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SHIPPINGPORT STATION DECOMMISSIONING PROJECT
Overview and Justification

Conference Paper
by
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at
ANS Spring '84 Meeting

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EXECUTIVE SUMMARY

The purpose of this briefing booklet is to describe the justification for funding of the Shippingport Station Decommissioning Project. Probably the most important justification for the project is that it will provide a needed demonstration of dismantlement of a large size nuclear power reactor. A number of other justifications are discussed, including the fact that initiation of dismantlement in FY 1984 costs less than any other acceptable decommissioning alternative.

In the next fifteen years, a total of approximately twenty power reactors are expected to be eligible for decommissioning. Although some power reactors, such as Elk River, have already been decommissioned, none of the past work has demonstrated the new and improved techniques that are planned for Shippingport. Further, unlike Elk River and other decommissioned reactors, the size and complexity of Shippingport are comparable to the commercial reactors which will be eligible for decommissioning in the near future.

One of the most promising of the new decommissioning techniques planned for use at Shippingport is one-piece removal of the reactor pressure vessel. (In all previous dismantlement work, the vessel was segmented.) Compared to the segmentation approach, one-piece removal of the Shippingport vessel would shorten the four-year decommissioning schedule by one year, would reduce the total cost by $7 million, would reduce occupational exposure from 240 rems to 140 rems, and would reduce packaging and transport of reactor vessel waste from 80 separate truck shipments to one barge shipment.

Subsequent wider use of this technique could result in cumulative savings of many millions of dollars in commercial reactor decommissioning as well as significant reductions in personnel exposure and waste shipments from these projects.

Because the number of power reactors eligible for decommissioning will increase substantially in the next fifteen years, a timely and effective demonstration of reactor decommissioning is needed now. The advantages of such a demonstration are:

- It could be clearly demonstrated to the industry and the public that power reactors can be decommissioned safely and at reasonable cost.
- The one-piece vessel removal concept could be demonstrated.
- Decommissioning lessons could be learned early enough to allow the industry to better plan and implement decommissioning of the commercial plants that will be shutting down over the next fifteen years.
- This project could serve DOE in fulfilling its responsibility to develop and demonstrate new techniques for efficient decommissioning of light water reactors.

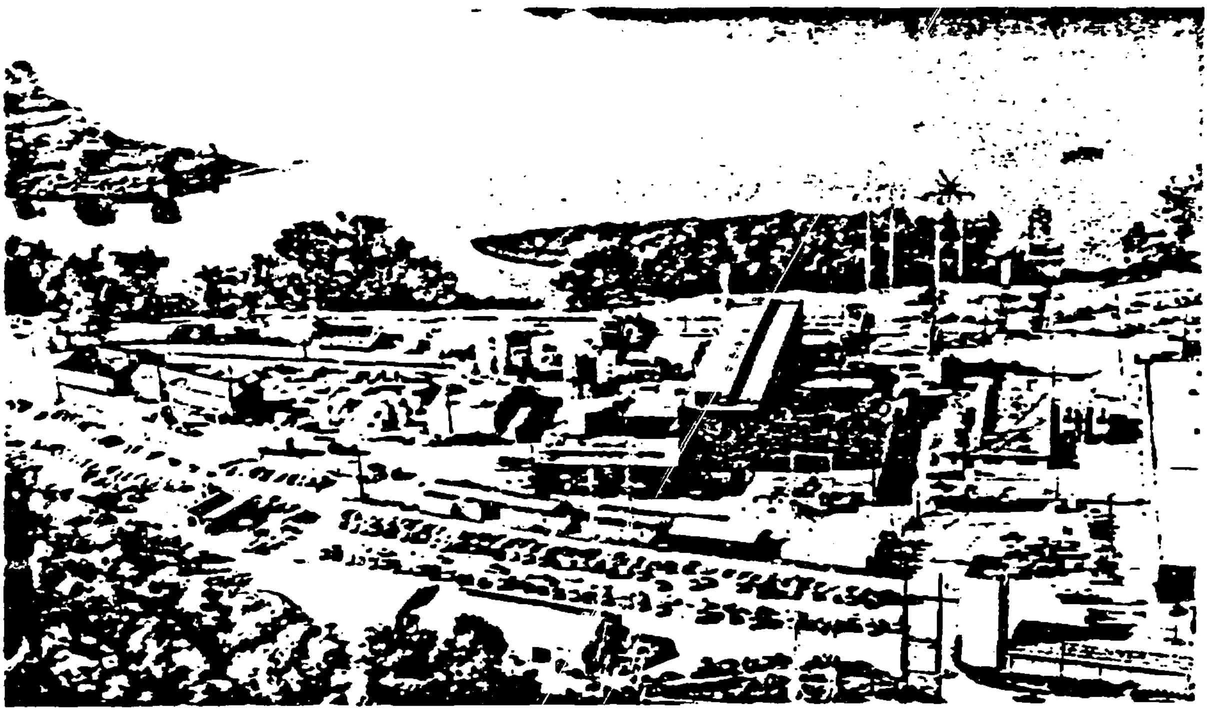
The Shippingport Project can provide the needed demonstration of reactor decommissioning and can significantly add to the viability of the light water reactor as an energy production alternative by showing that reactor decommissioning is both practical and affordable.

