burial ground would be required. A feasible route to Hanford would be down the Ohio River to the Mississippi River, south on the Mississippi River to the Gulf of Mexico, through the Panama Canal, north on the Pacific Ocean to the Columbia River, and up the Columbia River to Hanford. The distance by barge to Hanford is about 7,800 miles. A barge route to Savannah River would be down the Mississippi River, through the Gulf of Mexico, around Florida, and up the Savannah River to the burial site. The distance by barge to Savannah River is about 2,600 miles. Barge shipments would be in accordance with the regulations of the U.S. Coast Guard (46 CFR 146 and 149) and with the regulations of the DOT (49 CFR 170-189). Potential barge routes are shown in Figure 3.4-1.

Rail transport may also be used for the pressure vessel and for the internals. Routes would have to be evaluated at the time of shipment. Also, local transport on a tracked or multiwheeled transporter might have to be arranged at both Hanford and Savannah River, if there is no rail spur to the selected burial ground. Rail shipments would be in accordance with the regulations of the DOT (49 CFR 170-189). Rail transport routes are shown in Figure 3.4-1. Two potential rail routes are possible to Hanford. Both would use the Baltimore and Ohio railroad from Shippingport to Chicago. From Chicago one route would take the Burlington Northern to Hanford via Spokane, Washington. This route is about 2,350 miles long. The other route would take the Union Pacific Railroad from Chicago to Hanford via Salt Lake City, Utah. The distance by this route is about 2,550 miles.

There is one feasible rail route to Savannah River. It goes from Shippingport to Washington D.C. on the Baltimore and Ohio Railroad and from Washington D.C. to Savannah River on the Southern Railway system. The distance of this route is about 860 miles.

Air shipment of radioactive waste is not contemplated.

Shipment distances for all of the various transport modes are summarized in Table 3.4-1.

TABLE 3.4-1. Shipping Distance for Potential Highway, Barge, and Rail Routes for Transporting Shippingport Decommissioning Waste to Savannah River and Hanford

Shipment Alternative	Distance (miles)
Truck - Hanford	
I-90 Route	2,380
I-80 Route	2,620
Truck - Savannah River	
Thru Charleston, WV	715
Thru Roanoke, VA	750
Rail - Hanford	
Burlington Northern	2,350
Union Pacific	2,550
Rail - Savannah River	
Southern Railway System	860
Barge - Hanford	7,800
Barge - Savannah River	2,600

REFERENCES

1. Final Environmental Statement, Light Water Breeder Reactor Program, U.S. Energy Research and Development Administration, ERDA 1541, June 1976.

2. 1980 Census of Population, U.S. Department of Commerce, Bureau of the Census, March 1981.

3. 1979 Air Quality Report, Commonwealth of Pennsylvania, Department of Environmental Resources, Harrisburg, Pennsylvania.

4. Assessment of Water Quality Conditions, Ohio River Mainstream 1978-9, Ohio River Valley Water Sanitation Commission, Cincinnati, Ohio, 1980.

5. Letter from N. R. Chupp, U.S. Department of the Interior, to E. B. Moore, Jr., Pacific Northwest Laboratory, March 31, 1981. (See Appendix D.)

6. Shippingport Atomic Power Station Decommissioning Assessment, prepared for United Nuclear Industries, Inc., Richland, Washington, by Nuclear Energy Services, Danbury, Connecticut, June 1979.

7. R. I. Smith, G. J. Konzek and W. E. Kennedy, Jr., Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station, NUREG/CR-0130, Pacific Northwest Laboratory for U.S. Nuclear Regulatory Commission, June 1978.

8. Final Environmental Impact Statement, Waste Management Operations, Savannah River Plant, U.S. Energy Research and Development Administration, ERDA-1537, September 1977.

9. Final Environmental Statement, Waste Management Operations, Hanford Reservation, U.S. Energy Research and Development Administration, ERDA-1538, December 1975.

10. Spent Fuel and Waste Inventories and Projections, U.S. Department of Energy, ORO-778, August 1980.

4.0 ENVIRONMENTAL CONSEQUENCES

The environmental consequences of decommissioning a nuclear reactor must be viewed in a different light than the environmental consequences of building and operating the same reactor. This is because decommissioning ends the operation of the reactor, ends the environmental impact of operating the reactor, and serves to restore the environment by removing the radioactivity from the site or by isolating it effectively from the environment. Building and operating the reactor, on the other hand, necessarily impact the environment on both a temporary basis during construction and on a continuing basis during operation.

The principal environmental consequences of decommissioning a reactor are occupational radiation dose and commitment of land and other resources to the disposal of radioactive wastes. These are the environmental factors of importance in selecting an appropriate alternative for decommissioning the Shippingport Station. Additional factors that will affect the selection of the decommissioning alternative include cost, public radiation dose, longevity of the entombment structure in relation to the half-lives of important radioactive isotopes, and the potential for release of radiation from a breach in the safe storage or entombment structure. In the case of the Shippingport Station, the agreement between DOE and Duquesne Light will also be a factor in selecting the decommissioning alternative (see Section 1.1.1).

Other environmental impacts are either inconsequential or are reasonably similar no matter which alternative is chosen, and thus will have little impact on the choice of decommissioning alternative. For example, no land will need to be cleared at the reactor site for decommissioning and very little land will need to be cleared at the radioactive waste disposal sites. Thus, there will be little impact on terrestrial systems. Nor will there be much impact on aquatic systems because: 1) no new water intake or discharge structures will be required for decommissioning, 2) much less water will be used in decommissioning than in operation, and 3) the relatively small amount of water discharged to the river in decommissioning will conform to the standards in the existing NPDES permit, 10 CFR 20, and DOE Order 5480.1A. It should be noted, however, that temporary loading facilities may need to be constructed at Shippingport if it is decided to remove the pressure vessel intact and to transport it by barge to a disposal site, and if it is decided not to use the existing Beaver Valley barge dock. (E.6) Similarly, the only impacts on air quality will be from the automobiles of the decommissioning workers (180 maximum, 130 operation and maintenance workers are employed now), from fuel driven equipment used in decommissioning, and possibly from some concrete demolition activities. Thus, air quality impacts are minimal compared to the air quality impacts from construction and from the automobiles of the 1600 construction workers at the immediately adjacent Beaver Valley 2 plant. It is important to remember that the Beaver Valley 1 nuclear plant (923 MWe) is in operation, that the Beaver Valley 2 nuclear plant (852 MWe) is under construction, and that all three Bruce Mansfield coal-fired plants (835 MWe each) are in operation 1 mile from the Shippingport Station. Impacts of decommissioning the Shippingport Station must be considered relative to the impacts of constructing and operating the neighboring plants (see Figures 3.1-2, 3.1-3, and 3.1-4).

Costs and routine radiation doses are discussed in Section 2.0. Radiation effects and accidents are discussed in this section. Also discussed in this section are other potential environmental impacts that will play only minor roles in the selection of a decommissioning alternative for the Shippingport Station.

4.1 RADIOLOGICAL EFFECTS

For a discussion of the health effects of small amounts of radiation on a group of people, one may consult the BEIR Report.[1] This report, entitled The Effects on Population of Exposure to Low Levels of Ionizing Radiation, was prepared by the Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR) for the National Research Council of the National Academy of Sciences. It was first published in 1972 (BEIR I), and later revised in 1980 (BEIR III). The BEIR report discusses somatic effects, genetic effects, environmental effects, and the effects of radiation on growth and development.

In the case of somatic effects, the BEIR I Report on page 91 estimates the excess mortality from all forms of cancer to be 50 to 165 deaths per million exposed persons per rem during the first 25 to 27 years after irradiation. This may be expressed as 50 to 165 x 10^{-6} cancer deaths per man-rem in the 25- to 27-year period following exposure. The BEIR III Report on page 212 estimates the lifetime risk of cancer mortality to be 77 to 226 excess deaths per million exposed persons per rad. The BEIR III Report also recomputes the 1972 estimate based on 1969-71 life tables rather than on 1967 life tables. The new 1972 estimate is 117 to 621 deaths per million exposed persons per rad.

In its EIS on the Management of Commercially Generated Radioactive Wastes,[(2)] DOE has analyzed the experimental results and extrapolations to low radiation doses presented in the BEIR and in other reports, and has derived a range of health effects expected to occur in populations exposed to low levels of ionizing radiation. This derived range is 100 to 800 health effects per million man-rem. The range is the sum of 50 to 500 fatal cancers and 50 to 300 serious genetic effects for each million man-rem of radiation exposure.

Estimated occupational and public radiation doses resulting from routine activities associated with each decommissioning alternative are discussed in Section 2.0 and are summarized in Table 2.5-1. Potential health effects associated with these occupational doses are discussed in Sections 4.1.1 and 4.1.2 and in Appendix A. Estimated radiation doses from postulated accidents during decommissioning are discussed in Section 4.1.3.

4.1.1 Occupational Radiation Effects

The radiation dose to decommissioning workers as a group from the immediate dismantlement of the Shippingport Station is conservatively estimated to be 1275 man-rem. Occupational radiation doses from safe storage followed by deferred dismantlement and entombment are estimated to be 505 and 617 man-rem respectively. Expected health effects from these radiation doses range from a minimum of 0.05 for safe storage followed by deferred dismantlement to a maximum of 1.02 for immediate dismantlement.

Annual occupational health effects may be derived for no action alternatives. The 37 man-rem per year occupational dose for the no action continued operation alternative would be expected to result in 3.7 x 10^{-3} to 29.6 x 10^{-3} health effects annually; and the 25 man-rem per year occupational dose for the no action continued surveillance alternative would be expected to result in 2.5×10^{-3} to 20.0×10^{-3} health effects annually. There is, of course, no occupational radiation dose for the no action no surveillance alternative if there is never a need to enter the facility. Occupational health effects from routine radiation doses are summarized in Table 4.1-1.

4.1.2 Public Radiation Effects

Public radiation doses result principally from the transport of radioactive wastes. These doses are given for both Savannah River and Hanford in Section 2.0. Public radiation doses shown in Table 4.1-1 are for transport of all radioactive waste to Savannah River. The respective ranges of health effects for each decommissioning alternative are also given in Table 4.1-1.

The annual radiation dose to the public from no action continued operation is 1 man-rem, for which the range of health effects is 1.0×10^{-4} to 8.0×10^{-4}

TABLE 4.1-1. Expected Health Effects from Decommissioning the Shippingport Atomic Power Station

	No Action Continued Operation	No Action Continued Surveillance	No Action No Surveillance	Immediate Dismantlement	Safe Storage/ Deferred Dismantlement	Entombment
Occupational Radiation Dose (man-rem)	37/yr	25/yr	0	1275[b]	505[c]	617[d]
Occupational Health Effects	3.7×10^{-3} to 29.6×10^{-3} per year	2.5×10^{-3} to 20.0×10^{-3} per year	0	0.13[b] to 1.02	0.05[c] to 0.40	0.06[d] to 0.49
Public Radiation Dose (man-rem)	1 per year	0	(a)	28[b]	21[c]	16[d]
Public Health Effects	1×10^{-4} to 8×10^{-4} per year	0	(a)	2.8×10^{-3}[b] to 22.4×10^{-3}	2.1×10^{-3}[c] to 16.8×10^{-3}	1.6×10^{-3}[d] to 12.8×10^{-3}

(a) Curious members of the public could be subjected to dose rates as high as 24 R/hr, which would be fatal to one-half of the exposed persons after 10 hours.
(b) Numbers are based on total project duration.
(c) Numbers are based on the active periods of preparation work for safe storage and the execution of deferred dismantlement.
(d) Numbers are based on the active periods of preparation work for entombment.

per year. There is no radiation dose to the public for no action continued surveillance if no breakdown in surveillance occurs. The radiation dose to curious members of the public could be as high as 24 R/hr for no action no surveillance. This would result in clinical symptoms after a few hours exposure, and death to approximately 50% of the persons exposed after 10 hours exposure. Health effects from radiation doses are summarized in Table 4.1-1.

4.1.3 Radiation Doses from Postulated Accidents

Equipment failure, human error, and failure of necessary services could result in accidents that would cause the release of radionuclides during decommissioning of the Shippingport Station. However, after the spent fuel has been shipped from the facility, the inventory of radionuclides present will be significantly smaller than the inventory during reactor operation. Also, since there is no possibility of a critical nuclear reaction and since there is no high-temperature, high-pressure water or steam present to supply stored energy, the driving force for dispersal of the radionuclides in an accident is relatively weak during reactor decommissioning activities.

The inventory of radioactivity in any single truck shipment of radioactive wastes is limited by DOT regulations, and will be a small fraction of the total inventory of radioactivity within the facility at the beginning of decommissioning. Thus, the potential radiation doses from releases of radioactive material in truck accidents will be very small. On the other hand, most of the radioactivity in the facility is in the pressure vessel and its internals. Thus, barge or rail transport of the pressure vessel would seem to present a somewhat larger opportunity for release of radioactive material, except that most of the radioactive material is securely immobilized as activated metal in the pressure vessel walls. Crud will be confined within the pressure vessel by sealing all openings to the vessel.

Estimates of possible accidental radionuclide releases during decommissioning of an 1175-MWe PWR are presented in NUREG/CR-0130.(3) Although the inventory of radionuclides in the 1175-MWe PWR (4,826,000 Ci) after 40 years of operation would be much greater during decommissioning than the inventory in Shippingport (13,600 Ci), the airborne and waterborne radionuclide releases estimated for accidents at the larger reactor are small and the calculated radiation doses to the maximum-exposed member of the public are low. It is possible, however, that the inventory involved in some postulated accidents at Shippingport could be as large as the inventory involved in the accidents discussed in NUREG/CR-0130. This would occur if the radioactive material involved were being prepared for shipment at the maximum allowable curie content. Accidental radiation doses are discussed in the following four sections.

4.1.3.1 Occupational Radiation Doses from Decommissioning Accidents

Less than 5 lost-time injuries are predicted to result from industrial accidents that occur in the immediate dismantlement of the Shippingport Station (see Section 4.4). Not all of these injuries would involve radioactivity. Scenarios can be described, however, in which a worker injured or temporarily incapacitated by an accident could receive a substantial quantity of radiation by one or more of four radiation pathways (inhalation, ingestion, external radiation, and internal radiation from radioactive particles forced into the body by an explosion). Obviously accidents, particularly explosions, would have very serious consequences for any individuals immediately present.

4.1.3.2 Public Radiation Doses from Decommissioning Accidents

A wide spectrum of accidents resulting in the release of radioactivity to the atmosphere was studied in NUREG/CR-0130. The estimated radionuclide releases from these accidents are given in Table 4.1-2. Also possible are accidental releases of radioactivity to the Ohio River. These releases for the 1175-MWe reference reactor are given in Table 4.1-3. A summary of the estimated doses to the maximum-exposed member of the public for those accidents causing the larger releases of radionuclides is given in Table 4.1-4. These estimates represent a worst-case or upper bound condition for the Shippingport Station.

4.1.3.3 Occupational Radiation Doses from Transportation Accidents

Only 1 injury is predicted to result from transportation accidents (regardless of mode) during the decommissioning of the Shippingport Station (see Section 4.4). This accident need not involve radioactivity, but may be assumed

TABLE 4.1-2. Postulated Accidental Airborne Radioactive Releases During Decommissioning of an 1175-MWe PWR[(a)]

Incident	Reference Radionuclide Inventory Number[(b)]	Immediate Dismantlement: Airborne Radioactive Release in Building (μCi)	Immediate Dismantlement: Estimated Radioactive Release to the Atmosphere (μCi)	Preparation for Safe Storage: Airborne Radioactive Release in Building (μCi)	Preparation for Safe Storage: Estimated Radioactive Release to the Atmosphere (μCi)	Estimated Frequency of Occurrence[(f)]
Explosion of LPG Leaked from Front-End Loader	5		3.6×10^{3}	--[(c)]		Low
Explosion of Oxyacetylene during Segmenting of Vessel Shell	2	7.2×10^{5}	3.6×10^{2}	--		Medium
Explosion and/or Fire of Ion Exchange Resin	5	7.6×10^{4}	3.8×10^{1}	--		Medium
Gross Leak during In-Situ Decontamination						
Spray Leak	5	4.1×10^{4}	2.07×10^{1}	S[(d)]	S	Medium
Liquid Leak	5	1.38×10^{2}	7×10^{-2}	S	S	Medium
Segmentation of RCS Piping with Unremoved Contamination	4	2.1×10^{4}	1.05×10^{1}	--		High
Loss of Contamination Control Envelope during Oxyacetylene Cutting of Vessel Shell	2	4.7×10^{3}	2.30	--		Medium
Vacuum Bag Rupture	5	2×10^{3}	1	S	S	Medium
Pressure Surge Damage to Filters during Blasting of Activated Concrete Bioshield	3	504	0.30	--		Low
Accidental Cutting of Contaminated Piping	4	3.65×10^{2}	1.78×10^{-1}	S	S	High
Accidental Spraying of Concentrated Contamination with High-Pressure Spray	5	2.44×10^{2}	1.22×10^{-1}	S	S	High
Accidental Break of Contaminated Piping during Inspection	4	2.2×10^{2}	<0.11	S	S	Low
Loss of Integrity of Portable Filtered Ventilation Enclosure	5	60	3×10^{-2}	--		Medium
Fire Involving Contaminated Clothing or Combustible Waste	5	12	6.0×10^{-3}	S	S	Medium
Loss of Blasting Mat during Removal of Activated Concrete	3	5.3	2.7×10^{-3}	--		Medium
Detonation of Unused Explosives in Reactor Cavity	3	5.3	2.7×10^{-3}	--		Medium
Fire in Contaminated Sweeping Compound	5	0.15	7.5×10^{-5}	S	S	Medium
Temporary Loss of Local Airborne Contamination Control						
During Blasting	3	2.7×10^{-3}	1.35×10^{-6}	--		Low
During Scarfing of Contaminated Concrete Surfaces with Jack-hammer	5	Insig[(e)]		S	S	--
Temporary Loss of Services	3, 4, or 5	Insig		S	S	--
Dropping of Concrete Rubble	5	Insig		--		--
Natural Phenomena	5	Insig		S	S	--
Aircraft Crashes	5	Insig		S	S	--
Drop of Concrete Slab during Placement	5	--		Insig		--

(a) Table 11.1-2 from Reference 3. Preparation for safe storage values are also valid for entombment.
(b) These numbers refer to the radionuclide inventories shown in Tables J.3-1 through J.3-5 in Reference 3.
(c) A dash indicates that the accident does not apply to this decommissioning alternative.
(d) If the release is the same for the second alternative, it is marked with an S.
(e) Insignificant means a building release of less than 2×10^{-4} μCi, and radiation doses are not calculated.
(f) Frequency of Occurrence: High >1×10^{-2}; Medium 1×10^{-2} to 1×10^{-5}; Low <1×10^{-5} per year. A dash in this column means that no estimate was made for the specific incident listed.

TABLE 4.1-3. Postulated Accidental Waterborne Radioactive Releases During Decommissioning of an 1175-MWe PWR

Incident	Reference Radionuclide Inventory Number[a]	Immediate Dismantlement Release to the River (μCi)	Preparation for Safe Storage Release to the River (μCi)[b]
Liquid Release to Ohio River	4	9.9×10^8	9.9×10^8

(a) These numbers refer to the radionuclide inventories listed in Appendix J, Tables J.3-1 through J.3-5 of Reference 3.
(b) Also valid for entombment.

to do so for purposes of calculating a worst-case radiation dose from transportation accidents. Several possible transportation accidents, postulated releases, and radiation doses to the maximum exposed transportation worker are given in Table 4.1-5. The worst possible transportation accident with the release of radioactive material is truck transport involving fire. The potential release of radioactive material during barge or rail transport of the pressure vessel is lower because most of the radioactive material is nonvolatile and is securely immobilized as activated material in the vessel walls and neutron shield tank. The dose of 22 rem to the lung of a truck driver fighting a severe fire is less than that observable clinically. An indication of the potential for health effects may be derived, however, by applying the risk factor for lung exposure from page E.9 of Reference 2. This risk factor predicts 5 to 50 fatal cancers per million man-rem of exposure to the lung. Thus the probability of 22 rem resulting in fatal cancer is 1.1×10^{-4} to 1.1×10^{-3}.

4.1.3.4 Public Radiation Doses from Transportation Accidents

The maximum radiation doses to a member of the public from several truck accidents (any alternative) are given in Table 4.1-5. A calculation similar to that made in Section 4.1.3.3 may be made for the effects of the dose of 21 rem to the lung of the maximum-exposed member of the public.

