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(Fifth Volume of ORNL/NSIC-55)
NRC-1

**DESIGN DATA
and
SAFETY FEATURES
of
COMMERCIAL
NUCLEAR POWER PLANTS**

Fred A. Heddleson

NUCLEAR SAFETY INFORMATION CENTER

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Nuclear Safety Information Center

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DESIGN DATA AND SAFETY FEATURES
OF
COMMERCIAL NUCLEAR POWER PLANTS

Vol. V

Fred A. Heddleson
Reactor Division

JUNE 1976

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FOREWORD

The Nuclear Safety Information Center (NSIC), which was established in March 1963 at Oak Ridge National Laboratory, is principally supported by the U.S. Nuclear Regulatory Commission's Office of Nuclear Regulatory Research. Support is also provided by the Division of Reactor Research and Development of the U.S. Energy Research and Development Administration. NSIC is a focal point for the collection, storage, evaluation, and dissemination of safety information to aid those concerned with the analysis, design, and operation of nuclear facilities. A system of key words is used to index the information cataloged by the Center. The title, author, installation, abstract, and key words for each document reviewed are recorded at the central computing facility in Oak Ridge. The references are cataloged according to the following categories:

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7. Fission Product Release, Transport, and Removal
8. Sources of Energy Release under Accident Conditions
9. Nuclear Instrumentation, Control, and Safety Systems
10. Electrical Power Systems
11. Containment of Nuclear Facilities
12. Plant Safety Features - Reactor
13. Plant Safety Features - Nonreactor
14. Radionuclide Release and Movement in the Environment
(inactive September 1973)
15. Environmental Surveys, Monitoring, and Radiation Exposure
of Man (inactive September 1973)
16. Meteorological Considerations
17. Operational Safety and Experience
18. Safety Analysis and Design Reports

19. Radiation Dose to Man from Radioactivity Release to the Environment (inactive September 1973)
20. Effects of Thermal Modifications on Ecological Systems (inactive September 1973)
21. Effects of Radionuclides and Ionizing Radiation on Ecological Systems (inactive September 1973)

Computer programs have been developed that enable NSIC to (1) operate a program of selective dissemination of information (SDI) to qualified individuals according to their particular profile of interest, (2) make retrospective searches of the stored references, and (3) produce topical indexed bibliographies. In addition, the Center staff is available for consultation, and the document literature at NSIC offices may be examined by qualified personnel. These services are free of charge to the sponsoring agencies and their contractors and are available at cost to other organizations. NSIC reports (i.e., those with the ORNL-NSIC numbers) may be purchased from the National Technical Information Service (see inside front cover). Persons interested in the availability of any of the services offered by NSIC should address their inquiry to:

J. R. Buchanan, Assistant Director
Nuclear Safety Information Center
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DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS

Vol. V

ABSTRACT

Design data, safety features, and site characteristics are summarized for 34 nuclear power units in 17 power stations in the United States. Six pages of data are presented for each plant, consisting of thermal-hydraulic and nuclear factors, containment features, emergency-core-cooling systems, site features, circulating water system data, and miscellaneous factors. An aerial perspective is also presented for each plant. This volume covers Light Water Reactors (LWRs) with docket numbers 50-508 through 50-549, four HTGRs - 50-171, 50-267, 50-450/451, 50-463/464, the Atlantic Floating Station 50-477/478, and the Clinch River Breeder 50-537.

INTRODUCTION

The data summaries for this report were taken from the Preliminary Safety Analysis Reports (PSARs) and the Environmental Report generated for the U.S. Nuclear Regulatory Commission licensing authorities by applicants wishing to build and operate nuclear power plants. The PSAR and Environmental Report sometimes contain as many as 9000 pages of information presented in 22 volumes which describe the reactor, reactor site, power generation system, auxiliaries, and other aspects of importance in the safety assessment of reactor design, fabrication, construction, and operation. Unless a person is familiar with the organization of the reports, finding specific information therein can be very time consuming. Even when the organization is understood, it can still be difficult to find data because of variations in the style of the reports. This compilation of summary data is intended to make the more important information readily available.

The U.S. Nuclear Regulatory Commission has issued a guide for organization of material which is generally followed for PSARs and FSARs. The

suggested organization is as follows:

- I. Introduction and General Description of the Site
- II. Site Characteristics
- III. Design of Structures, Components, Equipment, and Systems
- IV. Reactor
- V. Reactor Coolant System
- VI. Engineered Safety Features
- VII. Instrumentation and Controls
- VIII. Electric Power
- IX. Auxiliary Systems
- X. Steam and Power Conversion System
- XI. Radioactive Waste Management
- XII. Radiation Protection
- XIII. Conduct of Operations
- XIV. Initial Tests and Operations
- XV. Safety Analysis
- XVI. Technical Specifications
- XVII. Quality Assurance

In 1967, the Advisory Committee on Reactor Safety (ACRS) requested that the Nuclear Safety Information Center (NSIC) compile design data on light-water power reactors in a concise tabular format for their use. Since that time, reports have been prepared for each power reactor and made available on a limited distribution basis to ACRS, several Headquarters offices, and the NSIC staff. The data summaries, which contain over 200 of the more important nuclear power plant facts, have proved to be quite useful to these groups, and numerous requests have been received for summaries from other organizations that became aware of their existence. These summaries are now issued in report form in order to make this information more widely available.

Volume II, published in January 1972, covered commercial power reactors with docket numbers 50-296 (Browns Ferry No. 3) through 50-395 (Virgil Summer). Volume I (December 1973) covered power reactors up to and including docket 50-295 (Zion Station). Volume III covered reactors with docket numbers 50-397 through 50-449. Volume IV covered plants from

Greenwood (50-452 and 50-453) to Koshkonong (50-502 and 503). This volume (V) covers plants from WPPSS (50-508, 509) to Greene Valley (50-549) plus other reports on High Temperature Gas Cooled Reactors - Peach Bottom No. 1 (50-171), Fort St. Vrain (50-267), Summit (50-450, 451), Fulton (50-463, 464), and a report on the Clinch River Breeder Reactor (50-537). Until recently, these summary reports covered only Light Water Reactors, but the others are now included to provide reports on all USA nuclear power plants. In the index by sequential docket number, some numbers are missing; these docket numbers are for experimental and export reactors, and/or reactors for which the application was withdrawn.

ORGANIZATION OF INFORMATION

Reactor summaries appear sequentially according to docket number. The format for the summaries is as follows:

- A. General - Plant name, location, utility, designers and builders.
- B. Site Data - Site description giving pertinent facts, plus nearby body of water, topography, population, land use, and meteorology facts.
- C. Containment and Structures - Design values, type of containment structure, heat removal systems, and safety features.
- D. Reactor Coolant - Pressure vessel data, leak detection system, etc.
- E. Thermal-Hydraulic and Nuclear - Tabulations of data values.
- F. Emergency-Core-Cooling Systems - Descriptions of the different types of injection systems, giving capacities and numbers of pumps, etc.
- G. Miscellaneous - Descriptions of residual heat removal system, radwaste system, plant vent, emergency power, emergency plans, and environmental monitoring.
- H. Circulating Water System - Descriptions of intake, discharge, cooling towers, water body data, and flow quantities.

Facing the first page of data for each summary is an aerial perspective sketch of the plant.

All parameters are related to rated power output for a single reactor unit unless otherwise noted. For instance, where the reactor report covers two or three reactors of the same rating at one site, all data values given

will be for one unit. The aerial perspective sketch presents a graphic description of the reactor and site features. The terms and features used in the sketch are explained in Fig. 1. In some cases, the size of the reactor building and turbine building on the sketch has been increased over true size to better show their relationship to the site.

ACCURACY OF DATA

All information presented in this publication was taken from the PSARs, the applicant's Environmental Report, or the Environmental Impact Statement. In view of the many changes that may be made in plant design and/or operating conditions in the course of the licensing and subsequent operation of nuclear power plant, the author cannot guarantee the accuracy of all the information herein. However, if readers are aware of information which is not correct, NSIC would like to be informed.

GLOSSARY OF TERMS

The following terms and abbreviations are used in the data summaries in this report. This glossary is provided to assist the user in understanding the context in which the terms are applied and to identify the abbreviations.

A-E - Architect-engineer for the plant. Sometimes the firm serves as consultants to the utility who do their own design and drafting.

Accumulator Tanks - Tanks that contain borated water under pressure (usually about 600 psig) for injection into the primary system of a PWR in the event of a loss-of-cooling accident. When coolant system pressure drops to tank pressure, check valves open allowing water flow that will flood the core.

Active Heat Transfer Surf. Area - The surface area of all fuel rods, measured on the active fuel portion of the rods.

Auto-Depressurization System - The system that uses pressure relief valves to vent steam to purposely lower reactor pressure so other core cooling systems can operate.

Fig. 1. Explanation of terms for site sketch

Average Discharge Exposure, MWD/Ton — Average burnup of fuel upon removal from service, expressed in megawatt days per metric ton of fuel.

Avg. Film Coeff. — An average over the active core of the convective film heat-transfer coefficient h , defined from $Q/A \Delta t_{lm} = h$, where Q is the heat removed per unit time from fuel surface area A and Δt_{lm} is the log-mean temperature difference between the coolant and the surface.

Avg. Film Diff. — The average difference between the local coolant bulk mean temperature and the local fuel clad surface temperature.

Avg. Power Density — The power generated in the active core divided by the core volume.

Average Power Range Monitor (APRM) — Selected amplifiers from the local Power Range Monitoring (LPRM) system are averaged in the APRM.

Blowdown — The quantity of water bled off from the cooling tower collection basin to rid the towers of progressive buildup of dissolved solids. Makeup water to the system replaces blowdown.

BWR — Boiling water reactor.

Burnable Poison — Neutron absorbing materials of relatively high microscopic absorption cross section which are converted to low absorption isotopes by neutron absorption and which are incorporated into reactors to compensate for part or all of the reactivity decrease that would otherwise result from fuel exposure.

Chemical Shim — Supplementary control of the core reactivity by the use of chemical poisons (such as boric acid) in the coolant.

Clean — The reactor and/or fuel elements are said to be clean if fuel elements are nonradioactive and uncontaminated by the products of nuclear reaction.

Closed-Loop Cooling — Operation of the circulating water system so that water is circulated within a closed loop for condensing steam in the condenser and cooling the water in cooling lakes, cooling towers, or other heat sinks.

Circulating Water System - An arrangement of pipes, valves, controls, and pumps that circulate water through the main turbine-condenser (to condense steam in the condenser) and the ultimate heat sink (cooling lake, cooling towers, etc.) where the heated water is cooled. This can be open-cycle cooling or closed-loop cooling (see definition).

Cold - At ambient temperature.

Containment Atmospheric Control System - A system used to inject nitrogen into containment for inerting. Other aspects of atmospheric control listed as applicable.

Containment Constructor - The contracting firm which erects or fabricates the primary containment structure. In most cases, the actual contractor's name is not available. In these cases, the responsible party such as the utility or A-E will be given.

Containment Cooling System - Spray cooling system for reducing dry well pressure following loss of coolant; or fan coil cooling units that recirculate the air.

Containment Isolation System - A system that provides the method for sealing all openings in the containment system. Each penetration has two isolation valves, one on the inside and one on the outside of the primary containment wall. In case of an accident, the isolation valves close automatically.

Control Rod - A device made of neutron absorbing material capable of being moved into or out of the core to regulate power.

Control-Rod-Drive Housing - Tube and flange attached to the reactor pressure vessel for the purpose of mounting and containing the control rod drives.

Control-Rod-Drive Housing Supports - Structural members located under the reactor vessel close to the control-rod-drive housing for the purpose of catching, supporting, and/or preventing excess movement of the control rod in case of a housing rupture.

Control-Rod Velocity Limiter - An integral part of a control rod mechanism which limits the free-fall velocity of a control rod.

Control-Rod Worth Minimizer - Electronic computing device which is used to monitor the control rod pattern in the reactor core. Interlocks are provided which prevent the withdrawal of a control rod with a worth above the established value.

Core Average Void Within Assembly - The percent of voids in the coolant within a fuel assembly.

Core Reflooding System - High-flow system to rapidly flood the reactor core following loss of coolant.

Core Spray System - A water system, activated in the event of loss of core cooling, which sprays water on the top of the core to remove reactor core decay heat (used on BWRs only).

Critical Heat Flux - The heat flux at which transition film boiling starts to replace nucleate boiling. It is characterized by an abrupt change in surface heat transfer coefficient.

Curtain Worth - The reactivity worth of the poison curtain.

Design Basis Earthquake - That earthquake which produces the vibratory ground motion for which those features of the plant necessary to shut down the reactor and maintain the plant in a safe condition without undue risk to the health and safety of the public are designed to remain functional.

Design Criteria - A list of requirements of the U.S. Atomic Energy Commission (now NRC) that govern reactor design.

Discharge Structure - The means of discharging water into the lake, river, ocean, or cooling pond. It can be very simple, such as a short canal running into the water body, or it can be a complex diffuser system that disperses the water through many openings or jets.

Docket No. - The number assigned by the Directorate of Licensing to a particular reactor when the PSAR is accepted for review.

Doppler Coefficient - The reactivity change due to Doppler broadening of ^{238}U resonance absorption cross section as a result of a change in temperature.

DNBR, Nominal - Departure from nucleate boiling ratio, the minimum value of the ratio of heat flux required for DNB as calculated from the Westinghouse correlation (W-3) divided by the local heat flux in the fuel element.

Drywell - Vessel enclosing the reactor primary system and forming part of the primary containment system of a BWR.

Eff. Flow Area for Heat Transfer - The total effective cross-sectional area of the fuel channels through which the water flows through the core.

Eff. Flowrate for Heat Transfer - That portion of the coolant flow that passes directly through the active core for cooling the fuel elements.

Emergency Power - Electrical power supplied to equipment that must operate in an emergency; usually supplied by diesel-generator sets if off-site power supply is lost. Emergency alternating current is available for engineered safety features and other necessary equipment.

Engineered Safety Features (ESF) - Special systems designed to operate in a nuclear power plant so as to prevent or mitigate the consequences of an accident. Engineered safety features include containment vessels, containment sprays, filter systems, emergency-core-cooling systems, scram system, etc.

Environmental Monitoring - Collection and analysis of samples of the environment (air, water, soil, aquatic life, terrestrial, etc.) to evaluate effects that might result as a consequence of plant operation.

Evaporative Loss - The loss of water from the cooling tower that evaporates into the cooling air that passes through the cooling tower. This water is continuously replaced by the makeup water system.

Exclusion Distance - The distance from the center line of the reactor to the nearest exclusion fence boundary.

Flow Restrictor - A static device placed in a steam or water line for the purpose of restricting the blowdown rate in the event of a major line break. The device affords protection for the core, reduced load on the containment system, and additional time for the initiation of the emergency systems.

Fuel Assembly - Assembly of fuel rods, spacers, and related hardware.

Fuel Channel - An open space in the core structure into which the fuel assembly is inserted that provides a coolant flow path through the assembly.

Fuel Element - See Fuel Assembly.

Fuel Rods - Assembly of fuel pellets, fuel cladding, and related hardware welded into a sealed unit.

Fuel Rod Cladding - The material enclosing the UO_2 fuel pellets.

Full Power Xe and Sm - The equilibrium concentrations of the Xenon and Samarium poisons present at full power.

Heat Dissipated to Environment - The quantity of heat ejected to a nearby body of water by discharging quantities of heated water into that water body; or the dissipation of heat to the atmosphere by cooling towers.

High-Head Safety Injection System - See High-Pressure Coolant-Injection System.

High-Pressure Coolant-Injection System - High-pressure pumps, valves, piping, etc., used to provide emergency core cooling in the event of failure of a small process line.

Hot - At temperatures corresponding to full-power operation.

Hydrogen Recombiner - Equipment that combines free oxygen and free hydrogen to produce water. The purpose is to eliminate free hydrogen from the gaseous systems.

Intake Structure - The structure that houses circulating pumps, traveling screens, bar screens, and other devices used in moving water from the water source to the plant. In some cases, the intake structure will include the pipes that run out into the water body and the remote structure for intake.

Isolation Cooling System - High-pressure system for rejection of core decay heat when the reactor is isolated from the main condenser.

k_{eff} - The effective multiplication constant of the core.

LOCA - Loss-of-coolant accident.

Local Power Range Monitor (LPRM) - In-core ion chambers for monitoring local neutron flux in the reactor core.

Low-Head Safety Injection System - See Low-Pressure Coolant-Injection System.

Low-Pressure Coolant-Injection System - A system of pumps, valves, piping, etc., that pumps quantities of water into the coolant system to reflood the core after blowdown.

Low Population Zone Distance - The radius that circumscribes an area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of serious accident.

MCHFR - See Minimum Critical Heat Flux Ratio.

MTU - Metric ton of uranium. One metric ton = 1000 kg = 2205 lb.

MWD - Energy in megawatt-days.

Main Steam Lines - Piping which passes steam from the reactor of a BWR or from the steam generator of a PWR to the turbine.

Max. Prob. Flood Level - The maximum hypothetical elevation at the site to which water could rise in case of the most severe rain, with the most severe winds, with bursting dams, etc.

Metropolis - The nearest city to the plant that is classified as a U.S. city with Standard Metropolitan Statistical Areas as compiled from the Bureau of the Census by the World Almanac. Population figures are the 1970 total metropolitan area census.

Minimum Critical Heat Flux Ratio (MCHFR) - The smallest ratio of critical heat flux divided by the local heat flux existing in the reactor core at any point in time.

Moderator Coefficient - A combination of moderator void coefficient and moderator temperature coefficient.

Moderator Pressure Coefficient - The change in core reactivity per unit change in moderator pressure.

Moderator Temperature Coefficient - The change in core reactivity level for a unit temperature change in the moderator.

Moderator Void Coefficient - The change in the core reactivity level for a unit change in moderator void content.

NSS Vendor - Supplier of the nuclear steam supply system.

Normal Level - Normal pool elevation in mean sea level (MSL) measurement of the body of cooling water.

Once Through - The cooling cycle where water is removed from the nearby water source, pumped through the condenser for cooling and then discharged back into the river, lake, or ocean.

Open-Cycle Cooling - The system that uses water in the circulating system for once-through cooling. Water is taken from the river, lake, or ocean and used to cool the condenser. It is then discharged back to the same body of water with the added heat.

Operating Basis Earthquake - That earthquake which produces the vibratory ground motion for which those features of the plant necessary for continued operation without undue risk to the health and safety of the public are designed to remain functional.

PWR - Pressurized-water reactor.

Peak Enthalpy on Rod Drop - Melting of UO_2 occurs between 220 and 280 cal/g, and fuel rod rupture will occur about 400 cal/g. Thus the 280 cal/g, which represents a safe condition for the fuel, is usually set as the peak enthalpy value acceptable during a power excursion that could occur in a rod drop accident.

Peaking Factor - A term used with heat flux where the peaking factor is the maximum value divided by the average value, whether it be along a fuel rod or radially in the core.

Penetration — A pipe or sleeve which penetrates the containment wall — pipes for flow of fluids, steam, or gases, and special sleeve-plugs for electrical distribution.

Percent Enrichment — Atoms of uranium 235 per 100 atoms of a uranium mixture of ^{235}U and ^{238}U . This quantity may also mean atoms of fissionable nuclide per 100 atoms of metal fuel mixture.

Plant Operating Mode — The manner in which the controls operate the plant, either changing reactor power to match changing electrical load patterns (load-following), or maintaining a constant electrical output from the generator (base-loaded).

Prevailing Wind Direction — The direction from which the wind usually blows.

Primary Containment (System) — Housing for the reactor primary system designed to prevent the release of radioactive materials to the environment in the remote event of accident. In a BWR, the system includes the dry well, the pressure-suppression pool contained in the torus, and the vent pipes. The pool provides a heat sink for rapid reduction of pressure following a loss-of-coolant accident. In a PWR, the containment system includes the containment vessel, its isolation system, and the spray system which cools the atmosphere and reduces the pressure.

Protective System — The instrumentation system which handles all functions of control relative to operation of engineered safety features or other equipment or functions designed for protection of the plant.

Radwaste — Contraction of the words "radioactive" and "waste," used to describe waste substances which may contain radioactive materials.

Radwaste System — System for handling, treating, or storing solid, gaseous, or liquid wastes which contain radioactive materials.

Reactor — The pressure vessel, the pressure vessel internals, and the control rod drives in which the fission process occurs. In power reactors the fission energy is removed from the reactor by a fluid system which utilizes the energy.

Reactor Building — A nominally leak-tight housing for the reactor, reactor auxiliary systems, and the primary containment system, generally referred to as secondary containment.

Reactor Core Isolation Cooling System (RCICS) — Provides core cooling in case the reactor is isolated from its normal heat sink. It is also used in case of loss of flow from the feedwater system and during shutdown by pumping makeup water into the reactor vessel.

Recirculation Flow Control — Provides regulation of the reactor forced cooling flow, which can be used for power regulation.

Residual-Heat-Removal System (RHRS) — A system of pumps, heat exchangers, valves, piping, and controls that function to move residual heat from the reactor core, the suppression pool, or the containment atmosphere.

River Flow — The average flow past the site in cubic feet per second.

Rod-Block Monitor — This subsystem hinders control rod withdrawal errors to prevent fuel damage. Two RBM monitoring channels are provided. Output signals from selected groups of low-power-range monitoring (LPRM) subsystem amplifiers are averaged to control rod movement. A computer system performs the averaging function.

Secondary Containment — Reactor building which is designed for low leakage in order to function as containment for reactor refueling operations and as a backup containment during power operation or hot standby.

Seismograph — An instrument used for the measurement of vibration, of particular interest in measuring ground motion and/or building motion due to an earthquake; sometimes called a strong motion accelerometer.

Service Water System — System which supplies process water for cooling purposes throughout the plant for other than the main condenser cooling.

Shutdown — A condition of the reactor in which the core is subcritical and power is not being generated (except that which might originate from afterheat).

Shutdown boron — The grams of boric acid H_3BO_3 per million grams of water required to achieve some desired subcritical reactivity level. Also may be given as grams of boron per million grams of water.

Shutdown Margin - Representative of the amount of reactivity which would have to be added to a subcritical reactor to achieve criticality.

Site - Land area location for a power station.

Standby Coolant System - A supply of cooling water that is available in case of emergency. A supply that is not normally used for the core cooling function. This supply is sometimes available by a cross connection between two or more cooling systems.

Standby Gas Treatment System - Special ventilation system for the reactor building. The system is used if radioactive materials are present in the reactor building. Air from the reactor building is removed, purified, and routed to the vent.