INTRODUCTION

The purpose of this booklet is to brief the reader on the Shippingport Station Decommissioning Project and to summarize the benefits of funding the project in FY 1984. Background information on the station and the decommissioning project is provided in this section of the booklet; the need for a reactor decommissioning demonstration is discussed in the next section; and a summary of how the Shippingport Station Decommissioning Project (SSDP) provides the needed demonstration is provided in the final section.

History of the Shippingport Atomic Power Station (SAPS)

The Shippingport Atomic Power Station was constructed during the mid-1950's as a joint project of the Federal Government and the Duquesne Light Company. The purpose of the project was both to develop and demonstrate pressurized water reactor (PWR) technology and to generate electricity. The station consists of a PWR currently rated at 72-MWe, a turbine generator and associated facilities. The station is located on the south bank of the Ohio River at Shippingport, Pennsylvania, on approximately seven acres of land leased from Duquesne Light Company by the U.S. Department of Energy (DOE).



The reactor and steam generating portions of the station are owned by DOE, and the electrical generating portion is owned by Duquesne Light Company. The station achieved criticality in December 1957 and is operated by Duquesne Light Company under supervision of the DOE Office of the Deputy Assistant Secretary for Naval Reactors. At completion of the light water breeder reactor (LWBR) demonstration program, DOE shut the station down in October 1982. Following end-of-life testing and defueling, which began immediately after shutdown and is expected to take two years, the station will be available for decommissioning.

Decommissioning Alternatives for the Shippingport Atomic Power Station (SAPS)

Once the decision was made by DOE to shut down the Shippingport Station, a range of decommissioning alternatives were evaluated and reported in an Environmental Impact Statement, "Decommissioning of the Shippingport Atomic Power Station", May 1982.

The primary decommissioning alternatives are:

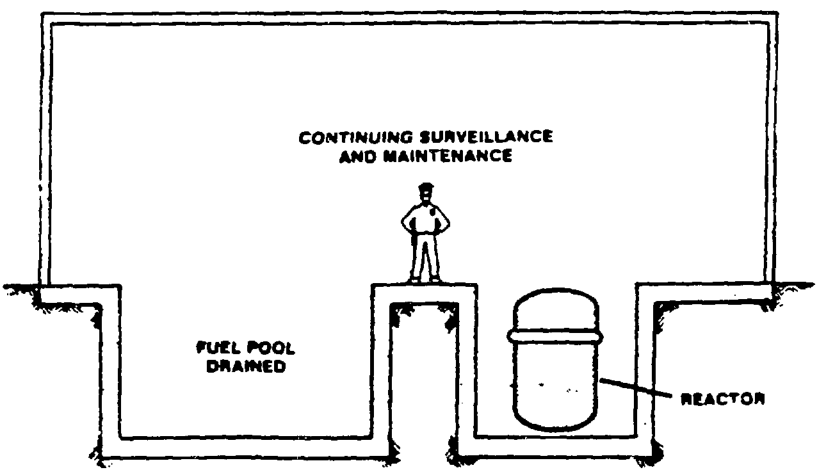
- Close the station and continue existing security and surveillance;
- Place the station in a safe storage condition and defer dismantlement for approximately 90 years;
- Entomb the major radioactive portions of the station and remove other contaminated material;
- Dismantle the station immediately.