TABLE 4.1-4. Summary of Radiation Doses to the Public from Accidental Radionuclide Releases During Decommissioning of an 1175-MWe PWR[(a)]

Release/Incident	Reference Radionuclide Inventory[(b)]	Immediate Dismantlement: Release (µCi)	Immediate Dismantlement: First-Year Dose (millirem) Total Body[(c)]	Immediate Dismantlement: First-Year Dose (millirem) Lung	Immediate Dismantlement: Fifty-Year Dose Commitment (millirem) Total Body	Immediate Dismantlement: Fifty-Year Dose Commitment (millirem) Lung	Preparation for Safe Storage: Release (µCi)	Preparation for Safe Storage: First Year Dose (millirem) Total Body[(c)]	Preparation for Safe Storage: First Year Dose (millirem) Lung	Preparation for Safe Storage: Fifty Year Dose Commitment (millirem) Total Body	Preparation for Safe Storage: Fifty Year Dose Commitment (millirem) Lung	Estimated Frequency of Occurrence[(d)]
• Atmospheric Release (Dose to Maximum Individual)												
Explosion of LPG Leaked from a Front-End Loader	5	3.6×10^{3}	3.6×10^{-2}	4.7×10^{-2}	4.4×10^{-2}	5.4×10^{-2}	--[(e)]					Low
Explosion of Oxyacetylene During Segmenting of the Reactor Vessel Shell	2	3.6×10^{2}	4.3×10^{-5}	6.1×10^{-3}	6.9×10^{-3}	6.9×10^{-3}	--					Medium
Explosion and/or Fire in the Ion Exchange Resin	5	3.8×10^{1}	3.8×10^{-4}	5.0×10^{-4}	4.6×10^{-4}	5.7×10^{-4}	--					Medium
Gross Leak During In-Situ Decontamination	5	2.1×10^{1}	2.1×10^{-4}	2.8×10^{-4}	2.5×10^{-4}	3.2×10^{-4}	2.1×10^{1}	2.1×10^{-4}	2.8×10^{-4}	2.5×10^{-4}	3.2×10^{-4}	Medium
Segmentation of RCS Piping with Unremoved Contamination	4	1.1×10^{1}	4.6×10^{-6}	7.3×10^{-4}	4.8×10^{-6}	7.9×10^{-4}	--					High
Loss of Contamination Control Envelope During Oxyacetylene Cutting of the Reactor Vessel Shell	2	2.3×10^{0}	(f)	(f)	(f)	4.4×10^{-4}	--					Medium
Vacuum Bag Rupture	5	1.0×10^{0}	1.1×10^{-6}	1.3×10^{-5}	1.2×10^{-5}	1.5×10^{-5}	1.0×10^{0}	1.1×10^{-6}	1.3×10^{-5}	1.2×10^{-5}	1.5×10^{-5}	Medium
Accidental Cutting of Contaminated Piping	4	1.8×10^{-1}	(f)	1.2×10^{-5}	(f)	1.3×10^{-5}	1.8×10^{-1}	(f)	1.2×10^{-5}	(f)	1.3×10^{-5}	High
Accidental Spraying of Concentrated Contamination with the High-Pressure Spray	5	1.2×10^{-1}	(f)	1.6×10^{-6}	1.5×10^{-6}	1.8×10^{-6}	1.2×10^{-1}	(f)	1.6×10^{-6}	1.5×10^{-6}	1.8×10^{-6}	High
• Liquid Release to the Ohio River (Dose to Maximum Individual)	4	9.9×10^{8}	5.3×10^{-2}	7.8×10^{-4}	5.3×10^{-2}	8.3×10^{-4}	9.9×10^{8}	5.3×10^{-2}	7.8×10^{-4}	5.3×10^{-2}	8.3×10^{-4}	Medium
		(µCi)	(man-rem)	(man-rem)	(man-rem)	(man-rem)	(µCi)	(man-rem)	(man-rem)	(man-rem)	(man-rem)	
• Liquid Release to the Ohio River (Dose to a Limited Population Group)	4	9.9×10^{8}	2.9×10^{0}	4.2×10^{-2}	2.9×10^{0}	4.5×10^{-2}	9.9×10^{8}	2.9×10^{0}	4.2×10^{-2}	2.9×10^{0}	4.5×10^{-2}	Medium

(a) From Table 11.2-3 of Reference 3.
(b) These numbers refer to the radionuclide inventories listed in Appendix J, Tables J.3-1 through J.3-5 of Reference 3.
(c) The average annual total body dose to an individual in the U.S. from natural sources ranges from 80 to 170 mrem.
(d) Frequency of occurrence: high $>1 \times 10^{-2}$; medium 1×10^{-2} to 1×10^{-5}; low $<1 \times 10^{-5}$ per year.
(e) A dash indicates that this accident does not apply to the decommissioning alternative shown.
(f) Less than 1×10^{-6} mrem.
(g) A total of 1.1×10^{5} people are each assumed to consume 1 ℓ of water from the Ohio River after the release. These people are for the first 8 water supply intakes downstream based on 1980 population data.

TABLE 4.1-5. Calculated Radiation Doses from Transportation Accidents Involving Radioactive Waste Shipments from an 1175-MWe Reference PWR

Accident Description/ Exposed Group	Atmospheric Release (Ci)[a]	First Year Dose (rem)		Fifty-Year Dose Commitment (rem)	
		Bone	Lung	Bone	Lung
• Moderate Severity Truck Accident with Limited Fire[b]					
Maximum Individual in the Public	1.0×10^{-4}	0.01	0.02	0.01	0.02
Truck Driver Fighting Fire	1.0×10^{-4}	1.0	1.0	1.0	1.0
• Severe Truck Accident and Fire[c]					
Maximum Individual in the Public	1.0×10^{-2}	1.1	21	1.1	24
Truck Driver Fighting Fire	1.0×10^{-2}	2.1	22	2.1	25

(a) Based on 1.25 Ci per waste drum, with 80 drums per truck.
(b) Moderate severity accidents involve a limited fire in one waste drum.
(c) Severe accidents involve a fire in 40 waste drums per truck.

4.2 AIR, WATER, AND TERRESTRIAL EFFECTS

Gaseous and liquid effluents that might reasonably be expected to result from decommissioning activities, along with their potential impacts, are discussed in Sections 4.2.1 and 4.2.2. Solid wastes are discussed in Sections 4.2.3 and 4.2.4. Terrestrial effects and endangered and threatened species are discussed in Section 4.2.5.

4.2.1 Gaseous Effluents

Continued operation of the Shippingport Station would not change existing air emissions. No action with continued surveillance or with no surveillance would reduce air emissions from Shippingport to zero.

(E.6) Airborne effluents from decommissioning the Shippingport Station will arise from the automobiles of decommissioning workers, from fuel driven equipment used in decommissioning, and from concrete demolition activities.

Air pollution from these sources will be both trivial and temporary compared to air pollution from other industrial activities in the immediate vicinity of the Shippingport Station. Compare, for example, the emissions from the automobiles driven by a maximum of 180 temporary decommissioning workers (immediate dismantlement) at Shippingport with the emissions from the automobiles driven by the 1600 temporary construction workers (Reference 4, p. 4-2) at the immediately adjacent Beaver Valley 2 plant, and with the emissions from the automobiles driven by the 6000 permanent steel workers (Reference 5, p. III-13) at Midland 1 mile away. The period of employment for the maximum number of workers will be about three months. During immediate dismantlement an average of 100 decommissioning workers will be employed. These workers will take the place of the 130 workers already operating and maintaining the station. Thus, the temporary increase in air pollution from automobiles will be caused by only approximately 50 workers over a 3-month period. During the rest of immediate dismantlement, fewer workers will be employed than are presently employed to operate and maintain the station, and air pollution from automobiles can be expected to decrease slightly.

(E.6) Daily ambient air standards for hydrocarbons are exceeded at Shippingport (see Section 3.1.5) about one-third of the time, and hydrocarbons from the additional 50 automobiles and fuel driven equipment will add to the total amount of hydrocarbons present in approximately the ratio of 50 to 7,600 or less. Hydrocarbon concentrations are reported by the Pennsylvania Department of Environmental Resources to three significant figures. (E.6) The addition of hydrocarbons in approximately the ratio of 50 to 7,600 would result in an increase in hydrocarbon concentration in the fourth significant figure and would thus be barely observable during the times standards were being exceeded.

(E.6) Ambient air standards for CO and NO_x are not exceeded at Shippingport and the additional amounts of the pollutants from the automobiles of Shippingport decommissioning workers and fuel driven equipment, in approximately the ratio of 50 to 7,600, will not cause these standards to be exceeded. Similar arguments can be made for safe storage followed by deferred dismantlement and entombment, where the maximum number of decommissioning workers is 170 over a 3-month period and the average number of decommissioning workers is 120 for both alternatives.

As a second example, consider the daily NO_x emissions from the three Bruce Mansfield coal-fired plants 1 mile away. Assume a 50-mile daily round trip from Pittsburgh for 50 cars, an emission of 2 grams of NO_x per vehicle mile (40 CFR 86), and an emission of 0.7 pound of NO_x per million Btu heat input to the coal-fired plants (40 CFR 60.44). The cars will emit 11 pounds of NO_x per day, while the powerplants will emit 40 tons per day. Here the contribution to NO_x concentration from automobiles is in the fifth significant figure and thus there is no possibility that measurements to three significant figures will observe this contribution.

(E.6) Emissions generated from fuel driven equipment used during decommissioning would be minimal compared to emissions from the construction of the adjacent Beaver Valley 2 Power Station. (E.6) Automobile and equipment emissions from Shippingport decommissioning activities are not likely to be noticed relative to the other emissions already taking place in the area. At the end of decommissioning, air pollution from the automobiles and equipment used to support this operation will cease.

Cutting of radioactive equipment and components will be done under water whenever possible to avoid release of radioactive particulates. When in-air cutting of highly radioactive parts is necessary, it will be done inside a contamination control envelope (CCE) equipped with high-efficiency particulate air (HEPA) filters in the CCE exhaust system, and inside buildings which are also equipped with HEPA filters in the building exhaust system. HEPA filters are available with a transmission factor of 5×10^{-4}. These precautions will reduce or eliminate the release to the environment of radioactive particulates from cutting operations.

Estimates are given in NUREG/CR-0130[3] of the amount of radioactivity released from routine cutting of the pressure vessel, internals, steam generators, and piping of a reactor containing a radioactive inventory of 4.8 million curies. The 50-year dose commitment to the lung of the maximum-exposed member of the public from the cutting of these items during immediate dismantlement is estimated to be 5.9×10^{-5} millirem (Reference 3, Table J.4-1). Since the Shippingport radioactive inventory is estimated to be 13,600 curies, or about

350 times less than the inventory estimated in NUREG/CR-0130, the radiation dose from Shippingport decommissioning activities is estimated to be much less than 5.9×10^{-5} millirem to the maximum-exposed member of the public, provided comparable precautions are observed. Safe storage followed by deferred dismantle-mantlement or entombment activities will produce smaller releases of airborne radioactive particles than will immediate dismantlement activities. The standard of the EPA for maximum radiation dose to the lung of any member of the public from fuel cycle activities (waste transport and disposal excepted) is 25 millirem per year (40 CFR 190).

Chipping, spalling, and blasting of interior radioactive concrete will be carried out inside a CCE whenever practical and inside a building equipped with HEPA filters. Affected areas will be sprayed, as appropriate, with water mist before, during, and after concrete removal to decrease dust levels. The estimated 50-year dose commitment to the lung of the maximum-exposed individual resulting from concrete removal, given in Reference 3, Table J.4-1, is 4.8×10^{-9} millirem. The radiation dose from equivalent Shippingport immediate dismantlement activities will be no greater, and probably much less because of the smaller inventory of radioactivity in the Shippingport Station concrete. The dose resulting from concrete removal during Shippingport safe storage followed by deferred dismantlement or entombment activities will be less than the dose resulting from concrete removal during immediate dismantlement. This is because less concrete will be removed and because the concrete will be less radioactive during deferred dismantlement.

A summary of the population doses from all airborne radionuclides released during normal immediate dismantlement operations is also given in Reference 3 (Table 11.2-2) for the 1175-MWe reference PWR. The total 50-year dose commitment to the lungs of the population is 7×10^{-4} man-rem, based on an inventory of 4.8 million curies, on a population of 3.58 million within a 50-mile radius, and on meteorological parameters from the ALAP study.(6) The meteorological parameters are for an average river site, but the inventory and total population are much larger for the reference PWR than for Shippingport. Thus, the population dose of 7×10^{-4} man-rem to the lung should be an upper limit for Shippingport.

Nonradioactive gaseous releases will occur during the controlled blasting of concrete structures. Water sprays, blasting mats, and other control methods will be used to reduce the dust within the blast area. The suspended particulate concentration in air within the station immediately after a blast may exceed the occupational limit for a brief period. The atmosphere from interior blasts will be passed through the building HEPA filters, resulting in a filtering of the particulates. Airborne concentrations of dust from blasting may be assumed to be 10 times the maximum average dust concentrations observed during the decommissioning of the Elk River reactor (10 mg/m^3), or 100 mg/m^3 (Reference 3, p. J-3). A HEPA filter with a transmission factor of 5×10^{-4} will reduce this concentration to 50 $\mu g/m^3$ at the vent, which is less than the EPA annual average ambient air quality secondary standard for suspended particulates of 60 $\mu g/m^3$ (40 CFR 50.7). Particulates (nonradioactive) from exterior blasts will quickly be dispersed by the blast, by settling, and by air movement. As mentioned in Section 2.2.1, blasting may require other special procedures for seismic reasons because of the proximity of the Beaver Valley plants.

4.2.2 Liquid Effluents

Liquid effluents from Shippingport decommissioning operations will consist of two major components: distillate from existing radioactive liquids in piping, equipment, and the fuel-handling canal; and distillate from water used to flush various components to reduce radiation levels. The amount of flushing wastes will be specific to each decommissioning method. Minor amounts of weak acids and organic chelating agents will be used in decontamination solutions. These substances will be removed in the same processes in which radioactive substances are removed.

(E.5) The total quantities of potentially radioactive liquids anticipated to be processed for disposal are shown in Table 4.2-1 for each decommissioning alternative. All radioactive (or potentially radioactive) liquids will be filtered, evaporated, and demineralized in the existing Shippingport liquid waste disposal system. The resulting solids will be processed as solid waste, solidified with concrete in drums, and shipped offsite for disposal. (E.11) The liquids will be monitored and recycled through the processing system if necessary, before release to ensure that they meet the concentration standards

TABLE 4.2-1. Liquid Volumes from Shippingport Decommissioning (in thousands of liters)

Decommissioning Alternative	Existing Radioactive Liquid Inventory[a]	Flushing Inventory	Total Inventory
No Action Continued Operation	2,650	500/yr[b,d]	2,650
No Action Continued Surveillance	2,650	0	2,650
No Action No Surveillance	2,650	0	2,650
Immediate Dismantlement	2,650	284[c]	2,934[d]
Safe Storage Followed by Deferred Dismantlement	2,650	117[c]	2,767[d]
Entombment	2,650	117[c]	2,767[d]

(a) Includes primary loop piping, steam generators, pressurizer, reactor vessel, canal crane lock, deep pit, and fuel storage area, as well as existing resins and evaporator concentrates.
(b) Annual volume of processed water.
(c) Includes two primary system water flushes, canal, and selected building floor and wall washes.
(d) Maximum volumes discharged to the river.

in 10 CFR 20 and DOE Order 5480.1A for release of radioactive material to water in an unrestricted area, and to ensure that they meet the quantity standards in 40 CFR 423 for the discharge of non-radioactive pollutants from a steam electric power generating plant. (E.5) The total amount of radioactivity entering the Ohio River from planned discharges of the liquid distillate will not exceed 2 curies (derived from Table 3.2-2, the concentration limits in 10 CFR 20 and DOE Order 5480.1A, and a maximum discharge of 2,650 kiloliters). In addition, the discharge of pollutants from decommissioning activities will meet the requirements of the existing NPDES permit (essentially the same as the requirements of 40 CFR 423), as well as the requirements of the existing State of Pennsylvania industrial wastes permits (see Appendix B). Should the standard for any pollutant (non-radioactive iron, copper, chlorine, chromium, or total suspended

TABLE 4.2-2. Estimated Volumes of Solid Radioactive Wastes from Shippingport Decommissioning

Decommissioning Alternative	Concentrate from Processed Liquids	Other Solid Rad-Waste Burial Volume
No Action Continued Operation	30 m^3/yr	233 m^3/yr
No Action Continued Surveillance	0	0
No Action No Surveillance	0	0
Immediate Dismantlement	84 m^3	11,700 m^3
Safe Storage/Deferred Dismantlement	84 m^3	3,300 m^3
Entombment	84 m^3	3,300 m^3

solids, or any radioactive pollutant) be found to be exceeded during monitoring, the liquid will be filtered and evaporated again until the standards are met. No discharge to the Ohio River from routine decommissioning activities will cause the ORSANCO or Pennsylvania water quality standards to be exceeded.

If no action is selected, the existing liquid inventory will remain within the plant. Continued operation requires approximately 500 kiloliters of water per year for radioactive waste processing purposes.

4.2.3 Radioactive Solid Wastes

The volumes of radioactive solid wastes expected to be generated by each decommissioning alternative are listed in Table 4.2-2. The concentrates from processed liquids will be solidified with concrete in 208-liter drums and buried as low-level radioactive wastes. Activated and contaminated material will be shipped in casks or other appropriate shipping containers, and also buried as low-level wastes.

4.2.4 Nonradioactive Hazardous Wastes

Most hazardous liquid wastes will also be radioactive and will therefore be handled in the station's liquid radioactive waste processing system. Those liquids that are not radioactive may be packaged and shipped to the waste disposal sites listed in Section 3.3.3 upon approval of the Pennsylvania Bureau of Solid Waste Management. Approximately 76 m^3 of asbestos will be removed from the station during immediate and deferred dismantlement and entombment. A small fraction of this amount will be contaminated and will be handled as radioactive waste. The rest may be packaged and shipped to nearby sanitary landfills (Section 3.3.3), again with approval of the Pennsylvania Bureau of Solid Waste Management. (E.5) The handling and disposal of asbestos will be in accordance with 40 CFR 61 and DOE Order 5480.1A.

4.2.5 Terrestrial Effects: Endangered and Threatened Species

Endangered or threatened species are not known to exist at Shippingport (Section 3.1.7.3) except for occasional transient species; thus no effect is expected on endangered or threatened species from decommissioning activities at Shippingport. Waste disposal activities at Savannah River or Hanford will take place in small areas (less than 1 hectare) already dedicated to that purpose. While both the red-cockaded woodpecker and the American alligator are known to occur at Savannah River (Section 3.3.1), suitable habitat for either species is not present at the burial ground. Therefore, disposal activities are not expected to affect either species. At Hanford (Section 3.3.2), the bald eagle is found on the reservation, but not on the burial ground site, so its habitat will not be impacted. Seventy-seven thousand acres of the Hanford Reservation are set aside as an Arid Lands Ecology Reserve.[8] The rest of the Hanford Reservation and all of the Savannah River Plant have been designated as National Environmental Research Parks. Environmental impacts of waste disposal activities at Savannah River and Hanford are thoroughly discussed in References 7 and 8.

4.3 NOISE POLLUTION

Noises from Shippingport decommissioning activities will include noise from exterior blasting, demolition equipment, and operation of trucks. These noises are not likely to be of significant impact compared to construction noise from the immediately adjacent Beaver Valley 2 plant. The nearest residence is one-half mile away. In any event, any noise will be transient.

4.4 OCCUPATIONAL SAFETY

No occupational safety analysis has yet been carried out specifically for Shippingport. However, the analysis carried out in NUREG/CR-0130[3] can be used to establish an upper bound on the industrial-type accidents expected to occur during the decommissioning of Shippingport. For the case of the reference 1175-MWe PWR, no fatalities are predicted to occur as a result of immediate dismantlement activities, and less than 5 lost-time injuries from industrial-type accidents are predicted to occur. One additional injury is predicted to result from transportation operations regardless of the considered transport modes if all radioactive waste is transported to Hanford.[9] Industrial accident occurrences are fewer for the other decommissioning alternatives and are not likely to be greater for Shippingport.

4.5 SOCIOECONOMIC EFFECTS

Minor socioeconomic effects may be noticed from the changing work force. The immediate dismantlement crew (180 maximum over a 3-month period, 100 average) will be similar in size to the operating crew (130). Some of the operating crew may be retained to assist with decommissioning, while the other members of the decommissioning crew will be hired, for the most part, from the greater Pittsburgh labor pool. When decommissioning is completed, the workers will return to the greater Pittsburgh labor pool or move to other construction jobs. Work force changes will be small relative to the total work force in the greater Pittsburgh area and relative to the number of persons at work in the immediate Shippingport area (6000 at Midland and 12,000 at Aliquippa; see Reference 5, p. III-13). Work force changes will also be small compared to the work force changes that have taken place during the construction of the three Bruce Mansfield plants and the Beaver Valley 1 plant, and that will take place with the completion of the Beaver Valley 2 plant (1600 construction workers will be replaced by 200 maintenance and operation workers). Socioeconomic effects from work force changes will be small for all decommissioning alternatives, including no action with surveillance and no action without surveillance. If one of these alternatives were selected, the present 130 operation and maintenance workers would be replaced by 10 and zero workers, respectively.

A quotation from page 4-2 of Reference 4 is appropriate here: "Construction of Beaver Valley 1 does not appear to have an adverse effect on any aspect of human activities near the plant beyond occasional traffic congestion when workers are arriving at or leaving the site. The potential serious effects of an influx of temporary labor providing a burden on schools and other public facilities have not developed with the construction of Unit 1. This is due to the mobility of the labor force, which is principally being drawn from the greater Pittsburgh area labor pool."

There will be no change in the local tax base from decommissioning the federally owned portion of the plant because federal property is not subject to local taxation. The local tax base will be reduced at the time the privately owned Duquesne Light turbine ceases to generate electricity and is declared to be retired from service. But this tax reduction will be minor compared to the new taxes generated from the new, nearby electric generating plants (72 MWe at Shippingport Station vs. 4280 MWe at adjacent power plants). Similarly, the reduction in generated electric energy will be minor.

4.6 COMMITMENT OF RESOURCES

Major resources committed to the decommissioning of the Shippingport Station will be land for the disposal of radioactive wastes, and the site itself if no action, safe storage, or entombment is the selected decommissioning alternative. Few new resources would be committed to no action except for reactor fuel and once-through cooling water if the station were continued in operation.

4.6.1 Materials

Only routine materials will be consumed in decommissioning the Shippingport Station: protective clothing, some tools, decontamination chemicals, materials for waste disposal containers, and explosives for blasting. A few tons of steel will be required for reinforcement if safe storage or entombment is chosen, and approximately 200 cubic yards of concrete will be required for entombment.[10] None of these materials will represent a major commitment of resources.

4.6.2 Energy

Only minor amounts of electricity and fuel oil will be consumed in onsite decommissioning activities. (E.5) An estimated 75,700 liters (20,000 gallons) of fuel oil will be used for the auxiliary boiler to supply steam and heat. The major energy use will be fuel oil for transportation of radioactive wastes to disposal sites, particularly if most of the wastes are transported to Hanford. The expected 230 truck trips for carrying immediate dismantlement radioactive waste could consume approximately 830,000 liters (220,000 gallons) of diesel fuel, at 5 miles per gallon for the round trip to Hanford. Safe storage followed by deferred dismantlement or entombment would result in fewer trips and correspondingly less consumption of gasoline (650,000 liters and 490,000 liters, respectively).

