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PROJECT PLAN FOR THE DECONTAMINATION AND DECOMMISSIONING OF THE ARGONNE NATIONAL LABORATORY EXPERIMENTAL BOILING WATER REACTOR

by

L. E. Boing

Waste Management Operations
Plant Facilities and Services

December 1989

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PREFACE

This document represents a revision to the original EBWR D&D Project Plan dated June 1986. Since D&D activities commenced early in FY 1986, it is appropriate to now update the information describing the project; both what has been accomplished and the current plan for future activities. Certain circumstances have caused the methodology and schedule of events to deviate somewhat from the original plan. The intent of this revised Project Plan is to explain the current thinking to the EBWR D&D Project.

December 1989

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ACRONYMS →

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ADM	Action Description Memorandum
ALARA	As Low As Reasonably Achievable
ANL	Argonne National Laboratory
ANL-IL	Argonne National Laboratory - Illinois Site
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASNE	Assistant Secretary for Nuclear Energy
D&D	Decontamination and Decommissioning
DFSD	Division of Facility and Site Decommissioning Projects
DOE	Department of Energy
DOE-CH	Department of Energy-Chicago Operations Office
DOT	Department of Transportation
EBWR	Experimental Boiling Water Reactor
EPA	Environmental Protection Agency
ESH	Environment Safety and Health Department
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	Fiscal Year
HEPA	High Efficiency Particulate Air (Filter)
INEL	Idaho National Engineering Laboratory
LSA	Low Specific Activity (Waste)
NEPA	National Environmental Policy Act of 1969
NIOSH	National Institute for Occupational Safety and Health
OHS	Occupational Health and Safety Department
PFS	Plant Facilities and Services
QA	Quality Assurance
QES	Quality Environment and Safety Officer
RWMC	Radioactive Waste Management Complex
SFMP	Surplus Facilities Management Program
TRU	Transuranic (Waste)
WBS	Work Breakdown Structure
WHC	Westinghouse Hanford Company
WMO	Waste Management Operations

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ABSTRACT

In 1956, the Experimental Boiling Water Reactor (EBWR) Facility was first operated at Argonne National Laboratory as a test reactor to demonstrate the feasibility of operating an integrated power plant using a direct cycle boiling water reactor as a heat source. Initial operation was at 20,000 kWt and the plant was later upgraded to operate at 100,000 kWt. In 1967, ANL permanently shut down the EBWR and placed it in dry lay-up. The facility was subsequently declared surplus and placed in the Department of Energy Surplus Facilities Management Program (SFMP). This project plan presents the schedule and organization for the decontamination and decommissioning (D&D) of the EBWR Facility which will allow it to be reused by other ANL scientific research programs. The D&D project was initiated in FY 1986 and will be completed in FY 1994. The project total estimated cost is $14.3M and is projected to generate 22,000 cubic feet of low-level radioactive waste which will be disposed of at an approved DOE burial grounds.

1.0 INTRODUCTION

The Experimental Boiling Water Reactor (EBWR) was built as a test reactor to demonstrate the feasibility of operating an integrated power plant using a direct cycle boiling water reactor as a heat source. The reactor was designed to produce 20,000 kW of heat in the form of 600 psig saturated steam which was fed directly to a turbo-generator producing 5,000 kW of electricity. Full power operation at its design output of 20,000 kWt was first achieved in December 1956. Figure 1 shows the plant as originally constructed.

Following intermittent operation at power levels up to 61,700 kWt. the EBWR was modified to increase its power output capability to 100,000 kWt. The modifications included the addition of a reboiler plant to utilize 80,000 kW of thermal energy in addition to the 20,000 kWt used by the turbo-generator. Figure 2 shows the EBWR Facility after the completion of this modification. In November 1962, the reactor was successfully operated at 100,000 kWt. Soon afterward the boiling water experimental program at the EBWR was completed and operation of the plant ceased temporarily.

The EBWR was next loaded with a core containing plutonium and operated in support of the Atomic Energy Commission's Plutonium Recycle Program. The EBWR's role in this program was completed in July 1967, and the plant was shutdown permanently. All nuclear fuel was removed from the reactor, all liquids drained from the various process systems, and the plant placed in a dry lay-up condition. All water supplied to the EBWR containment was shut off at that time. It remains in this condition at the present time.

As a result of the operating history briefly described above, the EBWR contains a significant inventory of radionuclides and, since it is surplus to future needs and no longer has a program sponsor, it has been accepted into the Department of Energy's (DOE's) Surplus Facilities Management Program (SFMP). It is currently undergoing decontamination and decommissioning which will allow the facility to be reused by other DOE research programs.

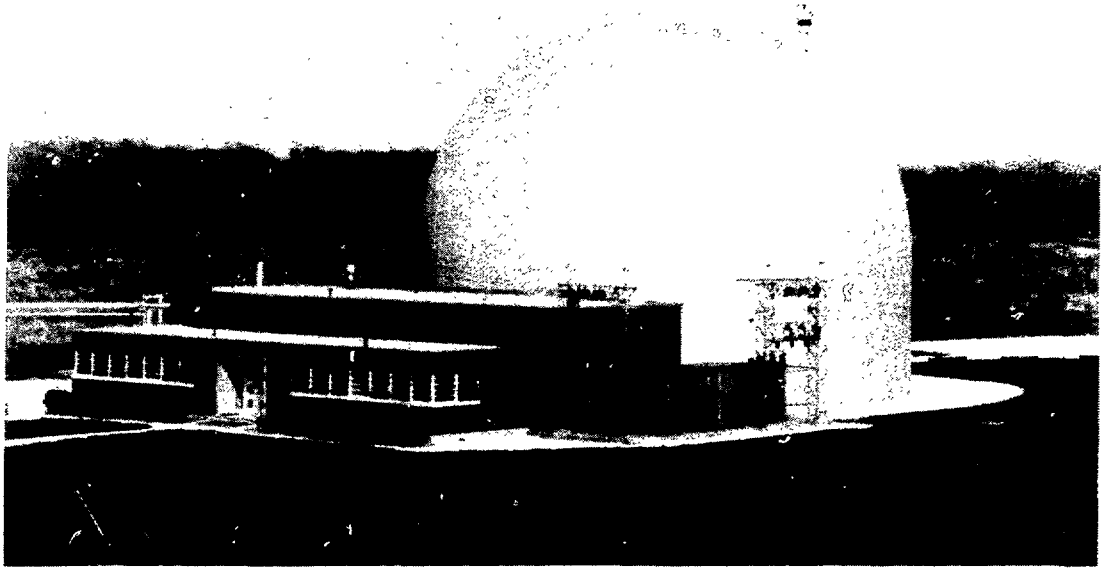

Fig. 1. The Experimental Boiling Water Reactor Facility as Originally Built

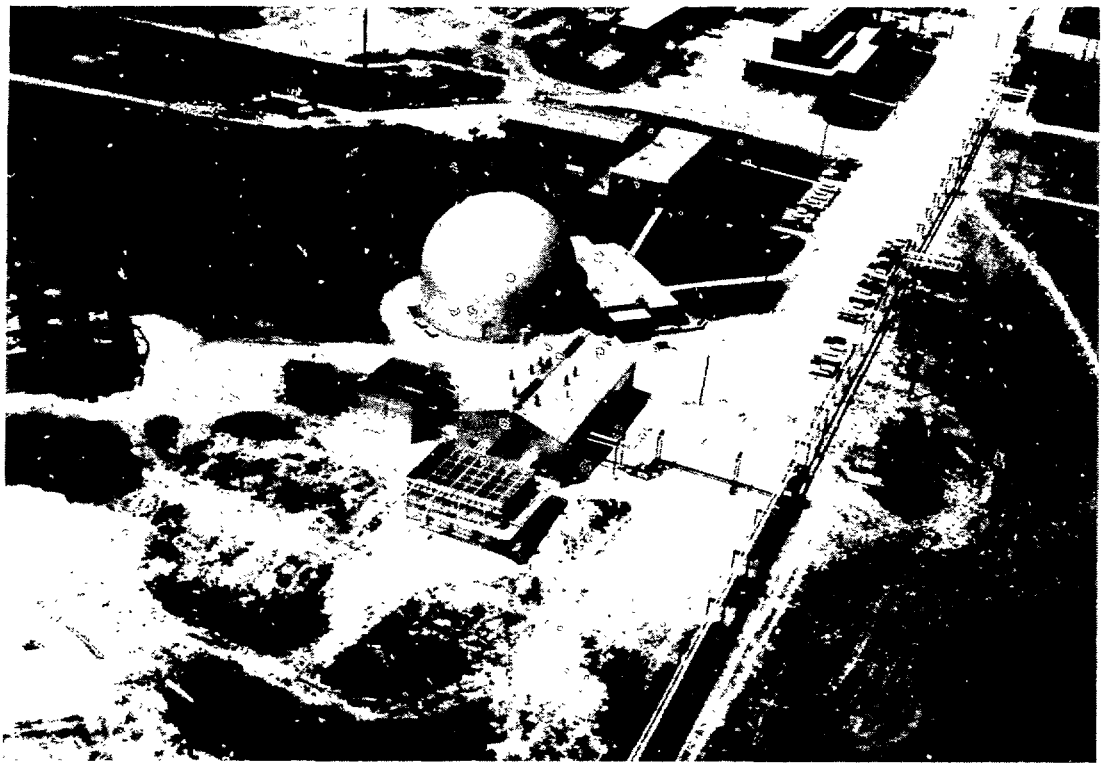

Fig. 2. The Experimental Boiling Water Reactor Facility as Modified for 100 MW Operation

2.0 PROJECT OBJECTIVES

The EBWR D&D Project is directed toward the following objectives:

a. The removal of all radioactive materials associated with the EBWR Facility from the Argonne National Laboratory's Illinois (ANL-IL) site.

b. The decontamination of the EBWR Facility to unrestricted use levels.

c. The cleanup of the EBWR containment building and its release for unrestricted use.

The purpose of the Project Plan is to ensure the achievement of these objectives safely, economically, and on schedule. Completion of the project will make a unique and valuable structure available for further programmatic use.

3.0 FACILITY DESCRIPTION

Argonne National Laboratory currently occupies a 1700-acre reservation in DuPage County, Illinois, approximately 22 miles southwest of downtown Chicago. Laboratory structures and support facilities occupy approximately 200 acres of the site with the remaining 1,500 acres devoted to landscaped areas and forest. Figure 3 shows the location of the Laboratory in relation to the Chicago metropolitan area. The location of EBWR, which is in the 300 West Area, is shown on the ANL-Illinois Site Map, Figure 4.

During its early operating life, the EBWR Facility consisted of the Nuclear Power Plant within the containment building, a connected office/service building, associated electrical switch gear, and a cooling tower. A reboiler building containing equipment designed to dissipate up to 80 megawatts of thermal energy was later added to operate EBWR at 100 MWt. The reboiler building was cleared of its equipment, decontaminated, and converted to other uses in the 1970's and is not a part of the EBWR D&D Project. The facility cooling tower has been dismantled and disposed of, and the office/service building has been converted to office space. Therefore, these are also outside the scope of this project. However, secondary cooling water