Closing the station and continuing security and surveillance, (also called a **no action** alternative), is not feasible because the potential environmental impacts are unacceptable. In addition, this alternative would require annual expenditures for surveillance and maintenance without accomplishing any disposition work.

The remaining alternatives are explained in the following narrative and diagrams:

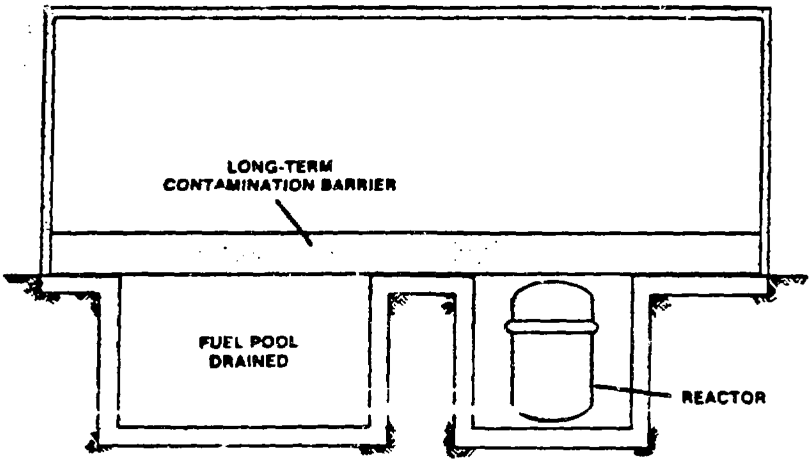
Safe storage followed by deferred dismantlement is defined as work necessary to place and maintain the facility in such condition that risk from the facility to public safety is within acceptable bounds, and in such condition that the facility may be safely stored for as long as desired. During the safe storage period, security, surveillance, monitoring, and maintenance are provided on a continuing basis. At the end of the safe storage period, dismantlement of the facility is carried out and all materials that still have radioactivity levels greater than those permitted for unrestricted use are removed and shipped to a disposal site.

SAFE STORAGE-
DEFERRED DISMANTLEMENT



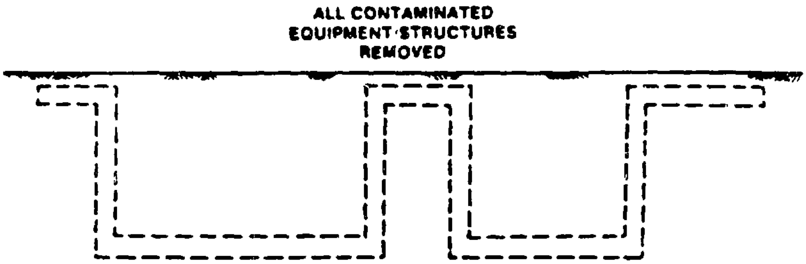
Entombment is defined as encasement of radioactive materials and components in a massive structure, sufficiently strong and long-lived to ensure the retention of the radioactivity until it decays to unrestricted use levels. During the entombment period, security, surveillance, monitoring, and maintenance are provided.

ENTOMBMENT



Immediate dismantlement is defined as 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 site and the remaining facility.

IMMEDIATE DISMANTLEMENT



Preferred Decommissioning Alternative

Immediate dismantlement was chosen by DOE (Record of Decision published in the Federal Register, August 19, 1982, Volume 47, page 36276) for the following reasons:

- Immediate dismantlement costs less than either entombment or safe storage followed by deferred dismantlement.
- Immediate dismantlement results in early release of the site and any remaining portion of the facility for other beneficial uses.
- While immediate dismantlement results in the highest occupational radiation dose and the largest volume of radioactive waste, it also eliminates any future potential for radioactive releases from the site and results in the early protection of the public by removal of radioactive material from the site and transferral to a waste disposal area.
- An operating crew, experienced with Shippingport Station, will be available to assist in decommissioning activities.
- Immediate dismantlement will serve as a demonstration that nuclear plants can be decommissioned safely and in a cost-effective manner.