4.6.3 Water

Water will be required for decontamination purposes and for wetting concrete surfaces before, during, and after concrete removal. (E.5) The quantities of water required from the river are far less than those involved in the once-through cooling of the operating plant. For example, the total quantity of water estimated to be needed for decontamination during immediate dismantlement is 284 kiloliters and during safe storage followed by deferred dismantlement and entombment is 117 kiloliters. (E.5) The maximum quantity diverted from the river (and mostly returned to the river) for once-through cooling is 621,000 kiloliters per day (see Reference 5, p. III-13).

4.6.4 Land

The 11,700 cubic meters (15,300 cubic yards) of radioactive waste from immediate dismantlement will require less than 1 hectare (2.5 acres) of ground at a radioactive waste disposal site, which will be offset by the release of the site's 2.8 hectares (7 acres) that will be made available for unrestricted use at the completion of immediate dismantlement. If safe storage is chosen, the site's 2.8 hectares will not be available for unrestricted use for several decades (98 years assumed here), but less than 0.4 hectare of waste disposal land will be required. Approximately the same amount of waste disposal land will also be required for entombment, but the site's 2.8 hectares (or at least the area occupied by the entombed structure) will be unavailable for other uses for at least 125 years. Projections for waste volumes to be buried in 1985 at Savannah River and Hanford are 13,740 m^3 per year and 9,350 m^3 per year, respectively.[11] Waste volumes from DOE's Surplus Facilities Management Program are included in these projected volumes. Even if all of the wastes were transported to Hanford, there would be virtually no impact on the disposal capacity at Hanford. The Hanford site occupies about 570 square miles of semi-arid land, many hectares of which are available for waste disposal. If all the wastes were transported to Savannah River, approximately 3 to 6% of the remaining disposal capacity would be required, depending on waste packing densities.

4.7 ADVERSE ENVIRONMENTAL IMPACTS THAT CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

The most important environmental impact that cannot be avoided should the proposal be implemented is radiation dose to the decommissioning workers and to the public from decommissioning activities. This radiation dose totals 1303 man-rem in the case of immediate dismantlement (1275 man-rem to decommissioning workers, 24 man-rem to truck drivers, and 4 man-rem to the public). (E.4) On a local basis, the one-time dose of 1303 man-rem will add to the annual dose from operating and maintaining the neighboring Beaver Valley nuclear plants. This annual dose will be approximately 500 man-rem per year for each of the two Beaver Valley reactors.[12] On the other hand, the 37 man-rem annual occupational radiation dose from operating the Shippingport Station will cease. Collective radiation doses from safe storage followed by deferred dismantlement and entombment are less than the collective dose from immediate dismantlement.

The second most important environmental impact that cannot be avoided is the dedication of approximately 1 hectare of land to the disposal of radioactive wastes. In the case of immediate dismantlement, however, the dedication of this land will be offset by the release of the site's 2.8 hectares for unrestricted use. Lesser amounts of land will be required for radioactive waste disposal in the case of safe storage followed by deferred dismantlement and entombment, but the site itself will not become available for decades.

Environmental impacts that cannot be avoided include those from the use of fuel and from the use of equipment and supplies.

4.8 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE OF LONG-TERM PRODUCTIVITY

Immediate dismantlement of the Shippingport Atomic Power Station will restore the site to unrestricted use. A new use for the site has not been determined; but since the site is owned by Duquesne Light, any new use is likely to be associated with the electric power industry. Safe storage followed by deferred dismantlement will make the site available in 98 years. Entombment may not make all of the site available at the end of the 125-year entombment period, because there are no plans to remove the entombment structures at that time. The radioactive waste disposal sites would not be made available for unrestricted use for an indefinite period of time.

4.9 MEANS TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS

Decommissioning workers will wear dosimeters which will be read frequently in order to assure that no worker receives more than the radiation dose limit for various parts of the body listed in DOE Order 5480.1A. High dose rate areas will be routinely monitored before workers are allowed to enter. Protective shields, remotely operated tools, and contamination control envelopes will be employed. Underwater cutting of very high dose rate components will be employed to take advantage of the shielding effect of water. Standard contamination control methods for monitoring personnel, such as hand and shoe counters, will be used. If engineering studies demonstrate the feasibility, the pressure vessel and possibly the vessel internals will be removed and shipped as a single unit in order to further reduce radiation dose to workers. ALARA principles will be applied to every phase of engineering planning that deals with radioactive material.

Gaseous effluents will be monitored at the release points in order to assure that releases meet permit requirements. Liquids will be filtered, evaporated, and demineralized. Effluent water will be sampled and monitored before release to assure that it meets permit standards for both radioactive and nonradioactive constituents. Solid radioactive wastes will be compacted when possible in order to reduce radioactive waste disposal volumes. (E.5) A monitoring system surrounding the site will be in operation to assure that releases do not result in any effect on the environment.

Safe storage is in itself a mitigating action which can be employed. If safe storage followed by deferred dismantlement is chosen as the decommissioning alternative, the sump pumps in the subbasement will be left on in order to remove any water that might accumulate, and thus, in turn, remove any danger of contaminated water seeping back into the ground water.

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5.0 LIST OF PREPARERS

The Draft Environmental Impact Statement on the Decommissioning of the Shippingport Atomic Power Station was prepared for the Department of Energy by staff members of the Pacific Northwest Laboratory, operated for the Department of Energy by Battelle Memorial Institute. Dr. Emmett B. Moore, Jr. was project manager. Resumes of the principal contributors follow.

EMMETT B. MOORE, JR. - Dr. Moore received his B.S. degree from Washington State University and his Ph.D. degree in physical chemistry from the University of Minnesota. He has taught both physics and chemistry at the university level and has conducted theoretical and experimental research in chemical physics. Before joining Battelle-Northwest he was director of power plant siting for the State of Minnesota Environmental Quality Board, where he was responsible for the siting of large electric power generating plants, the routing of high-voltage transmission lines, rule-making proceedings, site and route public hearings, and environmental review of proposed power plants and transmission lines. At Battelle-Northwest, he has been project manager for the U.S. Nuclear Regulatory Commission's Generic Environmental Impact Statement on the Decommissioning of Nuclear Facilities.

NORMAN G. WITTENBROCK - Mr. Wittenbrock received his B.S. degree in chemical engineering from Rose Polytechnic Institute and his M.S. degree in inorganic chemistry from the Polytechnic Institute of Brooklyn. He has over 33 years' experience in nuclear and energy-related research and development with Battelle-Northwest and predecessor organizations at the Hanford Reservation. He has served as manager of nuclear safety and energy conservation programs and as manager of quality assurance and safety for Battelle-Northwest's Nuclear Waste Vitrification Program. Mr. Wittenbrock was on leave-of-absence from Battelle-Northwest during 1972 and 1973 to serve as a senior officer on the staff of the International Atomic Energy Agency in Vienna, Austria. He participated in planning and conducting the nuclear safety program of the Agency; developing nuclear safety guides, criteria, and codes of practice; organizing and conducting nuclear safety inspections of research reactor projects; and organizing and conducting nuclear safety symposia and panel meetings.

Reviewers	Affiliation
C. M. Borgstrom	DOE-HQ[1]
L. C. Brazley	DOE-HQ
R. M. Carosino	DOE-RL[2]
T. E. Dabrowski	UNC[3]
P. F. X. Dunnigan Jr.	DOE-RL
A. J. Eirich	UNC
D. R. Elly	DOE-RL
A. G. Forssell	DOE-NR[4]
J. W. Handy	UNC
A. F. Kluk	DOE-HQ
J. L. Landon	DOE-RL
J. R. Mickelson	UNC
C. E. Miller, Jr.	DOE-RL
R. L. Miller	UNC
M. W. Shupe	DOE-RL
R. M. Smith	DOE-HQ
R. Strickler	DOE-HQ
J. D. White	DOE-RL
W. J. White	DOE-NR

[1]DOE-HQ Department of Energy
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[2]DOE-RL Department of Energy
Richland Operations Office
Richland, Washington 99352

[3]UNC UNC Nuclear Industries
Office of Surplus Facilities Management
Richland, Washington 99352

[4]DOE-NR Department of Energy
Naval Reactors Division
Arlington, Virginia 20545

APPENDIX A

RADIATION EFFECTS

A.1 RADIATION EFFECTS NOMENCLATURE

Three types of radiation are important in understanding the biological impacts of decommissioning: gamma rays or x-rays, alpha particles, and beta particles. Gamma rays are short wave length electromagnetic waves of nuclear origin; x-rays are slightly longer wave length electromagnetic waves, usually of extranuclear origin; alpha particles are doubly charged helium nuclei; and beta particles are electrons. Other species are also associated with radioactive decay, but are of more interest elsewhere. These include neutrons, protons, and fission products. Gamma radiation of the energy usually encountered in a reactor is extremely penetrating, while beta radiation is less penetrating, and alpha radiation will not penetrate a thin layer of skin.

Activity is defined as the number of nuclear disintegrations taking place in a given period of time: one curie (Ci) is defined as 3.7×10^{10} disintegrations per second. Specific activity is the activity per unit mass or volume. The specific activity of a given radionuclide decreases exponentially with time. Each radionuclide has a characteristic half life, which is the time for the specific activity to decrease 50%. It is the short half life of ^{60}Co (5.3 yr) that makes safe storage an attractive alternative. On the other hand, transuranics (isotopes with atomic number greater than 92) characteristically have very long half-lives and do not decay appreciably over a reasonably long storage period of, say, 100 years. Thus, safe storage is not an attractive strategy in dealing with facilities that contain transuranic materials.

Doses depend upon the type of radiation (alpha, beta, or gamma), the energy of the radiation, the amount of radiation, and the time span over which the radiation is delivered. Activity alone is not enough to specify dose.

Radiation dose (or more precisely, dose equivalent) is expressed in rem. One rem (roentgen equivalent man) is the quantity of radiation that produces the same biological damage in man as that caused by the absorption of one roentgen of x- or gamma rays. One roentgen (R) is defined as the quantity of x- or gamma radiation that will produce by ionization one electrostatic unit (esu) of electricity of either sign in 1 cm^3 of dry air at standard temperature and pressure. Equivalently, one R is the quantity of x- or gamma radiation that will result in the absorption of 83.8 ergs of energy in one gram of water or tissue. One rad is the quantity of radiation that will result in the absorbtion of 100 ergs of energy in one gram of material.

It may be helpful to recall that the estimated average annual whole-body background dose received by persons in the United States from natural radiation (both external and internal), not including medical radiation, is 102 millirem per person per year (Reference 1, p. 12).

The collective dose to a population is the sum of individual doses and is expressed in man-rem. When presented as a single number, this dose does not reveal the size of the exposed population or the magnitude of the dose to any individual. For example, the average occupational radiation dose received in the operation and maintenance of light water reactors in the United States in 1976 was approximately 500 man-rem per year per reactor.(2) But this number does not indicate the size of the exposed work force or the dose to any individual worker. It can, however, be related on a statistical basis to potential health effects of the radiation dose spread over a population (see Section A.3).

A.2 RADIATION PATHWAYS

Three pathways are important in understanding the biological effects on man of radiation from decommissioning: external exposure, inhalation, and ingestion. External exposure most often refers to external gamma radiation from radioactive materials, including activated or contaminated surfaces. The exposure may be to the whole body or to a portion of the body, such as the hands. Beta radiation occasionally contributes to external radiation dose, but alpha radiation does not, because it cannot penetrate the skin. Inhalation means breathing dust, aerosols, particles, or gases containing radionuclides. These radionuclides may become lodged in the air passages and lungs, or pass through to the blood stream, and give a radiation dose to the tissues of the body. Alpha, beta, and gamma radiation can all contribute to internal radiation. Ingestion means eating or drinking any radionuclide in food or water. If the radionuclide is soluble, it can be transferred through the walls of the gastrointestinal tract to the blood, and be taken up by internal organs such as the thyroid, liver, or bones, leading to a dose from alpha, beta, or gamma radiation. Insoluble radionuclides will irradiate the gastrointestinal tract while passing through the body.

The dominant mode of radiation exposure of decommissioning and transportation workers is external exposure to gamma rays. It is normally possible to protect workers to a great extent against inhalation of particles and ingestion through proper ventilation, contamination control envelopes, protective clothing, and masks. The dominant mode of radiation exposure of the public from decommissioning activities is external exposure to shipments of radioactive wastes, with inhalation of dust and particles from site activities contributing a very small portion. Direct ingestion of radioactive materials arising from decommissioning activities contributes very little to public radiation dose.

A.3 HEALTH EFFECTS

The health effects of large doses of radiation delivered in short periods of time are well-known (see Reference 1 and the references therein). Published values of doses of whole-body gamma radiation that are lethal to 50% of exposed individuals in 30 days range from 225 to 270 rem (Reference 1, p. 31). At the other extreme, immediate clinical effects are not detectable from acute whole-body radiation doses much lower than 50 rem.

The relationships of medical conditions to small doses of radiation delivered over long periods of time are not obvious on a cause and effect basis; they are observable only in a statistical sense. The 1972 BEIR report (p. 7) points this out: "Deleterious effects in individuals and populations of living organisms cannot be attributed to exposure to ionizing radiation at levels near that of average natural background except by inference. Such effects are not directly observable." The estimation of effects at low dose levels involves extrapolation from observations at high dose levels. The effects depend on the radiation dose, the span of time over which it is delivered, the kind of radiation (alpha, beta, or gamma), the portion or organ of the body to which it is delivered, and other assumptions. The 1972 BEIR report makes this extrapolation and (p. 89) estimates the excess mortality from all forms of cancer to be 50 to 165 deaths per 10^6 persons per rem in the 25-year period following exposure. A later Environmental Protection Agency report (Reference 3, p. 271) interprets the data to give an estimated cancer risk from whole-body radiation of 200 deaths per year from 10^6 man-rem annual whole-body exposure and 400 cancers per year from 10^6 man-rem annual whole-body exposure. The 1980 revision of the BEIR report (BEIR-III) estimates that a single exposure of 10 rads over the whole body to each of 1 million persons will produce an excess mortality from all forms of cancer of 766 to 2,255 (77 to 226 per million man-rad).

The DOE has examined the BEIR reports and other documents and has derived a formula for the range of health effects to be expected from a given collective dose.(4) This range is 100 to 800 health effects per million man-rem, and it includes 50 to 500 fatal cancers and 50 to 300 serious genetic defects per million man-rem. The DOE health effects formula is used in this document.

For a more complete discussion of health effects, the reader is referred to the BEIR reports.(1)

A.4 ACCEPTABLE RESIDUAL LEVELS OF RADIOACTIVITY

A need exists to specify criteria for residual radioactivity following decommissioning for both surface and volumetric facility component contamination and for residual radioactivity in soil.(5) Criteria consisting of simple numerical standards are not easy to derive, as can be seen from merely listing the steps in a pathway analysis that would be necessary to derive the criteria: 1) determine the maximum acceptable dose to the whole body and to each organ of the maximum exposed individual, 2) determine the pathways by which the individual receives this dose, 3) determine the nuclides likely to be present after decommissioning and determine their relative concentrations, 4) determine the maximum concentration of each nuclide that can remain after decommissioning without exceeding the maximum radiation dose to the maximum-exposed individual through the postulated pathways, and 5) develop methods of accurately and easily measuring the allowed concentrations. The U.S. Environmental Protection Agency (EPA) has authority for establishing generally applicable environmental standards for radioactivity. A specific standard is the EPA standard for exposure to radioactivity in processed drinking water of 4 millirem per year (40 CFR 141.16). No similar standard exists in particular for residual radioactivity following decommissioning. However, the NRC and EPA are coordinating efforts to develop residual radioactivity standards such that the resultant dose to the maximum-exposed individual from decommissioned NRC-licensed plants will be no hazard to human health. (E.8) Pending development of these standards, the Shippingport Station will be decommissioned to the residual radioactivity standards of NRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors." Pathway analyses will be carried out, as suggested in Reference 5, in order to assure that residual radioactivity in the soil meets standards current at the time (see also Reference 6).

REFERENCES

1. The Effect on Populations of Exposure to Low Levels of Ionizing Radiation, (BEIR Report), National Academy of Sciences. National Research Council, November 1972. Also BEIR III, July 1980.

2. Ninth Annual Occupational Radiation Exposure Report, 1976, NUREG-0322, p. 10, U.S. Nuclear Regulatory Commission, October 1977.

3. Radiological Quality of the Environment in the United States, 1977, U.S. Environmental Protection Agency, EPA 520/1-77-009, September 1977.

4. Final Environmental Impact Statement on Management of Commercially Generated Radiactive Waste, DOE/EIS-0046F, U.S. Department of Energy, October 1980.

5. E.F. Conti, Residual Activity Limits for Decommissioning, U.S. Nuclear Regulatory Commission, NUREG-0613, September 1979.

6. U.S. Nuclear Regulatory Commission, Decommissioning Criteria for Nuclear Facilities; Notice of Availability of Draft Generic Environmental Impact Statement, Federal Register. February 10, 1981 (46 FR 11666).

APPENDIX B

EXISTING MAJOR PERMITS

1. National Pollution Discharge Elimination System (NPDES) Permit No. PA 0001589. This permit, issued by the EPA, establishes criteria for liquid effluents and specifically imposes requirements limiting the discharge of radioactive liquid effluents. Maximum discharges allowed are as follows:

Effluent	Discharge Limitations	
	Daily Average	Daily Maximum
Temperature	Heat rejected to the waterway (Ohio River) shall not exceed a daily maximum of 8.78 x 10^8 Btu/hr. Stream temperature shall not exceed a 5°F rise above ambient temperature or a maximum of 87°F whichever is less, outside an approved mixing zone.	
Free Available Chlorine	0.2 mg/ℓ	0.5 mg/ℓ
Total Residual Chlorine		0.2 mg/ℓ
Total Suspended Solids	30 mg/ℓ	100 mg/ℓ
Oil and Grease	15 mg/ℓ	20 mg/ℓ
pH	Not less than 6 and not greater than 9	
Total Iron		1 mg/ℓ
Total Copper		1 mg/ℓ
Polychlorinated Biphenyl Transformer Fluids	No discharge allowed	
Radioactive Isotopes	Not to exceed limits in 10 CFR 20 and 10 CFR 50	
Metal Cleaning Wastes	No discharge allowed	

2. Pennsylvania Industrial Wastes Permit No. 0472205. This permit, issued by the Pennsylvania Department of Environmental Resources, contains specifications for discharge of chemical and biological liquid wastes. Requirements include secondary treatment of biodegradable wastes and equivalent treatment of non-biodegradable wastes, an effluent pH of not less than 6.0 nor more than 9.0, and an effluent concentration of not more than 7.0 mg/ℓ of dissolved iron. No untreated waste-waters shall be discharged.

3. Pennsylvania Industrial Wastes Permit No. 1832. This permit, issued by the Pennsylvania Department of Environmental Resources, contains specifications for discharge of industrial and radioactive liquid wastes to the Ohio River. The permit also imposes the requirements of Regulation 433, Radiation Protection Standards of the Pennsylvania Department of Health on the discharge of both liquid and solid wastes. Requirements include primary treatment for sewage and equivalent treatment for industrial wastes. Conditions on the release of radioactivity to the Ohio River are as follows: the average radioactivity, exclusive of tritium activity, of liquid wastes over any consecutive 365-day period, shall not exceed 1590 microcuries per day, with the maximum discharge not exceeding 6200 microcuries per day; liquid wastes shall at no time carry more radioactivity, exclusive of tritium activity, than 10^{-8} microcuries per milliliter in excess of that of the plant intake water from the Ohio River; and the discharge of tritium in liquid wastes shall be not more than 10 curies per day averaged over any consecutive 365-day period, nor more than 50 curies per day, maximum. Other conditions include limits of 0.05 ppm of hexavalent chromium and 1.0 ppm of trivalent chromium in the effluent liquid wastes.

4. Pennsylvania Industrial Wastes Permit No. 0473211. This permit, issued by the Pennsylvania Department of Environmental Resources, regulates the discharge of industrial wastes and radioactivity from Duquesne Light's Beaver Valley 1 and Beaver Valley 2 Stations, and has one section that pertains to the release of radioactivity from the Shippingport Station:

   "With respect to the concentrations of radioactivity released from the site (in this case including Shippingport, Beaver Valley No. 1 and Beaver Valley No. 2 Reactors), this permit [is] issued subject to the following limitations:

   a. Releases of radioactive material shall be kept to the lowest practicable level.

   b. With the exception of the thyroid, the annual dose equivalent above natural background to the total body or any organ, of any exposed individual who is a member of the public, shall be less than 5 millirems from all releases including water.

c. The annual dose equivalent above natural background to the thyroid of any exposed individual who is a member of the public shall be less than 15 millirems from all releases including water.

d. The total quantity above natural background of all radionuclides, excepting tritium and dissolved noble gases, discharged to the aquatic environment from the site shall be less than 5 curies per year for each 1000 megawatts of nuclear generating capacity at the site.

e. The total quantity above natural background of tritium discharged from the site shall be less than 600 curies per year for each 1000 megawatts of nuclear electrical generating capacity at the site.