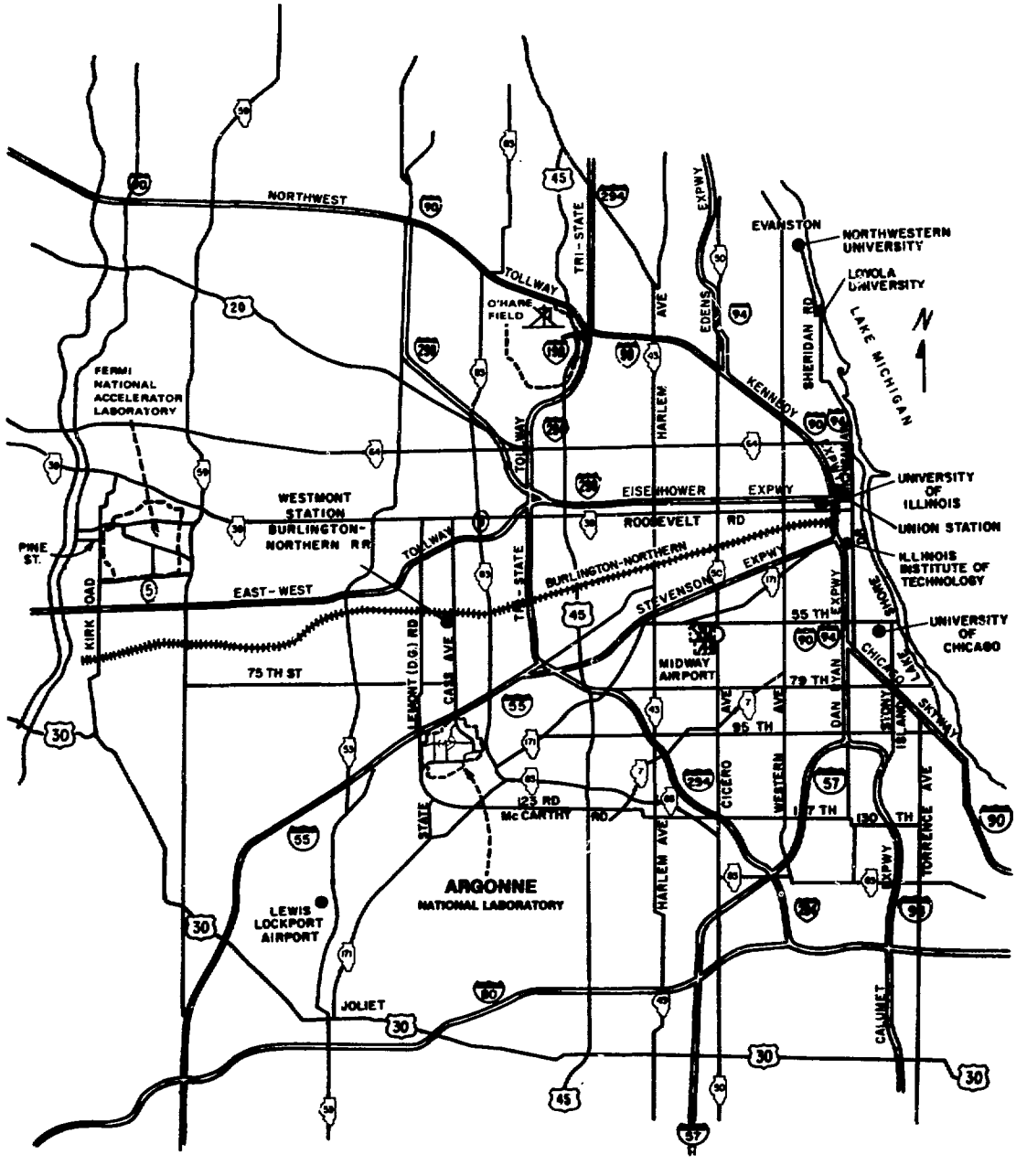

Fig. 3. Area Map

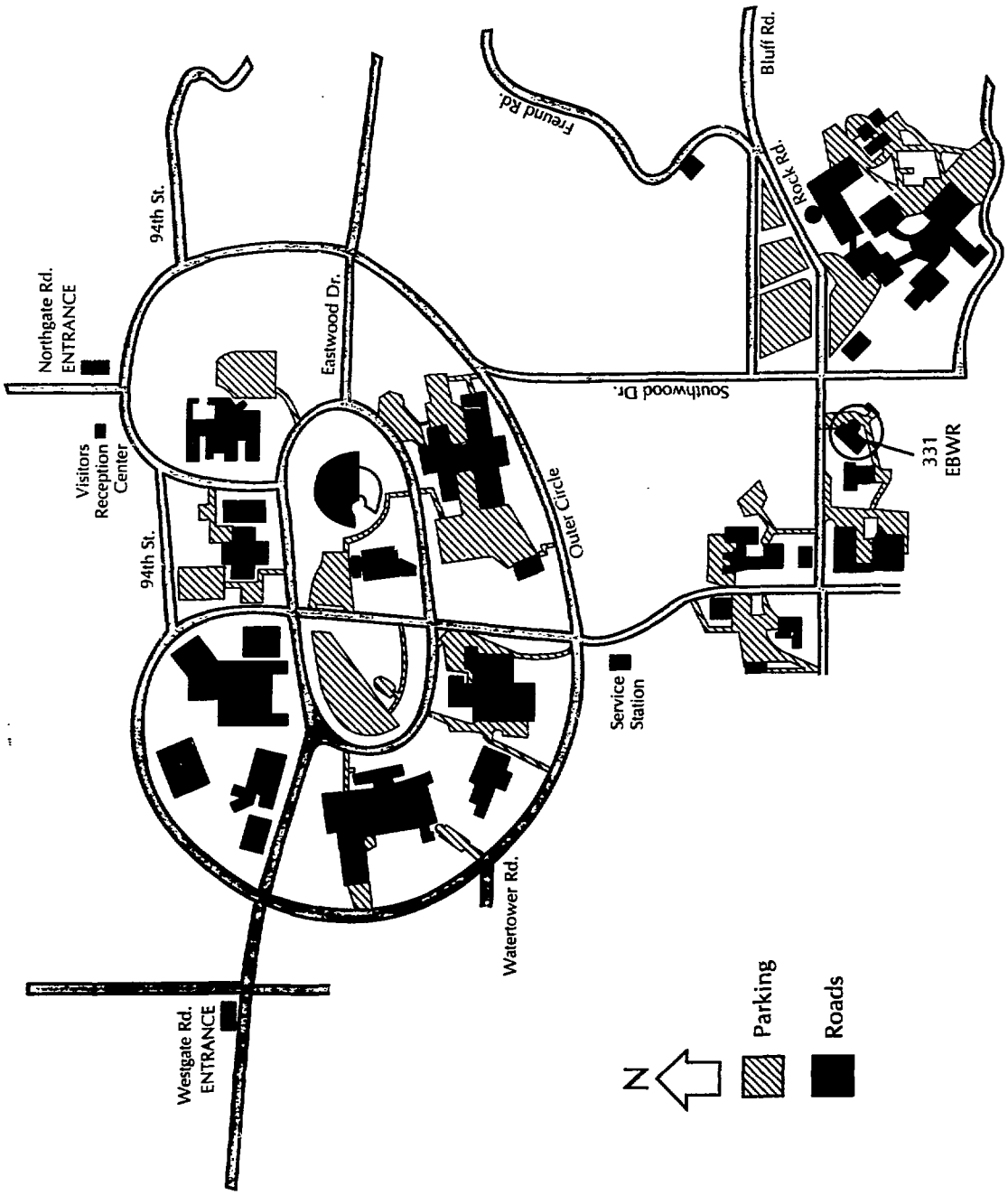

Fig. 4. Site Map

piping leading from the containment building to the cooling tower site remains buried in the field southeast of the containment building and will be excavated, surveyed for radioactivity, and disposed of in accordance with the D&D criteria.

3.1 Containment Building

The containment building is a circular, domed structure made of steel plates welded together that originally formed a gas-tight envelope around the power plant. It rises 63 feet above, and extends 56 feet below, ground level and has an inside diameter of approximately 80 feet. Below ground level, the steel shell is 5/8-inch thick; above ground level it is 3/8-inch thick. The interior of the steel shell is lined with a two-foot thickness of reinforced concrete below the main floor level. Above the main floor, to a height of 25 feet, there is a one-foot thick concrete lining. At the 26 foot height, a one-foot thick concrete ceiling slab faced with 3/8-inch thick steel plate completes the concrete envelope surrounding the power plant inside the containment shell. Details of the building's construction are shown in Figures 5 and 6.

The entire outside of the containment shell above an elevation five feet below ground level is covered with three-inch thick foam glass blocks which are impaled on metal studs welded to the shell. The joints between the blocks were filled with mastic during installation and a coat of mastic was then applied over the blocks followed by a layer of woven glass fabric. On the upper portion of the dome a second coat of mastic and another layer of glass fabric was applied. A final coat of mastic was then applied over the entire insulated surface. Corrosion protection of the shell below grade was provided by applying two coats of bituminous enamel. One-inch thick insulating board was applied over the enamel and left permanently in place to protect the enamel during backfilling of the excavation.

An unusual feature of the containment building is a 15,000 gallon storage tank located in the top of the dome. The tank is supported by the top dome structure of 3/8-inch thick steel plate which is strengthened where the tank attaches to the dome by metal reinforcing rings. The tank was designed to provide a dependable supply of water to the in-house sprinkler system in the event of a major steam release within the shell. It was drained at the time of shutdown and is expected to remain empty.

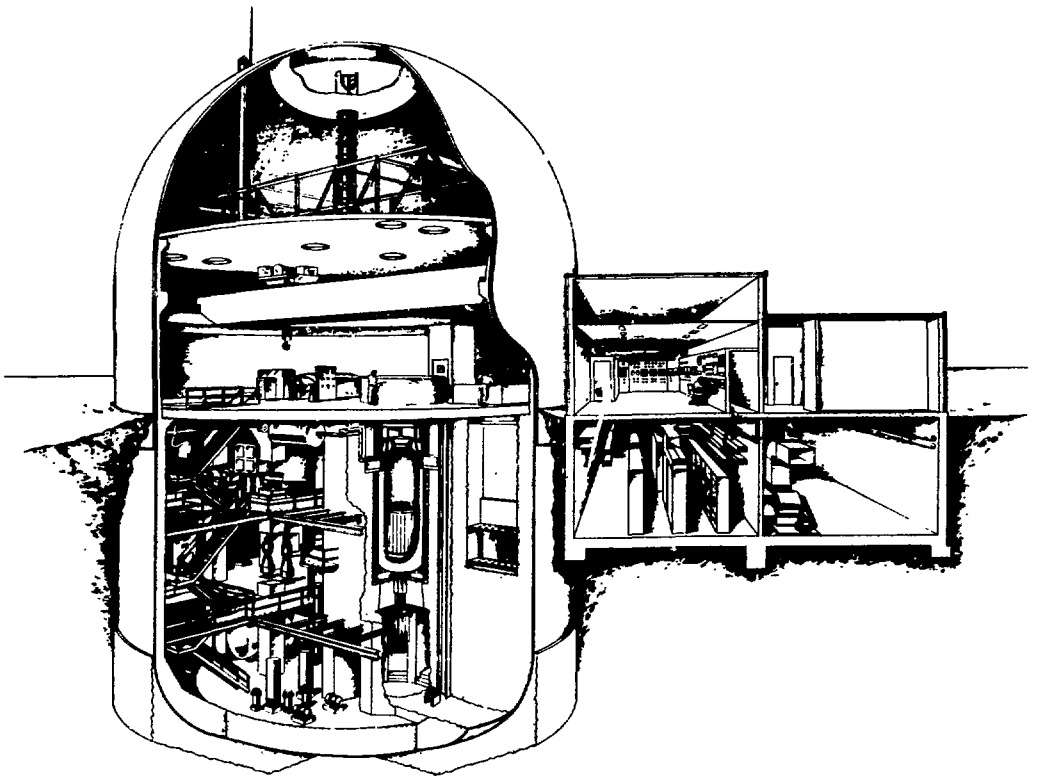

Fig. 5. EBWR Power Plant Perspective

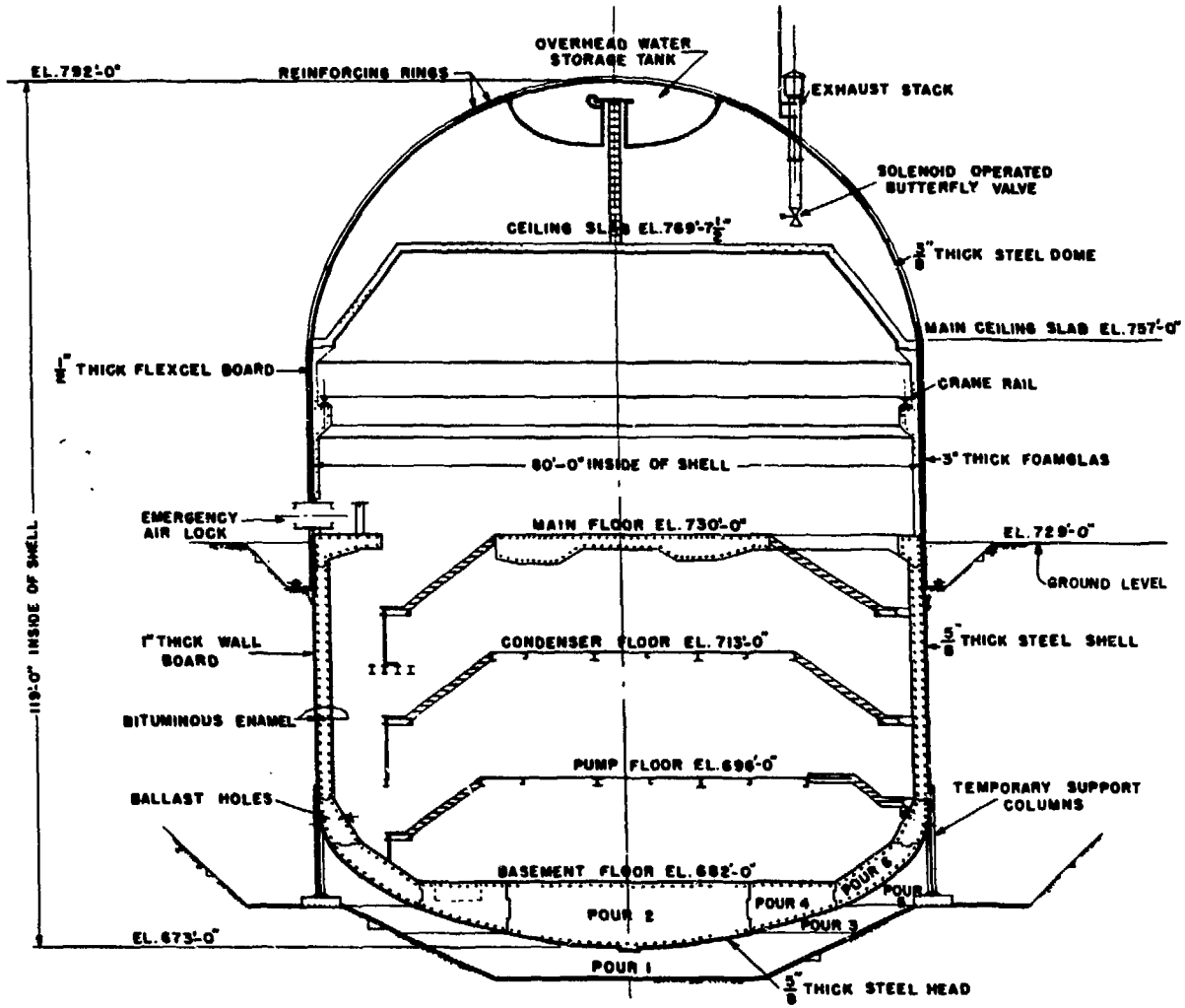

Fig. 6. Sectional View of EBWR Building

The building contains a main floor and three lower floors on which the power plant equipment is located. The main floor is a heavy, reinforced concrete slab designed for a uniform allowable floor loading of 2,000 pounds per square foot. The condenser floor and the pump floor also consist of reinforced concrete slabs in the areas where the main power plant equipment is located. These lower level slabs comprise approximately one-third of the total area at each elevation and are designed for a uniform allowable floor loading of 500 pounds per square foot. A further one-third of the condenser and pump floor areas consist of steel grating supported on structural steel beams and stringers. The remaining one-third consists of hatchways and other uncovered areas. The steel grating is designed for a uniform allowable floor loading of 75 pounds per square foot. Between floors, galleries floored with steel grating or steel plate, provide access to various plant equipment. This flooring is also designed for a uniform allowable loading of 75 pounds per square foot.

