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Shippingport Station Aging Evaluation

Prepared by R. P. Allen, A. B. Johnson, Jr.

Pacific Northwest Laboratory
Operated by
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Prepared for
U.S. Nuclear Regulatory Commission

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ABSTRACT

The Shippingport Atomic Power Station, the first U.S. large-scale, central-station nuclear plant, now in the final stages of decommissioning, has been a major source of naturally aged equipment for the Nuclear Plant Aging Research (NPAR) and other U.S. Nuclear Regulatory Commission (NRC) programs. Because naturally aged components and materials experience the actual service-related external stressors, corrosion and wear, testing procedures, and maintenance practices, their evaluation is valuable in verifying degradation models, validating aging projections based on the extrapolation of accelerated test data, and detecting unexpected aging mechanisms (surprises) that could significantly impact component or system safety performance.

As part of the Shippingport Station aging evaluation work, more than 200 items, ranging in size from small instruments and materials samples to one of the main coolant pumps, have been removed and shipped to designated NRC contractors. Although detailed evaluations of the components and material from the Shippingport Station are just beginning, the preliminary results from the studies conducted to date are indicative of the value of the aging information that ultimately may be obtained.

SUMMARY

The Shippingport Atomic Power Station, now in the final stages of decommissioning, has been a major source of naturally aged equipment for the Nuclear Plant Aging Research (NPAR) and other U.S. Nuclear Regulatory Commission (NRC) programs. The evaluation of naturally aged components is an integral part of the NPAR program strategy. Because naturally aged components and materials experience the actual service-related external stressors, corrosion and wear, testing procedures, and maintenance practices, their evaluation is valuable in verifying degradation models, validating aging projections based on the extrapolation of accelerated test data, and detecting unexpected aging mechanisms (surprises) that could significantly impact component or system safety performance.

Despite their importance for plant aging studies, access to naturally aged components of the desired type and vintage is limited. The best source is operational equipment from retired plants. The decommissioning of the Shippingport Station, particularly because it was managed by the U.S. Department of Energy (DOE), represented a valuable opportunity to conduct in-situ assessments at an aged reactor and to obtain a variety of naturally aged and degraded components and samples for detailed aging evaluations by NRC contractors.

As the first U.S. large-scale, central-station nuclear plant, the Shippingport Station parallels commercial pressurized water reactors in reactor, steam, auxiliary, support, and safety systems. The 25-year service life (1957 to 1982) covers almost the entire period of currently operating reactors. Also, because of substantial modifications during the mid-1960s and 1970s, it offers unique examples of identical or similar equipment used side-by-side but representing different vintages and degrees of aging.

As part of the Shippingport Station aging evaluation work, more than 200 items, ranging in size from small instruments and materials samples to one of the main coolant pumps, have been removed and shipped to designated NRC contractors. These items include battery chargers, inverters, relays, breakers, switches, power and control cables, electrical penetrations, check valves, solenoid valves, and motor-operated valves. Samples of piping from various plant systems also have been acquired for radiological characterization studies, and samples from the primary system check valves, main stop valves, and main coolant pumps will be used for materials degradation studies.

The following is a list of the NRC contractors and the number of items that have been sent to each by the Pacific Northwest Laboratory (PNL) as part of the NPAR Shippingport Station coordination effort:

NRC Contractor	Number of Items
Argonne National Laboratory (ANL)	24
Brookhaven National Laboratory (BNL)	37
Idaho National Engineering Laboratory (INEL)	88
National Institute of Standards & Technology (NIST)	4
Oak Ridge National Laboratory (ORNL)	24
Pacific Northwest Laboratory (PNL)	18
Wyle Laboratories	15
TOTAL	210

Data and records relevant to the procurement, operation and maintenance of these materials and components have been obtained to support the detailed aging evaluations. In-situ assessments of Shippingport Station components also have been conducted, including the pre-removal visual and physical examination of components, the testing of electrical circuits, and special measurements to assist in the selection of specific components for further evaluation.

Although detailed evaluations of the naturally aged components and material from the Shippingport Station are just beginning, the preliminary results from the studies conducted to date are indicative of the value of the aging information that ultimately may be obtained. Examples of this information, which is presented in more detail in the "Utilization of Research Results" section and in the papers and reports listed in the References and Bibliography, include the following:

Cast Stainless Steel - An ANL investigation of the microstructural characteristics of cast stainless steel from the Shippingport Station primary system check valves has helped clarify the thermal embrittlement processes that can occur at Light Water Reactor (LWR) operating temperatures. The phase changes that had occurred in this naturally aged material were found to be similar to those observed in artificially aged laboratory specimens, thus providing a direct means of validating aging projections based on the extrapolation of laboratory data.

Neutron Shield Tank Samples - Eleven 6-in. diameter samples of the inner wall of the Shippingport Station neutron shield tank were obtained by coring through the grout-filled tank from the outside. The preliminary results of an ANL evaluation of these samples, which represent base metal and weld material exposed to different neutron flux levels, suggest that the transition temperature changes resulting from low-temperature low-flux irradiation are less severe than a previous study had indicated.

Inverter/Battery Charger - Naturally aged inverters and battery chargers from the Shippingport Station were tested by BNL as part of the NPAR Program. Although some aging-induced changes were noted, it was concluded that aging had not substantially affected equipment operation.

Nuclear Protection System Panel - An INEL evaluation of a naturally aged 1960s vintage nuclear protection system panel and rack showed that the system is operating very close to the original response time of the equipment when it was new.

Check Valves - An ORNL evaluation of a piston lift check valve from the Shippingport Station found significantly more wear than would be expected based on the valve's normal service environment.

Motor-Operated Valves - An 8-in. diameter gate valve and operator from the Shippingport Station was refurbished and requalified at INEL, and then tested as part of an internationally sponsored seismic research program. No operational problems had been observed during periodic testing of the valve during Shippingport Station operations. The structural integrity of the valve and operator was not affected by the seismic excitations. However, these studies did reveal a previously unrecognized cable sizing problem that resulted in the issuance of NRC Information Notice No. 89-11: "Failure of DC Motor-Operated Valves to Develop Rated Torque Because of Improper Cable Sizing."

Radiological Assessment - A preliminary PNL assessment of the corrosion film on primary coolant piping samples from the Shippingport Station disclosed comparatively low concentrations of long-lived activation products and very low concentrations of fission products and transuranic radionuclides, reflecting the high integrity of the fuel cladding during reactor operation.

Outputs from these current and future investigations of Shippingport Station components and materials will include the addition of perspectives on aging to regulatory guides, standards and codes; improved performance indicator monitoring; improved maintenance guidelines; and other major contributions to the evaluation of aging effects on plant safety and to the technical basis for plant life extension.

ACKNOWLEDGMENTS

The interest, helpful suggestions and continuing encouragement of this work by J. P. Vora, J. J. Burns and other staff of the Division of Engineering of the U.S. Nuclear Regulatory Commission (NRC) are gratefully acknowledged. Appreciation also is extended to J. J. Schreiber, Manager, U.S. Department of Energy Shippingport Station Decommissioning Project Office; L. I. Tatum and W. P. Engel, DOE Office of Naval Reactors; R. F. Pratt, General Electric Company; W. W. Scott, Westinghouse Hanford Company; and many others associated with the former operation of the Shippingport Station and the decommissioning activities at the Shippingport site. Also acknowledged are the contributions of personnel in the following organizations: Argonne National Laboratory, Brookhaven National Laboratory, Idaho National Engineering Laboratory, National Institute of Standards & Technology, Oak Ridge National Laboratory, Pacific Northwest Laboratory, and Wyle Laboratories. Their cooperation, assistance, and technical input contributed to the success of the Shippingport Station aging evaluation.

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INTRODUCTION

This is a final report on the Shippingport Station Aging Evaluation Task work that the Pacific Northwest Laboratory[(a)] (PNL) performed for the U.S. Nuclear Regulatory Commission (NRC) under the Nuclear Plant Aging Research (NPAR) Program. The objective of the Shippingport Station Aging Evaluation Task was to provide the site coordination and other assistance needed to acquire selected components and samples, obtain data and records, perform in-situ assessments, and conduct postservice examinations and tests of Shippingport Station equipment and materials in support of NPAR and other programs sponsored by the NRC. Presented in this report is background information on the Shippingport Station and its decommissioning, a discussion of the selection and relevancy of naturally aged components from the Shippingport Station, an overview of the Aging Evaluation Task activities and accomplishments, and a summary of the lessons learned from the studies conducted to date on the removed components and materials.

The examination and testing of naturally aged nuclear power plant components is an important element of the NRC NPAR Program strategy (USNRC 1985). Only naturally aged components reflect the full range of possible detrimental effects resulting from internal processes and plant factors such as external stressors, service wear, testing procedures, and maintenance practices. Evaluation of naturally aged components is the only direct way to verify degradation models, to validate aging projections based on the extrapolation of accelerated test data, or to detect unexpected aging mechanisms (surprises) that could significantly impact component or system safety performance. The Shippingport Atomic Power Station, now in the final stages of decommissioning, has been a major source of naturally aged material and equipment for these NPAR evaluations and for other NRC programs.

As the first large-scale, central-station nuclear plant built in the United States (Bettis/DLC 1958), the Shippingport Station parallels commercial pressurized water reactors (PWRs) in reactor, steam, auxiliary, support, and safety systems. Its 25-year service life (1957-1982) covers almost the entire period of currently operating reactors. Also, because of substantial modifications during the mid-1960s and 1970s, it offers many examples of identical or similar equipment used side-by-side but representing different vintages and degrees of aging.

The entire Shippingport Station, including the structures and site support systems, has been completely dismantled (Schreiber 1987) under the direction of the U.S. Department of Energy (DOE) and its Shippingport Station Decommissioning Project Office (SSDPO). The General Electric Company served as the Decommissioning Operations Contractor under the direction of SSDPO. This DOE-directed decommissioning project represented a unique opportunity for NRC and its contractors to acquire naturally aged components and samples and to perform in-situ assessments to obtain critical information on plant aging.

(a)Operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830

SHIPPINGPORT STATION

The Shippingport Station is a pioneer in several respects. It was the first large-scale, central-station nuclear power plant in the United States and the first plant of its size in the world to be operated solely to produce electric power from nuclear fission. It provided valuable information and training during initial operation with two different PWR cores and then was converted to a light-water breeder reactor (LWBR) through installation of a third core to demonstrate the thermal breeding principle.

After completing its operational mission, the Shippingport Station became the first reactor of its size and type to be decommissioned by dismantlement, thus demonstrating the safe, cost-effective dismantlement of a large-scale nuclear power plant and providing valuable data for future decommissioning operations. Through the NRC studies of naturally aged components and materials from the site, the Shippingport Station also will make an important contribution to the continuing safety of operating plants.

The following sections provide a brief description and background information on the history, operating characteristics and decommissioning of the Shippingport Station. Much of this information is abstracted from the Safety Analysis Report for the LWBR, with the original material included as Appendix A.

DESCRIPTION AND HISTORY

The Shippingport Atomic Power Station is a four-loop PWR (Figure 1) with the same basic reactor, steam, auxiliary, support, and safety systems as current commercial PWRs (Table 1). The primary system pressure and temperatures were somewhat lower (Table 2) than normal parameters for a typical PWR. However, most components of interest for the aging studies (e.g., valves, inverters, and cabling) are not influenced by the primary system operating conditions.

The Shippingport Station was constructed during the mid-1950s as a joint project of the federal government and the Duquesne Light Company (DLC) to develop and demonstrate PWR technology and to generate electricity. The station initially consisted of a 68-MWe PWR, a turbine generator, and associated facilities. It was located on the south bank of the Ohio River (Figure 2) at Shippingport, Pennsylvania, about 25 miles northwest of Pittsburgh, on land owned by DLC. The reactor and steam generators were owned by DOE, and the electrical generating portion was owned by DLC. The station began operation in December 1957 and was operated by DLC under supervision of the DOE Division of Naval Reactors until final shutdown on October 1, 1982. DLC paid DOE for the steam and marketed the electricity.

During its history, the Shippingport Station operated with two light-water cooled PWR cores (designated as PWR Core I and PWR Core II) and most recently with a LWBR core. PWR Core I began operation in December 1957 with a design electrical power output of 68 MWe gross. Electrical generation was 1,798,600,000 kWh (gross) with three partial refuelings (seed

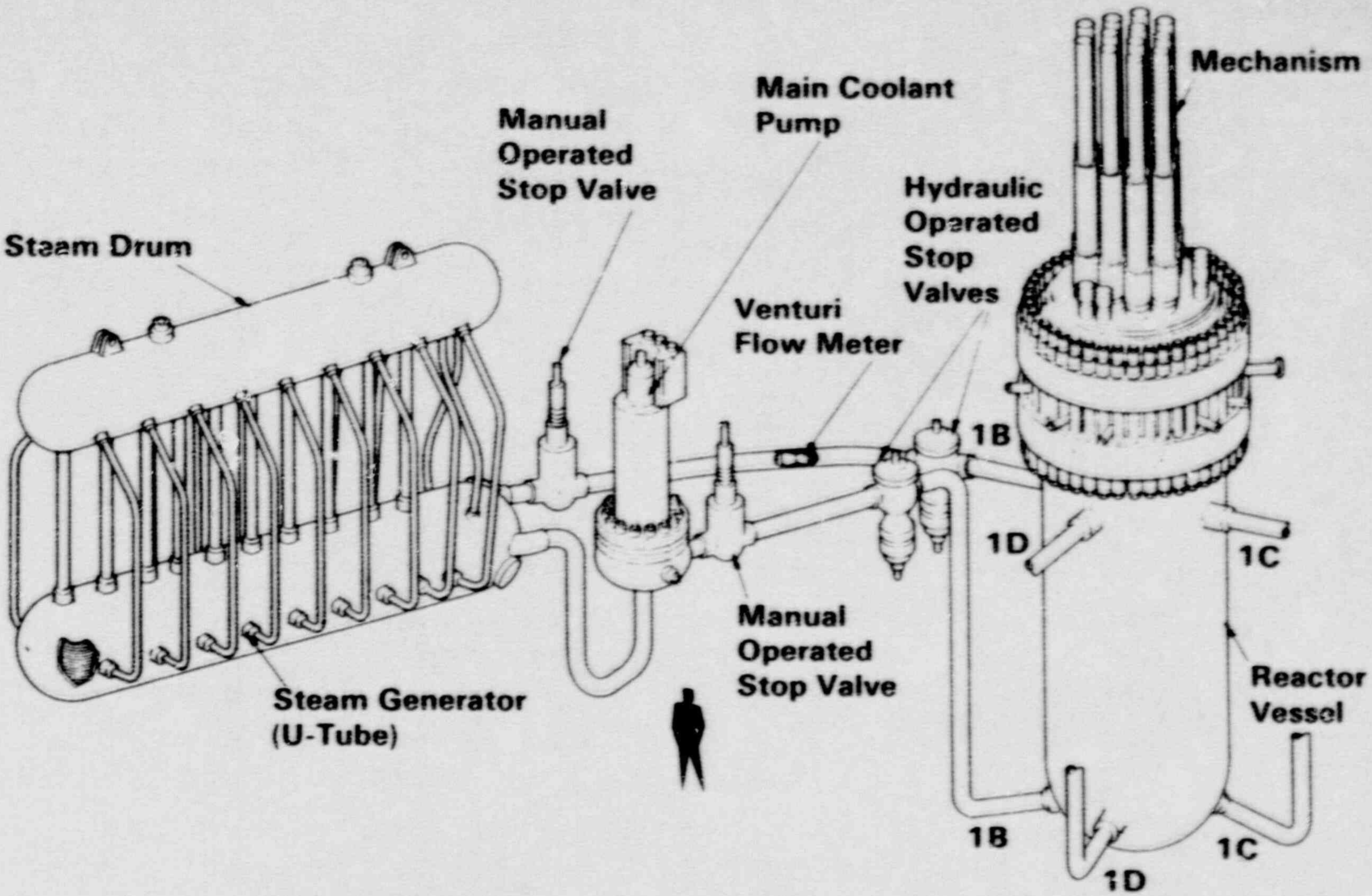


FIGURE 1. Shippingport Station Reactor Coolant System

TABLE 1. Comparison of Shippingport Station Systems and Components with a Typical PWR

Shippingport Station	Typical PWR
• Reactor Coolant System Pumps	• Reactor Coolant System Pumps
• Instrumentation and Control	• Instrumentation and Control
• Service Air	• Service Air
• HVAC Systems[a]	• HVAC Systems
• Chemical Shutdown	• Chemical Shutdown
• Steam System[b]	• Steam System
• Building Cranes	• Building Cranes
• Purification System	• Purification System
• Canal Water	• Canal Water
• Fuel Handling and Storage	• Fuel Handling and Storage
• DC Systems	• DC Systems
• Fire Protection	• Fire Protection
• Liquid, Gas, and Solid Waste Processing	• Liquid, Gas, and Solid Waste Processing
• Radiation Monitoring	• Radiation Monitoring
• Control Rod Drive Mechanism	• Control Rod Drove Mechanism
• Residual Heat Removal System	• Residual Heat Removal System
• Chemical Volume Control	• Chemical Volume Control
• Pressure Control and Release	• Pressure Control and Release
• Hydrogen Control	• Hydrogen Control
• Standby Power	• Standby Power
• Circulating Water Systems	• Circulating Water Systems
• Vent and Drain Systems	• Vent and Drain Systems
• Containment Chambers	
• Delayed Neutron Loop Monitoring	
• Reactor Plant Gravity Drain	

(a) Heating, ventilation, and air conditioning.
(b) Steam generators, condensers, pressurizers, turbines.

TABLE 2. Comparison of Reactor Operating Parameters

Parameter	Shippingport Station	Reference PWR[a]
Power Output		
Power Core I	68 MWe	1175 MWe
Power Core II	150 MWe	
LWBR	72 MWe	
Operating Pressure	2000 psi	2235 psi
Coolant Temperature		
Inlet	264 to 271 C	276 C
Outlet	281 to 293 C	312 C
pH Control	$LiOH/NH_4OH$	LiOH
Oxygen Control	Hydrogen	Hydrogen
Reactivity Control	$K_2B_4O_7$ (defueling only)	Boric Acid

(a) Smith et al. 1978.

replacements) before power operations were suspended in February 1964. PWR Core II was then installed and operated from April 1965 to February 1974 with a design electrical power output rating of 150 MWe gross. This core had one partial refueling and produced 3,476,600,000 kWh (gross).

In 1976, a LWBR core was installed in the existing PWR vessel of the Shippingport Nuclear Power Station. The LWBR core started operation in September 1977 and finished operation on October 1, 1982. During its operating life, the Shippingport Nuclear Power Station produced over 7.4 billion kWh of electricity.

The operating history for PWR Cores I and II is presented in detail in Appendix A. During this 17-year period, the only major operational problems were associated with the secondary systems and the steam generators. There were no safety-related accidents, and all safety-related systems functioned as required. The Shippingport Station operating history is summarized in Table 3.

The two major core changes and associated equipment and system upgrades provide a unique opportunity to compare identical or similar components that have operated side-by-side but represent different vintages and degrees of aging. For example, cells representing four vintages were in service in the same plant battery at the end of reactor operation.

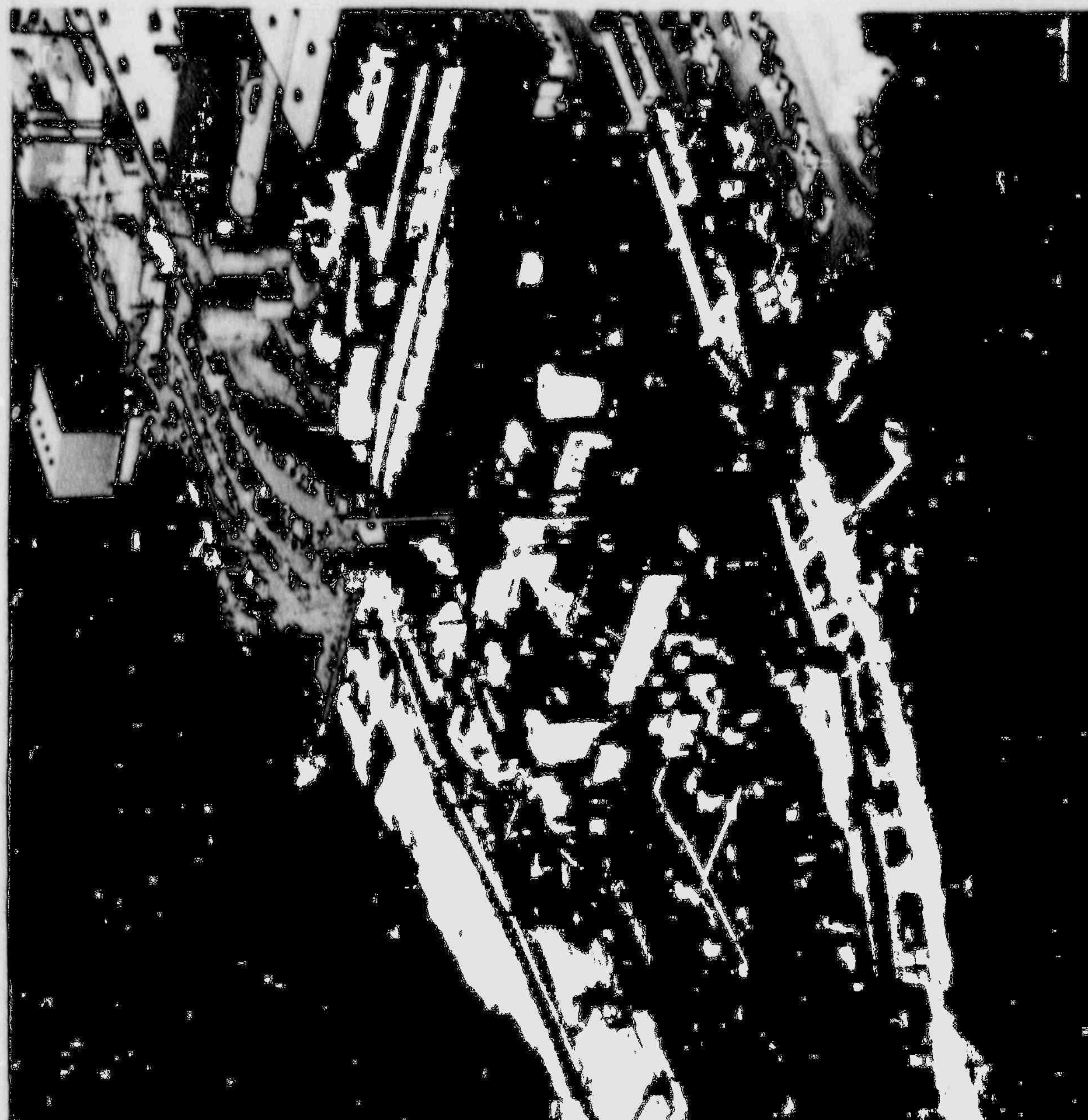


FIGURE 2. Shippingport Station Site

TABLE 3. Shippingport Station Operating History[a]

PWR Core I	Dec 1957-Feb 1964 (6.2 years)
PWR Core II	Apr 1965-Feb 1974 (8.8 years)
LWBR	Sep 1977-Oct 1982 (5.1 years)
Total Service Life	24.8 years
Total Operating Life	20.1 years
Effective Full Power	9.1 years

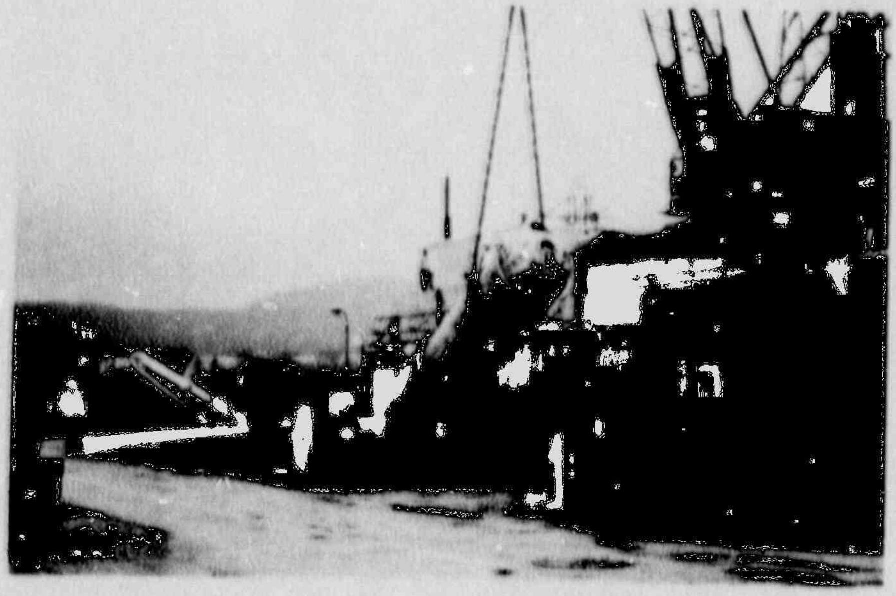
(a) No significant safety-related problems or use of the safety injection system occurred during Shippingport operation.

DECOMMISSIONING OPERATIONS

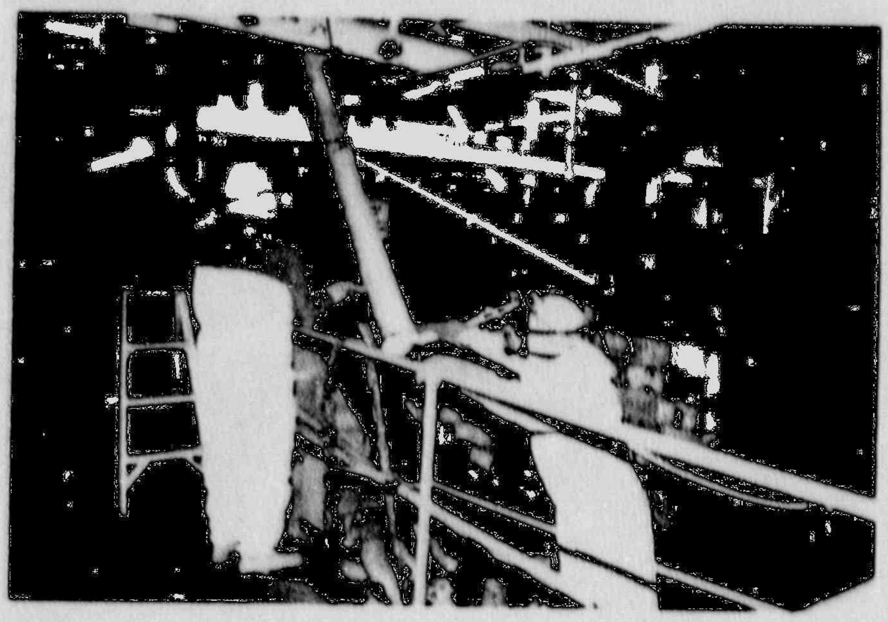
The Shippingport Station completed LWBR operation on October 1, 1982. The fuel was removed and responsibility for the station was transferred from DOE Naval Reactors to the DOE Office of Terminal Waste Disposal and Remedial Action on September 6, 1984. Decommissioning operations formally began on January 1, 1985, under the direction of the SSDPO with the General Electric Company as the Decommissioning Operations Contractor (DOC).

In accordance with the original decommissioning plans, all designated Shippingport Station systems and structures have been dismantled and removed to permit release of the site for unrestricted use. This dismantlement work included placement of liners containing in-core materials inside the pressure vessel, removal of asbestos from the primary system, removal of the primary system piping and major components (Figure 3), segmentation of the containment vessel chambers, removal of the power and control systems, dismantlement of the fuel handling building, and removal of concrete to three feet below grade.

All contaminated components and materials were shipped to the DOE Hanford Site for disposal. Small items were shipped by truck or train. The reactor pressure vessel was encased in concrete, removed from the reactor enclosure in one piece on December 14, 1988, and transported to Hanford by barge along with other large reactor coolant system components. Details of the Shippingport Station decommissioning operations are reported in papers presented at a special Shippingport Session of the 1987 International Decommissioning Symposium (Crimi and Mullee 1987; Kea 1987; LaGuardia and Lipsett 1987).



(a) Steam Drum Removal



(b) Canal Water Piping Removal

FIGURE 3. Shippingport Station Decommissioning Activities

NATURALLY AGED COMPONENTS

The post-service examination and laboratory testing of naturally aged components is an integral part of the NPAR program strategy. This approach provides essential information on failure modes and mechanisms and assists in the identification of the monitorable performance parameters needed to determine the time-dependent effects of aging. The evaluation of a broad range of naturally aged components also is required to validate models based on simulated or accelerated aging.

From a regulatory perspective, perhaps the most important rationale for the acquisition and testing of naturally aged components relates to the possible identification of presently unrecognized (unknown) synergistic aging mechanisms that could significantly impact component, structure, or system performance. Naturally aged components reflect the full range of possible detrimental effects resulting from internal processes and plant factors such as external stressors, service wear, testing procedures, and maintenance practices. Evaluation of naturally aged components and materials is the only way, other than through actual plant incidents, to identify these unexpected or synergistic aging and degradation mechanisms.

SOURCES OF NATURALLY AGED COMPONENTS

Despite their value for plant aging studies, access to naturally aged components of the desired type and vintage is generally limited. One potential source is failed equipment from operating nuclear plants. The components are directly relevant to current plants and designs, but equipment of the specific type and with the age and service history desired for aging studies may not be available. Also the failure may compromise the aging evaluation unless the failure analysis itself is of prime interest.

Operational equipment could be removed from operating plants under a replacement arrangement, but this could be very costly and only feasible for a limited number of components. Similarly, selected in-situ aging evaluations could be conducted at operating plants, but these would be limited to the use of nondestructive techniques.

The best source of naturally aged components for both in-situ and off-site aging studies is operational equipment from retired plants. A variety of components is available, including different vintages of replacement equipment. Not all components are Class 1E or otherwise typical of newer plants, but the older components are representative of equivalent vintage plants. In-situ tests can be performed without concern for equipment or operating schedules, and equipment and samples can be removed for detailed evaluation at other sites. The decommissioning of the Shippingport Station, particularly because it was managed by DOE, represented a valuable opportunity to conduct in-situ assessments at an aged reactor and to obtain a variety of naturally aged and degraded components and samples for detailed aging evaluations.