APPENDIX C

ENVIRONMENTAL IMPACT STATEMENTS INCORPORATED BY REFERENCE

Environmental impact statements incorporated by reference are ERDA-1541, Final Environmental Statement, Light Water Breeder Reactor Program; ERDA-1537, Final Environmental Impact Statement, Waste Management Operation, Savannah River Plant; and ERDA-1538, Final Environmental Statement, Waste Management Operations, Hanford Reservation. These documents are available for public inspection at the following locations:

B. F. Jones Memorial Library
663 Franklin Place
Aliquippa, PA 15001

Carnegie Library of Pittsburgh
440 Forbes Avenue
Pittsburgh, PA 15213

Freedom of Information Reading Room
Room 1E-190, Forrestal Building
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

Richland Operations Office
Federal Building
Richland, WA 99352

Savannah River Operations Office
Savannah River Plant
Aiken, SC 29801

APPENDIX D

ENDANGERED AND THREATENED SPECIES

Appendix D consists of statements from the U.S. Fish and Wildlife Service concerning endangered or threatened species.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
HARRISBURG AREA OFFICE
100 Chestnut Street, Room 310
Harrisburg, Pennsylvania 17101

March 31, 1981

Mr. Emmett B. Moore, Jr.
Energy Systems Department
Battelle Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington 99352

Dear Mr. Moore:

This responds to your letter of March 25, 1981, requesting information on the presence of federally listed or proposed endangered or threatened species onsite and within the immediate vicinity of the existing Shippingport Atomic Power Station, Beaver County, Pennsylvania, which is being proposed for decommissioning.

Except for occasional transient species, no federally listed or proposed species under our jurisdiction are known to exist at the station or in the immediate vicinity. Therefore, no Biological Assessment or further Section 7 consultation under the Endangered Species Act is required with the Fish and Wildlife Service (FWS). Should decommissioning plans reveal potential for impacts beyond the immediate station vicinity, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to endangered species under our jurisdiction. It does not address other FWS concerns under the Fish and Wildlife Coordination Act or other legislation.

A compilation of federally listed endangered and threatened species in Pennsylvania is enclosed for your information.

Sincerely,

Norman R. Chupp
Area Manager

Enclosure

FEDERALLY LISTED ENDANGERED AND THREATENED SPECIES
IN PENNSYLVANIA

Common Name	Scientific Name	Status	Distribution
FISHES:			
Cisco longjaw	Coregonus alpenae	E	Lake Erie - probably extinct
Pike, blue	Stizostedion vitreum glaucum	E	Deep water of Lake Erie - probably extinct
Sturgeon, shortnose*	Acipenser brevirostrum	E	Delaware River and other Atlantic coastal rivers
REPTILES:			
NONE			
BIRDS:			
Eagle, bald	Haliaeetus leucocephalus	E	Entire state
Falcon, American peregrine	Falco peregrinus anatum	E	Entire state - re-establishment to former breeding range in progress
Falcon, Arctic peregrine	Falco peregrinus tundrius	E	Entire state migratory - no nesting
Warbler, Kirtland's	Dendroica kirtlandii	E	Entire state - occasional migrant
MAMMALS:			
Bat, Indiana	Myotis sodalis	E	Entire state
Cougar, eastern	Felis concolor cougar	E	Entire state - probably extinct
MOLLUSKS:			
NONE			
PLANTS:			
NONE			

* Principal responsibility for this species is vested with the National Marine Fisheries Service.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Area Office
2625 Parkmont Lane S.W.
Olympia, WA 98502

June 26, 1981

Refer to: 1-3-81-TA-125

Emmett B. Moore, Jr.
Project Manager, Energy Systems Dept.
Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, WA 99352

Dear Mr. Moore:

This is in response to your request, dated May 26, 1981, for information on listed and proposed endangered and threatened species which may be present within the area of the proposed Shippingport radioactive waste disposal activities at burial grounds in the 200E or 200W areas of the Hanford Reservation, Richland, Benton County, Washington. Your request and this response are made pursuant to Section 7(c) of the Endangered Species Act of 1973, 16 U.S.C. 1531, et seq.

To the best of our present knowledge there are no listed or proposed species occurring within the area of the subject project. Should a species become officially listed or proposed before completion of your project, you should reevaluate your agency's responsibilities under the Act. We appreciate your concern for endangered species and look forward to continued coordination with your agency.

Sincerely,

Margaret S. Kolar

for Joseph R. Blum
Area Manager

Attachments

cc: RO (AFA-SE)
ES, Olympia & Moses Lake, WA
WDG, Non-Game Program
WNHP

LISTED AND PROPOSED ENDANGERED AND THREATENED
SPECIES AND CANDIDATE SPECIES THAT MAY OCCUR
WITHIN THE AREA OF THE PROPOSED
SHIPPINGPORT RADIOACTIVE WASTE DISPOSAL ACTIVITIES
AT BURIAL GROUNDS IN THE 200E OR 200W AREAS
OF THE HANFORD RESERVATION, RICHLAND, BENTON COUNTY, WASHINGTON
NUMBER # 1-3-81-TA-125

LISTED

None

PROPOSED

None

CANDIDATE

None

Attachment A

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Area Office
2625 Parkmont Lane S.W.
Olympia, WA 98502

July 28, 1981

Refer to: 1-3-81-TA-125

Emmett B. Moore, Jr.
Project Manager, Energy Systems Dept.
Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington 99352

Dear Mr. Moore:

On June 26, 1981, we responded to your request of May 26, 1981, for a list of threatened and endangered species that may occur in the area of the proposed Shippingport Radioactive Waste disposal activities at burial grounds in the 200 E and 200 W areas of the Hanford Reservation, Benton County, Washington. In your request, you mentioned the possibility that your knowledge of threatened and endangered species in the Hanford Reservation as a whole may be out of date. Therefore, you will find enclosed a list of species for this area.

You will note that we have included a list of candidate species. These species are currently being reviewed by this Service for consideration as threatened or endangered. Candidate species have no protection under the Endangered Species Act of 1973, 16 U.S.C. 1531, et seq.

Your interest in endangered species is much appreciated.

Sincerely,

for Joseph R. Blum
Area Manager

Attachments

cc: RO (AFA-SE)
ES, Olympia & Moses Lake, WA
WDG, Non-Game Program
WNHP

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CANDIDATE SPECIES THAT MAY OCCUR WITHIN THE AREA OF THE HANFORD RESERVATION BENTON COUNTY, WASHINGTON NUMBER #1-3-81-TA-125

LISTED

Bald Eagle (*Haliaeetus leucocephalus*)

PROPOSED

None

CANDIDATE

The following are plant species --

Allium robinsonii
Balsamorhiza rosea
Erigeron piperianus

Attachment A

United States Department of the Interior

FISH AND WILDLIFE SERVICE
PLATEAU BUILDING, ROOM A-5
50 SOUTH FRENCH BROAD AVENUE
ASHEVILLE, NORTH CAROLINA 28801

June 2, 1981

Mr. Emmett Moore
Energy Systems Department
Cattelle Northwest
P.O. Box 999
Richland, Washington 99352

Re: 4-2-81-182

Dear Mr. Moore:

We have reviewed the alternative of storage of low level redioactive waste from the proposed decommissioned Shipping Port Atomic Power Station in Shipping Port, Pennsylvania at the Department of Energy's Savannah River Plant facility in Aiken, Allendale, and Barnwell Counties, South Carolina, as requested by phone on May 28, 1981.

It appears that some endangered (E) and/or threatened (T) species and/or species proposed for listing may occur in the area of influence of this action.

The following is a list of species which we believe may be present in the area:

Red-cockaded woodpecker (Picoides borealis) - Endangered - all 3 counties
American alligator (Alligator mississippiensis) - Endangered - Aiken and Barnwell Counties
Georgia plume (Elliottia racemosa) - Status Review - Aiken County
Smooth coneflower (Echinacea laevigata) - Status Review - Aiken and Barnwell Counties
Loose watermilfoil (Myriophyllum taxum) - Status Review - Barnwell County
Nestronia (Nestronia umbellula) - Status Review - Aiken and Barnwell Counties
Stream mock-bishopweed (Ptilimnium fluviatile) - Status Review - Aiken County
Savannah bishopweed (Ptilimnium nodosum) - Status Review - Aiken County

Section 7(c) of the Endangered Species Act of 1973, as amended In 1978, requires Federal agencies such as the Atomic Energy Commission to provide a biological assessment for the listed species and/or the species proposed for listing which are likely to be affected. The biological assessment shall be completed within 180 days after the date on which initiated, or within a mutually agreed upon time frame, before any contracts for construction are entered into, and before construction is begun. We do not feel that we can adequately assess the effects of the proposed action on listed species, species proposed for listing or Critical Habitat without a complete assessment. At a minimum the following information is requested:

1. Identification of the listed species, species proposed for listing and Critical Habitat determined to be present within the area affected by the proposal.

2. Description of the survey methods used to determine presence of listed species or species proposed for listing within the area.

3. The results of a comprehensive survey of the area.

4. Description of any difficulties encountered in obtaining data and completing proposed studies.

5. Description of the proposed construction project and associated activities.

6. Description of methods and results of studies made to determine the actual and potential impacts of project or associated activities on listed species, species proposed for listing, or Critical Habitat. In addition to the direct (site related) impacts of project construction the biological assessments should include, when applicable, descriptions of:

   A. Impacts associated with project operation.

   B. Secondary impacts from activities, such as development, which will be generated by the proposed project.

   C. The cumulative effects of the proposal on the species and/or its Critical Habitat. Cumulative effects are defined as the direct and indirect impacts of the Federal action under consideration coupled with the identifiable effects of other reasonably foreseeable actions of the Federal agency; other Federal, State, and local agencies; corporations; and individuals upon a species or its Critical Habitat.

7. Where impacts to listed species, species proposed for listing, or Critical Habitat are identified, the assessment should include a discussion of the efforts that will be taken to eliminate, reduce, or mitigate any adverse effects.

8. Conclusions of the agency including recommendations regarding further studies.

9. Any other relevant information.

An assessment and formal consultation are not required for those species which are not on the Federal list or currently proposed for addition to the list (species designated "Status Review" in this letter). The status of these species is of concern to the Service and they may be added to the Federal list in the future. We would appreciate any efforts you may make to avoid adversely affecting them.

Should you require additional information on this subject, please contact Mr. Gary Henry, Mr. Robert Currie, or Ms. Nora Murdock in the Asheville Area Office, FTS 672-0321, commercial 704/258-2850, ext. 321.

Using the biological assessment the Atomic Energy Commission must review their actions to determine whether it may affect listed or proposed species or their habitats.

If the Atomic Energy Commission determines the activity or program will not affect any listed species or their habitats, consultation under Section 7a of the Act is not necessary, unless requested by the Fish and Wildlife Service. If the Atomic Energy Commission determines that the activity or program may affect listed species or their habitats, consultation is required by Section 7a of the Act with the Area Manager as provided in the Interagency Cooperation Regulations in 50 CFR Part 402.

This letter does not constitute a consultation required by Section 7a of the Act nor a Biological Opinion of the Fish and Wildlife Service. It is intended only as a response to your request under Section 7c relative to biological assessments.

We appreciate your concerns for Endangered species and will be happy to provide any assistance that we have available on this and any future projects.

Sincerely,

William C. Hickling
Area Manager

APPENDIX E

COMMENTS

The comment section is divided into two parts: 1) comments and DOE responses, and 2) full text of all comment letters. Each comment letter was assigned a successive number as it was received. The assigned numbers are used throughout the text to indicate text changes that were made as a result of comments. For example, comment Letter 4 is identified as E.4. A text change made as a result of comments contained in Letter 4 is identified by (E.4) in the text of the final EIS. The response to comment Letter 4 in Appendix E indicates that a text change was made in Section 2.3.1. If a text change was not made, the response immediately follows the letter comment in this section. Page numbers referred to in the comment letters are those used in the draft EIS issued in October 1981, not this final EIS. The comments are directly quoted from the letters, as received.

Several of the comment letters are dated after the January 31, 1982, deadline date for receiving comments. These comments were reviewed; and since responses could be made without impacting the final EIS publishing deadline, they were incorporated into the EIS.

Comment Letter		Comment and Response Page
E.1	Borough of Shippingport	E-3
E.2	International Brotherhood of Electrical Workers	E-4
E.3	U.S. Department of Interior	E-5
E.4	Arthur L. Baehr	E-6
E.5	Duquesne Light	E-9
E.6	Tennessee Valley Authority	E-14

(contd on next page)

E.1 COMMENT LETTER, Borough of Shippingport, Box 76, Shippingport, Pennsylvania, 15077

Comment

The Council would like to have at least four monitors placed within the Borough, the locations to be decided by the coordinator, Earl Graham.

Response

An appropriate radiation monitoring system will be operating in accordance with the criteria in DOE Order 5480.1A. An existing radiation monitoring system operated by the Duquesne Light Company (DLC) for both the Shippingport and Beaver Valley Power Stations is adequate for monitoring releases from both stations. Either this system or a similar system will be operating during decommissioning in order to monitor potential radiation releases from Shippingport. During decommissioning, any monitor located beyond the Shippingport Station boundary would identify Shippingport releases and also radioactive releases due to the DLC owned Beaver Valley Station and the nearby coal-fired plant. Such offsite monitors would indiscriminately identify releases. Identification of the origin of the release would depend upon local site monitors and knowledge of the activities going on during the time of the release at each potential origin. DOE feels that the need for an additional four monitors located within the Borough is a question to be answered outside the scope of the EIS.

E.2 COMMENT LETTER, Paul R. Shoop, International Representative, International Brotherhood of Electrical Workers, 1125 Fifteenth St., N.W. Washington, D.C. 20005

Comment

Immediate dismantlement would serve as a demonstration project for future decommissionings of light water reactors. Shippingport has operated for nearly a quarter of a century and is considerably larger than stations previously decommissioned.

Estimated 1275 man-rem of occupational radiation exposure, to...an average 180 workers, over the approximate five year schedule for immediate dismantlement should result in low individual occupational radiation exposures to the worker.

Response

A response is not required.

E.3 COMMENT LETTER, Bruce Blanchard, Director, Environmental Project Review, U.S. Department of Interior, Office of the Secretary, Washington, D.C. 20240

Comment

We have reviewed the draft environmental impact statement for Decommissioning of the Shippingport Atomic Power Station, Beaver County, Pennsylvania, and find we have no comments.

Response

A response is not required.

E.4 COMMENT LETTER, Arthur L. Baehr, 911 Pasadena Drive, Somerdale, N.J. 08083

Comment

On page 2-15 of the DEIS the total inventory of neutron activated material was reported to be 13,320 Ci. I understand that security considerations may prohibit a nuclide-specific partition of the total activity but perhaps the following partition could be provided:

Short Lived Nuclides	($t_{1/2}$ < 5 yrs.)	- C_1
Intermediate Lived Nuclides	(5 < $t_{1/2}$ < 100 yrs.)	- C_2
Long Lived Nuclides	($t_{1/2}$ > 100 yrs.)	- C_3
	TOTAL	13,320 Ci

With such a partition, one may independently judge the nature of the inventory to be disposed.

Response

See Table 3.2-1 where the 13,320 curie inventory is separated into radionuclide and curie content per component.

Comment

Re: The statement, "...these ribs will decrease the stresses in the concrete walls during the maximum probable flood..." found on pg. 2-24. The ribs, so constructed will decrease the stresses for any flood that may cover the structure, not just the maximum probable flood. This statement may mislead one to think that the maximum probable flood would be the only flood able to flood the structure.

E.4 COMMENT LETTER (Continued)

Response

A text change has been made in Section 2.3.1 for clarity to refer to flooding in general.

Comment

Use of the land resource at the Shippingport site is listed as an advantage to the immediate dismantlement option. Could the authors be more specific by speculating on some possible uses for the land? (e.g. power plant, specific industry, recreation, etc.).

Response

The Department of Energy is presently leasing the seven acres from the Duquesne Light Company. The immediate dismantlement option would result in the quickest release of the land back to Duquesne Light for unrestricted use. DOE cannot speculate on the future use of the Duquesne Light land and has not been advised by Duquesne Light of its intended use of the land.

Comment

Re: the discussion of the 70 year path to the nearest stream to the Savannah River disposal site found on pg. 3-23.

It is a well documented fact that the groundwater resource is heavily developed near Savannah, Georgia (see pg. 89 of Groundwater Hydrology by Todd, 2nd Edition, Wiley 1980). Perhaps nuclide migration to the aquifer and then subsequent ingestion of pumped groundwater could be the critical path. At any rate such a calculation should be provided along with the migration to the stream pathway. If such a path is improbable due to the location of the site in relation to the aquifer, then this fact should be clearly stated.

Furthermore, the DEIS does not provide an analogous analysis of the critical pathway to the water supply at the Washington disposal site.

Response

The Savannah River Plant and the Hanford Reservation have approved DOE burial sites that can accept the Shippingport wastes. Concerns relative to the adequacy of these sites and the wastes they can accept are more fully addressed in the EIS issued by each site, "Final EIS, Waste Management Operations, Savannah River Plant," ERDA-1537, September 1977, and "Final Environmental Statement, Waste Management Operations, Hanford Reservation," ERDA-1538, December 1975.

Comment

I strongly disapprove of the comparison of calculated man-rem to shipyard [sic] workers to the background man-rem incurred by the population of the U.S. found on top of pg. 4-21 in the DEIS. Such a comparison implies a relationship between the health effects incurred by the two vastly different populations, dependent on the unit man-rem.

Doses incurred by shipyard [sic] workers should be justified by merely stating that guidelines for the exposure of such workers would be met. The public should not be led to believe that the issue of exposure incurred by radiation workers can be resolved by comparing the worker exposure to general background exposure.

Response

Text changes have been made in Section 4.7 for clarity. The comparison of worker collective radiation dose to background population collective radiation dose has been deleted.

E.5 COMMENT LETTER, Duquesne Light Company, 435 Sixth Avenue, Pittsburgh, PA 15219

Comment

Section 1.1.2 Decommissioning Statutory and Regulatory Requirements - Paragraph 6, Line 8 - The Federal and State permits regulating the operation of the Shippingport Atomic Power Station are issued to Duquesne Light Company. Since Duquesne Light will not be operating the station after defueling, the permits delineated in Appendix B will not be in effect during decommissioning.

Response

The conditions of the federal and state permits will continue to be met during decommissioning where applicable. Changes to permits or to the permit holder will be made prior to the start of decommissioning operations.

Comment

Section 2.2 Immediate Dismantlement - DOE-Owned Structures listing - The building referred to as "Warehouse" should be corrected to "Demineralizer Building". The warehouse buildings are Duquesne Light owned.

Response

A text change was made in Section 2.2 to correct the listing.

Comment

Section 2.2.3.1 Liquid Waste Disposal - Table 2.2-3 - Inventory at Shutdown - Assuming that no liquid discharges are made to the river, the radioactive water inventory at shutdown will be 650,000 to 700,000 gallons.

Response

Text changes were made in the following sections to correct the tables, Section 2.2.3.1 Table 2.2-3, Section 2.3.3.1 Table 2.3-3, Section 2.4.3.1 Table 2.4-3, Section 2.5 Table 2.5-1, and Section 4.2.2 Table 4.2-1. The text change recognizes the maximum inventory of 700,000 gallons as an upper limit.

Comment

Section 3.1.6 Water Quality - Para. 2, Line 11 - The monitoring location and data reference source was not specified for the ORSANCO - Ohio River water quality standards that were exceeded at Shippingport during 1978 and 1979.

Response

The sentence in question has the same reference source, (4), as the sentence prior to it. This system, in which the first sentence has a given reference source and the succeeding sentences do not, is employed throughout the EIS.

Comment

Section 2.2.3.2 and 3.3 - There was no discussion of the handling and disposal practices that will be used for non-radiological, non-hazardous wastes.

Response

Text changes have been made in Sections 2.2.3.2, 2.3.3.2, and 3.3.3 to include discussion of nonradiological, nonhazardous wastes. Practices and standards of the industry will be used.

E.5 COMMENT LETTER (Continued)

Comment

Section 3.1.7 Aquatic and Terrestrial Ecology - A borrow area for 27,000 cubic yards of backfill material will be needed to return the site to existing grade upon removal of the below ground components.

Response

Text changes have been made in Sections 2.2.3.2 and 2.3.3.2. Reclaimed concrete rubble may be used to backfill below-grade building voids as stated in Sec- tion 2.2.3.2 and 2.3.3.2, thus reducing the soil requirements. A local source of soil to complete the filling will be identified at a later date.

Comment

Section 4.2.2 Liquid Effluents - Para. 2, Line 11 "...and a maximum discharge of 2 million liters." - See Comment 3 (third comment of Duquesne Light letter).

Response

A text change has been made in Section 4.2.2 to correct the amount of discharge.

Comment

Section 4.2.4 Nonradioactive Hazardous Waste - It should reference that the handling and disposal of asbestos should also be in accordance with EPA 40 CFR 61 and OSHA 29 CFR 1910.

Response

A text change has been made in Section 4.2.4 to include the referenced CFRs. DOE order 5480.1A includes 29 CFR 1910 as a prescribed standard.

Comment

Section 4.6.2 Energy (Commitment of Resources) - Fuel oil will also be consumed by the station auxiliary boiler during the decommissioning. The auxiliary boiler operating status after the completion of the decommissioning has yet to be determined. This fuel consumption should be addressed.

Response

A text change has been made in Section 4.6.2 to include the amount of fuel consumed by the auxiliary boiler during decommissioning.

Comment

Section 4.6.3 Water - The comparison of water requirements for the various decommissioning alternatives versus the normal plant operation is misleading (117 to 284 kiloliters for decommissioning versus 621,100 kiloliters per day for normal operation once-through condenser cooling.) Some (or all) decommissioning water use involves consumptive losses whereas once-through cooling does not. The water requirement comparisons would be more appropriate if made along these lines. Also, the operation of the Circulating Water System is required for dilution of the liquid effluents when discharging to the Ohio River. This fact is not stated.

Response

A text change has been made in Section 4.6.3 to clarify the intent. See Section 4.2.2 for discussion of liquid effluent discharges.

Comment

Section 4.9 Means to Mitigate Adverse Environmental Impacts - Para. 2, Line 7. The existing Beaver Valley/Shippingport monitoring system is operated by Duquesne Light through a government contract. It is not known whether this agreement will remain in effect during decommissioning.

Response

A text change has been made in Section 4.9 to correct the statement. An appropriate monitoring system will be operated during decommissioning in accordance with DOE Order 5480.1A. Either the existing Beaver Valley/Shippingport radiation monitoring system will be used or a similar, adequate radiation monitoring system will be in operation during Shippingport decommissioning.