The lease agreement between DOE and Duquesne Light Company requires DOE, upon expiration or termination of the lease, to "make the premises safe from a radiation standpoint" and conveys ownership to Duquesne Light Company of any buildings and equipment not removed from the site within two years after expiration or termination of the lease. The existing lease expires March 17, 1994. Duquesne Light Company has formally stated that the only method of decommissioning acceptable to the Company is prompt dismantlement.

Impacts of Delaying Dismantlement

If dismantlement of the Shippingport Station is delayed, the following problems will be encountered:

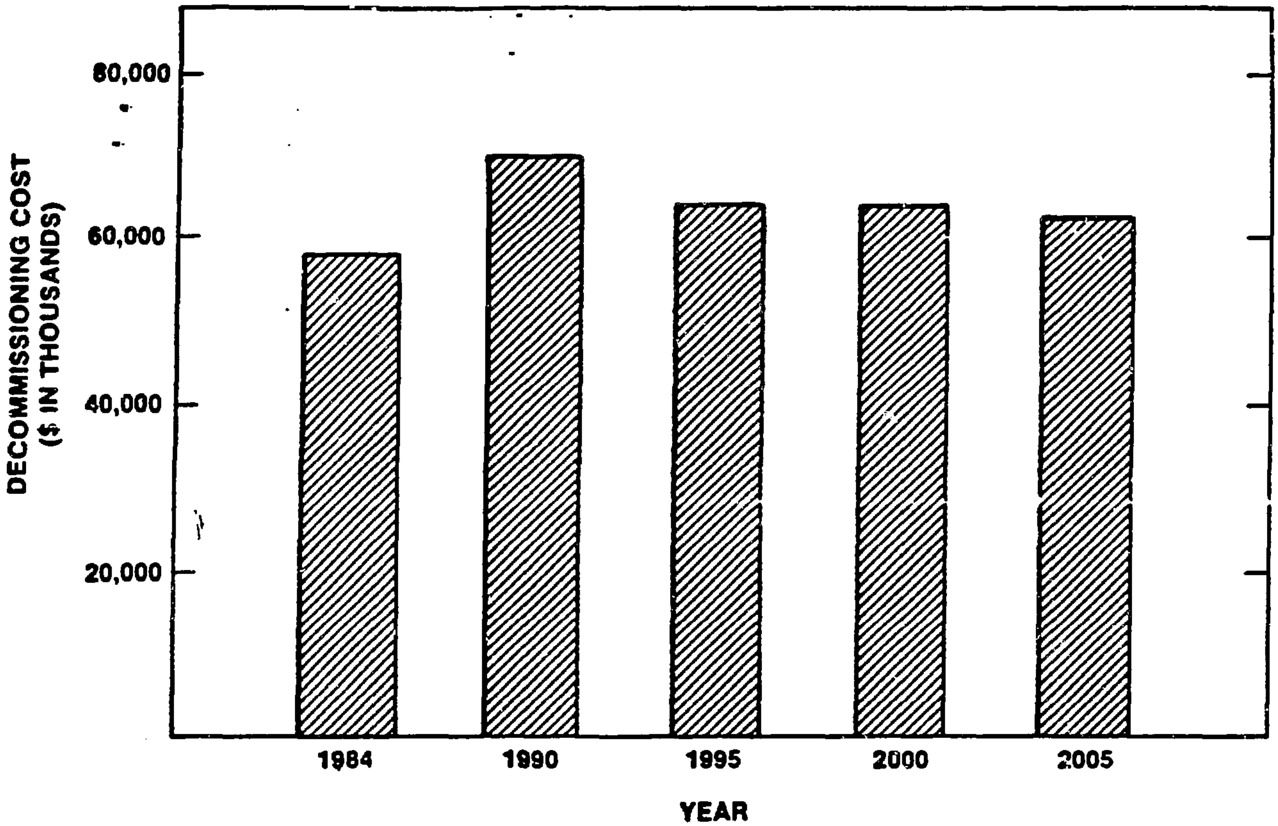
- If the Shippingport Station Decommissioning Project is not initiated in FY 1984, the present crew of experienced Duquesne Light Company operations personnel would be re-assigned and would not be available to operate the plant systems or train the Decomissioning Operations Contractor staff. If these experienced personnel are lost, this discontinuity will cause significant inefficiency in the project and result in higher costs.