COMPONENT SELECTION METHODOLOGY

One of the initial challenges of the Shippingport Station Aging Evaluation Task was to select, from the hundreds of possibilities, the specific components, samples, and in-situ evaluations that would be of most value to the NPAR Program and other NRC programs. A prioritization workshop was sponsored by PNL to identify safety-related systems and components of primary importance. NRC guidance also was received delineating the areas of interest for the overall NPAR Program.

The identification and selection of the specific components and samples to be acquired was accomplished primarily through several visits to the Shippingport site by NRC and contractor staff and consultants representing a range of disciplines and research interests. Table 4 lists the participants in one of those visits, together with their affiliations and areas of expertise.

The component selection site visits were preceded by extensive preparation, including preliminary site visits to review plant reports and records pertaining to Shippingport Station systems, components, and operating history. This general information was compiled into a Shippingport reference manual to provide background information for the selection visits. Additional detailed information and color photographs of specific candidate systems and components also were provided to the designated NPAR contractors for review.

A component fact sheet was used during the component selection visits to record and evaluate equipment type, vintage, status, availability of records, and potential for on-site examination and testing. Other criteria used to select the specific components for evaluation included the following:

- identical or similar equipment representing different vintages, but the same function and operating environment
- equipment representing different models or manufacturers, but the same vintage, function, and operating environment
- similar equipment operating in contrasting temperature and radiation environments
- equipment with performance concerns based on industry experience.

In addition to visual inspection, the component selection visits included physical tagging and some in-situ testing of the selected items.

RELEVANCY CONSIDERATIONS

It is recognized that many of the Shippingport Station components differ from current nuclear plant equipment designs. However, most of the Shippingport Station components such as valves and instrumentation are relevant to currently operating early plants, and almost all of the later

TABLE 4. Shippingport Site Visit - March 7, 1984

Name	Affiliation	Expertise
B. Morris	Nuclear Regulatory Commission	Program Guidance, Electrical and Mechanical Components
C. Serpan	Nuclear Regulatory Commission	Materials, Vessel, Pipings, Steam Generator, Nondestructive Examination
J. Vora	Nuclear Regulatory Commission	Program Coordination, Electrical Components
G. Arndt	Nuclear Regulatory Commission	Structures, Mechanical Components
E. Brown	Nuclear Regulatory Commission	Mechanical, Electro-Mechanical Components
Z. Rosztoczy	Nuclear Regulatory Commission	Pressurized Water Reactor Systems, Relevancy, Electrical and Mechanical Components
G. Murphy	Oak Ridge National Laboratory	Light Water Reactor Relevancy, Electrical and Mechanical Components
R. Meininger	Idaho National Engineering Laboratory	Light Water Reactor Relevancy, Electrical Components
J. Taylor	Brookhaven National Laboratory	Light Water Reactor Relevancy, Electrical Components
D. Berry	Sandia National Laboratory	Light Water Relevancy, Systems
V. Harris	Washington Public Power Supply System	Light Water Reactor Relevancy, Systems, Electrical and Mechanical Components, In-Situ Monitoring/Testing
V. Bacanskas	Franklin Research Center	Electrical Components
R. Allen	Pacific Northwest Laboratory	Project Coordination and Implementation

replacement components such as the battery chargers and inverters are identical to equipment in later vintage plants. The start dates for the Shippingport Station and its three cores are compared in Table 5 with the commercial operation start dates for other U.S. nuclear power plants. Four plants started operation within 6 years of the original Shippingport Station. Another 7 plants went on-line within 6 years of the PWR Core II upgrade, and a total of 62 reactors had begun commercial operation by the time the LWBR upgrade was completed in late 1977. Moreover, because these 62 reactors are the oldest plants in the United States, they represent the vintages of primary concern for near-term aging and life-extension evaluations.

Thus, because the Shippingport Station service life covers almost the entire time span of currently operating reactors, its equipment reflects a similar range of design, specifications, materials of construction, applicable codes and standards, and qualification testing. The original components represented the best off-the-shelf equipment then commercially available. In many cases, it was the same type of equipment used in other plants of that vintage. Conversely, the LWBR upgrade involved qualified components identical, in some cases, to equipment in current vintage plants. Table 6 lists the applicable codes and standards for safety-related equipment at the Shippingport Station. Also, it should be recognized that even though the design of a specific component may change, an aging evaluation of a particular material or subassembly from an earlier version may still be relevant to current equipment in terms of function, service environment, or a particular aging mechanism.

Based on these relevancy considerations, the Shippingport Station components and samples for the NRC studies were selected item-by-item by NRC and contractor staff and industry consultants with an in-depth understanding of the equipment and materials used in plants of the vintages of importance for the aging studies.

TABLE 5. U.S. Nuclear Power Plant Age Data (from actual commercial operation date)

Start Dates, Month/Year	Plant
12/57	**Shippingport Station (PWR Core I)**
08/60	Dresden 1 (Morris, IL)
06/61	Yankee (Rowe, MA)
12/62	Big Rock Point (Charlevoix, MI)
08/63	Humbolt Bay (Eureka, CA)
04/65	**Shippingport Station (PWR Core II)**
07/66	Hanford-N (Richland, WA)
01/68	Haddam Neck (Haddam Neck, CT)
01/68	San Onofre 1 (San Clemente, CA)
11/69	LaCrosse (Genoa, WI)
12/69	Nine Mile Point 1 (Scriba, NY)
12/69	Oyster Creek 1 (Forked River, NJ)
03/70	Robert E. Ginna (Ontario, NY)
08/70	Dresden 2 (Morris, IL)
12/70	Millstone 1 (Waterford, CT)
12/70	Point Beach 1 (Two Creeks, WI)
03/71	Robinson 2 (Hartsville, SC)
07/71	Monticello (Monticello, MN)
10/71	Dresden 3 (Morris, IL)
12/71	Palisades (South Haven, MI)
08/72	Quad-Cities 1 (Cordova, IL)
10/72	Quad-Cities 2 (Cordova, IL)
10/72	Point Beach 2 (Two Creeks, WI)
11/72	Vermont Yankee (Vernon, VT)
12/72	Maine Yankee (Wiscasset, ME)
12/72	Pilgrim 1 (Plymouth, MA)
12/72	Turkey Point 3 (Florida City, FL)
12/72	Surry 1 (Gravel Neck, VA)
05/73	Surry 2 (Gravel Neck, VA)
07/73	Oconee 1 (Seneca, SC)
09/73	Ft. Calhoun 1 (Ft. Calhoun, NB)
09/73	Turkey Point 4 (Florida City, FL)
12/73	Prairie Island 1 (Red Wing, MN)
12/73	Zion 1 (Zion, IL)
05/74	Calvert Cliffs 1 (Lusby, MD)
05/74	Duane Arnold (Palo, IA)
06/74	Kewaunee (Carlton, WI)
07/74	Cooper (Brownsville, NB)
07/74	Indian Point 2 (Indian Point, NY)
07/74	Peach Bottom 2 (Peach Bottom, PA)
08/74	Browns Ferry 1 (Decatur, AL)
09/74	Oconee 2 (Seneca, SC)
09/74	Three Mile Island 1 (Londonderry Twp., PA)
09/74	Zion 2 (Zion, IL)
12/74	Nuclear One 1 (Russellville, AK)

TABLE 5. U.S. Nuclear Power Plant Age Data (cont'd.)
(from actual commercial operation date)

Start Dates, Month/Year	Plant
12/74	Oconee 3 (Seneca, SC)
12/74	Peach Bottom 3 (Peach Bottom, PA)
12/74	Prairie Island 2 (Red Wing, MI)
03/75	Browns Ferry 2 (Decatur, AL)
04/75	Rancho Seco (Clay Statron, CA)
07/75	James A. Fitzpatrick (Scriba, NY)
08/75	Donald C. Cook 1 (Bridgman, MI)
11/75	Brunswick 2 (Southport, NC)
12/75	Edwin I. Hatch 1 (Baxley, GA)
12/75	Millstone 2 (Waterford, CT)
05/76	Trojan (Prescott, OR)
08/76	Indian Point 3 (Indian Point, NY)
12/76	St. Lucie 1 (Hutchinson Island, FL)
03/77	Browns Ferry 3 (Decatur, AL)
03/77	Brunswick 1 (Southport, NC)
03/77	Crystal River 3 (Red Level, FL)
04/77	Beaver Valley 1 (Shippingport, PA)
04/77	Calvert Cliffs 2 (Lusby, MD)
06/77	Salem 1 (Salem. NJ)
09/77	**Shippingport Station (LWBR Core)**
11/77	Davis-Besse 1 (Oak Harbor, OH)
12/77	Joseph M. Farley 1 (Dothan, AL)
06/78	North Anna 1 (Mineral, VA)
07/78	Donald C. Cook 2 (Bridgman, MI)
12/78	Three Mile Island 2 (Londonderry Twp., PA)
01/79	Ft. St. Vrain (Platteville, CO)
08/79	Edwin I. Hatch 2 (Baxley, GA)
03/80	Nuclear One 2 (Russellville, AK)
12/80	North Anna 2 (Mineral, VA)
07/81	Joseph M. Farley 2 (Dothan, AL)
07/81	Sequoyah 1 (Daisy, TN)
10/81	Salem 2 (Salem, NJ)
12/81	McGuire 1 (Cornelius, NC)
06/82	Sequoyah 2 (Daisy, TN)
10/82	LaSalle County 1 (Seneca, IL)
10/82	**End of Shippingport Station operation**

TABLE 6. Codes and Standards for Safety-Related Equipment at the Shippingport Station

Quality Group	Applicable Codes and Standards
A	10 CFR 50.55a
B, C, D	Regulatory Guide 1.26
DM (D augmented)	Branch Technical Position ETSB 11-1
SR (safety-related electrical equipment)	IEEE 279-1971 or IEEE 308-1974
NS	Not Safety-Related
Code Class	
ASME 3-1, -2, -3	Section III of the ASME Boiler and Pressure Vessel Code - Class 1, 2, or 3; Section VIII of the ASME Boiler and Pressure Vessel Code
ANSI B31.1	ANSI B31.1.0, Power Piping
MFG. STD.	Manufacturer's Standards
API-620, -650	American Petroleum Institute
IEEE-279, -308	Institute of Electrical and Electronics Engineers

AGING EVALUATION TASK

The objectives of the NPAR Aging Evaluation Task were to assist in acquiring selected components and samples, performing in-situ assessments, obtaining data and records, and conducting postservice examinations and tests of Shippingport Station equipment and materials in support of the NPAR Program and other NRC programs. The following sections describe the task organization and activities established to accomplish these objectives, and summarize progress since the inception of the work in 1983.

TASK ORGANIZATION

The PNL Aging Evaluation Task was divided into the following major subtasks (Figure 4):

Subtask 1 - Data/Records Acquisition

The objective of this subtask was to obtain, to the extent available, background information and data for the Shippingport Station components selected for NPAR evaluation. The desired information included the following:

- name plate data - manufacturer, model, year, ratings, etc.
- design and specifications from Procurement and Design (PDS Specs) and Materials and Equipment (MEP Specs) records
- equipment specification file used for vendor bid process
- manufacturer's technical manuals, instruction books, and data sheets
- plant operating manuals pertaining to system/component description and function, operating parameters, relationship to other system elements, and special features
- system drawings showing component locations and part numbers
- operation and postoperation history from technical reports, monthly and quarterly operating reports, operating logs, and original operating records
- maintenance/replacement history and equipment/materials problems from monthly and quarterly operating records, trouble records, incident reports, and the KAR-DEX maintenance file
- quarterly check and start-up records, test procedures, and results.

Additional information on component and equipment malfunctions, repairs, replacements, and performance test results was obtained through a comprehensive review of the Shippingport Station monthly and quarterly operating reports covering the entire period of plant operation, including

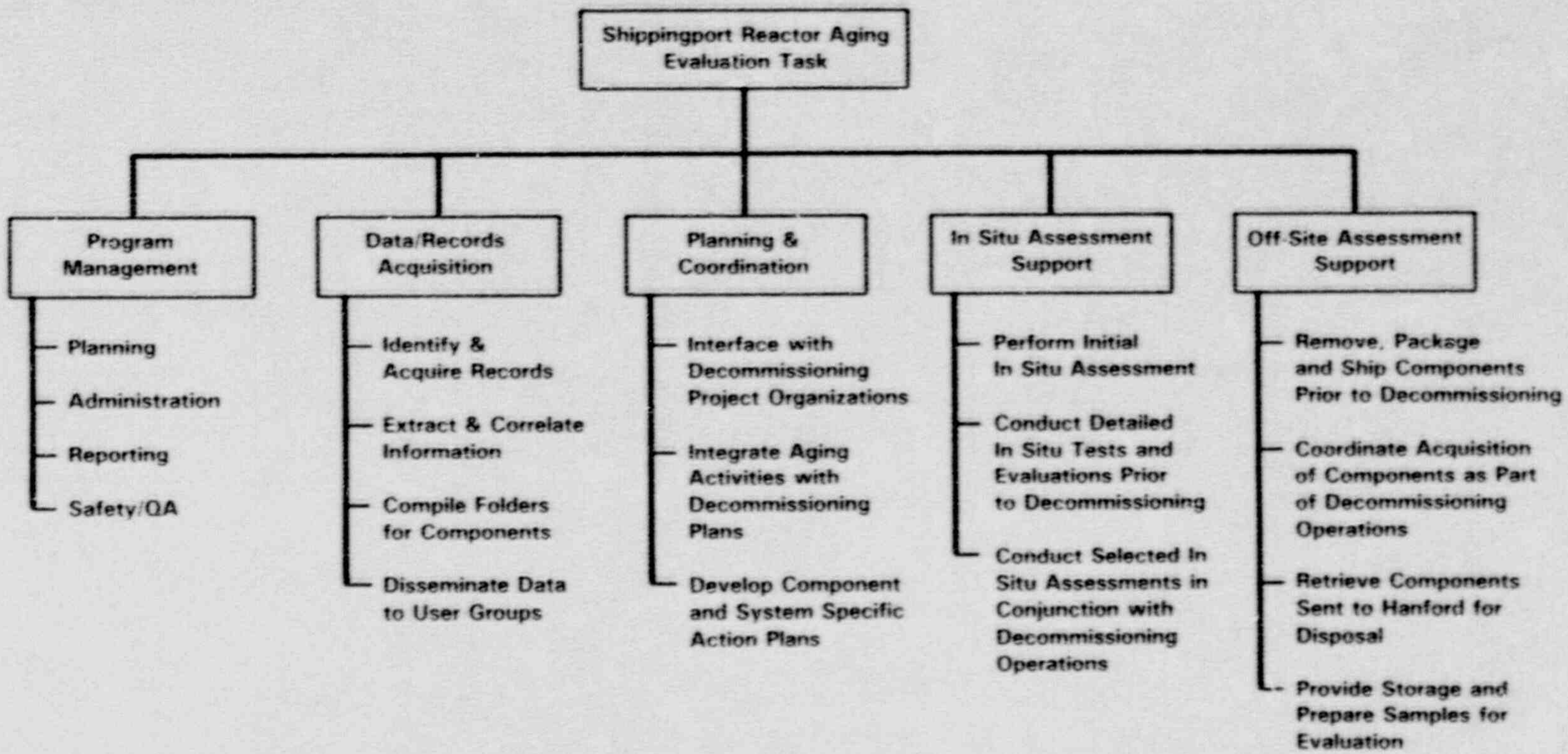


FIGURE 4. Shippingport Reactor Aging Evaluation Task Organization

the core changes and associated modifications. Relevant information also was extracted from the plant operating manuals and the LWBR Safety Analysis Report. For equipment still in use, data was obtained directly from the manufacturers. The written information collected on components and equipment was supplemented in selected cases by interviews with Shippingport Site personnel formerly involved in the operation and maintenance of plant systems and components.

Subtask 2 - Planning and Coordination

The PNL role at the Shippingport Station as illustrated in Figure 5A was to incorporate NRC research interests into the overall Shippingport Station decommissioning plans and to obtain the technical and administrative support required to successfully implement the planned activities. To accomplish this, PNL staff worked closely with the DOE-RL Shippingport Station Decommissioning Project Manager and other designated project and site organizations and personnel as illustrated in Figure 5B. The solid lines in this figure denote management, reporting and contractual arrangements, while the dotted lines denote communications, reviews, and other less formal interactions.

This Shippingport Station coordination effort included the development of component- and system-specific plans, schedules and cost estimates for the in-situ assessment, component removal, and associated support activities. These plans were coordinated with both the designated decommissioning project personnel and the assigned NPAR contractors and were approved by the DOE-RL Shippingport Station Decommissioning Project Manager and the NRC Program Manager.

An additional important part of the planning and coordination subtask was the preparation of detailed procedures and work activity packages for approval by the site engineering and decommissioning staff and by the DOC and subcontractor organizations (i.e., operations, radiation control, safety, quality assurance, and craft services).

Subtask 3 - In-Situ Assessment Support

The objective of this subtask was, wherever feasible, to conduct an in-situ assessment of Shippingport Station systems, components and materials of interest to the NPAR Program prior to removal. This initial in-situ assessment was visual and physical and included the following activities:

- location of the item and physical tagging or marking to indicate NPAR interest and prevent inadvertent damage or disposal during the subsequent decommissioning operations
- visual and physical examination to assess condition and functional capability and to identify and define the component-system boundaries for testing and removal
- acquisition of information needed to plan in-situ tests and to prepare components for removal, packaging, shipping, and off-site assessment.

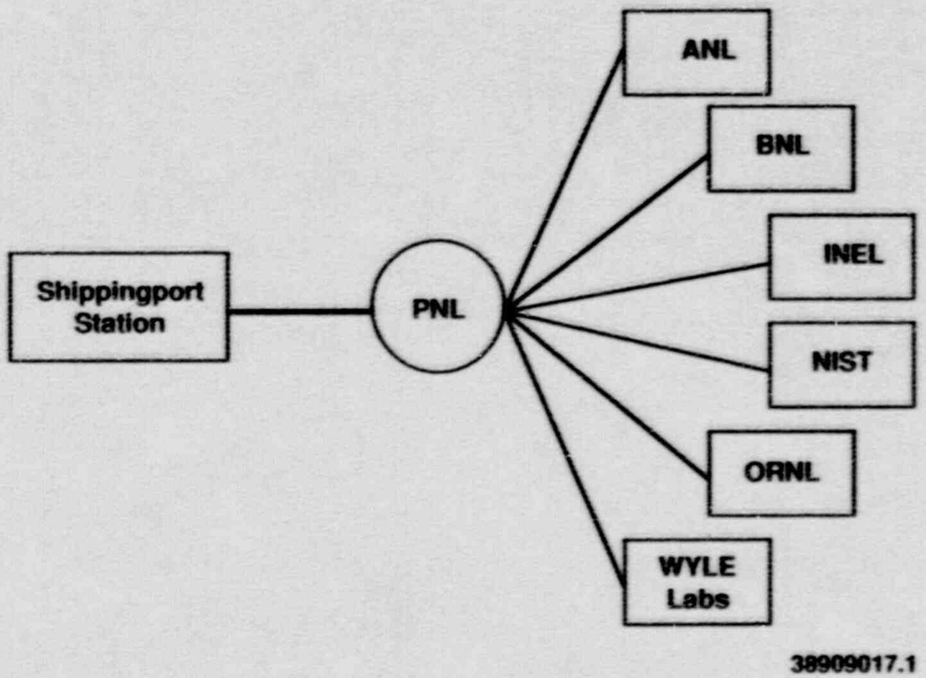


FIGURE 5A. PNL Coordination of NRC Shippingport Site Research Interests

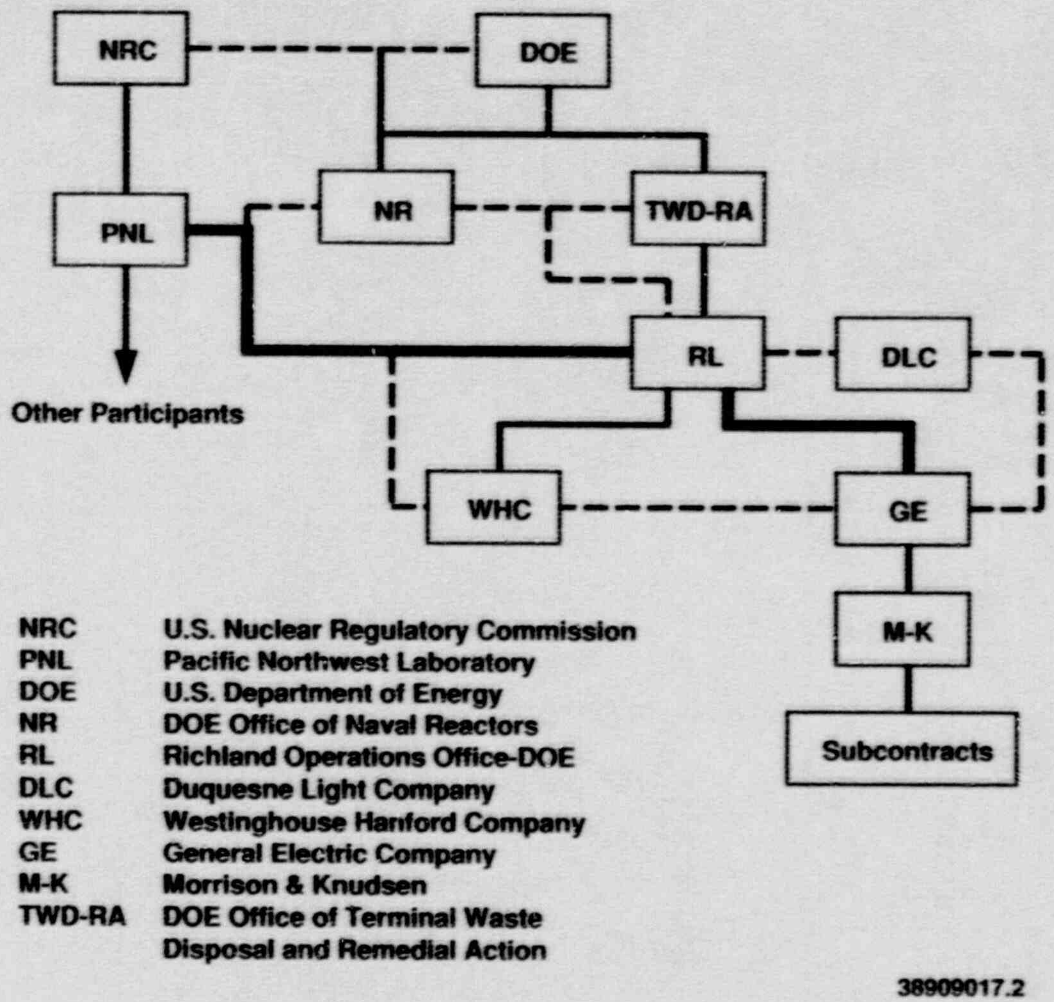


FIGURE 5B. Shippingport Planning and Coordination Relationships

More extensive in-situ tests, including the evaluation of electrical circuits and the determination of materials properties, were conducted for selected systems, components and materials.

Subtask 4 - Off-Site Assessment Support

The objective of this subtask was to acquire, with the approval of the DOE-RL Decommissioning Project Manager, selected components and samples for off-site assessment by NRC contractors. This work included the following:

- predecommissioning removal, packaging, and shipping of components to designated contractors or to storage
- coordinating the acquisition, packaging, and shipping of components removed as part of the decommissioning operations
- retrieving or sampling selected components after shipment to the Hanford disposal site
- providing storage for components and materials at PNL and assisting with the sampling of components for assessment by other NRC contractors.

ACCOMPLISHMENTS

Task activities were started in July 1983. The major accomplishments for each of the subtasks are summarized below. A detailed record of activities is presented in Appendix B as abstracted from the NPAR monthly reports for the August 1983 through May 1989 time period.

Data/Records Evaluation

More than 50 technical manuals for plant components, many original equipment and materials specifications, and the maintenance histories and record of changes for key components were obtained. The information for several selected systems and components was compiled and distributed to the assigned NPAR contractors to support their aging evaluation studies. This documented information was supplemented in selected cases by interviews with key Shippingport Station personnel involved in the operation and maintenance of plant systems and components.

Planning and Coordination

A concerted effort was made to identify and select components and in-situ testing opportunities of maximum value for NRC research tasks. In the early stages of the Shippingport program, site visits were conducted for more than 30 visitors representing NRC and major subcontractor organizations. Interfaces were established with other groups not represented at the visits to ensure that all potential Shippingport interests were addressed. These visits and interface contacts culminated in the identification and selection of more than 200 specific components, samples and in-situ testing opportunities.

Extensive efforts also were devoted to developing and maintaining the interfaces with the various Shippingport decommissioning organizations needed to implement the testing and removal plans. These efforts required frequent and extended site visits and close coordination with the DOE Shippingport Station Decommissioning Office, the Westinghouse Hanford Company Site Engineering and Decommissioning staff, and the DOC groups and subcontractors (operations, radiation control, safety, quality assurance, craft services, etc.). This work included the preparation and submission of more than 40 detailed procedures and work activity packages for the in-situ testing and component removal operations. Several PNL staff members were trained on-site and certified as Shippingport Station radiation workers. A contract was established between PNL and the Shippingport Station DOC to obtain the required site technical and administrative support for the in-situ testing and component acquisition activities.

In-Situ Assessment Support

Arrangements were coordinated and site services were obtained as required to support the in-situ assessment of systems, components and materials prior to their removal by the DOC. INEL staff, for example, conducted a comprehensive in-situ evaluation of 46 Shippingport Station electrical components and circuits (Dinsel 1987) representing more than 1600 individual measurements of insulation resistance, dc loop resistance, total capacitance, total inductance, and impedance. INEL staff also conducted in-situ tests and an inspection of the Shippingport Station battery cells to select and establish the pre-shipping condition of the specific units to be sent to INEL. The inspection disclosed that there were four vintages of cells (10-56, 9-67, 6-77, and 3-80) operating side-by-side in the same battery. Electrical characteristics and electrolyte status were determined for each cell, and detailed pictures were taken to document their physical condition. Contact was made with the plant staff responsible for battery maintenance to obtain load test and other battery maintenance records and information.

Similarly, ANL staff conducted in-situ measurements of the ferrite content of the primary system main valves and coolant pump volutes to identify candidate materials for NRC-sponsored thermal embrittlement studies. These measurements indicated that 9 of the 24 cast austenitic stainless steel primary system components had ferrite levels that were sufficiently high to make them of interest for acquisition for detailed materials studies.

Off-Site Assessment Support

Arrangements were coordinated and site services obtained as required to support the acquisition of components selected by NRC and its contractors for off-site evaluation. This effort included the identification, removal, packaging and shipment of more than 200 Shippingport Station components and samples. Every precaution was taken to prevent damage to the components during their removal and shipment. Sensitive components such as relays were hand carried to the designated NPAR contractor. Other components, such as the battery cells, were packaged in special containers with shock-absorbent material and shipped in air-ride vans.

Table 7 lists the components acquired for each NRC contractor as part of the NPAR Shippingport Station coordination effort. Examples of some of the components selected for evaluation are shown in Figures 6-14.

TABLE 7. Items Acquired Through the NPAR Shippingport Station Coordination Effort

NRC Contractor	Number of Components
Argonne National Laboratory	
• Check Valves	4
• Cold Leg Pipe Section	1
• Hot Leg Pipe Section	1
• Main Coolant Pump	1
• Manual Isolation Valves	3
• Neutron Shield Tank Samples	11
• Reactor Chamber Steel	1 Drum
• Spare Pipe Section	1
• Spare Volute	1
Brookhaven National Laboratory	
• Agastat Relays	5
• Battery Chargers	2
• Charger/Inverter Spare Parts	1 box
• Circuit Breakers	8
• Control Air System Piping	7
• DB-50 Breakers	2
• Inverters	3
• MG-6 Relays	4
• Motor Control Center	1
• Motor-Generator Set	1
• Relay Panel	1
• Scram Breakers	2
Idaho National Engineering Laboratory	
• Battery Cells	24
• BF3 Detectors	4
• Compensating Ion Chamber Detectors	4
• Differential Pressure Cells	6
• Electrical Cable	4
• Electrical Stop Joints	6
• Instrumentation Cable	2
• Level Indicator	1
• Limit Switches	8
• Motor-Operated Valves	2

TABLE 7. Items Acquired Through the NPAR Shippingport Station Coordination Effort (Continued)

NRC Contractor	Number of Components
Idaho National Engineering Laboratory (Continued)	
• Nuclear Instrumentation Channels	2
• Nuclear Protection System Panel	1
• Power Lead Junction Box	2
• Pressure Switches	7
• Rod Control Junction Boxes	2
• Rosemount Transducers	3
• Selector Switches	3
• Thermocouple Junction Box	1
• Thermocouple Signal Box	1
• Transmitters	5
National Institute of Standards & Technology	
• Electrical Cable	4
Oak Ridge National Laboratory	
• Check Valves	5
• Concrete Cores	6
• Motor-Operated Valves	6
• Solenoid Valves	7
Pacific Northwest Laboratory	
• Contaminated Concrete	1 Drum
• Coolant Purification Piping	2
• Feedwater Piping	1
• Fuel Pool Piping	2
• Instrument Piping	2
• Main Steam Piping	1
• Pressure Vessel Nozzle Cutouts	5
• RadWaste Piping	2
• Service Water System Heat Exchangers	2
Wyle Laboratories	
• Differential Relays	2
• Circuit Breaker	1
• Constant Voltage Transformers	2
• Current Transformers	2
• Potential Transformers	2
• Protective Relays	4
• 480/120 Transformers	2

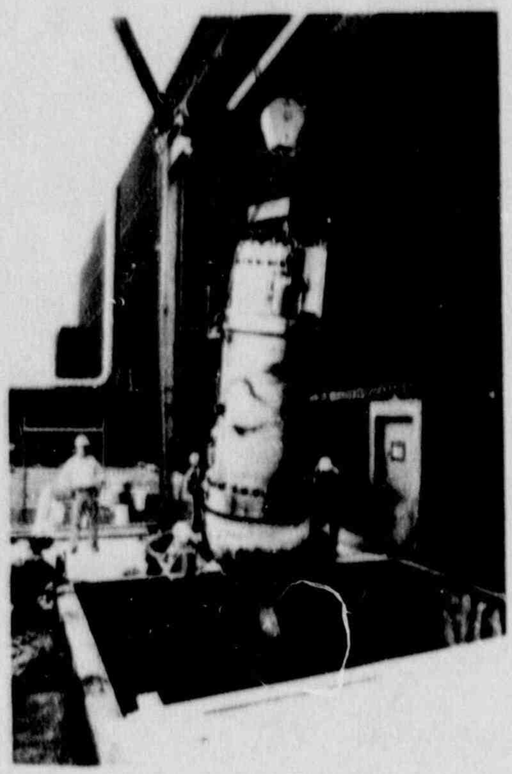


FIGURE 6. Main Coolant Pump for Cast Stainless Steel Thermal Embrittlement Studies at ANL

SAMPLING OPERATIONS

Several types of samples from the Shippingport Station were provided to NRC contractors for metallurgical and radiological evaluation. Most were removed as part of the decommissioning operation. These samples included the following and were shipped as noted:

- Five disk samples from the pressure vessel nozzles, sent to PNL for detailed radiological characterization.
- A 55-gal drum of contaminated concrete chips and dust from the concrete scabbling operation on the canal walls, sent to PNL for radionuclide source term measurement studies.
- Several sections of activated steel taken from different levels and quadrants of the reactor chamber, sent to ANL and PNL for metallurgical and radiological studies.
- Six concrete cores from the reactor enclosure, sent to ORNL for evaluation.