E.6 COMMENT LETTER, Tennessee Valley Authority, Knoxville, Tennessee 37902

Comment

We note that the preferred alternative (i.e., immediate dismantlement of the Government-owned portion of the station) results in no significant environmental impacts. Therefore, we see no legal requirement that an environmental impact statement should be prepared.

Response

The EIS was prepared in order to assess the environmental implications of the proposed DOE action and to provide an opportunity for public comment.

Comment

As another potential alternative, we suggest investigation of the feasibility of delaying the Shippingport decommissioning until it is time to decommission the Beaver Valley Power Station. The use of some part of safe storage until that time would allow the reduction of cobalt-60 activity by radioactive decay, with the potential for significantly reducing occupational exposure during decommissioning. The environmental impact of the combined decommissioning may be less than what would occur from two separate efforts.

Response

Safe storage followed by deferred dismantlement, as suggested, is an alternative that is discussed in the EIS. The environmental impact of a combined decommissioning effort may be less. However, the EIS demonstrates that the environmental impact from either immediate or deferred dismantlement is small. Decommissioning of Shippingport is the responsibility of the U.S. government while decommissioning of the Beaver Valley Power Station will be the responsibility of Duquesne Light and is outside the scope of this EIS.

E.6 COMMENT LETTER (Continued)

Comment

The schedules for the several decommissioning methods do not allow time for the preparation and approval process for a process control program for the solidification of radioactive waste material. It would be prudent to include the preparation of this document as a necessary effort and include it in the schedules.

Response

In our view the current schedules presented in the EIS include enough time for the preparation and approval process for a program for the solidification of radioactive waste material.

Comment

Section 2.2.3.1; Section 3.1.6; Section 4.2.2 - The concentration of radioactive material discharged to the river should also meet the as low as reasonably achievable criteria of 10 CFR 50, Appendix I, as well as the stated regulations. The Safe Drinking Water Act, 40 CFR 141, should also be addressed since special reports concerning the impact of radioactive effluents from this activity on downriver water supply systems may be required.

Response

The Shippingport Atomic Power Station is not in general subject to NRC regulations, but decommissioning will adhere to the applicable standards of DOE order 5480.1A as stated in Section 1.1.2. Since the Ohio River in the vicinity of Shippingport is used as a drinking water source, 40 CFR 141 does apply. Discharges to the Ohio River from Shippingport decommissioning activities will be limited as stated in Sections 2.2.3.1, 3.1.6, 4.2 and Table 4.1-4 of Section 4.2. If during decommissioning, reports or data on water discharges are required by downriver water supply systems, they will be available from the DOE.

Comment

Section 3.1.2 - The plant is designed to be protected from flooding to elevation 706 but the probable maximum flood level is elevation 730. This provides another positive reason for adopting the preferred alternative, immediate dismantlement, if plant flooding could expose the public to radioactive wastes.

Response

Although this may be another positive reason for selecting the preferred alternative, the probability of the maximum flood is so low that this factor is not as supportive as the other factors discussed in the EIS.

Comment

Table 3.1-1 - The primary and secondary National Ambient Air Quality Standards (NAAQS) for ozone are both listed as 240 g/m^3 (0.12 ppm), and footnote (a) states "Not to be exceeded more than once a year." The primary and secondary NAAQS for ozone should read 0.12 ppm (235 g/m^3) to agree with 40 CFR 50 (paragraph 50.9). It is suggested that footnote (a) be rewritten to read "Not to be exceeded more than once per year. For ozone, exceedances are determined by a method which utilizes the most recent three year running average (see 40 CFR 50, Appendix H, for details)."

Response

A text change has been made in Section 3.1.5 Table 3.1-1 to correct the table.

Comment

Page 3-12 - The first sentence on this page states "Discharge of nonradioactive materials into the air from decommissioning will not detectably change ambient air conditions." While this statement may be true, it cannot be confirmed from the limited information given in the DEIS.

Response

A text change has been made in Section 3.1.5 to support the statement. Section 4.2.1 Gaseous Effluents fully discusses the discharge of nonradioactive materials into the air from decommissioning and supports the statement.

Comment

Sections 4.0; 4.2.1 - An inconsistency needs to be eliminated. On page 4-2, the first full sentence states "Similarly, the only impacts on air quality will be from the automobiles of the decommissioning workers (180 maximum, 130 operation and maintenance workers are employed now) and possible from some concrete demolition activities." However, on page 4-10, section 4.2.1, the first sentence states "Airborne effluents from decommissioning the Shippingport Station will arise from the automobiles of decommissioning workers and from internal combustion engines used to power equipment used in decommissioning." Although some information concerning air quality impacts from workers' cars is presented, none is presented relative to impacts from the fossil fueled equipment used in decommissioning and from the concrete demolition. Emissions to the air from such heavy equipment, operating more or less continuously over the workday, are likely to be much higher than from the automobiles cited. Particulate matter generated from concrete demolition could be significant without adequate mitigation. While these emissions may not cause NAAQS violations, they should be presented to show this to be the case.

Response

Text changes have been made in Sections 4.0 and 4.2.1 to eliminate the inconsistency in effluent sources. See last paragraph in Section 4.2.1 in which particulate matter due to concrete blasting will be controlled to meet the EPA secondary standard of 60 g/m^3 for suspended particulates (40 CFR 50.7).

E.7 COMMENT LETTER, Heyward G. Shealy, Chief, Bureau of Radiological Health, South Carolina Department of Health and Environmental Control.

Comment

Our comments will focus on the possibility of the Savannah River Plant (SRP) being utilized for land disposal of the decommissioned Shippingport Reactor. The impact of transporting this material on South Carolina highways to SRP must receive serious evaluation. A substantial amount of radioactive waste, spent fuel, etc. is already being shipped into or within this State.

If you choose to bury this material at SRP, it must be handled under existing agreement between the State and DOE regarding transportation of waste to SRP.

In conclusion, we urge that you give serious consideration to the most logical and economical way to decommission the spent Shippingport reactor.

Response

The selection of the transportation method and disposal site for the radioactive waste from the decommissioning of the Shippingport Atomic Power Station will be based upon review and analysis of all relevant factors. This EIS provides environmental input to that decision. Any actions taken will be in accordance with all applicable regulations.

E.8 COMMENT LETTER, Peter S. Duncan, Commonwealth of Pennsylvania, Department of Environmental Resources, P.O. Box 2063, Harrisburg, PA 17120

Comment

Section 1.1.2 and Appendix A.4. It is stated that the EPA is responsible for developing residual radioactivity standards for decommissioning and since these standards have not yet been developed, the residual radioactivity limits of Regultory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", will be used. We agree that those standards will probably provide adequate protection for the public, however, an assessment should be made to estimate the dose commitment that could be realized by the use of these limits assuming unrestricted use of the site. Since such a methodology was developed as part of the Battelle-Northwest study, NUREG/CRO-0130, ("Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station"), the Regulatory Guide 1.86 standards should be compared with that methodology and the impacts expressed in terms of dose commitment to the public after release for unrestricted use. This will also provide a more consistent method of comparison with the Battelle methodology, which apparently is one of the objectives of the decommissioning. It should also be noted that the Regulatory Guide 1.86 limits do not address residual soil contamination which could provide a major pathway for public exposure after release for unrestricted use.

Response

Text changes have been made in Section 1.1.2 and Appendix A.4 to clarify the intent. As stated in Section A.4, a need does exist to specify criteria for residual radioactivity following decommissioning. The NRC and EPA are coordinating efforts to develop residual radioactivity standards. Pending development of these standards, Shippingport will be decommissioned to the standards in NRC Regulatory Guide 1.86. Pathway analyses will be carried out as suggested in Reference 5 of Appendix A (NUREG-0613) to assure that residual radioactivity in the soil meets standards current at the time.

Comment

Section 2.2.1. It is noted that special procedures may be required so that concrete blasting will not seismically affect the adjacent Beaver Valley Nuclear Plant. Will the NRC require verification that the decommissioning of the Shippingport Atomic Power Station will not adversely affect the safety of the Beaver Valley Nuclear Station in any way?

Response

The NRC has been notified of the proposed Shippingport decommissioning activities. Whether required by NRC or not, the DOE will take all steps necessary to assure that decommissioning activities will not adversely affect the safety or operation of the Beaver Valley Power Station. These activities will be coordinated with Duquesne Light.

E.9 COMMENT LETTER, Ruth Thomas, Authorized Representative, Environmentalists Inc., 1339 Sinkler Road, Columbia, S.C. 29206

Comment

The conclusion that the public would only receive "trivial" radiation doses (page 2-13) from Immediate Dismantling is apparently not based on findings of those who prepared the draft EIS. It is instead based on predictions related to a theoretical power plant. The draft EIS fails to provide information specific enough about the data input which was used to evaluate the calculations. The question of verification is not discussed.

Response

The conclusion as stated in Section 2.2.2.2 reads, "Thus, public radiation doses from routine airborne releases at Shippingport will also be trivial." (Emphasis added.) This conclusion is based on calculations from a decommissioning study (NUREG/CR-0130) of a presently operating nuclear power plant which showed that the radiation dose to the public, for this larger PWR (1175 MWe versus 72 MWe), from routine airborne releases is trivial. Since techniques to be used at Shippingport will be similar to those used in the referenced study and have actually been used in other decommissioning projects, the conclusion reached regarding the Shippingport Station is appropriate. A radiation monitoring system, as stated in Section 4.9 will be used to monitor the actual releases.

Comment

The Sections on Public Radiation Dose and Occupational Radiation Dose (pages 2-10 and 2-13) do not include information regarding radiation contamination. It is the particles of radiation pollution which are released as the result of dismantling operations which are of concern to us. Radiation contamination in this form can be taken into the body easily and without a person knowing it.

As is pointed out on page 2-10 and in other sections of the text, shielding and distance can be used to protect against radiation coming from large pieces of equipment, but loose alpha and beta particles present a different problem. The draft EIS fails to contain adequate and specific information regarding the topic of alpha and beta particulate matter.

Response

As stated in Section 4.2.1, all potentially radioactive particulate matter will be controlled by using such equipment as a contamination control envelope equipped with a HEPA filter during processes such as in-air cutting, chipping, spalling, and blasting. Buildings where these types of activities take place will be equipped with HEPA filters. This technology has been demonstrated successfully in past decommissioning projects. Section 4.9 states that gaseous effluents will be monitored at the release points in order to assure that release limitations are met.

Also, as stated in Section 4.9 the decommissioning workers will wear dosimeters and follow standard contamination control methods such as using hand and shoe counters for personnel monitoring when leaving a radiation zone. Trucks are also monitored for radioactivity when leaving the site. Compliance with ALARA principles will protect the workers and the public from radioactive particulate matter.

Comment

The discovery that long-lived radioactive isotopes (nickel-59 and niobium-94) are produced at a nuclear power plant makes decommissioning decisions even more difficult than previously thought. (Trace Elements in Reactor Steels: Implications for Decommissioning, John Stephen and Robert Pohl, August 1977), however, the plan for immediate dismantling would not reduce people's exposure to these radioactive isotopes. It appears, in fact more individuals would come within the range of radiation rays during dismantling, loading, transporting and disposal operations.

Response

The inventory and resultant doses to the public from all radioactive isotopes, including Ni-59 and Nb-94, are presented in Sections 2.4.1, 3.2.2 and 4.1.2 for each of the decommissioning alternatives considered. Ni-59 and Nb-94 do not add appreciably to the projected radiation doses regardless of the decommissioning alternative chosen.

Comment

On page 3-22 of the draft EIS, the migration time to the nearest stream at the SRP is estimated to be approximately 70 years, yet the report does not question the choice of this site for the burial of wastes which remain toxic for hundreds of thousands of years. No mention is made of such geologic conditions as shallow water table and the possibility that the ground-water could be contaminated by radioactive waste operations yet this is a concern of earth scientists with the National Academy of Sciences (NAS 1966 report by Committee on Geologic Aspects of Radioactive Waste Disposal) and geologists with the U.S. Geological Survey. The lack of geologic data and information in the draft EIS needs to be corrected.

Response

Operational aspects of the waste disposal site at Savannah River including geologic and hydrologic conditions are discussed in the "Final EIS, Waste Management Operations, Savannah River Plant," ERDA-1537. It is beyond the scope of this EIS to address these except by reference to the existing document.

Comment

There is a lack of decontamination, dismantling and decommissioning data from actual operations appearing in the draft EIS. No reference is made to Nuclear Fuel Services and the contamination of workers at this plant. The tracking of radiation contamination from this and other facilities out into the community is also not discussed. Other sources of information which relate to the plans for decommissioning the Shippingport reactor and other power plant equipment are the records on migration from nuclear burial sites such as Nuclear Fuel Services, Maxey Flats and the SRP.

Response

A text change has been made in the Summary to provide the following information. The draft EIS is based on data and experience gained from the actual decontamination, dismantling, and decommissioning of such facilities as the Piqua Nuclear Power Facility, the Hallam Nuclear Power Facility, BONUS, and the Elk River reactor, in addition to the decommissioning analysis in NUREG/CR-0130. As stated in Section 4.9, standard methods and procedures for containing contamination will be in effect. This technology has been successfully demonstrated in past decommissioning projects. Waste management impacts at the proposed burial grounds (Savannah River and Hanford) have been evaluated in ERDA-1537 and ERDA-1538.

Comment

Failure to use transcripts of hearings which contain evidence regarding decommission is another example of how this draft EIS is incomplete. The hearing record related to the Barnwell Nuclear Fuel Plant (Docket No. 50-332) includes dismantling, decontamination and decommissioning information which has been tested by cross-examination. The expert witness for the Nuclear Regulatory Commission, Robert Brooksbank, answered questions about the dismantling of several nuclear facilities, including Elk River, yet this draft EIS does not contain data gathered from decommissioning operations.

Response

As stated in the response to the preceding comment, the EIS is based on reviews and analyses of actual decommissioning operations including Elk River.

Comment

It is unclear why more people were not involved in preparing the draft EIS. With so many different factors to evalute and incorporate into the decision-making process, there was a need for individuals with a variety of educational background and work experience to be involved.

Response

In Section 5.0 the list of preparers includes the two principal authors and many reviewers and contributors. The numbers and expertise of those responsible for preparing the EIS are believed appropriate by DOE.

Comment

According to the distribution list, no one in the state government of Georgia received a copy of this draft EIS, yet the plans include sending the wastes to the SRP for disposal, where these toxic and long-lived radioactive materials have the potential for contaminating water sources which they use. The area is already experiencing problems. For example, five square miles of Allendale County [SC] are contaminated with cesium-137.

E.9 COMMENT LETTER (Continued)

Response

The EIS was distributed in accordance with the requirements of Sections 1502.19 and 1506.6 of the Council on Environmental Quality Regulations. Two Federal Register notices regarding the preparation and publication of the draft EIS were published (45 FR 35414, May 27, 1980; and 46 FR 60643, December 11, 1981). Copies of the document were made available to anyone expressing an interest in reviewing the document.

E.10 COMMENT LETTER, William A. Lochstet, 104 Davey Laboratory, Pennsylvania State University, University Park, PA 16802

Comment

The health consequences to the general public are estimated from the dismantling of the plant components and their transport to a burial site. There is no estimation of the impact after the radioactive materials reach the burial site at either Savannah River or Hanford. This is particularly curious since the amounts of radioactivity to be handled as shown in table 3.2-1 include Carbon-14, Nickel-59, Niobium-94, and Technetium-99. These isotopes have partcularly long half lives (half million years for technetium-99). Burial under a few feet of earth as is contemplated at Savannah River or Hanford cannot possibly be expected to contain these nuclides for such long time periods. Ordinary erosion and leaching will certainly return this material to the biosphere within a few hundreds to thousands of years. It should be noted that these issues were recently discussed in Science magazine (Vol. 215, pp. 376, 377; 22 January 1982).

The realistic environmental impact is obtained by considering that the entire inventory of these isotopes is released to the environment after a few hundred to a thousand years. This material will then mix with stable elements of the earth surface. Uniform dilution in this nonradioactive material will provide a reasonably optimistic estimate of the final concentrations.

Finally the population at risk is the entire world population. A first estimate is to use the present value of four billion people. The impact of this radiation must, of course, be carried out for the full radioactive decay of the material. A similar calculation can be found in the "Final EIS on Long-Term Management of Defense High-Level Radioactive Wastes, Savannah River Plant" (DOE/EIS-0023) at page B-72 thru B-77. These impacts are going to occur in the long time scale regardless of what method is used for decommissioning. It is unlikely that the decommissioning procedure will have a large effect on these impacts.

E.10 COMMENT LETTER (Continued)

Despite the above critical comments, it is agreed that immediate dismantlement is the alternative of choice.

Response

The overall environmental impacts of waste management activities at Savannah River and Hanford are evaluated in ERDA-1537 and ERDA-1538. Disposal of the Shippingport waste was analyzed with regard to its potential for change in impact to waste management at Savannah River or Hanford, and found to be within the range of impacts evaluated in ERDA-1537 and ERDA-1538. Discussion of the impacts on the burial grounds is outside the scope of this EIS. Disposal of Shippingport waste at Savannah River or Hanford will be consistent with the existing activities at those sites.

Comment

The Draft evaluates the emissions of NO_x in Section 4.2.1. The emissions of NO_x for automobiles is here compared with that of the Bruce Mansfield plants. In terms of the airshed at large these are fair to compare. However, at the street level of Shippingport, the emissions from Bruce Mansfield do not count, but the automobiles count directly. This is due to the fact that the coal plant injects its NO_x into the air at a large distance above the street, which the automobiles do not.

Response

In terms of the street level at Shippingport the temporary (3 month peak period) increase of 50 cars in the area will not noticeably increase the NO_x beyond that caused by the 1600 cars at the immediately adjacent Beaver Valley 2 plant. These impacts are discussed in Section 4.2.1.

E.11 COMMENT LETTER, Daniel R. Muller, Assistant Director for Environmental Technology, Division of Engineering, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555

Comment

Although we suspect the impacts are minor, the analysis of aquatic discharges and effects is poor. No estimate is given of the quantity or quality of liquid discharges. On page 4-14 it is implied that only distillates from radiation treatment systems will be discharged. However, later on the page it is indicated that monitoring of the discharge will be continued and discharge will be halted if conditions of the current NPDES Permit cannot be met. This implies the discharge may indeed contain potential pollutants.

Response

A text change was made in Section 4.2.2 to clarify the intent to recycle the liquid through the processing system if necessary. In Section 4.2.2, Table 4.2-1 discusses the maximum liquid volumes that could be discharged to the river for each decommissioning alternative. The quality of the liquid discharge is also discussed in Section 4.2.2, which states that ORSANCO, Pennsylvania Water Quality, 40 CFR 423, and the NPDES permit standards will not be exceeded. To assure that discharges will be in compliance with the above standards, a monitoring system will be used to analyze the liquid prior to discharge. Should the analysis show that the liquid exceeds the standards cited above, instead of being discharged the liquid will be recycled through the processing system until the liquid meets the release standards.

Comment

The existing permit and the EPA regulations (40 CFR 423) which are cited apply to startup and to operation of the power plant. EPA did not consider dismantling reactors in developing their guidelines for steam-electric power plants. Thus, they are probably not very helpful in assuring the absence of impact from dismantling.

Response

The existing permit and the EPA regulations do not specifically apply to decommissioning; however, by performing the decommissioning in compliance with these regulations there will be no greater environmental impact than that allowed for plant startup and operation. In addition, as stated in Section 4.9 of the EIS, the decommissioning work will be performed in accordance with DOE policy which requires that all adverse impacts be reduced to as low as reasonably achievable.

Comment

Have the State and EPA been advised of the dismantling operation and of the discharges which will occur? The NPDES Permit (as outlined in Appendix B) bans the discharge of metal cleaning wastes. Does this in effect ban the discharge of any decontamination wastes?

Response

The state and EPA each received a copy of the draft EIS and have responded to it. As indicated in Section 2.2.3.1, all radioactive liquid wastes will be filtered, demineralized, and evaporated and the processed liquids monitored before release to the river. The metal cleaning wastes that might be present will be removed during this process. Should the liquid wastes still contain detectable metal cleaning residues, the wastes will be reprocessed until they can be released.

Comment

The unrestricted use levels of radioactivity for the preferred option of immediate dismantlement are not defined other than using the requirements of

Regulatory Guide 1.86. Since only surface contamination criteria is addressed in Regulatory Guide 1.86, Shippingport should be decommissioned to the criteria developed for the Plum Brook Test Reactor dismantlement.

Response

The text in Section 1.1.2 and Appendix A.4 has been revised to include pathway analyses for residual soil contamination as suggested in reference 5 of Appendix A, "Residual Activity Limits for Decommissioning", NUREG-0613. The specific guidelines stated for the Plum Brook Test Reactor, are not generalized guidelines with which DOE must comply.

Comment

The inventory of radioactivity included neutron activation of pressure vessel components and radioactive contaminants in the reactor coolant. The deposited radioactive corrosion products on reactor coolant system surfaces and in crud traps should also be considered.

Response

The estimate of 20 Ci in Table 3.2-2 includes the crud activity from deposited radioactive corrosion products.

Comment

The type of waste decontamination fluids have not been specified. The proposed rule 10 CFR Part 61, Licensing Requirements for Land Disposed of Radioactive Waste, states that waste containing chelating agents in concentration greater than 0.1% are not permitted except as specifically approved by the Commission. Hence, chelating decontamination fluids should either be avoided or should be decomposed prior to disposal.

Response

Shippingport is not an NRC licensed facility and therefore NRC regulations do not necessarily apply. However, the DOE will comply with the intent of the NRC regulations through adherence to DOE orders which govern DOE facilities. By complying with these values, public health and safety will be protected to the same extent afforded by the NRC regulations. The fluids that are selected to be used for decontamination will be processed, as stated in Section 4.2.2, in order to meet DOE release requirements.