3.2 PLANT COMPONENTS AND EQUIPMENT

The components, apparatus, and other items of equipment which constituted various systems of the reactor plant are distributed throughout several floors of the containment building. Brief descriptions of these items follow.

3.2.1 Reactor Pressure Vessel and Internals

As shown in Figure 5, the reactor pressure vessel is contained within a shielded cell which extends from the main floor downward approximately 25 feet to the region of the pump floor. The pressure vessel and its internal arrangement is shown in Figure 7. The vessel is made of carbon steel, clad with stainless steel on those surfaces which were in contact with reactor water or steam. It is approximately 7-feet 5-inches in outside diameter, 24-feet 8-inches in length and has a nominal wall thickness of 2-1/2 inches. Nine control rod drive tubes and four forced circulation inlet pipe stubs extend downward from the bottom of the vessel approximately seven feet, penetrating the cell's bottom shielding. Two 12-inch diameter forced circulation outlet pipes also extend from the pressure vessel through the cell's bottom shield. The vessel is closed by a forged steel cover plate approximately 9-inches thick which is retained by forty-four 2-1/2-inch studbolts. Figure 8 shows the vessel cover.

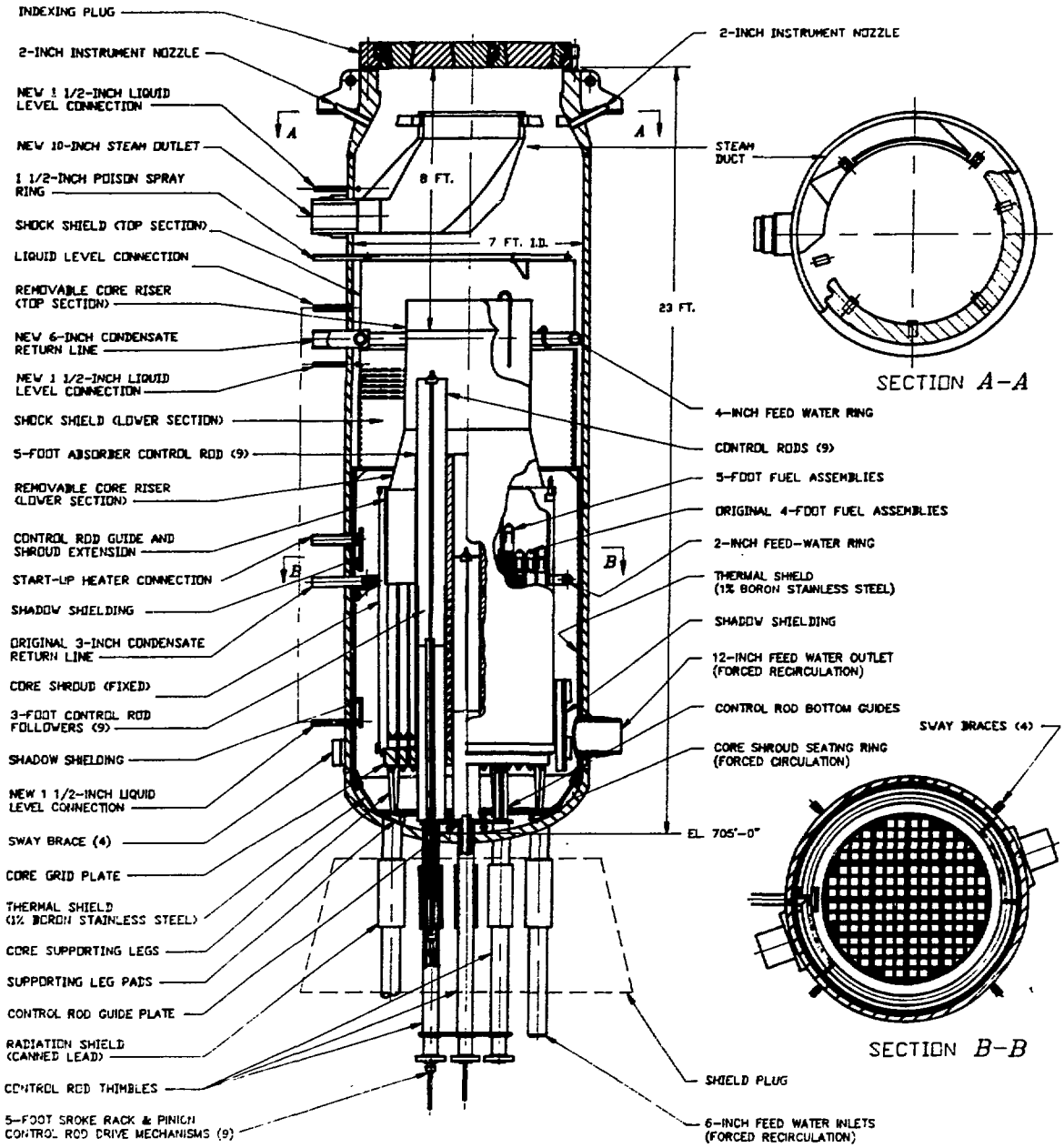

Fig. 7. Diagram of EBWR Pressure Vessel and Internals

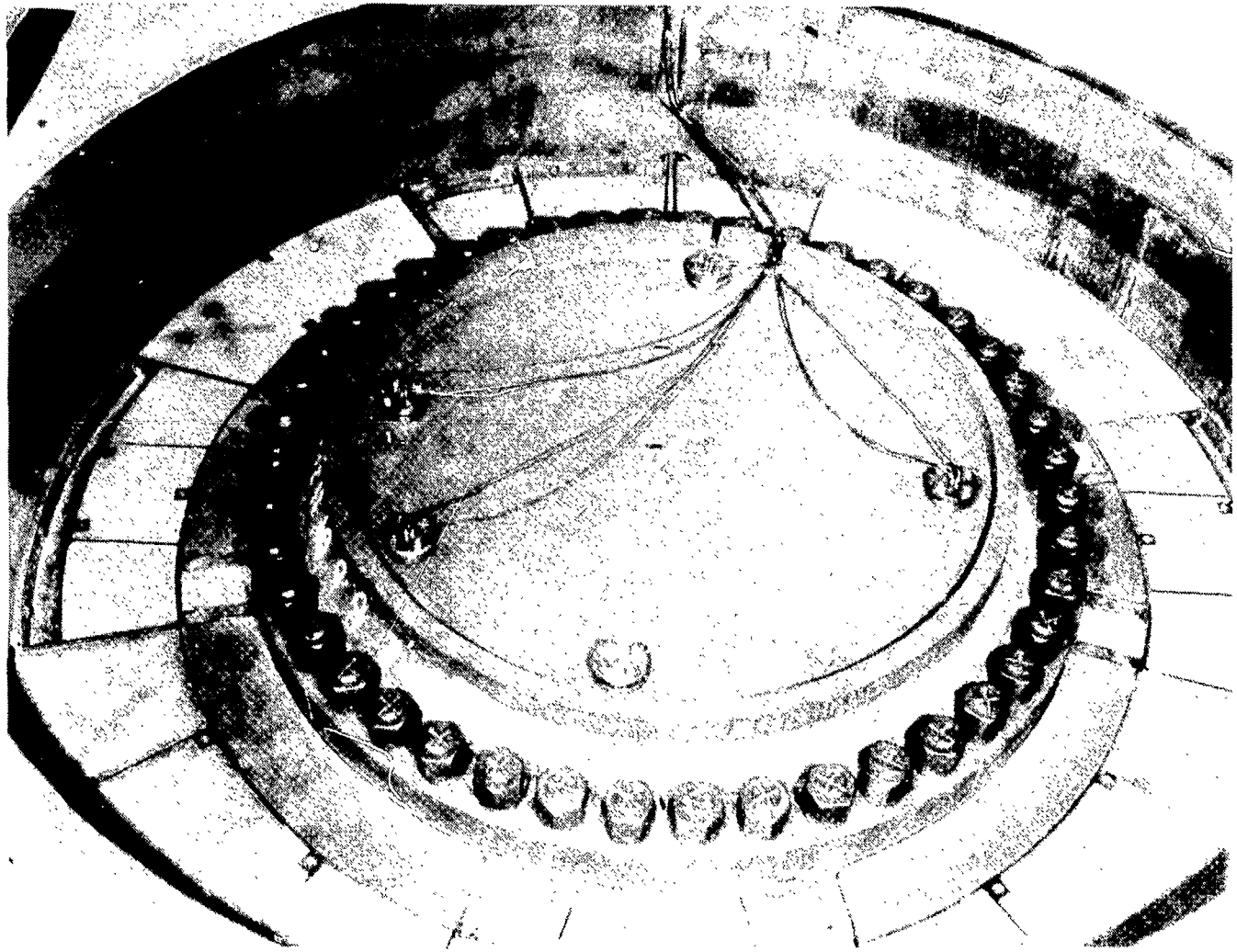

Fig. 8. EBWR Pressure Vessel Cover

Items which are contained within the pressure vessel include the following:

The Indexing Shield Plug
The Steam Duct
The Poison Spray Ring
Two Condensate Return Rings
The Shock Shield
The Core Riser
The Core Shroud
The Control Rods Guide Shroud
The Control Rods (9)
The Core Support Grid

The pressure vessel and its internal structure are expected to be the most radioactive items that will be encountered during the project.

The outside of the pressure vessel is covered by a layer of thermal insulation consisting of a three-inch thickness of stainless steel wool which is held in place by stainless steel bands and wire mesh. Three inches of dead air space separate the steel wool from the inner surface of the steel cylinder, approximately 8-1/2 feet in diameter and made of 3/4-inch thick plate, which constitutes the inner boundary of the cell. Lead bricks are stacked against the outside of the cylinder to provide a gamma-radiation shield. Shield cooling coils made of copper tubing are fastened to the steel cylinder beneath the lead.

3.2.2 Main Floor - El, 730'-0"

Plant components located on the main floor of the containment building include the following:

Reactor Top Shield Tank and Integral Steel Backup Plate
Fuel Coffin and Transfer Carriage
Turbine-Generator and Associated Equipment
High Pressure Boric Acid Tank and Injection Valves
The Fuel Storage Pool

3.2.3 Condenser Floor - El, 713'-0"

Plant components located on the condenser floor are:

The Main Condenser
Two Main Cooling-Water Circulating Pumps
Main Cooling-Water System Valves and Piping
The Steam Dryer/Emergency Cooler
The Desuperheater
The Deaerator
The Air Ejectors
Main Steam System Valves and Piping
Feed Water Filters Nos. 1 and 2
Instrument Air Compressors Nos. 1 and 2
The Electrical Generator Surge Protection Gear
the Reactor Water-Level Column

3.2.4 Pump Floor - El, 696'-0"

Plant components located on the pump floor include:

The Start-up Heater
The Feed Water System Subcooler
Feed Water Pumps Nos. 1 and 2
Feed Water Filters Nos. 3 and 4
Feed Water System Valves and Piping
Auxiliary Cooling Water Pumps Nos. 1 and 2
The Fluid (Vapor) Recovery System
The Condenser Tube-Sheet Vacuum/Drain Tank
The Recombiner System

3.2.5 Basement Floor - El, 682'-0"

The following plant components are located on the basement floor:

The Reactor Water Purification System
The Reactor Control Rod Drives
The Reactor Vessel Blowdown System
The Reactor Shield-Cooling Pumps and Heat Exchanger
Feedwater Pumps Nos. 3 and 4
Two Retention Tanks and Pumps

With the termination of the EBWR research program in 1967, the reactor was shut down, the fuel was removed and sent offsite for reprocessing, and the EBWR Facility was placed in dry lay-up. This deactivated condition was achieved by draining all liquids from the primary, secondary, and auxiliary systems, flushing them thoroughly, and then leaving all valves in their open position. In addition, to ensure complete draining, certain flanges were removed and in some cases holes were drilled at system low points. Also, the fuel storage pit was drained, flushed, and decontaminated. Electrical switch gear, except for building lights, the crane and the elevator, were taken out of service and power and control cables leaving the containment shell were cut. The facility was maintained in a safe storage mode up until the actual D&D Project was initiated in the first quarter of FY 1986.