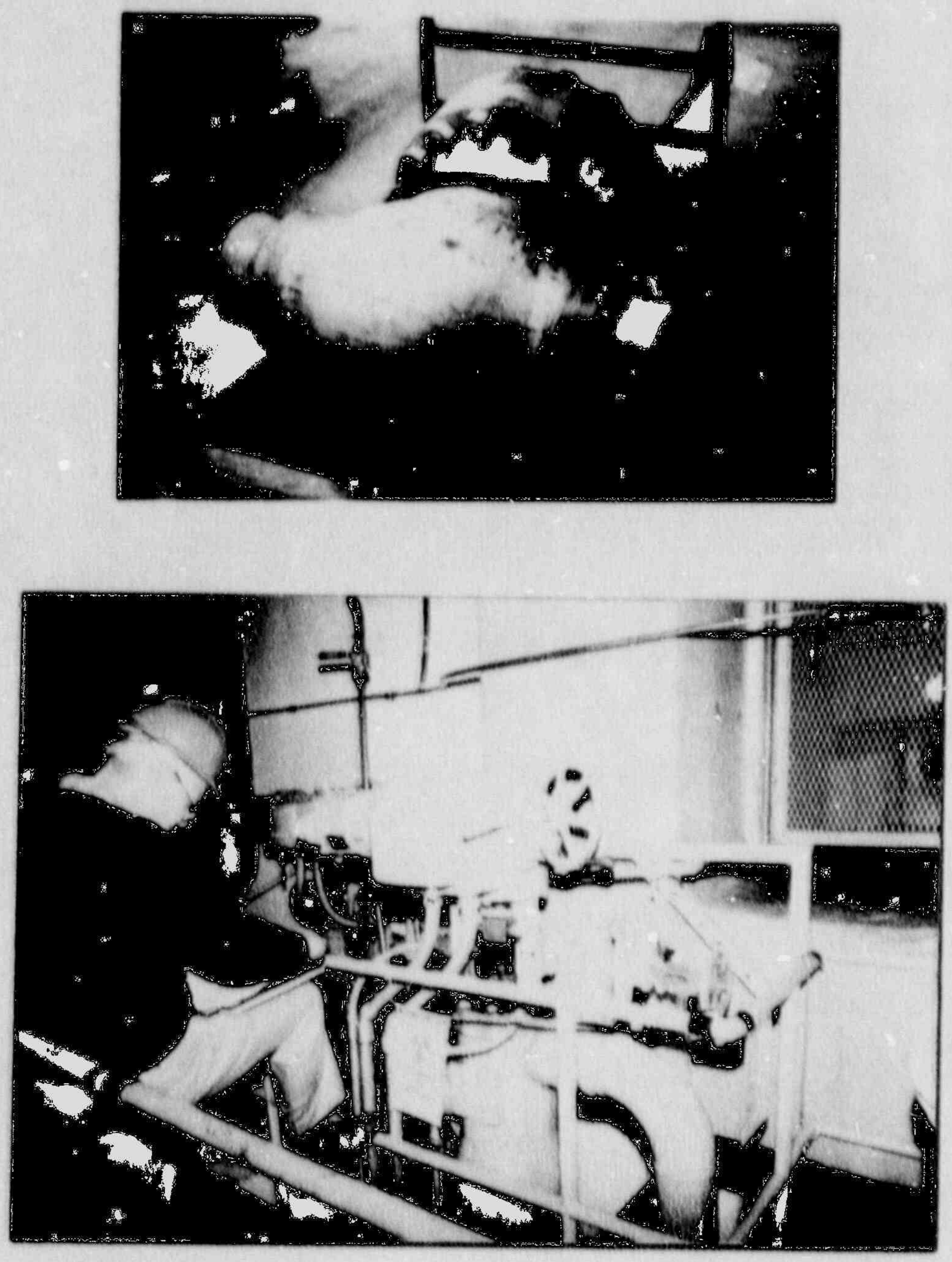


FIGURE 7. Check Valve (Top) and Motor-Operated Valve (Bottom) for NPAR Studies at ORNL

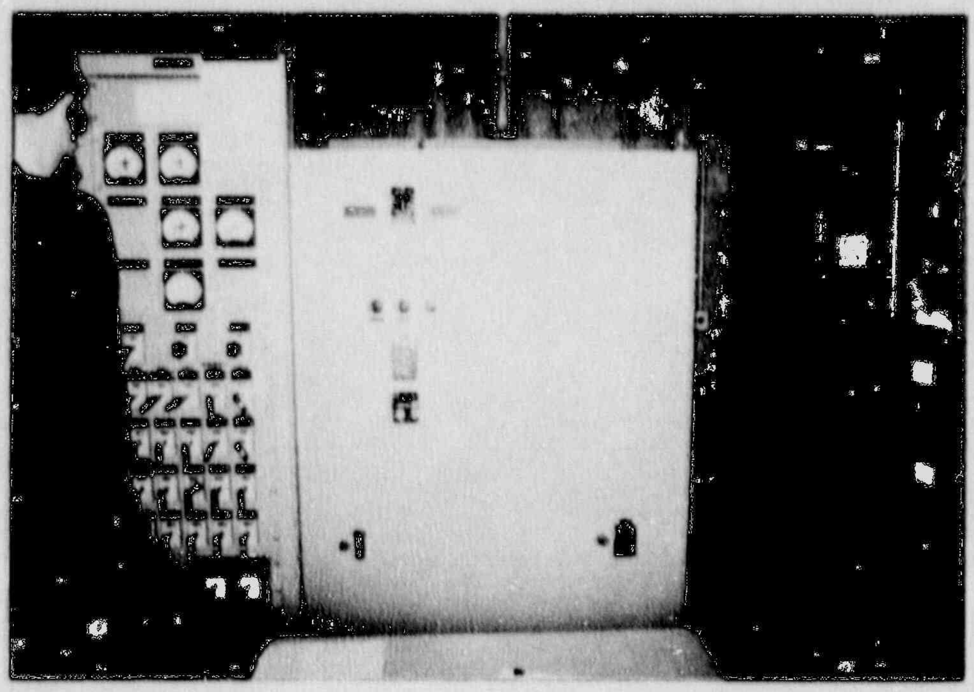


FIGURE 8. Original (Top) and Mid-1970s (Bottom) Vintage Electrical Equipment for NPAR Studies at BNL

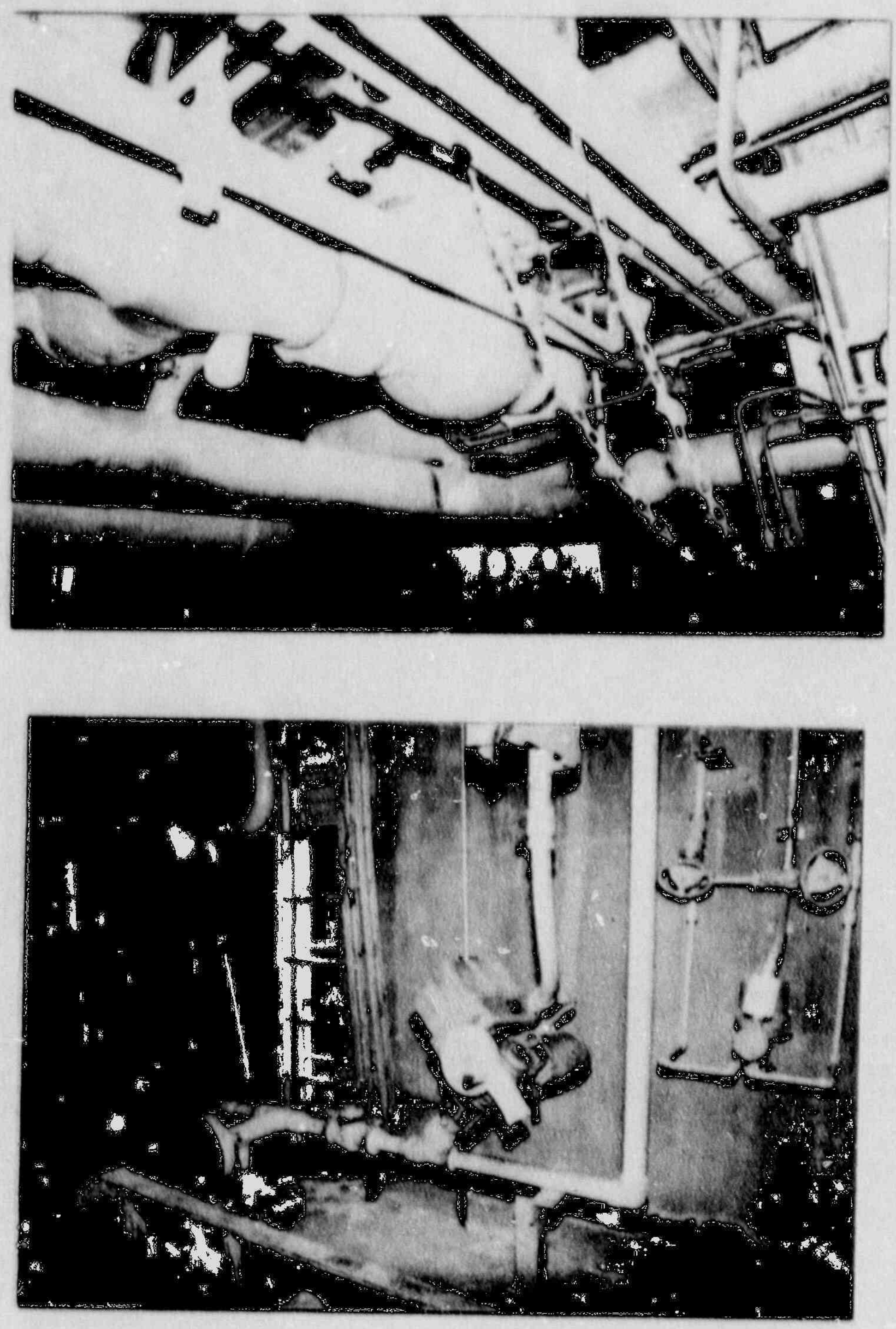


FIGURE 9. Original (Top) and Mid-1970s (Bottom) Vintage Motor-Operated Valves for Equipment Qualification Studies at INEL

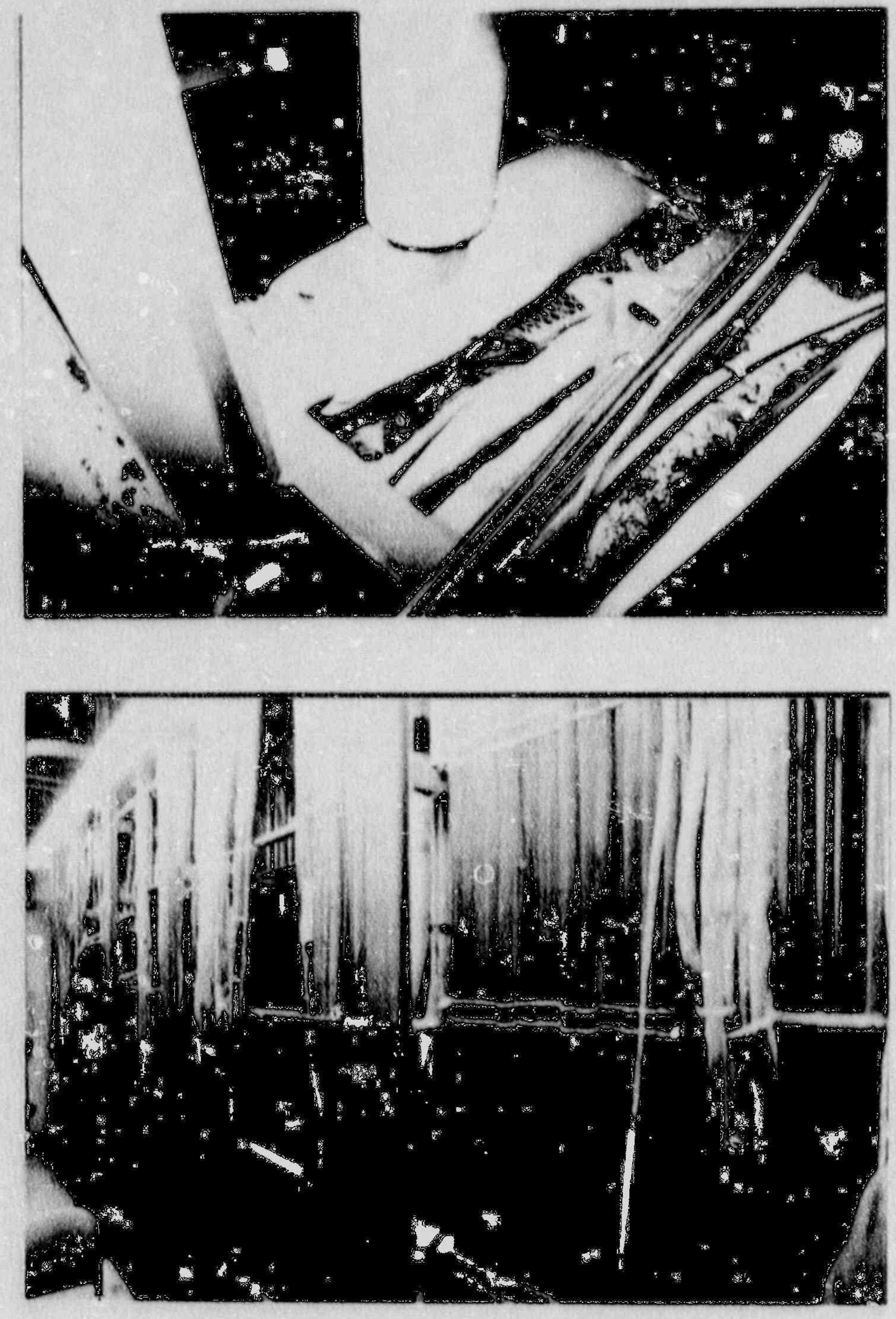


FIGURE 10. Electrical Cable from Radiation (Top) and Control (Bottom) Areas for NPAR Studies at INEL

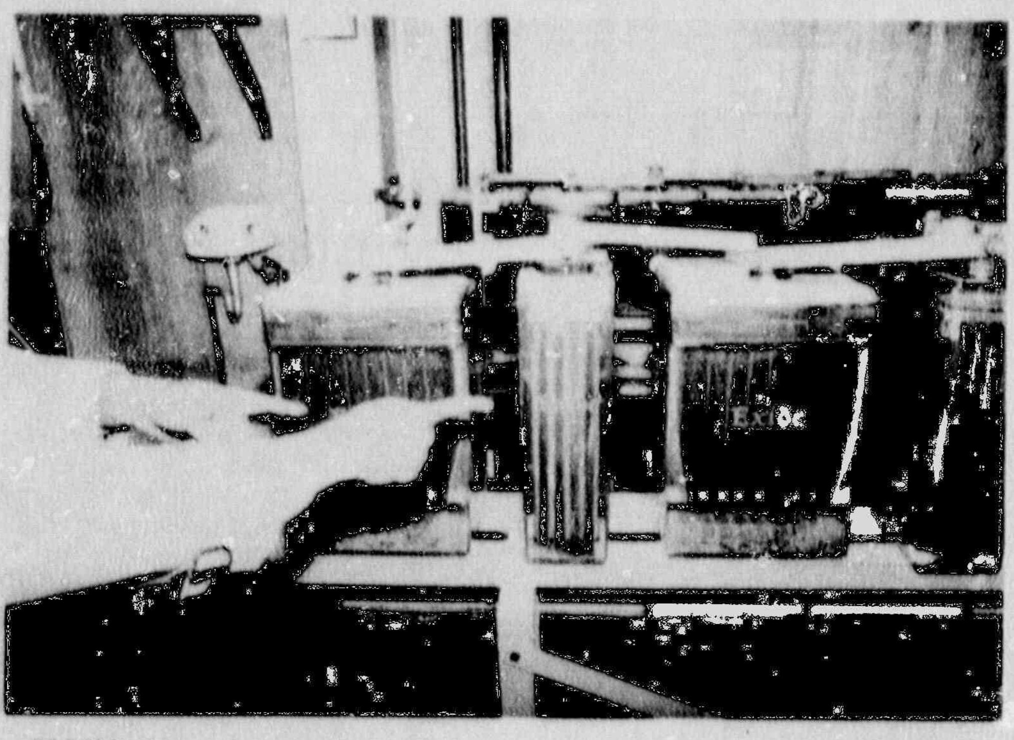


FIGURE 11. Original (Left) and Replacement (Right) Battery Cells from the Same Service Environment for NPAR Studies at INEL

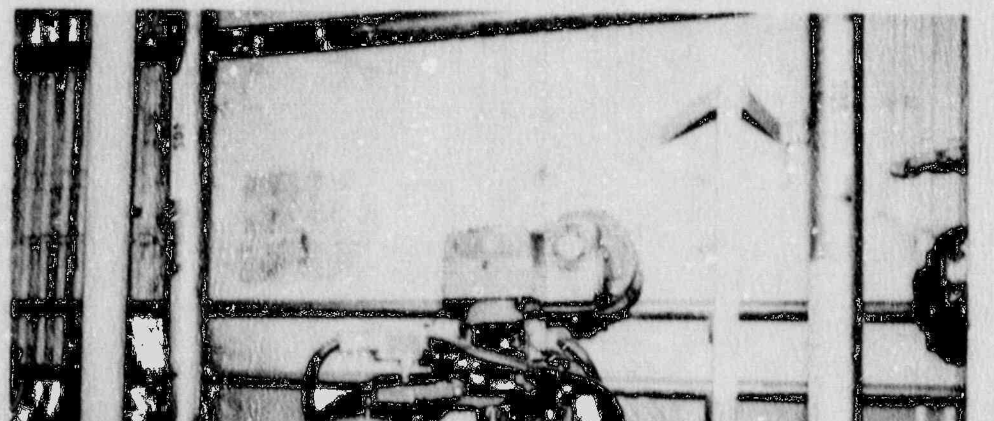


FIGURE 12. Original and Replacement Microswitches Operating in the Same Service Environment

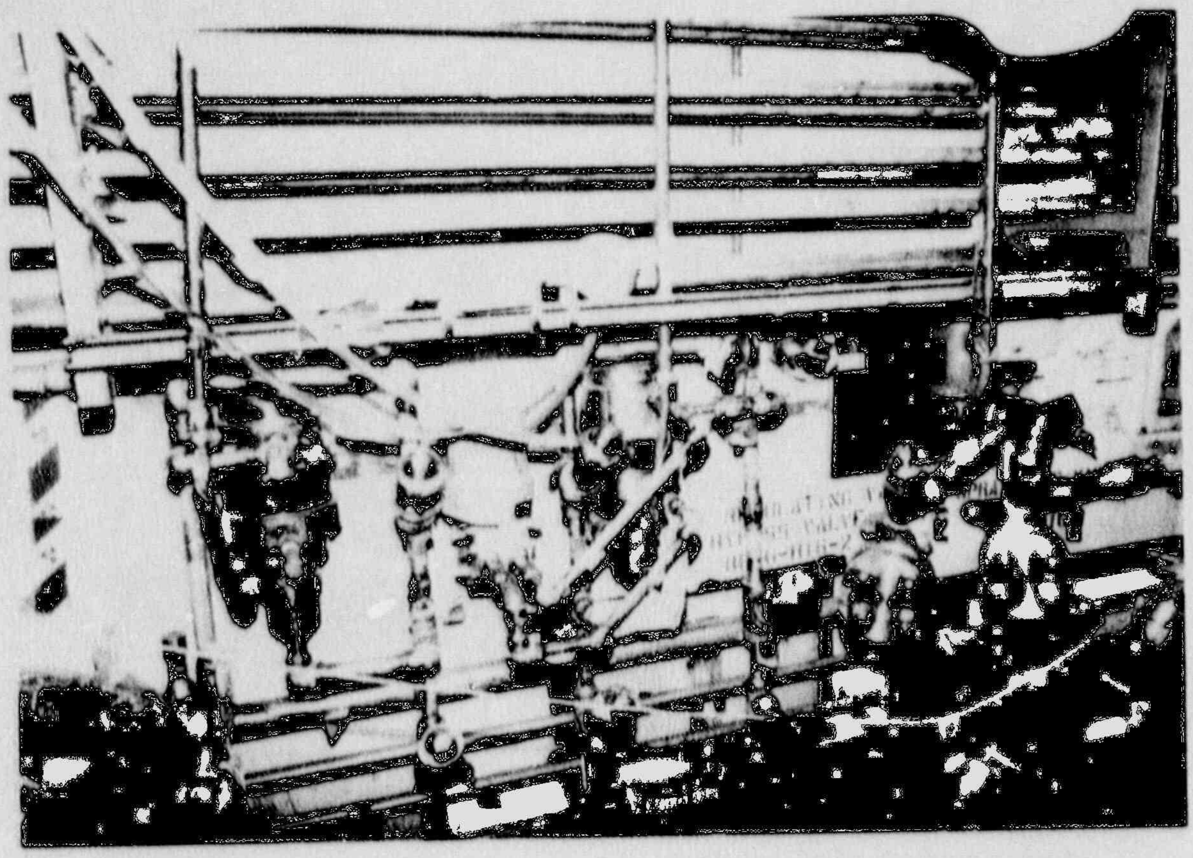


FIGURE 13. Similar Equipment by Different Manufacturers Operating in the Same Service Environment

In addition to these samples, a special sampling operation was conducted by PNL to obtain material from the inner wall of the neutron shield tank (NST). The NST is an annular water tank 35-in. thick that surrounds the mid-section and bottom of the pressure vessel to reduce the neutron and gamma radiation in the reactor chamber. The inner and outer NST walls are 1-in. thick steel plate. The tank also contains cooling coils and support braces.

The sampling operation was conducted in two parts. In January 1988, a video camera was lowered into the drained tank to locate the inner wall welds and the cooling coil support braces. The actual coring operation was conducted in May 1988, after the NST had been filled with grout. A portable concrete coring system was used to cut a 7-in. diameter core from the outer NST wall using a bi-metal hole saw, core through the grout and cooling coils using a 6.5-in. diameter diamond bit, and cut a 6-in. diameter core from the inner wall using a second hole saw. The equipment and its use are shown in the following pictures (Figures 15-18) taken during the mock-up studies conducted to develop and demonstrate the coring technology:

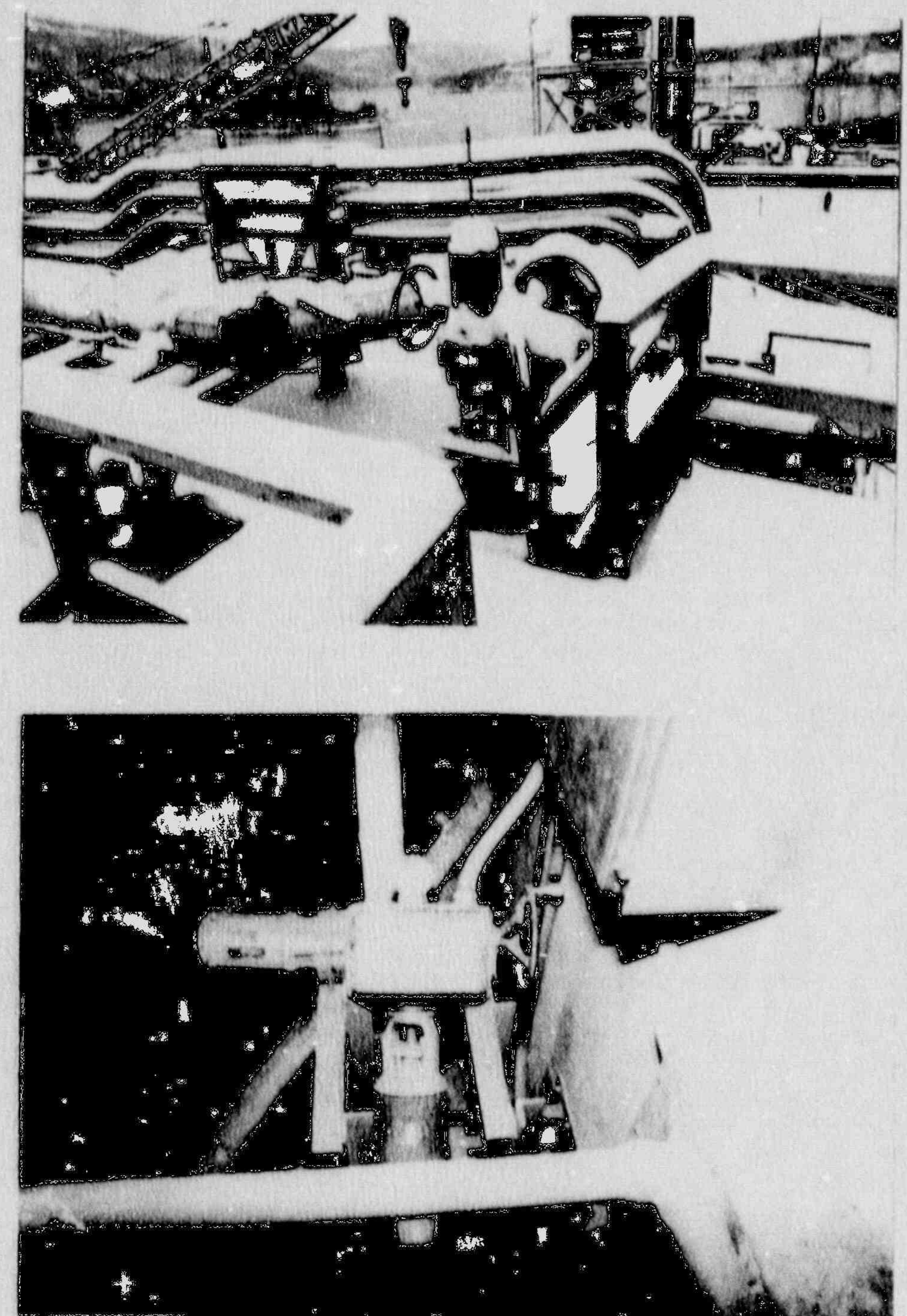


FIGURE 14. Similar Equipment (Motor-Operated Valves) Operating in Thermally Severe and Mild Service Environments

- Figure 15 - This shows the coring equipment mounted on the NST mock-up section. Use of the small, portable coring system facilitated working at the top of a 20-ft scaffold. A completed hole is shown at the upper right of the mock-up.

- Figure 16 - This is a close-up of the bi-metal hole saw used to core the outer and inner NST walls. Cutting time for the 1-in. thick metal was less than 10 minutes. All coring, including the grout, normally was performed dry using compressed air to blow out the cutting chips and dust. The cutting debris was collected by the rectangular dust collector and conveyed through a vacuum hose to a HEPA-filtered vacuum cleaner. A permanent magnet assembly fastened to the back of the hole saw was used for the inner wall cut to ensure capture and removal of the disk.

- Figure 17 - This shows the diamond core bit used to core the grout. Note that the mock-up duplicates the radius and cooling coil arrangement of the NST. Cutting time for the grout and cooling coils was approximately 1 hour. The diamond bit also was used to complete the inner wall cuts (~4 h/cut) on a few occasions when an inclusion or other problem prevented cutting with the hole saw. A water recirculation system employing the same dust collector and vacuum pickup was used to cool the diamond bit when cutting metal.

- Figure 18 - This shows a removed core including the outer wall disk (on the right), four grout cores with an entrained section of the cooling coil, and the inner wall disk (on the left). The core sections were broken loose and removed using a wedge. This figure also shows the mold and type of grout plugs that were used to fill the holes as part of the post-coring repair procedure.

Eleven 6-in. diameter inner-wall disks were successfully removed by coring through the grout-filled tank from the outside as illustrated in these figures. These samples, which represent base metal and weld regions at different neutron fluence levels, are essential to the investigation of possible low-temperature low-flux embrittlement processes in reactor pressure vessel support structures.

An effort also was made during late 1985 to obtain samples of irradiated material from the core barrel, thermal shield and pressure vessel before the pressure vessel was filled with grout. The intent was to core from inside the water-filled pressure vessel using a unique trepanning tool for stainless steel developed by the Electric Power Research Institute (EPRI) that permits removing samples of the pressure vessel wall without penetrating the pressure boundary. The specialized positioning and support equipment needed for the coring operation was developed by J. A. Jones Applied Research Corporation under contract to ANL and EPRI. Unfortunately, the trepanning tool could not be made fully operational within the time window available for the on-site operations.