E.12 COMMENT LETTER, John F. Spencer, Deputy Director, State of Washington, Department of Ecology, Mail Stop PV-11, Olympia, Washington 98504

Comment

Department of Ecology (WDOE) comments (enclosed): The discussion in the EIS of groundwater quality impacts appears adequate. However, the EIS does not discuss in reasonable detail the potential for accidental spillage of nuclear wastes either liquid or solid. There is always the possibility of a transportation accident accompanied by the spillage of radioactive waste water. Two proposed shipping routes are discussed in the EIS if the Hanford site is used for disposal. Since one of the proposed shipping routes passes directly over Spokane's "sole source" aquifer, the liquid wastes should be shipped via Salt Lake City, Utah, rather than Spokane, Washington (see pages 3-25 and 3-27).

Response

A text change has been made in Section 2.2.3.1 to clarify the intent. Liquid waste will not be transported offsite. All liquid waste will be processed at the Shippingport Atomic Power Station as described in Section 2.2.3.1. Potential accidental onsite liquid waste spillage is discussed in Section 4.1.3 and in Table 4.1-4. In order to assure safe shipment of the solid waste, all material will be packaged and transported in accordance with DOT regulations. These plans are described in Section 3.4 of the EIS.

E.12 COMMENT LETTER (Continued)

Comment

Department of Social and Health Services (DSHS) comments (enclosed): There appears to be little or no discussion in the EIS on the need for continued use of the reactor facility. If the plant must be closed, we recommend the dismantling of the reactor facility even if procedures call for the work to be done in stages. Staged operations should allow for the more radioactive sections to be dismantled at the latest possible date.

Response

The need for continued use is discussed in detail in Sections 1.1, 1.1.1, and 2.1. Prompt dismantlement of the power station is DOE's preferred alternative.

Comment

As discussed in the EIS, certain areas of the facility will remain highly radioactive for a long period of time. Proper procedures and close monitoring should be ensured during dismantling operations to restrict radiation exposure to workers within those levels discussed in the EIS. Radiation exposures to offsite residents and the environment, as specified in the EIS, do not appear as low as reasonably achievable.

Response

Initially the radiation exposure was calculated using Shippingport and NUREG/CR-0130 data to establish a conservative upper bound on radiation exposure. As the engineering planning proceeds more accurate calculations will be made. Whatever alternative is chosen, proper procedures and close monitoring will be provided to ensure compliance with ALARA principles as stated in Section 4.9.

E.12 COMMENT LETTER (Continued)

Comment

Because the distance to Hanford is much farther than the Savannah River site, the overall radiation exposure to the public and to transportation personnel would be far greater, as would the costs involved in the Hanford option.

In conclusion, DSHS strongly recommends that the Savannah River site be used as the disposal location and that further consideration not be given to the Hanford site.

Response

The selection of the disposal site for the radioactive waste from the decommissioning of the Shippingport Atomic Power Station will be based on a review and analysis of all relevant factors. This EIS provides the environmental input to that decision. Any actions taken will be in accordance with all applicable regulations.

E.13 COMMENT LATTER, W. T. Hotchkiss P.E.

Comment

Comparisons of current costs to deferred costs must be based on discounting the deferred costs. The time value of money is real and must be considered. This is not the same issue as escalation or inflation.

Response

Discounting the deferred costs has been considered; however, at this time there remains considerable uncertainty as to the appropriate discount rate to use for decommissioning and to the applicability of discounting to decommissioning projects. DOE considers that the cost estimates contained in the EIS are adequate for comparing the relative costs of the alternatives.

Comment

The cost of future dismantlement is based on current technology. As experience in dismantling facilities (radioactive or nonradioactive) is gained, new, less costly, methods may develop. Immediate dismantlement forecloses that possibility.

Response

The comment is appropriate to all technological related fields. DOE has concluded that existing technology will provide for cost effective decommissioning.

Comment

Immediate dismantlement has much more potential for high radiation exposure to very few people. This sort of exposure is important to avoid. The most important radiation benefit of postponed dismantlement is that nobody will be subjected to a large radiation dose.

Response

The EIS evaluates environmental impacts of reasonable decommissioning alternatives. Regardless of the alternative selected, Shippingport will be decommissioned in accordance with ALARA principles that control the amount of radiation to which the workers and the public can be exposed.

Comment

Most of the property, perhaps six of the seven acres, will be available for immediate use regardless of which option is selected. The seventh acre cannot conceivably be worth the tens of millions of dollars being spent on decommissioning. The value of decommissioning is reduction of exposure to radiation. In this regard, the "no action, continued surveillance" option can be considered. (The "continued operation" option is not commercially feasible. The "no surveillance" option violates NRC regulations.)...This suggests that immediate dismantlement is the least attractive alternative because it combines the greatest exposure and the greatest cost. Continued surveillance results in the least exposure and the least cost.

Deferred decommissioning may be politically unpalatable or logistically difficult. If so, immediate action may be preferred, but the DEIS does not support that recommendation.

E.13 COMMENT LETTER (Continued)

A deferred decommissioning proposal has this pitfall: Unless a sinking fund is operated by a non-profit entity, the taxes will probably erode the interest income too fast to keep up with inflation.

In summary, continued surveillance is the preferred alternative.

- It costs the least.
- It results in the least exposure.
- It retains all future options.

Response

The intent of the EIS is to explore decommissioning alternatives and the environmental impacts of these alternatives. Discounting the deferred costs has been considered, but is not appropriate to use in this EIS. While the continued surveillance alternative may result in the least exposure in the short-term, surveillance may result in higher long-term radiological exposure (see page vi). The choice of alternative will be based on several factors including cost, safety, long-term liability, and the desirability of demonstrating decommissioning technology, in addition to potential radiation doses and other environmental impacts.

EXHIBIT 1

BOROUGH OF SHIPPINGPORT

Box 76
SHIPPINGPORT, PENNSYLVANIA 15077

Jan. 8, 1982

Surplus Facilities Management Program Office
P. O. Box 550, Room 667
Richland, Washington 99352

Att: J. D. White

Subject: monitors

Dear Mr. White:

At the regular meeting of the Council for the Borough of Shippingport on Tuesday, Jan. 5, 1982, the emergency cordinator, Earl Graham informed the Council on the decommissioning of the Shippingport Atomic Power Station and the placing of monitors in the Borough to register any radioactivity which may occur when the decommission is done.

The Council would like to have at least four monitors placed within the Borough, the locations to be decided by the coordinator, Earl Graham.

Also the Council would like to have twelve copies of the decommission of the power plant.

Very Truly Yours

William N. Green,
Borough Secretary

EXHIBIT 2

IBEW

INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS
1125-Fifteenth St. N.W.
Washington, D.C. 20005

Charles H. Pillard
International
President

Ralph A. Leigon
International
Secretary

January 11, 1982

US Department of Energy
Surplus Facilities Management Program Office
P.O. Box 550
Room 667
Richland, WA 99352

ATTENTION: J. D. White

Dear Sir:

Of the decommissioning alternatives presented in draft DOE/EIS-0080D the IBEW favors the immediate dismantlement for the Shippingport Atomic Power Station.

Immediate dismantlement would serve as a demonstration project for future decommissionings of light water reactors. Shippingport has operated for nearly a quarter of a century and is considerably larger than stations previously decommissioned.

Estimated 1275 man-rem of occupational radiation exposure, to the on an average 180 workers, over the approximate five year schedule for immediate dismantlement should result in low individual occupational radiation exposures to the worker.

Best wishes.

Sincerely yours,

Paul R. Shoop
International Representative

PRS:sdm

EXHIBIT 3

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 81/2621

JAN 21 1982

U.S. Department of Energy
Surplus Facilities Management Program Office
ATTN: J. D. White
P.O. Box 550, Room 667
Richland, Washington 99352

Dear Mr. White:

We have reviewed the draft environmental impact statement for Decommissioning of the Shippingport Atomic Power Station, Beaver County, Pennsylvania, and find we have no comments.

The opportunity to review this document is appreciated.

Sincerely,

Bruce Blanchard, Director
Environmental Project Review

EXHIBIT 4

January 25, 1982

J. D. White
U.S. Dept. of Energy
Surplus Facilities Management Program Office
P.O. Box 550, Room 667
Richland, Washington 99352

Dear Mr. White:

I have reviewed the Draft Environmental Impact Statement: Decommissioning of the Shippingport Atomic Power Station - October (DOE/EIS-0080D), attached you will find my comments.

I am grateful for the opportunity to participate in the Environmental Impact Assessment process for Shippingport.

Sincerely,

Arthur L. Baehr

ALB/dab

Attachment

EXHIBIT 4 (Continued)

Comment 1:

On page 2-15 of the DEIS the total inventory of neutron activated material was reported to be 13,320 Ci. I understand that security considerations may prohibit a nuclide-specific partition of the total activity but perhaps the following partition could be provided:

Short lived Nuclides	($t_{1/2} < 5$ yrs.)	-	C_1
Intermediate Lived Nuclides	($5 < t_{1/2} < 100$ yrs.)	-	C_2
Long Lived Nuclides	($t_{1/2} > 100$ yrs.)	-	C_3
	TOTAL		13,320 Ci.

With such a partition, one may independently judge the nature of the inventory to be disposed.

Comment 2:

Re: The statement, "...these ribs will decrease the stresses in the concrete walls during the maximum probable flood..." found on pg. 2-24. The ribs, so constructed will decrease the stresses for any flood that may cover the structure, not just the maximum probable flood. This statement may mislead one to think that the maximum probable flood would be the only flood able to flood the structure.

Comment 3:

Use of the land resource at the Shippingport site is listed as an advantage to the immediate dismantlement option. Could the authors be more specific by speculating on some possible uses for the land? (e.g. power plant, specific industry, recreation, etc.).

Comment 4:

Re: the discussion of the 70 year path to the nearest stream to the Savannah River disposal site found on pg. 3-23.

It is a well documented fact that the groundwater resource is heavily developed near Savannah, Georgia (see pg. 89 of Groundwater Hydrology by Todd, 2nd Edition, Wiley 1980). Perhaps nuclide migration to the aquifer and then subsequent ingestion of pumped groundwater could be the critical path. At any rate such a calculation should be provided along with the migration to the stream pathway. If such a path is improbable due to the location of the site in relation to the aquifer, then this fact should be clearly stated.

Furthermore, the DEIS does not provide an analogous analysis of the critical pathway to the water supply at the Washington disposal site.

Comment 5:

I strongly disapprove of the comparison of calculated man-rem to shipyard workers to the background man-rem incurred by the population of the U.S. found on top of pg. 4-21 in the DEIS. Such a comparison implies a relationship between the health effects incurred by the two vastly different populations, dependent on the unit man-rem.

Doses incurred by shipyard workers should be justified by merely stating that guidelines for the exposure of such workers would be met. The public should not be led to believe that the issue of exposure incurred by radiation workers can be resolved by comparing the worker exposure to general background exposure.

EXHIBIT 5

Duquesne Light
435 Sixth Avenue
Pittsburgh, Pa.
15219

(412) 456-6000

Shippingport Atomic Power Station
Post Office Box 57
Shippingport, PA 15077

January 25, 1982

Environmental Impact Statement

Mr. J. D. White
Surplus Facilities Management
Program Office
U. S. Department of Energy
P. O. Box 550, Room 667
Richland, Washington 99352

Dear Mr. White:

Duquesne Light Company has reviewed the October 1981, Draft Environmental Impact Statement for the Decommissioning of the Shippingport Atomic Power Station. Duquesne Light considers the preferred method of decommissioning, (Immediate Dismantlement), to be the only viable and acceptable alternative.

Listed below are comments on specific sections of the Draft Environmental Impact Statement.

1. Section 1.1.2 Decommissioning Statutory and Regulatory Requirements - Paragraph 6, Line 8 - The Federal and State permits regulating the operation of the Shippingport Atomic Power Station are issued to Duquesne Light Company. Since Duquesne Light will not be operating the station after defueling, the permits delineated in Appendix B will not be in effect during decommissioning.

2. Section 2.2 Immediate Dismantlement - DOE - Owned Structures listing - The building referred to as "Warehouse" should be corrected to "Demineralizer Building". The warehouse buildings are Duquesne Light owned.

3. Section 2.2.3.1 Liquid Waste Disposal - Table 2.2.-3 - Inventory at Shutdown - Assuming that no liquid discharges are made to the river, the radioactive water inventory at shutdown will be 650,000 to 700,000 gallons.

4. Section 3.1.6 Water Quality - Para. 2, Line 11 - The monitoring location and data reference source was not specified for the ORSANCO - Ohio River water quality standards that were exceeded at Shippingport during 1978 and 1979.

5. Section 2.2,3.2 and 3.3 - There was no discussion of the handling and disposal practices that will be used for non-radiological, non-hazardous wastes.

6. Section 3.1.7 Aquatic and Terrestrial Ecology - A borrow area for 27,000 cubic yards of backfill material will be needed to return the site to existing grade upon removal of the below ground components.

7. Section 4.2.2 Liquid Effluents - Para. 2, Line 11 - See comment 3.

8. Section 4.2.4 Nonradioactive Hazardous Waste - It should reference that the handling and disposal of asbestos should also be in accordance with EPA 40CRF 61 and OSHA 29 CFR 1910.

9. Section 4.6.2 Energy (Commitment of Resources) - Fuel oil will also be consumed by the station auxiliary boiler during the decommissioning. The auxiliary boiler operating status after the completion of the decommissioning has yet to be determined. This fuel consumption should be addressed.

10. Section 4.6.3 Water - The comparison of water requirements for the various decommissioning alternatives versus the normal plant operation is misleading (117 to 284 kiloliters for decommissioning versus 621,100 kiloliters per day for normal operation once-through condenser cooling.) Some (or all) decommissioning water use involves consumptive losses whereas once-through cooling does not. The water requirement comparisons would be more appropriate if made along these lines. Also, the operation of the Circulating Water System is required for dilution of the liquid effluents when discharging to the Ohio River. This fact is not stated.

11. Section 4.9 Means to Mitigate Adverse Environmental Impacts - Para. 2, Line 7 - The existing Beaver Valley/Shippingport monitoring system is operated by Duquesne Light through a government contract. It is not known whether this agreement will remain in effect during decommissioning.

Very truly yours,

J. F. Zagorski
J. F. Zagorski
Station Superintendent

cc: T. D. Jones
G. Van Sickle
W. G. Logan
D & D File

EXHIBIT 6

TENNESSEE VALLEY AUTHORITY
KNOXVILLE, TENNESSEE 37902

JAN 27 1982

Mr. Jerry D. White, Director
Surplus Facilities Management Program Office
U.S. Department of Energy
Post Office Box 550, Room 667
Richland, Washington 99352

Dear Mr. White:

We have reviewed the draft environmental impact statement (DEIS) on the decommissioning of the Shippingport Atomic Power Station (DOE/EIS-0080D, October 1981) and our comments are provided as an enclosure. We appreciate the opportunity to comment on the DEIS.

Sincerely,

Mohamed T. El-Ashry, Ph.D.
Assistant Manager of Natural
Resources (Environment)

Enclosure

TVA COMMENTS ON THE U.S. DEPARTMENT OF ENERGY'S DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS) ON DECOMMISSIONING OF THE SHIPPINGPORT ATOMIC POWER STATION, OCTOBER 1981, DOE/EIS-0080D

General Comments

1. We note that the preferred alternative (i.e., immediate dismantlement of the Government-owned portion of the station) results in no significant environmental impacts. Therefore we see no legal requirement that an environmental impact statement should be prepared.

2. As another potential alternative, we suggest investigation of the feasibility of delaying the Shippingport decommissioning until it is time to decommission the Beaver Valley Power Station. The use of some part of safe storage until that time would allow the reduction of cobalt-60 activity by radioactive decay, with the potential for significantly reducing occupational exposure during decommissioning. The environmental impact of the combined decommissioning may be less than what would occur from two separate efforts.

3. The schedules for the several decommissioning methods do not allow time for the preparation and approval process for a process control program for the solidification or radioactive waste material. It would be prudent to include the preparation of this document as a necessary effort and include it in the schedules.

Specific Comments

1. Page 2-14, section 2.2.3.1; page 3.13, section 3.1.6; and page 4-14, section 4.2.2--The concentration of radioactive material discharged to the river should also meet the as low as reasonably achievable criteria of 10 CFR 50, Appendix I, as well as the stated regulations. The Safe Drinking Water Act, 40 CFR 141, should also be addressed since special reports concerning the impact of radioactive effluents from this activity on downriver water supply systems may be required.

2. Page 3-7, section 3.1.2--The plant is designed to be protected from flooding to elevation 706 but the probable maximum flood level is elevation 730. This provides another positive reason for adopting the preferred alternative, immediate dismantlement, if plant flooding could expose the public to radioactive wastes.

3. Page 3-9, Table 3.1-1--The primary and secondary National Ambient Air Quality Standards (NAAQS) for ozone are both listed as 240μg/m^3 (0.12 ppm), and footnote (a) states "Not to be exceeded more than once a year." The primary and secondary NAAQS for ozone should read 0.12 ppm (235μg/m^3) to agree with 40 CFR 50 (paragraph 50.9). It is suggested that footnote (a) be rewritten to read "Not to be exceeded more than once per year. For ozone, exceedances are determined by a method which utilizes the most recent three year running average (see 40 CFR 50, Appendix H, for details)."

4. Page 3-12--The first sentence on this page states "Discharges of nonradioactive materials into the air from decommissioning will not detectably change ambient air conditions." While this statement may be true, it cannot be confirmed from the limited information given in the DEIS.

5. Pages 4-2 and 4-10--An inconsistency needs to be eliminated. On page 4-2, the first full sentence states "Similarly, the only impacts on air quality will be from the automobiles of the decommissioning workers (180 maximum, 130 operation and maintenance workers are employed now) and possibly from some concrete demolition activities." However, on page 4-10, section 4.2.1, the first sentence states "Airborne effluents from decommissioning the Shippingport Station will arise from the automobiles of decommissioning workers and from internal combustion engines used to power equipment used in decommissioning." Although some information concerning air quality impacts from workers' cars is presented, none is presented relative to impacts from the fossil fueled equipment used in decommissioning and from the concrete demolition. Emissions to the air from such heavy equipment, operating more or less continuously over the workday, are likely to be much higher than

from the automobiles cited. Particulate matter generated from concrete demolition could be significant without adequate mitigation. While these emissions may not cause NAAQS violations, they should be presented to show this to be the case.

EXHIBIT 7

South Carolina Department of Health and Environmental Control

COMMISSIONER
Robert S. Jackson, M.D.
2600 Bull Street
Columbia, S.C. 29201

January 28, 1982

William A. Vaughan
Assistant Secretary
Environmental Protection, Safety,
and Emergency Preparedness
Department of Energy
Washington, D.C. 29211

Dear Mr. Vaughan:

Your letter and a copy of the U. S. Department of Energy Draft Environmental Impact Statement (EIS), "Decommissioning of the Shippingport Atomic Power Station" received by Governor Riley has been sent to my Department for review and comment.

Our comments will focus on the possibility of the Savannah River Plant (SRP) being utilized for land disposal of the decommissioned Shippingport Reactor. The impact of transporting this material on South Carolina highways to SRP must receive serious evaluation. A substantial amount of radioactive waste, spent fuel, etc. is already being shipped into or within this State.

If you choose to bury this material at SRP, it must be handled under existing agreement between the State and DOE regarding transportation of waste to SRP.

In conclusion, we urge that you give serious consideration to the most logical and economical way to decommission the spent Shippingport reactor.

Please keep us informed as progress develops in this area.

Very truly yours,

Heyward G. Shealy

Heyward G. Shealy, Chief
Bureau of Radiological Health

HGS:bo

cc: Governor Richard W. Riley
Mr. J. D. White, Richland Operations Office ✓

EXHIBIT 8

The Secretary

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
P.O. Box 2063
Harrisburg, PA 17120
(717) 787-2814

January 29, 1982

J. D. White
U.S. Department of Energy
Surplus Facilities Management
Program Office
P.O. Box 550, Room 667
Richland, WA 99352

Dear Mr. White:

The Commonwealth has reviewed the Draft Environmental Impact Statement covering the Decommissioning of the Shippingport Atomic Power Station. The Commonwealth feels the Environmental Statement is an adequate statement of expected environmental impacts from the decommissioning process. The Commonwealth feels that decommissioning the plant in any of the methods described in the Environmental Statement will result in negligible environmental and public health and safety impacts.

Since the Shippingport Atomic Power Station will be the largest nuclear power reactor to be completely decommissioned, it will provide important data to verify the methodology that has been developed for the NRC by Battelle-Northwest Laboratory for assessing the technology, safety and cost of decommissioning light water reactors. It should, therefore, be assured that the decommissioning effort is fully documented and related to the Battelle study whenever possible.

Attached are staff comments on the Draft EIS for your consideration.

Thank you for the opportunity to review this Environmental Impact Statement.

Sincerely,

PETER S. DUNCAN

Attachment

EXHIBIT 8 (Continued)

Staff Review
Draft EIS covering the Decommissioning
of the Shippingport Atomic Power Station
by the
Commonwealth of Pennsylvania

We have reviewed the Draft EIS and offer the following specific comments.

Section 1.1.2 and Appendix A.4. It is stated that the EPA is responsible for developing residual radioactivity standards for decommissioning and since these standards have not yet been developed, the residual radioactivity limits of Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", will be used. We agree that those standards will probably provide adequate protection for the public, however, an assessment should be made to estimate the dose commitment that could be realized by the use of these limits assuming unrestricted use of the site. Since such a methodology was developed as part of the Battelle-Northwest study, NUREG-CR0130, ("Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station"), the Regulatory Guide 1.86 standards should be compared with that methodology and the impacts expressed in terms of dose commitment to the public after release for unrestricted use. This will also provide a more consistent method of comparison with the Battelle methodology, which apparently is one of the objectives of the decommission. It should also be noted that the Regulatory Guide 1.86 limits do not address residual soil contamination which could provide a major pathway for public exposure after release for unrestricted use.