3.3 PRE-D&D RADIOLOGICAL CONDITION

In August 1979, a radiological survey of accessible areas in the EBWR containment building was performed for ANL-IL by a subcontractor. This survey showed that there were significant but not necessarily high radiation levels in various locations within the building, primarily due to the radioactive isotope cobalt-60. This activation product resulted from the irradiation of small amounts of cobalt-59 which are present as an impurity in the materials of which the reactor is made. After 12 years of safe storage, the highest radiation levels occur in the basement where a gamma reading of 300 mR/h was measured at a purification system regenerative cooler. Gross beta-gamma activities of from 1,640 dpm/100cm^2 to 39,300 dpm/100cm^2 were measured from smear samples taken in this location. Significant gamma radiation was also detected at the reactor's liquid level column which measured up to 70 mR/h, the steam dryer, the desuperheater, and along a piping run adjacent to the deaerator. These latter areas were measured at from 3 to 30 mR/h gamma. No radiological survey of the reactor vessel was performed in 1979.

In February 1983, ANL conducted measurements of the radiation field in the reactor vessel. These were made using a Victoreen Radcon 550 ion chamber instrument introduced into the vessel through an instrument port. Based on these measurements and on the assumption that the majority of the radiation impinging on the instrument probe was cobalt-60 photons contributed by activated steel, primarily on the core shroud and the reactor vessel, radiation fields were estimated to be as follows:

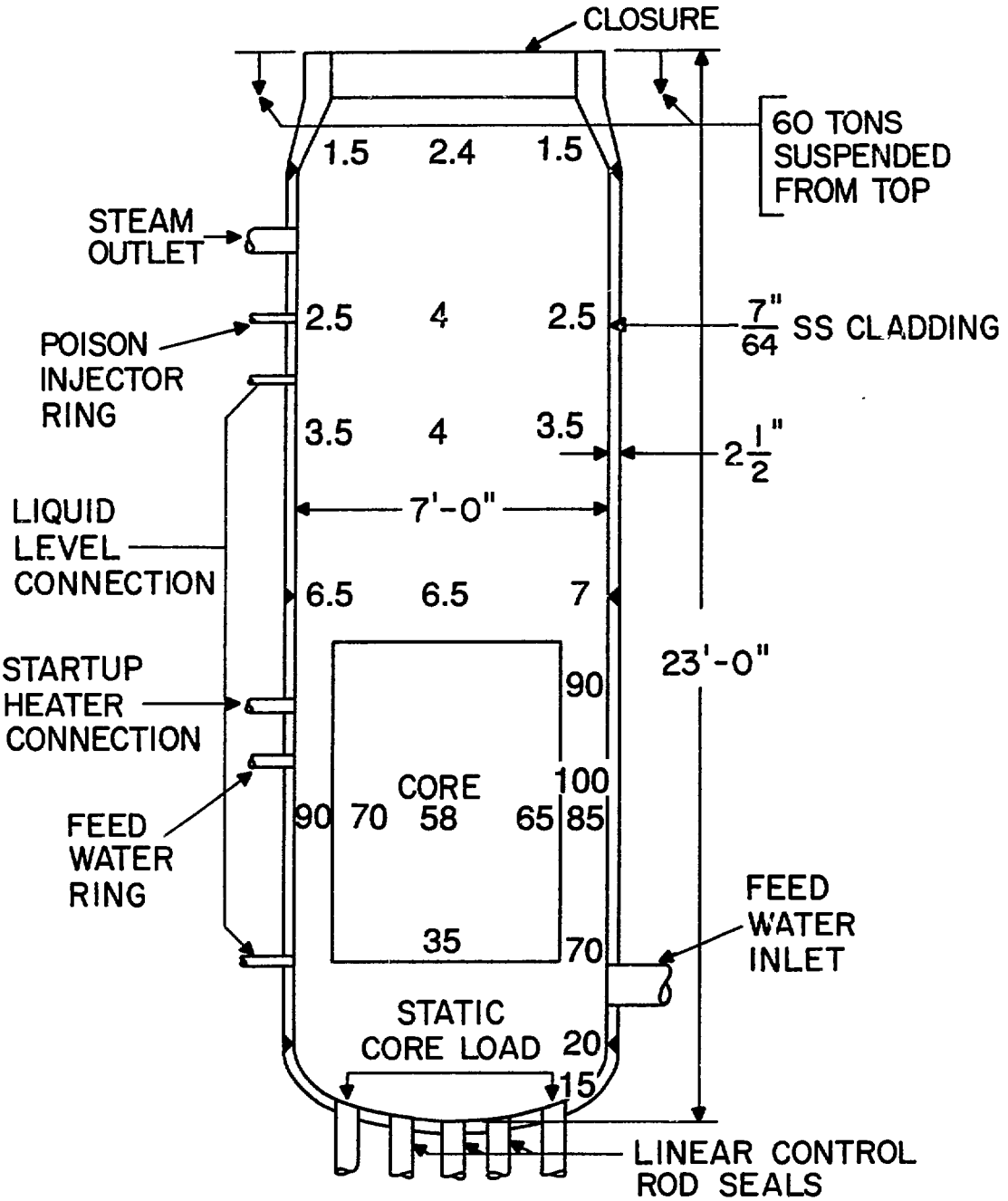

Fig. 9. Measured Dose Rates in EBWR

Reactor Vessel	10 R/h @2"
Core Shroud	306 R/h @2"

A similar survey of the inside of the vessel was made in February of 1989. The results of this survey are summarized in Figure 9.

These radiological surveys made inside the containment shell indicate that while localized areas will result in personnel exposures, workers will not be subjected to any unusually high backgrounds while performing the various operations. Gamma-ray assay of certain samples show that the source of all readings is primarily cobalt-60 which has already undergone almost five half-lives of decay. The lack of any cesium or strontium lead to the conclusion that the EBWR fuel integrity was excellent and the fission products should not be a problem during the D&D activities.

4.0 PROJECT MANAGEMENT

In this section of the project plan, administrative, programmatic, and technical responsibilities for the performance of the project are delineated, and management controls and reporting systems are specified.

4.1 Management Organization

The various organizations involved in this project along with their responsibilities are described in this subsection.

4.1.1 Department of Energy

The overall responsibility for the EBWR D&D Project rests with the Secretary of the Department of Energy and passes through the Office of the Assistant Secretary for Nuclear Energy (ASNE), the Office of Remedial Action and Waste Technology to the Division of Facility and Site Decommissioning (DFSD) with the DOE Headquarters (DOE-HQ) being designated the Program Office for the Surplus Facilities Management Program (SFMP).

4.1.2 Assigned Field Office

The DOE Chicago Operations Office (DOE-CH) has been designated the Assigned Field Office and is responsible for the administrative, programmatic, contractual, technical, and fiscal aspects of the project. In addition, the Project Plan must be approved by DOE-CH.

4.1.3 Contractor

Argonne National Laboratory has been assigned the lead role for the actual decommissioning of EBWR. The Laboratory will direct, manage and control all phases of the work. ANL's Project Manager will be responsible for the day to day operations at the site. He will be responsible for the following tasks:

(a) Preparing the Project Plan, the Project Schedule, and the Project Budget and Cost Plan
(b) Preparing the Project Quality Assurance Plan
(c) Obtaining and directing the project work force
(d) Monitoring and documenting the progress of the project and exercising cost control
(e) Arranging for radiation measurements and radionuclide identifications to determine the type and activity concentrations of the radioactive decommissioning waste
(f) Assuring that auditable records are maintained for:
    - Radiological instrument surveys and smear surveys
    - Air sampling data (both radiological and industrial)
    - Radionuclides identification and concentrations
    - Personnel radiation exposures
    - Materials released for unrestricted use
    - Materials packaged and sent for burial
(g) Industrial hygiene and safety guidance, instruction and training
(h) Developing work procedures
(i) Determining the disposition of all structures, materials, equipment and contaminated soil
(j) Physical decommissioning work
(k) Overseeing the handling and packaging of all decommissioning waste
(l) Documenting radioactive wastes for off-site shipment and disposal
(m) The final radiological characterization of the facility and an independent verification survey
(n) Preparing the project D&D Final Report
(o) Preparing the project Technology Transfer Plan

4.2 QUALITY ASSURANCE (QA)

The project Quality Assurance Program prescribes the requirements for achieving a satisfactory level of quality in the performance of project activities. These requirements will be based upon existing codes, standards, and practices and most specifically on those found in ANSI/ASME NQA-1-1985.

4.2.1 Quality Assurance Program Scope

The following activities will be within the project QA Program:

(a) Waste Segregation as to Radioactive and Nonradioactive
(b) Packaging of Radioactive Waste
(c) Radioactive Content of Waste Packages
(d) Instrument Calibrations
(e) QA Program Audits

4.2.2 Quality Assurance Program Responsibilities

Project management personnel shall have the following responsibilities relative to the project QA Program.

4.2.2.1 Project Manager

The Project Manager has the overall responsibility for the execution of project QA Program. He will be assisted in carrying out the specified QA requirements by the project's Health Physics Manager and by the Waste Management Operations Manager.

4.2.2.2 Health Physics Manager

The Health Physics Manager is responsible for complying with the project QA Program requirements for sampling, sample analysis, standards, instrument calibrations, radiation safety, radiation monitoring, and the final radiation survey of the facility. He is also responsible for establishing qualification requirements for the project's Health Physics personnel and for their training, as needed.

4.2.2.3 Waste Management Operations Manager

The Waste Management Operations Manager is responsible for compliance with the QA Program requirements for dismantling, decontaminating, waste handling, waste packaging, and waste disposal activities. He is also responsible for establishing the qualification requirements for the project operating personnel and for their training, as needed.

4.2.2.4 Divisional QA Representatives

The Divisional Quality Assurance Representatives for the Plant Facilities and Services Division-Waste Management Operations and for the Support Services Division - Environment Safety and Health Department have joint responsibility for the review and approval of the QA Plan with respect to the project. They will assist the Project Manager in implementation of the QA Plan and serve as an interface with the Quality Environment and Safety (QES) Office.

4.2.2.5 Argonne National Laboratory Quality Environment and Safety Officer

The ANL Quality Environment and Safety (QES) Officer is responsible for auditing the project to verify compliance with the QA plan and to determine its effectiveness. He shall review QA plans prior to issuance and provide guidance and consultation to the Divisional QA Representatives.

4.3 PROJECT CONTROL

The EBWR D&D Project Manager shall have prime control and overall responsibility for the project. Details of the project activities will be documented in monthly progress reports which will be prepared for submittal to the DOE. Reporting will be via the Earned Value System as directed by the DOE-CH Surplus Facilities Management Program office. The Project Manager, Health Physics Manager, and Waste Management Operations Manager will review the reports in order to identify any project deficiencies. The Project Manager will also schedule periodic meetings of project management personnel to assess progress and to deal with any problems that arise.

4.4 PROJECT DATA

Data generated during the D&D activities, such as survey results, instrument calibrations, sample analyses, personnel radiation and toxic material exposures, etc., will be retained as permanent records of the project. The appropriate ANL management staff will review the data to assure that all operations are in compliance with QA Program specifications. Periodic QA audits of the data will be performed to verify such compliance. The current plan is that a Technology Transfer Plan will be developed in FY 1989, albeit on a smaller scale than the Shippingport Reactor Decommissioning Project had. The format for this plan and the amount of information to be included has yet to be determined due to staff manpower constraints.

4.5 TRAINING

The project will be staffed by persons having previous training and experience in the tasks they will perform. Personnel assigned special tasks with which they are unfamiliar will be given additional and specialized training to enable them to perform the work safely and expeditiously.

4.5.1 Health Physics

Experienced Health Physics personnel of the ANL Environment Safety and Health (ESH) Department will be employed to monitor the radiological aspects of the project. These personnel will have received formal training in their field of specialization and will have practical and varied radiation monitoring skills. Qualified ESH staff members will supervise the Health Physics radiation monitoring personnel and provide additional training as necessary.

4.5.2 Decontamination

Waste Management Operations (WMO) mechanics from the Plant Facilities and Services (PFS) Division will perform the plant dismantling and decontamination activities. The WMO mechanics will have received practical training in their specialty and will have previous experience in applying the various decontamination processes required by the project. Any special training that becomes necessary will be provided by qualified members of the WMO staff.

4.5.3 Other Training

Training in other areas such as rigging and hoisting, respirator usage, industrial safety, etc., will be provided on an as needed basis by those ANL organizations who have expertise in such fields. Also training films and videos produced by various outside firms will be utilized as appropriate to the project work.

4.6 HEALTH AND SAFETY

Health and Safety aspects of the project are within the purview of the ANL-East Environment Safety and Health Department as promulgated by the ANL-East Health and Safety Manual. The ESH Department in addition to approving procedures will assign staff members specializing in the areas of Health Physics, Industrial Hygiene and Safety Engineering to monitor the project for the purpose of identifying and evaluating conditions which might affect health and safety.

4.6.1 Planning and Review Committee

In order to provide a mechanism for the review of the plans and procedures related to this D&D effort, the Manager of the Environment Safety & Health Department, who will issue final approvals, has appointed a Planning and Review committee made up of Laboratory technical, operating and safety personnel. This group is responsible for reviewing the proposed plans and procedures in a timely fashion so that work will not be unduly delayed, resolving differences that may arise regarding methods of operations and serving as the ANL internal safety evaluation committee which, after appropriate consideration, will recommend approval to the Director of ESH. This committee will remain active until the project is complete.