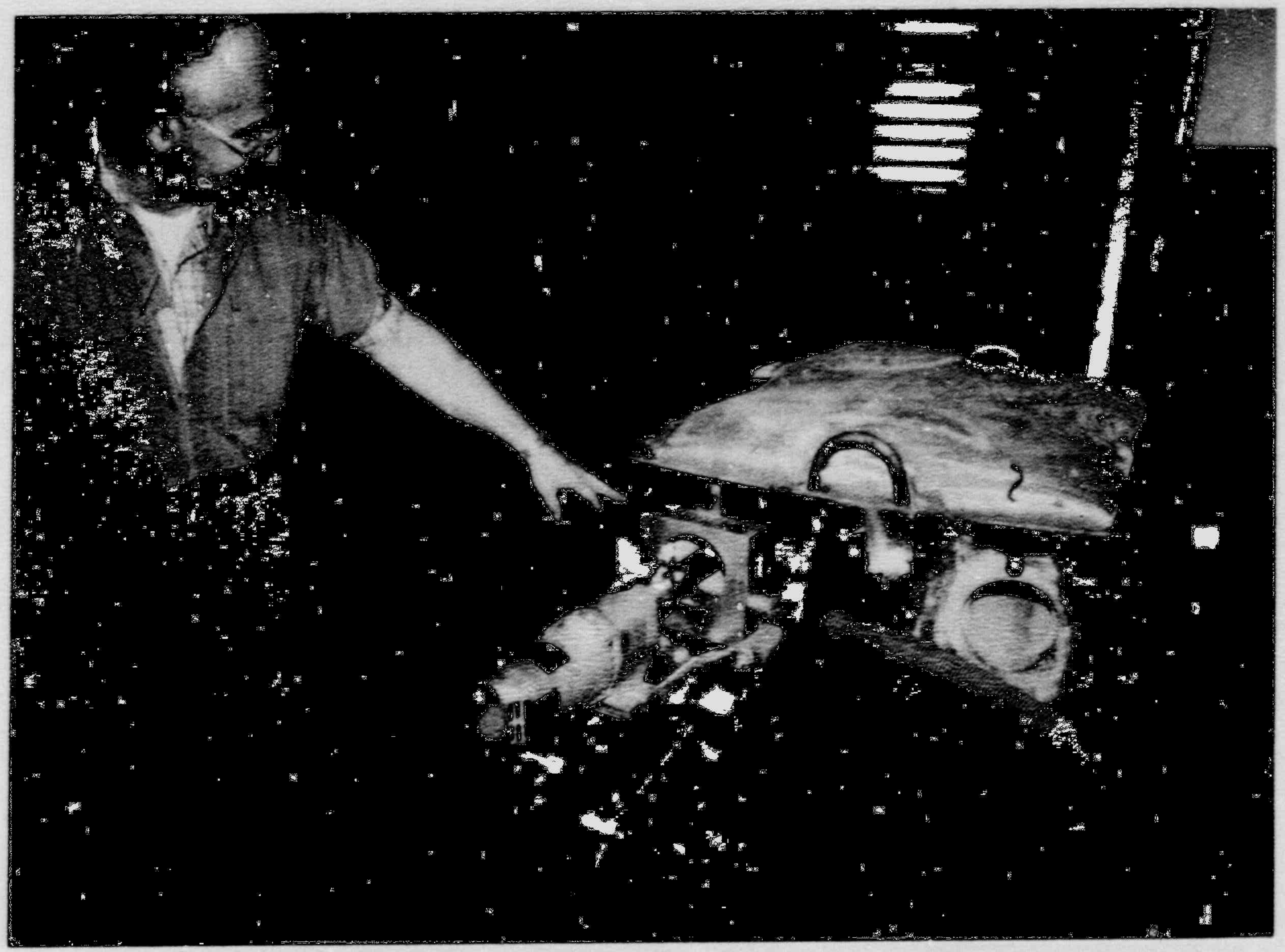


FIGURE 15. Coring Equipment Mounted on the Neutron Shield Tank Mock-up

FIGURE 16. Bi-Metal Hole Saw Used to Core the Steel NST Walls

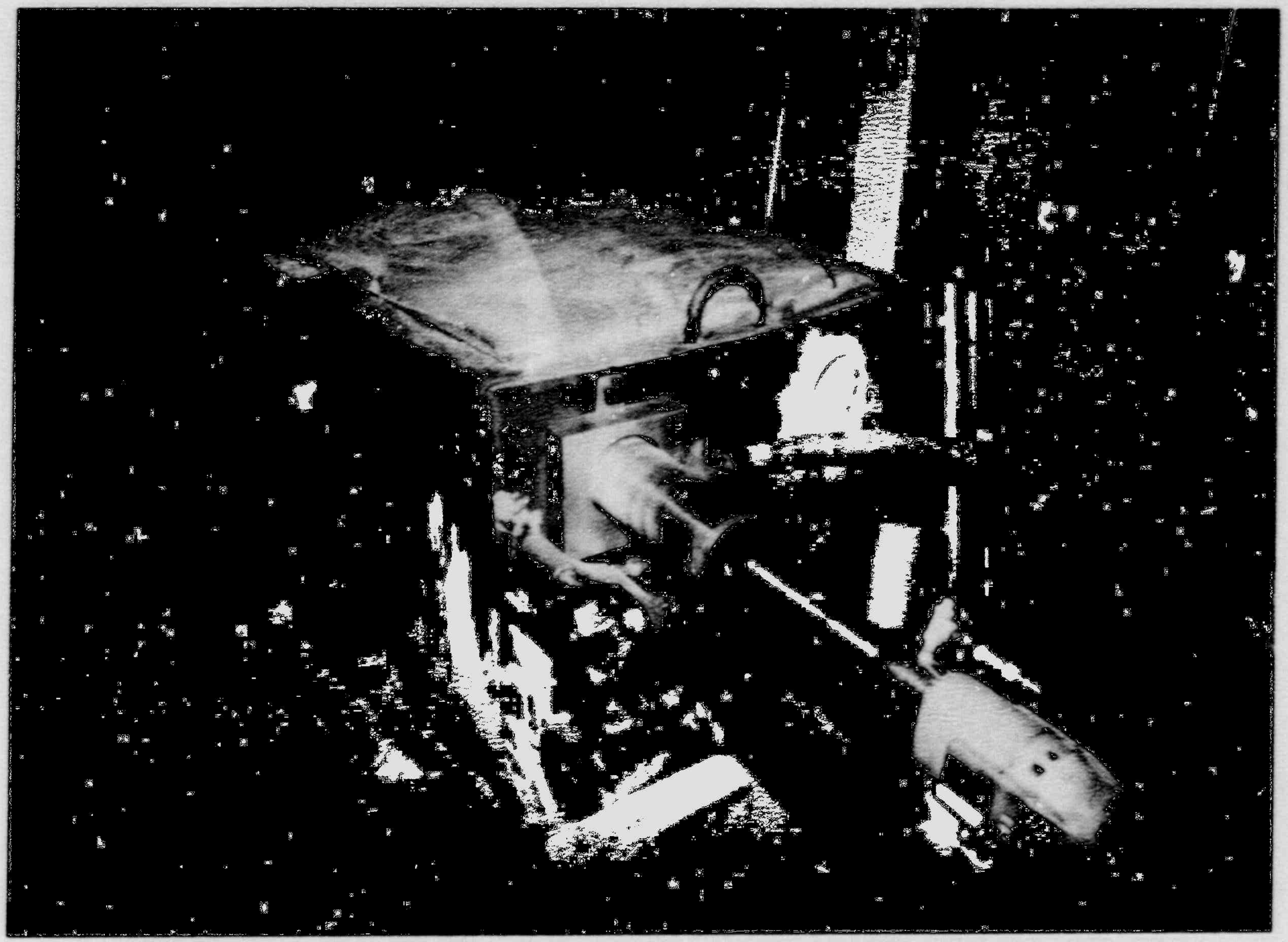


FIGURE 17. Diamond Bit Used to Core the Grout

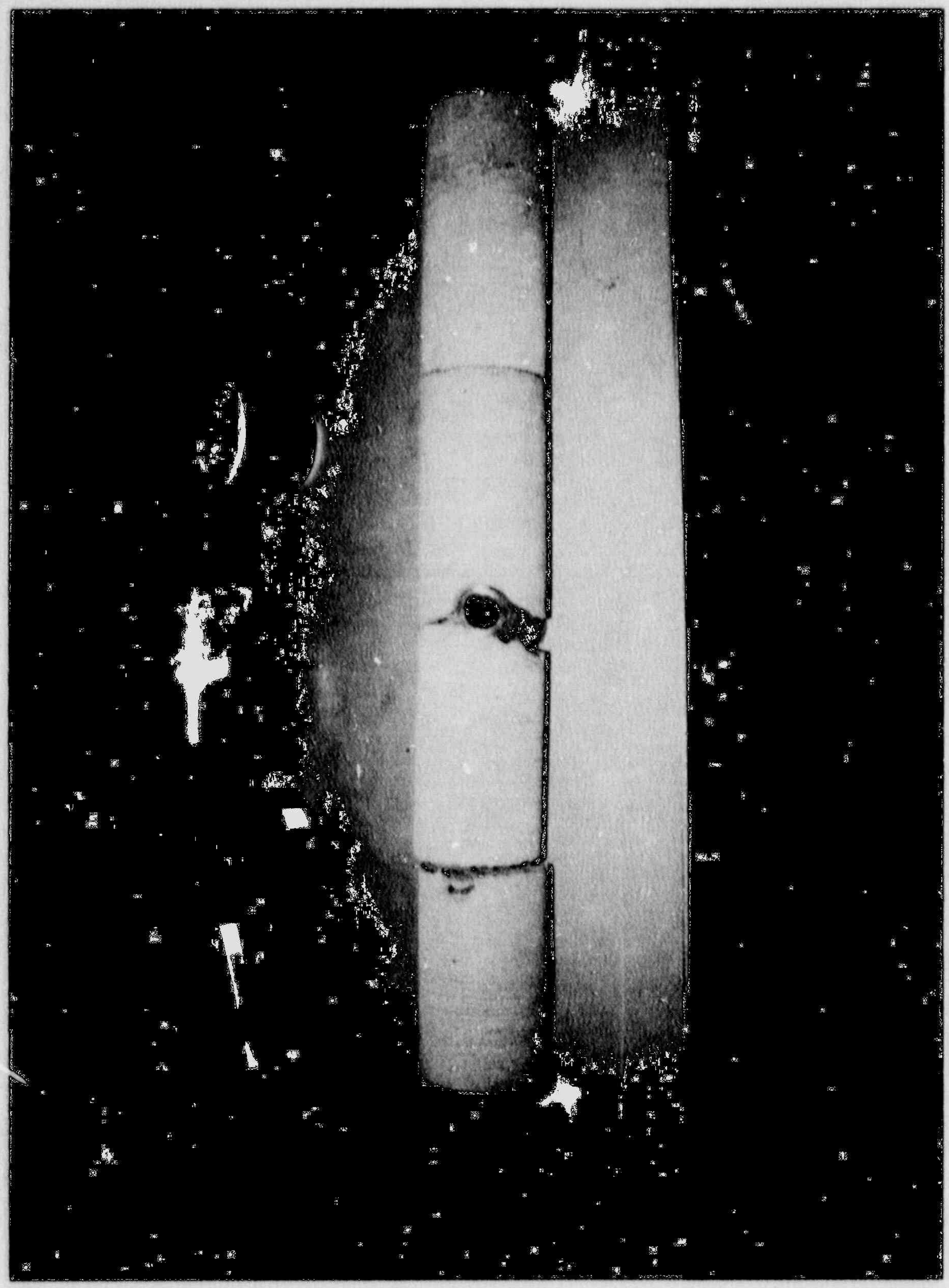


FIGURE 18. Removed Core and Wall Disks

UTILIZATION OF RESEARCH RESULTS

SAFETY SIGNIFICANCE

The evaluation of naturally aged components and materials from the Shippingport Station will provide NRC with valuable information needed to help resolve safety issues and support regulatory applications. This includes confirming and quantifying expected degradation mechanisms and failure modes for susceptible equipment, providing assurance that other components and materials will be minimally affected by aging, validating aging projections based on the extrapolation of accelerated test data, and detecting unexpected aging mechanisms (surprises) that could significantly impact component or system safety performance.

Eventual outputs from current and future investigations of Shippingport Station components and materials will include the addition of aging perspectives to regulatory guides, standards and codes; improved performance indicator monitoring; improved maintenance guidelines; and other major contributions to the evaluation of the effects of aging on plant safety and to the technical basis for plant life extension.

LESSONS LEARNED

In-situ assessments and the post-service examination and testing of naturally aged components are an integral part of the NPAR program strategy. Only actual plant systems and naturally aged components reflect the full range of effects from plant and service factors such as external stressors, service wear, testing procedures and maintenance practices.

The various types of plant aging information that can be derived from these system and component studies include the following:

- the identification of equipment demonstrating satisfactory long-term performance with minimal aging effects
- aging rate data for expected degradation processes
- detection of unexpected aging mechanisms (surprises)
- basic insights on failure modes and mechanisms
- comparison data for validating aging projections from accelerated aging studies
- identification of suitable condition and performance parameters to detect and monitor aging.

Although detailed evaluations of the naturally aged components and material from the Shippingport Station are just beginning, the preliminary results from the studies conducted to date are indicative of the value of the aging information that ultimately may be obtained. Examples include the following:

Electrical Circuits - INEL personnel conducted a comprehensive in-situ evaluation of 46 Shippingport Station electrical circuits and components (Dinsel, Donaldson and Soberano 1987). This electrical testing included more than 1600 individual measurements of voltage, effective series capacitance, effective series inductance, impedance, effective series resistance, dc resistance, insulation resistance, and time-domain reflectrometry parameters. The dual objectives were to determine the extent of aging or degradation of selected plant circuits and also to evaluate previously developed surveillance technology. Circuits evaluated included pressurizer heaters, control rod position indicator cables, primary system resistance temperature detectors, nuclear instrumentation cables, and motor-operated valves. The in-situ tests confirmed the effectiveness of the measurement system for detecting degradation of circuit connections and splices because of high resistance paths. The anomalies that were detected were attributed to corrosion. This is not surprising because the surveillance/maintenance program for these circuits was terminated following plant shutdown several years before the tests were performed. A similar rapid degradation of the plant battery cells following termination of their maintenance program was observed. This further illustrates the critical role of maintenance in minimizing the effects of aging.

Cast Stainless Steel - An ANL investigation of the microstructural characteristics of cast stainless steel from selected Shippingport Station primary system components (Shack, Chopra and Chung 1989) has helped clarify the thermal embrittlement processes that can occur at LWR operating temperatures. The ferrite content of the cast stainless steel primary system main valves and coolant pump volutes was measured in situ to identify candidate materials for these thermal embrittlement studies. Five valves with ferrite contents in the 2 to 16% range were obtained and sent to ANL for detailed evaluation. Examination of specimens from the valves by transmission electron microscopy showed very finely scaled mottle images in the ferrite, which are known to be characteristic of alpha prime formation by spinodal decomposition. G phase also was observed in the ferrite. These observations are consistent with studies on low-temperature (~300°C) laboratory-aged materials. The availability of this naturally aged Shippingport Station material thus provides a direct means of validating aging projections based on the extrapolation of laboratory data. It also has the potential of identifying unexpected aging processes and effects.

Neutron Shield Tank Samples - The embrittlement suffered by the HFIR vessel at ORNL has raised the issue of whether low-temperature low-flux irradiation can produce an unexpectedly high degree of embrittlement of reactor support structures. To help resolve this question, a special sampling operation was conducted to obtain material from the inner wall of the Shippingport Station NST for special low-temperature low-flux embrittlement studies. The NST is an annular water tank 35-in. thick that surrounds the mid-section and bottom of the pressure vessel to reduce the neutron and gamma radiation in the reactor chamber. The inner and outer NST walls are 1-in. thick steel plate.

Eleven inner-wall disks were successfully removed from locations representing base metal and weld material exposed to different neutron flux levels and sent to ANL for evaluation. Although uncertainties exist at present, the preliminary results suggest that the changes in transition temperature are not as severe as might be expected on the basis of the changes observed in HFIR. However, the actual value of the transition temperature is high, and the toughness at service temperature is low, even when compared with the HFIR data. Further detailed studies of these samples will help resolve this low-temperature low-flux irradiation embrittlement concern (Shack, Chopra, and Chung 1989).

Inverter/Battery Charger - Naturally aged inverters and battery chargers from the Shippingport Station were tested by BNL as part of the NPAR Program (Gunther 1988). Component temperatures and circuit waveforms were monitored during steady state testing and step load changes. A decrease in silicon controlled rectifier heat transfer capacity and an increase in output filter capacitor case temperature were noted and attributed to aging effects. However, it was concluded that aging had not substantially affected equipment operation. These results illustrate the use of naturally aged components to confirm the continued operability and satisfactory performance of plant equipment. This study also demonstrated the usefulness of circuit monitoring to detect impending failure in an incipient stage.

Nuclear Protection System Panel - A naturally aged nuclear protection system panel and rack was inspected and laboratory tested by INEL as part of the NPAR program. The visual inspections showed no obvious degradation, and the electronics functioned normally when electrical power was applied. A response time test of the electronics including a nuclear channel amplifier, power/flow bistable, two out of four logic circuit, and output relay was performed. The results showed that the system is operating very close to the original response time of the equipment when it was new. These tests have shown that the equipment, even though it is solid state using discrete transistors typical of the 1960s, was well maintained and would continue to function as a reactor protection system channel if it were connected to a working sensor.

Check Valves - Eighteen naturally aged check, solenoid and motor-operated valves representing a variety of types, sizes and vintages were obtained from the Shippingport Station for NPAR studies at ORNL. The first component evaluated was an 8-in. piston lift check valve from the safety injection system. Although it was in a loop that operated only during system tests, detailed examination revealed a characteristic wear pattern indicative of significant service with the piston opened about 25% of its normal travel. This is an example of the value of naturally aged components in detecting unexpected aging effects.

Motor-Operated Valves - A naturally aged 8-in. diameter gate valve and operator from the Shippingport Station was refurbished and requalified at

INEL and then tested as part of an internationally sponsored seismic research program (Steele, MacDonald and Arendts 1987). No operational problems had been observed during periodic testing of the valve during Shippingport Station operations. The valve was installed in the decommissioned Heissdampfreaktor, located in the Federal Republic of Germany, and subjected to seismic loadings in addition to normal internal pressure and flow loads. The structural integrity of the valve and operator was not affected by the seismic excitations (Steele, Arendts and Weidenhamer 1988). However, these studies did reveal a previously unrecognized cable sizing problem that resulted in the issuance of NRC Information Notice No. 89-11: "Failure of DC Motor-Operated Valves to Develop Rated Torque Because of Improper Cable Sizing."

Radiological Assessment - In addition to the evaluation of naturally aged components, the decommissioning of the Shippingport Station provided a valuable opportunity to study the composition, distribution and inventory of residual radionuclides residing in contaminated piping, components and materials. Samples of piping and concrete from selected Shippingport Station systems and surfaces were obtained for radionuclide source term measurements at PNL. One of the most significant results was that essentially all of the residual Shippingport Station radionuclides were neutron activation products dominated by ^{60}Co. No significant concentrations of fission products or transuranic radionuclides were associated with the residual activity. This condition would be representative of commercial nuclear power stations which have experienced little or no fuel cladding failures during their operations. Although other products were present with the ^{60}Co, their combined concentrations associated with the radioactive residues in piping and plant components (excluding the pressure vessel internals) never exceeded the 10 CFR 61 Class A waste limit. These findings suggest that commercial stations having similar residual radionuclide inventories and distributions can expect to dispose of most radioactive decommissioning materials and components (except reactor pressure vessel internals) as Class A waste. This will greatly simplify the disposal methods and the dismantling options during decommissioning (Robertson et al. 1988).

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APPENDIX A

SHIPPINGPORT STATION OPERATIONAL HISTORY SUMMARY

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SHIPPINGPORT STATION OPERATIONAL HISTORY SUMMARY

The following material is from the Shippingport Station LWBR Safety Analysis Report (SAR Volume 3); references are to other volumes and sections of the SAR. It should be noted that this operational history was prepared in support of the planned operations of the LWBR core. Section 3.12.1 reflects the plant status at that time and not the current state of the Shippingport Station; i.e., in the final stages of decommissioning with all of the major reactor components removed.

3.12 SUMMARY OF OPERATIONAL HISTORY

Since 1957, Shippingport Atomic Power Station has been operated successfully for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA) Division of Naval Reactors with the objectives of investigating the technical, practical, and evolutionary considerations involved in the production of nuclear electrical power in a utility distribution system. The purpose of this section is to summarize this history which serves to provide a proven foundation upon which to operate the Light Water Breeder Reactor (LWBR) Core.

Since the LWBR Core is to be operated in this plant with a minimum of modification to existing systems and since the LWBR Core represents a natural extension of the technology of past Shippingport cores, the operational knowledge and experience obtained over the years is directly applicable to LWBR operations.

3.12.1 INTRODUCTION

Shippingport was the first large-scale, central-station nuclear power plant in the United States and the first plant of such size in the world to be operated solely to produce electric power from nuclear fission. Since initial full-power operation on December 23, 1957, the reactor plant has been operated successively with two pressurized, light-water-moderated-and-cooled, seed and blanket type cores designated as PWR Core 1 and PWR Core 2. Currently, the station is shut down awaiting installation of the LWBR Core. Discussion concerning the objectives and design philosophy behind the original construction of the plant and of the design of PWR Core 1 with Seed 1 is presented in Reference 1. A summary of release history at Shippingport is presented in Section 11.7. As discussed in Chapter 11, the release of liquid and gaseous radioactivity from Shippingport has been well within applicable limits and has not resulted in a buildup of radioactivity adjacent to the site.

Section 3.12.2 summarizes the operational history of these PWR cores in terms of data on capacity factors, availability, operating dates, and energy generated and includes a summary of actual operational occurrences.

Section 3.12.3 presents a summary of operational and maintenance experience with primary plant components.

3.12.1.1 PWR Core Design and Operations

The seed-blanket core design is a concept which involves optimizing two parts of a single core design; one for the production of neutrons, the other for the utilization of neutrons. Within the PWR seed-blanket core design, reactor operations were sustained with successive replacements of enriched uranium seed assemblies whose in-core locations enable significant power production to be obtained from fertile blanket fuel assemblies which are also located in the core region. Both PWR Core 1 and PWR Core 2 were seed-blanket cores, and the successful operation of these cores has proven the acceptability of this concept from an operational viewpoint. The LWBR Core design represents a natural evolution of this seed-blanket concept as discussed throughout Chapter 4.

During its operating history, PWR Core 1 operated with four successive seeds designated as Seed 1 through Seed 4; PWR Core 2 operations involved two successive seed installations designated as Seed 1 and Seed 2. The fueling and defueling operations, as well as the subsequent acceptance testing associated with these seed and core replacements, were conducted in accordance with procedures approved by the Naval Reactors Division of ERDA. The completion of these past operations gives assurance that the LWBR installation, preoperational and acceptance testing, and full-power operations and refueling will be accomplished safely in accordance with written procedures. Over the past 17 years of operation at Shippingport, including over 90,000 hours of Reactor Critical Operations, these PWR seed-blanket cores have generated over 5.2 billion KW(e) hours gross electrical energy.

3.12.1.2 Plant Design and Operational Experience

The probability of occurrence of severe accidents which could jeopardize core integrity is minimized through the Shippingport Plant design and operational philosophy which is based upon the proven defense-in-depth concept backed by engineered safety systems which would mitigate the consequences of worst case postulated accidents. For Shippingport operation, the defense-in-depth concept incorporates: (1) the use of conservative design basis analyses, (2) the utilization of high quality, inspected and controlled, materials and components, (3) the inclusion of multiple high quality barriers to prevent the uncontrolled release of radioactivity. Among these multiple barriers are the fuel cladding, Primary Coolant System boundary, primary steel containment, and concrete enclosure structure with its emergency filtration systems, and (4) the establishment of conservative operating practices. Further, Shippingport cores have always been provided with backup Safety Injection Systems designed to mitigate the consequences of postulated loss-of-coolant accidents and containment structures designed to contain the release of any radioactivity associated with such unlikely occurrences. Aspects of these design features and safety systems for LWBR are discussed throughout this Safety Analysis Report. For LWBR operation, additional modifications have been made to the engineered safety systems to obtain additional assurances of safe operation as discussed in Chapters 6, 7, and 8. Section 3.8 summarizes further information on the containment and its test history throughout past Shippingport operations which have assured continued acceptable leakage relative to postulated radiological consequences of reactor plant accidents.

In addition, since LWBR is being installed in the Primary Coolant System with only minor modifications, the detailed operational knowledge and experience obtained over the previous 17 years of PWR operations is directly applicable to LWBR Core operations in Shippingport and provides additional assurance that the procedures to be utilized during LWBR operations are adequate.

Section 3.12.3 presents a brief summary of the operations and maintenance experience associated with various classes of plant components utilized during past operations. Included is information on the operation and maintenance history of the primary system's valves, pumps, mechanisms, piping, protection system, and steam generators. During past operations, there have been no significant safety-related problems with these components. The plant design and operating procedures have provided for effective handling of those problems which have occurred. For example, in cases where primary-to-secondary leaks have occurred in the steam generators, the associated loops have been isolated and repairs have been made. As discussed in Sections 3.12.2 and 5.2, the actual numbers of operational transients and postulated accidents which have occurred during past operations have been significantly less than the original design requirements, thereby providing additional assurances of component acceptability for LWBR use.

As shown throughout this section, past operations at Shippingport have been safe and controlled and provide a sound foundation upon which to operate the LWBR Core.

3.12.2 SUMMARY OF PAST OPERATIONS

3.12.2.1 Shippingport Operations with PWR Core 1

PWR Core 1 with Seed 1 installed achieved initial criticality on December 2, 1957, and operated at full power for the first time on December 23, 1957. Power operations with PWR Core 1 Seed 1 consisted mainly of steady-state, full-power runs interrupted only by scheduled testing operations and required maintenance. PWR Core 1 Seed 1 power operations were terminated on October 5, 1959 in preparation for scheduled fueling operations prior to replacement of Seed 1 with Seed 2 and initiation of Seed 2 operations. Table 3.12-1 summarizes pertinent capacity factor, availability, and energy generation data for PWR Core 1 Seed 1. Over 380 million KW(e) hours gross of energy were generated with this first seed.

Core 1 operations with Seed 2 installed began May 7, 1960 and were terminated August 16, 1961, for scheduled fueling operations prior to replacement of Seed 2 with Seed 3 and initiation of Seed 3 operations. Power operations with Core 1 Seed 2 consisted mainly of steady-state, full-power runs. Shutdowns were scheduled for physics testing and training. Over 500 million KW(e) hours gross were generated with this seed. Table 3.12-1 summarizes pertinent data on the operation of Core 1 Seed 2.

Core 1 with Seed 3 installed began power operations on October 24, 1961 and was shut down on November 26, 1962 in preparation for replacement with Seed 4. Power operations, as with Seed 2 consisted mainly of steady-state, full-power runs with shutdowns for physics testing. Over 475 million KW(e) hours gross were generated with this seed. Table 3.12-1 summarizes pertinent operating data.

Core 1 Seed 4 began full-power operations January 30, 1963 and was operated until February 9, 1964 when preparation for replacement of Core 1 with Core 2 was initiated. During the latter stages of Core 1 Seed 4 operations, power operations were governed by the requirements of the Duquesne Light Company system load schedule. Table 3.12-1 summarizes pertinent operating data. Over 420 million KW(e) hours gross were generated with this seed.

Core 1 Summary

During Core 1 life, the station demonstrated the ability to operate at full power for extended periods of time. Equipment reliability was constantly monitored throughout this period and design modifications were made as necessary. The majority of equipment deficiencies occurred early in life and were corrected by design modifications, equipment repair, or replacement. Such deficiencies were, principally, related to the steam-producing portion of the plant and were not associated with the safe operation of the core.

As shown by the data on Table 3.12-1, PWR Core 1 operations achieved satisfactory availability and capacity factor values in view of the fact that these figures include expanded, scheduled testing; and maintenance and training as part of the primary Shippingport objective of investigating and verifying the practical, technical, and evolutionary aspects of electrical energy generation from nuclear power. Excluding the figures for initial Seed 1 operations, Seeds 2, 3, and 4 achieved excellent availabilities of 78, 85, and 90 percent, respectively, and the total availability for all of Core 1 operations, including Seed 1 operation, intermediate seed fuelings, expanded testing, and training operations reached 62 percent.

During Core 1 operations, detailed testing and core performance evaluations were performed throughout each seed lifetime to verify predicted design characteristics, to obtain data on operational modes, and to measure fundamental reactor parameters and their variations with fuel depletion. The reactivity depletion lifetime characteristics and core flow behavior were predicted utilizing computer code models which were developed for such tasks.

Reference 2 presents documentation and discussion of Shippingport operations during Core 1 lifetime. Section 3.12.3 presents a summary of pertinent Core 1 primary component operational experience and maintenance history.

The performance of Core 1 provided information which was used in the design of Core 2. (Core 2 history is discussed in Section 3.12.2.2.) First, the overall reactivity characteristics, power sharing behavior and control parameters provided a basis for extrapolation to the higher performance requirements of Core 2. Second, the operational data from Core 1 was utilized to perform detailed design type lifetime calculations employing design techniques used in the Core 2 design work. In this manner, the accuracy of the calculational models and their ability to calculate depletion-dependent behavior could be assessed and improved.

Throughout its operational history, Core 1 performed according to design and as required to verify its performance objectives.

3.12.2.2 Shippingport Operations with PWR Core 2

PWR Core 2 had a design rating of 150 MW(e) gross and was developed to demonstrate increased core performance in terms of power density, power rating, and core lifetime. Its design rating required the installation of a 50-MW(e) Heat Dissipation System to complement the 100-MW(e) plant turbine capacity. Periodically throughout its operational history, PWR Core 2 was operated up to the 150-MW(e) level to demonstrate its design objectives.

PWR Core 2 with Seed 1 began power operations April 30, 1965 and was shut down in preparation for the Seed 2 replacement March 1, 1969.

Power operations during Core 2 Seed 1 lifetime were conducted in accordance with the Duquesne Light Company system load demand as a swing load station and prescribed test program. Table 3.12-2 presents pertinent operational data for Seed 1 operation. Because of the swing load mode of operation during PWR Core 2 operations, the plant capacity factors quoted in Table 3.12-2 are, in general, lower than those quoted for Core 1 operation when the plant was operated for the most part as a baseload station. The availability factors, however, indicated the plant's readiness to respond to power demand as required.

PWR Core 2 Seed 2 began power operations July 6, 1969 and operated as a swing load plant until February 4, 1974 when failure of the main turbine unit caused the plant to be shut down for repairs. The nuclear portion of the station was not damaged.

In view of the repair and inspection operations required to return the turbine to service and the fact that PWR Core 2 had exceeded its design lifetime objectives, PWR Core 2 operations were terminated and preparation was initiated for LWBR fueling. Chapter 10 discusses the turbine failure and subsequent repair actions. Like the development of Core 2, the development of LWBR has utilized and benefitted from the detailed operational characteristics which were accumulated during PWR Core 2 operations and testing.