Standby Liquid Control System - A redundant control system for shutting down the reactor in the unlikely event that the normal control system is inoperable. Liquid poison is pumped into the reactor to provide the negative reactivity to assure subcriticality.

Supprn Chamb - Suppression Chamb .

Suppression Chamber - The part of the pressure suppression system which contains the suppression pool to condense steam upon LOCA to minimize pressure buildup in the primary containment system of a BWR.

Suppression Chamber Cooling System - Cooling system for reducing suppression pool temperatures and torus pressure following a loss-of-coolant accident in a BWR.

Temporary Control Curtain - Burnable poison sheets placed in a new core to compensate for the excess reactivity associated with the initial core. All or any number of the curtains are removable, usually during refueling, when the reduction in reactivity in the core or region thereof makes the control provided by the curtains unnecessary.

Thermal Output - Thermal heat energy output of the reactor.

Total Flow Rate - Quantity of coolant flow through the reactor.

Total Heat Output for Safety Design - The value of heat output for the core used in accident analysis.

Total Peaking Factor — The product of the individual peaking factors. This assumes each peaking factor is effective simultaneously and is therefore a maximum estimate.

Total Rod Worth, Percent — $100 \times$ the change in the multiplication constant from the most reactive configuration of the control rods to the least reactive configuration divided by k_{eff} . In some places it may be expressed in terms of that value of k_{eff} which the rods will hold just critical.

Turbine Orientation — The direction of the turbine center line with respect to the center line of the reactor. The interest is in the possibility of ejected turbine blades being missiles that could strike or penetrate the containment.

Unborated Water Control — Aspects of boron dilution control, i.e., reduction of boron concentration in the coolant. See Chemical Shim.

Variable-Cycle Cooling — Both towers and once-through cooling are combined and used in a variable manner, depending upon limitations on heat rejection to a river, lake, etc.

Vessel Vendor — Supplier of the reactor vessel.

DOCKETS

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A. GENERAL**PROJECT NAME:** Peach Bottom Atomic Power Station**LOCATION:** York Co. in SE Pennsylvania, 38 mi. NE of Baltimore**OWNER:** Philadelphia Electric Co.**OWNER'S ADDRESS & CONTACT:** Philadelphia Electric Company2301 Market Street
ARCHITECT/ENGINEER: Bechtel Philadelphia, Pa 19101**REACTOR MANUFACTURER:** Gulf General Atomics**CONTAINMENT CONSTRUCTOR:** Bechtel**TURBINE MANUFACTURER:** Westinghouse**DATE:** February 1976**COMPILED BY:** Fred Heddleson**ESTIMATED STARTUP DATE:** 1967**NUCLEAR SAFETY INFORMATION CENTER****B. SITE DATA**

Site Description: Located on the Conowingo Pond of the Susquehanna River. The river here is characterized by deep, narrow valleys. Within 20 miles there are 2 hospitals, Bainbridge Naval Training Station, Aberdeen Proving Ground, and The Army Chemical Center. All land along Conowingo Pond is owned by Philadelphia Electric or their subsidiaries. The nearest communities are Delta, Pa, and Cardiff, Md. about 4 mi SW. The plant is located on a moderately wooded, gentle slope near where Rock Run Creek discharges into the reservoir. US hwy #1 intersects Md. St Route #136 about 9 mi S. A railroad spur from the Maryland and Pennsylvania railroad runs to the site from the W. The nearest house is 3200 ft SE. The Pennsylvania-Maryland line is 2 1/2 mi S.

Nearby Body of Water: Conowingo	Normal Level 109' (MSL)
Pond of the Susquehanna R.	Max Prob Flood Level 134' (MSL)

Size of Site 620	Acres	Site Grade Elevation 115' (MSL)
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Topography of Site: Rolling to Hilly**of Surrounding Area (5 mi rad):** Rolling to Hilly**Total Permanent Population:** In 2 mi radius 502 ; 10 mi 25,998**Date of Data:** 1970 In 5 mi radius 5959 ; 50 mi 4,359,531**Nearest City of 50,000 Population:** Lancaster, Pa**Dist. from Site** 19.4 **Miles, Direction** N, **Population** 57,690**Land Use in 5-Mile Radius:** Agricultural and wooded

Meteorology: Prevailing wind direction Variable Avg. speed 4 mph
Stability Data - Stable dispersion ~30% of time.

Meteorological Measurements - Data collection started in 1959.

B. SITE DATA (Continued)			REACTOR: PEACH BOTTOM #1	
Exclusion Distance, Miles		0.57	Design Winds in mph:	
Low Population Zone Distance, Miles		17.9	At 0 - 50 ft elev 100	
<u>Metropolis</u>	<u>Distance</u>	<u>Population</u>	50 - 150 ft 120	
Baltimore, Md	35 mi	2,070,670	150 - 400 ft 140	
Safe Shutdown Earthquake Acceleration, g (Design Basis)		0.05	Tornado NA	
Operating Basis Earthquake Acceleration, g		NA	$\Delta P = \text{--- psi/---sec}$	
Earthquake Vertical Shock, % of Horizontal		NA		
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig		8	Free Volume, cu ft 800,000	
Calculated Max Inter- nal Pressure, psig Equilibrium		8	Max Leak Rate at Design Pressure, %/day 0.2	
<p><u>Type of Construction:</u> A vertical, capsule-shaped, cylindrical steel shell with dished top and bottom heads. After the lower portion is constructed which will be below grade, internal concrete structures will be poured. After all concrete is in place, the upper part of the containment shell will be constructed.</p>				
<p><u>Design Basis:</u> To contain fission products so that leakage even under accident conditions, will not cause releases in excess of agency regulations.</p>				
<p><u>Vacuum Relief Capability:</u> Designed for 0.2 psig negative pressure.</p>				
<p><u>Post-Construction Testing:</u> Pressure testing will be performed after the containment structure is complete. Following the pressure test, a leakage rate test will be conducted at design pressure to verify that leakage is within design limits.</p>				
<p><u>Penetrations:</u> Stainless steel expansion joint used on hot pipes. Electrical penetrations are sealed.</p>				
<p><u>Weld Channels:</u> Seams will be soap bubble tested with a vacuum box. Radiographs will be taken as required by the code.</p>				

C. CONTAINMENT & STRUCTURE (Contd) REACTOR: PEACH BOTTOM #1

Containment Air Filtration: The containment atmosphere is a low oxygen concentration supplied from a liquid nitrogen storage tank. Some air is filtered, cooled and recirculated or can be exhausted thru the vent stack. Another system exhausts air from the Air Room, filters it and exhausts thru the stack.

Containment Cooling: Three fan-coil units with circulating fans cool the containment atmosphere. Each of these units cools air from a containment cavity such as #1 Primary Loop Cavity, #2 Primary Loop Cavity, and the Fission Product Trap Cavity.

Fuel Storage and Handling: Equipment includes a fuel transfer machine, a charge machine, a fuel element canning machine, a pickup cell and a viewing system. A gas purge fills the equipment with clean helium and removes contaminated helium. A storage pit is available for storage of spent fuel. New fuel, when received, is in sealed cans, assembled, and ready for insertion into the reactor.

Strong Motion Accelerometer: Not applicable.

Turbine Orientation: Turbine and reactor are on the same centerline, so it is unlikely that ejected turbine parts could strike containment.

D. PRESSURE VESSEL AND STEAM SYSTEM

Reactor Vessel: Material A212 Gr B carbon steel
Height 35'-6 1/2" Average Diameter (ID) 14 ft

Core Cavity Height ~30 ft Average Core Cavity Diam 13'-7"

Minimum Vessel Wall Thickness 2 1/2"

Miscellaneous Cylindrical with elliptical heads - has two 42" nozzles which connect to coolant piping.

Steam Generator System: Two helium circuits, each containing one forced recirculation type steam generator, cool the helium from 1352 F to 622 F and generate 365,500 lb/hr of superheated steam at 1005 F and 1544 psig. Each steam generator is a vertical shell-tube type with separate economiser, evaporator and superheater sections in the same shell. Each steam generator connects to a steam drum, turbine, and recirculation pump. The recirculation pump is located in the steam drum downcomer.

Feedwater & Condensate: Feedwater enters the economiser at about 425 F and 1587 psig at full load. After heating in the economiser the feedwater enters the steam drum where it is mixed with the recirculating bulk water, and then pumped to the evaporator section. Condensate from the main condenser is pumped to 2 low-pressure horizontal U-tube closed feedwater heaters and then to the deaerating feedwater heater before it is pumped back through 2 high pressure feedwater heaters.

E. REACTOR CHARACTERISTICS		REACTOR: PEACH BOTTOM #1	
E1. THERMAL COOLANT FLOW DESIGN		E2. NUCLEAR DESIGN	
Thermal Output, MWt	115	Avg 1st-Cycle Burnup, MWD/Tonne U + Th	Batch cycle 3 years
Electrical Output, MWe (net)	40	Average Burnup, MWD/Tonne U + Th	77,000
Total Heat Output, Safety Design, MWt	115	K _{eff} , Cold, No Power, Clean	0.95
Total Heat Output, Btu/hr	---	K _{eff} , Hot, Full Power Xe and Sm Equilibrium	1.05
Steam Flow Rate in Main, lb/hr	367,000	Total Rod Worth, Δk _{eff} (hot)	25%
Total Core Helium Flow Rate, lb/hr	440,000	Moderator Temp Coeff, $\times 10^{-5} \Delta k/^{\circ}C$	(-2.4 to -0.8)
Helium Core Press In/Out, psia	2.7 psi Core Δp	Doppler Coefficient, $\times 10^{-5} \Delta k/^{\circ}C$	-3.5
Helium Core Temp In/Out, $^{\circ}F$	654/1380	Min Shutdown Margin all Rods in	4% Δk
Core Heat Flux AVG	69,000	Carbon-to-Thorium Ratio	1727/5.44 cent. 3087/22.7 outer
Btu/hr-ft ² MAX	110,650	Carbon-to-Uranium (235) Ratio	1727/1 cent. 3087/1.0 outer
Maximum Fuel Temperature $^{\circ}F$	2730	Burnable Poisons, Type and Form	1.1 kg natural boron
Average Fuel Temperature $^{\circ}F$	1985	Number of Control Rods	36
Heat Transfer Area Coolant Hole, ft ²	708	Neutron Adsorber	Boron-Carbide
Core Effective Flow Area Ft	12.8% void, in core	Control Rod Cladding	Graphite
Avg Sur Heat Trans Coeff, Btu/hr-ft ² - $^{\circ}F$	230	Number of Graphite Fuel Elements	804
Average Core Power Density, kW/liter	8.3	Fuel Element Dimensions	3.5" dia x 144"lg
Max Power per Fuel Rod kW/ft	23	No. Fuel Rods Per Fuel Assembly	NA
Maximum Graphite Temperature $^{\circ}F$	~4200	Total Fuel Rods in Core	NA
Maximum Radial Power Peaking	1.24	Fuel Rod Diameter, inches	2.75 OD x 1.75 ID
Number of Coolant Loops	2	Fuel Particle FISSILE and Coating FERTILE	---
Miscellaneous:		Fuel Particle Matrix	BISO Core 2
		Uranium Charged to Initial Core, Kg	184.8 enriched + 173.3 U-235
		Thorium Charged to Initial Core, Kg	1987
		Outer region is last row of fuel elements at core reflector interface.	

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E3. HELIUM SYSTEMS	REACTOR: PEACH BOTTOM #1
<p>Primary Helium Coolant System: Consists of 2 helium compressors exterior to the reactor vessel and piping connecting the reactor vessel with the two steam generators. The steam generators and compressors are arranged to form 2 parallel loops. Helium flow in the reactor vessel is common to both loops. The purification system, described below, continuously cleans up the helium stream.</p>	
<p>Helium Purification System: A purge system removes helium continuously from the reactor and/or the coolant system. The gas is passed through charcoal traps for removal of radioactive contaminants. Gases are cooled before entering the charcoal traps. The cleaned-up helium is recycled.</p>	
<p>Helium Moisture Monitoring: Moisture detectors continuously sample the coolant helium stream at each steam generator to check for water leaks from steam generator tubes. There are 3 detectors for each steam generator so one false signal can be known. One leak level signals an alarm and the 2nd level shuts down the plant.</p>	
F. EMERGENCY SYSTEMS	
<p>Core Auxiliary Cooling System: Consists of a steel plate shroud surrounding the pressure vessel and a series of coils welded to the shroud. Water is circulated through the pipe coils. Coils are made up of several separate circuits each one supplied by a separate pipe from outside containment. Insulation covers the outside of coils and shroud.</p>	
<p>Backup Shutdown System: There are 19 electrically driven control rods that can be driven into the core even though the core is damaged or crushed.</p>	
G. MISCELLANEOUS	
<p>Decay Heat Removal System: During shutdown, heat is removed from the core and vessel by circulating water through the evaporator section of the steam generator to cool the helium flow circulated from the reactor. Water is cooled by the sub-boiling heat exchanger which has a capacity of $7 \cdot 10^7$ Btu/hr.</p>	
<p>Radwaste System: The helium purification system will collect much of the contaminants from the reactor vessel. Other filtering systems will filter gases before venting from the stack. Stack gases will be monitored to prevent release of activity exceeding regulated limits. Liquid wastes are minimal, but will be collected in tanks and processed. Liquids after treatment will be released into the circulating water system discharge. Solid wastes will be packed into shielded casks and shipped offsite for disposal.</p>	
<p>Plant Vent: A metal stack a few feet from the containment structure vents at a level slightly higher than top of containment.</p>	

G. MISCELLANEOUS (Continued) REACTOR: PEACH BOTTOM #1

Emergency Power: Equipment for emergency plant shutdown will be connected to a 440 volt bus arranged for normal power supply from the emergency diesel-generator which starts automatically when initiated by an undervoltage relay which senses loss of other plant electrical power.

Emergency Plans: Plans are formulated with public agencies so that Plant personnel receive instructions in emergency procedures and use of emergency equipment. Periodic training drills are held. Emergencies involving personnel, on or off-site, can be handled in an orderly, effective manner. Procedures include services of the State Police, the local fire department, a local hospital, and other public agencies. The above description was for Peach Bottom #2 and #3, and probably holds true for unit #1.

Environmental Monitoring: Survey started in 1960. Objective was to get quantitative data on radioactivity in the vicinity of the plant prior to operation. The program of sampling is still going on. Sampling stations are used to monitor materials in the food chain of both animals and humans. Samples are taken for background gamma, airborne particulate, water, milk, vegetation, aquatic biota, fish, shellfish, small game, soil, and silt.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Conowingo Pond

Intake Structure: Located on the bank along Conowingo Pond and housing 1 vertical, axial flow pump. Water enters the structure thru a bar screen and then thru a traveling screen. An intermittently operated chlorine system is provided for water treatment.

Water Body Temperatures: Winter minimum 34 °F; Summer maximum 80 °F

River Flow 1400 (cfs) minimum; 36,200 (cfs) average

Service Water Quantity 5000 gpm/reactor

Flow Thru Condenser 50,000 (gpm)/reactor Temp. Rise 12 °F

Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser --- (Btu/hr)/reactor

Discharge Structure: Water from the condenser is piped in a 5 ft dia. pipe to the pond and discharges into the pond about 200' out from shore.

Cooling Tower(s): Description & Number -- None

Blowdown --- gpm/reactor Evaporative loss --- gpm/reactor

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NUCLEAR SAFETY INFORMATION CENTER

A. GENERAL

PROJECT NAME: Fort St. Vrain Nuclear Generating Station
 LOCATION: North Central Colorado in Weld County, 35 mi N. of Denver
 OWNER: Public Service Co. of Colorado
 OWNER'S ADDRESS & CONTACT: R.F. Walker, Vice-Pres. Engg. & Planning
 P. O. Box 840
 ARCHITECT/ENGINEER: Sargent & Lundy Denver, Colorado 80201
 REACTOR MANUFACTURER: Gen. Atomics
 CONTAINMENT CONSTRUCTOR: G. A.-Ebasco
 TURBINE MANUFACTURER: --- DATE: December 1975
 ESTIMATED STARTUP DATE: 1975 COMPILED BY: Fred Heddleson
 NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Located on a flat plain between S. Platte River and St. Vrain Creek. These two streams flow together about two miles N. of the plant. Water for the plant is taken from both streams. The Rocky Mountains rise up about 20 miles west. Union Pacific R.R. is adjacent to the W. boundary from which a spur serves the site. I-25 runs N-S about 6 mi W, and US 85 runs N-S about 3 mi E. A farm road runs thru the west side of the site, forming one side of the exclusion area. Nearest permanent residence is 2300 ft N. It is intended that farming continue around the plant exclusion area. Platteville is the nearest town (pop about 600) about 3.5 mi SE. Greeley (38,900) is the nearest population center about 14 mi NW. Denver, nearest metropolitan area, is 35 mi S and easily accessible by I-25 and US 85. Water in this area is scarce and any water taken from streams must be allotted by the Colorado Water Commission.

Nearby Body of Water: South Platte Normal Level ~4760 (MSL)
 River and St. Vrain Creek Max Prob Flood Level 4778' (MSL)

Size of Site 2238 Acres Site Grade Elevation 4790' (MSL)

Topography of Site: Flat
of Surrounding Area (5 mi rad): Flat to Rolling

Total Permanent Population: In 2 mi radius 150 ; 10 mi 8456

Date of Data: 1970 In 5 mi radius 1987 ; 50 mi ---

Nearest City of 50,000 Population: Denver (1970)

Dist. from Site 35 Miles, Direction S, Population 514,000

Land Use in 5-Mile Radius: Agricultural

Meteorology: Prevailing wind direction SW A. speed ~6 mph
Stability Data - Winds of 2 mph or less occur only ; of time.

Meteorological Measurements - A 202' tower used for data collection beginning Nov. 1966.

B. SITE DATA (Continued)			REACTOR: FORT ST. VRAIN	
Exclusion Distance, Miles	1 mile square		<u>Design Winds in mph:</u> At 0 - 50 ft elev 100 50 - 150 ft 120 150 - 400 ft 140 Tornado 300 mph $\Delta P = .3 \text{ psi} / 3 \text{ sec}$	
Low Population Zone Distance, Miles	About 1 mile			
<u>Metropolis</u>	<u>Distance</u>	<u>Population</u>		
Denver	35 mi.	1,227,529 (1970)		
Safe Shutdown Earthquake Acceleration, g	0.10			
Operating Basis Earthquake Acceleration, g	0.05			
Earthquake Vertical Shock, % of Horizontal	66			
C. CONTAINMENT AND STRUCTURES				
Design Pressure,	10 in. w.g.		Free Volume,	---
Calculated Max Inter- nal Pressure, psig	slightly over atmospheric		Max Leak Rate at Design Pressure, %/day	1000 at 1/4" wg
<u>Type of Construction:</u> Reactor building is 120' x 76' x 170' high. It is of steel frame construction enclosed with insulated metal panels composed of a colored, fluted exterior sheet with insulation and an interior sheet. Appropriate construction joints and seals restrict leakage. Roof of the building consists of galvanized steel decking with insulation and built-up gravel-surface roofing. Overpressure protection is provided by a series of moveable louvers which open as vents.				
<u>Design Basis:</u> Building is not really classed as minimum leakage containment but is designed to provide weather protection serving as an enclosure in which an appropriate working environment is maintained.				
<u>Vacuum Relief Capability:</u> Found no reference, however, building design permits sufficient in-leakage to preclude any considerable negative pressure.				
<u>Post-Construction Testing:</u> Not applicable for pressure test or leakage rate tests.				
<u>Penetrations:</u> Not applicable				
<u>Weld Channels:</u> Not applicable.				

C. CONTAINMENT & STRUCTURE (Contd) REACTOR: FORT ST. VRAIN

Containment Air Filtration: Ventilation system holds reactor building pressure slightly below atmospheric so there will be in-leakage. During a PCRV leak or DBDA accident, vent system continues to operate normally to filter and exhaust the air. There are redundant fans and filters. This system is not classed as an engineered safety system.

Containment Cooling: Normally, temperatures are held between 70 and 105 F depending upon the area of containment and the conditions. In case of DBDA, temperatures could reach 450 F but for less than 1 minute. Recirculating fans and chilled water-cooled heat exchangers cool and distribute the air. Ring headers with high velocity air diffusers provide a uniform curtain of air flowing down around the PCRV.

Fuel Storage and Handling: Fuel storage wells are provided for new and irradiated fuel and reflector elements. Each storage well forms a gas and water tight enclosure to contain new and spent fuel under all conditions arranged to prevent nuclear criticality, even when filled with maximum reactivity fuel and complete flooded. Fuel handling equipment is provided to transfer fuel between reactor and storage wells.

Strong Motion Accelerometer: Found no reference.

Turbine Orientation: Turbine centerline is parallel with PCRV centerline with a few feet of separation. It is unlikely that ejected turbine parts could strike the reactor vessel.

D. PRESSURE VESSEL AND STEAM SYSTEM

Prestressed Concrete Reactor Vessel:

Height 106 ft Overall Diameter 61 ft

Core Cavity Height 75 ft Average Core Cavity Diam 31 ft

Minimum Vessel Wall Thickness --- ft

Liner Material & Thickness carbon steel 3/4" thick

Steam Generator System: Consists of 2 identical once-through steam generators in parallel within the cavity of the PCRV. Each generator consists of six steam generator modules operating in parallel, each with an integral reheater and steam/water section. Tubes and subheaders are designed to limit water/steam leakage to about 22 #/second after leaking for 5 seconds. Generators are designed so full capacity can be obtained after partial plugging of tubes or subheaders.

Feedwater & Condensate: Feedwater passes through a demineralizer and water treatment system for removal of contaminants to a level of 5-10 ppb suspended solids and 25 ppb dissolved solids. Feedwater enters each steam generator through a semicircular header from which flow is distributed to each steam generator module. Condensate from the main condenser is pumped to the feedwater treatment system.