4.6.2 Radiation Safety

Data concerning the radiological exposure of project personnel will be collected, recorded, and analyzed by members of the ESH Health Physics section who are assigned to the project. They will also review project work procedures and monitor project activities with the objective of identifying potential radiological hazards and eliminating or controlling them. Project Health Physics personnel will make recommendations regarding project safety

procedures and criteria for D&D activities as well as for radioactive waste disposal. These recommendations will embody the "As Low As Reasonably Achievable" (ALARA) principle.

4.6.3 Industrial Hygiene

Staff members of ESH/Industrial Hygiene will furnish technical guidance in the areas of toxic materials handling (especially for asbestos), respiratory protection, ventilation and protective clothing. In addition, they will perform HEPA filter and respiratory testing, monitor for toxic material exposures, and give training in respirator usage. Data obtained from these activities will be evaluated to determine if further mitigating measures are needed and retained as part of the permanent project records.

4.6.4 Industrial Safety

The industrial safety aspects of the project will be reviewed by staff members of ESH who are specialists in the field of Safety Engineering. They will evaluate the potential exposure of personnel to accidental injury hazard and recommend means to minimize such occurrences.

4.6.5 Fire Protection and Safety

Project fire protection services and safety guidance will be provided by the ANL Fire Department. They will make periodic tours of the work site to assess fire potential and advise where improvements can be made.

5.0 TECHNICAL PLAN

The Technical Plan for this project includes activities ranging from the formation and staffing of the project organization to the final close-out report. These activities are described below in the order proposed for their performance and are presented graphically in work breakdown structures (WBS) format as shown on Figure 10.

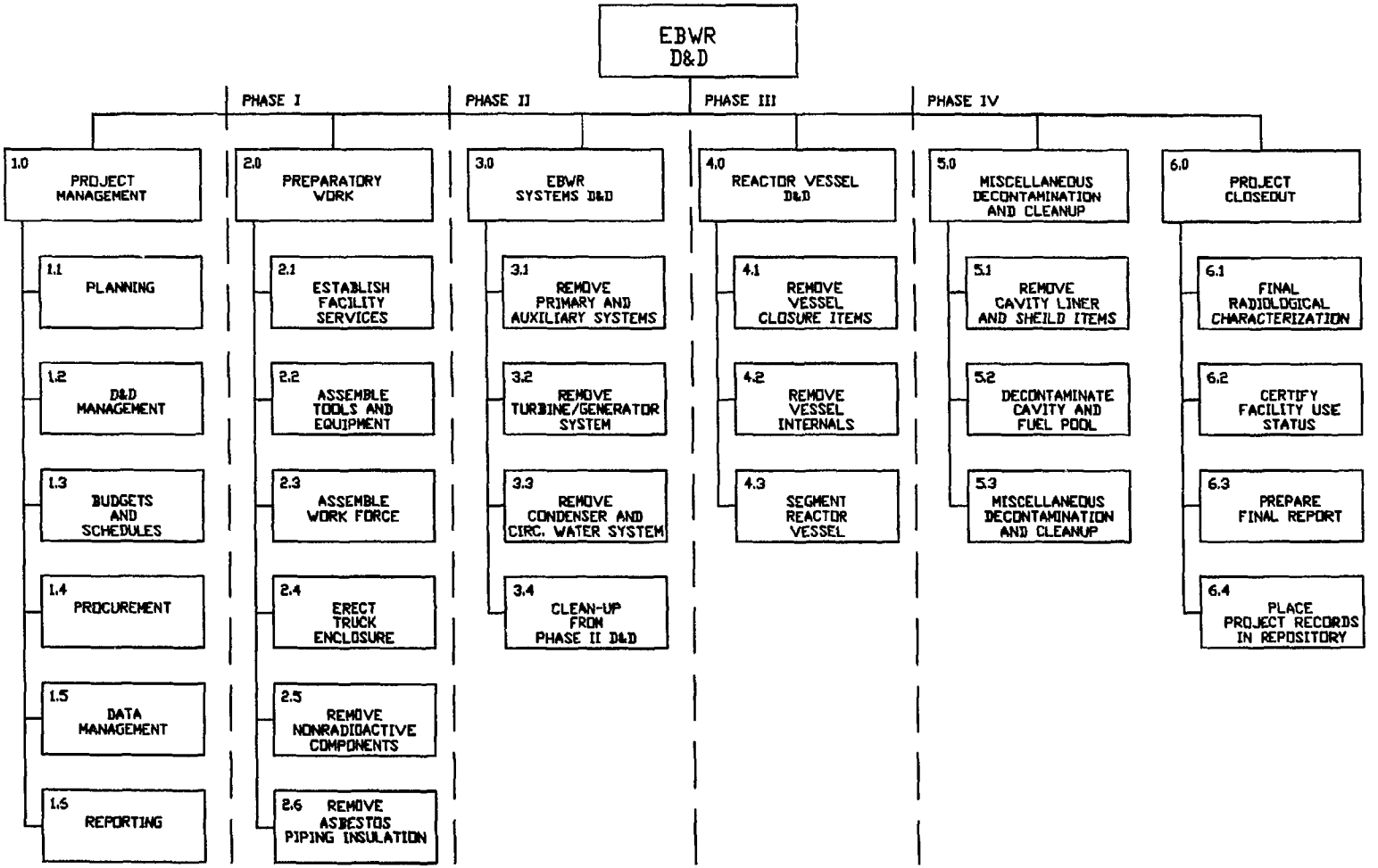

Fig. 10. EBWR D&D Project Outline WBS

5.1 Key Decision Points

There are relatively few key decision points for the EBWR D&D Project. Since this is not a major project as defined in DOE Order 4700, many of the administrative decisions were not as significant or were not required since the EBWR is located at a national laboratory. Table 1 lists the key decision points for the EBWR D&D Project.

5.2 Alternatives Considered

There were 2 major issues on which different alternatives were considered. These two issues were:

(a) Use of ANL workforce or subcontract entire job, and

(b) One piece reactor vessel removal or segmentation of the reactor vessel.

5.2.1 Work Force

The ANL D&D crew was chosen for this work due to the fact that the crew has had extensive experience in the D&D area. Costs are kept as low as possible using this option.

5.2.2 Reactor Vessel Removal

In the engineering study performed for the EBWR D&D, two scenarios were evaluated. The first was one piece removal of the reactor vessel and the second was segmentation of the vessel. The first option resulted in a cost savings for the total project of well less than 5%. In addition, this technique had already been shown possible in the Shippingport D&D Project. The technology exists to perform the segmentation of the EBWR reactor vessel. Therefore, the decision was made to segment the reactor vessel and <u>not</u> to attempt a one piece removal.

Table 1. EBWR D&D Key Decision Points

Activity	Resp. Office	Status*
Acceptance into SFMP	DOE-HQ	C
Engineering Study Completed	DOE-CH/ANL	C 6/81
NEPA Documentation Approved	DOE-HQ	C 12/85
Approval to Initiate D&D	DOE-RL	C 1/86
Complete Project Plan	DOE-CH/ANL	C 6/86
Complete Physical D&D	DOE-CH/ANL	P 7/95
Complete Independent Verification Survey	DOE-HQ	P 1/94
Close Out Project	DOE-CH/ANL	P 7/94

*C - Completed P - Planned

5.3 Project Organization

The EBWR D&D Project Manager will utilize support services of existing organizations as shown in Figure 11. Qualified ANL personnel having experience in decommissioning work will staff the organization. These project personnel will be assigned responsibilities as described in Section 4.0 of this project plan. A work breakdown of the project's Management Function is shown in Figure 12.

5.4 Decontamination and Decommissioning

In general, the work will be performed in four phases (Figure 10) with the first phase consisting of preparatory activities plus any decommissioning tasks the Project Manager determines can be advantageously carried out during Phase I. Examples of such tasks are the removal of certain noncontaminated equipment and removal of asbestos from the facility. Phase II of the project will accomplish the removal of the turbine-generator, the main condenser, and all of the process and auxiliary systems. In Phase III components of the reactor vessel complex will be removed, while Phase IV will encompass any further decontamination required, the cleanup of the facility, as well as the project close-out activities.

Health Physics personnel will monitor all project activities. They will survey all materials removed from the facility for radioactive contamination,