Section 2.2.1. It is noted that special procedures may be required so that concrete blasting will not seismically affect the adjacent Beaver Valley Nuclear Plant. Will the NRC require verification that the decommissioning of the Shippingport Atomic Power Station will not adversely affect the safety of the Beaver Valley Nuclear Station in any way?

EXHIBIT 9

Environmentalists Inc.
FOUNDED 1972

January 30, 1982

J. D. White
Surplus Facilities Management Program Office
U. S. Department of Energy
P. O. Box 550, Room 667
Richland, Washington 99352

Dear Mr. White:

Please use the enclosed letter related to the draft Environmental Impact Statement, Decommissioning of the Shippingport Atomic Power Station (draft EIS) in place of the one dated January 29th. Some of the revisions we had made in the comments were not changed when the handwritten notes were typed, therefore the complete letter has been retyped.

We did not find out about the draft EIS until a week ago, although Environmentalists, Inc. (E.I.) is usually either sent a copy of impact statements related to nuclear waste issues or notified that such a report is available. Since the time for comments was so near over, we made arrangements to borrow one of the two copies sent to South Carolina.

E.I. has a ten year history of participating in activities related to nuclear waste issues. We plan on contacting you with additional comments and questions.

Sincerely,

Ruth Thomas
Ruth Thomas,
Authorized Representative

Enclosure

1339 SINKLER ROAD, COLUMBIA, S. C. 29206 (803) 782-3000

Environmentalists Inc.

FOUNDED 1972

January 30, 1982

J. D. White
Surplus Facilities Management Program Office
U. S. Department of Energy
P. O. Box 550, Room 667
Richland, Washington 99352

Dear Mr. White:

The draft Environmental Impact Statement, Decommissioning the Shippingport Atomic Power Station (draft EIS) is of interest to members of Environmentalists, Inc. because the report suggests the Savannah River Plant (SRP) as a possible disposal site for the wastes produced by dimantling operations.

Comments:

1. The conclusion that the public would only receive "trivial" radiation doses (page 2-13) from Immediate Dismantling is apparently not based on findings of those who prepared the draft EIS. It is instead based on predictions related to a theoretical power plant. The draft EIS fails to provide information specific enough about the data input which was used to evaluate the calculations. The question of verification is not discussed.

2. The Sections on Public Radiation Dose and Occupational Radiation Dose (pages 2-10 and 2-13) do not include information regarding radiation contamination. It is the particles of radiation pollution which are released as the result of dismantling operations which are of concern to us. Radiation contamination in this form can be taken into the body easily and without a person knowing it.

As is pointed out on page 2-10 and in other sections of the text, shielding and distance can be used to protect against radiation coming from large pieces of equipment, but loose alpha and beta particles present a different problem. The draft EIS fails to contain adequate and specific information regarding the topic of alpha and beta particulate matter.

3. The discovery that long-lived radiactive isotopes (nickel-59 and niobrium-94) are produced at a nuclear power plant makes decommissioning decisions even more difficult than previously thought. (Trace Elements in Reactor Steels: Implications for Decommissioning, John Stephen and Robert Pohl, August 1977), however, the plan for immediate dismantling would not reduce people's exposure to these radioactive isotopes. It appears, in fact more individuals would come within the range of radiation rays during dismantling, loading, transporting and disposal operations.

4. On page 3-22 of the draft EIS, the migration time to the nearest stream at the SRP is estimated to be approximately 70 years, yet the report does not question the choice of this site for the burial of wastes which remain toxic for hundreds of thousands of years. No mention is made of such geologic conditions as shallow water table and the possibility that the ground-water could be contaminated by radioactive waste operations yet this is a concern of earth scientists with the National Academy of Sciences (NAS 1966 report by Committee on Geologic Aspects of Radioactive Waste Disposal) and geologists with the U. S. Geological Survey. The lack of geologic data and information in the draft EIS needs to be corrected.

5. There is a lack of decontamination, dismantling and decommissioning data from actual operations appearing in the draft EIS. No reference is made to Nuclear Fuel Services and the contamination of workers at this plant. The tracking of radiation contamination from this and other facilities out into the community is also not discussed. Other sources of information which relate to the plans for decommissioning the Shippingport reactor and other power plant equipment are the records on migration from nuclear burial sites such as Nuclear Fuel Services, Maxey Flats and the SRP.

6. Failure to use transcripts of hearings which contain evidence regarding decommission is another example of how this draft EIS is incomplete. The hearing record related to the Barnwell Nuclear Fuel Plant (Docket No. 50-332) includes dismantling, decontamination and decommissioning information which has been tested by cross-examination. The expert witness for the Nuclear Regulatory Commission, Robert Brooksbank, answered questions about the dismantling of several nuclear facilities, including Elk River, yet this draft EIS does not contain data gathered from decommissioning operations.

7. It is unclear why more people were not involved in preparing the draft EIS. With so many different factors to evaluate and incoporate into the decision-making process, there was a need for individuals with a variety of educational background and work experience to be involved.

8. According to the distribution list, no one in the state government of Georgia received a copy of this draft EIS, yet the plans include sending the wastes to the SRP for disposal, where these toxic and long-lived radioactive materials have the potential for contaminating water sources which they use. The area is already experiencing problems. For example five square miles of Allendale county are contaminated with cesium-137.

Sincerely,
Ruth Thomas
Ruth Thomas, Authorized Representative

EXHIBIT 10

104 Davey Laboratory
Penn. State University
University Park
Pa., 16802

1 February 1982

Mr. J.D. White
Surplus Facilities Management Program Office
U.S. Department of Energy
P.O. Box 550, Room 667
Richland, Washington, 99352

Dear Mr. White:

Enclosed are my comments on the Draft Environmental Impact Statement on Decommissioning of the Shippingport Atomic Power Station, (DOE/EIS-0080D), which I received on 4 January 1982. Please note that the information presented is my own, and does not necessarily reflect the position of The Pennsylvania State University, which affiliation is given for identification purposes only.

I hope that this information is useful in revising the Draft. I would also like to receive a copy of the Final EIS when it is ready.

Sincerely,

William A. Lochstet

Wm. A. Lochstet, Ph.D.

Long Term Environmental Impact of Decommissioning of the Shippingport Atomic Power Station

by

William A. Lochstet

The Pennsylvania State University*

January 1982

The Department of Energy has attempted to evaluate the health consequences of decommissioning the Shippingport nuclear power plant in its draft environmental statement (DOE/EIS-0080D).

The health consequences to the general public are estimated from the dismanteling of the plant components and their transport to a burial site. There is no estimation of the impact after the radioactive materials reach the burial site at either Savannah River or Hanford. This is particularly curious since the amounts of radioactivity to be handled as shown in table 3.2-1 include Carbon-14, Nickel-59, Niobium-94, and Technetium-99. These isotopes have particularly long half lives (half million years for technetium-99). Burial under a few feet of earth as is contemplated at Savannah River or Hanford cannot possibly be expected to contain these nuclides for such long time periods. Ordinary erosion and leaching will certainly return this material to the biosphere within a few hundreds to thousands of years. It should be noted that these issues were recently discussed in Science magazine (Vol 215, Pp.376,377; 22 January 1982).

The realistic environmental impact is obtained by considering that the entire inventory of these isotopes is released to the environment after a few hundred to a thousand years. This material will then mix with stable elements of the earth surface. Uniform dilution in this nonradioactive material will provide a reasonably optimistic estimate of the final concentrations.

* Affiliation for identification purposes only. Material here does not necessarily represent the opinion of The Pennsylvania State University.

EXHIBIT 10 (Continued)

Finally the population at risk is the entire world population. A first estimate is to use the present value of four billion people. The impact of this radiation must, of course, be carried out for the full radioactive decay of the material. A similar calculation can be found in the "Final EIS on Long-Term Management of Defense High-Level Radioactive Wastes, Savannah River Plant" (DOE/EIS-0023) at page B-72 thru B-77. These impacts are going to occur in the long time scale regardless of what method is used for decommissioning. It is unlikely that the decommissioning procedure will have a large effect on these impacts.

Dispite the above critical comments, it is agreed that immediate dismantlement is the alternative of choice.

The Draft evaluates the emissions of NO_x in section 4.2.1. The emissions of NO_x for automobiles is here compared with that of the Bruce Mansfield plants. In terms of the airshed as large these are fair to compare. However, at the street level of Shippingport, the emissions from Bruce Mansfield do not count, but the automobiles count directly. This is due to the fact that the coal plant injects its NO_x into the air at a large distance above the street, which the automobiles do not.

EXHIBIT 11

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

FEB 0 1 1982

Jerry D. White, Director
Surplus Facilities Management
Program Office
Department of Energy
Richland Operations Office
P. O. Box 550
Richland, Washington 99352

Dear Mr. White:

As requested in your letter of December 14, 1981 to Mr. Robert L. Tedesco, the NRC staff has reviewed the Draft EIS on Decommissioning of the Shippingport Atomic Power Station and our comments are enclosed.

Thank you for the opportunity to review the DEIS. We would appreciate receiving a copy of the final statement when issued.

Sincerely,

Daniel R. Muller, Assistant Director
for Environmental Technology
Division of Engineering

Enclosure:
As stated

COMMENTS ON DEIS ON SHIPPINGPORT DECOMMISSIONING

Water Quality

Although we suspect the impacts are minor, the analysis of aquatic discharges and effects is poor. No estimate is given of the quantity or quality of liquid discharges. On page 4-14 it is implied that only distillates from radiation treatment systems will be discharged. However, later on the page it is indicated that monitoring of the discharge will be continued and discharge will be halted if conditions of the current NPDES Permit cannot be met. This implies the discharge may indeed contain potential pollutants.

The existing permit and the EPA regulations (40 CFR 423) which are cited apply to startup and to operation of the power plant. EPA did not consider dismantling reactors in developing their guidelines for steam-electric power plants. Thus they are probably not very helpful in assuring the absence of impact from dismantling.

Have the State and EPA been advised of the dismantling operation and of the discharges which will occur? The NPDES Permit (as outlined in Appendix B) bans the discharge of metal cleaning wastes. Does this in effect ban the discharge of any decontamination wastes?

Radiological

Page iv. The unrestricted use levels of radioactivity for the preferred option of immediate dismantlement are not defined other than using the requirements of Regulatory Guide 1.86. Since only surface contamination criteria is addressed in Regulatory Guide 1.86, Shippingport should be decommissioned to the criteria developed for the Plum Brook Test Reactor dismantlement (See Attachment 1).

page 3-20. The inventory of radioactivity included neutron activation of pressure vessel components and radioactive contaminants in the reactor coolant. The deposited radioactive corrosion products on reactor coolant system surfaces and in crud traps should also be considered.

Page 2-14. The type of waste decontamination fluids have not been specified. The proposed rule 10 CFR Part 61, Licensing Requirements for Land Disposed of Radioactive Waste, states that waste containing chelating agents in concentration greater than 0.1% are not permitted except as specifically approved by the Commission. Hence, chelating decontamination fluids should either avoided or should be decomposed prior to disposal.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

February 11, 1981

Dockets Nos. 50-30
and 50-185

Mr. Donald E. Benedict, Project Manager
Reactor Decommissioning Projects Office
National Aeronautics and Space Administration
Lewis Research Center
Cleveland, Ohio 44135

Dear Mr. Benedict:

By application dated March 17, 1980 as supplemented by letter dated November 7, 1980 you requested authorization to dismantle the Plum Brook Test Reactor and the Plum Brook Mock-Up Reactor and to decontaminate the NASA Hot Laboratory and Radiochemistry Laboratory all located at the Plum Brook Reactor Facility.

As discussed with you, your proposed radiation limits for release of the Plum Brook Reactor Facility following dismantling and decontaminating must be revised.

Enclosure No. 1 specifies "Radiation Levels for Release of Plum Brook Reactor Facility to Unrestricted Access" that are acceptable to the staff. The Materials Licensing Branch of the NRC Nuclear Materials Safety and Safeguards Office concurs with Enclosure No. 1 with respect to Plum Brook Reactor Facility Byproduct Material License No. 34-06706-3.

Sincerely,

Robert W. Reid

Robert W. Reid, Chief
Operating Reactors Branch #4
Division of Licensing

Enclosures:
1. Radiation Levels for Release of Plum Brook Reactor Facility
2. Regulatory Guide 1.86

cc w/enclosures:
see next page

Mr. Donald E. Benedict -2-

cc w/enclosures:

Ohio Power Siting Commission
ATTN: Chief, Office of Technical Evaluation
361 East Broad Street
P. O. Box 1735
Columbus, Ohio 43216

Ohio Department of Health
ATTN: Director of Health
450 East Town Street
Columbus, Ohio 43216

EXHIBIT 11 (Continued)

Enclosure

RADIATION LEVELS FOR RELEASE OF PLUM BROOK REACTOR

FACILITY TO UNRESTRICTED

ACCESS

Surface Contamination

Surfaces must be decontaminated to levels consistent with Table 1 of Reg. Guide 1.86.

Radioactive Material Other Than Surface Contamination (Co 60, Eu 152, Cs 137, Sr 90)

Co 60, Eu 152 and Cs 137 that may exist in concrete, components, structures, and soil must be removed such that the radiation level from these isotopes is less than 5μR/hr above natural background[1)] as measured at one meter from surface. Soil samples must be taken in the Emergency Retention Basin at its inlet location to determine the amount of Sr 90 present. Sr 90 in the retention basin soil must be no more than 5p Ci/gm.

General

A statistically sound sampling and monitoring methodology acceptable to the NRC must be used. A site survey plan must be submitted to the NRC prior to conducting final sampling and monitoring.

1) Radiation from naturally occurring radioisotopes as measured at a comparable uncontaminated structure or exterior soil surface.

EXHIBIT 12

JOHN SPELLMAN
Governor

DONALD W. MOOS
Director

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Mail Stop PV-11 • Olympia, Washington 98504 • (206) 459-6000

February 1, 1982

Mr. J. D. White
Richland Operations Office
U.S. Department of Energy
P.O. Box 550, Room 667
Richland, Washington 99352

Dear Mr. White:

Thank you for the opportunity to comment on the draft environmental impact statement (EIS) for the "Decommissioning of the Shippingport Atomic Power Station". We have coordinated the review of the EIS with state agencies and offer the following comments from two of these agencies.

1. Department of Ecology (WDOE) comments (enclosed): The discussion in the EIS of groundwater quality impacts appears adequate. However, the EIS does not discuss in reasonable detail the potential for accidental spillage of nuclear wastes either liquid or solid. There is always the possibility of a transportation accident accompanied by the spillage of radioactive waste water.

2. Two proposed shipping routes are discussed in the EIS if the Hanford site is used for disposal. Since one of the proposed shipping routes passes directly over Spokane's "sole source" aquifer, the liquid wastes should be shipped via Salt Lake City, Utah, rather than Spokane, Washington (see pages 3-25 and 3-27).

1. Department of Social and Health Services (DSHS) comments (enclosed): There appears to be little or no discussion in the EIS on the need for continued use of the reactor facility. If the plant must be closed, we recommend the dismantling of the reactor facility even if procedures call for the work to be done in stages. Staged operations should allow for the more radioactive sections to be dismantled at the latest possible date.

2. As discussed in the EIS, certain areas of the facility will remain highly radioactive for a long period of time. Proper procedures and close monitoring should be ensured during dismantling operations to restrict radiation exposure to workers within those levels discussed in the EIS. Radiation exposures to off-site residents and the environment, as specified in the EIS, do not appear as low as reasonably achievable.

3. Because the distance to Hanford is much farther than the Savannah River site, the overall radiation exposure to the public and to transporation personnel would be far greater, as would the costs involved in the Hanford option.

EXHIBIT 12 (continued)

3. Cont.

In conclusion, DSHS strongly recommends that the Savannah River site be used as the disposal location and that further consideration not be given to the Hanford site.

If you have any questions, please call Mr. Greg Sorlie, Environmental Review Section, at (206) 459-6016 or Mr. E. L. Gronemyer, Radioactive Waste Management, Department of Social and Health Services, at (206) 753-3462.

Sincerely,

John F. Spencer
Deputy Director

JFS:lc

Enclosures

cc: Dennis Lundblad, WDOE
Greg Sorlie, WDOE
Mr. E. L. Gronemyer, DSHS
Agencies

JOHN SPELLMAN
Governor

M. [illegible]
Director

STATE OF WASHINGTON
DEPARTMENT OF AGRICULTURE
406 General Administration Bldg., AX-41 • Olympia, Washington 98504

Date: **January 12, 1982**

To: **Barbara Ritchie, NEPA Coordinator, Department of Ecology**

From: **Art Scheunemann**

RE: **NEPA Documents**

This is to advise you that the Department of Agriculture has no comments to make at this time on the following NEPA documents:

1. **Draft EIS - U.S. Department of Energy - "Decommissioning of the Shippingport Atomic Power Station."**

2. **Final EIS - Federal Aviation Administration - "Ocean Shores Airport, City of Ocean Shores, Washington."**

ACS/v

JOHN SPELLMAN
Governor

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Mail Stop PV-11 • Olympia, Washington 98504 • (206) 459-6000

DONALD W. MOOS
Director

January 7, 1982

TO: Barbara Ritchie

THROUGH: Bob Monn

FROM: Carol Fleskes

SUBJECT: DEIS for Decommissioning of the Shippingport Atomic Power Station

I reviewed the DEIS by U. S. Dept. of Energy on Decommissioning of the Shippingport Atomic Power Station for impacts to our state's ground water. Ground water quality impacts were discussed through reference to the FEIS on waste management Operations, Hanford Reservation. The discussion appears adequate.

The DEIS did not discuss in any detail the potential for the accidental spillage of nuclear wastes either liquid or solid. There is always a possibility for a trafic accident accompanied by the spillage of radioactive waste water.

One of the proposed shipping routes passes directly over Spokane's sole source aquifer. As a precautionary measure, we could recommend that the liquid wastes be shipped via Salt Lake City, Utah rather than Spokane, WA. See pages 3-25 and 3-27.

CLF:bh

cc: Joan Thomas
Glen Fiedler

JOHN SPELLMAN
Governor

STATE OF WASHINGTON
DEPARTMENT OF SOCIAL AND HEALTH SERVICES
Olympia, Washington 98504

ALAN J. GIBBS
Secretary

January 18, 1982

TO: Barbara Ritchie
Department of Ecology
PV-11

FROM: E. L. Gronemyer, In Charge
Radioactive Waste Management
DSHS - Radiation Control Section

SUBJECT: COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE DECOMMISSIONING OF THE SHIPPINGPORT ATOMIC POWER STATION

The draft environmental impact statement (DEIS) included enough information to understand, evaluate and draw conclusions as to the nature of the proposed project. The DEIS mentioned three options for the Shippingport reactor facility; immediate dismantlement, safe storage shut-down condition, or entombment. There appeared to be little or no discussion over the need for continued use of the reactor facility in the EIS. The reader is, therefore, left with the impression that the facility is no longer needed for research nor economically feasible to maintain.

The tone of the EIS indicates that Duquesne Light and U.S. DOE have concluded that immediate dismantling of the facility is the most logical approach. Apparently, continued operation through upgrading appears unrealistic.

The dismantling of a reactor facility, even after several months of shut-down, will result in high radiation exposures to workers. As discussed in the DEIS, certain areas of the facility will remain highly radioactive for a long period of time, mainly the pressure vessel and some related equipment. With existing high radiation areas, will proper procedures and close monitoring be adequate during dismantling operations to restrict radiation exposure to workers within those limits mentioned in the EIS? Radiation exposures, as specified in the EIS to off-site residents and to the environment, do not appear as low as reasonably achievable (ALARA).

EXHIBIT 12 (Continued)

Barbara Ritchie
Page 2
January 18, 1982

Following the dismantling of the facility, there appears to be two locations considered for the ultimate disposal of the radioactive equipment, contaminated concrete, waste and debris; Savannah River or Hanford.

Hanford should not be considered due to the excess transportation distance, costs and personnel radiation exposures. The miles to Hanford by water or highway are so far in excess of the distance to Savannah River one would think that the possibility of accidents alone would rule out Hanford.

A significant reduction in radiation exposures to transportation personnel could also be realized by using the Savannah River as the radioactive waste disposal location. The time involved and radiation exposure to personnel responsible for the safe transport of the material could be one-fourth as much by using the Savannah River disposal location. Also, overall radiation exposures to personnel along the route would be reduced appreciably by less travel time and fewer people in general being exposed.

In conclusion, we recommend the dismantling of the reactor facility even if procedures call for the work to be done in stages. Staged operations should allow for the more radioactive sections of the facility to be scheduled for dismantling at the latest date possible.

We also strongly recommended that Savannah River be used as the disposal location for the reactor components and debris with no further consideration being given to Hanford.

ELG/db

EXHIBIT 13

February 4, 1982

10 Nashoba Rd.

Sudbury MA 01776

Mr. J. D. White
Surplus Facilities Management Program Office
U.S. Department of Energy
P. O. Box 550, Room 667
Richland, Washington 99352

Dear Mr. White:

DEIS/SHIPPINGPORT DECOMMISSIONING

I have the following comments on the draft environmental impact statement.

1. Comparisons of current costs to deferred costs must be based on discounting the deferred costs. The time value of money is real and must be considered. This is not the same issue as escalation or inflation.

   Based on a modest discount rate, 1 percent/yr, the relative costs excluding contingency, of immediate dismantlement, deferred dismantlement or entombment are:

	Immediate	Deferred	Entombment
Current	$33,929,000	$11,776,500	$17,681,600
Annual Sum (present value)	0	6,633,400	7,579,700
Future (present value)	0	5,022,200	0
Total	$33,929,000	$23,432,100	$25,261,300

EXHIBIT 13 (Continued)

This shows that either of the deferred alternatives has an economic advantage over immediate dismantlement. (The value of 1 percent/yr is based on the difference between the prime commercial paper rate and the inflation rate over the past 75 years. Some other discount rate may be more appropriate. Most discount rates used to compare present to future costs are much higher than 1 percent/yr. Those would result in much more favorable costs for the deferred alternatives.)