E. REACTOR CHARACTERISTICS		REACTOR: FORT ST. VRAIN	
E1. THERMAL COOLANT FLOW DESIGN		E2. NUCLEAR DESIGN	
Thermal Output, MWt	842	Avg 1st-Cycle Burnup, MWD/Tonne U + Th	---
Electrical Output, MWe (net)	330	Average Burnup, MWD/Tonne U + Th	100,000
Total Heat Output, Safety Design, MWt	879	k_{eff} , Cold, No Power, Clean	---
Total Heat Output, Btu/hr	---	k_{eff} , Hot, Full Power Xe and Sm Equilibrium	---
Steam Flow Rate in Main, lb/hr	2.25×10^6	Total Rod Worth, Δk (%)	20
Total Core Helium Flow Rate, lb/hr	3.4×10^6	Moderator Temp Coeff, $\times 10^{-5} \Delta k/^{\circ}C$	---
Helium Core Press In/Out, psia	~ 700	Doppler Coefficient, $\times 10^{-5} \Delta k/^{\circ}C$	---
Helium Core Temp In/Out, $^{\circ}F$	760/1430	Max Shutdown Margin all Rods in	0.148
Heat Flux AVG	45,000	Carbon-to-Thorium Ratio	200
Btu/hr-ft ² MAX	120,000	Carbon-to-Uranium (235) Ratio	4350
Maximum Fuel Temperature $^{\circ}F$	2300	Burnable Poisons, Type and Form	Boron Carbide
Average Fuel Temperature $^{\circ}F$	1750	Number of Control Rods	37
Heat Transfer Area Coolant Hole, ft ²	45,000	Neutron Adsorber	B ₄ C
Core Effective Flow Area Ft ²	57.3	Control Rod Cladding	0.065" thk SST
Avg Sur Heat Trans Coeff, Btu/hr-ft ² - $^{\circ}F$	230	Number of Graphite Fuel Elements	1482
Average Core Power Density, kW/liter	6.3	Fuel Element Dimensions	14.7" across flats 11.2" lg.
Max Power per Fuel Rod kW/ft	---	No. Fuel Rods Per Fuel Assembly	210
Maximum Graphite Temperature $^{\circ}F$	~ 2000	Total Fuel Rods in Core	311,220
Radial Power Peaking	1.2	Fuel Rod Diameter, inches	0.491
Number of Coolant Loops	2	Fuel Particle FISSILE and Coating FERTILE	Uranium carbide Thorium carbide
Miscellaneous:		Fuel Particle Matrix	Graphite
		Uranium Charged to Initial Core, Kg	1,095
		Thorium Charged to Initial Core, Kg	19,200
		Fuel particles are coated with layers of pyrocarbon and silicon carbide: TRISO.	

E3. HELIUM SYSTEMS**REACTOR: FORT ST. VRAIN**

Primary Helium Coolant System: Consists of reactor core, steam generators, circulators, and helium shut off valves all contained within a prestressed concrete pressure vessel. Reactor heat is transferred by helium to water in the steam generator to produce steam. Each of the 2 loops has one steam generator and 2 helium circulators. Helium flows into the steam generator modules just below the core.

Helium Purification System: Helium at about 758 F enters the high-temp filter/adsorber from the PCRV cavity. The purifier consists of a cooler, centrifugal dust separator, charcoal adsorber, charcoal cooler, and a filter section. All impurities are removed except some neon. Eventually, the helium is cooled to -295 F where fission produced gases are removed.

Helium Moisture Monitoring: Found no direct reference to moisture monitoring, however excess moisture would show up in the purification system.

F. EMERGENCY SYSTEMS

Core Auxiliary Cooling System: Variations in operation of normally used circulators and steam generators make it possible to cool the core in emergency conditions. Cooling water for the steam generator can be supplied from several sources, or the decay heat removal exchanger can be used if needed. The circulators can be run by the steam turbine as in normal operation, or by the auxiliary water-turbine drive.

Backup Shutdown System: Boronated graphite balls 0.5 in. in diameter can be introduced into the core through cylindrical holes in the central fuel element of each refueling region. Nominal reactivity worth of the system is at least 0.13 ΔK which provides for more than the required reactivity for shutdown.

G. MISCELLANEOUS

Decay Heat Removal System: Decay heat removal is accomplished by running the circulators to pick up the core heat with the helium and then cool the helium in the steam generator. Steam generated could be condensed in the main condensers or in the decay heat removal heat exchanger.

Radwaste System: Most of the radioactive gas will come from the helium purification system. This high activity gas will be collected, compressed and stored for decay. When sufficiently decayed, the gas will be released thru the building vent. About 3000 gal of liquid waste will be produced each year by decontamination operations. Liquids will be filtered and demineralized and recycled or discharged in the blowdown liquid from the cooling towers. Solid wastes will be packed in shipping containers for shipment to offsite disposal areas.

Plant Vent: Vent extends 10 ft above containment roof (180 ft above grade). Exit velocity is 125 ft/sec.

G. MISCELLANEOUS (Continued) REACTOR: FORT ST. VRAIN

Emergency Power: There are two generators each rated 1210 KW for continuous service. Each generator is driven by 2 diesel engines, each having half the capacity of the generator. Each generator is connected to a separate 480 V essential bus. Diesel-generator sets are independent of each other with all required separate auxiliaries for each. Starting is automatic on loss of power but it can be done manually.

Emergency Plans: Plans will cover situations in which radioactivity materials could be released, fires, or other action requiring special attention. Civil authorities will be asked to participate in emergency activities. Medical facilities are available for treatment of contaminated patients. Off-site plans will coordinate efforts of Colorado Dept. of Health, Civil Defense, local, state, and national law enforcement bodies. Plans specify responsibilities of both off-site and on-site personnel. Evacuation routes have been designated.

Environmental Monitoring: Radiation surveillance was conducted by Colorado State University on a graded approach based upon a mathematical model. Sampling included air, water, silt, milk, and forage. Biota sampling includes fish and other aquatic organisms. Water quality of the 2 streams has been followed. A program of sampling and counting was started to develop environmental sampling for vegetation and mammals, as well as birds.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using one cooling tower.

Water Taken From: South Platte River and/or St. Vrain Creek
4100 gpm

Intake Structure: From St. Vrain Creek, Bar gate opens for water to run into a settling pond from which it is pumped thru a traveling screen. The S. Platte intake uses a bar gate to flow water into the pumping chamber.

Water Body Temperatures: Winter minimum --- °F; Summer maximum --- °F

River Flow Probably 0 (cfs) minimum; 194 SV, 326 SP (cfs) average

Service Water Quantity 10,500 gpm/reactor SV - St. Vrain
SP - South Platte

Flow Thru Condenser 156,000 (gpm)/reactor Temp. Rise 21.5 °F

Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 1670×10^6 (Btu/hr)/reactor

Discharge Structure: Effluents and blowdown flow thru a ditch to a holding pond and from there into the South Platte R. near where the South Platte and St. Vrain Creek join.

Cooling Tower(s): Description & Number - 1 mech. draft - 400' lg

Blowdown 1800 gpm/reactor Evaporative loss 2300 gpm/reactor

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A. GENERAL

PROJECT NAME: Summit Power Station, Units 1 & 2

LOCATION: Northern Delaware, about 17 miles SW of Wilmington

OWNER: Delmarva Power and Light Co. and Philadelphia Electric

OWNER'S ADDRESS & CONTACT: William G. Price, Vice-Pres. Generation

ARCHITECT/ENGINEER: United Engrs.

Delmarva Power

800 King Street

REACTOR MANUFACTURER: Gulf C.A.

Wilmington, Del. 19899

CONTAINMENT CONSTRUCTOR: ---

TURBINE MANUFACTURER: Allis-Chalmers DATE: August 1975

COMPILED BY: Fred Heddleson

ESTIMATED STARTUP DATE: 1980

NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

39° 31' 21" N

4,374,900 MN

75° 41' 11" W

440,900 ME

Site Description: Located 1 1/4 mi S of the Chesapeake and Delaware Canal and 1 mi E of the Penn Central R.R. Land all along the canal is owned by the government and is noted as a Wildlife preserve. US hwy 13-301 is 2 mi E and state hwy 896 is 1.5 mi SW. There are only 4 farm houses within 1 mi of the plant. The nearest community is Mt. Pleasant 1.5 mi WSW with population of 111. Just over 5 mi there are Middletown (2644) SSW, Delaware City (2024) NE, and Chesapeake City (1031) W. NE 30 mi is Philadelphia. The nearest school is at St. Georges, Del 3.2 mi NE having 428 pupils. The nearest recreational facility is the wild life refuse where hunting and fishing are the major activities. Another significant facility is Lums Pond State Park 2.3 mi NNE having 1200 acres devoted to swimming, boating, hiking, and hunting. Nearest dairy cows are 45 about 0.5 mi WNW. Within 2 mi there are 265 cows mostly SE and W.

Nearby Body of Water:

Normal Level 0 (MSL)

Chesapeake and Delaware Canal

Max Prob Flood Level NA (MSL)

Size of Site 1800 Acres Site Grade Elevation 80' (MSL)

Topography of Site: Flat to Rollingof Surrounding Area (5 mi rad): Relatively flatTotal Permanent Population: In 2 mi radius 1925 ; 10 mi 81,958Date of Data: 1970 In 5 mi radius 16,555 ; 50 mi 6,380,000Nearest City of 50,000 Population: Wilmington, Del.Dist. from Site 17 Miles, Direction NE, Population 80,386Land Use in 5-Mile Radius: Farmland and vacant 45%, marsh - 20%, and woodland 15%.Meteorology: Prevailing wind direction WNW Avg. speed ~7 mph

Stability Data - 54% Pasquil A

Southerly in Summer

Meteorological Measurements - At time PSAR was issued, data station was planned.

B. SITE DATA (Continued)			REACTOR: SUMMIT	
Exclusion Distance, Miles	0.28 radius		Design Winds in mph:	
Low Population Zone Distance, Miles	2		At 0 - 50 ft elev	90
Metropolis	Distance	Population	50 - 150 ft	115
Wilmington, Del.	17	499,493	150 - 400 ft	145
Safe Shutdown Earthquake Acceleration, g	0.15		Tornado 300 mph tang. + 60 trans	
Operating Basis Earthquake Acceleration, g	0.08		$\Delta P = \frac{3 \text{ psi}}{3 \text{ sec}}$	
Earthquake Vertical Shock, % of Horizontal	66 2/3			
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig	31		Free Volume, cu ft	1.94×10^6
Calculated Max Inter- nal Pressure, psig	28		Max Leak Rate at Design Pressure, %/day	0.5
<p><u>Type of Construction:</u> A vertical right cylindrical reinforced concrete shell with 4' thick walls hemispherical dome 3' thick and a flat base. It completely encloses the prestressed concrete reactor vessel. Containment structure is lined with 1/4" min. thickness welded carbon steel plate for leak tightness. Wall thickness is sufficient to provide required radiation shielding during a design basis depressurization accident (DBDA). The PCRV provides necessary shielding to permit personnel access to containment during normal power operation. An enclosure building will be built around containment structure for architectural reasons.</p>				
<p><u>Design Basis:</u> Designed to withstand the internal pressure and temperature transients associated with the Design Basis Depressurization Accident (DBDA) and to limit radioactive fission product leakage.</p>				
<p><u>Vacuum Relief Capability:</u> Found no reference.</p>				
<p><u>Post-Construction Testing:</u> Structure will be tested at 1.15 times the design pressure using strain gages to measure deflections. Integrated leakage tests will be run when construction is completed at 31 and 15.5 psig.</p>				
<p><u>Penetrations:</u> All penetrations are double sealed and nearly all are individually fitted for leak testing.</p>				
<p><u>Weld Channels:</u> Will be continuously welded over all liner seam butt welds which will be embedded in concrete on both sides of the liner, and may be used for leak testing of liner welds during life of plant.</p>				

C. CONTAINMENT & STRUCTURE (Contd) REACTOR: SUMMIT

Containment Air Filtration: A containment air purification and cleanup system is provided to collect and process radioactive particulates following a DBDA. Two 100% recirculation cleanup units are provided, each consisting of roughing filters, demisters, high efficiency particulate air (HEPA) filters, charcoal filters and fans. The two units are located between the containment structure and the PCRV.

Containment Cooling: Energy discharged into containment in a DBD accident is transferred by natural convection to the steel liner and then to the concrete walls and eventually to the external atmosphere. No containment heat removal systems are required for this function. Normally, temp will be held between 70 and 130 F with a normal heat load of 3×10^5 , using 4 fan-coil units. Four more units are available and redundant.

Fuel Storage and Handling: Fuel storage wells are provided for new and irradiated fuel and reflector elements. Each storage well forms a gas and water tight enclosure to contain new and spent fuel under all conditions arranged to prevent nuclear criticality, even when filled with maximum reactivity fuel and completely flooded. Fuel handling equipment is provided to transfer new and spent fuel.

Strong Motion Accelerometer: Installed in Unit 1 only - accelerometers in containment and free field. Seismoscopes on PCRV and all Category I structures.

Turbine Orientation: Ejected turbine blades could strike containment structure. Centerlines are 270' apart.

D. PRESSURE VESSEL AND STEAM SYSTEM
Prestressed Concrete Reactor Vessel:

Height 90.5 ft Average Diameter 90 ft

Core Cavity Height 46 ft Average Core Cavity Diam 32.6 ft

Minimum Vessel Wall Thickness 14.5 ft

Liner Material & Thickness Steel liner (SA 537B) 3/4" thick.

Steam Generator System: Consists of steam generator modules in parallel within cavities of the PCRV. Each module contains main steam and reheater heat transfer sections. Function of steam generator is to transfer heat from primary coolant (helium) to the secondary coolant (water/steam). Helium that cools reactor core enters steam generator modules at high temperature and transfers heat to the reheat steam section and main steam/water sections.

Feedwater & Condensate: Includes two main condensers of the deaerating type, one supplied for each pair of low pressure exhaust openings. Also includes condensate pumps, a full flow deep bed type condensate demineralizer, closed feedwater heaters, deaerating feedwater heater and feed pumps. The feed pumps will be steam turbine driven with provision for operation of variable speeds.

E. REACTOR CHARACTERISTICS		REACTOR: SUMMIT	
E1. THERMAL COOLANT FLOW DESIGN		E2. NUCLEAR DESIGN	
Thermal Output, MWt	2000	Avg 1st-Cycle Burnup, MWD/Tonne U + Th	19,400
Electrical Output, MWe (net)	766	Average Burnup, MWD/Tonne U + Th	94,000
Total Heat Output, Safety Design, MWt	2100	k _{eff} , Cold, No Power, Clean	1.228
Total Heat Output, Btu/hr	6825×10^6	k _{eff} , Hot, Full Power Xe and Sm Equilibrium	1.036
Steam Flow Rate in Main, lb/hr	5.4×10^6	Total Rod Worth, Δk	0.256
Total Core Helium Flow Rate, lb/hr	6.94×10^6	Moderator Temp Coeff, $\times 10^{-5} \Delta k/^{\circ}C$	-0.8
Helium Core Press In/Out, psia	700/691	Doppler Coefficient, $\times 10^{-5} \Delta k/^{\circ}C$	-3.7
Helium Core Temp In/Out, $^{\circ}F$	642/1434	Max Shutdown Margin all Rods in	0.180
Heat Flux at Coolant Hole AVG	66,000	Carbon-to-Thorium Ratio	214
Surface, Btu/hr-ft ² MAX	185,000	Carbon-to-Uranium (235) Ratio	4920
Maximum Fuel Temperature $^{\circ}F$	2588	Burnable Poisons, Type and Form	B ₄ C in graphite
Average Fuel Temperature $^{\circ}F$	1575	Number of Control Rods	98
Heat Transfer Area Coolant Hole, ft ²	101,000	Neutron Adsorber	B ₄ C in graphite
Core Effective Flow Area Ft ²	86	Control Rod Cladding	Incoloy 800
Avg Sur Heat Trans Coeff, Btu/hr-ft ² - $^{\circ}F$	285	Number of Graphite Fuel Elements	2744
Average Core Power Density, kW/liter	8.1	Fuel Element Dimensions	14.17 inches across flats
Max Power per Fuel Rod kW/ft	6.8	No. Fuel Rods Per Fuel Assembly	132
Maximum Graphite Temperature $^{\circ}F$	2050	Total Fuel Rods in Core	362,208
Maximum Radial Power Peaking	1.6	Fuel Rod Diameter, inches	0.614
Number of Coolant Loops	4	Fuel Particle FISSILE and Coating FERTILE	UC ₂ TRISCO ThO ₂ BISCO
Miscellaneous:		Fuel Particle Matrix	Graphite
		Uranium Charged to Initial Core, Kg	1237
		Thorium Charged to Initial Core, Kg	26,080

E3. HELIUM SYSTEMS**REACTOR: SUMMIT**

Primary Helium Coolant System: Heat in the core is transferred to the steam generator by helium which circulates in a closed cycle. There are 4 steam generators, each having a helium circulator above it to draw helium through the steam generator coils. Helium circulators are driven by steam at 6750 rpm.

Helium Purification System: Helium at 630°F enters high temperature filter adsorbers, where particulates are removed. A carbon bed removes fission products including radiohalogens. Purification driers, low temperature exchangers and the low temperature adsorber are in PCRV wells.

Helium Moisture Monitoring: System continuously monitors helium coolant in each main loop for moisture content that would indicate inleakage of steam or water from the steam generators and/or auxiliary loop heat exchangers. Ninety lbs/sec is max allowable leakage.

F. EMERGENCY SYSTEMS

Core Auxiliary Cooling System: Two independent cooling loops which circulate and cool helium to remove reactor decay heat during reactor shutdown or when main loops are unavailable. Each loop includes a heat exchanger, an auxiliary circulator, and a helium shutoff valve, located within PCRV cavity.

Backup Shutdown System: Spheres containing 40 wt % B₄C in graphite are contained in 49 hoppers which will be discharged into the core by gravity if needed. Gas pressure ruptures a disc to cause the gravity injection. Total worth hot is 0.15% Δk.

G. MISCELLANEOUS

Decay Heat Removal System: This function is performed by the Core Auxiliary Cooling System that transfers core residual heat to external heat exchangers which are cooled by one of the plant water systems.

Radwaste System: Liquid is filtered to remove particulates. Filtrate is redirected to form a recirculatory cleanup loop. Permeate is passed through mixed bed demineralizing resins and retained in a holdup tank prior to recycling. Condensate from helium purification and radgas recovery are segregated and solidified inside a licensed shipping cask. If radioactive gas cannot be released to the plant vent, it will be stored and transferred to the radioactive gas recovery system for processing prior to release. Inputs to waste gas system are segregated according to activity level: high level waste gases and low level system vents gases normally expected to be non-radioactive. Most of the dry radwaste shipped during the life of the plant will consist of spent graphite reflector blocks encased for off-site disposal. Drums of compacted material are transported to the licensed burial site.

Plant Vent: The main ventilation exhaust which discharges above the highest point of the reactor service building roof.

G. MISCELLANEOUS (Continued) REACTOR: SUMMIT

Emergency Power: Each reactor Unit has 2 diesel-generator sets, each rated 3500 kW. Each set is completely independent and has full capacity to supply emergency power required for shutdown. Units can start to take load within 15 seconds after the starting signal. Day tank will provide at least 2 hours of operation and the underground storage will have fuel for 7 days operation.

Emergency Plans: A manual will be prepared giving detailed procedures, check lists, and other information to conduct on-site and off-site activities for emergencies; so as to protect the public, Delmarva property and personnel. Teams will be trained, and drills will be held to keep people aware of their responsibilities. Outside state, local, and federal agencies will be contacted for assistance as needed. Personnel decontamination will be done on the site.

Environmental Monitoring: Preoperational program will determine pre-existing characteristics of the site and establish a base for measuring effects of plant construction and operation. Program includes aquatic surveys, groundwater, air monitoring, geological studies, surface waters, soil studies, ecology of the land, and radiological monitoring. Operational monitoring will be similar to the preoperational program with changes made as needed, particularly expanding some programs.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using mechanical draft cooling towers.

Water Taken From: Chesapeake and Delaware Canal for tower makeup, etc (23,000 gpm).

Intake Structure: Located on the bank of the Chesapeake and Delaware Canal with traveling screens and 3 pumps (one redundant). Makeup is 23,000 gpm. Intake flow velocities are 0.5 fps or lower.

Water Body Temperatures: Winter minimum 36 °F; Summer maximum 84 °F

River Flow NA (cfs) minimum; NA (cfs) average

Service Water Quantity 11,600 gpm/reactor

Flow Thru Condenser 330,000 (gpm)/reactor Temp. Rise 26 °F

Heat Dissipated to Environment 4300×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser 4190×10^6 (Btu/hr)/reactor

Discharge Structure: Blowdown from both units (8080 gpm) will be conveyed to the C&D Canal thru a 30" diam pipe and jetted into the canal at 10 fps velocity.

Cooling Tower(s): Description & Number — 2 mech. draft towers/reactor

Blowdown 4040 gpm/reactor Evaporative loss 7400 gpm/reactor

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A. GENERAL**PROJECT NAME:** Fulton Generating Station, Units 1 and 2**LOCATION:** SE Pennsylvania (Lancaster Co.) about 17 mi S. of Lancaster, Pa.**OWNER:** Philadelphia Electric Co.**OWNER'S ADDRESS & CONTACT:** V. S. Boyer, Vice President**ARCHITECT/ENGINEER:** Stone & Webster Philadelphia Electric Co.
2301 Market Street**REACTOR MANUFACTURER:** Gulf General Atomics Philadelphia, Pa. 19101**CONTAINMENT CONSTRUCTOR:** Stone & Webster**TURBINE MANUFACTURER:** --- **DATE:** February 1976**COMPILED BY:** Fred Heddleson**ESTIMATED STARTUP DATE:** 1981 **NUCLEAR SAFETY INFORMATION CENTER****B. SITE DATA** Lat. 39°45'50"N Long. 76°14'15"W

Site Description: The site is on a high terrace overlooking Conowingo Pond, a 14 mi long reservoir. Site elevation is about 380 ft above the river. A single track of the Penn Central RR passes through the SW edge of the property about 15 ft above the water, running along the edge of the reservoir. A spur will be run from this railroad up to the plant site. The nearest major highway is State Route #272 which is 4 mi E. Access to the site will be by a new private road from the north. Slate Hill Road which now passes thru the exclusion area will be relocated to the east. There are 7 houses within the exclusion area; these will be purchased and abandoned. The nearest permanent residence will be 2600 ft SSE. The area near the mouth of Peter's Creek has a number of summer homes. The nearest school is 3 mi ENE. Within a 5 mi rad. there are 5188 milk cows, 238 of these within 1.5 miles.

Nearby Body of Water: Susquehanna R. Normal Level 109' (MSL)
Conowingo Pond Max Prob Flood Level 134' (MSL)

Size of Site 360 Acres **Site Grade Elevation** 387' (MSL)

Topography of Site: Flat knoll above the river
of Surrounding Area (5 mi rad): Rolling

Total Permanent Population: In 2 mi radius 1023/1286; 10 mi/35,544

Date of Data: 1970/1980 In 5 mi radius 6143/7714; 50 mi/5,215,258

Nearest City of 50,000 Population: Lancaster, Pa.

Dist. from Site 17 Miles, **Direction** N, **Population** 57,690

Land Use in 5-Mile Radius: Agricultural 50%, Wooded 30%

Meteorology: Prevailing wind direction NW-Winter S-Summer Avg. speed 8 mph
Stability Data - Calms occur about 1% of the time.