- If the Shippingport Station Decommissioning Project is not initiated in FY 1984 and is deferred to 1990, the radioactive liquids in the plant would have to be removed and most of the equipment would have to be deactivated. The plant would no longer be in the configuration required for dismantlement, and many systems would probably become inoperable. Re-engineering and equipment repair or replacement would be required prior to start of decommissioning operations. The cost of this additional work could be significant.

- If the Shippingport Station Decommissioning Project is not supported in FY 1985 and is postponed to 1990 or later, additional costs will be incurred to place the plant in a safe shutdown condition. Additional lease payments to Duquesne Light Company will also have to be made each year, beginning in FY 1985. Duquesne Light Company has advised DOE that the utility will not charge for the lease if the dismantlement project is initiated in FY 1984.

By delaying dismantlement of Shippingport, the extra costs discussed above would be incurred when DOE finally dismantles the station. A "time value" analysis (which factors in these extra costs and the effects of inflation, escalation and the cost of borrowing money) shows that a delay in dismantlement would result in higher decommissioning costs than beginning the project in FY 1984.

TIME VALUE ANALYSIS OF COSTS



This graph shows that prompt initiation of dismantlement results in lower cost than even a few years delay in the project. For example, dismantlement initiated in 1984 will cost a total of approximately $60 M, excluding preliminary engineering. Dismantlement initiated in 1990 would result in a total cost of approximately $70 M in "time value" dollars.

THE NEED FOR A DECOMMISSIONING DEMONSTRATION

Decommissioning of commercial nuclear power plants will be an ever increasing need within the next fifteen years.

There are seventy-five Pressurized Water Reactors (PWR) and Boiling Water Reactors (BWR) presently operating in the United States. Another sixty-nine commercial nuclear reactors are on order, or have limited work authorization, construction permits or operating licenses. Assuming a lifetime of thirty years, it is estimated that approximately fifteen reactors will be eligible for decommissioning by the end of the century, fifty-three by the year 2005 and seventy by the year 2010. In addition, several other reactors have already been shutdown prior to their estimated thirty-year life span. These reactors may not be restarted for power production, thereby making them prime candidates for decommissioning.

Some decommissioning of test reactors and small commercial reactors has taken place over the past twenty years. The following table shows the reactor decommissioning work that has been performed, along with the decommissioning alternative chosen.

PREVIOUSLY DECOMMISSIONED REACTORS

Reactor	Mode of Decommissioning	Date of Decommissioning
Hallam Nuclear Power Facility	Entombment	1968
Piqua Nuclear Power Facility	Entombment	1969
BONUS	Entombment	1970
Elk River	Dismantlement	1974
Peach Bottom	Safe Storage	1978
Los Alamos Molten Plutonium Reactor Experiment	Dismantlement	1980
SRE (Sodium)	Dismantlement	1982

Only three reactors have actually been dismantled. Of these three dismantled reactors, Elk River is the closest in size and type to older commercial PWR and BWR reactors now in operation.

The next table shows Elk River and the reactors that are now or will soon be ready for decommissioning. Most of these reactors are larger than Elk River. A few of them closely approach the reactor pressure vessel size of the present day commercial plants.

POWER REACTORS ELIGIBLE FOR DECOMMISSIONING

REACTOR VESSEL CHARACTERISTICS

PLANT	POWER (MWe)	VESSEL SIZE	WALL THICKNESS	ACTIVITY (CURIES)	WEIGHT (TONS)	COMM. OPS.	TYPE	POWER GENERATED (MWhrs X 10^6)
Elk River	22.5	D= 7.5' H= 28'	3"	1.0×10^3	<90	1964	BWR	0.4
Shippingport	72	D= 10.5' H= 35'	8.4"	1.2×10^4	218	1957	PWR	7
Indian Point #1	265	D= 10' H= 33'	7"	3.5×10^6	225	1962	PWR	30
Humbolt Bay	65	D= 10' H= 40.5'	6"	N.A.	159	1963	BWR	5
Dresden 1	207	D= 13' H= 41'	5.5" Sides 9" Bottom	N.A.	–	1960	BWR	17
Yankee Rowe	175	D= 10.5' H= 31.5'	8"	N.A.	150	1961	PWR	24
Big Rock Point	64	D= 9.7' H= 30'	5.3	N.A.	120	1963	BWR	7
Haddam Neck	582	D= 13' H= 42'	10.6"	N.A.	–	1968	PWR	59
Monticello	545	D= 17' H= 63'	5"	N.A.	–	1971	BWR	*39
Oyster Creek	650	D= 18' H= 64'	7.3"	N.A.	–	1969	BWR	*44
San Onofre	436	D= 12' H= 37'	9.8"	N.A.	–	1968	PWR	*37
Nine Mile Point	620	–	7"	N.A.	–	1969	BWR	*43
Vermont Yankee	514	D= 17' H= 63'	5"	N.A.	–	1972	BWR	*31