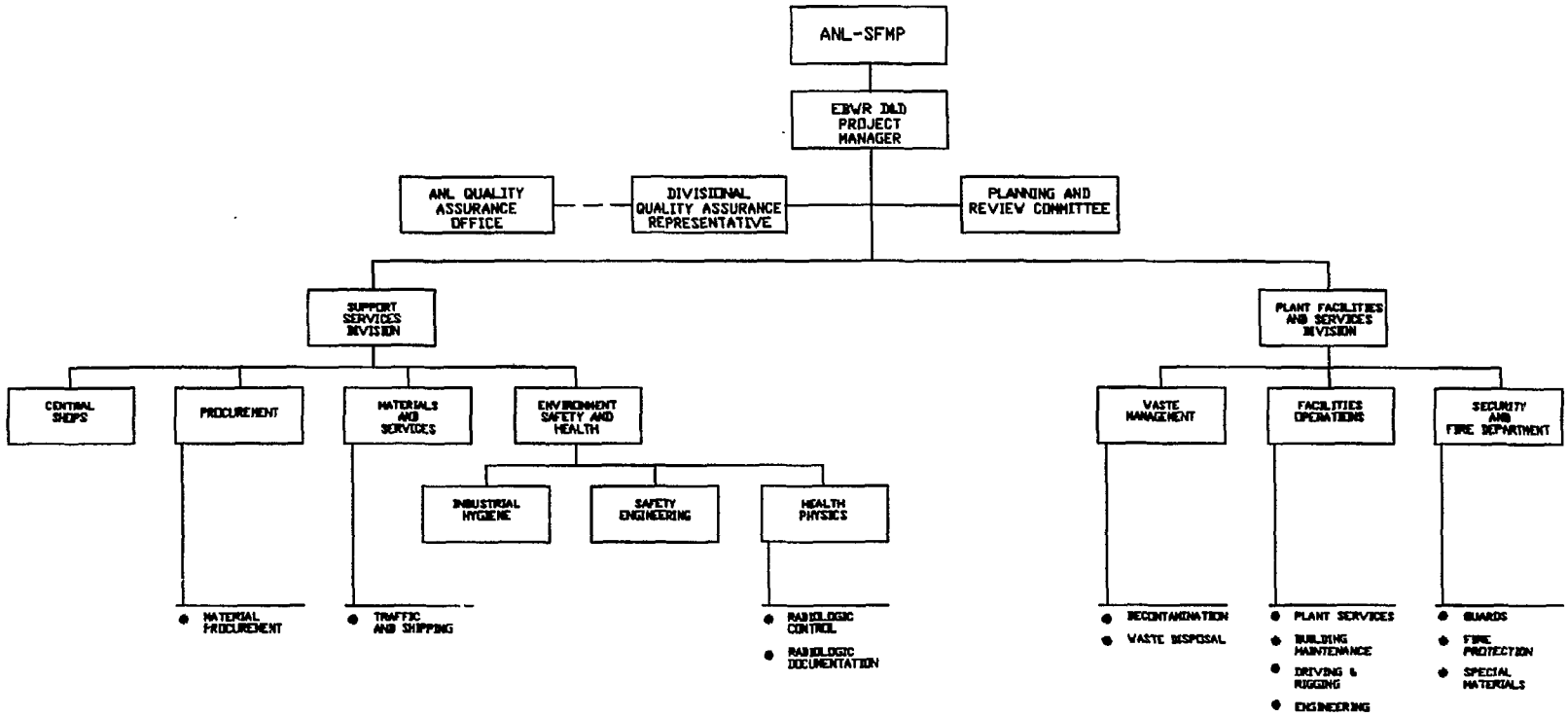

Fig. 11. EBWR D&D Project Organization

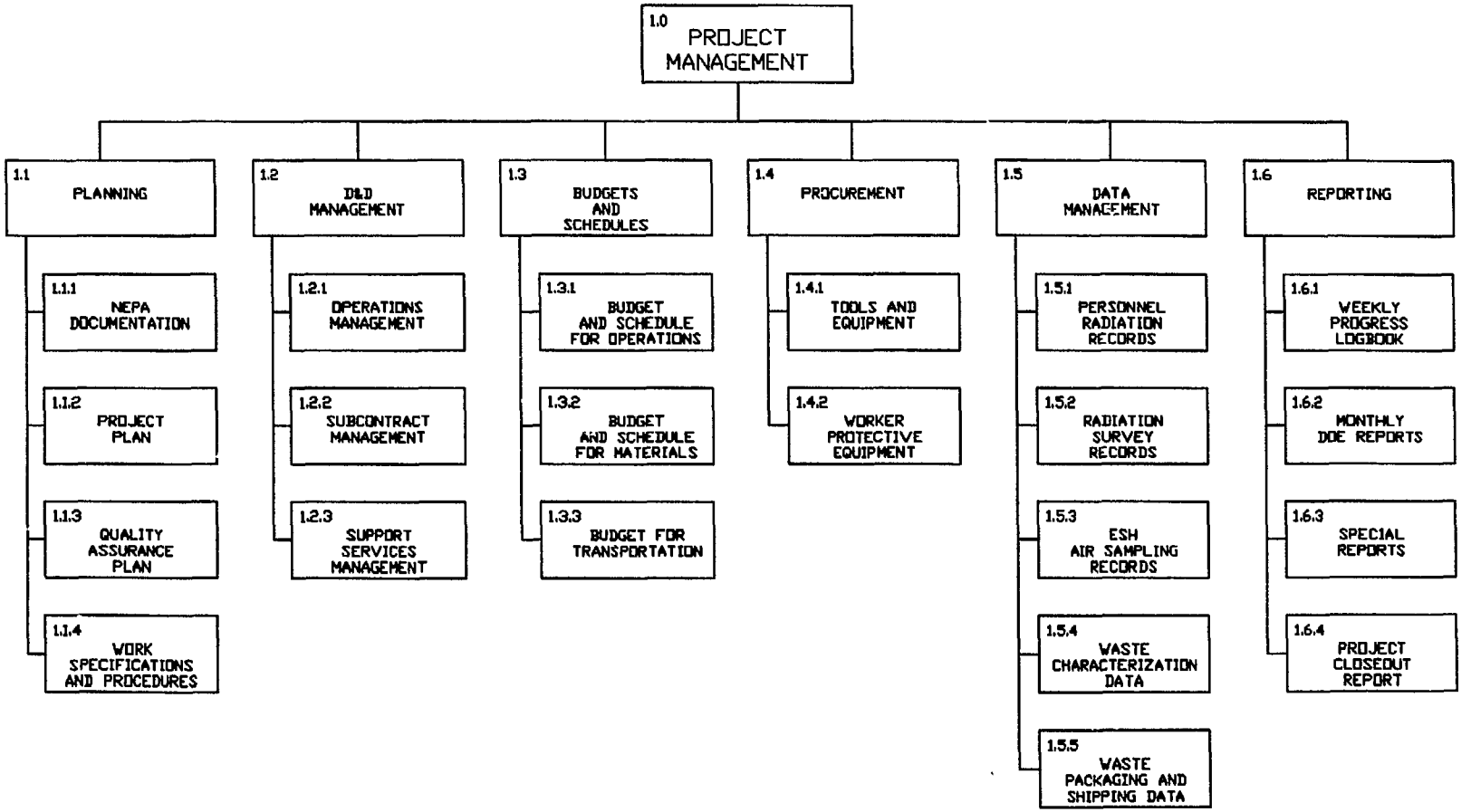

Fig. 12. EBWR D&D Project Management Outline

and will determine the radiological identity of any materials that are found to be contaminated. All contaminated materials will be placed in appropriate radioactive-waste shipping containers. Health Physics personnel will also provide general radiation safety functions, such as personnel monitoring and routine floor surveys. Air samples will be taken on a continual basis to monitor for airborne radioactive contamination. If airborne contamination is probable, precautions will be taken to prevent its spread and to protect personnel prior to initiating D&D tasks.

Records will be kept of all data generated during the project. These data will include the weight of radioactive waste placed in each shipping container together with the radionuclide identification and the identification of the shipping container and its disposition. All survey and sample analysis data will be included in these records.

5.4.1 General

In general the D&D activities will be conducted in the following manner:

(a) Facility Contents

All unattached items of equipment, furniture, and debris will be removed from the facility to clear it for further D&D work. These items will be surveyed for radioactivity as they are removed and if found to be contaminated, they will be packaged for burial as radioactive waste. Uncontaminated material will be salvaged for reuse or scrap disposal, or disposed of in the ANL-IL landfill.

Installed equipment such as the turbine-generator, the condenser, and motors, pumps, tanks, compressors, etc., will be decontaminated if possible and salvaged for scrap. If decontamination is not possible, such items will be size reduced as necessary and packaged for burial as radioactive waste.

(b) Piping, Conduit, and Ductwork

All process piping, conduit, and ductwork will be surveyed for radioactive contamination during removal. If it is not possible to survey the internal surfaces of any of these items, such items except for conduit, will be disposed of as radioactive waste even if surveys of their outer surfaces show no radioactive contamination. The piping of systems known to be "closed", such as domestic and

laboratory water, air, and the laboratory steam heating system, and conduit will be surveyed on their exterior surfaces and at open ends only. Piping and ductwork that are found to be uncontaminated after internal and external surfaces will be salvaged for reuse, disposed of as scrap, or placed in the ANL-IL landfill.

(c) Interior Walls and Ceilings

The surface of each wall and ceiling will be surveyed for radioactive contamination. If contamination is found decontamination techniques will be used to remove it.

(d) Floors and Gratings

Floors and gratings will be cleaned of all debris and dust. Floor coverings will be removed and the floor surface beneath will be surveyed for radioactive contamination. The floor covering material will also be surveyed and disposed of as appropriate. Any portion of the floors or gratings of the facility which are found to be contaminated will be decontaminated by use of appropriate techiques. Where scrubbing with cleaning solutions is not effective concrete surfaces will be scrabbled to decontaminate them. Those gratings that cannot be effectively decontaminated will be properly disposed of.

(e) Underground Piping

All underground piping associated with the operation of the reactor will be excavated and surveyed. Radiological measurements and air sampling will be performed during this work and all materials identified as radioactive will be disposed of as radioactive waste.

(f) Contaminated Soil

Soil exposed by the removal of underground piping will be surveyed for radioactive contamination, sampled, and analyzed for radioactive content. Radioactively contaminated soil will be removed and placed in radioactive-waste shipping containers for disposal.

(g) Asbestos

Samples of materials suspected of containing asbestos will be submitted to the ANL Industrial Hygiene Group for positive identification prior to removal. Where asbestos has been identified and is to be removed, the workers will follow EPA and DOE guidelines and will utilize protective clothing and respiratory protective equipment approved by the National Institute for Occupational Safety and Health (NIOSH). The asbestos-bearing material will be removed in a manner that minimizes shredding and air contamination and will be packaged and sealed in approved asbestos disposal bags. If no radioactivity is detected in the material it will be disposed of in the ANL-IL on-site landfill. If radioactivity is detected, the asbestos-bearing material will be packaged and disposed of as radioactive waste.

5.4.2 Phase I - Preparatory Activities

As shown in Figure 13, preparatory activities will include the following:

(a) Establish a base of operations in the vicinity of the work site. The base will include office(s), locker and shower facilities, storage space for equipment, tools and materials, shop space, and a main entry way including air lock and step-off pad. Emergency or temporary power/light services will be established.

(b) Establish liaison with appropriate ANL organizations to coordinate the provision of laboratory services to the project; especially emergency and medical services (i.e., ambulance, fire protection, medical personnel, and rescue equipment).

(c) Carry out any required training of project personnel. Although personnel will be experienced in the performance of their tasks, when it is deemed necessary training in specific project operations will be provided.

(d) Acquire project supplies such as tools and equipment, decontamination materials, and radioactive-waste shipping containers.

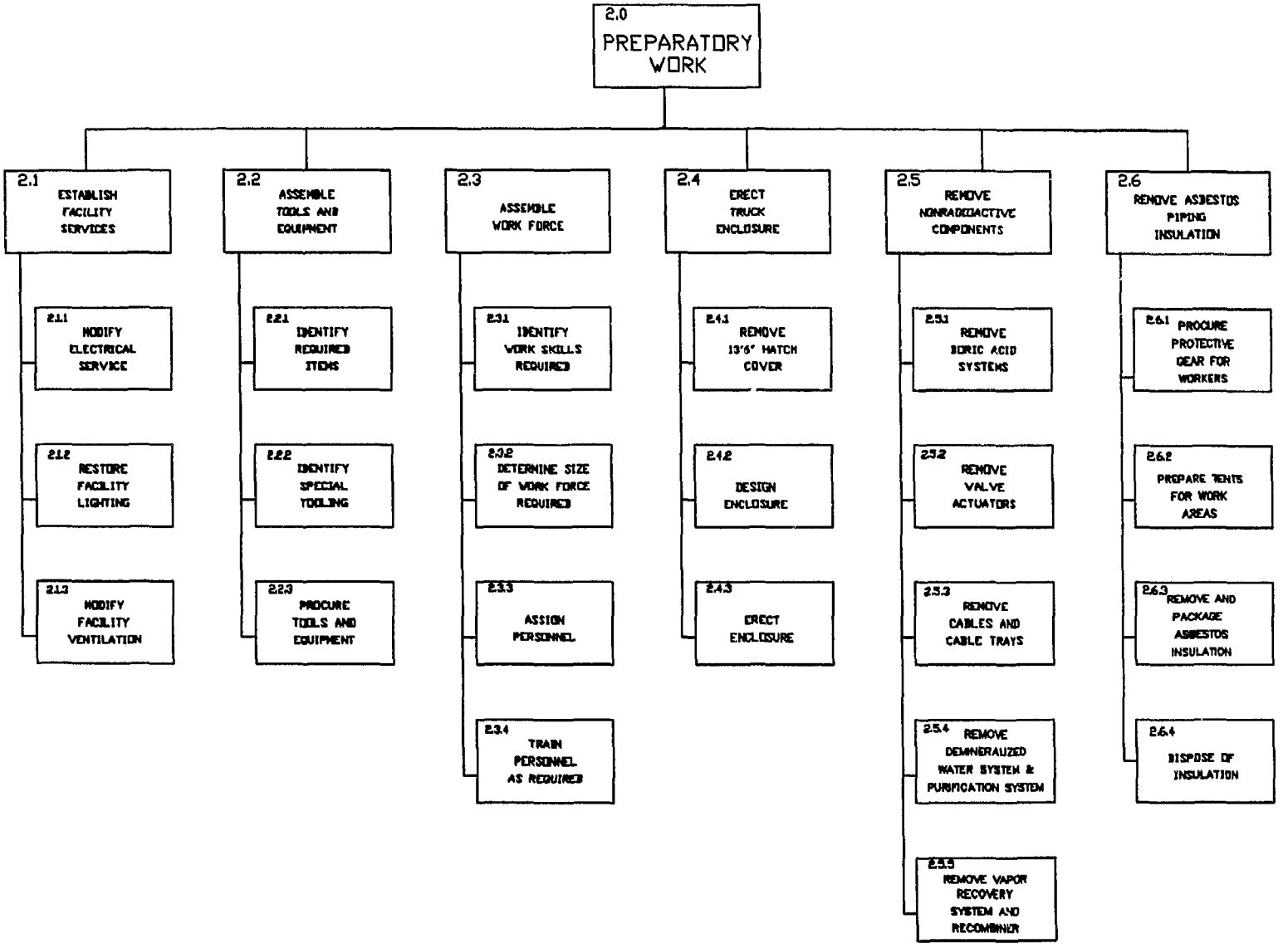

Fig. 13. EBWR D&D Project, Phase I Work Breakdown Structure Diagram

(e) Establish a marshalling area in the yard south and west of the containment shell where items removed from the facility can be prepared for shipment and required equipment and supplies can be assembled.

(f) Reopen the large, temporary hatchway in the south-west side of the containment shell on the main floor level. Fabricate and install a truck enclosure for moving large items out of the shell and ensuring satisfactory containment for the shell.

(g) Recertify the polar crane in the containment shell.

(h) Perform necessary safety related construction activities.

(i) Remove all asbestos bearing material from the facility.

(j) Remove unneeded nonradioactive systems and components to provide better access for asbestos removal and other D&D operations.

5.4.3 Phase II - EBWR Systems Disassembly

Figure 14 gives a breakdown of the tasks which will be carried out in Phase II. At the beginning of Phase II all asbestos bearing materials will have been removed from the facility. The turbine-generator will then be disassembled and removed, followed by all of the pumps, tanks, piping, and other equipment belonging to the plant's primary process and auxiliary systems will be systematically removed. Next, the main condenser will be removed followed by a general clean-up of the plant. After Phase II is completed, safety railings will be erected around areas or in areas as deemed necessary by the project manager to maintain a safe work area.

5.4.4 Phase III - Reactor Vessel Disassembly

A work breakdown for the disassembly and removal of the EBWR reactor vessel complex is shown in Figure 15. It is expected that the most radioactive materials to be dealt with during the project will be encountered in Phase III. Of primary concern will be the reactor vessel and its internal