Meteorological Measurements - Peach Bottom #1 site has data collected since 1967 from level of 688' MSL which is applicable to Fulton.

B. SITE DATA (Continued)			REACTOR: FULTON	
Exclusion Distance, Miles	0.48	<u>Design Winds in mph:</u> At 0 - 50 ft elev 80 50 - 150 ft 95 150 - 400 ft 110 Tornado 300 mph tang + 60 trans. ΔP = 3 psi/ 10 sec		
Low Population Zone Distance, Miles	1.50			
<u>Metropolis</u>	<u>Distance</u> <u>Population</u>			
Lancaster	17 mi. 319,693			
Safe Shutdown Earthquake Acceleration, g	0.12			
Operating Basis Earthquake Acceleration, g	---			
Earthquake Vertical Shock, Z of Horizontal	66 2/3			
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig	39	Free Volume, cu ft	2.526 × 10 ⁶	
Calculated Max Internal Pressure, psig	31	Max Leak Rate at Design Pressure, %/day	0.1	
<u>Type of Construction:</u> A steel lined, reinforced concrete structure with vertical cylindrical walls (4'-6" thk) and a torispherical dome supported on a flat base. Liner is 3/8" thk on vertical walls and 1/2" on dome. Structure is founded on rock about 25' below grade. The ID is 140 ft, and 193 ft from top of mat to spring line of vertical walls. The steel liner is attached to and supported by the concrete. During construction, the liner serves as the inside form for the concrete walls and dome. Containment normally operates at 1 or 2 psi above atmospheric pressure.				
<u>Design Basis:</u> Structure is designed so that its leakage rate is less than 0.1% by vol of its contents per day under Post-DBDA conditions; and is designed to withstand pressures and temperatures above those that are calculated to result from a DBDA.				
<u>Vacuum Relief Capability:</u> Designed for 3 psig vacuum. Found no reference to vacuum relief valves.				
<u>Post-Construction Testing:</u> Structural acceptance test shall be run with an internal pressure 1.15 times design pressure. Deflection and strain measurements will be taken. Leakage rate tests will be run per App. J of 10CFR50, and periodic tests will be run during the operating life of the plant.				
<u>Penetrations:</u> Sketches show them as single barrier with no pressure taps for individual testing. Hot pipe penetration are water cooled.				
<u>Weld Channels:</u> Found no reference to weld channels.				

C. CONTAINMENT & STRUCTURE (Contd) REACTOR: FULTON

Containment Air Filtration: Systems for fission product cleanup are the containment cleanup system and the leak collection system. The cleanup system is recirculation type drawing in air in the upper part of containment and discharging it near the bottom. There are 3 50% cap. fans and each containing 2 charcoal filter trains having prefilters, HEPA filters, and charcoal absorbers. The leak collection systems filter out contaminants that leak into the penetration enclosure.

Containment Cooling: Special cooling to remove heat after a DBDA is not required. The volume and heat dissipation characteristics of containment are sufficient. For normal operational cooling, temperature will be held from 70 to 100 F. Six 20% capacity air handling assemblies are provided with heating/cooling coils and circulation fans. Air is taken in at top of containment, heated or cooled, and discharged at the bottom of containment.

Fuel Storage and Handling: Utilizes specialized equipment to provide safe remote-controlled removal of spent fuel from the reactor, insertion of new fuel into the reactor, and storage of spent fuel. New fuel and spent fuel are stored together in a dry-type cell using cooling coils around the cell to dissipate heat. A special fuel-handling machine removes fuel from the reactor and replaces it with new fuel.

Strong Motion Accelerometer: There will be 3 accelerometers, 2 mounted in containment structure, and one in the reactor service building. Units are recording type with range from 0.01 to 1.0 g.

Turbine Orientation: Centerline of 2 turbines for each reactor project into containment, almost intersecting center of the reactor. It is unlikely that ejected turbine parts could strike containment. The 2 turbines are side by side.

D. PRESSURE VESSEL AND STEAM SYSTEM**Prestressed Concrete Reactor Vessel:**

Height 91.2 ft Average Diameter 100.5 ft

Core Cavity Height 47.3 ft Average Core Cavity Diam 37 ft

Minimum Vessel Wall Thickness 17.5 ft

Liner Material & Thickness Carbon Steel, 0.5" and 0.75" thick

Steam Generator System: Consists of 6 independent steam generator modules arranged in parallel within the cavities of the PCR. The steam generator produces superheated steam which goes to the high pressure turbine. Cold steam returned from the high pressure turbine enters the reheat section of the heat exchanger for reheating and then goes to the intermediate pressure turbines. Steam as it returns from the high pressure turbine is used to drive the helium circulator turbines.

Feedwater & Condensate: Condensate collected in the turbine condenser hotwells is returned to the steam generators in the PCR cavities. Three pumps take suction from the hotwell - 2 have 100% capacity. After misc. treatment, the condensate ends up in the deaerator storage tank from which feedwater pumps transfer water to the steam generators as needed.

E. REACTOR CHARACTERISTICS		REACTOR: FULTON	
E1. THERMAL COOLANT FLOW DESIGN		E2. NUCLEAR DESIGN	
Thermal Output, MWt	3000	Avg 1st-Cycle Burnup, MWD/Tonne U + Th	22,300
Electrical Output, MWe (net)	1160	Average Burnup, MWD/Tonne U + Th	98,000 Uranium & Thorium
Total Heat Output, Safety Design, MWt	3164	k_{eff} , Cold, No Power, Clean	1.220
Total Heat Output, Btu/hr	$\sim 10,200 \times 10^6$	k_{eff} , Hot, Full Power Xe and Sm Equilibrium	1.033
Steam Flow Rate in Main, lb/hr	8×10^6	Total Rod Worth, Δk	0.258
Total Core Helium Flow Rate, lb/hr	10.84×10^6	Moderator Temp Coeff, $\times 10^{-5} \Delta k/^{\circ}C$	-0.8
Helium Core Press In/Out, psia	725/713.7	Doppler Coefficient, $\times 10^{-5} \Delta k/^{\circ}C$	-3.5
Helium Core Temp In/Out, $^{\circ}F$	606/1392	Min. Shutdown Margin all Rods in	0.181
Heat Flux at Coolant Hole AVG	65,000	Carbon-to-Thorium Ratio	214
Surface, Btu/hr-ft ² MAX	185,000	Carbon-to-Uranium (235) Ratio	4350
Maximum Fuel Temperature $^{\circ}F$	2570	Burnable Poisons, Type and Form	B ₄ C in graphite
Average Fuel Temperature $^{\circ}F$	1634	Number of Control Rods	146
Heat Transfer Area Coolant Hole, ft ²	150,000	Neutron Adsorber	B ₄ C in graphite
Core Effective Flow Area Ft ²	121	Control Rod Cladding	Incoloy 800
Avg Sur Heat Trans Coeff, Btu/hr-ft ² - $^{\circ}F$	295	Number of Graphite Fuel Elements	3944
Average Core Power Density, kW/liter	8.4	Fuel Element Dimensions	Hexagonal-14.17" across flats
Max Power per Fuel Rod kW/ft	7.0	No. Fuel Rods Per Fuel Assembly	132
Maximum Graphite Temperature $^{\circ}F$	2088	Total Fuel Rods in Core	520,608
Maximum Radial Power Peaking	1.6	Fuel Rod Diameter, inches	0.614
Number of Coolant Loops	6	Fuel Particle FISSILE and Coating FERTILE	TRISO BISO
Miscellaneous:		Fuel Particle Matrix	Graphite
		Uranium Charged to Initial Core, Kg	1725
		Thorium Charged to Initial Core, Kg	37,487

E3. HELIUM SYSTEMS**REACTOR: FULTON**

Primary Helium Coolant System: Contains 6 independent loops each having a helium circulator and a steam generator. The helium is circulated by a steam-turbine driven axial flow helium circulator. Each helium circulator has a coolant shutoff valve whose purpose is to limit reverse coolant flow thru a non-operating loop. Total helium inventory is 22,000 # 20,750 of which is in the coolant circuit.

Helium Purification System: Remove radioactive material and chemical impurities from helium coolant by continuously purifying a side stream of gas. This system also purifies helium transferred from reactor coolant to helium storage. System consists of filters, hydrogen removal module, compressor, and purification module.

Helium Moisture Monitoring: There are 3 moisture monitors per loop with 2-out-of-3 logic. Compressors for these monitoring loops are outside the PCR. Purpose of moisture monitoring is to watch for heat exchanger leaks.

F. EMERGENCY SYSTEMS

Core Auxiliary Cooling System: There are 3 loops each one containing a heat exchanger, circulator, and shut off valve. These loops are backup for the regular cooling system and can circulate helium to cool the core when the other loops are inoperative. These circulators are driven by 700 HP electric motors. These loops operate if core cooling is needed while the reactor is shut down.

Backup Shutdown System: Releases neutron-absorbing spheres containing boron carbide into the core. This system is actuated manually in case control rods fail to function. Spheres, which are contained in hoppers located in the refueling penetrations, are released by rupture discs actuated by gas pressure.

G. MISCELLANEOUS

Decay Heat Removal System: Heat will be removed by use of the main cooling loops using steam generators for cooling the helium. Steam for turbines driving the helium circulators can come from the auxiliary boilers. Another system, the Core Auxiliary Cooling System, can also remove the decay heat. This system is described above.

Radwaste System: During normal operation only small quantities of liquid wastes are generated. These are collected, processed and either prepared for off-site disposal; or if free of radioactivity, discharged with the cooling tower blowdown to Conowingo Pond. The helium purification system removes most of the gaseous waste contaminants. Gases generally free of radioactivity are vented to the atmosphere. Contaminated gases are processed through the gas waste system and gas recovery system which collects, compresses, and stores temporarily. After proper cleanup, gases are released to the atmosphere. Very little solid waste is generated. Solid wastes come from replacement of titanium sponge in the hydrogen getters, and replaced contaminated equipment. Solid wastes are shipped off-site for disposal.

Plant Vent: The process vent system exhausts through a pipe venting 20 ft above containment (vent is 240 ft above grade). A tritiated vapor release point is above the turbine building about 95 ft above grade.

G. MISCELLANEOUS (Continued) REACTOR: FULTON

Emergency Power: There will be 3 independent diesel-generator (2900 KW continuous) sets per reactor, any 2 of which can supply the power needed for an emergency shutdown. Units are independently housed and each has its own auxiliaries. A day tank has sufficient fuel for 2 hours of full load operation, and a storage tank for each has 7 days supply of fuel. Each unit has 2 transfer pumps for transferring fuel from the storage tank to the day tank.

Emergency Plans: Primary objective of the plans are protection of the health and safety of the public and plant personnel. Plans will cover normal situations plus unusual occurrences such as first aid needs, fire, evacuation, re-entry, search and rescue, survey of accident, radioactive releases, etc. Command centers will be established both on site and off site from which emergency crews will work. State, Federal and local agencies will be used in case of serious accidents to assist Philadelphia Electric personnel.

Environmental Monitoring: Much of the studies performed for the Peach Bottom nuclear plants is applicable to Fulton. Physical and chemical parameters of Conowingo Pond are being carried out. Sampling consists of Zooplankton, benthos, fish, planktonic organisms, soils, flora, fauna, and other samples needed for radiological monitoring. Beginning in 1973, the program being carried out for the Peach Bottom plants was expanded to give additional coverage for Fulton.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using cooling tower.

Water Taken From: Conowingo Pond
Makeup 22,000 per reactor total.

Intake Structure: Reinforced concrete located at edge of reservoir water. Structure has 3 traveling screens, 3 trash bar racks, and 2 pumps in each of the 3 cavities. Approach velocity in front of traveling screens is 0.5 fps.

Water Body Temperatures: Winter minimum 32 °F; Summer maximum 88 °F

River Flow 1400 (cfs) minimum; 35,500 (cfs) average

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 463,200 (gpm)/reactor Temp. Rise 28 °F

Heat Dissipated to Environment 6000×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser 6000×10^6 (Btu/hr)/reactor

Discharge Structure: Blowdown is discharged to Conowingo Pond about 250 ft from shore thru a slotted discharge pipe. Point of discharge is about 1200 ft downstream of intake.

Cooling Tower(s): Description & Number - One hyperbolic tower/reactor
Blowdown 11,300 gpm/reactor Evaporative loss 9,700 gpm/reactor

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NUCLEAR SAFETY INFORMATION CENTER

A. GENERAL

PROJECT NAME: Atlantic Generating Station 1 and 2 (Floated in Ocean)
 LOCATION: 2.8 mi off Jersey Coast at Little Egg Inlet
 OWNER: Pub. Serv. Elec. & Gas (80%) + Atlantic Electric & Jersey Cen
 OWNER'S ADDRESS & CONTACT: R. L. Mittl General Manager - Projects
 80 Park Place
 ARCHITECT/ENGINEER: Offshore Power Systems Newark, N.J. 07101
 REACTOR MANUFACTURER: West.
 CONTAINMENT CONSTRUCTOR: Offshore Power Systems
 TURBINE MANUFACTURER: West. DATE: November 1975
 ESTIMATED STARTUP DATE: 1985 COMPILED BY: Fred Heddleson
 NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA Lat 39°-28'-20" N Long 74°-15'-20" W

Site Description: Located in the Atlantic Ocean on floating barges about 2.8 miles from the New Jersey shore just east of Little Egg Inlet. Water depth at the site is 35 to 40 ft deep, but the bottom will be dredged to a depth of 47 ft. A semi-circular breakwater will surround the two floating barges to provide protection from waves. The barges upon which will be erected the nuclear plants will be moored to sunken caissons. The breakwater will be built up with rock, sand, and dolosse. Atlantic City is 11 miles SW which is the nearest large city. The nearest year round house is 4.3 mi N. Nearest school is 5 mi N. Brigantine National Wildlife Refuge begins about 4 mi WSW and extends westerly to about 10 mi. The nearest public beach is 4 mi N. Because of the beach properties, considerable transient population is in the area during the summer.

Nearby Body of Water: Normal Level 0 (MSL)
 Max Prob Flood Level --- (MSL)
Designed for 50' high waves

Size of Site 186 ocean Acres Plant Draft Elevation -32' (MLW)

Topography of Site: Ocean
of Surrounding Area (5 mi rad):

Total Permanent Population: In 2 mi radius 0; 10 mi 26,640

Date of Data: 1980 proj. In 5 mi radius 381; 50 mi 1,139,980

Nearest City of 50,000 Population: Atlantic City

Dist. from Site 11 Miles, Direction SW, Population 47859 (70)

Land Use in 5-Mile Radius: Mostly water and marsh land with a small land usage for residential.

Meteorology: Prevailing wind direction SSW Avg. speed 4-6 mph
Stability Data - low potential for air pollution.

Meteorological Measurements - Measurements started in June -73 with a tower supported on the ocean floor. Instruments are about 10 meters above mean water low level.

B. SITE DATA (Continued)			REACTOR: ATLANTIC STATION	
Exclusion Distance, Miles	1		Design Winds in mph:	
Low Population Zone Distance, Miles	2		At 0 - 50 ft elev 160	
Metropolis	Distance	Population	50 - 150 ft ---	
Atlantic City	11 mi	175,043	150 - 400 ft ---	
Safe Shutdown Earthquake Acceleration, g		0.30	Tornado 290 mph rot. + 70 trans.	
Operating Basis Earthquake Acceleration, g		0.15	ΔP = <u>3</u> psi/ --- sec	
Earthquake Vertical Shock, % of Horizontal		66		
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig	15		Free Volume, cu ft	1.30×10^6
Calculated Max Internal Pressure, psig	12.5		Max Leak Rate at Design Pressure, %/day	0.5
<p><u>Type of Construction:</u> A free-standing steel structure (ID 120') with an ice condenser and a separate reinforced concrete shield building (ID 130') having an annulus between the two structures. Shield building is a right cylinder with 3' thick walls and a shallow dome roof 2' thick. Both structures are attached to the top deck of the steel platform which serves as base plate for containment. Bottom of the reactor sump is 27'-3" below the steel platform deck and is included in the containment system. The annulus collects all leakage from containment and filters it before exhausting to the atmosphere.</p>				
<p><u>Design Basis:</u> Designed to sustain, without loss of integrity, all effects of piping failure including double-ended rupture of the largest pipe in the coolant system. Engineered safety features are considered part of the design to cool the reactor core and return containment to near atmospheric pressure so that no serious leakage occurs from containment after a LOCA.</p>				
<p><u>Vacuum Relief Capability:</u> Not needed.</p>				
<p><u>Post-Construction Testing:</u> Containment will be tested after construction before being towed to the N.J. site. Pressure tests and integrated leak rate tests will be run. Leakage rate tests will be conducted after startup every 3 years.</p>				
<p><u>Penetrations:</u> Some penetrations are double barrier and some are single as shown by sketches. Some are individually testable.</p>				
<p><u>Weld Channels:</u> Will be used locally.</p>				

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: ATLANTIC STATION

Containment Spray System: There are 4 separate 1/3 capacity spray trains which are designed to keep pressure below design level after all the ice has melted and if steam is still generated by core heat. Each spray train has 1 pump rated 2800 gpm. In case of LOCA, 4 pumps will run to spray 11,200 gpm. Three pumps provide adequate flow. Containment spray and the ice system can effect long term cooling. Recirculation from the sump will start when refueling water storage tank is empty.

Containment Cooling: After LOCA, containment atmosphere is cooled by the ice condenser system and by the containment spray system described above. Sufficient ice for double capacity is available, and ice will be frozen from a Boron solution with sodium hydroxide added for Iodine removal.

Containment Air Filtration: Provides capability for a controlled purge thru fission product removal system consisting of HEPA and charcoal filters. A backup purge system can exhaust air from containment and filter it before discharge to the atmosphere.

Combustible Gas Control: There are 2 hydrogen recombiners that limit the percentage of hydrogen below safe H_2/O_2 mixture levels.

Containment Floodability: Design criteria is that containment will not flood.

Strong Motion Accelerometer: Triaxial accelerometers are mounted at 4 locations surrounding areas housing safety-related equipment. The control room operator is notified of an event and can read the recorded peak accelerations as a function of frequency.

Turbine Orientation: At design overspeed (120%), the probability of a turbine missile either perforating the shield bldg. or causing unacceptable flooding by perforating the hull is less than 1×10^{-2} .

D. REACTOR COOLANT

Reactor Vessel Failure: Vessel will be designed, fabricated, and inspected frequently so as to preclude failure.

Reactor Vessel Design: Material SA553 GrA, B, Cl 1

Shell ID, in. 173 Shell Thickness varies

Overall Height, ft/in. 43'-10" Cladding Thickness, in. 5/32 SST

Reactor-Coolant Leak-Detection System: The in-containment coolant leak detection system detects leakage from systems within containment. Particulate activity, gaseous activity, dew point, temperature and condensate are monitored.

Failed-fuel-Detection System: Neutron activity in the let down line is monitored and an alarm is sounded should an abrupt change occur.

E. REACTOR CHARACTERISTICS		REACTOR: ATLANTIC STATION	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3411	H ₂ O/U, Cold	3.55
Electrical Output, MWe (net)	1150	Avg 1st-Cycle Burnup, MWD/MTU	14,600
Total Heat Output, Safety Design, MWe	3579	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	$11,642 \times 10^6$	Region-1 Enrichment, %	2.10
System Pressure, psia	2250	Region-2 Enrichment, %	2.60
DNBR, Nominal	2.04	Region-3 Enrichment, %	3.10
Total Flowrate, lb/hr	142.2×10^5	k _{eff} , Cold, No Power, Clean	1.222
Eff Flowrate for Heat Trans, lb/hr	135.8×10^6	k _{eff} , Hot, Full Power, Xe and Sm	1.148
Eff Flow Area for Heat Trans, ft ²	51.1	Total Rod Worth, % BOL/EOL	8.26 to 8.13
Avg Vel Along Fuel Rods, ft/sec	16.8	Shutdown Boron, No Rods-Clean-Cold, ppm	1435/1408 BOL/EOL
Heat Generated in Fuel, %	97.4	Shutdown Boron, No Poisoned-Hot, ppm	1178/882 BOL/EOL
Hot Channel Factors, Fq	2.32	Boron Worth, Hot, %	1%Δp/120 ppm
Nominal Core Inlet Temp, °F	557.3	Boron Worth, Cold, %	1%Δp/60 ppm
Avg Rise in Core, °F	62.3	Full Power Moderator Temp Coeff, Δk/k/°F	-3.5×10^{-4}
Nom Hot Channel Outlet Temp, °F	622.7	Moderator Pressure Coeff, Δk/k/psi	(-0.04 to +3) $\times 10^{-6}$
Avg Film Coeff, Btu/hr ft ² -°F	6000	Moderator Void Coeff, Δk/k/% Void	(+0.5 to -2.5) $\times 10^{-3}$
Avg Film Temp Diff, °F	36.2	Doppler Coefficient, Δk/k/°F	Negative at all power levels
Active Heat Trans Surf Area, ft ²	59,700	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Heat Flux, Btu/hr ft ²	129,800	Burnable Poisons, Type and Form	Borated glass tubes in SST
Max Heat Flux, Btu/hr ft ²	454,000	Number of Control Rods	1272
Avg Thermal Output, kw/ft	5.44	Number of Part-Length Rods (PLR)	102
Max Thermal Output, kw/ft	12.6	Number of Fuel Assemblies	193
Max Clad Surface Temp, °F	~660	Overall Dimensions, inches	8.426 x 8.426
No. Coolant Loops	4	Number of Fuel Rods	50,902
All data on this page from Westinghouse RESAR 3 and designated as W		Fuel Rod Cladding Material	Zircaloy-4
		Weight of Uranium, lbs. UO ₂	222,739

W

F. SAFETY INJECTION SYSTEMS REACTOR: ATLANTIC STATION

W

Core Flooding System: There are 4 accumulators each holding 6360 gal of borated water and pressurized with nitrogen gas. When pressure in the reactor coolant system drops below 650 psig, a swing-disc check valve opens and the accumulators discharge their contents into the reactor cold legs - one accumulator is connected to each cold leg.

High-Pressure Injection System: There are 4 high-pressure pumps. Two are identical to charging pumps, each rated at 650 gpm. Two pumps are each rated at 550 gpm. One of each pair of pumps can perform injection function for 100% capacity. Suction is taken from refueling water storage tank. When water in refueling water storage tank has been used up, suction is switched automatically to containment sump for recirculation. Two high pressure pumps charge thru boron injection tank to add 12% conc. boric acid soln. to reactor coolant.