*As of early 1982

The Elk River Reactor decommissioning project is probably the most directly applicable dismantling experience gained by the nuclear industry to date. However, the **experience gained at Elk River is of limited value because:**

- Elk River demonstrated segmentation (or cutting apart) of the reactor pressure vessel. A new and improved concept, one-piece removal of the vessel, has been suggested for the future. This technique, which has never been demonstrated, would result in lower cost and personnel exposure, fewer radioactive waste shipments and shorter decommissioning project schedules.
- The Elk River decommissioning techniques are now nearly a decade old. Current state of the art techniques, such as improved remote tooling, new decontamination methods, and improved explosive demolition should be demonstrated. In addition, the radiation levels at most power reactors are much higher than Elk River (because these reactors have significantly greater cumulative power generation).
- The Elk River project did not include decommissioning of the systems found in typical power reactors. For example, no radioactive waste treatment systems were decommissioned as a part of Elk River project. In addition, the Elk River pressure vessel was smaller than the vessel in most older PWR's and BWR's.
- Previous decommissioning projects such as Elk River and the BONUS, Piqua and Hallam Facilities (which were entombed) did not collect data on cost, schedule and occupational exposure in such a way to provide a good base for future planning.

Because of the limitations of earlier reactor decommissioning work and because a large number of reactors will be ready for decommissioning within the next fifteen years, a need clearly exists to begin now to develop and demonstrate improved techniques. **If a full scale power reactor decommissioning demonstration project is completed in the immediate future, the following advantages would be realized:**

- The public and power generation industry could be clearly shown that power reactors can be decommissioned safely and at reasonable cost.
- Decommissioning lessons could be learned earlier, on one major project rather than waiting for multiple decommissioning projects that proceed simultaneously.
- A good engineering data base could be developed earlier, so that the power generation industry could more accurately estimate and plan for ultimate decommissioning costs. To date, power reactor decommissioning cost data have been developed from conceptual studies and by extrapolating results from earlier projects, such as Elk River.
- A dismantlement demonstration could provide improvement in the design of commercial power plants. A plant designed and built after an actual decommissioning demonstration should benefit from the decommissioning experience. This could result in improved design and lower ultimate decommissioning costs.
- A demonstration project, especially one involving removal of the vessel in one piece, could provide a data base that might assist the analysis of a "repowering" option. (Repowering consists of removing the old reactor pressure vessel, replacing it with a new vessel and then continuing operation of the plant using the longer-lived auxiliary and generating equipment.)
- Use of the new techniques such as one-piece vessel removal, that would be proven by a demonstration project, could result in significant cumulative reductions in reactor decommissioning costs, personnel exposure and radioactive waste transportation over the next several decades.

As discussed on the preceeding page, an early demonstration of the complete dismantlement of a power reactor offers many powerful advantages. Based on the following excerpts from Section 102 of the DOE Organization Act, it appears that the Department is charged with the responsibility for such development and demonstration work.

Section 102(5)

"...to carry out the planning, coordination, support, and management of a balanced and comprehensive energy research and development program including - (C) undertaking programs for the optimal development of the various forms of energy, production, and conservation; (D) disseminating information resulting from such programs, including disseminating information on the commercial feasibility and use of energy from fossil, nuclear, solar, geothermal, and other energy technologies."

Section 102(13)

"To assure incorporation of natural environmental protection goals in the formulation and implementation of energy programs, and to advance the goals of restoring, protecting, and enhancing environmental quality, and assuring public health and safety."