Table 3.12-2 summarizes pertinent operational data for Core 2 Seed 2 through February 4, 1974. Reference 3 presents discussion and documentation on Core 2 operations with Seed 1. Data on Seed 2 operations has been obtained from Duquesne Light Company Quarterly Operating Reports.

Core 2 Summary

As shown by the data of Table 3.12-2, PWR Core 2 operations achieved availability factors of over 80 percent including intermediate fueling downtime. Its power and lifetime objectives were achieved prior to the turbine failure, and its swing load capability was demonstrated. Section 3.12.3 summarizes pertinent Core 2 primary component operational maintenance history associated with Core 2 operations. Throughout its operational history, Core 2 performed according to design and verified its performance objectives prior to the turbine failure.

3.12.2.3 Summary of Operational Occurrences and Postulated Accidents

During 17 years of PWR operations, no major safety-related accidents have occurred to the primary plant portion of the station. Additionally, since the initial shakedown period, key safety-related systems such as safety injection have always functioned as required during testing operations.

In over 33,000 hours of PWR Core 1 critical core operations, excluding testing, there were less than 53 reactor scrams from all causes most of which were due to non-safety-related causes. The majority of these scrams occurred during Seed 1 operations as the system was being shaken down and successfully integrated into a working unit.

For Core 2 operations, there were less than 34 reactor scrams (excluding testing) in over 62,000 hours of critical operations. The frequency of scrams for Core 2 was significantly less than that for Core 1: about 1 scram every 2000 hours of operation for Core 2 versus about 1 scram every 600 hours during Core 1 operations, indicating that the operational knowledge gained during Core 1 operations was successfully applied to obtain improved operations during Core 2 operations. In all cases, the nuclear protection system responded when called upon to provide a required protective functions.

Table 3.12-3 tabulates the classes of scrams which have occurred for both PWR Core 1 and Core 2 operations. As can be seen, there have been less than 10 safety-related scrams and no significant safety-related operational accidents in over 90,000 hours of core critical operations at Shippingport. In all cases, including the non-safety-related scrams, the Reactor Protection System responded, and performed as designed, to protect the Primary Coolant System and core fuel from any damage. In no case during the past 17 years was Primary System integrity impaired to the point of requiring the use of the PWR Safety Injection System's emergency cooling water.

3.12.3 SUMMARY OF OPERATIONAL AND MAINTENANCE EXPERIENCE ASSOCIATED WITH PRIMARY PLANT COMPONENTS

Throughout Shippingport history, detailed testing and operating procedures have provided assurance that operational problems would be minimized. Problems which have occurred during operation have been of no safety-related significance and have been corrected or resolved without undue delay.

3.12.3.1 Core 1 Component Experience

The reactor plant hydraulic systems operated satisfactorily during Core 1 lifetime. Minor modifications, alterations, and additions to the plant were made throughout the Core 1 operating period to assure continued safe, reliable operation. The following paragraphs briefly summarize operating experience of selected Primary System components during Core 1 operation. Reference 3.12-2 presents further documentation concerning Core 1 operations.

3.12.3.1.1 Steam Generators

During Core 1 operations, primary-to-secondary leaks were experienced with the steam generators. As a result of inspections of these leaks, changes were made to the secondary plant water specifications and modifications were made to the 1B and 1C heat exchangers to alleviate the potential for steam blanketing of the heat exchanger tubing. Following Core 1 operations, these Core 1 steam generators were replaced with new steam generators for PWR Core 2 operations.

3.12.3.1.2 Main Coolant Pumps

Two pumps, which were initially installed, remained in place throughout Core 1 operation. During this period, each pump accumulated more than 40,000 hours of operation and 5,000 pump switching operations. Of the remaining pumps, one pump suffered a stator can collapse due to system low pressure, was reconditioned, returned to service, and operated until removal in 1964. One pump failed due to failure of upper and lower radial bearings, was reconditioned and used as a spare. Following Core 1 operation, an examination program of specific pump parts was undertaken at the time of their removal from the Core 1 loops to gain information on their in-service wear characteristics.

Upon completion of Core 1 operations, the main coolant pumps were removed from service because the motors could not produce the shaft horsepower needed to develop the required Core 2 flow and head. New main coolant pumps were provided for Core 2 operations. As a result of the larger impeller provided in the new Core 2 pumps, it was necessary to increase the shroud diameter of the pump bearings to enable the Core 2 pumps to be used in the original pump volute casings.

Four Core 1 pumps were also refurbished for use as spares for Core 2 operations. These pumps will also serve as backups for LWBR operations as discussed in Chapter 5. A refurbished Core 1 pump was operated in the 1B main coolant loop during Core 2 operation.

3.12.3.1.3 Valves

No major valve problems were encountered during Core 1 operation. Minor problems such as the 18-inch hydraulic valves sticking, minor leaks across both the primary coolant motor-operated and hydraulic valves, and hydraulic valve drift were encountered. To verify that the installed Core 1 valves were suitable for continued Core 2 operations, a valve component inspection and examination program was developed. The results of the valve inspections and examinations conducted during the Core 2 modification program revealed no excessive wear on any of the valves and showed that all installed valves were satisfactory for continued operation during Core 2 lifetime.

The primary system relief valves were tested and an evaluation of the test data led to the conclusions that the PWR self-actuated primary coolant relief valves performed reliably during Core 1 operations and that they demonstrated stable operation.

3.12.3.1.4 Piping

No primary piping failures occurred during Core 1 lifetime. Periodically during Core 1 operations and again during the Core 2 modification program, piping areas such as stainless steel-to-carbon steel transition welds and resistance thermometer attachment welds were checked to assure their continued integrity. A small primary coolant leak from an instrument stalk seal did occur during Core 1 but caused no safety-related problems.

3.12.3.1.5 Primary Plant Instrumentation

The Primary Plant Instrumentation System includes all non-nuclear instruments associated with primary plant and auxiliary fluid systems. The electrical null-balance instrumentation used in measuring reactor plant flows, pressures, temperatures, and levels performed satisfactorily. The amount of drift experienced between calibrations was small.

3.12.3.1.6 Reactor Protection System

The system performed as required for safety operations throughout Core 1 life. Two minor modifications were made to the Reactor Protection System as a result of the installation of the Heat Dissipation System during Seed 4 operation.

3.12.3.1.7 Rod Control System

Performance of the Rod Control System was essentially trouble-free during Core 1 life. Problems with the commutator-inverter units, which arose early in Seed 1 life were resolved and no re-occurrence was noted. These problems were such that they did not affect the system safety function, i.e., scram. For Core 2 operation, the commutator-inverters were replaced with static inverters which eliminated moving parts and provided additional reliability.

3.12.3.1.8 Failed Element Detection and Location System (FEDAL)

The FEDAL system was utilized to monitor for potential blanket fuel element defects throughout Core 1 lifetime. This system was designed to sequentially monitor a water sample from each of the 113 Core 1 blanket assemblies (two at a time), determine its fission product delayed-neutron activity, and return the sample, together with the non-monitored bulk flow, back into the Reactor Coolant System. The FEDAL system successfully located defects in four blanket clusters during Core 1 operations. In each case, the identified defects were in the form of small pinholes in the cladding and had caused no deleterious effects on plant operations. For LWBR operations, a similar system, the Delayed Neutron Loop Monitoring System, will be utilized based on the same principles proven through use of the PWR FEDAL system. (See Section 9.3.5).

3.12.3.2 <u>Core 2 Component Experience</u>

The following paragraphs summarize operating experience of selected Primary System components during Core 2 operations. Reference 3 presents further documentation concerning Core 2 Seed 1 operations and component experience.

3.12.3.2.1 Steam Generators

The principal operational problems experienced during Core 2 operations were associated with leaking steam generator tubes. Where such leaks occurred, the secondary activity was monitored with increased frequency until the loop was isolated and the leak repaired. For LWBR operations, the heat exchanger portions of the 1A and 1D steam generators are being replaced to improve plant reliability and reduce the possibility of primary-to-secondary leakage.

3.12.3.2.2 Main Coolant Pumps

With one exception, the Primary System main coolant pumps performed satisfactorily during Core 2 operations. The 1B reactor coolant pump tripped off due to overcurrent protective action on December 6, 1967 while in slow-speed operation. The plant was being cooled down at the time, and the pump trip incident did not result in power interruption. The Core 2 pump was removed from the reactor coolant loop and shipped to the pump vendor for inspection. The pump failure was found to have resulted from a Phase C current overload caused by buckling of the rotor can. The pump was repaired by the vendor and was reinstalled during the Seed 1-Seed 2 refueling period. A refurbished Core 1 pump, maintained as a spare for Core 2 operation, was installed in the 1B reactor coolant loop. The refurbished Core 1 pump was checked out operationally and tests were performed with various coolant loops in service to verify predicted plant flow conditions with a refurbished Core 1 pump installed.

3.12.3.2.3 Valves

The following minor valve problems were experienced during PWR Core 2 Seed 2 operation.

(1) The 1A/1B boiler feed pump check valves leaked at the threaded area of the seats resulting in reverse rotation of the pumps when they were shut down. They were reassembled and returned to service.

(2) On two occasions (the 1B loop in 1968, the 1C loop in 1970), a Primary System leak in the bonnet seal ring of the loop manual outlet valve occurred. In each case the leak was isolated, the plant was cooled down, and the crack in the bonnet seal ring was repaired and successfully hydrotested prior to its return to operations.

(3) During a shutdown period in the fourth quarter of 1973, the 1B self-actuated relief valve was replaced with a spare valve. The containment bellows of the spare valve failed during hot testing, and a second replacement relief valve which was installed also failed during its hot testing. After the second failure, the valve, which is needed only if the associated loop is isolated, was capped.

3.12.3.2.4 Piping

No major primary piping failures occurred during Core 2 lifetime. A small isolable primary leak did occur during Core 2 lifetime when a temporary reactor pressure transmitter failed. The reactor was manually scrammed and no safety-related problems occurred.

3.12.3.2.5 Primary Plant Instrumentation

The Primary Plant Instrumentation System performed satisfactorily during Core 2 operation.

3.12.3.2.6 Nuclear Protection System

The Nuclear Protection System design parameters were verified by tests, and the system provided adequate protection during Seed 1 operation. A scram interlock was added to close the four boiler feedwater valves upon a reactor scram and successfully tested to verify its performance. Signal resistor malfunctions, which caused several false reactor scrams, were also corrected. In all cases, the Nuclear Protection System responded when called upon to provide required protective functions during Core 2 operations.

3.12.3.2.7 Control Rod System and Mechanism Performance

The installation of PWR Core 2 involved replacement of the Core 1 mechanisms with new mechanisms designed specifically for use throughout Core 2 operation. The design of the LWBR mechanisms represents a natural extension of the proven PWR Core 2 mechanism concept as discussed in Section 4.2.3.

After initial shakedown operations, the PWR Core 2 mechanisms operated satisfactorily. The operating experience, the periodic testing conducted, and the visual inspections conducted during the Core 2 Seed 1-Seed 2 refueling indicated that these mechanisms fulfilled Core 2 Seed 1 operating requirements and were adequate for use for Core 2 Seed 2 operations.

The measured scram times for each of the mechanisms were always within the acceptable limit established for Core 2 mechanisms, and no tendency toward increasing scram times was observed during the Seed 1 operations. The scram times measured during the precritical testing following Seed 2 installation were comparable to those measured during Seed 1 periodic testing and indicated no increasing scram time. The mechanisms performed as designed throughout Seed 2 operations.

3.12.3.2.8 Failed Fuel Detection

Essentially the same FEDAL system was utilized for Core 2 as was successfully operated for Core 1. No fuel failures were detected during the entire Core 2 operational history.

3.12.3.2.9 Turbine

In the second quarter of 1970, a steam leak inside the enclosure of the main unit turbine was observed and the steam chest cover was removed and inspected. Repairs were made and the turbine returned to service.

In the first quarter of 1974, the turbine experienced severe vibration and failure of rotating turbine blades. Refer to Chapter 10 for a discussion of this failure and subsequent repair actions. The turbine failure had no affect upon the nuclear portion of the plant.

3.12.3.3 Summary

The major operational problems which occurred during Core 1 and Core 2 history were associated primarily with the secondary systems and the steam generators and were not core-related. In each case when an operational or maintenance problem occurred, the problem was detected and corrective action instituted in a manner commensurate with assuring safe, reliable, continued power operations. No significant safety-related accidents occurred during any of the more than 90,000 hours of critical core operations. The high availability factors achieved with each seed after Core 1 Seed 1 attest to this fact. The inherent flexibility of the plant design enabled these successful operations to occur with only minor problems and with no hazards to the environment. This history (1) confirms the fact that the plant design and construction are adequate and, that the method of conducting operations is successful and proven, and (2) demonstrates that LWBR can be operated safely to support planned core operations and objectives.

REFERENCES FOR SECTION 3.12

1. The Shippingport Pressurized Water Reactor, Addison-Wesley Publishing Company, Inc. Reading, Massachusetts, 1958 (Textbook).

2. WAPD-294, "Shippingport Operations during PWR Core 1 Depletion (December 1957 to February 1964)," dated December 1968.

3. WAPD-332, "Shippingport Operations from Initial PWR Core 2 Power Operation to Power Operation after First Refueling," dated June 1973.

TABLE 3.12-3

SUMMARY OF REACTOR SCRAM CAUSES
DURING SHIPPINGPORT OPERATIONS

	PWR Core 1	PWR Core 2
1. Hours of Core Critical Operation	33,299	62,235
2. Non-Safety-Related Scrams[a]	49	29
3. Safety-Related Scrams:[b]		
A. Loss of Power with Scram[c]	2	3[d]
B. Scram Caused by Control Rod Drop	1	1
C. Isolatable Small Leak with Scram	None	1
D. Scram Due to Off-Site Accident Not Related to Site Operations	1	None
E. Other Operational Accidents	None	None

(a) Non-safety-related scram is defined as a scram which is not due to either 1) an actual operational accident, or 2) an occurrence of a severe or unusual natural or man-made event not associated with site operations. Examples of non-safety-related scrams would include scrams due to shake down operations and power spiking on trip instrumentation not caused by accident conditions.

(b) A safety-related scram is a scram due to 1) an actual operational accident, or 2) an occurrence of a severe or unusual natural or man-made event. The scram may be either automatic or manually initiated.

(c) Loss of power with scram includes scrams from either loss of dc or ac power due to either loss-of-off-site or on-site power sources.

(d) Includes loss of load due to turbine failure.

TABLE 3.12-2

CORE 2 OPERATING DATA

	Seed 1	Seed 2
Initial Full-Power Operation Date	4/30/65	7/06/69
Total Seed Lifetime (EFPH)[a]	13,652.0	10,160.0
Gross Electrical Energy Generated (KW(e)h)	1,952,933,000	1,523,659,300
Date Power Operations Completed	3/01/69	2/04/74
Average Plant Capacity Factor[b] During Associated Seed Operations (%)	41	25
Availability During Associated Seed Operation (%)[b]	85	84
Mode of Operation for Power System	Swing Load	Swing Load
Average Capacity Factor for Core 2 Operation (%)[c]	-------------31------------	
Availability for Core 2 Based upon Hours Reactor Critical (%)[c]	-------------81------------	

(a) Includes extended power operation beyond target full-power lifetime.
(b) Includes testing and extended power operations beyond full-power lifetime; excludes refueling.
(c) Includes testing and refueling down-time for Seed 1 to Seed 2. Value quoted is for entire Core 2 period 4/65 to 2/74.

TABLE 3.12-1

CORE 1 OPERATING DATA

	Seed 1	Seed 2	Seed 3	Seed 4
Initial Criticality Date	12/02/57	4/12/60	10/07/61	1/11/63
Initial Full Power	12/23/57	5/06/60	10/24/61	1/30/63
Total Seed Lifetime[a] (EFPH)	5806.1	7900.7	7329.0	6745.1
Gross Electrical Energy Generated (KW(e)h)	388,535,700	514,274,600	475,003,900	420,767,500
Date Power Operations Completed	10/05/59	8/16/61	11/26/62	2/09/64
Average Plant Capacity[b] Factor During Associated Seed Operations (%)	37	70	77	75
Availability During[b] Seed Operations (%)	53	78	85	90
Mode of Operation for Power System	Base Load	Base Load	Base Load	Base Load/ Swing Load
Average Capacity Factor[c] for Core 1 Operation (%)	--------------------52--------------------			
Availability for Core 1[c] Based on Hours Reactor Critical (%)	--------------------62--------------------			

(a) One effective full-power hour = operation at full power for 1 hour. Value quoted includes extended power operation beyond full-power lifetime.
(b) Value quoted includes testing, training operations, and extended power operations beyond full-power lifetime; excludes refueling down-time.
(c) Value quoted includes testing, training, extended power operations beyond full-power lifetime and intermediate refueling downtimes for entire period of Core 1 operations at Shippingport from 12/57 to 2/64.

Note: Availability and capacity factor definitions utilized in Tables 3.12-1 and 3.12-2 conform to those presented in Regulatory Guide 1.16, "Reporting of Operating Information," Appendix D.

APPENDIX B

MONTHLY PROGRESS REPORTS

APPENDIX B

MONTHLY PROGRESS REPORTS

PROGRESS DURING AUGUST 1983

Substantial progress was made in planning, preparing, and initiating the activities, contacts and studies needed for the early phases of this program. These included: 1) meetings with NRC, NR, and DOE-RL/UNC to establish interfaces and appropriate points of contact; 2) initiation of Shippingport plant familiarization studies and the acquisition of specific information relating to Shippingport systems and components; 3) contact with NR/Duquesne Light Co. personnel to initiate efforts to identify and preserve essential records; 4) interaction with Prioritization Task personnel to develop the early guidance needed to focus the Shippingport activities, and 5) preparation of the program plan for the FY 1984 work.

PROGRESS DURING SEPTEMBER 1983

Major project activities for the month of September included 1) preparation for and participation in the Shippingport Prioritization Workshop, 2) continuation of the Shippingport plant familiarization studies and the acquisition of information on specific Shippingport systems and components, 3) initiation of work on a ready-reference report that will summarize the information developed relating to Shippingport systems, components and materials; operating and maintenance histories; and comparisons with representative current PWR systems, 4) continuation of contacts and preparations for a site visit by a select NPAR group, and 5) a meeting with NR and Duquesne Light Co. management and records personnel to assess the nature, value and accessibility of the plant records, and explore preservation options for the records of importance for the subsequent plant aging studies.

The NR and DLC staff were very cooperative and indicated that no records of potential value to NRC and the aging studies would be destroyed. NR has requested DLC to compile a listing of early plant operating records including recorder charts and other original data. This records inventory will be available in about two months. Other types of available records identified during the visit included Trouble Records (malfunctions), Incident Reports, Operating Logs and some maintenance and design/procurement records. All of these records should be reasonably accessible.

PROGRESS DURING OCTOBER 1983

Project activities and accomplishments for the month of October included the following:

- Work continued on the acquisition of information on specific Shippingport systems and components and the preparation of a reference manual that will summarize the evaluation/comparison material obtained relating to Shippingport and current PWR systems. In addition to the data derived from Shippingport reports and operating histories, a very useful response was received from NR providing specific Shippingport-related information on 20 different components and systems of interest to NRC.

- Preparation for a Shippingport site visit continued. Contacts were made to identify potential participants with a commercial PWR equipment background. The possibility of visiting a partially-completed WPPSS PWR to view normally inaccessible components and equipment also was explored.

- A briefing meeting was held on October 5, 1983, with J. J. Schreiber, the new DOE-RL Shippingport Station Decommissioning Project Manager. He was supportive of the projected NPAR activities and expressed a willingness to work with the DOE Decommissioning Operations Contractor to facilitate the preservation and careful removal of components of interest to the NPAR program. However, he did express concern that there be no adverse impact on the decommissioning project schedules and activities.

- A consulting contract was initiated with Viking Energy Corporation of Pittsburgh, PA. This firm conducted a comprehensive study for Burns & Roe to evaluate the scrap/salvage potential of components and equipment at the Shippingport Plant. This work included on-site evaluation of all accessible DOE structures, components and equipment, supplemented by an evaluation of inaccessible components using NR drawings and other available plant information.

PROGRESS DURING NOVEMBER 1983

Project activities for the month of November centered around the visit to the Shippingport plant on November 30, 1983. Preparatory activities for the visit included:

- Compilation of system and component lists from various sources into a composite list of 40 components and 11 systems to serve as a basis for the Shippingport site discussions.

- Preparation of a Component Fact Sheet for each of the components and systems to facilitate acquisition and recording of information relating to equipment type, vintage, status, availability of records, and potential for on-site examination or testing.

- Inclusion of these lists and fact sheets along with other relevant information in a Shippingport Reference Manual that was provided to each of the visit participants.

- Participation by A. B. Johnson and R. P. Allen in a visit to the partially-completed WPPSS Unit No. 1 to view PWR systems and components of potential interest for the NPAR studies. Pictures were obtained of all these items for comparison with the corresponding Shippingport components.

- A planning meeting was held the evening before the Shippingport site visit to distribute the preparatory information, finalize the visit logistics, and agree on objectives and approach to maximize the value of the visit. Those attending the meeting and participating in the visit were:

  J. P. Vora - NRC
  A. S. Masciantonio - NRC
  S. P. Carfagno - Franklin Institute
  A. B. Johnson, Jr. - Battelle, PNL
  R. P. Allen - Battelle, PNL
  W. J. Apley - Battelle, PNL

The site visit began with an NPAR overview by J. P. Vora and a review of the visit objectives by A. B. Johnson. The balance of the morning was devoted to a detailed discussion of the Shippingport systems and components including an item-by-item consideration of the composite systems and components list from the Shippingport Reference Manual. The Naval Reactors and Bettis staff participating in the discussions were:

F. Bayer - Bettis
E. Topeleski - Bettis
R. E. Ledtje - DOE/NR
L. I. Tatum - DOE/NR

One of the major items noted was that the periodic Shippingport system changes and upgrades were generally related to changes in the core and affected the reactor head area and associated equipment rather than the auxiliary systems. In addition to the components in the plant, there also is a significant inventory of spare parts that are slated for disposal by the end of FY 1984. The identification of inventory items of interest for NPAR studies thus represents another high priority area. The discussions were recorded, and the details of these and other items discussed at the meeting will be prepared to serve as a basis for further selection of the areas of focus for the relevancy determinations.

After the discussions, an extensive tour of the entire plant including the containment areas was conducted. Pictures were taken of all components and items of potential interest. These will be correlated with the information developed during the discussions and compiled as part of the Reference Manual.

PROGRESS DURING DECEMBER 1983

During December, PNL obtained color prints from the Shippingport and Supply System No. 1 visits and developed a photo book, including captions. The notes and details of the visit were summarized. A letter of acknowledgment was sent to Bud Tatum for the November 30 visit. A. B. Johnson met with Jit Vora and Bill Morris at NRC on December 15 to review the visit and future plans. Plans were developed for Phase II activities at Shippingport.

PROGRESS DURING JANUARY 1984

Project activities for the month of January included participation in a Shippingport orientation meeting for NRC staff, coordinating project plans with NR and DOE-RL, and visiting the Washington Public Power Supply System Unit No. 3 at Satsop, WA. The following are highlights for these activities:

- Meeting Preparation - Substantial effort was devoted to preparing information and visual aids for presentation at the Shippingport orientation meeting. This included assembling slides and a picture book reflecting the Shippingport Plant visit and the previous tour of the Supply System's Unit No. 1 at Hanford, annotating the list of 51 components and systems of potential NPAR interest with the comments and information obtained through the Shippingport site visit in November, updating and summarizing the preliminary decommissioning schedule, delineating the relationships and interfaces among DOE-RL, NR, UNC, DLC, NRC and other groups with Shippingport involvement and interests, preparing a program plan and summary, and providing other background information for the orientation meeting. A. B. Johnson, Jr. and R. P. Allen of PNL also met with J. P. Vora of NRC on January 12, 1984, to review preparations for the meeting and discuss plans for future project activities.

- Orientation Meeting (January 16, 1984) - The objective of the meeting was to familiarize NRC staff with the Shippingport Plant, review the decommissioning plans and consequent opportunities for aging-related research and component evaluations, and solicit comments and suggestions on the plans and areas of potential interest. Key comments and discussion items included opportunities related to the possible re-use of Shippingport equipment, the importance of the Shippingport records to component relevancy determinations, and the need to identify both potential near-term site activities and the records to be preserved as soon as possible.

- NR Visit (January 13, 1984) - A. B. Johnson, Jr. of PNL met with L. I. Tatum of NR to coordinate project plans and obtain additional information on Shippingport systems and components. Tentative agreement was reached on an early March date for the next site visit. As reported in the orientation meeting, the need to rapidly identify the records to be preserved and the increased difficulty of supporting on-site NPAR studies after April due to decreasing site staff and substantial craft labor commitments attendant to the defueling and site turnover preparation activities were stressed.

- DOE-RL/UNC Meeting (January 20, 1984) - The purpose of this meeting was to promote a better understanding of the relationship and expected interactions of the various Shippingport project participants and interests. The need for all parties to recognize that DOE-RL will maintain full control of all site activities during the decommissioning operations and that all plans and activities must be coordinated through and receive approval from DOE-RL was emphasized. The importance of not impacting the decommissioning project cost or schedule also was reiterated. Those attending were:

  J. J. Schreiber - DOE-RL
  J. M. Usher - DOE-RL
  M. J. Plahuta - DOE-RL
  L. Pasquini - UNC
  A. B. Johnson, Jr. - PNL
  R. P. Allen - PNL

- WNP Unit No. 3 Visit (January 25, 1984) - J. P. Vora of NRC and A. B. Johnson, Jr. and R. P. Allen of PNL met with Supply System personnel and toured the partially-completed Combustion Engineering plant. The participating Supply System staff and the topics discussed were:

  D. W. Coleman - Introduction
  M. F. Keller - Equipment Qualification Program
  C. M. Butros & V. R. Harris - Preservation Period Preventative Maintenance Program

  The discussions provided some very valuable information and insights on potentially useful data developed as part of the equipment qualification activities, the possible availability of surplus parts for aging studies, and the relative importance of operational and environmental factors on equipment performance and life.

PROGRESS DURING FEBRUARY 1984

Plans are in advanced stages for a visit to the Shippingport reactor, March 7, 1984, expected to involve about 12-14 persons, including PNL, Washington Public Power Supply System, NRC staff and NRC contractors. Visits also have been arranged to the Westinghouse Advanced Energy Systems Division, Pittsburgh and Duquesne Light Company (DLC), at the Shippingport site. Contracting is in place to involve Vaughn Harris of WPPSS in the visit.

Visit preparations included:

- Reviewed monthly and quarterly operating reports (DLC).
- Contacted Naval Reactors and Duquesne to coordinate the visit.
- Updated component lists, etc.
- Prepared portfolios for visit participants.
- Checked with WPPSS regarding electrical penetrations and personnel locks.
- Coordinated motel reservations.
- Gene Skeins provided a summary of PNL capabilities regarding radiation and thermal degradation of polymeric materials.
- Transcribed recordings from Satsop visit.
- Checked with WPPSS regarding EBASCO equipment qualification list for Unit No. 3. Will be supplied when re-typing is completed.

PROGRESS DURING MARCH 1984

Project activities for the month of March focused on a March 7 visit to the Shippingport site by a group of 13 NRC and contractor personnel representing a variety of interests, disciplines and areas of expertise. The major objective of this visit was to identify the specific components to be used for the Phase II testing and evaluation work. The following are highlights for the visit and other preparatory and supporting activities:

- Visit Preparations - In addition to coordination with site personnel and arrangements for lodging and transportation, a portfolio was prepared for each participant containing forms and information to assist in the component selection and recommendation process.
- PNL-NRC Coordination Meeting (March 5, 1984) - R. P. Allen of PNL met with J. P. Vora of NRC to review preparations for the site visit and to develop plans for compilation, evaluation and incorporation of the resulting recommendations in the detailed Phase II action plans. A coordination meeting also was held with D. Reisenweaver, NRC/RES, relating to the decommissioning cost and exposure data collection work that will be conducted by UNC.
- Westinghouse Visit (March 6, 1984) - J. P. Vora of NRC, G. A. Murphy of ORNL, J. H. Taylor of BNL, and R. P. Allen of PNL met with the following staff of Westinghouse Electric Corporation's Advanced Energy Systems Division:

J. M. Sucevic - Manager, Engineering Laboratories
R. R. Orawiec - Manager, Seismic & Vibration Testing
B. Gergos - Nuclear Safety
M. S. Chang - NDT
D. Clites - AESD
R. Jabs - RD
E. G. Fischer - Consultant
C. G. Morris - NSID
M. Yalich - NSID

The Westinghouse equipment qualification testing program and facilities were reviewed and toured, with emphasis on the aging evaluation program and the seismic testing capabilities. The aging work specifically addresses seismic-event-induced common-mode failures in aged components using available data, aging mechanism experience, and an accelerated aging test program based on an Arrhenius model for the time-temperature relationships.

- Planning Meeting (March 6, 1984) - A meeting of the Shippingport site visit participants was held to distribute the portfolios, review visit logistics, and discuss the visit objectives and the desired information and recommendations.

- Shippingport Site Visit (March 7, 1984) - The group met with the NR/site personnel for a preliminary orientation and discussion, participated in a detailed component-by-component examination of the Shippingport plant and equipment, and then reconvened for additional discussion and questions on specific components and the possibilities of near-term tests and component removal activities. Those participating in the visit and discussions were:

L. I. Tatum - DOE/NR
F. Bayer - Bettis
E. Topeleski - Bettis
R. E. Ledtje - DOE/NR
B. Morris - NRC/RES (Prog. Guidance, Elect. & Mech. Comp.)
C. Serpan - NRC/RES (Materials, Vessel, Piping, NDE)
J. Vora - NRC/RES (Prog. Coord., Elect. Comp.)
G. Arndt - NRC/RES (Structures, Mech. Comp.)
E. Brown - NRC/AEOD (Mech., Electro-Mech. Comp.)
Z. Rosztoczy - NRC/NRR (PWR Relevancy, Elect. & Mech. Comp.)
G. Murphy - ORNL (LWR Relevancy, Elect. & Mech. Comp.)
R. Meininger - INEL (LWR Relevancy, Elect. Comp.)
J. Taylor - BNL (LWR Relevancy, Elect. Comp.)
D. Berry - SNL (LWR/NR Relevancy)
V. Bacanskas - FRC (Elect. Comp.)
R. Allen - PNL (Proj. Coord. & Implementation)
V. Harris - WPPSS (LWR Relevancy, Syst. & Comp., Testing)

The following is a listing of some of the major plant areas visited as part of the tour:

Main Control Room
Auxiliary Control Room
Battery Room
Relay Room
Safety Injection Pump House
Air Treatment Building
Auxiliary Power Room
Component Cooling Water Building
Fuel Handling Building
Auxiliary Chamber
Pressurizer Cubicle
Blow-off & Flash Tank Cubicle
Reactor Chamber

Additional pictures were taken of components of interest including the scram breakers, relays, a battery charger, coolers, valves, and a side-by-side comparison of electrical panels showing original vintage and mid-70's electrical equipment of the same type and function.