W

Low-Pressure Injection System: The 2 Residual Heat Removal pumps discussed below perform this function when pressure in the reactor drops to operating level of the pumps. The core is flooded by water from the Refueling Water Storage Tank. Recirculation from the containment sump is possible for cooling thru the residual heat removal heat exchangers and this function can be prolonged for long term cooling. Each pump is rated 3000 gpm @ 160 psig.

G. MISCELLANEOUS

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Residual Heat Removal System: System has 3 main functions as follows: Transfers residual heat from the core and reduces temperature of the reactor coolant system during shutdown. Can reduce temp from 350 F to 140 F in 16 hours using the 2 pumps and 2 heat exchangers. Also, transfers refueling water between the refueling water storage tank and the refueling cavity. The 2 pumps are used for low-pressure injection as described above.

Radwaste System: Liquid wastes are collected, processed on a batch basis and liquids not recycled are discharged with the circulating water discharge. Since nearly all liquids are recycled, very little liquid is discharged. System is designed to contain all waste gases for the life of the plant. Gases collected will be mixed with nitrogen and pumped to a recombiner where hydrogen will be combined with oxygen to be oxidized to water. Gases will be compressed in tanks and held indefinitely. Solid wastes will be homogenized into a solid mass which will be packed into drums for off-site disposal.

Plant Vent: A vent stack runs up the side of the containment structure venting at plant elevation 293'.

G. MISCELLANEOUS (Continued) REACTOR: ATLANTIC STATION	
<p><u>Standby Power:</u> There will be 4 diesel-generator sets for each reactor plant, each set rated at 2500 kW. Fuel supply for each unit separately will have sufficient capacity for 7 days of full power operation. Each diesel-generator is connected to one of the four engineered safety feature buses.</p>	
<p><u>Emergency Plans:</u> Procedures will be developed to establish responsibilities and operational guides for types of emergencies postulated. An off-duty supervisor at the plant will assume duties of Emergency Coordinator. Also an auxiliary control center will be set up on shore. State, Federal, and local agencies will be used as required, especially the Coast Guard and New Jersey EPA and state police. Medical facilities will be available at the plant as well as at shore hospitals.</p>	
<p><u>Environmental Monitoring:</u> Studies were started in 1971 to study the ocean environment to provide baseline data needed to evaluate the effect of the plant on the environment. Particular attention is being given to possible water interchange between the site and Little Egg Inlet. Temperatures, salinity, and currents are investigated. Fish and other aquatic specimen are being collected. Terrestrial studies examine the beaches and marshes for sampling vegetation, mammals, amphibians, and birds. Radiological monitoring will start 2 years before plant operation.</p>	
H. CIRCULATING WATER SYSTEM	
<p><u>Type of System:</u> Once through using the ocean for cooling water</p>	
<p><u>Water Taken From:</u> Atlantic Ocean</p>	
<p><u>Intake Structure:</u> There are 6 flow paths each having its own intake with trash racks, traveling screens, circulating pump, etc. Water is pumped through 96 in. dia. pipes to the condensers.</p>	
<p><u>Water Body Temperatures:</u> Winter minimum <u>38</u> °F; Summer maximum <u>71</u> °F</p>	
<p><u>River Flow</u> <u>NA</u> (cfs) minimum; <u>NA</u> (cfs) average</p>	
<p><u>Service Water Quantity</u> <u>100,000</u> gpm/reactor</p>	
<p><u>Flow Thru Condenser</u> <u>960,000</u> (gpm)/reactor Temp. Rise <u>17.2</u> °F</p>	
<p><u>Heat Dissipated to Environment</u> --- (Btu/hr)/reactor</p>	
<p><u>Heat Removal Capacity of Condenser</u> <u>2500 × 10⁶</u> at 60 F(Btu/hr)/reactor</p>	
<p><u>Discharge Structure:</u> Water flows from the condensers thru 90 in. dia. pipes to a point near discharge where line size is reduced to 72 in. dia. The 72 in. pipe has 3-40° turns and discharges vertically downward into the catchment basin.</p>	
<p><u>Cooling Tower(s):</u> Description & Number - None</p>	
<p><u>Blowdown</u> --- gpm/reactor Evaporative loss --- gpm/reactor</p>	

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A. GENERAL									
PROJECT NAME: WASH. Public Power Supply System Nuclear Projects 3 & 5									
LOCATION: Grays Harbor Co., Wash., 26 miles WSW of Olympia, Wash.									
OWNER: Washington Public Power Supply System (70%) + 4 utilities*									
OWNER'S ADDRESS & CONTACT: J. J. Stein, Managing Director									
ARCHITECT/ENGINEER: Ebasco	Wash. Public Power Supply 3000 Geo. Wash. Way, Box 968								
REACTOR MANUFACTURER: Comb. Engg.	Richland, Washington 99352								
CONTAINMENT CONSTRUCTOR: Ebasco									
TURBINE MANUFACTURER: West.	DATE: February 1975								
ESTIMATED STARTUP DATE: 1981	COMPILED BY: Fred Meddleson								
NUCLEAR SAFETY INFORMATION CENTER									
B. SITE DATA <table border="0"> <tr> <td>* Pacific Power & Light</td> <td>Puget Sound Power & Light</td> </tr> <tr> <td>Portland General Electric</td> <td>Wash. Water Power Co.</td> </tr> </table>		* Pacific Power & Light	Puget Sound Power & Light	Portland General Electric	Wash. Water Power Co.				
* Pacific Power & Light	Puget Sound Power & Light								
Portland General Electric	Wash. Water Power Co.								
<u>Site Description:</u> Site is about 1 mi S. of the Chehalis River at the confluence with the Satsop River about 26 mi WSW of Olympia, Wash. and 33 mi E. of Pacific Ocean. Aberdeen, 16 miles W., is the nearest sizeable city having a population of 18,500. Other closer towns are Elma, 4 mi NE (2,300) and Montesano, 5 1/2 mi NW (2,850). US hwy #12 runs E-W 3 mi N. of the site. The Northern Pacific RR parallels #12 in this area. Union Pacific RR runs along southbank of the Chehalis R. The RR spur to the plant comes from this RR. Nearest school is in Satsop 3 mi N. A boy scout camp is 3 mi SE on Delezen Creek. The site is on a ridge overlooking and utilizing part of a terrace and is surrounded by hills on the South and East.									
<p>*FIG 3 Long. 123°-28'-11", Lat. 46°-57'-11" N 52 55 531 274 301</p> <p>WPTB 5 123°-28'-11", 46°-57'-31" N 52 55 535 264 613</p>									
<table border="0"> <tr> <td><u>Nearby Body of Water:</u></td> <td>Normal Level</td> <td>Sea Level</td> <td>(MSL)</td> </tr> <tr> <td>Chehalis River</td> <td>Max Prob Flood Level</td> <td>67'</td> <td>(MSL)</td> </tr> </table>		<u>Nearby Body of Water:</u>	Normal Level	Sea Level	(MSL)	Chehalis River	Max Prob Flood Level	67'	(MSL)
<u>Nearby Body of Water:</u>	Normal Level	Sea Level	(MSL)						
Chehalis River	Max Prob Flood Level	67'	(MSL)						
Size of Site <u>2450</u> Acres Site Grade Elevation <u>390'</u> (MSL)									
<u>Topography of Site:</u> Rolling Generally rolling but hilly on the of Surrounding Area (5 mi rad): E and NE.									
<u>Total Permanent Population:</u> In 2 mi radius <u>83</u> ; 10 mi <u>10,451</u>									
<u>Date of Data:</u> <u>1980</u> In 5 mi radius <u>3989</u> ; 50 mi <u>391,475</u>									
<u>Nearest City of 50,000 Population:</u> Tacoma, Wash.									
Dist. from Site <u>50</u> Miles, Direction <u>ENE</u> , Population <u>154,581</u>									
<u>Land Use in 5-Mile Radius:</u> Mostly forest lands plus agricultural areas in the river valleys.									
<u>Meteorology:</u> Prevailing wind direction <u>SW</u> Avg. speed <u>6 mph</u>									
Stability Data - "Western Wash. experiences better diffusion conditions than much of the rest of the country."									
<u>Meteorological Measurements -</u> Have been made for about 2 years.									

B. SITE DATA (Continued)			REACTOR: WPPS 3 & 5	
Exclusion Distance, Miles	0.8 radius		<u>Design Winds in mph:</u>	
Low Population Zone Distance, Miles	3 radius		At 0 - 50 ft elev	105
<u>Metropolis</u>	<u>Distance</u>	<u>Population</u>	50 - 150 ft	125
Tacoma, Wash.	50 mi	411,027	150 - 400 ft	145
Safe Shutdown Earthquake Acceleration, g	0.32		Tornado 240 mph rot. + 60 trans.	
Operating Basis Earthquake Acceleration, g	0.16		$\Delta P = 2.25 \text{ psi} / 2 \text{ sec}$	
Earthquake Vertical Shock, % of Horizontal	66 2/3			
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig	44		Free Volume, cu ft	3.4×10^6
Calculated Max Internal Pressure, psig	38		Max Leak Rate at Design Pressure, %/day	0.5
<p><u>Type of Construction:</u> A steel containment vessel surrounded by a reinforced concrete shield building. There is an annulus between the 2 structures which are cylindrical with hemispherical domes. Steel containment is a low leakage structure. The shield building is a medium leakage structure. ID is 150'. Steel vessel walls are 2 5/16" thick with 1- 3/16" thick dome. Concrete walls are 3' thick with 2.5' thick dome.</p>				
<p><u>Design Basis:</u> Designed to contain the pressures and temperatures resulting from LOCA or a ruptured steam line based on engineered safety features beginning to operate within 30 seconds after the line break.</p>				
<p><u>Vacuum Relief Capability:</u> There will be 2 independent vacuum relief lines each having a check valve inside containment and an automatic butterfly valve outside in the annulus. Vacuum design is 0.7 psi.</p>				
<p><u>Post-Construction Testing:</u> Structural acceptance test will be run at 1.15 times the design pressure and held for at least 1 hour. Leakage rate tests will be run after the structural acceptance test.</p>				
<p><u>Penetrations:</u> Penetrations appear to be single barrier type. Electrical penetrations have a pressure tap for pressurizing and leakage testing.</p>				
<p><u>Weld Channels:</u> Found no reference</p>				

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: WPPS 3 & 5

Containment Spray System: There are 2 completely redundant 100% cap. systems, each with one pump, one shutdown cooling heat exchanger, and 1 spray header. Pumps initially take suction from the refueling water storage tank, but circulate water from the containment sump when the tank supply is exhausted. Each pump delivers 15,000 gpm at 260 psig. A heat exchanger has 171×10^6 Btu/hr heat removal capacity.

Containment Cooling: There are 4 fan coolers designed to remove the heat gain during normal operation only. Two units have sufficient capacity to maintain desired temperatures. Ducts distribute the air to promote mixing. Each unit moves 60,000 cfm. Other fan coil units remove heat from control elements.

Containment Air Filtration: A negative pressure is held in the annulus by one of two 100% capacity ventilation systems which filters any radioactivity that leaks from containment. Air passes thru HEPA and charcoal filters before release to the environment.

Combustible Gas Control: Hydrogen recombiner is provided with a redundant hydrogen purge system.

Containment Floodability: Found no reference to containment flooding.

Strong Motion Accelerometer: Two units will be installed in the containment structure, one 100' above the other. Also, one peak recording accelerograph will be provided.

Turbine Orientation: Turbine and reactors are on the same centerline. It is unlikely that ejected blades from the turbines could strike containment structures.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference to vessel failure. Text infers that proper design, material surveillance, vessel fabrication and inspection will produce a failure safe vessel.

Reactor Vessel Design: Material SA 533, Gr B, Cl I & SA 508, Cl II

Shell ID, in. 182 - 1/4 Shell Thickness 9 1/16"

Overall Height, ft/in. 50' - 1 5/8" Cladding Thickness, in. 1/8 min.

Reactor-Coolant Leak-Detection System: Leakage will be detected by the following means: (1) Containment sump level and pump operation, (2) Water level changes in pressurizer and makeup quantities, (3) Air particulate monitor, and (4) Detection of airborne gaseous isotopes. A leak of 1 gpm could be detected after 1 hour.

Failed-Fuel-Detection System: The process radiation monitor is designed to detect increased fission products in the coolant which would indicate cladding failure for less than 1 percent of fuel rods. The instrumentation continuously monitors a slip stream off the let-down flow path.

E. REACTOR CHARACTERISTICS		REACTOR: WPPS 3 & 5	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3800	H ₂ O/U, Hot	2.09
Electrical Output, MWe (net)	1240	Avg 1st-Cycle Burnup, MWD/MTU	13,740
Total Heat Output, Safety Design, MWt	4200	Maximum Burnup, MWD/MTU	< 55,000
Total Heat Output, Btu/hr	$13,000 \times 10^6$	Region-1 Enrichment, %	1.9
System Pressure, psia	2250	Region-2 Enrichment, %	2.4
DNBR, Nominal	2.22	Region-3 Enrichment, %	2.9
Total Flowrate, lb/hr	164×10^6	k _{eff} , Cold, No Power, Clean	1.17
Eff Flowrate for Heat Trans, lb/hr	157.4×10^6	k _{eff} , Hot, Full Power, Xe and Sm	1.07
Eff Flow Area for Heat Trans, ft ²	60.8	Total Rod Worth, %	~ 10
Avg Vel Along Fuel Rods, ft/sec	16.6	Shutdown Boron, No Rods-Clean-Cold, ppm	960
Heat Generated in Fuel, %	96.5	Shutdown Boron, No Rods-Clean-Hot, ppm	980
Hot Channel Factors, F _q	2.35	Boron Worth, Hot, % ppm/Δk/k	84
Nominal Core Inlet Temp, °F	565	Boron Worth, Cold, % ppm/Δk/k	65
Avg Rise in Core, °F	58	Full Power Moderator Temp Coeff, Δk/k/°F	(-0.4 to -2.1) × 10 ⁻⁴
Non Hot Channel Outlet Temp, °F	653	Moderator Pressure Coeff, Δk/k/psi	(+0.49 to 2.55) × 10 ⁻⁶
Avg Film Coeff, Btu/hr ft ² -°F	6300	Moderator Void Coeff, Δk/k/% Void	(-0.26 to -1.35) × 10 ⁻³
Avg Film Temp Diff, °F	30	Doppler Coefficient, Δk/k/°F	(-1 to -1.8) × 10 ⁻⁵
Active Heat Trans Surf Area, ft ²	69,000	Shutdown Margin, Hot 1 rod stuck, %Δk/k	2.4 T4.3-5
Avg Heat Flux, Btu/hr ft ²	182,200	Burnable Poisons, Type and Form	Al ₂ O ₃ -B ₄ C in Zircaloy - 4
Max Heat Flux, Btu/hr ft ²	425,700	Number of Control Rods	676
Avg Thermal Output, kw/ft	5.34	Number of Part-Length Rods (PLR)	32
Max Thermal Output, kw/ft	12.5	Number of Fuel Assemblies	241
Max Clad Surface Temp, °F	656	Overall Dimensions, inches	16 × 16
No. Coolant Loops	2	Number of Fuel Rods	56876
System 80 NSSS Combustion Engineering		Fuel Rod Cladding Material	Zircaloy-4
		Weight of Uranium, lbs.	260,520

F. SAFETY INJECTION SYSTEMS REACTOR: WPPS 3 & 5

Core Flooding System: There are 4 safety injection tanks, each containing 14,000 gallons of borated water, under nitrogen gas pressure of 600 psig. When reactor pressure drops below 600 psig, these tanks automatically (thru operation of check valves) inject their contents into the 4 reactor inlet lines - thus flooding the reactor core to prevent fuel melting.

High-Pressure Injection System: There are 2 pumps whose primary function is to inject borated water into the reactor in case of small pipe breaks. These pumps are also used for the recirculation phase. Pumps are rated 800 gpm at 1100 psig or 1100 at 650 psig. These 2 pumps with valves, piping, etc constitute 2 redundant systems.

Low-Pressure Injection System: System has 2 pumps (also used for shutdown cooling) each rated 4200 gpm at 150 psig. Pumps take suction from the refueling water storage tank until that supply is exhausted. These pumps do not run in the recirculation phase, although they could be if the operator desired. These 2 pumps, with valves and piping constitute 2 redundant systems.

G. MISCELLANEOUS

Decay Heat Removal System: Pumps and heat exchangers used for containment spray and low-pressure injection are also used for shutdown cooling. The shutdown cooling system takes over when reactor temp is 350F. A cross-connection between containment spray system and shutdown cooling system provides flexibility and a larger water supply for cooling. Heat exchangers transfer heat to the component cooling water system. Long term recirculation uses the high-pressure injection pumps and the shutdown cooling heat exchangers.

Radwaste System: Liquid waste system collects all radioactive or potentially radioactive fluids and treats them for complete recycling as makeup and feed water to the coolant system and steam generating system - thus reducing consumptive use and quantity of fluids discharged to the environments. The gaseous system has 2 subsystems - the retention subsystem and the recycle subsystem. Gases are collected in the gas surge tank, compressed, and held in the gas decay tank. Hydrogen gases are recombined with oxygen to water. Gases will be held for the 40 year life of the plant. Solid wastes are collected, stored, and shipped offsite for disposal.

Plant Vent: Vent stacks run up the outside of the containment structure.

G. MISCELLANEOUS (Continued) REACTOR: WPPS 3 & 5

Emergency Power: Each reactor system has 2 diesel-generator sets, each one serving the safety related loads in its division (1 or 2). Units will be independently housed with all auxiliaries independent for each. Units will be rated 5730 kw contin., or larger. Each unit will have a day tank, storage tank and fuel pump. Fuel storage will be adequate to run a diesel at full load for 7 days.

Emergency Plans: A manual will be prepared with procedures, check lists, and other necessary information to handle onsite and offsite emergencies, both radiological and nonradiological. Plans will provide procedures; communication channels; evaluation techniques; liason with AEC, city, county, state, and federal agencies; and periodic training and drills. Medical support will be arranged with physicians, hospitals, and ambulance crews. Final plans will be ready before AEC licensing.

Environmental Monitoring: Studies on the Chehalis and Satsop rivers started in June 73 to determine water quality, characteristics, and aquatic ecological factors. Pre-operational baselines will be established during the 2 years before startup, and monitoring will continue after operation. Ground water studies will be made in the area. Geologic and soil samples will be collected. Terrestrial Ecological samples will be obtained. Radiological monitoring started in May 1973 and consists of 3 phases - preliminary, preoperational and operational.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using hyperbolic cooling tower, 500' high.

Water Taken From: Infiltration type Ranney wells along south bank of the Chehalis River about 3 1/2 miles W. of plant.

Intake Structure: Three Ranney wells will supply about 16,000 gpm for makeup to each cooling tower or about 32,000 gpm total.

Water Body Temperatures: Winter minimum 36 °F; Summer maximum 80 °F
River Flow ~ 400 (cfs) minimum; 6640 (cfs) average
Service Water Quantity 16,000 gpm/reactor Essential & component cooling systems
Flow Thru Condenser 530,000 (gpm)/reactor Temp. Rise 31.3 °F
Heat Dissipated to Environment 8700×10^6 (Btu/hr)/reactor
Heat Removal Capacity of Condenser --- (Btu/hr)/reactor

Discharge Structure: Blowdown will be returned to the Chehalis River by a multiport diffuser system in the bottom of the river. Blowdown will be cooled before discharge.

Cooling Tower(s): Description & Number — 1 hyperbolic tower for each unit.
Blowdown 2800 gpm/reactor Evaporative loss 13,100 gpm/reactor

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Meteorology: Prevailing wind direction SE summer Avg. speed 12 mph
N winter 12.5
 Stability Data - The 'High air-pollu-
 tion potential' is very low.
Meteorological Measurements -
 On-site measurements started in the spring of 1973 with a 180' tower.

SITE DATA (Continued)		REACTOR: BLUE HILLS	
Exclusion Distance, Miles		0.82 radius	<u>Design Winds in mph:</u> At 0 - 50 ft elev 90 50 - 150 ft --- 150 - 400 ft --- Tornado 360 mph trans. + 60 rot. $\Delta P = \text{--- psi/ --- sec}$ Values not given in PSAR Bechtel report BC-TOP-3 is ref
Low Population Zone Distance, Miles		3 radius	
<u>Metropolis</u>	<u>Distance</u>	<u>Population</u>	
Beaumont-Port Arthur	75 mi.	315,343	
Safe Shutdown Earthquake Acceleration, g		0.13	
Operating Basis Earthquake Acceleration, g		0.07	
Earthquake Vertical Shock, % of Horizontal		66	
C. CONTAINMENT AND STRUCTURES			
Design Pressure, psig		60	Free Volume, cu ft 1.95×10^6
Calculated Max Internal Pressure, psig		48.6	Max Leak Rate at Design Pressure, %/day 0.1
<u>Type of Construction:</u> A single containment system consisting of a steel-lined, prestressed concrete, cylindrical shell, with a hemispherical dome. Steel liner is 1/4 inch thick, side walls are 4' thick with dome varying from 4' to 3'. The inside height is 193' with an ID of 130'. Base mat foundation is reinforced concrete 9' thick.			
<u>Design Basis:</u> Designed to maintain structural integrity under most severe postulated loading conditions, including combined effects of permanent loads, LOCA loads, earthquake, and tornado loads. Also designed to retain released fission products and maintain a leak rate below design levels.			
<u>Vacuum Relief Capability:</u> Found no reference			
<u>Post-Construction Testing:</u> Containment integrity test will be run after the structure is complete - in accordance with Bechtel test procedures. Leakage rate tests will also be run to their specifications.			
<u>Penetrations:</u> Found no reference			
<u>Weld Channels:</u> Leak chase channels are provided at seam welds when the welds are inaccessible.			

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: BLUE HILLS

Containment Spray System: Sodium hydroxide is added to the spray water for iodine removal. There are 2 - 50% capacity spray systems and also 2 - 50% fan-coil cooler systems. Each of the 2 spray pumps have capacity of 1750 gpm at about 200 psig. Also the circulating fans run after LOCA to circulate the air to prevent air stratification.

Containment Cooling: There are 2 independent trains with 2 coolers each. Normal cooling uses chilled water in the coils, but after LOCA, the nuclear service water system cools the coils. Each emergency cooling unit can remove 40×10^6 Btu/hrs with a max. cooling water temperature of 95 F. Also, there are 8 recirculation fans.

Containment Air Filtration: There is no ESF filtration system. Filtration is provided for the hydrogen purge back up system consisting of heating coil, high eff. filter, HEPA filter, charcoal absorber section, and final HEPA filter.

Combustible Gas Control: There are 2 hydrogen recombiners shared by the 2 units. These are backed up by a purge system. Recombiners are portable and operated manually.