HOW SSDP FULFILLS THE NEED FOR DEMONSTRATION

As discussed in the Introduction, the Shippingport reactor is largely owned by the U.S. Department of Energy (DOE). The Office of Deputy Assistant Secretary for Naval Reactors shut the plant down in October, 1982, and, after a two-year end-of-life testing and defueling process, will turn the plant over to DOE Nuclear Energy for decommissioning.

Shippingport offers many advantages as a dismantling demonstration project. The reactor vessel is 35 feet high, 10.5 feet in diameter and has a wall thickness of 8 3/4 inches. The typical older generation BWR or PWR has a reactor vessel height of about 40 feet, a 10-13 foot diameter and a wall thickness of 8 inches. Because of the similarity in size and type of the Shippingport vessel and plant systems to commercial power reactors, the Shippingport Station Decommissioning Project would serve to demonstrate successful technology and procedures for decommissioning of other power reactors.

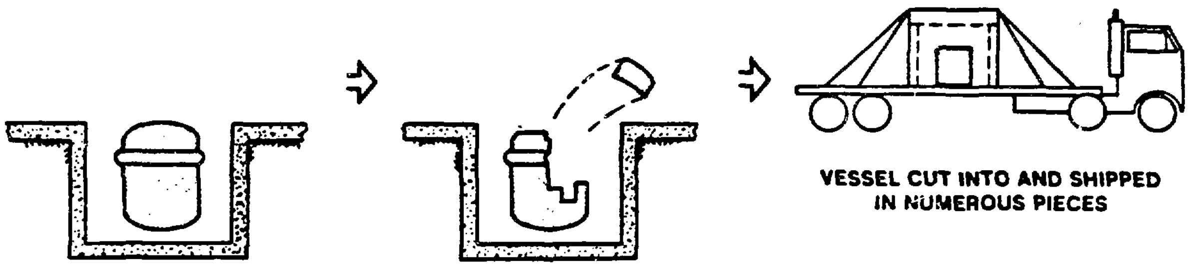
Preliminary engineering studies have shown the one-piece reactor vessel removal concept to be feasible. The most significant advantages of one-piece removal are shown in the following table.

TYPICAL ADVANTAGES OF ONE-PIECE VESSEL REMOVAL (Shippingport Station Decommissioning)

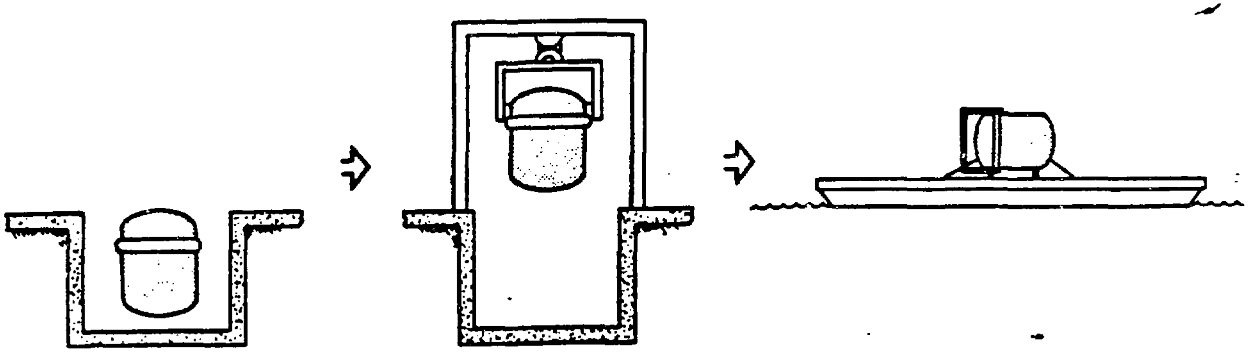
	Segmented	One-Piece	Advantages
Project Duration:	4 years	3 years	save 1 year
Exposure: (Reactor Vessel & Internals)	240 rems	140 rems	save 100 rems
Waste Shipment: (Reactor Vessel & Internals)	80 trucks	1 barge	no highway shipments
Total Project Cost:	$75 million	$68 million	save $7 million

One piece removal is a new concept to decommissioning and has never been demonstrated with a reactor pressure vessel. The drawings below illustrate the major differences between the one-piece and segmented approaches in the vessel removal sequence.