2. The cost of future dismantlement is based on current technology. As experience in dismantling facilities (radioactive or non-radio-active) is gained, new, less costly, methods may develop. Immediate dismantlement forecloses that possibility.

3. Immediate dismantlement has much more potential for high radiation exposure to very few people. This sort of exposure is important to avoid. The most important radiation benefit of postponed dismantlement is that nobody will be subjected to a large radiation dose.

4. Most of the property, perhaps six of the seven acres, will be available for immediate use regardless of which option is selected. The seventh acre cannot conceivably be worth the tens of millions of dollars being spent on decommissioning. The value of decommissioning is reduction of exposure to radiation. In this regard, the "no action, continued surveillance" option can be considered. (The "continued operation" option is not commercially feasible. The "no surveillance" option violates NRC regulations.)

	Continued Surveillance	Immediate Dismantlement	Deferred Dismantlement	Entombment
Time Considered	500 yr	4 yr	98 yr	125 yr
Man rem	300	1,303	526	633
Total Cost	19,861,852	33,929,000	23,432,100	25,261,300

This suggests that immediate dismantlement is the least attractive alternative because it combines the greatest exposure and the greatest cost. Continued surveillance results in the least exposure and the least cost.

Deferred decommissioning may be politically unpalatable or logistically difficult. If so, some immediate action may be preferred, but the DEIS does not support that recommendation.

A deferred decommissioning proposal has this pitfall: Unless a sinking fund is operated by a non-profit entity, the taxes will probably erode the interest income too fast to keep up with inflation.

In summary, continued surveillance is the preferred alternative.

- It costs the least.
- It results in the least exposure.
- It retains all future options.

W T Hotchkiss

W. T. Hotchkiss P.E.

EXHIBIT 13 (Continued)

Calculation Notes:

A. The present value of an expenditure of $13,316,400 ninety eight years hence is:

$$(13,316,400)\left(\frac{1}{1.01}\right)^{98} = 5,022,179$$

13,316,400 is from table 2.3-4

98 is from table 2.3-4

1.01 is derived as follows:

From the statistical abstract of the U.S. (Table 890 in the 1978 edition, other table numbers in other editions), the product of interest rates on prime commercial paper from 1906 through 1980 is 20.8514. The change in consumer price index over the same period is 9.1481, so the net is:

$$\frac{20.8514}{9.1481} = 2.2793, \quad e^{\frac{\ln 2.2793}{75}} = 1.011046 \approx 1.01$$

B. The present value of $106,500 spent each year for the next ninety-eight years is:

$$(106,500) \sum_{1}^{98} \left(\frac{1}{1.01}\right)^{n} = 6,633,433$$

and for 125 years = 7,579,721

106,500 comes from tables 2.3-4 and 2.4-4

125 years comes from table 2.4-4

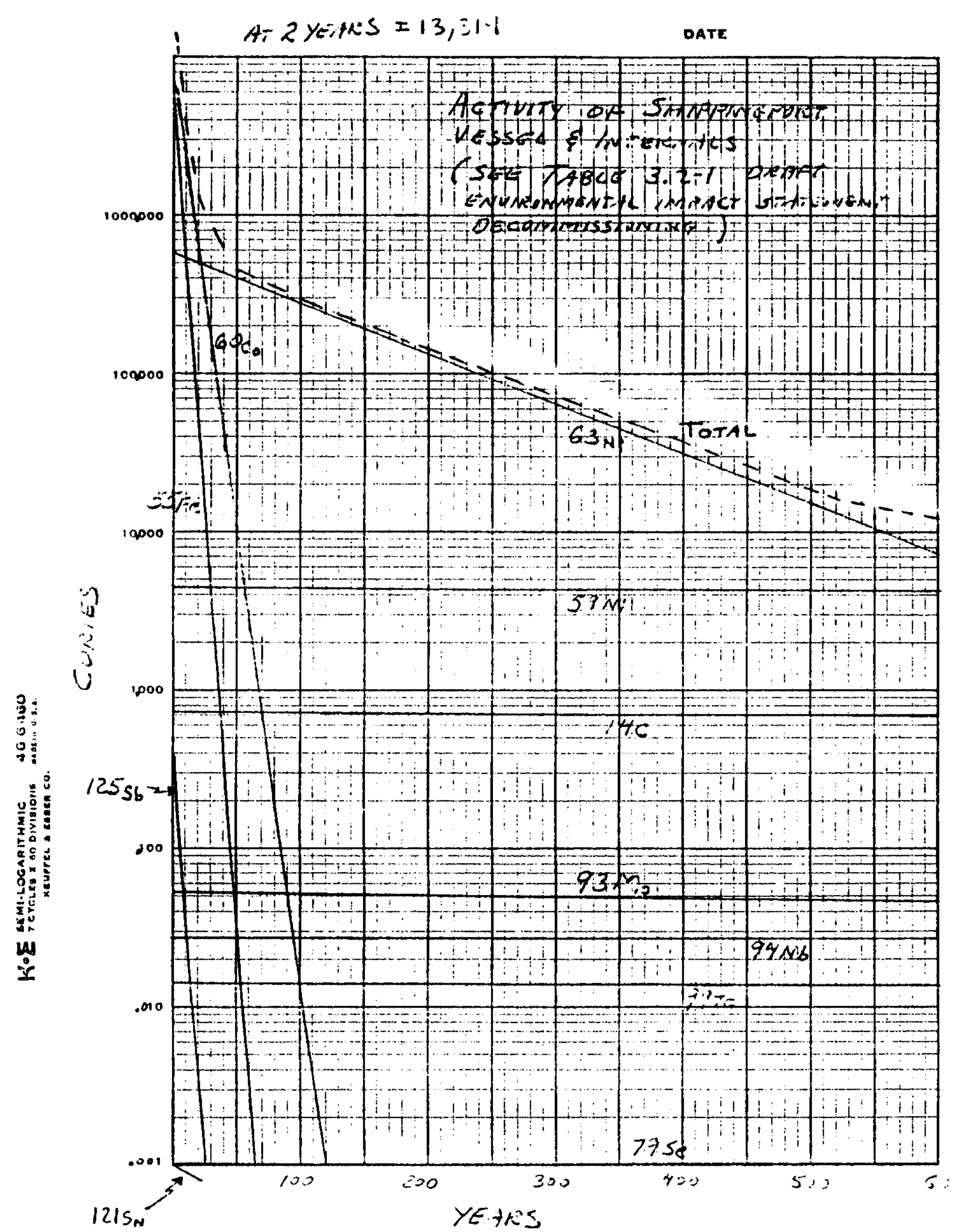
C. The present value of $200,000 spent each year for the next 500 is 19,861,852. $200,000 comes from table 2.5-1. 500 years is arbitrary.

D. The source term from the eleven isotopes on table 3.2-1 is 13,319 curies. Based on the half lives of those isotopes the source term in future years is as follows:

Year	Source (Curies)
2	13,319
10	3,657
20	1,202
50	430
100	288
200	138
500	19
1,000	5.4

A dose rate of 25 MR/yr (see table 2.5-1) will surely fall as the source term decays. If it falls at the same rate as the source term, the integrated dose for 500 yrs is 300 man rem.

EXHIBIT 13 (Continued)



GLOSSARY

Abbreviations, terms, definitions, and symbols directly related to decommissioning work and related technology are defined and explained in this glossary. It is divided into two parts, with the first part containing the abbreviations and the second part containing terms and definitions (including those used in a special sense for this work). Common terms covered adequately in standard dictionaries are not included.

GLOSSARY ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ci	Curie
DOE	Department of Energy
DOT	Department of Transportation
ha	hectare
HEPA	High Efficiency Particulate Air (Filter)
kl	kiloliter
LSA	Low Specific Activity
LWR	Light Water Reactor
$\mu g/m^3$	micrograms per cubic meter
mg/m^3	milligrams per cubic meter
mg/l	milligrams per liter
mrad	millirad
mr	milliroentgen
mrem	millirem
MWe	Megawatts, electric
MWt	Megawatts, thermal
NRC	Nuclear Regulatory Commission
ppm	parts per million
PWR	Pressurized Water Reactor

R	Roentgen
rad	radiation absorbed dose
rem	roentgen equivalent man

GLOSSARY DEFINITIONS

Activation:	The process of making a material radioactive by bombardment with neutrons, protons, or other nuclear particles.
Activity:	A measure of the rate at which a material emits nuclear radiation, usually given in terms of the number of nuclear disintegrations occurring in a given period of time.
Airborne Radioactive Material:	Radioactive particulates, mists, fumes, and/or gases in air.
ALARA:	A philosophy to maintain exposure to radiation As Low As is Reasonably Achievable.
Arc Saw:	A device with a toothless, circular saw blade that cuts by means of an arc melting the metal workpiece.
Background:	That level of radioactivity from external sources existing without the presence of a nuclear plant, adjusted for any change occurring during the lifetime of a nuclear facility such as might result from atmospheric weapons testing.
Blanket:	A layer of fertile material, such as uranium-238 or thorium-232, placed around the fissionable material in a reactor.

Breeder Reactor: A reactor that produces fissionable fuel as well as consuming it, especially one that creates more than it consumes.

Burial Ground: An area designated for burying unwanted radioactive objects to prevent the escape of their radiation, with near-surface soils acting as a shield.

Cladding: The outer jacket of nuclear fuel elements. It prevents corrosion of the fuel and the release of fission products into the coolant.

Code of Federal Regulations (CFR): The Code of Federal Regulations is a codification of the general rules of agencies of the Federal Government. The code is divided into 50 titles that represent broad areas subject to Federal regulation. Each title is divided into chapters that usually bear the name of the issuing agency. Each chapter is further subdivided into parts covering specific regulatory areas.

Contamination: Undesired radioactive materials that have been deposited on surfaces, are internally ingrained into structures or equipment, or that have been mixed with another material.

Coolant: A substance circulated through a nuclear reactor to remove or transfer heat.

Curie: A special unit of activity. One curie equals 3.7×10^{10} nuclear disintegrations per second (abbreviated Ci). Several fractions of the curie are in common usage:

- Millicurie - one thousandth of a curie. Abbreviated mCi.
- Microcurie - one millionth of a curie. Abbreviated μCi.
- Nanocurie - one billionth of a curie. Abbreviated nCi.
- Picocurie - one millionth of a microcurie. Abbreviated pCi; replaced term pC.

Decay, Radioactive: A spontaneous nuclear transformation in which a particle, gamma radiation, or x radiation is emitted.

Decommissioning: Preparations made for retirement from active service of nuclear facilities, accompanied by the execution of a program to reduce or stabilize radioactive contamination. Actions are taken to minimize potential health and safety impacts of the retired nuclear facility on the public (see also "Mode").

Decontamination: Those activities employed to reduce the levels of contamination in or on structures and equipment.

Decontamination Agents: Those chemical materials used to effect decontamination.

Dismantlement: Those actions required to disassemble and remove sufficient radioactive or contaminated equipment/ materials from the facility and site to permit release of the property for unrestricted use. This may also involve removal of noncontaminated materials (see "Mode").

Disposal: The management of radioactive waste in a manner that precludes or severely restricts recovery of the waste.

Dose, Absorbed: The mean energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. The unit of absorbed dose is the rad. One rad equals 0.01 joules/kilogram in any medium (100 ergs per gram.)

Dose, Equivalent: Expresses an effective radiation dose in man, in rems, when modifying factors have been considered. The product of absorbed dose multiplied by a quality factor multiplied by a distribution factor.

Dose, Occupational: The exposure of an individual to radiation above background as imposed by his employment.

Dose, Radiation: As commonly used, it is the quantity of radiation absorbed in a unit mass of a medium, frequently a human organ.

Dose Rate: The radiation dose delivered per unit time and measured, for instance, in rems per hour.

Effluent: Radioactive wastes discharged to the offsite environment. These effluents are not discharged to the environment until after all engineered waste treatment and all effluent controls, including onsite retention and decay, have been effected. The term does not include solid wastes, wastes which are contained or stored, or wastes which remain onsite through treatment or disposal.

Entombment: Sealing or burying radioactive or contaminated equipment/material within a strong and structurally long-lived receptacle (e.g., concrete). The structure must provide integrity for a period of time sufficient to assure retention until radioactivity decays to an unrestricted level (see "Mode").

Environmental Impact Statement (EIS): Provides the information required to evaluate the impact of alternative actions and provides guidance for preparation of engineering and procedures for the project. Preparation guidelines are contained in "Regulations for Implementating the Procedural Provisions of the National Environmental Policy Act," (40 CFR Parts 1500-1508)

Exposure: A measure of the ionization produced in air by x or gamma radiation. It is the sum of the electrical charges on all ions of one sign produced in air when all electrons liberated by photons in a volume element of air are completely stopped in air, divided by the mass of the air in the volume element. The special unit of exposure is the roentgen.

Fission: The splitting of a heavy nucleus into two approximately equal parts, accompanied by the release of a relatively large amount of energy and generally one or more neutrons. Fission can occur spontaneously, but usually is caused by nuclear absorption of gamma rays, neutrons or other particles.

Fission Products: Elements or compounds resulting from fission. These materials are normally beta and/or gamma emitters. Primary examples are Cs-137 and Sr-90.

Fuel: Fissionable material used or usable to produce energy in a reactor.

Fuel Rod: A rod into which nuclear fuel is fabricated for use in a reactor.

Genetic Effects: Radiation effects that can be transferred from parent to offspring. Any radiation caused changes in the genetic material of sex cells.

Half-life: The time required for the activity to decay to half its initial value. Each radionuclide has a unique half-life. For example, a specimen of Pu-241 decays by 50% into Am-241 in about 13 years.

Heavy Water: [Symbol D_2O] Water containing significantly more than the natural proportion of heavy hydrogen atoms (mass number 2) to ordinary hydrogen atoms (mass number 1). Heavy water is used as a moderator in some reactors because it slows down neutrons effectively and also has a low cross section for absorption of neutrons.

Ionizing Radiation: Any radiation displacing electrons from atoms or molecules, thereby producing ions. Examples: alpha, beta, gamma, radiation, short-wave ultraviolet light. Ionizing radiation may produce severe skin or tissue damage.

Isotope: The species of an element that is characterized by the number of neutrons in its nucleus, and hence by the same atomic number for a given element but by a unique mass number. In most instances, a particular element can exist as several isotopes, all with similar chemical properties. Isotopes can be either stable or decay by radiation (also called radioisotopes).

Light Water: Ordinary water (H_2O), as distinguished from heavy water (D_2O).

Liquid Radioactive Waste: Solution, suspensions, and mobile sludges consisting of, including, or contaminated with radioactive waste.

Long-Lived Nuclides: For this study, radioactive isotopes with long half-lives typically taken to be greater than about 10 years. Most nuclides of interest to waste management have half-lives on the order of one year to millions of years.

Loose Contamination: Undesired radioactive materials that have been deposited on surfaces.

Low-Level Waste: Wastes containing types and concentrations of radioactivity such that no shielding or relatively little shielding is required to minimize personnel exposure.

Man-rem: Used as a measure of population dose and calculated by summing the dose equivalent in rem received by each person in the population. Also, it is used as the absorbed dose of one rem by one person with no rate of exposure inferred.

Maximum-Exposed Individual: A hypothetical individual in the general population who is located at the point of highest ground-level concentration of radioactive materials and is subject to the highest radiation dose from radioactive materials that are discharged from the plant.

Millirad: A submultiple of the rad, equal to one-thousandth of a rad. (See Rad.)

Milliroentgen:	A submultiple of the roentgen, equal to one-thousandth of a roentgen. (See Roentgen.)
Millirem:	A submultiple of the rem, equal to one-thousandth of a rem. (See Rem.)
Mode:	The method or option selected by a facility owner-operator as a course of decommissioning/disposition action. Several terms (many having their origin in NRC Regulatory Guide 1.86) have been used to describe varying degrees of such action. Examples are layaway, mothballing, protective storage, safe storage, entombment, and immediate dismantlement.
Monitoring:	Taking measurements or observations in order to recognize significant changes in conditions.
Natural Background Radiation:	Radiation in the human environment from naturally occurring elements and from cosmic radiation.
Neutron Flux:	A measure of the intensity of neutron radiation. It is the number of neutrons passing through 1 square centimeter of a given target in 1 second.
Neutron:	An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen. Neutrons sustain the fission chain reaction in a nuclear reactor.
Nuclide:	Isotope.

Nuclide Inventory: A list of the kinds and amounts of radionuclides present in a facility. Amounts are usually expressed in activity units: curies or curies per unit volume.

Oxyacetylene Cutting: This cutting process consists of a flowing mixture of a fuel gas and oxygen ignited at the orifice of a torch. The cutting tip of the torch consists of a main oxygen jet orifice surrounded by a ring of preheater jets. When the metal to be cut reaches approximately 1500^{O}F, the main oxygen jet is turned on, the heated metal is "burned" away leaving a cut surface.

Plasma-Arc: This cutting process is based on the establishment of a direct current arc between a tungsten electrode and any conducting metal. The arc is established in a gas, such as argon, which flows through a constricting orifice in the torch nozzle to the workpiece. The plasma is ejected from the nozzle at a very high temperature and velocity and, in combination with the arc, melts the contacted workpiece metal.

Pressure Vessel: A strong-walled container housing the core of most types of power reactors; it usually also contains moderator, reflector, thermal shield, and control rods.

Pressurized Water Reactor: A power reactor in which heat is transferred from the core to a heat exchanger by water kept under high pressure to achieve high temperature, without boiling in the primary system. Steam is generated in a secondary system.

Rad: The unit of absorbed dose. The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. One rad equals 0.01 joules/kilogram of absorbing material.

Radiation: Energetic nuclear particles including neutrons, alpha particles, beta particles, x-rays, and gamma rays (nuclear physics). Also includes electromagnetic waves (radiation) of any origin.

Radiation Shielding: Reduction of radiation by interposing a shield of absorbing material between any radioactive source and a person, laboratory area, or radiation-sensitive device.

Radioactive Waste: Materials of no current use consisting of high-level waste, transuranic waste, low-level waste, including or contaminated with, radioactive nuclides in excess of the levels of concentrations permitted for unconditional release of excess contaminated property.

Radioactivity: The property of certain nuclides of spontaneously emitting particles, gamma or radiation. Often shortened to "activity."

Reflector: A layer of material immediately surrounding a reactor core which scatters back or reflects into the core many neutrons that would otherwise escape. The returned neutrons can then cause more fissions and improve the neutron economy of the reactor.

Rem: (Acronym for roentgen equivalent man.) A unit of dose equivalent. The dose equivalent in rems is numerically equal to the absorbed dose in rads multiplied by the quality factor, the distribution factor, and any other necessary modifying factors.

Remotely Operated: Operations by remote means, i.e., the human is separated by a shielding wall from the item being operated.

Residual Radioactivity: Lingering or remaining radioactivity.

Roentgen: A unit of exposure to ionizing radiation. It is that amount of gamma or x-rays required to produce ions carrying one electrostatic unit of electrical charge (either positive or negative) in one cubic centimeter of dry air under standard conditions. One roentgen equals 2.58 x 10^{-4} coulomb per kilogram of air.

Safe Storage: Those actions required to place and maintain a nuclear facility in a condition that future risk from the facility to public and occupational safety is within acceptable limits, so that the facility can be safely stored for the time desired. (See "Mode").

Seed-blanket: A reactor core which includes a relatively small volume of highly enriched uranium (the seed) surrounded by a much larger volume of natural uranium or thorium (the blanket). As a result of fissions in the seed, neutrons are supplied to the blanket where more fission takes place. In this way, the blanket is made to furnish a substantial fraction of the total power of the reactor.

Shaped Charges: Explosives that are formed in a geometric shape especially designed and sized to produce the desired separation of the workpiece.

Shield: A body of material used to reduce the passage of particles or radiation. A shield may be designated according to what it is intended to absorb (as a gamma ray shield or neutron shield), or according to the kind of protection it is intended to give (as a background, biological, or thermal shield).

Short-Lived Radionuclides: For this study, those radioactive isotopes with half-lives less than about 10 years.

Shutdown: The time during which a facility is not in operation.

Site: The geographic area upon which the facility is located and which is subject to controlled public access.

Solid Radioactive Waste: Material that is essentially solid and dry but may contain absorbed radioactive fluids in sufficiently small amounts as to be immobile.

Solidification: Conversion of radioactive wastes (gases or liquids) to dry, stable solids.

Somatic Effect: Effects of radiation limited to the exposed individual, as distinguished from genetic effects. Larger radiation doses can be fatal. Smaller doses may make the individual noticeably ill, may merely produce temporary changes in blood-cell levels detectable only in the laboratory, or may produce no detectable effects whatever.

Specific Activity: The radioactivity of a radioisotope of an element per unit mass or volume of the element in a sample. The activity per unit mass or volume of a pure radionuclide. The activity per unit mass or volume of any sample of radioactive material.

Spent Fuel:	Nuclear fuel that has been removed from the reactor for disposal.
Storage:	The management of radioactive waste in a manner that permits retrieval.
Surface Contamination:	The deposition and attachment of radioactive materials to a surface.
Surveillance:	Those activities necessary to assure that the site remains in a safe condition (including periodic inspection and monitoring of the site, maintenance of barriers limiting access to radioactive materials left on the site, and prevention of activities on the site which might impair these barriers).
Test Reactor:	A reactor specially designed to test the behavior of materials and components under the neutron and gamma fluxes and temperature conditions of an operating reactor.
Transuranics:	Radioactive material contaminated with elements having an atomic number greater than 92, having a half-life greater than 5 years and in concentrations greater than 100 nanocuries per gram.
Unrestricted Use:	Complete removal of radioisotopes to another site or facility, releasing the facility for general use or for general public access.
Waste, Radioactive:	Equipment and materials (from nuclear operations) that are radioactive and for which there is no further use. Also called radwaste.

Wind Rose: A radial graph of which the arms represent average wind velocities and/or wind direction frequencies for each of the four, eight, or sixteen points of the compass over a given period of time.

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