Containment Floodability: Found no reference

Strong Motion Accelerometer: Triaxial accelerographs will be located in Cat. I structures plus one in the open area of the site. Peak values at the basement will be available in the control room.

Turbine Orientation: The turbine, furnished by Westinghouse, is on the same centerline as the reactor. Ejected turbine blades would probably not strike containment.

D. REACTOR COOLANT

Reactor Vessel Failure: Quality assurance and in-process examination programs, as well as inservice inspection, demonstrates that the vessel is adequate for all normal and transient operating conditions.

Reactor Vessel Design: Material SA-533, Gr.B, Cl I low alloy steel
 Shell ID, in. 157 Shell Thickness 7 7/8 in. min.
 Overall Height, ft/in. 43'-4" Cladding Thickness, in. 1/8 min.

Reactor-Coolant Leak-Detection System: Various detection methods are air particulates, radioactive gas, humidity, condensate in fan-coil coolers, dewpoint, charging pump operation, sump levels, and liquid levels in pressurizer or volume control tank. Sensitivity is 1 gpm for 1 hr. Max. allowed leakage is 50 gpm.

Failed-Fuel-Detection System: A sample line is tapped off the letdown stream with a shielded scintillation detector, and controls. The detector continuously measures gross gamma which could indicate fission product leakage from failed fuel elements.

E. REACTOR CHARACTERISTICS		REACTOR: BLUE HILLS	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	2814	H ₂ O/U, O ₂ vol ratio Cold first cycle-hot	2.08
Electrical Output, MWe (net)	953	Avg 1st-Cycle Burnup, MWD/MTU	12,500
Total Heat Output, Safety Design, MWe	2966	Maximum Burnup, MWD/MTU	55,000
Total Heat Output, Btu/hr	9604×10^6	Region-1 Enrichment, %	1.9
System Pressure, psia	2250	Region-2 Enrichment, %	2.3
DNBR, Nominal	2.31	Region-3 Enrichment, %	2.9
Total Flowrate, lb/hr	120.4×10^6	k _{eff} , Cold, No Power, Clean	1.92
Eff Flowrate for Heat Trans, lb/hr	116.2×10^6	k _{eff} , Hot, Full Power, Xe and Sm	1.081
Eff Flow Area for Heat Trans, ft ²	44.7	Total Rod Worth, hot, %	12.3
Avg Vel Along Fuel Rods, ft/sec	16.4	Shutdown Boron, No Rods-Clean-Cold, ppm	1000
Heat Generated in Fuel, %	96.5	Shutdown Boron, No Rods-Clean-Hot, ppm	990
Hot Channel Factors, F _q	2.35	Boron Worth, Hot, % $\Delta k/k/ppm$	82
Nominal Core Inlet Temp, °F	557.5	Boron Worth, Cold % $\Delta k/k/ppm$	62
Avg Rise in Core, °F	60.5	Full Power Moderator Temp Coeff, $\Delta k/k/°F$	(-0.5 to -2.5) $\times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	651	Moderator Pressure Coeff, $\Delta k/k/psi$	(+0.06 to +2.6) $\times 10^{-6}$
Avg Film Coeff, Btu/hr ft ² -°F	6170	Moderator Void Coeff, $\Delta k/k/\% \text{ Void}$	(-0.03 to -1.22) $\times 10^{-3}$
Avg Film Temp Diff, °F	31	Doppler Coefficient, $\Delta k/k/°F$	(-1.1 to -1.6) $\times 10^{-5}$
Active Heat Trans Surf Area, ft ²	51,000	Shutdown Margin, Hot 1 rod stuck, % $\Delta k/k$	1% min.
Avg Heat Flux, Btu/hr ft ²	182,200	Burnable Poisons, Type and Form	Al ₂ O ₃ -B ₄ C in Zircaloy - 4
Max Heat Flux, Btu/hr ft ²	425,800	Number of Control Rods	365
Avg Thermal Output, kw/ft	5.34	Number of Part-Length Rods (PLR)	40
Max Thermal Output, kw/ft	12.5	Number of Fuel Assemblies	177
Max Clad Surface Temp, °F	657	Overall Dimensions, inches	7.98 $\times$ 7.98
No. Coolant Loops	2	Number of Fuel Rods	40,716
		Fuel Rod Cladding Material	Zircaloy - 4
		Weight of Uranium, lbs. (UO ₂)	183,640

F. SAFETY INJECTION SYSTEMS REACTOR: BLUE HILLS

Core Flooding System: Four tanks, each containing 11,000 gal. of borated water under 600 psig pressure of nitrogen gas, inject their contents into one of the reactor cold legs when the system pressure drops below 600 psig. Two check valves in series are the only functioning equipment. The contents of 3 tanks are sufficient to cover the core with one tank pouring out thru a broken pipe.

High-Pressure Injection System: Primary function of the 2 high-pressure safety injection pumps is to inject borated water into the coolant system if a small break in piping occurs. Each pump is rated 300 gpm at 1250 psig. Maximum flow at low pressure is 825 gpm. Pumps take suction from the Refueling Water Storage Tank, except when performing the recirculation phase. Then water is pumped from the containment sump through the shutdown heat exchangers.

Low-Pressure Injection System: There are 2 pumps each rated 3100 gpm at 150 psig used to inject large quantities of borated water into the reactor after LOCA, or to provide shut down cooling, see Decay Heat Removal below. Pumps take suction from the Refueling Water Storage Tank. These pumps do not normally run in the recirculation phase, but can be used for that function if required. The high-pressure injection pumps provide the recirculation function.

G. MISCELLANEOUS

Decay Heat Removal System: This system uses the same pumps as the low-pressure injection system (see above) and the shutdown heat exchangers to circulate water through the reactor for cooldown from about 325 F. Long term cooling can be accomplished (after LOCA) by using high-pressure injection pumps to circulate borated water from the containment sump through the shutdown heat exchangers and the core.

Radwaste System: Liquid waste system recovers demineralized water and concentrates radioactive or chemical wastes for solidification. Particulate and ionic impurities in low TDS waste are removed by filters and ion exchangers. High TDS liquid wastes are concentrated. Evaporator distillate flows through ion exchangers prior to recycling as condensate makeup. Gaseous waste system has two separate process paths. High-activity, hydrogen rich gases are collected, compressed, and stored in tanks for radioactive decay. Low-activity, aerated gases are collected and released through building exhausts. After decay, waste gas decay tank contents are diluted, filtered and released with low-activity gases. Solid waste system collects, packages, provides temporary storage, compresses into drums, and ships offsite for disposal.

Plant Vent: Plant release point is at 368' elevation near the top of containment.

G. MISCELLANEOUS (Continued) REACTOR: BLUE HILLS

Emergency Power: There are 2 diesel-generator sets for each reactor, each rated 4500 kW. Each generator is connected to one load group. Each reactor has 2 load groups which are similar. Diesel units are completely independent. A day tank has 2 3/4 hr. supply and an underground storage tank has fuel for 7 days operation.

Emergency Plans: Objective of plans are protection of the public and plant personnel. Plans will cover minor accidental releases of activity to the design basis accident. An emergency committee will evaluate all accidents and decide course of action. Personnel will be trained to carry out plans with outside Texas organizations as required. Evacuations will be made in the utilities vehicles and employees cars as required. Local hospitals will be instructed in care of contaminated patients.

Environmental Monitoring:

NOTE - Environmental Report was not available so information on monitoring was not available. Also, information in PSAR on the Circulating Water System was not complete.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using mechanical draft cooling towers.

Water Taken From: Toledo Bend reservoir for make up.

Intake Structure: On the shore of Toledo Bend Reservoir 8 mi E. Water enters thru screens. Two pumps (each 100% capacity) are available.

Water Body Temperatures: Winter minimum ---°F; Summer maximum ---°F

River Flow ~695 (cfs) minimum; ~8400 (cfs) average

Service Water Quantity 23,000 gpm/reactor

Flow Thru Condenser 504,000 (gpm)/reactor Temp. Rise 28.6 °F

Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 6500×10^6 (Btu/hr)/reactor

Discharge Structure: Blowdown first goes into a plant discharge collection sump from which it is pumped back to Toledo Bend Reservoir. There is 1 discharge point about one mile downstream of the intake.

Cooling Tower(s): Description & Number - 3 mech. draft towers

Blowdown --- gpm/reactor Evaporative loss --- gpm/reactor

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NUCLEAR SAFETY INFORMATION CL. TER

A. GENERAL	
PROJECT NAME: Pebble Springs Nuclear Plant	
LOCATION: Gilliam Co., N. Central Ore., 55 mi WSW of Richland, Wash.	
OWNER: Portland General Electric Co.	
OWNER'S ADDRESS & CONTACT: J. L. Williams, Vice-President 621 S.W. Alder Street Portland, Oregon 97205	
ARCHITECT/ENGINEER: Bechtel	503-228-7181
REACTOR MANUFACTURER: B & W	
CONTAINMENT CONSTRUCTOR: Bechtel	
TURBINE MANUFACTURER: G.E.	DATE: April 1975
ESTIMATED STARTUP DATE: 1980	COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER	
B. SITE DATA Lat 45°42'5.9" N N 5064665 M Unit #1 Long 120°08'17.8 W E 722787 M	
Site Description: Site is 3 mi SE of the Columbia River and about 3 miles ESE of Arlington, Ore (pop 390) the only incorporated town within 10 miles of the site. Oregon State hwy #19 runs mostly N-S 1 1/2 mi W of site. I-80 runs along the Columbia River 3 mi NW. The Union Pacific RR runs along the river thru Arlington, and also parallels St. Rt #19 near the site, from which a spur will be run into the site. Except for a proposed nuclear waste burial site 8 mi SW, there is no industrial activity within 10 miles. Nearest schools are in Arlington. Average annual rainfall is 8 inches. There are no current plans for a visitor's center. The old Oregon Trail is 5 mi S.	
Nearby Body of Water: Normal Level 265' (MSL) Columbia River Max Prob Flood Level --- (MSL)	
Size of Site 8400 Acres Site Grade Elevation 740' (MSL)	
Topography of Site: Flat to Rolling of Surrounding Area (5 mi rad): Rolling with canyons on E. and W.	
Total Permanent Population: In 2 mi radius 9 ; 10 mi 510	
Date of Data: 1970 In 5 mi radius 460 : 50 mi 69,250	
Nearest City of 50,000 Population: Portland, Oregon	
Dist. from Site 120 Miles, Direction W , Population 365,000	
Land Use in 5-Mile Radius: Dryland Agriculture and grazing	
Meteorology: Prevailing wind direction WSW Avg. speed ~8 mph	
Stability Data - Category E about 50% of time - good mixing	
Meteorological Measurements - Data collection started in Dec -73 with a 230' tower.	

B. SITE DATA (Continued)			REACTOR: PEBBLE SPRINGS	
Exclusion Distance, Miles		0.5 radius	<u>Design Winds in mph:</u>	
Low Population Zone Distance, Miles		2 radius	At 0 - 50 ft elev 100	
<u>Metropolis</u>	<u>Distance</u>	<u>Population</u>	50 - 150 ft 120	
Portland, Ore.	120 mi	1,009,129	150 - 400 ft 140	
Safe Shutdown Earthquake Acceleration, g		0.25	Tornado 240 mph	
Operating Basis Earthquake Acceleration, g		0.125	$\Delta P = 0.84 \text{ psi/ } 1 \text{ sec}$	
Earthquake Vertical Shock, % of Horizontal		---	See Bechtel report BC-TuP-3	
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig		60	Free Volume, cu ft 2.45×10^6	
Calculated Max Inter- nal Pressure, psig		52.5	Max Leak Rate at Design Pressure, %/day 0.1	
<u>Type of Construction:</u> Prestressed, post-tensioned reinforced concrete vertical cylinder with 3.5 ft thick walls and 2.5 ft concrete dome. Interior has leak-proof steel liner (1/4" thick). ID is 130 ft, 225 ft high. All set on flat reinforced concrete foundation slab.				
<u>Design Basis:</u> Designed so that the containment structure, including access openings, penetrations, and heat removal systems can accommodate without exceeding design leakage rate the calculated pressure and temp conditions resulting from a LOCA, which is designated as a double-ended rupture of a reactor coolant pipe.				
<u>Vacuum Relief Capability:</u> Containment design considered 2 1/2 PSI external pressure. Found no reference to relief valves.				
<u>Post-Construction Testing:</u> Containment is pressured to 1.15×60 psig to determine structural integrity. Bechtel report BC-TCP-5 is referenced. Leakage rate tests are run to measure leakage and to verify design leak rate.				
<u>Penetrations:</u> All piping systems penetrating containment will have test vents and test connections for periodic leak testing.				
<u>Weld Channels:</u> Found no reference.				

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: PEBBLE SPRINGS

Containment Spray System: There are 2 independent trains, each having full capacity; each train has 1 pump, spray header, piping, valves, etc. The sodium hydroxide injection tank is common to both headers. Pumps, each rated 3350 gpm at 30 psig, take suction from the borated water storage tank.

Containment Cooling: There are 4 fan coil units which cool containment during normal operation and assist containment spray system to cool after LOCA. Emergency LOCA rating of each unit is 17.5×10^6 Btu./hr, in which case 600 gpm of cooling water flows thru the coils of each unit.

Containment Air Filtration: Hydrogen Vent System--2 full-capacity trains of equipment with blowers exhausting air from high point of containment filters the air thru HEPA and CHARCOAL filters in the Fuel Bldg. HVAC system.

Combustible Gas Control: Hydrogen is controlled by use of 2 hydrogen recombiners, an air mixing system and a hydrogen vent system that filters the air and exhausts it to the environment.

Containment Floodability: Found no reference.

Strong Motion Accelerometer: Section 3.7.4 states that seismic instrumentation will be installed and will be described in the FSAR. Bechtel report # BC-TOP-4 is referenced.

Turbine Orientation: Turbine centerline and reactor centerline are perpendicular. Ejected turbine blades could strike containment. Centerlines are about 203 ft apart.

D. REACTOR COOLANT

Reactor Vessel Failure: Ref. Sect. 5.2, "...descriptions of design, fabrication, and operating procedures.... support the conclusion that a rupture of the reactor vessel is not credible."

Reactor Vessel Design: Material SA-533 Grade B-18-8 clad

Shell ID, in. 182 Shell Thickness 9 1/4"

Overall Height, ft/in. 43-0 Cladding Thickness, in. 1/8 min.

Reactor-Coolant Leak-Detection System: Leakage will be detected by makeup tank liquid level, containment sump level and pump operation, area radiation monitors in the building, analysis of samples from the steam generator, humidity changes, and condensate increase from unit coolers. Allowable leakage limit is 10 gpm.

Failed-Fuel-Detection System: Main steam line radiation monitors would detect fission products in the steam which would indicate failed fuel rods.

E. REACTOR CHARACTERISTICS		REACTOR: PEBBLE SPRINGS	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3600	H ₂ O/U, Cold	2.93
Electrical Output, MWe (net)	1260	Avg 1st-Cycle Burnup, MWD/MTU	17,760
Total Heat Output, Safety Design, MWt	3760	Maximum Burnup, MWD/MTU	55,000
Total Heat Output, Btu/hr	$12,287 \times 10^6$	Region-1 Enrichment, %	2.95 avg.
System Pressure, psia	2,250	Region-2 Enrichment, %	---
DNBR, Nominal	1.82	Region-3 Enrichment, %	---
Total Flowrate, lb/hr	150.5×10^6	k _{eff} , Cold, No Power, Clean	1.261
Eff Flowrate for Heat Trans, lb/hr	142.4×10^6	k _{eff} , Hot, Full Power, Xe and Sm	1.136
Eff Flow Area for Heat Trans, ft ²	56.6	Total Rod Worth, % ($\Delta k/k$)	8.4
Avg Vel Along Fuel Rods, ft/sec	16.2	Shutdown Boron, with Rods-Clean-Cold, ppm	1399
Heat Generated in Fuel, %	97.3	Shutdown Boron, with Rods-Clean-Hot, ppm	1021
Hot Channel Factors, F _q	2.71	Boron Worth, Hot, % $\Delta k/k/ppm$	1/108
Nominal Core Inlet Temp, °F	572.3	Boron Worth, Cold % $\Delta k/k/ppm$	1/82
Avg Rise in Core, °F	59.3	Full Power Moderator Temp Coeff, % $k/k/°F$	(+0.12 to -3.0) $\times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	652.7	Moderator Pressure Coeff, % $k/k/psi$	-3×10^{-7} to $+3 \times 10^{-6}$
Avg Film Coeff, Btu/hr ft ² -°F	---	Moderator Void Coeff, % $k/k/\% \text{ Void}$	-1.36×10^{-4} BOL
Avg Film Temp Diff, °F	---	Doppler Coefficient, % $k/k/°F$	-1.25 to -1.45
Active Heat Trans Surf Area, ft ²	3,991	Shutdown Margin, Hot 1 rod stuck, % $\Delta k/k$	1.0
Avg Heat Flux, Btu/hr ft ²	186,800	Burnable Poisons, Type and Form	B ₄ C in Al ₂ O ₃ in Zircaloy -4 rod
Max heat Flux, Btu/hr ft ²	507,000	Number of Control Rods 64 x 24	1536
Avg Thermal Output, kw/ft	5.43	Number of Part- 8 x Length Rods (PLR) 24	192
Max Thermal Output, kw/ft	14.74	Number of Fuel Assemblies	205
Max Clad Surface Temp, °F	657	Overall Dimensions, inches	8.536 x 8.536
No. Coolant Loops	2	Number of Fuel Rods	54,120
		Fuel Rod Cladding Material	Zircaloy -4
		Weight of Uranium, lbs.	233,884

F. SAFETY INJECTION SYSTEMS REACTOR: PEBBLE SPRINGS

Core Flooding System: There are 2 tanks each having 10,125 gallons of borated water held at 600 psig by nitrogen gas. When pressure in the reactor coolant system drops to 600 psig in an emergency, check valves open automatically and contents of the tanks are injected into the reactor to flood the core and prevent fuel melting.

High-Pressure Injection System: There are 3 makeup or charging pumps which operate to inject borated water into the reactor to prevent small pipe leaks from uncovering the core. Pumps are rated 700 gpm at 1125 psig.

Low-Pressure Injection System: Two pumps, each rated 5500 gpm at 165 psig, pump borated water from the borated water storage tank into the core through the core flooding nozzles. When water in the storage tank is gone, pumps then recirculate the water from the containment sump through the Decay Heat removal heat exchangers. These pumps are part of the Decay Heat Removal System.

G. MISCELLANEOUS

Decay Heat Removal System: Normally operates for shutdown cooling using low pressure injection pumps (see above) and heat exchangers of the Decay Heat Removal System. This system can operate for long term cooling. Each of the 2 heat exchangers are rated 41×10^6 Btu/hr. These pumps provide an alternate means of pumping water into or out of the refueling canal.

Radwaste System: Radioactive gases are collected and held for decay. When sufficient decay has occurred, gaseous wastes are discharged through monitored exhaust ducts to the environment through filters to remove particulates. Makeup and Purification System and Boron Recovery System remove ionic, particulate, and gaseous radioactive materials from the reactor coolant. Liquid radioactive effluents are collected and processed by filtration, demineralization, and evaporation to give either high quality water of low radioactivity for reuse in the plant or concentrated sludges that are then converted to solid form. Solid radioactive wastes are shipped off-site for disposal.

Plant Vent: Stack runs up the side of the containment structure and vents at 968', 228' above grade.

G. MISCELLANEOUS (Continued) REACTOR: PEBBLE SPRINGS

Emergency Power: Two diesel-generators are available for each reactor unit. Each generator is connected to an ESF load group and is completely independent from other units. Ratings are 5000 kW continuous for each diesel-generator. Each diesel has a day tank and fuel oil storage tank with at least 7 days supply of fuel for full load operation.

Emergency Plans: Plans cover measures required to safeguard plant personnel, protect public health and safety, and to prevent property damage in case of accidents involving radioactive materials. Because of low population density, there are not many people living or working near the plant. Procedures and drills will be used to train personnel. Local, state and federal agencies will be used as needed. The Hanford facility medical group will be used.

Environmental Monitoring: Preoperational environmental programs will collect baseline data to establish references for assessing later environmental effects attributable to site preparation, plant construction and operation. Information is being collected to evaluate surface waters, groundwater, air and land. Surface water studies cover the Columbia River for physical and chemical parameters including studies of aquatic life. Studies of the air are mostly meteorological. Land studies cover soils, geology, ecological factors for vegetation and animal life.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using surface cooling of a proposed 1900 acre cooling pond.

Water Taken From: Columbia River for makeup - 17,500 gpm max (summer) for each reactor.

Intake Structure: Reinforced concrete on edge of reservoir. Each of 2 structures has 3 bays with circulating pumps, trash racks, and traveling screens. Passageways for fish to escape are provided.

Water Body Temperatures: Winter minimum 32 °F; Summer maximum 70 °F

River Flow 75,000 (cfs) minimum; 188,000 (cfs) average

Service Water Quantity 22,630 gpm/reactor

Flow Thru Condenser 780,000 (gpm)/reactor Temp. Rise 20 °F

Heat Dissipated to Environment 8500×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser 7880×10^6 (Btu/hr)/reactor

Discharge Structure: Designed for discharge slightly underwater, reducing discharge velocity so heated water will rise to the surface.

Cooling Tower(s): Description & Number - No towers - cooling pond

Blowdown --- gpm/reactor Evaporative loss 16,000 gpm/reactor

NUCLEAR SAFETY INFORMATION CENTER

A. GENERAL

PROJECT NAME: Jamesport Nuclear Power Station, Units 1 & 2

LOCATION: N. Shore of Long Island, Suffolk Co. 65 mi E. of N.Y. City

OWNER: Long Island Lighting Co.

OWNER'S ADDRESS & CONTACT: Andrew W. Wofford, Vice President

175 E. Old County Road
Hicksville, N.Y. 11801

ARCHITECT/ENGINEER: Stone & Webster

REACTOR MANUFACTURER: West.

CONTAINMENT CONSTRUCTOR: Long Island Light.

TURBINE MANUFACTURER: G.E.