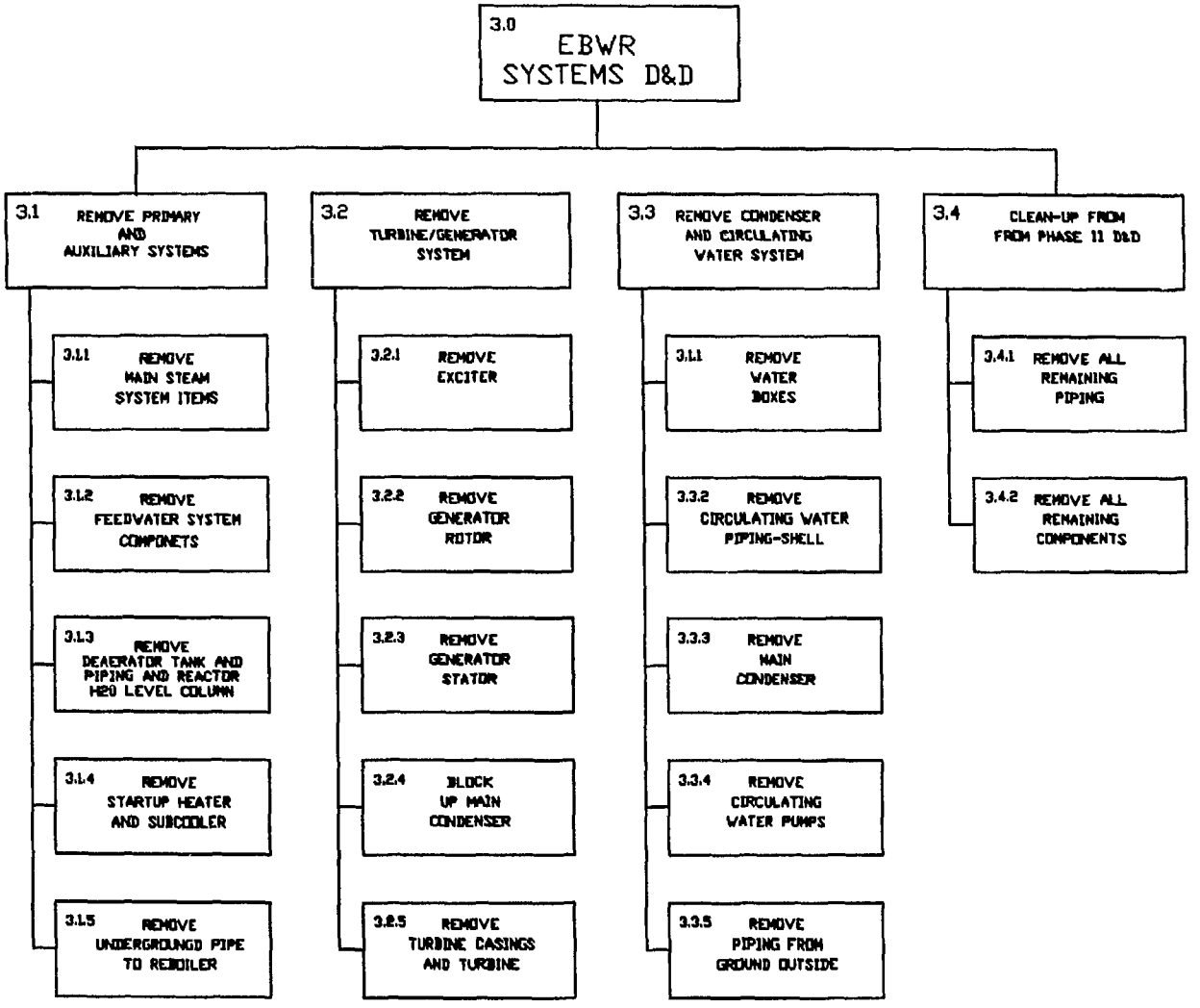

Fig. 14. EBWR D&D Project, Phase II Work Breakdown Structure Diagram

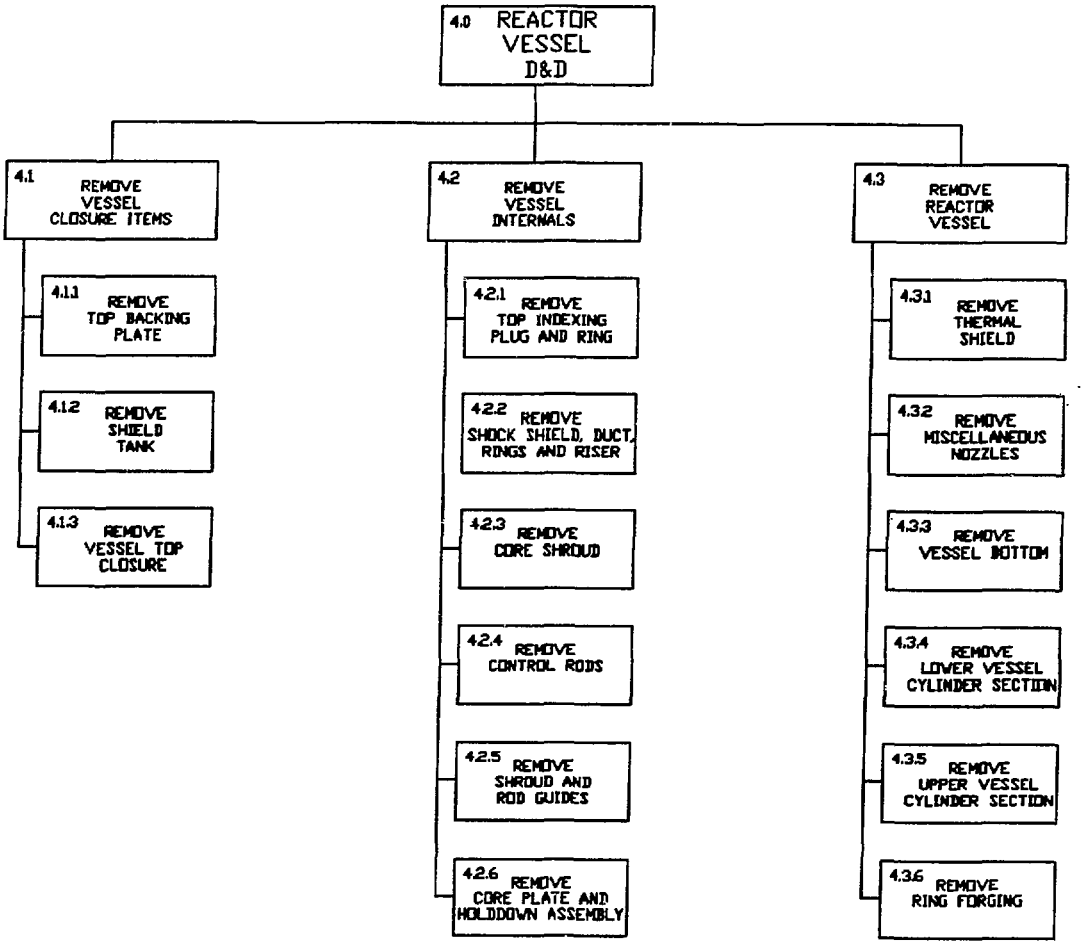

Fig. 15. EBWR D&D Project, Phase III Work Breakdown Structure Diagram

structures and, to a much lesser degree, the reactor closure equipment. Components of the reactor biological shield are not expected to be sufficiently radioactive to present a handling problem. The sequence of operations will be:

The reactor vessel closure items will be removed first, and if radioactively contaminated, packaged and shipped for burial.

The structures contained within the reactor vessel, such as the control rods, core shroud, shock shield, steam collector, etc., will be removed next. These items will be size reduced as necessary to facilitate shipping, packaging, and transporting for burial.

The reactor vessel will then be cut into pieces sized for efficient handling, packaged, and shipped for burial.

Components of the biological shield will next be removed from the cell formerly occupied by the reactor vessel and salvaged for reuse (lead bricks, etc.) or disposed of depending upon a Health Physics survey.

5.4.5 Phase IV - Project Completion

The tasks that make up Phase IV of the project are shown in Figures 16 and 17. During the project completion phase, any remaining decontamination activities will be performed. A final radiological survey will then be made and, upon certification that the facility meets predetermined release criteria, a general clean-up will be carried out. A final project close-out report will be prepared and all project records, reports, and other data will be packaged and delivered to the designated custodian.

5.5 RELEASE CRITERIA

The radiological release criteria that will be used during this project are as given in the following documents and will be applied as appropriate.

U.S. Department of Energy Guidelines for Residual Radioactivity at formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites.

Department of Energy Order 5480.11, "Requirements for Radiation Projection."

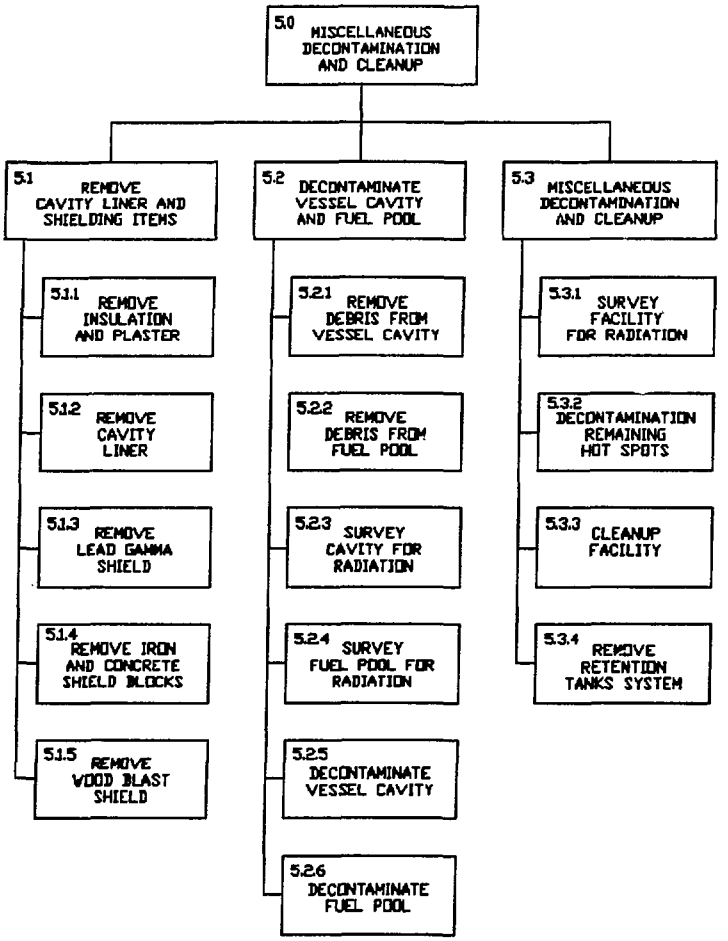

Fig. 16. EBWR D&D Project, Phase IV - Miscellaneous Tasks Work Breakdown Structure Diagram

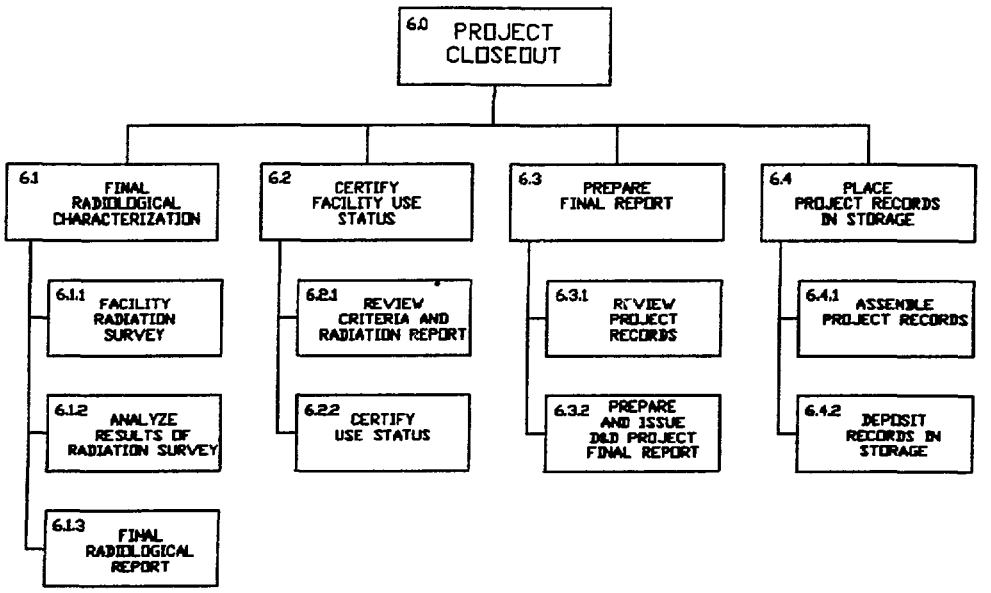

Fig. 17. EBWR D&D Project, Phase IV - Project Close-Out Work Breakdown Structure Diagram

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.86.

The responsibility for releasing, and the authority to release, buildings and materials for unrestricted use resides with DOE-CH with documentation and recommendations from the Health Physics Section of Argonne National Laboratory's Environmental Safety and Health Department.

Once the physical D&D of EBWR is completed, an independent verification contractor will be sent to ANL by DOE-HQ to perform an independent verification that the D&D has been satisfactorily performed. The independent verification contractor will report their radiological survey results directly to DOE-HQ who will report the results to DOE-CH. Once DOE-HQ and DOE-CH agree that the D&D has been satisfactorily performed, the facility will be released for unrestricted use.

5.6 RESTORATION POLICY

The restoration policy that will be used during this project is as follows:

> No restoration of the EBWR Facility will be undertaken which is not deemed necessary for the safety of building occupants or workers.
> No restoration of useable research space will be undertaken unless deemed necessary for the safety of building occupants or workers.
> Any restoration other than the above, will be the responsibility of the ANL program that utilizes the former EBWR Facility once the D&D is completed.

6.0 WASTE MANAGEMENT

All waste materials generated during this project will be classified as either "Radioactively Contaminated" or "Clean" in accordance with the criteria contained in "DOE Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites" (See Table 1). Materials classified as "Clean" will be salvaged for reuse, disposed of as scrap, or placed in the ANL on-site landfill. Radioactively contaminated waste will be further classified according to its composition and the level of its radioactivity. Liquid radioactive waste will be converted to a solid form using existing ANL systems and equipment.

6.1 Type and Volume

It is estimated that the EBWR D&D project will generate approximately 22,000 cubic feet of low-level radioactive waste requiring off-site disposal. The waste is expected to include materials and items of equipment that cannot be decontaminated satisfactorily, such as the reactor vessel and its internals, process and drain systems piping, ion exchangers, pumps, tanks, filters, and contaminated building materials -- primarily concrete. No TRU waste is anticipated. Metallic waste and rubble are categorized as follows:

Metallic Waste

(a) Reactor Vessel Complex = 4,000 cubic feet
(b) Balance of Plant Equipment and Piping = 10,000 cubic feet

Included in these volumes is an estimated 1,100 cubic feet of low-level radioactive stainless steel.

The volume of nonradioactive debris which will result from the project is estimated to be 4,000 cubic feet.