SEGMENTED REMOVAL



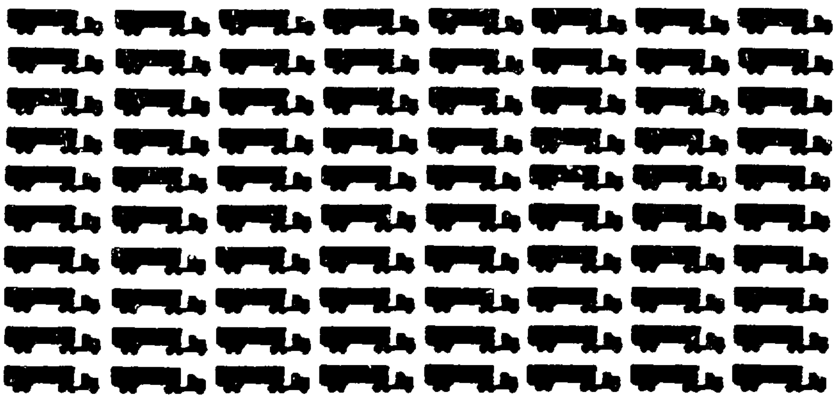
ONE-PIECE REMOVAL



By demonstrating this concept now, utilities may begin to plan to use one-piece removal during decommissioning of their old reactors. Use of this concept will reduce radiation exposure, shorten the project schedule, reduce project costs, and, as shown by the drawing below, greatly reduce the number of waste shipments to disposal sites.

Comparative Waste Shipment Volumes
(Reactor Vessel and Internals)

SEGMENTED REMOVAL
Truck Shipment
(Approx. 80 Loads)



ONE-PIECE REMOVAL
Barge Shipment
(1 Load)

Shippingport contains many of the same or similar auxiliary support systems as an older generation BWR or PWR. As shown below, the Elk River plant had few of the same systems and therefore, did not provide a demonstration of decommissioning techniques for such systems. Shippingport would provide the needed demonstration on auxiliary support systems similar to those in commercial plants.

MAJOR AUXILIARY/SUPPORT SYSTEMS

ELK RIVER SYSTEMS

- Reactor Coolant Sys/Natural Circulation
- Instrumentation & Control
- Service Air
- HVAC System (Heating, Ventilation and Air Conditioning)
- Chemical Shutdown
- Steam System (Super-Heater Boiler)
- Building Cranes
- Purification System
- Canal Water
- Fuel Handling & Storage
- DC Systems

SHIPPINGPORT SYSTEMS

- Reactor Coolant Sys/Pumps
- Instrumentation & Control
- Service Air
- HVAC Systems (Heating, Ventilation and Air Conditioning)
- Chemical Shutdown
- Steam System (Steam Generators, Condensers, Pressurizers, Turbines)
- Building Cranes
- Purification System
- Canal Water
- Fuel Handling & Storage
- DC Systems
- Fire Protection
- Liquid, Gas & Solid Waste Processing
- Radiation Monitoring
- Control Rod Drive Mechanism
- Residual Heat Removal System
- Chemical Volume Control
- Pressure Control & Release
- H_2 Control
- Standby Power
- Circulating H_2O Systems
- Vent & Drain Systems
- Containment Chambers
- Delayed Neutron Loop Monitoring
- Reactor Plant Gravity Drain
- Concrete Enclosure Emergency Filter

TYPICAL PWR SYSTEMS

- Reactor Coolant Sys/Pumps
- Instrumentation & Control
- Service Air
- HVAC Systems (Heating, Ventilation and Air Conditioning)
- Chemical Shutdown
- Steam System (Steam Generators, Condensers, Pressurizers, Turbines)
- Building Cranes
- Purification System
- Canal Water
- Fuel Handling & Storage
- DC Systems
- Fire Protection
- Liquid, Gas & Solid Waste Processing
- Radiation Monitoring
- Control Rod Drive Mechanism
- Residual Heat Removal System
- Chemical Volume Control
- Pressure Control & Release
- H_2 Control
- Standby Power
- Circulating Water Systems
- Vent & Drain Systems

In summary, the Shippingport Project can provide a needed demonstration of dismantlement of a large size power reactor, using new and more efficient concepts and techniques that have never been used before. If the project is funded in FY 1984 rather than being postponed, the cost of the project can be kept to a minimum, thereby showing the industry and public that reactor decommissioning is both practical and affordable.