DATE: April 1975

COMPILED BY: Fred Heddieson

ESTIMATED STARTUP DATE: 1981

NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA Long 72°35'39" Lat 40°59'24" E702,378 N4,540,223 #1
72°35'45" 40°59'22" E702,247 N4,540,164 #2

Site Description: Located on N. shore of Long Island about 14 mi E. of the Shoreham Nuclear Plant, 6.2 mi NE of Riverhead (pop 7585) and 3 mi NNE of Jamesport (pop 890). State hwy #25 runs E-W 2 mi S. of site. Sound Ave which forms southern boundary of site will be 3000 ft from reactors. Nearest RR is the Long Island which runs thru Jamesport. Nearest community is Northville 1.5 mi SW (pop 2503), and nearest homes are about 1/2 mi S. Jamesport beach is 3.5 SSE and a boys camp is 2 mi WSW. Nearest school is in Laurel 2.5 mi ESE. Central Suffolk Hospital is in Riverhead. The nearest commercial airport is 4.2 mi SSE in Mattituck. Grumman Aerospace Corp is the nearest large industrial firm 11 mi WSW.

Nearby Body of Water:

Normal Level 0 (MSL)

Long Island Sound

Max Prob Flood Level 34' (MSL)

Size of Site 525 Acres Site Grade Elevation 61' (MSL)

Topography of Site: level - on a bluff overlooking Long Island Sound
of Surrounding Area (5 mi rad): level

Total Permanent Population: In 2 mi radius 632 ; 10 mi 35,006

Date of Data: 1970 In 5 mi radius 8934 ; 50 mi 3,059,715

Nearest City of 50,000 Population: West Haven, Conn.

Dist. from Site 28 Miles, Direction NW, Population 52,851

Land Use in 5-Mile Radius: AgriculturalMeteorology: Prevailing wind direction SW Avg. speed 8 mph

Stability Data - Conditions causing air pollution occurs twice a year.

Meteorological Measurements - Measurements started in Sept. -73 using
 a 400 ft tower.

B. SITE DATA (Continued)			REACTOR: JAMESPORT	
Exclusion Distance, Miles	0.42 radius	Design Winds in mph:		
Low Population Zone Distance, Miles	2	At 0 - 50 ft elev	100	
<u>Metropolis</u>	<u>Distance</u>	<u>Population</u>	50 - 150 ft	120
New York City	65 mi	11,571,900	150 - 400 ft	140
Safe Shutdown Earthquake Acceleration, g	0.20	Tornado 300 mph Rot + 60 trans.		
Operating Basis Earthquake Acceleration, g	0.10	$\Delta P = \underline{3} \text{ psi} / \underline{3} \text{ sec}$		
Earthquake Vertical Shock, Z of Horizontal	66			
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig	45	Free Volume, cu ft	2.3×10^5	
Calculated Max Inter- nal Pressure, psig	40.6	Max Leak Rate at Design Pressure, Z/day	0.1	
<p><u>Type of Construction:</u> Steel-lined, reinforced concrete structure with a vertical cylindrical wall and hemispherical dome, all supported on a flat concrete base mat. ID is 140', overall height is 200'; side walls are 4'-6" thick with a 2'-6" thick dome. Containment operates at subatmospheric pressure. Steel liner on walls is 3/8" thick with 1/2" thick on the dome.</p>				
<p><u>Design Basis:</u> Designed to operate at subatmospheric pressure so containment pressure after a LOCA can be brought back to atmospheric in 60 minutes. Designed to be leaktight and to withstand by some margin the loads imposed on the system by a LOCA.</p>				
<p><u>Vacuum Relief Capability:</u> Found no reference -- probably vacuum pump that maintains subatmospheric pressure would be cut off automatically. Designed for 8 psia.</p>				
<p><u>Post-Construction Testing:</u> Acceptance test will be run in accordance with Regulatory Guide 1.18 at 1.15×45 psig (design pressure). Leakage rate tests will be performed after construction and periodically thereafter.</p>				
<p><u>Penetrations:</u> Electrical penetrations can be pressurized to check for leak tightness. Other penetrations are single barrier type.</p>				
<p><u>Weld Channels:</u> Leak chase channels will be placed over all seam welds that will be inaccessible. These channels can be pressurized for leak testing.</p>				

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: JAMESPORT

Containment Spray System: Identified as Quench Spray and Recirculation Spray; designed to cool containment and depressurize after LOCA back to subatmospheric pressure. Consists of two parallel 100% cap. quench sprays with two 360° spray header and two parallel 100% cap. recirculation systems with two 360° spray headers. Quench spray has 2 pumps with 8000 gpm total flow. Recirculation has 4 pumps (13,800 gpm total)

Containment Cooling: There are 3 fan-coil units that cool during normal operation, and do not run under emergency conditions such as LOCA. Each unit has cap. of 2×10^6 Btu/hr using chilled water at 45F. Two units are required to dissipate the normal heat load.

Containment Air Filtration: There are 2-100% capacity systems consisting of fan, demister, electric heater prefilter, HEPA filter, charcoal absorber, and HEPA filter. Rated capacity is 12,000 cfm each. This system circulates the air. The purge system removes air.

Combustible Gas Control: Either 2 catalytic or 2 thermal type hydrogen recombiners will be supplied, each 100% capacity. The containment vacuum system is backup for the recombiners and can exhaust hydrogen.

Containment Floodability: Found no reference

Strong Motion Accelerometer: Two accelerographs will be installed in containment of Unit 1, one on the base mat and one above it on the operating floor; another in aux. bldg. and 1 in the field.

Turbine Orientation: Reactor and turbine are on same centerline. It is unlikely that ejected turbine blades could strike containment.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference

Reactor Vessel Design: Material SA 533 Gr. A, B, or C, Cl 1 or 2

Shell ID, in. 173 Shell Thickness 8 1/2"

Overall Height, ft/in. 43'-10" Cladding Thickness, in. 1/8" min.

Reactor-Coolant Leak-Detection System: Leakage can be determined by gas and particulate radiation monitors (0.1 gpm in 1.5 min), containment air recirculation fan coolers (5 gpm in 60 min), drain sump (10 gal. leak) reactor coolant makeup rate, containment drains transfer tank level, and the pressurizer relief tank temperature. Maximum allowable leakage will be given in the FSAR.

Failed-Fuel-Detection System: The presence of minor quantities of fission products in the coolant can be detected with the gross gamma monitor on the letdown line.

E. REACTOR CHARACTERISTICS		REACTOR: JAMESPORT	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3411	H ₂ O/U, Cold	4.0
Electrical Output, MWe (net)	1153	Avg 1st-Cycle Burnup, MWD/MTU	11,500
Total Heat Output, Safety Design, MWt	3636	Maximum Burnup, MWD/MTU	38,000
Total Heat Output, Btu/hr	$11,642 \times 10^6$	Region-1 Enrichment, %	2.25
System Pressure, psia	2250	Region-2 Enrichment, %	2.80
DNBR, Nominal	2.03	Region-3 Enrichment, %	3.30
Total Flowrate, lb/hr	142.2×10^6	k _{eff} , Cold, No Power, Clean	<1.60
Eff Flowrate for Heat Trans, lb/hr	135.8×10^6	k _{eff} , Full Power, Xe and Sm	<1.25
Eff Flow Area for Heat Trans, ft ²	51.4	Total Rod Worth, %	9.74
Avg Vel Along Fuel Rods, ft/sec	16.9	Shutdown Boron, No Rods-Clean-Cold, ppm	<1500
Heat Generated in Fuel, %	97.4	Shutdown Boron, No Rods-Clean-Hot, ppm	<1200
Hot Channel Factors, F _q	2.33	Boron Worth, Hot, % $\Delta k/k/ppm$	1/120
Nominal Core Inlet Temp, °F	557.3	Boron Worth, Cold % $\Delta k/k/ppm$	1/60
Avg Rise in Core, °F	62.3	Full Power Moderator Temp Coeff, $\Delta k/k/°F$	0 to -4×10^{-4}
Nom Hot Channel Outlet Temp, °F	~650	Moderator Pressure Coeff, $\Delta k/k/psi$	(-0.04 to +3) $\times 10^{-6}$
Avg Film Coeff, Btu/hr ft ² -°F	~6000	Moderator Void Coeff, $\Delta k/k/\%$ Void	Negative
Avg Film Temp Diff, °F	~36	Doppler Coefficient, $\Delta k/k/°F$	Negative
Active Heat Trans Surf Area, ft ²	52,000	Shutdown Margin, Hot 1 rod stuck, $\Delta k/k$	1
Avg Heat Flux, Btu/hr ft ²	217,200	Burnable Poisons, Type and Form	Borosilicate glass crystals in tubes
Max Heat Flux, Btu/hr ft ²	521,300	Number of Control Rods	53
Avg Thermal Output, kw/ft	7.05	Number of Part-Length Rods (PLR)	160
Max Thermal Output, kw/ft	16.9	Number of Fuel Assemblies	193
Max Clad Surface Temp, °F	~660	Overall Dimensions, inches	8.426 $\times$ 8.426
No. Coolant Loops	4	Number of Fuel Rods	39,372
W RESAR-3		Fuel Rod Cladding Material	Zircaloy-4
		Weight of Uranium, lbs. (as UO)	218,000

F. SAFETY INJECTION SYSTEMS REACTOR: JAMESPORT

Core Flooding System: There are 4 accumulators each containing 6400 gal. of borated water held at about 600 psig by nitrogen cover gas. Each tank is connected to one of the reactor vessel cold legs so that when system pressure drops below 600, check valves open allowing the accumulator contents to be injected into the reactor vessel to flood and cover the core.

High-Pressure Injection System: There are 3 charging pumps which are used for high-pressure injection. Each of these pumps is rated 150 gpm at 2500 psig and can replace water lost from a 6" pipe break. Also, there are 2 intermediate pressure range pumps, each rated 425 gpm at 1080 psig which operates in conjunction with other pumps to flood the core. High-Pressure Injection pumps deliver through the boron injection tank.

Low-Pressure Injection System: Low-pressure injection pumps are the Residual Heat Removal system pumps which perform 3 main functions. All injection pumps take suction from the refueling water storage tank. Each of the 2 RHR pumps is rated 4000 gpm at 150 psig. When water in the RFW tank is running low, RHR pumps would be switched over to recirculate water from the containment sump.

G. MISCELLANEOUS

Residual Heat Removal System: System is used to reduce reactor temp from 350 F to 120 F in 20 hours for shutdown. Also, system is used to transfer refueling water from the storage tank to the cavity and return. These same pumps serve as the low-pressure injection pumps. There are 2 systems each consisting of 1 pump, and 1 heat exchanger, with the associated piping and controls. Pumps are rated 4000 gpm each at 150 psig. This system could be used for long term cooling. Heat exchanger capacity is 35×10^6 Btu/hr each.

Radwaste System: Liquid waste system collects, classifies and processes waste liquids generated during operation and refueling, either for recycle or for discharge offsite. Processes are filtration, evaporation, and demineralization. Gaseous wastes, consisting of hydrogen streams and air streams containing radioactivity, are treated before release to the environment or recycle. Degasification and purification produces hydrogen waste gas streams, which are passed through charcoal decay beds to provide holdup time for decay of noble gases and iodine removal. Aerated waste gas streams, are passed through carbon adsorbers for iodine removal. Radioactive solid waste system provides holdup, packaging and storage facilities for offsite shipment and ultimate disposal.

Plant Vent: Release point for process vent is top of containment structure about 160 ft above grade.

G. MISCELLANEOUS (Continued) REACTOR: JAMESPORT

Emergency Power: There will be 2 diesel-generator sets for each reactor unit. Each diesel-generator set is completely independent from others with complete auxiliaries for each. Each diesel has 2 air starting systems, day fuel tank, and underground storage adequate for 7 days full power operation. Size of units will be given in FSAR.

Emergency Plans: Will cover emergencies from minor incidents involving only plant personnel to major accidents which may endanger the health and safety of the public; covering 4 areas - 1. Identification and evaluating the potential danger, 2. Direction of activities to limit consequences, 3. Organization and control relative to use of off-site authorities, and 4. Delineation of protective levels. Prepared procedures will be made familiar to all involved and training programs will be carried out.

Environmental Monitoring: Studies began in July -73 to obtain data for analysis of Long Island Sound water for chemical parameters, tidal currents, temp measurements, dye diffusion studies, plus analyses of Hallock Pond for chemical parameters and water level. Studies consider fish, zooplankton, phytoplankton, benthos and aquatic macrophytes. Terrestrial ecology studies are looking at vegetation, animal life, reptiles, birds, and mammals. Soils have been studied relative to geology. A preliminary radiological survey has been conducted, and a preoperational study will begin about 2 years prior to operation.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Long Island Sound

Intake Structure: Water flows into the intake structure - pump houses through a 700' wide canal that runs 800' out into the sound. Each unit has a pump house which is a reinforced structure at the shore line. There are 6 circulating pumps with bar racks, traveling screens, etc.

Water Body Temperatures: Winter minimum 30 °F; Summer maximum 77°F

River Flow NA (cfs) minimum; NA (cfs) average

Service Water Quantity 30,000 gpm/reactor

Flow Thru Condenser 906,700 (gpm)/reactor Temp. Rise 18 °F

Heat Dissipated to Environment 7900×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser --- (Btu/hr)/reactor

Discharge Structure: Water discharged from the condenser flows into a static lift chamber which maintains acceptable backpressure on the condenser. Water flows from this chamber through a 14' dia. pipe into the lake where it is discharged 2000 to 2890 ft off shore by a diffuser.

Cooling Tower(s): Description & Number - ONE

Blowdown --- gpm/reactor Evaporative loss --- gpm/reactor

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HARTSVILLE, 50-518, -519, -520, -521

Page 1, BWR

A. GENERAL	
PROJECT NAME: Hartsville Nuclear Plants	
LOCATION: North Central Tenn., 40 mi. NNE of Nashville, Tenn.	
OWNER: TVA	
OWNER'S ADDRESS & CONTACT: James E. Watson, Manager of Power TVA	
ARCHITECT/ENGINEER: TVA & C. F. Braun	818 Power Building Chattanooga, Tenn. 37401
REACTOR MANUFACTURER: G.E.	
CONTAINMENT CONSTRUCTOR: TVA	
TURBINE MANUFACTURER: Brown-Boveri	DATE: May 1975
COMPILED BY: Fred Heddleson	
ESTIMATED STARTUP DATE: 1980	
NUCLEAR SAFETY INFORMATION CENTER	
Lat 36° 21' 15.16" N N 4,023,423.6 B. SITE DATA Long 86° 05' 09.81" W E 582,004.5	
<p><u>Site Description:</u> On the county line between Smith & Trousdale counties on the north bank of the Cumberland River (Old Hickory Reservoir) at River Mile 285. Nearest communities are Dixon Springs (pop less than 100) 1 1/2 mi E, Hartsville (pop 2,243) 5 mi W, and Carthage (pop 2491) 10 mi SE. Nearest larger town is Lebanon 16 mi SW with 12,492 people. The site is bounded on the north by Tn hwy 25. U.S. hwy 70 is across the river and about 6 mi S. I-40 is about 12 miles S. The nearest school is 3.7 mi NW. Within a 5 mi radius, there are 900 dairy cattle. There are 13 recreational areas within 10 mi having about 1300 people located there during peak hours. Within 5 mi, there are 300 people. A natural gas transmission line crosses the northern part of the site having a gas pumping station located immediately adjacent to the NE corner. A railroad spur will be run in from Hartsville.</p>	
<u>Nearby Body of Water:</u> Cumberland R.	Normal Level 442' (MSL)
Old Hickory Reservoir	Max Prob Flood Level 533' (MSL)
Size of Site 1940 Acres	Site Grade Elevation 545' (MSL)
<u>Topography of Site:</u> Rolling	
<u>of Surrounding Area (5 mi rad):</u> Rolling	
<u>Total Permanent Population:</u> In 2 mi radius 260 ; 10 mi 12,340	
<u>Date of Data:</u> 1970 In 5 mi radius 2585 ; 50 mi 891,355	
<u>Nearest City of 50,000 Population:</u> Nashville, TN	
<u>Dist. from Site</u> 40 Miles, <u>Direction</u> WSW, <u>Population</u> 275,000	
<u>Land Use in 5-Mile Radius:</u> Mostly agricultural, pasture land and hay crops predominating.	
<u>Meteorology:</u> Prevailing wind direction ENE Avg. speed 24 mph	
Stability Data - Pasquill D & E over 50% of the time	
Meteorological Measurements - Data collection started in Feb. 1973 with data taken at 33' and 150' above the ground.	

B. SITE DATA (Continued)			REACTOR: HARTSVILLE	
Exclusion Distance, Miles		0.63	Design Winds in mph:	
Low Population Zone Distance, Miles		3 radius	At 0 - 50 ft elev 95	
Metropolis	Distance	Population	50 - 150 ft 110	
Nashville, TN	40	448,444	150 - 400 ft 145	
Safe Shutdown Earthquake Acceleration, g		0.18	Tornado 300 mph tang. + 60 mph trans.	
Operating Basis Earthquake Acceleration, g		0.09	$\Delta P = \underline{3} \text{ psi} / \underline{3} \text{ sec}$	
Earthquake Vertical Shock, % of Horizontal		100		
C. CONTAINMENT AND STRUCTURES				
G.E.	Drywell Design Pressure, psig		25	Primary Containment Leak Rate, %/day 0.5
	Suppression Chamber Design Pressure, psig		15	Secondary Containment Design Pressure, psig 0.2
	Calculated Max Internal Pressure, psig		26	Secondary Containment Leak Rate, %/day 0.1
G.E.	<u>Type of Construction:</u> Mark III type using drywell/pressure suppression concept in a dry containment structure. The cylindrical suppression pool surrounds the drywell but is inside the free standing steel containment vessel which is cylindrical with a domed roof. A reinforced concrete shield building surrounds the steel containment vessel leaving an annulus space between the two structures. Free volume of containment is 1.16×10^6 cu ft. Drywell free volume is 280,000 cu ft. Suppression pool water volume is 152,600 cu ft.			
G.E.	<u>Design Basis:</u> Designed to control release of radioactivity to the environment using the leak-tight steel shell, the shield building, standby gas treatment system, and auxiliaries after LOCA. Design based on double-ended break of the largest reactor coolant pipe. Containment temperature and pressure are limited following LOCA by the Engineered Safety Features, Suppression Pool, and Residual Heat Removal System.			
G.E.	<u>Vacuum Relief Capability:</u> There will be 2 vacuum relief lines with a check valve and an automatic air-operated butterfly valve.			
G.E.	<u>Post-Construction Testing:</u> Structural acceptance test will be run at 115% of design pressure and held for 1 hr. After the structural test, a leak-rate test will be run at design pressure. Three leak-rate tests will be performed during each 10-yr period after startup.			
<u>Penetrations:</u> Sketches of penetrations show them to be single sealed; however, the text states that electrical penetrations can be pressurized and checked for leakage.				
<u>Weld Channels:</u> Found no reference.				

C. CONTAINMENT & STRUCTURES (Contd) REACTOR: HARTSVILLE

G.E. Containment Heat Removal System: Steam dumped into containment in case of LOCA will vent to the suppression pool. As the steam condenses there, the suppression pool water will be heated. It will be pumped back to the reactor vessel, through the Residual Heat Removal heat exchangers for cooling. System is designed to limit suppression pool to a maximum of 185 F. A reactor vessel head spray can be operated to condense steam in the vessel before it is vented to containment.

G.E. Standby Gas Treatment System: Consists of two 100% capacity (5000 cfm) systems with demister, electric heater, prefilter, HEPA filter, charcoal absorber, and a final HEPA filter that maintains a slight vacuum in the annulus during operation and cleans up all air discharged to the atmosphere after LOCA. A vacuum system prevents annulus pressure from exceeding atmospheric after LOCA.

G.E. Combustible Gas Control: Containment air will be mixed with drywell air after LOCA to dilute hydrogen. Also, a recombiner will limit long term hydrogen buildup. A backup system can purge containment.

G.E. Containment Floodability: Can be flooded to the top of the weir wall.

G.E. Strong Motion Accelerometer: One unit will be placed in the basement of containment and another one higher in the structure. Peak recording accelerographs will be installed and will read out in the control room.

Turbine Orientation: Turbines by Brown-Boveri Co.p. Turbine and reactor are on the same centerline.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference to failure.

G.E. Reactor Vessel Design: Material - Low alloy steel SA533 Gr.B
 Shell ID, in. 238 Shell thickness, in. 5.70
 Overall height, ft/in. about 73' Cladding thickness, in. 1/8

G.E. Leak-Detection System: Small leaks are detected by temperature and pressure changes, fill-up rate of drain sumps, and fission product concentrations. Changes in water level and/or flow rates are best indication of large leaks. Large leak detection initiates automatic isolation, small leaks initiate an alarm in the control room. The total leakage rate limit is set at 50 gpm.

G.E. Failed-Fuel-Detection System: Four gamma radiation monitors are located external to the main steam lines just outside containment. On detection of high radiation, the reactor will be scrammed and main steam line isolation valves will close.

Long-Term Cooling: Recirculation of suppression pool water or use of soray pond water will provide long-term cooling.

E. REACTOR CHARACTERISTICS		REACTOR: HARTSVILLE	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, Mwt	3579	Moderator Temp Coef Cold, $\Delta k/k/^{\circ}F$	$+4 \times 10^{-5}$
Electrical Output, Mwe (net)	1205	Moderator Temp Coef Hct, No Voids	-14×10^{-5}
Total Heat Output, Safety Design, Mwt	3758	Moderator Void Coef Hot, No Voids, $\Delta k/k/\%$	$\sim -5 \times 10^{-4}$
Steam Flow Rate, lb/hr	15.39×10^6	Moderator Void Coef Operating	$\sim -20 \times 10^{-4}$
Total Core Flow Rate, lb/hr	105×10^6	Doppler Coefficient, Cold	-1.7×10^{-5}
Feedwater Flow Rate, million lb/hr	15.354×10^6	Doppler Coefficient, Hot, No Voids	-1.05×10^{-5}
Feedwater Temperature, $^{\circ}F$	420	Doppler Coefficient, Operating	-1.1×10^{-5}
Coolant Pressure, psig	1040	Initial Enrichment, %	2.07
Heat Transfer Area, ft^2	73,409	Average Discharge Exposure, MWD/Ton	12,000 to 19,000
Max Power per Fuel Rod Unit Lgth, kw/ft	13.4	Control Rod Worth, %	0.01 Δk
Maximum Heat Flux, Btu/hr- ft^2	354,000	Burnable Poisons, Type and Form	Gd ₂ O ₃ mixed with UO ₂
Average Heat Flux, Btu/hr- ft^2	159,570	Number of Moveable Control Rods	177
Maximum Fuel Temperature, $^{\circ}F$	3325	No. of In-Core Neutron Detectors (Fixed)	164
Average Fuel Rod Surface Temp., $^{\circ}F$	~ 565	No. of In-Core Detector Assemblies	41
MCHFR	≥ 1.9	Number of Fuel Assemblies	732
Coolant Enthalpy at Core Inlet, Btu/lb	527.8	Fuel Rod Array	8 x 8
Total Peaking Factor	2.22	No. Fuel Rods Per Fuel Assembly	63
Avg Power Density, Kw/l	56.0	MISCELLANEOUS:	
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	BWR/6 238-732 G.E. Reactor Island Design Fuel rod cladding - Zircaloy-2 Uranium weight 304,200#	
Core Max. Exit Voids Within Assembly, %	76		
Number of Recirculation Loops	2		
Pipe Diameter, in.	22/24		
Recirculation Pump Flow, gpm	35,400		
Number of Jet Pumps in Reactor	20		
Number of Main Steam Lines	4		
Pipe Diameter, in.	26		

G.E.