With respect to near-term site activities, it was noted during the discussion that site turnover will probably occur sometime between August 15 and September 15, 1984. The available site manpower will decrease from the current level of 160 to 0 in August. NR continued to express a willingness to assist with component removal and other aging evaluation activities consistent with their manpower and schedule constraints, but stressed the need to initiate these activities as soon as possible. The availability of various types of records also was discussed, and the need for an early decision on the retention of some of the records presently slated for disposal was noted.

- Duquesne Light Company Visit (March 8, 1984) - J. P. Vora of NRC and R. P. Allen of PNL met with DLC staff to acquaint them with the NPAR program and expected near-term site activities and to obtain a better understanding of the type, extent and accessibility of the relevant records. Those attending from DLC were:

  J. M. Crum - Results Coordinator
  A. D. Konopka - Nuclear Operations Supervisor
  W. E. Strayhorn - Station Office Manager
  G. Van Sickle - Maintenance Support Coordinator

  J. P. Vora presented an overview of the NPAR program, after which the various plant records were discussed in detail and some of the record holdings of primary interest were examined. Some of the information that was obtained and the record categories that were identified as potentially of interest include:

  -- A list of the plant operating charts to be retained by the DLC Records Management Department

-- A list of the plant operating charts slated for disposal or transferal to the NPAR program (309 boxes presently stored at the Wampum Mine Records Repository)

-- Shippingport Atomic Power Station Operating Manuals

-- Technical Manuals and associated correspondence/comments for plant equipment and components

-- Trouble Records - only extend back to mid-70s

-- Test Procedures and Results - primarily relate to core data; filed at Bettis by test number as listed in the Quarterly Operating Reports

-- Quarterly Check and Start-Up Check Records

-- Equipment Specification File - used for vendor bid process; reference numbers are obtainable through the Plant Operating Manuals or a separate index

-- KAR-DEX File - contains a component listing by system and a partial maintenance history.

- Site Visit Follow-Up - The participants in the Shippingport site visit responded with over 90 recommendations of components and items of interest ranging from microswitches to structures. Work was initiated to correlate these recommendations with those from the January 16, 1984, familiarization meeting and previous site visits to eliminate duplication and to clearly identify the corresponding plant component so that the detailed information needed to develop the Phase II plans can be obtained.

- NR-NRC Meeting (March 30, 1984) - J. P. Vora of NRC met with L. I. Tatum of DOE/NR to discuss the results of the site visit and coordinate efforts to obtain information on the candidate components. Based on this meeting, NR initiated work to locate records and other data for specific components, and also provided valuable information from the Plant Operating Manuals.

PROGRESS DURING APRIL 1984

Project activities for the month of April focused on continuation of intensive work to complete identification and acquisition of information on the components recommended for Phase II in situ, on-site and component removal evaluations and activities. This began with an April 4, 1984, meeting between R. P. Allen of PNL and J. P. Vora of NRC to correlate plans for the follow-up work and to transfer the recommendations and other information obtained from NR on Shippingport systems and components. Based on the material received at this meeting, a file was established for each of the more than 90 candidate components. After eliminating duplication to the extent possible, the components were prioritized according to their amenability to Phase II activities before site turnover. The highest priority components included items such as switches, relays, transformers, cable, selected motors and other relatively accessible components and system elements. Detailed information was then compiled for the components in order of priority that included:

- The recommendations for the specific components from the March site visit, the January 16, 1984, familiarization meeting, and previous site visits.
- Pictures of the component where available.
- The system and component description from the plant operating manuals including information on system/component function, operating parameters, type, manufacturer, relationship to other system elements, and special features.
- System drawings showing the location and part number of the component.
- Vintage, maintenance and status information.

Contacts were made with those recommending the components and other knowledgeable individuals where additional information or clarification was required. This work is basically completed for the highest priority components, but still requires incorporation of information developed by NR and additional maintenance and operating history data extracted from a detailed review of the monthly and quarterly operating records.

Other project and related activities during April included:

- A presentation on the Shippingport project status and activities at the April 5-6, 1984, NPAR Program Review by A. B. Johnson, Jr.
- Interactions with L. I. Tatum of DOE/NR to explore the possibility of obtaining samples of activated core materials for radiological characterization studies.
- Preparation of a revised candidate component list, a Shippingport section for the NPAR Program Plan, and FY 1985 program brief information.
- Identification of storage areas at PNL for records acquired from the site and other sources and for contaminated components and other items removed from the plant.

PROGRESS DURING MAY 1984

Project activities for the month of May included a continuation of the intensive work to complete identification and acquisition of information on the components recommended for Phase II in-situ assessments and post-service examinations and tests. The original list of more than 90 candidate components was reduced to about 60 through elimination of duplication and consolidation (by function and location) into identifiable categories. Sufficient information has been obtained to complete the identification of several of the specific components within these categories, although additional information will be acquired as feasible relating to original specifications, operating and maintenance history, inspection and test data, and other information of value for the aging evaluations. One of the major subtasks in progress is a review of all the monthly and quarterly operating records to extract references to any operating problems or maintenance activities possibly affecting the components of interest. Although the "Summary of Incidents" and "Major and Minor Maintenance" sections of the reports are quite comprehensive, they do not always provide sufficient information to identify which of a particular category of components was repaired or replaced.

A coordination meeting was held on May 21, 1984, with J. J. Schreiber and M. J. Usher of the Shippingport Atomic Power Station Decommissioning Office to review recent aging evaluation project activities and to discuss interests and plans for future work in conjunction with the decommissioning operations. They were very cooperative and helpful with respect to the proposed NPAR activities. Some of the key information and actions resulting from this meeting included:

- A copy of the candidate component list will be provided to the Decommissioning Operations Contractor (General Electric Company) and the NPAR interests will be discussed by J. J. Schreiber, the Shippingport Station Decommissioning Project Manager (DOE-RL), with F. Crimi, the GE Decommissioning Operations Project Manager, during a June 6 meeting.

- Based on the DOE-GE meeting, an interface schedule will be developed to permit incorporation of the NPAR interests in the decommissioning plans prepared by the Decommissioning Operations Contractor.

- The Shippingport Station Decommissioning Office initially will maintain a close overview of NPAR plans and activities, with subsequent involvement of UNC in this function.

- As part of the decommissioning activities, the Decommissioning Office plans to note anything unusual with respect to the condition of the plant and the major systems and components. These observations and findings will be photographed, recorded or otherwise documented. Any suggestions relating to potential problem areas or indications that should be considered based on NRC experience and examination procedures would be welcomed.

- The potential for in-situ evaluations was discussed. The site will essentially be in caretaker status from site turnover until about July 1985. Initial activities will primarily be preparatory in nature, such as decontamination of selected areas. The major concern with respect to on-site NPAR studies, assuming compatibility with decommissioning schedules and operations, is that interface control be maintained so that all activities are approved by the Decommissioning Project Manager and comply with all safety and other site requirements.

Other project activities and contacts during May included:

- Presentation of the Shippingport Project status and plans to G. A. Arlotto during a visit to PNL on May 17, 1984.

- Receipt of suggestions relating to the acquisition of Human Factors safety-related information through interviews of Shippingport personnel.

- Contact with W. J. Shack of ANL to discuss the availability of cast austenitic stainless steel for embrittlement evaluations. The fact that the main isolation valves have cast Type-304 stainless steel bodies and operated at differing inlet/outlet temperatures over the life of the plant make these of particular interest for these studies.

- Contact by L. I. Tatum, DOE-NR, indicating that some of the key records of interest for the NPAR studies had been collected at the Shippingport site and would be shipped to PNL (5/25/84).

- Development of a detailed Events Description and Milestone Schedule documenting past and planned project activities.

- Preparation of a sample Component Folder illustrating the type of information collected for each of the candidate components.

PROGRESS DURING JUNE 1984

Major project activities and events for the month of June included:

- Continuation of the intensive work to identify and acquire information on the components recommended for in-situ assessment and post-service examinations and tests. A folder has been established for each of the candidate components that will contain descriptions, pictures, drawings, operating and maintenance history, technical manual excerpts, and any other relevant information and data than can be obtained. Compilation of these folders with most of the basic information is nearly complete for more than half of the candidate components. The objective is to provide these folders to the assigned NPAR contractors for review by the end of August.

- Receipt on June 14, 1984, of three cartons of records collected at Shippingport and sent to PNL by DOE-NR. This material consisted of approximately 40 technical manuals, instruction books and data sheets containing general information, installation, operating and maintenance instructions; drawings; and other manufacturer-provided information and data on the key Shippingport components and systems as identified and requested by J. Vora of NRC during a March 30, 1984, meeting with L. I. Tatum of DOE-NR.

- Contact with L. I. Tatum of DOE-NR on June 15, 1984, to thank him for the Shippingport records and discuss near-term site-related activities. Because of the manpower commitments associated with the remaining site turnover preparations, Tatum felt that further on-site NPAR work would best be conducted after completion of all of the DOE-NR activities and formal site turnover to the DOE Office of Terminal Waste Disposal and Remedial Actions.

- Contact with J. J. Schreiber, Project Manager, Shippingport Station Decommissioning Project Office (SSDPO), on June 15, 1984, to discuss coordination and planning for the post-turnover NPAR work at Shippingport. He indicated that there should be a good opportunity, as compatible with site requirements and with SSDPO approval, to conduct substantial in-situ assessment and component removal work before commencement of the decommissioning operations. In addition, extensive interfacing with SSDPO-designated site operations organizations should commence during the first quarter of FY 1985 to ensure incorporation of the NRC interests in the overall decommissioning plan and the specific work packages affecting the candidate components. In this regard, a letter was sent from SSDPO to F. P. Crimi, Shippingport Project Manager for the Decommissioning Operations Contractor (General Electric Company) on June 18, 1984, informing him of the NRC interests at Shippingport and providing a copy of the candidate component list.

- Based on the information obtained from DOE-NR and SSDPO, a program plan entitled "Plan to Acquire Aging-Related Data and Components from the Shippingport Atomic Power Station" was prepared and submitted to NRC on June 20, 1984. The following are the major subtasks as outlined in the plan:

  I. Program Management - Planning; Administration, Reporting, Safety/QA.

  II. Data/Records Acquisition - Identify and acquire records; Extract and correlate information; Compile folders for the components; Disseminate data to user groups.

  III. Planning and Coordination - Interface with decommissioning project organizations; Integrate aging activities with decommissioning plans; Develop component and system specific action plans.

  IV. In-Situ Assessment Support - Perform initial in-situ assessment; conduct detailed in-situ tests and evaluations prior to decommissioning; Conduct selected in-situ assessments in conjunction with decommissioning operations.

V. Off-Site Assessment Support - Remove, package and ship components prior to decommissioning; Coordinate acquisition of components as part of decommissioning operations; Retrieve components sent to Hanford for disposal; Provide storage and prepare samples for evaluation.

- A letter and calls were received from PENTEK, Inc., located in Pittsburgh, expressing an interest in providing on-site engineering and liaison support for the NPAR work at Shippingport.

PROGRESS DURING JULY 1984

Major project activities and contacts for the month of July included:

- Continuation of the intensive work to identify and acquire information on the components recommended for in-situ assessment and post-service examinations and tests. A comprehensive review of the Shippingport Atomic Power Station Monthly and Quarterly Operating Reports was completed. The resulting information on component and equipment malfunctions, repairs, replacement and test results was included in the folders for the candidate components. Component- and system-specific technical information, descriptions and operating procedures also were incorporated from the SAPS technical manuals received last month and from the operating manuals and plant SAR. Additional technical information was obtained directly from manufacturers of equipment in current use.

- Coordination with the Shippingport Station Decommissioning Project Office concerning their relocation to Shippingport and the availability of decommissioning project records and information. The FTS number for SSDPO at Shippingport is 722-2639. PNL has obtained a complete set of the decommissioning plans including the detailed activity specifications as prepared by Burns and Roe Industrial Services Corporation.

- Discussions with ANCO Engineers, Inc., of Culver City, CA. This firm has developed a capability for the on-site vibration testing of buildings and large equipment. They currently have a portable machine with 250,000 lb force capacity (at 2 Hz, 0-30 Hz range) and are constructing a machine with five times the force capacity. With respect to possible applications at Shippingport, they have demonstrated that these tests can be performed without affecting adjacent buildings or plant sites.

PROGRESS DURING AUGUST 1984

Major project activities and contacts for the month of August included:

- Continuation of the work to identify and acquire information on the components recommended for in-situ assessment and post-service examinations and tests. Information folders for the following components were prepared and submitted for review by the assigned NPAR contractors:

  -- Auxiliary Control Room Building
  -- Personnel Air Locks
  -- Motor-Operated Valves
  -- 48" Diameter Butterfly Valves
  -- Hydraulic Pump Motors
  -- Pressure Switches
  -- Pressurizer
  -- Pressurizer Heating Elements

  The folders for relays, breakers and pumps are nearing completion. Special information also was provided for DB-50 type breakers. Although a concerted effort has been made to make the folders as complete as possible, they are intended primarily to serve as a basis for interaction with the potential user groups to identify additional information requirements.

- Initiation of periodic coordination meetings with other PNL groups involved in Shippingport-related studies. The first meeting was held August 1, 1984. Those attending and their interests were R. P. Allen (NPAR-Shippingport Reactor Aging Evaluation), R. I. Smith (DOE-RL/SSPDO-Technology Transfer) and D. E. Robertson (NRC-Activated Core Structural Material Studies).

- Continuation of procurement activities to obtain the services of a consultant with maintenance-related plant experience to assist in the identification and assessment of equipment and components for the NPAR evaluations.

PROGRESS DURING SEPTEMBER 1984

Major project activities and contacts for the month of September included:

- Continuation of the work to identify and acquire information on the components recommended for in-situ assessment and post-service examinations and tests. The information folders for relays, breakers and pumps were prepared for submission during early October.

- Initiation of contacts with NRC staff and assigned NPAR contractor personnel as a follow-up to the distribution of the initial set of information folders. Requests for additional information and the opportunity for on-site inspections were received for the Auxiliary Control Room Building and the Personnel Air Locks.

- Receipt of requested additional information on the Auxiliary Control Room Building from DOE Division of Naval Reactors. This material included 31 construction drawings, the building installation specifications, a catalog describing the electrical penetration seals, and a report (WAPD-LP(PE)-115) evaluating the results of the air leakage testing of the new building.

- Contact with L. I. Tatum of DOE-NR to express appreciation for the Auxiliary Control Poom Building information and to obtain background information on the Boron Recycle Pumps and the Mg-6 Relays.

- Continuation of efforts to obtain the services of a consultant with maintenance-related plant experience to assist in the identification and assessment of equipment and components for the NPAR evaluations.

PROGRESS DURING OCTOBER 1984

The major planned FY 1985 activities for this task are:

1. Data/Records Acquisition - Relevant information will be obtained for the candidate Shippingport systems, components and materials to facilitate identification of the specific items to be tested and acquired and to provide the data base for the aging evaluations.

2. Planning and Coordination - PNL will work closely with the Shippingport Station Decommissioning Project Office (SSPDO) and the designated project and site personnel to incorporate the NPAR activities into the overall site decommissioning plans and to obtain the technical and administrative support required to implement the planned activities.

3. In-Situ Assessment Support - Systems and components will be examined visually and physically prior to removal to assess condition and functional capability, define component-system boundaries and acquire information needed for component removal and handling. Support will be provided for more extensive in situ tests and evaluations as requested by the assigned NPAR contractors.

4. Off-Site Assessment Support - In coordination with SSDPO and site activities, components will be prepared, removed, packaged, shipped, stored and distributed to the assigned NPAR contractors.

The schedule for these activities will be governed by the need to maintain coordination and compatibility with the decommissioning project plans and schedules. The intent is to complete the in-situ assessments for accessible components and remove as many of the smaller components as possible before initiation of the actual decommissioning operations near the latter part of the fiscal year.

In accordance with this preliminary schedule, progress during October included:

- Contacts with SSDPO that culminated in the selection of the week of December 3-7, 1984, for an on-site component inspection and tagging visit. The assigned NPAR contractors have been informed and visit preparations are in progress. The intention is to focus on a specific component area each day with the interested NRC and contractor personnel. Components and system boundaries will be identified, defined and marked, and discussions with SSDPO and GE personnel will be conducted to initiate plans for in-situ testing and eventual component removal.

- Continuation of the work to identify and acquire information on the components recommended for in-situ assessment and post-service examinations and tests. The information folders for Inverters and RTD Pressurizer Temperature Sensors were completed and submitted. Other folders nearing completion include:

  -- Motor-Generator Set
  -- Boron Recycle Pumps and Motors
  -- Combination Check Valve/MOV
  -- Primary Coolant Relief Valve
  -- Foxboro Transmitters

- A special agreement was established with the Washington Public Power Supply System (WPPSS) to provide the services of Vaughn R. Harris as a consultant to assist in the identification and assessment of equipment and components for the NPAR evaluations. Mr. Harris is the Maintenance Manager for WPPSS Unit No. 3, and has 17 years of maintenance-related supervisory experience covering a variety of PWR systems and components.

PROGRESS DURING NOVEMBER 1984

Emphasis during the month of November was on preparation for the December 4-7, 1984, on-site component inspection and tagging visit. The following preliminary agenda was established:

Tuesday, December 4, 1984

- Visitors - W. E. Gunther (BNL)
  - V. P. Bacanskas (FRI)

- Interests - Battery chargers, inverters, circuit breakers, relays

Wednesday, December 5, 1984

- Visitors - C. V. Subramanian (SNL)
  - H. Ashar (NRC)

- Interest - Personnel air locks

Thursday, December 6, 1984

- Visitors - D. M. Eissenberg (ORNL)
  - R. D. Meininger (INEL)

- Interests - Cables, valves and operators, switchgear, in-situ electrical measurements.

Friday, December 7, 1984

- Visitors - J. G. Bennett (LANL)
  R. Kenneally (NRC)

- Interest - Auxiliary control room building.

Contact also was made with other contractor representatives that could not participate in the site visit to incorporate their interests in the tagging and planning activities.

An information packet was prepared for the visitors to assist in travel to the Shippingport site. Other preparations included compilation of location information for the components of interest, arrangements for a camera and recorder to document the location and status of the components, and the marking of tags to identify the specific components and their boundaries.

The site representatives for the visit were M. J. Usher of the DOE Shippingport Station Decommissioning Project Office, and W. Scott, UNC Manager of Site Engineering. Arrangements were made for wrap-up discussions with J. J. Schreiber, the Shippingport Station Decommissioning Project Manager, to review the identified components and initiate plans for their in-situ testing and removal.

Work also continued on the acquisition of information and the compilation of folders for the components recommended for the in-situ assessments and post-service examinations and tests.

PROGRESS DURING DECEMBER 1984

The major activity was the December 4-7, 1984, Shippingport Site component inspection and tagging visit. The following is a list of the participants and the items selected and tagged for removal and/or in-situ testing:

W. E. Gunther - Brookhaven National Laboratory

- Battery Charger
- Inverter

V. P. Bacanskas - Franklin Research Institute

- MG-6 Relays (2) - Main Control Room
- MG-6 Relays (2) - Auxiliary Control Room
- Agastat Time Delay Relay
- Scram Breakers (2)
- DB-50 Breakers (2)
- Molded-Case Circuit Breaker Motor Control Center Drawer

C. V. Subramanian - Sandia National Laboratories

- Personnel Access Air Lock

D. M. Eissenberg - Oak Ridge National Laboratory

- Type W Gang Switches (3)
- Safety Injection Booster Pump and Motor
- Check Valves (4)
- Motor Operated Valves (2)
- Valve Operator
- Solenoid Valves (4)
- Pressurizer Heater Cables and Terminal Box
- Electrical Penetrations
- Control and Power Cables

R. Kenneally - NRC/J. G. Bennett - Los Alamos National Laboratory

- Auxiliary Control Room Building

Other component and testing interests conveyed to the DOE Shippingport Station Decommissioning Project Office (SSDPO) personnel but not represented by a visit participant were:

- Samples of thermally-aged cast stainless steel from the main stop valves, check valves and reactor coolant pump volutes (NRC).

- Globe and gate valves for qualification tests (INEL).

- In-situ testing of circuits and components before removal (INEL).

Excellent site support for the visit was provided by M. J. Usher of SSDPO and W. Scott, UNC Manager of Site Engineering. A wrap-up session was held with J. J. Schreiber, the SSDPO Manager, to review the results of the visit and to formulate plans for the subsequent in-situ testing and component removal activities. Based on this discussion, a list of the identified components categorized by size, location, contamination status and difficulty of removal will be submitted to SSDPO.

Subject to SSDPO approval and site support constraints, it should be possible for qualified PNL staff to remove a majority of the components, including some contaminated items, before the end of May 1985. The noncontaminated components will be shipped directly to the designated NPAR contractors. The contaminated material must be stored on-site until SSDPO receives approval for off-site shipments, probably in late FY 1985.

Tentative approval also was received for proposed in-situ tests of electrical components and the auxiliary control building, subject to the same SSDPO approval and site support constraints.

PROGRESS DURING JANUARY 1985

Program emphasis during January was on compilation of the information from the December site visit and preparation for the in-situ testing and component removal operations. At the request of J. J. Schreiber, Manager of the DOE Shippingport Station Decommissioning Project Office (SSDPO), the components selected for removal were categorized with respect to removal difficulty and the extent of site support required. The following are the categories and items in each category:

Category 1 (Small, Easily Removed, Noncontaminated Items)

- Westinghouse MG-6 Relays (4)
- Agastat Time Delay Relay
- Scram Breakers (2)
- DB-50 Breakers (2)
- Molded-Case Circuit Breakers
- Motor Control Center Drawer
- Type W Gang Switches (3)
- Solenoid Valves (4)
- Limitorque Motor Operator

Category 2 (Larger, Noncontaminated Items That are More Difficult to Remove and/or Package and Transport)

- Battery Charger
- Inverter
- SIS Booster Pump and Motor
- Check Valves (2)
- Limitorque Motor Operated Valves (2)
- Gate Valve
- Glove Valves (2)

Category 3 (Contaminated Items that Potentially can be Removed by PNL Staff)

- Solenoid Valves (2)
- Pressurizer Heater Cables and Terminal Box
- Check Valves (2)

- Control and Power Cables

Category 4 (Contaminated Items that will be Removed in Conjunction with the Plant Dismantlement Operation)

- Personnel Access Air Lock
- Mechanical Penetrations
- Electrical Penetrations
- Main Stop and Check Valve Bodies and Reactor Coolant Pump Volutes.

Most of the requested items fall within Categories 1 and 2. These can be removed and shipped directly to the designated NPAR contractors. The smaller contaminated items potentially can be removed at the same time, but must be stored on-site until SSDPO receives approval for shipment of contaminated material.

Based on evaluations made during the December site visit, the SRL and NRC/LANL visit participants concluded that the Shippingport Station personnel access air locks and the auxiliary control room building were not suitable for projected in-situ tests. However, INEL personnel expressed a strong interest is using computer-based instrumentation to measure and evaluate the resistance, capacitance and other circuit/load electrical parameters of the various electrical components before their removal.

An effort was made to schedule the in-situ testing and preliminary component removal operations for the end of February and first part of March. However, schedule conflicts with site activities and other testing personnel commitments made this impossible. The current schedule, as proposed to the SSDPO, calls for the in-situ electrical testing to be conducted during the March 25 - April 15, 1985 period, followed by component removal, with completion of these initial on-site operations by May 20, 1985.

PROGRESS DURING FEBRUARY 1985

Program emphasis during February was on obtaining Shippingport Station Decommissioning Project Office (SSDPO) approval for the proposed in-situ testing and component removal operations and establishing a firm schedule for accomplishing this work. A categorized list of equipment with associated information and pictures was submitted to SSDPO for review. A copy of this listing is attached. The following is the approved schedule for conducting the in-situ testing and completing the removal/shipment of the Category 1-3 items:

A) Date: March 28, 1985
Participants: PNL/INEL
Objective: Preliminary review of electrical diagrams to ensure the availability of the required circuit information and to coordinate the subsequent in-situ measurements.

B) Date: April 8-26, 1985
Participants: PNL/INEL
Objective: Obtain circuit information (April 8-12) followed by in-situ electrical measurements.

C) Date: May 6-24, 1985
Participants: PNL
Objective: Remove and ship Category 1 and 2 items, remove and store Category 3 items (all equipment, shipping and storage containers, etc., will be provided by PNL).

D) Date: After SSDPO receipt of radioactive shipment authorization (August-September 1985)
Participants: PNL
Objective: Arrange for shipment of stored Category 3 components.

There will be an opportunity for some site visits by NRC/Contractor personnel during these time periods to identify additional components and view the testing and removal operations. However, these visits should be scheduled as soon as possible. Also, an early review and comparison of the attached equipment list and the lists developed during previous site visits is requested to identify other items of potential NPAR interest for inclusion in the testing and removal operations.

PROGRESS DURING MARCH 1985

Program emphasis during March was on detailed planning for the in-situ testing and component removal operations. A visit was made to the Shippingport Plant on March 28, 1985, by R. P. Allen of PNL and M. R. Dinsel of INEL to assess the availability of electrical circuit information and to further coordinate the testing and removal plans.

A comprehensive review of the circuit drawings for the plant electrical systems indicated that the information required for the in-situ testing is essentially complete and readily accessible. Based on this favorable evaluation, plans were formulated for three INEL staff to conduct the in situ tests during the April 22 - May 10 time period. The first week will be devoted to further review of the circuit information, identification of the access points for the testing, and preparation of procedures. The in-situ measurements will be initiated the second week. It should be possible to make all measurements from uncontaminated areas such as the control room. The circuits presently selected for evaluation are the high-pressure injection system, the pressurizer heaters, and motor-operated valves inside containment.

As part of the site visit, a meeting was held with J. M. Usher of the DOE Shippingport Station Decommissioning Project Office and W. J. Scott, UNC Manager of Site Engineering, to further coordinate the planned on-site NPAR activities. The major topic discussed was the need to initiate an interface with the Decommissioning Operations Contractor (General Electric and Morrison-Knudsen) for the in-situ testing and component removal operations. This will involve preparation and prior submission of Work Authorization Procedures for each NPAR activity to facilitate integration with other site work. In addition, a knowledgeable Duquesne Light Company staff member will be assigned on a subcontract basis to work with the NPAR personnel and serve as a liaison with the site operations group. Inquiries were initiated to identify a mechanism to reimburse the site groups for their support activities.

Substantial progress also was made in preparing for the component removal operations. These will be conducted during the May 20 - June 7 time period by three PNL specialists, each with several years experience in radiation work combined with a background in electrical and mechanical work. They will be assisted by an engineer who is planning and coordinating the packaging, storage and shipment of the removed items. Most of the uncontaminated items should be delivered to the respective NPAR contractors by mid-June.

PROGRESS DURING APRIL 1985

A site visit was made on April 17, 1985, by NRC/ANL/PNL staff to explore opportunities for the acquisition of primary system and core component samples. Those participating were:

J. P. Vora	NRC
A. Taboda	NRC
E. O. Woolridge	NRC
W. J. Shack	ANL
R. P. Allen	PNL

The group met with W. J. Scott, UNC Manager of Site Engineering, and then toured the primary system area of the plant. Based on the discussions, it would appear quite feasible to obtain samples of cast austenitic stainless steel from the primary system valves and pump volutes both by coring and subsequently by acquiring some of these components. Samples of primary system pipe weldments also should be readily obtainable. Conversely, it may only be possible to obtain samples of core materials by taking the entire waste liner containing the items of interest. Similarly, specimens from the thermal shield and pressure vessel will be difficult if not impossible to obtain, except possibly by core drilling through the concrete encasement after shipment to Hanford.

The in-situ testing of electrical circuits by INEL staff began on April 22, 1985, with a comprehensive review of the circuit drawings for the plant electrical systems to identify the access points for the testing and to prepare the required procedures. The actual in-situ measurements began the week of April 29, and are scheduled for completion about May 13, 1985. Those assisting with the in-situ testing are M. Dinsel, M. Donaldson, J. Follett and M. Lebo, all of INEL.

R. P. Allen, of PNL, was at the plant during the week of April 29 to coordinate initiation of the measurement work with the site organizations. This also provided an opportunity to acquire additional component information for the NPAR contractors. Twelve operating manuals, several original equipment and material specifications, and the maintenance history of eight components were located and copied.

PROGRESS DURING MAY 1985

The identification and in-situ testing of electrical circuits, which began on April 22, continued until May 13, 1985. This work was conducted by three staff members from INEL. The study included the evaluation of 46 separate components and circuits (pressurizer heaters, rod position control indicator cables, RTD circuits, motor-operated valves and nuclear instrumentation circuits). More than 1600 individual measurements were made of insulation resistance, dc loop resistance, total capacitance, total inductance and impedance. Time domain reflectometry data also was taken as an indication of cable length.

Component removal operations at the Shippingport Plant were initiated by PNL staff on May 21, and will continue into June. An INEL engineer familiar with the electrical circuits from the previous in-situ tests assisted with identification of tag-out points for the electrical equipment. Although the initial emphasis is on removal of noncontaminated items, our PNL staff completed on-site training to become certified Shippingport Plant radiation workers in preparation for subsequent work in plant radiation zones.

Both the in-situ testing and the component removal operations required substantial prior preparation (more than 40 detailed procedures and work activity packages were prepared and submitted for site approval) and extensive on-site coordination with the UNC Site Engineering and Decommissioning staff and the Decommissioning Operations Contractor and subcontractor organizations (operations, radiation control, safety, quality assurance and craft services). Although these initial on-site operations have proceeded more slowly than desired, they have established the working relationships and site interfaces needed for the ongoing component removal activities. They also have benefited the DOE Shippingport Decommissioning Project by serving as an initial test case for the site procedures and approval sequence that will be used for subcontractor work during the actual decommissioning operations.