6.2 Waste Packaging

Radioactive waste generated by the EBWR D&D project will be packaged to conform with Department of Transportation (DOT) regulations and with the requirements of the receiving waste disposal site. It is expected that a majority of this waste will be of low specific activity (LSA) and can be packaged and shipped in the standard ANL M-3A radioactive-waste bin. The M-3A bins are made of 12 gauge steel reinforced with angle iron and measure 4 feet by 5 feet by 6 feet in height. A cover made of the same material and equipped with an integral gasket is fastened to the bin with eight bolts. The bin has a load limit of 8,000 lbs and meets DOT requirements for the shipment of LSA waste. If an item of LSA waste is too large or heavy to fit into a M-3A bin and cannot be size reduced readily, alternate packaging will be fabricated as needed which will be acceptable to the receiving disposal site.

Radioactive waste requiring remote handling will be size reduced as necessary and packaged in 30- or 55-gallon steel drums and/or M-3A bins. When

required, shipment will be in DOT approved shielded containers. Special packaging and special shielded containers will be utilized for items which cannot be size reduced and are too large or too heavy to be contained in standard packaging.

Liquid radioactive waste generated during decontamination operations will be processed into a solid by evaporation or other means after neutralization and then placed into standard packaging for off-site shipment. Liquid volumes are expected to not exceed several thousand gallons over the term of the project. Since the reactor system is in dry lay-up there are no liquids associated with the original facility operations.

6.3 Waste Transport

Packaged radioactive waste from the project will be transported to a DOE radioactive waste disposal site by "Sole Use" tractor-trailer trucks. Shipments will meet DOT and DOE regulations for transporting such materials. Special transport vehicles will be used to ship radioactive items that because of size, weight, radioactivity, or a combination of characteristics, cannot be transported routinely.

6.4 Waste Burial

Argonne is currently authorized to ship radioactive waste to the DOE sites in both Idaho and Washington with Idaho being the prime receiver. Current plans call for the EBWR waste to be combined with the low-level waste generated from other ANL activities and sent to the Idaho National Engineering Laboratory (INEL) Radioactive Waste Management Complex (RWMC) operated by EG&G Idaho. In the event that some unforeseen circumstance prevents this from taking place, arrangements will be made with the Westinghouse Hanford Company (WHC) Hanford Site to accept the radioactive wastes.

7.0 PROPERTY DISPOSITION

Substantial quantities of material and equipment are expected to be salvaged during the EBWR D&D project. Since it is normally more cost effective to reuse items, sell them as scrap, or bury them in a sanitary landfill rather than dispose of them as radioactive waste, efforts will be made not only to separate items that are radioactively contaminated from those

that are not, but to identify radioactively contaminated items that can be decontaminated economically. The ultimate disposition of items will be decided on a case-by-case basis and, when it is feasible, radioactively contaminated items will be decontaminated to unrestricted use levels. Uncontaminated items and those that have been decontaminated will be reused, sold as scrap or placed in the ANL sanitary landfill. Radioactive items which cannot be economically decontaminated will be packaged and transported to a DOE radioactive waste disposal facility.

8.0 SAFETY ASPECTS

The EBWR D&D project will require the successful completion of many separate tasks, each having radiological and/or industrial safety aspects. It will be an important responsibility of project management to ensure that any safety concerns are carefully considered and satisfactorily resolved before the relevant tasks are begun.

8.1 Safety Criteria

The project will be carried out in conformity with DOE Health and Safety criteria and guildlines and with the requirements of the ANL-Illinois Health and Safety Manual. In the performance of project activities, the safety of the public and project personnel will be of paramount importance.

8.2 Radiological Safety

Trained Health Physicists and technicians of the Health Physics Section of the ANL Environment Safety and Health Department will supervise and participate in the project's radiological safety program. The objectives of this program will be:

To assure that the project is carried out in accordance with the radiation protection standards contained in DOE Order 5480.11, and in conformity with the As-Low-As-Reasonably-Achievable (ALARA) principle,

To ensure that the exposure of project personnel to radiation is minimized,

To prevent the spread of radioactive contaminants, and

To identify radionuclides contained in project wastes and to characterize them by type and activity concentration.

In order to attain these objectives the radiation safety program will incorporate the following responsibilities:

The evaluation of work procedures prepared for the various project tasks, prior to their implementation.

The performance of project radiation surveys by direct reading instruments, smear samples and air samples, and the maintenance of records documenting the data obtained.

Radiation exposure monitoring and the maintenance of personnel radiation exposure records.

The maintenance of records describing all radioactive materials prepared for shipment, including radionuclide, waste type, activity concentration, package identification, and destination.

The performance of radiation surveys and other necessary evaluations to determine the disposition of decommissioned equipment, project waste, soil, etc., with respect to the release criteria.

The performance of final radiation surveys and sample analyses documenting the effectiveness of project decontamination efforts and attesting to the fact that all release criteria have been met.

8.2.1 Mitigative Measures

As appropriate for the protection of personnel and/or to prevent the spread of radioactive contaminants, one or more of the following protective measures will be utilized during project D&D tasks.

Training and practice in the tasks.

Protective clothing.

Radiation shielding.

Remotely operated tools and devices

Plastic sheeting covered work-enclosures with HEPA filtered air exhausts.

NIOSH approved respirators and breathing apparatus.

Personnel barriers around work zones, with radiation monitoring stations at points of egress.

Sealing of the open ends of pipes, tubes, and other components immediately upon disassembly.

To prevent the spread of radioactive contaminants off-site, all personnel, vehicles, tools, and other equipment will be surveyed for radiation whenever they leave the work area.

8.2.2 Incurred Dose Equivalent

It has been conservatively estimated that project personnel will receive a total dose equivalent of 40 person-Rem over the project's 95 month duration. Most of the dose equivalent will be incurred in project Phase III during a 36 month period, while the reactor vessel complex is being disassembled. Phase II of the project, which accomplishes the disassembly of all EBWR process and auxiliary systems, will also incur a significant dose equivalent, over a period of 15 months. As shown in Table 2, most of the dose equivalents incurred will be during project Phase III over a 36 month period, while the reactor vessel complex is being disassembled. Phase II of the project, which accomplishes the disassembly of all EBWR process and auxiliary systems, will also incur a significant dose equivalent, over a period of 15 months. As shown in Table 2, the dose equivalents incurred during project Phase I and IV will be small.

Table 2. Estimated Total Radiation Dose Equivalent Incurred During the EBWR D&D Project

Project Phase	Description	Duration (Months)	Dose Equivalent (Person-Rem)
I	Preparatory Activities	20	0.1
II	EBWR Systems Disassembly	15	12.8
III	Reactor Vessel Complex Disassembly	36	26.8
IV	Project Completion	24	0.3
	Total	95	40.0

8.3 Industrial Safety

An Industrial Hygienist and a Safety Engineer from the ANL-ESH Department will make periodic inspections of the work site during the project to ensure that the D&D activities conform to Health and Safety guidelines.

8.3.1 Nonradioactive Hazardous Materials

ANL-ESH Health Physics and Industrial Hygiene personnel and ANL-PFS Waste Management personnel will coordinate the handling of any nonradioactive hazardous materials encountered during the project. Insulating materials which contain asbestos fibers will be removed, packaged, tagged, and disposed of in accordance with state and federal regulations. Persons engaged in such work will be provided with protective clothing and NIOSH approved respiratory protection as prescribed by Industrial Hygiene.

8.3.2 Emergencies and Emergency Response Groups

Existing ANL-IL emergency plans and procedures will be reviewed with respect to project activities and where needed, project emergency procedures will be developed.

The hazard of fire is considered to be rather remote as the building itself is concrete or steel and the greatest majority of the reactor components are also metal. Therefore, by carefully controlling the combustible materials used during the D&D operations and by keeping them to a minimum, the potential for fire is greatly reduced. In the event of fire, smoke detectors in the shell will automatically notify the ANL Fire Department on a 24-hour-per-day basis and they are located less than a quarter of a mile from EBWR.

Onsite emergency medical treatment is available from the Health Department during normal working hours for all D&D personnel. In addition, ambulance service staffed by paramedic from the Fire Department is on-call for any incident that may occur.

8.4 Physical Security

Since the project is entirely located within the boundaries of the ANL-IL site, its physical security will be provided by Laboratory security forces. These security personnel control access to the Laboratory site and prevent unauthorized entry.

9.0 SCHEDULE AND COST

Barring unforeseen funding problems, the project will be carried out as a continuous D&D action without significant interruptions. As shown in Table 3 and in Figure 18, it is scheduled to be accomplished in four phases over a period of 95 months at an estimated total cost of $14,300,000. This figure includes maintenance and surveillance costs over the term of the project.

Table 3. EBWR D&D Project Cost Estimate

Phase	Work Description	Cost (In Thousands)
I	Preparatory Work	1,255
II	EBWR Disassembly (Except Reactor Vessel Complex)	2,615
III	Reactor Vessel Complex Disassembly	5,700
IV	Miscellaneous Decontamination, Clean-up and Project Close-out	4,730
	Total	14,300

10.0 ENVIRONMENTAL ISSUES

An Action Description Memoranda (ADM) covering the D&D of the EBWR for DOE review was prepared in May 1985, and revised in December of 1985. The ADM considered both radiological and nonradiological aspects of the project's impact upon the environment and concluded that no adverse effects would result. A finding of no significant impact was issued by the Office of Remedial Action and Waste Technology, Office of Nuclear Energy on February 24, 1986, and it further stated that neither an environmental assessment nor an environmental impact statement was required.

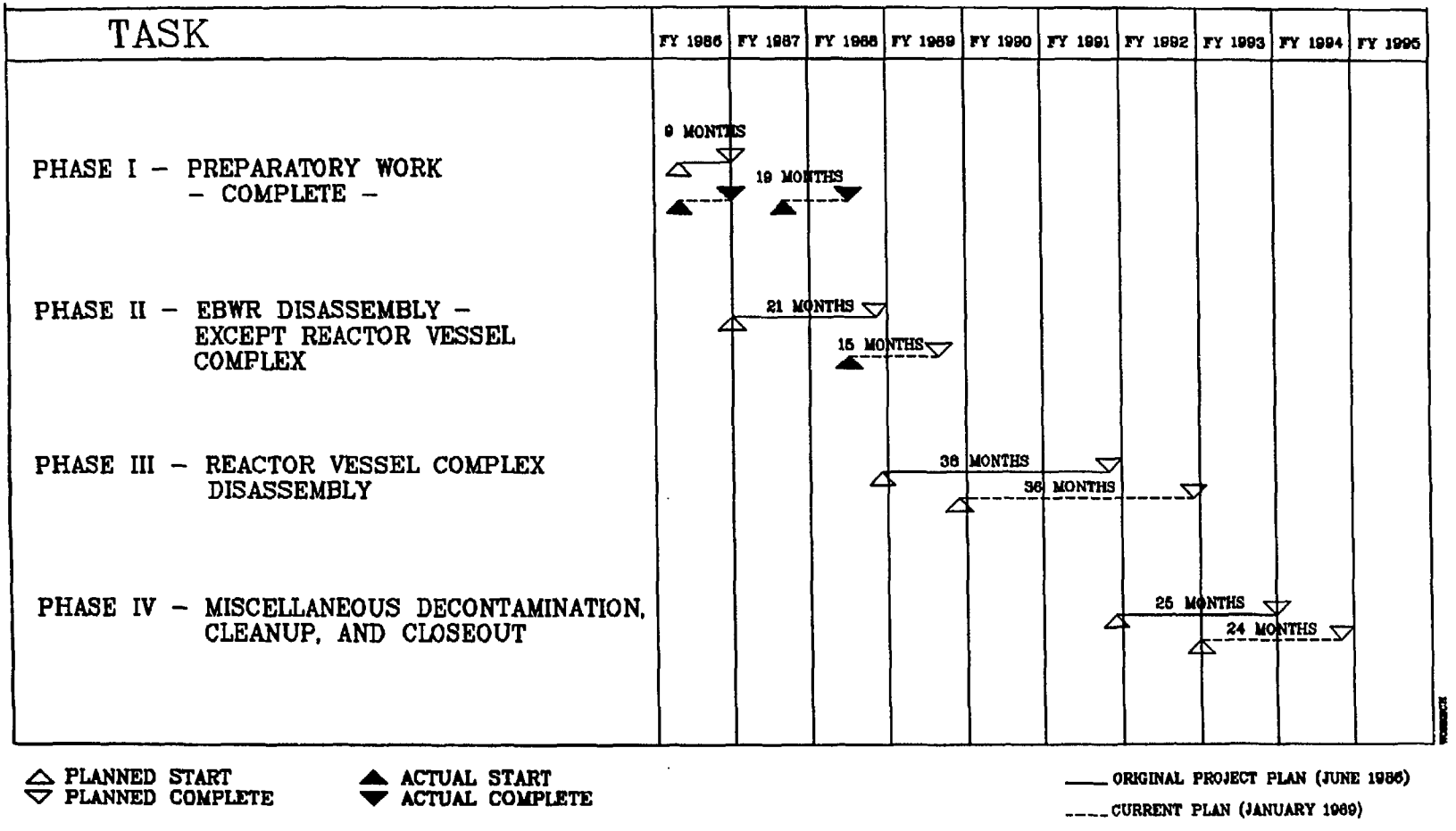

Fig. 18. Planned vs. Actual Work Schedule for EBWR D&D Project

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