PROGRESS DURING JUNE 1985

PNL staff completed removal and delivery of five Shippingport components to NPAR contractors on June 6, 1985. These components were two Westinghouse MG-6 relays and an Agastat time delay relay from the Auxiliary Control Room, a motor-generator set from the Turbine Room Basement, and a spare inverter from the Auxiliary Power Room. The relays went to FRC and the motor-generator set and inverter to BNL. A battery charger from the Auxiliary Control Room also was slated for removal, but plant personnel discovered that it was still servicing essential plant safety systems. The charger and a second inverter will be removed as soon as the circuits for these systems can be isolated.

Most of the effort for these removal operations was associated with the preparation and approval of the required work authorization forms, procedures and documentation for each component or set of similar components. This included:

- Preparation of a system description (including circuit drawings or piping schematics) showing the relationship of the component to other system elements and identifying clearance points to isolate the component.

- Preparation of an activity package that addresses: work location; summary work description; responsibilities of contractor, DOE and others; personnel requirements and date; access and removal paths; special tools, large equipment and special material requirements; operational support requirements; prerequisites and completion approvals; radiological conditions and need for Radiation Work Permit; hazards and precautions; electrical and mechanical tag out status and approvals; detailed work schedule with hold points; interfaces with the DOC and other contractors; and removed materials disposition.

- Preparation of detailed work procedures for each operation.

- Compilation of the above information and procedures into work packages and submission for approval by 1) Responsible Manager, 2) Operations, 3) Safety, 4) RAD CON, 5) Quality Assurance, 6) Plant Manager, 7) Shift Supervisor and 8) Work Administrator.

To date, more than 40 activity packages and work procedures have been prepared, and five work packages representing 24 components have been processed through the approval chain.

Other major activities during June included:

- Completion of a revised program plan incorporating all of the identified NRC Shippingport research interests.

- Development of cost estimates for some of the proposed in-situ sampling and component removal activities.

- Discussions with ANL/PNL staff representing MEB/CHEB interests, and Shippingport personnel planning the reactor vessel loading operation to explore the possibility of obtaining samples of core structural materials from the storage liners and metallurgical specimens from the thermal shield.

- Preparation and submission to Shippingport personnel of an updated equipment list containing revised component need dates to assist in scheduling the remaining component removal operations.

PROGRESS DURING JULY 1985

A 2-inch Safety Injection System high-pressure pump outlet throttle valve was removed from the SIS Pump House by plant personnel and sent to INEL. This valve will be inspected at INEL, refurbished as required, and used in a containment isolation system valve test program. Activity packages have been submitted and other preparations completed for removal of a second SIS valve during August.

Substantial effort was devoted to investigating alternatives and formulating plans with ANL staff for the possible acquisition of thermal shield and pressure vessel samples in conjunction with a proposed pressure vessel loading operation. This also would provide an opportunity to obtain samples of irradiated core structural materials. These possibilities will be explored with SSDPO during an early August meeting.

PROGRESS DURING AUGUST 1985

A visit was made to Shippingport by R. P. Allen on August 8, 1985, to further coordinate the component acquisition and other NRC site activities. The meetings and discussion topics included:

- A meeting with J. M. Usher, DOE Shippingport Station Decommissioning Project Office, to review the NRC site activities and program status. These discussions emphasized again that SSDPO will try to accommodate the NRC site interests, but the activities must not impact the decommissioning schedules and costs.

- A meeting with J. M. Usher, J. P. O'Donnel, GE Manager of Materials, and E. F. Kurtz, GE Manager of Home Office Programs, to discuss the mechanism for providing and funding site support activities. The decision was made to use GE and Force Account staff rather than subcontractors wherever possible for the component removal and other site operations. The costs would be covered by a Memorandum Purchase Order arrangement between PNL and GE. The work would be defined on a task-by-task basis, with cost and schedule established for each task. SSPDO and designated UNC staff would provide site overview monitoring of cost and performance.

- A meeting with W. W. Scott, UNC Manager of Engineering, and H. M. Dougherty, GE Manager of Operations Support, to review the list of NPAR components and need dates. Based on the decisions reached in the previous meeting, GE initiated preparation of cost and schedule information for the removal activities as input for the initial MPO task submission. The initial task authorization also will cover the costs accumulated for prior site support work (~$10K).

- A meeting with A. R. Schulmeister, GE Manager of Waste Processing/Decommissioning, to further explore the possibility of acquiring thermal shield, pressure vessel, and irradiated core component samples in conjunction with a proposed pressure vessel loading operation. A copy of the Technical Specification for the transfer of irradiated components to the pressure vessel and a preliminary schedule for the operation were obtained and provided to W. J. Shack of ANL. Since the irradiated core components of primary interest are in a liner that will not be unloaded, it will be necessary to take the entire liner if these items are to be acquired.

Other August activities included:

- Extensive interaction with W. J. Shack, of ANL, and various resource personnel to develop plans for in-situ sampling of the Shippingport thermal shield and pressure vessel. This would involve working remotely under water, from inside the pressure vessel, to cut an access window through the filler units, core barrel and thermal shield, and then obtain core samples from the pressure vessel. In addition to the technical considerations, the work must be performed before mid-January to be compatible with the irradiated component transfer schedule, and must not impact this critical site operation.

- Contact with L. I. Tatum of DOE-NR to obtain additional information on the pressure vessel components and operating history. Based on this discussion and a review of site documents and drawings, it appears that the outer thermal shield was not changed for PWR Core II. The core barrel and filler units were replaced for the LWBR core.

- Contact with PNL hot cell operations personnel to explore capabilities for removing selected irradiated samples from the Shippingport liner. It was determined that the PNL cask handling capacities are not adequate for the weight of the required CNS 3-55 transport cask.

- Establishment of an interface between GE and PNL Subcontracts to initiate work on the MPO to cover site support.

- Confirmation of the availability of the Shippingport 150 kW diesel generator system and provision of the Technical Manual for the equipment to D. A. Dingee of PNL.

PROGRESS DURING SEPTEMBER 1985

A meeting was held at Shippingport on September 5, 1985, to consider technical and other issues raised by a site review of the proposed pressure vessel sampling work. Those attending were:

W. W. Scott	UNC
G. E. VanSickle	UNC
R. G. Bauer	UNC
A. R. Schulmeister	GE
W. J. Shack	ANL
T. Griesbach	EPRI
P. Schoenecke	J. A. Jones
S. Toomoth	J. A. Jones
T. Oldfield	
R. P. Allen	PNL

ANL is the NRC contractor responsible for irradiated materials studies. J. A. Jones Applied Research Company and Mr. Oldfield, working under EPRI sponsorship, are developing the equipment and procedures needed for in-vessel operations.

The proposed sampling work was discussed in detail. The major technical concerns as outlined by Mr. Schulmeister of GE were:

- Possible shifting of the filler units lining the core barrel if these were completely severed.
- Elevation of contaminated components above the water level or other problems due to improper placement of excess cut material in the vessel.
- Possible impact on water clarity from the cutting operations.

These technical issues were addressed and a more detailed description of the proposed work based on the site discussions was provided for site review in a September 16, 1985, letter to J. M. Usher of DOE-SSDPO.

Concern also was expressed about the ability to correlate the proposed work with the contractor schedule for the irradiated component transfer operation, particularly since a final schedule would not be available until sometime in October. Also, the time windows potentially available for this work are subject to change if problems are encountered in the preparations of the transfer operation.

The suggestion was made that it might be best to integrate the sampling work with the transfer operation, if feasible, by using the services of the contractor selected for this activity; i.e., the contractor would conduct the sampling operation using technology, equipment and skilled personnel provided through J. A. Jones. The contractor thus would have full control over the schedule for the sampling work and could avoid impact on the transfer operation. Enough cost flexibility could be provided to permit off-shift or weekend work, if required, to further avoid interference with the transfer work.

As an alternative to the in-vessel sampling approach, the possibility of taking the samples from the outside after draining of the neutron shield tank was explored with F. A. Maclean of GE. This appears technically feasible but would be less desirable because of the present mid-1987 schedule for draining and the inability to obtain samples of the thermal shield or the pressure vessel wall region closest to the core without penetration of the pressure boundary. If this approach were adopted, it would be necessary to perform stress analyses and carefully repair the shield tank after sampling to ensure retention of the concrete and preclude interference with the lifting skirt. Also, there would be a narrow time window between completion of draining and the concrete fill, and worker exposure levels would be higher after draining.

Health and safety issues related to the proposed sampling work were discussed with Dr. K. J. Eger of GE. No major concerns were identified. The opinion was expressed that the drilling of blind holes in the pressure vessel would not affect its integrity.

Discussions also were held with R. G. Bauer and M. L. Davis concerning proposed in-situ measurements of the ferrite content of the cast austenitic stainless steel primary system components (main valves and pump volutes) to select specific components suitable for embrittlement studies. The in-situ measurements require access to the metal surface. It was determined that the insulation will be removed from 12 of the valves, but not from the eight valves in the reactor chamber and the four pump volutes. Since only a small opening (6" x 6") is required for the measurements, the suggestion was made that this could be done by the insulation removal contractor in conjunction with the work on adjacent pipe sections.

A follow-up visit was made to Shippingport by R. P. Allen on September 19, 1985. Items covered during the visit included:

- Additional information on the Boiler Feedwater Pump Header Isolation Valve and Operator that will be sent to the Federal Republic of Germany (FRG) as part of an international test program was obtained and sent to INEL.
- Preparations were made to use PNL staff to remove the valve if labor problems should prevent completion of the operation by site personnel.
- Discussions were held with J. M. Usher, of DOE-SSDPO, concerning removal of the FRG valve, the proposed pressure vessel and ferrite sampling operations, and the MPO for site support. SSDPO expressed interest in and a willingness to assist in accomplishing the pressure vessel sampling work to the extent possible within the noninterference guidelines. The possibility of presenting a paper discussing the sampling operations and resultant research results at the next International Decommissioning Symposium also was mentioned.

Based on the site discussions, arrangements were made to have S. H. Bush and F. A. Simonen, of PNL, evaluate the structural integrity implications of the proposed core drilling operation for use by DOE-SSDPO in discussions with the DOT. A work statement and MPO for the projected site activities also were prepared and submitted to GE.

A meeting was held at Shippingport on September 30, 1985, to discuss details of proposed future site activities with DOE, GE, and UNC staff. Those attending were:

J. J. Schreiber DOE-SSDPO
J. M. Usher DOE-SSDPO
F. P. Crimi GE
J. P. O'Donnell GE
G. R. Mullee GE
D. M. Yannitell GE
W. W. Scott UNC
W. J. Shack ANL
R. P. Allen PNL

Key information, suggestions, directions and action items were:

- A suggestion by GE that all of the primary system valves and pump volutes be sampled for ferrite content as soon as possible so that the asbestos could be completely removed from the selected components by the asbestos contractor.

- Various interface arrangements for conduct of the pressure vessel sampling work were discussed. GE favored just providing a window and basic support services, with PNL, ANL, and subcontractors responsible for all procedures, approvals, and on-site operations. A "Memorandum of Agreement" will be prepared by PNL detailing the responsibilities of each of these organizations.

- ANL will develop detailed technical specifications and associated time and cost estimates for the pressure vessel sampling operation. GE will provide a tentative time window for the work by October 4, 1985. A decision on continuation of the work must be made by NRC/ANL by the end of October so that SSDPO can address potential pressure vessel integrity concerns during November discussions with the DOT.

- Award of the contract for the irradiated component transfer operation has been delayed. This could either slip or shorten the window for the pressure vessel sampling operation. It was emphasized by SSDPO that the window, even if scheduled by GE, would be defined by the irradiated component transfer contractor operations. The window could even disappear if schedule problems were encountered. SSDPO would not want pressure to keep a window open if either technical or schedule problems were to prevent completion of the sampling operation as originally scheduled.

- SSDPO wants PNL to be the shipper for all contaminated site equipment for the NRC studies.

- The MPO needs to be revised to accommodate GE comments and to reflect changes in the work scope based on suggestions and decision made at the meeting.

Three staff (W. H. Wolf, L. R. Harrell, and T. French) from Jones Technology, Incorporated, accompanied W. J. Shack to Shippingport on September 30, 1985, to review drawings and obtain further information preparatory to design of the pressure vessel sampling equipment. Also, a PNL team (H. E. Kjarmo, G. H. Hauver, and E. L. Grohs) began work at Shippingport on September 30, 1985, to remove the valve needed for MSEB studies. An adjacent check valve also will be removed and sent to ORNL.

PROGRESS DURING OCTOBER 1985

Major preparatory and Shippingport Site activities during October included:

- Removal and shipment of two major valves by PNL staff. Because of craft labor problems at the site, a PNL team (H. E. Kjarmo, G. H. Hauver, and E. L. Grohs) went to Shippingport on September 29, 1985, to remove a motor operated valve needed by MSEB for incorporation in an FRG test program. An adjacent check valve also was removed and sent to ORNL for NPAR evaluation studies. The MSEB valve was an 8" Crane gate valve with an SMA-2 Limitorque operator. It served as the boiler feed-water pump header isolation valve for the Safety Injection System. The check valve was an 8" Walworth unit. Removal of these valves was complicated by their size, weight (greater than 1500 lb each) and location. They were installed near the ceiling of the basement level of the turbine building and were surrounded by a maze of piping. Removal required careful rigging and extensive interaction with the site safety groups. Also, because of other site commitments, it was difficult to obtain operational support and sign-offs on a timely basis. Despite these difficulties, the removal operation was completed on October 3, 1985, and the valves were prepared and shipped on October 8, 1985.

- Presentation of a Shippingport Task status report was made at the NPAR Program Review held October 1-3, 1985, at Oak Ridge, TN.

- Revision of the Memorandum Purchase Order for GE site support to incorporate comments and suggestions by GE and DOE-RL. The work statement also was modified to reflect changes in work scope developed at the September 30, 1985, site meeting. A revised equipment list was prepared, reflecting items already removed and changes in need dates based on discussions with NPAR contractor personnel at the Program Review.

- Continuing extensive interactions with ANL and Shippingport site personnel to coordinate and plan the acquisition of thermal shield and pressure vessel samples. In response to a request by DOE-SSDPO, two PNL experts evaluated the proposed pressure vessel sampling operation with respect to subsequent use of the vessel to ship the activated LWBR components. The first evaluation was prepared by Dr. S. H. Bush, Chairman of the American Society of Mechanical Engineers, Section XI. The major points in Dr. Bush's evaluation were: 1) from a fracture mechanics viewpoint, even through-wall small-diameter cylindrical holes would not impair the integrity of the pressure vessel, and 2) the Code even permits operation of pressure vessels at high temperatures and pressures with substantial local thinning of the wall. The second evaluation was prepared by Dr. J. R. Friley of PNL's Applied Mechanics and Structures Section. His expertise is in the structural mechanics of transportation casks and packages. Dr. Friley, after considering the transportation risks of impact, puncture and fire, concluded that the resistance of the vessel to these risks would not be significantly degraded by the drilled holes, particularly when encased in the thick concrete shield.

PROGRESS DURING NOVEMBER 1985

Major preparatory and Shippingport Site activities during November included:

- Efforts to locate spare parts for the 8-in. Crane gate valve and SMA-2 Limitorque operator sent to INEL in October. The only spare component remaining in storage at Shippingport was an SMB-1 operator.

- Establishment of a Memorandum Purchase Order for GE site support for the NPAR-related component removal operations.

- A visit to Shippingport on November 11, 1985, by R. P. Allen to plan and coordinate the proposed pressure vessel sampling work. The following schedule was developed for the critical preparatory and work activities:

  1. Submission of detailed work schedule - 11/18/85.
  2. Establishment of MPO for cost estimate and procedure review - 11/21/85.
  3. Submission of cost estimate for GE site support - 12/13/85.
  4. Establishment of site support contract - 12/20/85.
  5. Completion of equipment and procedures and initiation of Operational Readiness Review - 1/16/86.
  6. Initiation of sampling operation - 1/16/86.
  7. Project completion - 1/31/86.

- A briefing visit to NRC-DET by R. P. Allen on November 12, 1985, to discuss the status of the Shippingport work and the proposed pressure vessel sampling operation. This included an in-depth review of the technical and site constraint factors that could impact the proposed work.

- Continuing extensive interactions with ANL, J. A. Jones Applied Research Company and Shippingport site personnel to coordinate and plan the acquisition of the thermal shield and pressure vessel samples. Direct PNL efforts focused on development of the detailed work schedule for the operation, identification and assembly of required documentation, initiation of procedure preparation, and work with UNC site personnel to plan and implement an Operational Readiness Review to ensure the operability, completion and preparation of equipment, procedures and personnel for the operation.

PROGRESS DURING DECEMBER 1985

Program emphasis during December was on preparation for the pressure vessel coring operation. Specific activities included the following:

- R. P. Allen, of PNL, visited Shippingport on December 4-6, 1985, to continue planning and coordination of the pressure vessel sampling work. Details of the Operational Readiness Review (ORR) required by the Shippingport Station Decommissioning Project Office to ensure the readiness of equipment, procedures and personnel for the sampling operation were developed. Critical requirements identified by site personnel were:
  - -- The equipment must be demonstrated underwater in a realistic mock-up to ensure the ability to control the depth of cut, re-position the equipment, obtain successive samples and remove the equipment despite jamming or other abnormal conditions.
  - -- The sample shipping cask must be on-site before initiation of the cutting operation.
  - -- All procedures must be in place and the equipment operators must be trained and qualified against the procedures and through participation in the mock-up demonstration and dry runs.
  - -- Tests must be conducted to demonstrate that the cutting and hydraulic fluids used with the equipment will not impair water visibility in the pressure vessel.
- Based on the site discussions, a Management Oversight and Risk Tree (MORT) analysis of the project was performed and submitted for site review.
- A PNL staff member (D. K. Oestreich) was stationed at the Shippingport site to assist with the development, review and revision of the required procedures and documentation.
- R. P. Allen of PNL, W. J. Shack of ANL, and two representatives of J. A. Jones Applied Research Company (JAJARC) visited Shippingport on December 15-21, 1985, to continue project preparations, including site radiation worker training. Because of equipment preparation delays, the following revised schedule was developed for the preparatory activities, reviews and sampling operation:

-- Equipment/Personnel Operational Readiness Review at Charlotte, NC (JAJARC) 1/22-23/86

-- Equipment assembled/tested; Dry runs and ORR completed 1/28/86

-- Coring operation initiated 1/29/86

-- Coring operation/sample transfer completed 1/31/86

-- All site operations completed 2/07/86

In addition to the pressure vessel coring preparatory activities, arrangements were made to obtain the line starter and switch for the 8-in. Crane gate valve and SMA-2 Limitorque operator sent to INEL in October.

PROGRESS DURING JANUARY 1986

Program work during January continued to focus on preparation for the pressure vessel coring operation. Specific activities included the following:

- An Operational Readiness Review Action List for the pressure vessel coring operation was prepared and submitted for site review.
- A PNL staff member (D. K. Oestreich) returned full time to the site to assist with the development, review and revision of the required procedures and documentation.
- R. P. Allen of PNL visited Shippingport on January 15, 1986, to review and coordinate project preparations.
- R. P. Allen, W. J. Shack of ANL, and the following site personnel visited J. A. Jones Applied Research Company (JAJARC) at Charlotte, NC, on January 16-17, 1986:

J. M. Usher	DOE
J. W. Handy	UNC
W. W. Scott	UNC
B. Harrison	GE
S. E. Miller	GE
M. R. Morton	GE

The purpose of the visit was to coordinate completion of the equipment procedures, preview the conduct of the Operational Readiness Review (ORR), assess the validity of the coring operation mock-up and define required site services.

- A PNL review of the ORR Action List items was conducted on January 20, 1986, by representatives of PNL line management, safety organizations and NPAR project management. The adequacy of the MORT analysis was assessed, the completion status of the action items was reviewed, and the supporting documentation was evaluated.

- A request was made by JAJARC to delay the ORR due to difficulties with the trepanning equipment for the stainless steel components. R. P. Allen, W. J. Shack, and T. Griesbach, of EPRI, visited JAJARC on January 22-23, 1986, to review the problem. After extensive testing of equipment modifications and evaluation of possible alternative approaches, it was concluded that the stainless steel trepanning equipment could not be made operational within the established time window for the on-site operations. Additional intensive equipment development efforts also were precluded by limits on the EPRI funding for their portion of the effort.

- R. P. Allen met with the Shippingport site personnel on January 23-24, 1986, to inform them of the decision not to proceed with the sampling operation. Appreciation was expressed for the outstanding site support and cooperation provided by DOE, UNC, and GE in the planning and preparatory activities. The request was made to preserve relevant information and documentation to assist in possible future applications of the sampling technology.

In addition to the pressure vessel coring activities, arrangements were made to expedite removal of some of the other plant components needed for near-term NPAR studies. The line starter and switch for the 8-in. Crane gate valve and SMA-2 Limitorque operator, sent previously to INEL were removed by plant personnel and shipped to INEL for use in the FRG test program.

Arrangements also were initiated to measure the ferrite content of some of the primary system main valves and pump volutes to assess their suitability for thermal embrittlement studies of cast austenitic stainless steel. Based in part on the MEB interest in these components, the Shippingport Station Decommissioning Project decided to remove all of the asbestos from the primary system components in the boiler chambers rather than just from the piping as originally planned. The removal of all asbestos, which should be completed for two of the four boiler chamber compartments by the end of February, will greatly facilitate both the ferrite measurements and also the handling of the components acquired for further investigation at ANL.

PROGRESS DURING FEBRUARY 1986

Program work during February was limited due to funding constraints. Specific activities included the following:

- An updated list of the Shippingport components and contractor need dates was prepared and submitted to the Decommissioning Operations Contractor through the DOE Shippingport Station Decommissioning Project Office.

- Arrangements were made for a March site visit, following completion of asbestos removal work in two of the boiler chambers, to measure the ferrite content of primary system main valves and pump volutes to assess their suitability for thermal embrittlement studies of cast austenitic stainless steel.

- Discussions were initiated with INEL staff to define their Shippingport needs with respect to recently assigned NPAR components. Proposed work includes additional on-site testing and extensive evaluation of electrical components to verify previously detected anomalies, select specific components for removal, and identify those components with definite evidence of degradation for off-site study. These plans will be discussed with Shippingport personnel in conjunction with the March ferrite measurement visit.

PROGRESS DURING MARCH 1986

Major program activities during March included:

- Three Type W Gang Switches from the main control room (pressurizer spray control, narrow range selector and emergency air loading switches) were removed and shipped to INEL for evaluation.

- The planned March site visit to measure the ferrite content of primary system main valves and pump volutes was rescheduled for mid-April due to a delay in completion of the asbestos removal work. This later time will permit evaluation of additional primary system components.

- Arrangements were made to discuss decommissioning plans and schedule revisions with Shippingport personnel in conjunction with the April ferrite measurement visit to permit updating the program plan for the DET Shippingport activities.

PROGRESS DURING APRIL 1986

Major program activities during April included:

- R. P. Allen of PNL, met with M. L. Stanley at INEL, on April 11, 1986, to review needs and schedule for Shippingport components. A copy of the revised report, "In-Situ Testing of the Shippingport Atomic Power Station Electrical Circuits" was obtained and taken to Shippingport for review.

- R. P. Allen visited Shippingport on April 14-16, 1986, to coordinate the ferrite sampling operation and to obtain information on the current plant decommissioning plans and schedules to permit updating the program plan for the DET Shippingport activities.

- The ferrite content of the cast austenitic stainless steel in six main isolation valves and one pump volute was measured by W. J. Shack and a technician from ANL. The ferrite levels were sufficiently high in the pump volute and one of the hot-leg valves to make these items good candidates for acquisition for thermal embrittlement studies.

- Plans were made to measure the ferrite content of the remaining 14 valves and three pump volutes in late May after completion of the asbestos removal operations. The possibility of obtaining core samples from these items (after the primary system is drained) for an initial metallurgical evaluation also was explored.

The following is the current schedule for major decommissioning activities of DET interest:

• Drain Primary System	6/86
• Drain Neutron Shield Tank	7/86
• Remove Boiler Chamber Primary System Components	6/86 - 4/87
• Remove Power and Control Systems	6/86 - 6/88
• Remove Reactor Chamber Primary System Components and Prepare Vessel for Removal	10/86 - 10/87
• Remove Reactor Vessel	12/88
• Remove Containment Chambers	3/88 - 7/89
• Barge Vessel and Components to Hanford	7/89 - 10/89
• Complete Decommissioning Operations	2/90

These dates are subject to change. In particular, some of the later operations may occur as much as a year earlier. However, it appears that most of the primary system valves, piping and other components will become available during the last quarter of FY 1986 and the first two quarters of FY 1987.

PROGRESS DURING MAY 1986

Removal of asbestos from the Shippingport Plant reactor chamber was not completed until the end of May. Measurement of the ferrite content of the remaining primary system valves and pump volutes was therefore rescheduled for the first week in June. However, the primary system was drained a month ahead of schedule. This will permit early sampling of these systems to obtain metallurgical and radiological specimens.

Based on a request from W. Gunther of BNL, a special effort was made to accelerate acquisition of the inverters and battery chargers from the Auxiliary Control Room. This has been made a high priority item on the DOC schedule and should be completed in June as soon as plant electrical system preparations for the primary system removal operations are completed. A letter also was prepared for the Shippingport Station Decommissioning Project Office to send to equipment manufacturers to request release of test and qualification data for the inverters.

A meeting was held with D. E. Robertson and J. C. Evans of PNL, to review plans for the acquisition of radiological samples in conjunction with the primary system and piping removal activities. This work will be coordinated with the site contractor for these operations during the June ferrite measurement visit.

PROGRESS DURING JUNE 1986

Ferrite content measurements for the cast austenitic stainless steel primary system valves and pump volutes were completed during a June 3-5, 1986, site visit by R. P. Allen of PNL, and W. J. Shack of ANL. Of the 24 cast components, nine had sufficiently high ferrite levels to make them of interest for thermal embrittlement studies. These were the hot-leg main stop and check valves in Loop A, the hot-leg main stop valve in Loop B, the cold-leg main stop and check valves in Loop C, and all of the pump volutes.

The possibility of obtaining core samples from these cast components for metallurgical and radiological studies was discussed with site and contractor personnel responsible for the primary system removal operations. Additional information on coring procedures, equipment and site support requirements will be developed by PNL so that an estimate of site costs can be prepared.

Efforts to acquire the inverters and battery chargers from the Auxiliary Control Room continued. The site may retain one of the chargers based on a recent power outage that forced use of the emergency power system. However, the other components still should be obtainable.

Other June activities included a meeting with Decommissioning Operations Contractor finance staff to clarify costs associated with the pressure vessel coring operation, and discussions with site personnel concerning the acquisition of radiological evaluation samples.

PROGRESS DURING JULY 1986

A statement of work was prepared and arrangements were initiated to revise the Memorandum Purchase Order with the General Electric Company to provide site services for two additional Decommissioning Operations Contractor (DOC) tasks. These tasks will support the acquisition of components and samples for the Materials Branch for thermal embrittlement and radiological characterization studies. The specific items to be obtained are: 1) four primary system main check valves; 2) one or more main coolant pumps; 3) three primary system main stop valves; 4) samples of hot-leg and cold-leg weldments; 5) sections of pipe from the coolant purification system, the radwaste treatment system, the monitoring/instrumentation systems and the fuel pool recirculation system; and 6) corrosion film samples from the secondary side piping.

The statement of work was structured to conform as closely as possible to the planned site activities to minimize cost and schedule impacts. In many cases, all that may be required will be to cut the connections so as to preserve the pipe-to-component welds, and then place the components in special containers for shipment to ANL or PNL.

Most of these components and samples will be acquired in conjunction with the decommissioning activities scheduled for September 1986 through January 1987. Since some of the cast austenitic stainless steel components will become available earlier than expected, efforts to obtain core samples of this material were discontinued.

PROGRESS DURING AUGUST 1986

A proposal to extend the Memorandum Purchase Order (MPO) with the General Electric Company (Shippingport Station Decommissioning Operations Contractor) to provide site services for the acquisition of components and samples for the Materials Branch for thermal embrittlement and radiological characterization studies was submitted on August 6, 1986. R. P. Allen visited the Shippingport site on August 7-8, 1986, to discuss the new tasks and obtain agreement on the proposed scope of work. Based on these discussions, a revised Statement of Work was prepared and incorporated in the MPO.

PROGRESS DURING SEPTEMBER 1986

The Memorandum Purchase Order (MPO) with the General Electric Company (Shippingport Station Decommissioning Operations Contractor) was replaced by a direct contract between the General Electric Company and Pacific Northwest Laboratory. The DOE-RL Contracting Officer decided not to extend the existing MPO arrangement beyond the end of FY 1986, but to make the necessary changes in the DOE contract with the General Electric Company to permit establishment of a direct PNL-GE contract. R. P. Allen visited the Shippingport Site on September 9-10, 1986, to assist in completing these arrangements.

The new contract was signed September 17, 1986. The initial scope of work was developed to support the acquisition of components and samples for the Materials Branch for thermal embrittlement and radiological characterization studies. These items include all four primary system check valves and main coolant pumps, three of the primary system manual isolation valves, and several samples of pipe weldments and piping samples from various plant systems.

The site services provided under the contract include marking location and ID numbers on the components, cutting them out so as to preserve pipe-to-component welds, packaging the components in LSA containers, identifying the containers and placing them in a storage area for shipment. The check valves, main coolant pumps and some of the pipe samples will be available for shipment by the end of November 1986. The balance of the items will be removed by the end of July 1987. Since these site support activities are correlated with ongoing decommissioning operations, the estimated cost for this portion of the contract is only $16,000.

Negotiations are in progress to add the balance of the NPAR work at Shippingport previously covered by the MPO with GE to the new contract. One of the advantages of the new arrangement is that responsibility for this work has been transferred from operations to site engineering, and a GE engineer (R. F. Pratt) has been assigned to coordinate the NRC site activities with force account personnel and the subcontractors performing the decommissioning operations.

A DOE-Shippingport Station Decommissioning Project Office (SSDPO) review of the 189 (TD1957/FIN B2299) prepared by PNL for submission to NRC for the radiological characterization of Shippingport Station samples and materials uncovered some concerns relating to scope and possible conflicts with SSDPO site characterization studies. R. P. Allen, D. E. Robertson and J. C. Evans of PNL visited Shippingport on September 30, 1986, and met with SSDPO, UNC and GE personnel to discuss these concerns. All of the issues were resolved and a revised draft was prepared and approved by SSDPO. Some of the proposed work will develop information of value to SSDPO in characterizing their waste for shipment and disposal.

PROGRESS DURING OCTOBER 1986

All of the main coolant pumps have been removed and stored on site awaiting shipment to Hanford for sample acquisition. Work is progressing rapidly on the removal of other primary system valves and piping. The first shipment of this material to ANL should occur during November.

R. P. Allen visited the Shippingport Site on October 14-16, 1986, to help facilitate the transfer of the NPAR work from the previous Memorandum Purchase Order to a new direct PNL contract with the site Decommissioning Operations Contractor (General Electric Company). All of the currently identified NPAR components were visited and retagged. Arrangements also were made to have site QA tags placed on these items as further assurance against inadvertent disposal. A meeting was held with the site force account staff to discuss each component as input for the revised site support cost estimate required for the new contract.

Arrangements also were initiated for a visit by INEL staff in November to identify any additional components required for their studies. The delay in obtaining a battery charger and inverter for the BNL work was resolved. These units were tagged out and two BNL representatives will visit Shippingport on November 5, 1986, to inspect and conduct in-situ tests of this equipment before it is removed and shipped to them. The BNL staff also will select the motor control centers and transformers required for their work.

The abstract for a paper entitled "The Shippingport Atomic Power Station - A Source of Power Plant Aging Information" was cleared by PNL and the Shippingport Station Decommissioning Project Office for submission to the Second ASM Nuclear Power Plant Aging and Life Extension Conference.

PROGRESS DURING NOVEMBER 1986

R. P. Allen visited the Shippingport Site on November 2-6, 1986, to coordinate in-situ testing and component acquisition activities. Major accomplishments during this visit included:

- A site visit on November 3, 1986, by P. Jacobs and L. Meyer of INEL, to perform a pre-removal examination of previously selected components and to identify additional components for acquisition.

- A site visit on November 5, 1986, by W. Gunther and W. Shire of BNL, to conduct in-situ electrical tests on the battery charger and inverter that they will receive in December; additional components also were selected for their NPAR studies.

- Location of four drawers of spare parts for the inverters and battery chargers; these will be packaged and sent with the inverter and charger.

- Revision of the original NPAR component list to assist in the transfer of this work from the previous Memorandum Purchase Order to a direct PNL contract with the site Decommissioning Operations Contractor (General Electric Company).

- Inspection of the main coolant pumps that have been removed and placed in storage for ANL.

The contract supplement between PNL and GE to cover removal of the previously identified NPAR components was signed on November 18, 1986. As a result of the site visits by INEL and BNL, an additional 70 items were identified for acquisition. These include instruments, relays, circuit breakers, transformers, RTDs, detectors, and switches. Another contract supplement was initiated to cover these items.

Other progress included the identification and shipment of several manuals to BNL to provide technical information on the components that they will be receiving, the site QA tagging of all NPAR components including those recently identified to preclude accidental disposal, and initiation of arrangements to ship five disc specimens from the pressure vessel nozzles to PNL for a detailed radiological characterization.

PROGRESS DURING DECEMBER 1986

Major accomplishments during December included:

- Removal of a battery charger, inverter and motor control center from the Auxiliary Control Room.
- Shipment of these components plus four drawers of spare parts for the inverters and battery chargers to BNL on December 12, 1986. W. Shire, of BNL, visited the Shippingport Site on December 11-12, 1986, to assist with the shipment. The items were shipped in a dedicated truck to avoid transport damage.
- A site visit by R. P. Allen of PNL, on December 11-12, 1986, to coordinate the component acquisition and shipping activities.
- Preparation and packaging of five contaminated stainless steel disc specimens from the pressure vessel nozzles for shipment to PNL for a detailed radiological characterization.
- Completion of two supplements to the contract between PNL and GE to cover the removal and acquisition of additional NPAR components identified during the November site visits by INEL and BNL.

Shipment of the first primary system valve to ANL had been scheduled for December. However, this was postponed until January because of plant efforts to meet a major year-end milestone. The decision was made by MB/ANL to take only one of the main coolant pumps (A-Loop) for metallurgical studies. This pump will be shipped to PNL for sample acquisition, and then to the Hanford Site for disposal.

PROGRESS DURING JANUARY 1987

Major accomplishments and activities during January included:

- Removal and packaging of several additional components including coolant purification piping, instrument piping, three primary system check valves, a primary system cold-leg pipe section, six relays, three junction boxes, eight RTDs, six D/P cells, six transmitters, five solenoid valves, three motor-operated valves, one check valve, and sections of power and instrumentation cable from the reactor chamber.
- A site visit by R. P. Allen of PNL, on January 19-21, 1987, to coordinate the component acquisition and shipping activities.

- Shipment of five contaminated stainless steel disc specimens from the pressure vessel nozzles to PNL for detailed radiological characterization as part of a Materials Branch program on radionuclide source term measurements for decommissioning assessments.

- Completion of the third supplement to the contract between PNL and GE to cover component removal and acquisition costs. This brings the total GE contract amount to $78.8K.

PROGRESS DURING FEBRUARY 1987

Prepared for and participated in the NPAR Program Managers' Review Meeting at Oak Ridge, TN.

Visited the Shippingport Site on February 27, 1987, to coordinate the component acquisition and shipping activities.

Arranged for a PNL shipping representative (P. H. Burke) to visit the site the first week in March to assist with the shipment of a main coolant pump to PNL and a large container of LSA components to ORNL.

Compiled and sent extensive background information (system descriptions, technical manuals, specifications, maintenance data, etc.) to ORNL for the check valves and motor-operated valves that will be shipped in March.

Met with former Shippingport Naval Reactors and Duquesne Light Company operations and maintenance personnel to obtain additional information for ORNL on the 8-in. boiler feed-water line check valve with the unexpected wear pattern. The valve apparently was not changed and, except for a brief initial installation test, never experienced any flow.

Obtained and conveyed to site personnel the initial radiological characterization data for the five contaminated primary system disc specimens that were shipped to PNL for analysis in January. The results show that the hot-leg piping is activated and that the hot-leg corrosion film has substantially higher ^{60}Co, ^{55}Fe and ^{63}Ni levels than the cold-leg film. This data will be helpful to the decommissioning project in planning the primary system shipping and disposal operations.

PROGRESS DURING MARCH 1987

R. P. Allen and a PNL shipping representative (P. H. Burke) visited the Shippingport site during the March 2-5, 1987, time period to coordinate the component acquisition and shipping activities.

The A-Loop main coolant pump and 44 BF_3 tubes (for PNL use) were shipped to PNL on March 3, 1987.

Five motor-operated valves, five solenoid valves and two check valves were shipped to ORNL on March 5, 1987.

Four primary system check valves, a section of cold-leg piping containing a weldment, two sections of coolant purification piping, two sections of instrument piping, two sections of fuel pool piping, a section of main steam piping and a section of feed-water piping were shipped to ANL on March 10, 1987.

Arranged for the acquisition of 23 additional components for ANL and INEL. These included 12 more batteries, six stop joints, a spare main coolant pump volute, a section of unused primary system piping, and some additional cabling.

Provided INEL with the technical manuals for the nuclear protection system. Arranged to ship the nuclear protection system control panel rack and the scram breakers to INEL rather than to BNL as originally designated.

Contacted SNL concerning the personnel air lock that was tagged during the December 5, 1987, site selection visit by C. V. Subramanian. According to W. A. von Riesemann, this component is not needed for the SNL studies. It will therefore be released for disposal.

Made arrangements for an April site visit by an INEL representative (J. L. Edson) to conduct in-situ tests and a pre-shipping inspection of the 18 storage batteries.

PROGRESS DURING APRIL 1987

R. P. Allen from PNL, and J. L. Edson from INEL, visited the Shippingport Site on April 13-15, 1987, to conduct in-situ tests and a pre-shipping inspection of the storage batteries that will be sent to INEL.

The inspection disclosed that there are four vintages of batteries represented (10-56, 9-67, 6-77, and 3-80) rather than the three previously identified. Based on this finding, an additional six batteries were selected for evaluation, making a total of 24 batteries that will be shipped to INEL.

The in-situ battery tests and inspection included electrical and electrolyte status and detailed pictures of physical condition. Contact was made with plant staff responsible for the batteries to obtain load test and other battery maintenance records and information.

Arrangements were made for the construction of special shipping containers for the batteries and packaging with shock-absorbent material. An air-ride van will be used to transport the batteries, along with other components destined for INEL.

Two primary-system manual valves and a primary system hot-leg section containing a weldment were removed and prepared for shipment to ANL.

Arrangements also were initiated for a visit by INEL staff in November to identify any additional components required for their studies. The delay in obtaining a battery charger and inverter for the BNL work was resolved. These units were tagged out and two BNL representatives will visit Shippingport on November 5, 1986, to inspect and conduct in-situ tests of this equipment before it is removed and shipped to them. The BNL staff also will select the motor control centers and transformers required for their work.

The abstract for a paper entitled "The Shippingport Atomic Power Station - A Source of Power Plant Aging Information" was cleared by PNL and the Shippingport Station Decommissioning Project Office for submission to the Second ASM Nuclear Power Plant Aging and Life Extension Conference.

PROGRESS DURING NOVEMBER 1986

R. P. Allen visited the Shippingport Site on November 2-6, 1986, to coordinate in-situ testing and component acquisition activities. Major accomplishments during this visit included:

- A site visit on November 3, 1986, by P. Jacobs and L. Meyer of INEL, to perform a pre-removal examination of previously selected components and to identify additional components for acquisition.
- A site visit on November 5, 1986, by W. Gunther and W. Shire of BNL, to conduct in-situ electrical tests on the battery charger and inverter that they will receive in December; additional components also were selected for their NPAR studies.
- Location of four drawers of spare parts for the inverters and battery chargers; these will be packaged and sent with the inverter and charger.
- Revision of the original NPAR component list to assist in the transfer of this work from the previous Memorandum Purchase Order to a direct PNL contract with the site Decommissioning Operations Contractor (General Electric Company).
- Inspection of the main coolant pumps that have been removed and placed in storage for ANL.

The contract supplement between PNL and GE to cover removal of the previously identified NPAR components was signed on November 18, 1986. As a result of the site visits by INEL and BNL, an additional 70 items were identified for acquisition. These include instruments, relays, circuit breakers, transformers, RTDs, detectors, and switches. Another contract supplement was initiated to cover these items.

Other progress included the identification and shipment of several manuals to BNL to provide technical information on the components that they will be receiving, the site QA tagging of all NPAR components including those recently identified to preclude accidental disposal, and initiation of arrangements to ship five disc specimens from the pressure vessel nozzles to PNL for a detailed radiological characterization.

PROGRESS DURING DECEMBER 1986

Major accomplishments during December included:

- Removal of a battery charger, inverter and motor control center from the Auxiliary Control Room.
- Shipment of these components plus four drawers of spare parts for the inverters and battery chargers to BNL on December 12, 1986. W. Shire, of BNL, visited the Shippingport Site on December 11-12, 1986, to assist with the shipment. The items were shipped in a dedicated truck to avoid transport damage.
- A site visit by R. P. Allen of PNL, on December 11-12, 1986, to coordinate the component acquisition and shipping activities.
- Preparation and packaging of five contaminated stainless steel disc specimens from the pressure vessel nozzles for shipment to PNL for a detailed radiological characterization.
- Completion of two supplements to the contract between PNL and GE to cover the removal and acquisition of additional NPAR components identified during the November site visits by INEL and BNL.

Shipment of the first primary system valve to ANL had been scheduled for December. However, this was postponed until January because of plant efforts to meet a major year-end milestone. The decision was made by MB/ANL to take only one of the main coolant pumps (A-Loop) for metallurgical studies. This pump will be shipped to PNL for sample acquisition, and then to the Hanford Site for disposal.

PROGRESS DURING JANUARY 1987

Major accomplishments and activities during January included:

- Removal and packaging of several additional components including coolant purification piping, instrument piping, three primary system check valves, a primary system cold-leg pipe section, six relays, three junction boxes, eight RTDs, six D/P cells, six transmitters, five solenoid valves, three motor-operated valves, one check valve, and sections of power and instrumentation cable from the reactor chamber.
- A site visit by R. P. Allen of PNL, on January 19-21, 1987, to coordinate the component acquisition and shipping activities.

- Shipment of five contaminated stainless steel disc specimens from the pressure vessel nozzles to PNL for detailed radiological characterization as part of a Materials Branch program on radionuclide source term measurements for decommissioning assessments.

- Completion of the third supplement to the contract between PNL and GE to cover component removal and acquisition costs. This brings the total GE contract amount to $78.8K.

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PROGRESS DURING APRIL 1987

R. P. Allen from PNL, and J. L. Edson from INEL, visited the Shippingport Site on April 13-15, 1987, to conduct in-situ tests and a pre-shipping inspection of the storage batteries that will be sent to INEL.

The inspection disclosed that there are four vintages of batteries represented (10-56, 9-67, 6-77, and 3-80) rather than the three previously identified. Based on this finding, an additional six batteries were selected for evaluation, making a total of 24 batteries that will be shipped to INEL.

The in-situ battery tests and inspection included electrical and electrolyte status and detailed pictures of physical condition. Contact was made with plant staff responsible for the batteries to obtain load test and other battery maintenance records and information.

Arrangements were made for the construction of special shipping containers for the batteries and packaging with shock-absorbent material. An air-ride van will be used to transport the batteries, along with other components destined for INEL.

Two primary-system manual valves and a primary system hot-leg section containing a weldment were removed and prepared for shipment to ANL.

PROGRESS DURING MAY 1987

Emphasis during May was on completing the arrangements for a major shipment of components to ANL, INEL, PNL and ORNL. These shipments were originally scheduled for May, but were rescheduled for early June due to a hold on release of noncontaminated materials from the site. A PNL shipping representative will be at the site to coordinate the final preparations and shipments.

PROGRESS DURING JUNE 1987

P. H. Burke, a PNL Shipping Representative, visited the Shippingport Site during June 2-5, 1987, to coordinate a major shipment of components to the NPAR contractors. Items distributed included:

- ANL - Hot-leg pipe section, two hot-leg and one cold-leg manual valves, and a spare main coolant pump volute and section of primary system piping.
- INEL - Twenty-four battery cells, a large nuclear protection system instrument panel, eight limit switches, five D/P cells, seven transducers, eight resistance temperature detectors, two thermocouple junction boxes, two rod control junction boxes, two power lead junction boxes, four BF3 detectors, four compensating ion chamber detectors, seven pressure switches, two samples of instrument cable, and several electrical (stop joint) penetrations.
- ORNL - Two solenoid valves, two check valves, and a motor-operated valve.
- PNL - Two sections of radwaste system piping.

W. Gunther of BNW visited the Shippingport Site on June 12, 1987, to coordinate the shipment of an additional 24 items to BNL. These included eight motor control centers, a battery charger, an inverter, two current transformers, two potential transformers, two 480/120 transformers, two constant voltage transformers, and six protective relays. A second large motor control center from the auxiliary control room was selected for acquisition.

With the completion of these shipments, 148 or 80% of the requested 186 items have been shipped.

R. P. Allen of PNL, visited the Shippingport site on June 29-30, 1987, and met with F. Martzloff, of the National Bureau of Standards, to assist in the identification and acquisition of cable samples for NPAR evaluation. Arrangements were initiated to save two disposal boxes containing cable from the reactor chamber. Samples of instrumentation cable and electrical stop joints will be provided by INEL from the items shipped earlier in the month.

The possibility of obtaining samples from the Shippingport Station pressure vessel was explored with site DOE and support staff. The approach would be to core drill through the neutron shield tank and into the pressure vessel wall from the outside. Based on the site discussions, the proposed sampling operation appears feasible from both a technical and scheduling standpoint.

PROGRESS DURING JULY 1987

R. P. Allen of PNL visited the Shippingport site on July 10, 1987, to coordinate the component and sample acquisition work. As of the end of July, 86% of the 198 selected items had been removed, and 84% had been shipped to the designated NPAR contractors. All requested items have been provided to ORNL and ANL. Most of the remaining 31 items will be removed and shipped during August. Arrangements have been made for a PNL shipping representative to be at the site to coordinate the final preparations and shipments. Some components still are in service or, as in the case of the service water system, have yet to be thoroughly assessed and selected for subsequent acquisition.

The possibility of obtaining samples from the Shippingport Station pressure vessel and neutron shield tank was further explored at a meeting with NRC, DOE, EPRI and industry representatives at Rockville on July 9, 1987. The consensus was that the sampling operation should be conducted at the Hanford site to avoid possible regulatory impacts on the transport of the vessel. Subsequent direction, however, was that a near-term effort should be made to obtain samples of the neutron shield tank. Exploration of this approach with SSDPO and other site staff is in progress.

PROGRESS DURING AUGUST 1987

The major emphasis during August was on preparation of the annual progress report for the Shippingport Reactor Aging Evaluation Task. Coordination of the site activities continued, with a shipment of most of the remaining identified NPAR items planned for late September. Preliminary planning and identification of cutting technology for obtaining core samples from the neutron shield tank were initiated. A request also was made to the site to save samples of the reactor chamber steel for possible evaluation of very low flux effects. Contact was made with DLC staff to explore the possibility of obtaining samples of the Shippingport Station service water system.

PROGRESS DURING SEPTEMBER 1987

R. P. Allen of PNL visited the Shippingport site on September 3-4, 1987, to coordinate the component and sample acquisition work.

P. H. Burke, a PNL shipping representative, was at the Shippingport site from September 14-21, 1987, to oversee a major shipment to NRC contractors. Items distributed included:

- ANL: An LSA box containing activated steel from the reactor chamber beltline region. Samples of this material will be sent to PNL for radiological analyses.
- BNL: One switch, four agastat time delay relays, two scram breakers, two MG-6 relays, two DB-50 breakers, a relay panel, and a large motor control center.
- INEL: Two nuclear instrumentation channels, and 100' lengths of power, instrument and coaxial cable from the main control room.
- PNL: Two LSA boxes containing cable from the reactor chamber (for INEL and NBS), two heat exchangers, and samples of instrument/control air piping.

The annual progress report and program plan update for the Shippingport Reactor Aging Evaluation Task was completed and submitted for review.

Coordination of the site activities continued, with a shipment of most of the remaining identified NPAR items planned for late September. Preliminary planning and identification of cutting technology for obtaining core samples from the neutron shield tank were initiated. A request also was made to the site to save samples of the reactor chamber steel for possible evaluation of very low flux effects. Contact was made with DLC staff to explore the possibility of obtaining samples of the Shippingport Station service water system.

PROGRESS DURING OCTOBER 1987

P. H. Burke, a PNL shipping representative, was at the Shippingport site on October 26, 1987, to oversee a shipment to NRC contractors. Items distributed were:

- ANL: A 55-gal drum containing several sections of activated steel taken from different levels and quadrants of the reactor chamber. Samples of this material will be sent to PNL for detailed radiological analyses.
- PNL: A 55-gal drum containing contaminated concrete ships and dust from the concrete scabbling operation on the canal walls. This

material also will be used for NRC radionuclide source term measurement studies.

Cutting technology evaluation studies continued in preparation for the Shippingport neutron shield tank coring operation. R. P. Allen of PNL visited the Shippingport site on October 12, 1987, to further plan and coordinate this activity and the remaining component and sample acquisition work.

PROGRESS DURING NOVEMBER 1987

The status of the Shippingport Reactor Aging Evaluation Task was reviewed with Milton Vagins, Chief of the Electrical and Mechanical Engineering Branch, on November 16, 1987.

The technical manual for the canal water and component cooling water heat exchangers was obtained to guide the evaluation studies. Contact with a Duquesne Light Company staff member who was involved with the operation and maintenance of the heat exchangers also was arranged.

Cutting technology evaluation studies continued in preparation for the Shippingport neutron shield tank (NST) coring operation. A Statement of Work for the coring operation was prepared and submitted for site review. Based on the current decommissioning schedule, it should be possible to core the grouted NST during an April-June, 1988, window while the fuel handling building is being dismantled.

PROGRESS DURING DECEMBER 1987

Procedures were developed to use a video camera system to locate the welds on the inner wall of the Shippingport neutron shield tank (NST) in preparation for the NST sampling operation.

PROGRESS DURING JANUARY 1988

The major Shippingport-related activity during January was the successful use of a video camera system to locate the welds on the inner wall of the Shippingport neutron shield tank (NST) in preparation for the NST sampling operation. This ANL-funded operation determined that the inner wall welds are on the same north-south axis as the outer wall welds, and also revealed a previously unsuspected horizontal weld.

Arrangements were made to ship the remaining NPAR component (level detector on the NST) with the NST core samples.

PROGRESS DURING FEBRUARY 1988

All Shippingport-related activities during February were in support of the neutron shield tank coring (NST) operation and were funded by ANL. Development of the coring equipment is essentially complete. The coring operation is scheduled to begin about the first of May.

PROGRESS DURING MARCH 1988

R. P. Allen visited the Shippingport Site on March 28-30, 1988, to review the detailed work procedure for the ANL-funded neutron shield tank (NST) sampling operation. This work is scheduled to begin on May 9, 1988, and will require about three weeks for completion. As part of this site visit, technical manuals slated for disposal were reviewed, and those relevant to Shippingport NPAR components and systems were saved and sent to PNL for subsequent distribution to the appropriate NPAR contractors.

PROGRESS DURING APRIL 1988

The Shippingport activities in April focused on completing all preparations for the neutron shield tank (NST) sampling operation. The procedure for this work was revised to incorporate site review comments and submitted to GE for final approval. Eight boxes (1200 lb) of equipment and supplies were sent to the site, and arrangements were made for the direct delivery of other miscellaneous supplies. Equipment setup and testing will begin May 5, 1988, with the first inner wall coring operation scheduled for May 10, 1988.

PROGRESS DURING MAY 1988

The major accomplishment during May was the successful conduct of the Shippingport Station neutron shield tank (NST) sampling operation. Equipment setup and testing at the site began May 5, 1988, and the last cut was made on June 2, 1988. A total of 11 inner wall samples were obtained. The contact readings for these ~6-in. diameter x 1-in. thick cores ranged from 5 to 350 mR/h. A distinct increase in cutting difficulty was noted for the higher fluence samples, indicative of possible radiation hardening effects.

Opportunities for obtaining concrete samples using the NST coring equipment were discussed with Gunter Arndt of NRC. It was decided to wait and acquire a sample of activated reinforced concrete that can be made available in conjunction with the backfilling of the reactor enclosure.

PROGRESS DURING JUNE 1988

The weld repairs to the Shippingport Station neutron shield tank (NST) were completed, and the samples obtained through the coring operation were shipped to ANL. The last NPAR item, a level detector from the NST, was sent to INEL as part of this shipment.

Shippingport Reactor Evaluation Task accomplishments and plans were reviewed with J. P. Vora as part of his June 28-30, 1988, visit to PNL.

PROGRESS DURING JULY 1988

The summary for a paper entitled "Lessons Learned to Date From the Shippingport Aging Evaluation" was prepared and submitted for the 16th Water Reactor Safety Information Meeting.

PROGRESS DURING AUGUST 1988

Based on a letter from Gunter Arndt of NRC, Shippingport Site staff were contacted to explore the possibility of obtaining samples of activated concrete from the top of the reactor enclosure. A no-cost contract extension was submitted to GE to cover this work and any additional records acquisition or other assistance during the coming fiscal year.

An abstract entitled "Shippingport Neutron Shield Tank Sampling and Analysis Program" by S. T. Rosinski of SNL and W. J. Shack of ANL was submitted to SSDPO for review. This paper will present the results of the studies conducted on the 11 samples removed from the inner wall of the Shippingport Station neutron shield tank.

A summary entitled "Shippingport Aging Studies - Results and Plans" by W. J. Shack, O. Chopra and H. Chung of ANL was submitted to SSDPO for review. This paper will describe the studies conducted on the primary- and secondary-coolant system materials obtained from the Shippingport Station.

Information was received regarding the function and history of the control air system components from the Shippingport Station.

Joe Hazeltine of Wyle Laboratories called concerning the Shippingport Station relays and circuit breakers. They will obtain these items from BNL, and contact PNL as required for supporting information.

PROGRESS DURING SEPTEMBER 1988

Dan Naus of ORNL visited the Shippingport Site on September 23, 1988, to select the specific locations for obtaining samples of activated concrete and control material from the top of the reactor enclosure. The concrete will be cored by a GE subcontractor that has been doing similar work at Shippingport in support of the decommissioning operations.

The Shippingport Aging Evaluation Progress Report was revised to include the FY 1988 NPAR and Materials Branch work, and submitted for review.

A paper for the Sixteenth NRC Water Reactor Safety Information Meeting entitled "Lessons Learned to Date From the Shippingport Aging Evaluation" was prepared and submitted for clearance.

PROGRESS DURING OCTOBER 1988

R. P. Allen attended the Sixteenth Water Reactor Safety Information Meeting at Gaithersburg, MD, and presented a paper entitled "Lessons Learned to Date From the Shippingport Aging Evaluation." This paper also will appear in the Proceedings of the meeting.

Preparations were completed to obtain samples of activated concrete and control material from the top of the reactor enclosure for shipment to ORNL. The site work will be performed by a GE subcontractor, and the cost will be covered by ORNL via a Memorandum Purchase Order to PNL. The coring operation originally was scheduled for mid-October, but has been rescheduled for mid-November due to a delay in the pressure vessel lift.

PROGRESS DURING NOVEMBER 1988

Published materials were collected and a letter was prepared for NRC review in response to a request by the Civil Defense Agency and Office of Emergency Preparedness, The Commonwealth of Massachusetts, for copies of reports prepared by NRC contractors studying the aging of Shippingport Station components and systems. Continuing task activities included coordinating site reviews of Shippingport-related papers, and preparation for the concrete coring work.

PROGRESS DURING DECEMBER 1988

The Shippingport Station pressure vessel was lifted from the reactor enclosure on Wednesday, December 14, 1988. The concrete coring operation began on Monday, December 19, 1988, and was completed two days later. Six concrete cores were removed and shipped to ORNL for evaluation. These cores were approximately 30 inches long and consisted of three samples from the area near the refueling ring at the SE corner of the 710-ft elevation, two control samples from a corner of the same quadrant, and one sample of enclosure floor concrete. This coring operation completes the on-site acquisition of Shippingport Station components and samples.

A request was received from the editors of NUPLEX News for a summary of the Shippingport Aging Program for publication in the newsletter. The abstract for the Water Reactor Safety Meeting paper entitled "Lessons Learned to Date From the Shippingport Aging Evaluation" was slightly revised and submitted for consideration. The newsletter reaches about 350 people who are actively working in the area of nuclear plant life extension.

PROGRESS DURING JANUARY 1989

The Project Management Plan for the Shippingport Task was prepared and submitted. Contacts were made to obtain neutron exposure information for the concrete samples that were provided to ORNL. Work was initiated to organize and catalogue the data and records acquired from Shippingport to identify additional information of value for the Phase II studies of the naturally aged Shippingport Station components and materials.

An invitation was received from The Journal of Nuclear Engineering and Design to submit the Water Reactor Safety Meeting paper entitled "Lessons Learned to Date From the Shippingport Aging Evaluation" for possible peer-reviewed publication.

PROGRESS DURING FEBRUARY 1989

Preparations were initiated for the March NPAR Review Group Meeting. A March visit to Shippingport to complete the acquisition of relevant site records was arranged. Shippingport Task status and plans were reviewed with Dr. J. J. Burns as part of his February 27-28, 1989, visit to PNL.

PROGRESS DURING MARCH 1989

R. P. Allen visited the Shippingport Atomic Power Station Site on March 9-10, 1989, and obtained the following maintenance and installation records to support the Phase II studies of the Shippingport components:

Record	Description
1) Work Item Card Index	10 Kardex Files
2) Work Item Card Index	1 Binder
3) Work Item Cards	9 File Drawers
4) Job Orders	Selected Orders

5) Modification Orders — Selected Orders
6) Equipment Specifications — Selected Specifications

The Shippingport Task status and accomplishments were presented by R. P. Allen at the NPAR Program Research Review Group Meeting at Rockville, MD, on March 21-23, 1989.

PROGRESS DURING APRIL 1989

A request was received from BNL for additional information on the Shippingport Station circuit breakers, relays, and control rod drive system cables and connectors. As a follow-up to the Shippingport Meeting held in conjunction with the NPAR Review Group Meeting, the instrument air tubing currently at PNL will be sent to BNL, and information on the Shippingport heat exchangers will be sent to ORNL to see if these units are potentially useful for their Phase II studies.

PROGRESS DURING MAY 1989

Preparation of the Shippingport Task final report was initiated and a summary of the Shippingport Meeting held in conjunction with the NPAR Review Group Meeting was written. Information on the Shippingport Station heat exchangers was sent to ORNL and preparations were made to ship the Shippingport Station control air system piping to BNL. Close out of the subcontract with the Shippingport Station Decommissioning Operations contractor was initiated. Total subcontract costs are $140K, with approximately 60% of this for acquisition of the NPAR components.

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11. ABSTRACT (200 words or less)

The Shippingport Atomic Power Station, the first U.S. large-scale, central-station nuclear plant, now in the final stages of decommissioning, has been a major source of naturally aged equipment for the Nuclear Plant Aging Research (NPAR) and other U.S. Nuclear Regulatory Commission (NRC) programs. The evaluation of naturally aged components is an integral part of the NPAR program strategy. Because naturally aged components and materials experience the actual service-related external stressors, corrosion and wear, testing procedures, and maintenance practices, their evaluation is valuable in verifying degradation models, validating aging projections based on the extrapolation of accelerated test data, and detecting unexpected aging mechanisms (surprises) that could significantly impact component or system safety performance. As part of the Shippingport Station aging evaluation work, more than 200 items, ranging in size from small instruments and materials samples to one of the main coolant pumps, have been removed and shipped to designated NRC contractors. Although detailed evaluations of the components and material from the Shippingport Station are just beginning, the preliminary results from the studies conducted to date are indicative of the value of the aging information that ultimately may be obtained.

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