F. EMERGENCY CORE COOLING SYSTEMS REACTOR: HARTSVILLE

- G.E. High-Pressure Core Spray: Consists of one motor-driven pump, 1465 gpm at 1130 psid or 6000 gpm at 200 psid, piping, valves, etc., the pump and motor located outside containment. Suction is from the RCIC condensate storage tank, or the suppression pool. Piping inside the reactor vessel has spray nozzles which spray water over the core. Low water level or high drywell pressure starts the pump. System is designed to cool the core sufficiently to limit cladding temperatures to less than 2300 F.
- G.E. Auto-Depressurization System: If the RCIC and HPCS cannot maintain reactor water level, the ADS causes steam to be released to the suppression pool through pressure relief valves so pressure in the vessel is lowered to where low pressure emergency core cooling systems can operate. ADS will not reduce pressure unless LPCS and LPCI pumps are operating.
- G.E. Low-Pressure Core Spray: Consists of one pump (6000 gpm at 122 psid), spray sparger in the reactor vessel above the core, piping, etc. Suction is taken from the suppression pool. Pump is actuated by low water in the reactor vessel or high pressure in the drywell. System can spray enough water on the core to hold cladding temperatures below 2300 F.
- G.E. Low-Pressure Coolant-Injection System: This is one of the independent operating subsystems of the KPRS. It is actuated by low water level in the reactor or high pressure in the drywell. There are 3 pumps (each rated 7100 gpm at 20 psid) with associated valves, piping, etc. that take suction from the suppression pool, thus providing closed loop recirculation capability.

G. MISCELLANEOUS

- G.E. Residual-Heat-Removal System (RHRS): The system has 3 pumps rated 7100 gpm each at 20 psid, 2 heat exchangers rated 45×10^6 Btu/hr each, piping, etc. There are 4 modes of operation:
1. Shutdown cooling to 125F in 20 hours after reactor shutdown.
 2. Use heat exchangers to condense steam from the reactor vessel.
 3. Low-Pressure Coolant-Injection System - described above.
 4. Containment Heat Removal System - discussed at top of page 3.
- The heat exchangers are cooled by RHR service water.

Radwaste System: Units 1 & 2 will have shared facilities, as will Units 3 & 4 (2 independent systems). Liquid wastes will be processed on a batch basis (filtration, evaporation, and demineralization). Processed liquids will be discharged to the river (0.1 ci/yr/reactor excluding tritium). Main source of gaseous waste is offgas from the main condenser air ejectors. A refrigerated charcoal delay system will remove iodine, etc. Processed gases will be vented to atmosphere. Solid wastes will be either wet or dry. Wet will be shipped offsite in 170 cu ft containers - dry in 55 gal drums.

Plant Vent: Vented from roof top.

G. MISCELLANEOUS (Continued) REACTOR: HARTSVILLE

G.E. Emergency Power: Each reactor will have 3 diesel-generator sets for emergency power. One set will be used exclusively for the HPCS which has a 3050 HP pump. Each of the other 2 diesel will be connected to a separate load group. Each set will be independent with separate fuel day tanks and storage tanks with 7 days supply of fuel.

Emergency Plans: Emergency plans will cover precautionary planning, delegation of authority, actions taken to protect the public, plant, employees and equipment. TVA general plans will be used plus supplementary plans to cover the Hartsville Plant which will cover automatic actions required, emergencies within plant boundaries, offsite emergencies and State of Tenn. support organizations.

Environmental Monitoring: Vegetation, birds, small mammals, and reptiles & amphibians will be sampled in the terrestrial ecology studies. Baseline aquatic studies will include monitoring of water quality, benthos, plankton, periphyton, and fish. This program will be continued and modified as needed when plant startup occurs. Preoperational radiological monitoring will investigate radiation levels and radioactivity in the plant environs for 2 years prior to operation namely atmospheric, reservoir, and terrestrial.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system with one hyperbolic natural draft cooling tower for each reactor.

Water Taken From: Old Hickory Reservoir for tower makeup 103,000 gpm total for the 4 units.

Intake Structure: Water will enter pipes at center of reservoir about 20' below water level and flow by gravity into a 2500' long canal from the shore to the plant where intake structure will house pumps, screens, etc. Velocity will be 0.5 fps thru pump sta. openings.

Water Body Temperatures: Winter minimum 46 °F; Summer maximum 74 °F

River Flow variable (cfs) minimum; 17,600 (cfs) average

Service Water Quantity 14,000 gpm/reactor

Flow Thru Condenser 450,000 (gpm)/reactor Temp. Rise 36 °F

Heat Dissipated to Environment 8100×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser 8480×10^6 (Btu/hr)/reactor

Discharge Structure: Tower blowdown and other wastes will go into a 30 acre holding pond which will connect to an underwater diffuser pipe in the reservoir; flow by gravity. Flow from the holding pond will be regulated with river flow.

Cooling Tower(s): Description & Number - 1 Nat. draft tower/unit

Blowdown 12,500 gpm/reactor Evaporative loss 13,000 gpm/reactor

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NUCLEAR SAFETY INFORMATION CENTER

SKAGIT, 50-522, 50-523

Page 1, BWR

A. GENERAL	*Pacific Power & Light Idaho Power	Wash. Public Power Supply System Wash. Water Power Company
<p>PROJECT NAME: Skagit Nuclear Power Project, Units 1 & 2</p> <p>LOCATION: NW Washington 64 miles north of Seattle</p> <p>OWNER: Puget Sound Power & Light (50%) + 4 other Utilities*</p> <p>OWNER'S ADDRESS & CONTACT: R. V. Myers, Mgr. Nuclear Licensing Puget Power Building Bellevue, Washington 98009</p> <p>ARCHITECT/ENGINEER: Bechtel (206-454-6363)</p> <p>REACTOR MANUFACTURER: G.E.</p> <p>CONTAINMENT CONSTRUCTOR: ---</p> <p>TURBINE MANUFACTURER: West. DATE: June 1975</p> <p>ESTIMATED STARTUP DATE: 1981 COMPILED BY: Fred Heddleson</p> <p>NUCLEAR SAFETY INFORMATION CENTER</p>		
B. SITE DATA	Lat. 48° 32' 01" N Long. 122° 05' 26" W	537,550 MN 564,000 ME
<p><u>Site Description:</u> Located on the shoulder of a hill about 300' above the flood plane of the Skagit River. The valley at this point is about 3 1/2 miles wide with mountains rising up 3000' on the south side of the valley and up to 4300' on the north of the plant site. The site is north of River Mile 32, the Skagit River flowing into Skagit Bay SW of the plant. Samish Bay of the Pacific Ocean system is 17 miles west. State Hwy #20 borders the site on the south. Small communities nearby are Lyman (pop 324) 3 mi ESE, Hamilton (pop 196) 6 mi E, Sedro Woolley (pop 4596) 6 mi WSW, and Burlington (pop 3138) 10 mi WSW. The closest school is in Lyman, and the nearest hospital is 8 mi WSW. This area is known for milk production and has 80 milk cows within 1 mi of the site, and 700 cows in a 2-mi radius with most of these SW of the site. Plant water will be supplied by Ranney wells 5 mi SE and upstream of the site.</p>		
<p><u>Nearby Body of Water:</u> Skagit River Normal Level ~50' (MSL) Max Prob Flood Level --- (MSL)</p>		
<p>Size of Site 1500 Acres Site Grade Elevation 415' (MSL)</p>		
<p><u>Topography of Site:</u> Flat to rolling shoulder of a hill <u>of Surrounding Area (5 mi rad):</u> Flat in the valley (S), mountains (N)</p>		
<p><u>Total Permanent Population:</u> In 2 mi radius 306 ; 10 mi 15,894</p>		
<p><u>Date of Data:</u> 1970 In 5 mi radius 3857 ; 50 mi 505,723</p>		
<p><u>Nearest City of 50,000 Population:</u> Seattle, Washington <u>Dist. from Site</u> 64 Miles, <u>Direction</u> S, <u>Population</u> 530,831</p>		
<p><u>Land Use in 5-Mile Radius:</u> Agricultural, especially dairy, beef, and poultry production; and forestry.</p>		
<p><u>Meteorology:</u> Prevailing wind direction ENE Avg. speed ~8mph <u>Stability Data</u> - Calms occur about 0.2% of time. <u>Meteorological Measurements</u> - Measurements were started in May 1973 at 30 and 60 meter levels.</p>		

B. SITE DATA (Continued)		REACTOR: SKAGIT	
Exclusion Distance, Miles	0.35 min.	<u>Design Winds in mph:</u>	
Low Population Zone Distance, Miles	4 pop 1563	At 0 - 50 ft elev	90
<u>Metropolis</u>	<u>Distance</u> <u>Population</u>	50 - 150 ft	105
Seattle, Wash.	1,421,869	150 - 400 ft	125
Safe Shutdown Earthquake Acceleration, g	0.25	Tornado 250 mph rot. + 60 trans.	
Operating Basis Earthquake Acceleration, g	0.13	ΔP = <u>3</u> psi/ <u>3</u> sec	
Earthquake Vertical Shock, Z of Horizontal	---		
C. CONTAINMENT AND STRUCTURES			
Drywell Design Pressure, psig	30	Primary Containment Leak Rate, %/day	0.1
Suppression Chamber Design Pressure, psig	15	Secondary Containment Design Pressure, psig	15
Calculated Max Internal Pressure, psig	21.5	Secondary Containment Leak Rate, %/day	0.1
<p><u>Type of Construction:</u> Mark III type using drywell/pressure suppression concept in a dry containment structure. The cylindrical suppression pool surrounds the drywell but is inside the free standing steel containment vessel which is cylindrical with a domed roof. A reinforced concrete shield building surrounds the steel containment vessel leaving an annulus space between the two structures. Free volume of containment is 1.75×10^6 cu ft. Drywell free volume is 303,000 cu ft. Suppression pool water volume is 153,930 cu ft.</p>			
G.E.	<p><u>Design Basis:</u> Designed to control release of radioactivity to the environment using the leak-tight steel shell, the shield building, standby gas treatment system, and auxiliaries after LOCA. Design based on double-ended break of the largest reactor coolant pipe. Containment temperature and pressure are limited following LOCA by the Engineered Safety Features, Suppression Pool, and Residual Heat Removal System.</p>		
G.E.	<p><u>Vacuum Relief Capability:</u> There will be 2 vacuum relief lines with a check valve and an automatic air-operated butterfly valve.</p>		
G.E.	<p><u>Post-Construction Testing:</u> Structural acceptance test will be run at 115% of design pressure and held for 1 hr. After the structural test, a leak-rate test will be run at design pressure. Three leak-rate tests will be performed during each 10-yr period after startup.</p>		
<p><u>Penetrations:</u> Single barrier piping penetrations will be used. Penetrations for power, control, or instrumentation will have provision for leak testing.</p>			
<p><u>Weld Channels:</u> Found no reference.</p>			

C. CONTAINMENT & STRUCTURES (Contd) REACTOR: SKAGIT

Containment Heat Removal System: A containment spray system can spray to condense steam released from the reactor to lower temp and reduce pressure. A subsystem of RHRS cools by use of heat exchangers to limit temp in containment to 185 F on long term. Suppression pool water is cooled to hold down temp. Capacity of circulating pump is 7100 gpm at 20 psid.

G.E. Standby Gas Treatment System: Consists of two 100% capacity (4000 cfm) systems with demister, electric heater, prefilter, HEPA filter, and charcoal absorber, plus fan that maintains a slight vacuum in the annulus during operation and cleans up all air discharged to the atmosphere after LOCA. A vacuum system prevents annulus pressure from exceeding atmospheric after LOCA.

G.E. Combustible Gas Control: Containment air will be mixed with drywell air after LOCA to dilute hydrogen. Also, a recombiner will limit long term hydrogen buildup. A backup system can purge containment.

Containment Floodability: Can be flooded to a level 6' - 10" above the top of the active fuel in the core.

Strong Motion Accelerometer: Units will be installed in 5 locations to record acceleration. Peak acceleration units will be in 3 locations.

Turbine Orientation: Turbine and reactor are on the same centerline. Probability of ejected turbine blades striking containment is very low.

D. REACTOR COOLANT

Reactor Vessel Failure: Designed, fabricated, and operated such that vessel integrity will always be maintained.

Reactor Vessel Design: Material - Low Alloy Steel SA 533 Gr. B
 Shell ID, in. 251 Shell thickness, in. 6.14
 Overall height, ft/in. 73'-0" inside Cladding thickness, in. 1/8

G.E. Leak-Detection System: Small leaks are detected by temperature and pressure changes, fill-up rate of drain sumps, and fission product concentrations. Changes in water level and/or flow rates are best indication of large leaks. Large leak detection initiates automatic isolation, small leaks initiate an alarm in the control room. The total leakage rate limit is set at 30 gpm.

G.E. Failed-Fuel-Detection System: Four gamma radiation monitors are located external to the main steam lines just outside containment. On detection of high radiation, the reactor will be scrammed and main steam line isolation valves will close.

Long-Term Cooling: Low pressure coolant injection pumps would be used for long term cooling, probably circulating water thru RHRS heat exchangers. Supply of water is available from the suppression pool or the ultimate heat sink.

E. REACTOR CHARACTERISTICS		REACTOR: SKAGIT	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3800	Moderator Temp Coef Cold, $\Delta k/k/^{\circ}F$	$+4 \times 10^{-5}$
Electrical Output, MWe (net)	1265	Moderator Temp Coef Hot, No Voids	-14×10^{-5}
Total Heat Output, Safety Design, MWt	4100	Moderator Void Coef Hot, No Voids, $\Delta k/k/Z$	$\sim -3 \times 10^{-4}$
Steam Flow Rate, lb/hr	16.35×10^6	Moderator Void Coef Operating	$\sim -9 \times 10^{-4}$
Total Core Flow Rate, lb/hr	122.5×10^6	Doppler Coefficient, Cold	$\sim 1.9 \times 10^{-5}$
Feedwater Flow Rate, million lb/hr	16.31×10^6	Doppler Coefficient, Hot, No Voids	$\sim -1.05 \times 10^{-5}$
Feedwater Temperature, $^{\circ}F$	426	Doppler Coefficient, Operating	$\sim 1.3 \times 10^{-5}$
Coolant Pressure, psig	1055	Initial Enrichment, %	1.80
Heat Transfer Area, ft^2 total core	85,042	Average Discharge Exposure, MWD/Ton	23,500
Max Power per Fuel Rod Unit Lgth, kw/ft	12.3	Control Rod Worth, Total	0.01 ΔK
Maximum Heat Flux, Btu/hr- ft^2	324,500	Burnable Poisons, Type and Form	Gd ₂ O ₃ mixed with UO ₂
Average Heat Flux, Btu/hr- ft^2	146,260	Number of Moveable Control Rods	205
Maximum Fuel Temperature, $^{\circ}F$	3337	No. of In-Core Neutron Detectors (Fixed)	187
Average Fuel Rod Surface Temp., $^{\circ}F$	~ 560	No. of In-Core Detector Assemblies	47
ACHFR	≥ 1.24	Number of Fuel Assemblies	848
Coolant Enthalpy at Core Inlet, Btu/lb	529.9	Fuel Rod Array	8 x 8
Total Peaking Factor	2.22	No. Fuel Rods Per Fuel Assembly	63
Avg Power Density, Kw/l	51.3	MISCELLANEOUS:	
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	BWR/6 251-848 G.E. 251 NSSS GESSAR Cladding Material - Zircaloy 2 Uranium weight - 159,960 kg	
Core Max. Exit Voids Within Assembly, %	75		
Number of Recirculation Loops	2		
Pipe Diameter, in.	24		
Recirculation Pump Flow, gpm	47,100		
Number of Jet Pumps in Reactor	24		
Number of Main Steam Lines	4		
Pipe Diameter, in.	28		

G.E.

F. EMERGENCY CORE COOLING SYSTEMS REACTOR: SKAGIT

High-Pressure Core Spray: Consists of one motor-driven pump, 1650 gpm at 1147 psid or 7000 gpm at 200 psid, piping, valves, etc., the pump and motor located outside containment. Suction is from the RCIC condensate storage tank, or the suppression pool. Piping inside the reactor vessel has spray nozzles which spray water over the core. Low water level or high drywell pressure starts the pump. System is designed to cool the core sufficiently to limit cladding temperatures to less than 2200 F.

Auto-Depressurization System: If the RCIC and HPCS cannot maintain reactor water level, the ADS causes steam to be released to the suppression pool through pressure relief valves so pressure in the vessel is lowered to where low pressure emergency core cooling systems can operate. ADS will not reduce pressure unless LPCS and LPCI pumps are operating.

Low-Pressure Core Spray: Consists of one pump (7000 gpm at 122 psid), spray sparger in the reactor vessel above the core, piping, etc. Suction is taken from the suppression pool. Pump is actuated by low water in the reactor vessel or high pressure in the containment. System can spray enough water on the core to hold cladding temperatures below 2200 F.

Low-Pressure Coolant-Injection System: This is one of the independent operating subsystems of the RHRS. It is actuated by low water level in the reactor or high pressure in the containment. There are 3 pumps (each rated 7450 gpm at 20 psid) with associated valves, piping, etc. that take suction from the suppression pool, thus providing closed loop recirculation capability.

G. MISCELLANEOUS

G.E.

Residual-Heat-Removal System (RHRS): System has 3 independent loops, each with one pump rated 7450 gpm at 20 psid; 2 heat exchangers rated 52.4×10^6 Btu/hr. each; plus valves, piping, and controls. Modes of operation are:

1. Shutdown cooling to 12° F in 20 hrs from a reactor temperature of 350°F. Water can be diverted to reactor vessel head spray. This mode also can provide fuel pool cooling.
2. Use heat exchangers to condense steam from reactor vessel.
3. Low-pressure Coolant injection system described immediately above.
4. Containment heat removal system - described at top of p 3. Heat exchangers are cooled by VHR service water.

Radwaste System: Units will have shared facilities. Liquid wastes will be filtered and dewatered, and processed by evaporation and demineralization to reduce to solids or to recycle for reuse. No liquids will be discharged. Gaseous waste from the main condenser steam-jet air ejector will be treated using catalytic recombination and low-temperature charcoal adsorption (RECHAR). Design basis annual average noble radiogas source term is 100,000 μ Ci/sec. Processed gases will be monitored before release. Solid wastes consisting of ion exchange resins and misc. filter media, concentrated salt solutions and misc. dry wastes will be held for decay, then packaged into 55 gal. drums, and 50 to 200 cu ft shipping containers for offsite disposal.

Plant Vent:

Top of Radwaste building.

G. MISCELLANEOUS (Continued) REACTOR: SKAGIT

Emergency Power: Each reactor will have 3 diesel-generator sets for emergency power. One set will be used exclusively for the HPCS which has a 3050 HP pump. Each of the other 2 diesel will be connected to a separate load group. Each set will be independent with separate fuel day tanks and storage tanks. Units will start and accept load in 10 sec. Ratings will be supplied in the FSAR.

Emergency Plans: A manual of procedures, check lists and supporting information to establish on-Site and off-Site actions in response to emergencies. Both radiological and nonradiological emergencies will be included. All plant personnel will be instructed on the purpose, content, and use of the Emergency Plan. Off-Site support organizations and groups will receive training commensurate with their responsibilities. Periodic reviews of employees and off-Site support groups will be made to ensure that they are up-to-date.

Environmental Monitoring: Programs will establish pre-operational baselines, and will guide later work. Surface water sampling will concentrate on physical and chemical aspects, and aquatic sampling of organisms and fish will be carried out concurrently. Ground water will be studied using wells and springs. Air particulate samples will be collected, soils sampled, and terrestrial biota including vegetation, birds, mammals, and reptiles will be counted. Radiological monitoring will concentrate in areas covered by the prevailing winds and in population centers.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using cooling towers. Service Water Cooling tower basins serve as ultimate heat sink.

Water Taken From: Ranney wells along the Skagit River - 40,200 gpm required for makeup (2 reactor units)

Intake Structure: No intake in the river. Water will be pumped from Ranney wells.

Water Body Temperatures: Winter minimum 38 °F; Summer maximum 57 °F

River Flow 14,700 (cfs) minimum; 16,200 (cfs) average

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 440,000 (gpm)/reactor Temp. Rise 39 °F

Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 8865×10^6 (Btu/hr)/reactor

Discharge Structure: About 11,600 gpm (2 units) will be discharged to the Skagit River thru a diffusers system at river mile 25. A 30" line will run 37,000 ft from the plant to the multi-port diffuser.

Cooling Tower(s): Description & Number - 1 hyperbolic tower for each
Blowdown 1300 gpm/reactor **Evaporative loss** ^{unit} 14,000 gpm/reactor

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NUCLEAR SAFETY INFORMATION CENTER

A. GENERAL	
PROJECT NAME: Alan R Barton Nuclear Plant, Units 1, 2, 3, and 4	
LOCATION: Central Alabama, 27 miles N of Montgomery	
OWNER: Alabama Power Company	
OWNER'S ADDRESS & CONTACT: Alan R. Barton, Senior Vice President Alabama Power Company	
ARCHITECT/ENGINEER: Southern Services	600 North 18th Street Birmingham, Ala. 35291
REACTOR MANUFACTURER: G.E.	
CONTAINMENT CONSTRUCTOR: Alabama Power	
TURBINE MANUFACTURER: G.E.	DATE: July 1975
ESTIMATED STARTUP DATE: 1983	COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER	
B. SITE DATA	For Unit 3
	32° 44' 59.34" N N 3,623,522.5 M
	86° 23' 51.06" E E 556,441.4 M
<p><u>Site Description:</u> Located on the west side of the Coosa River at River Mile 32.5 on a flat to rolling area about 200 ft above the river-reservoir. Clanton (pop 5868) is 15 mi WNW. County line between Chilton and Elmore counties splits the site having 2 units in each county. The Jordan Dam (about 15 mi downstream) forms the reservoir which is about 900 ft wide at the site. The nearest school is about 6 mi WSW, and a Boy Scout camp is 6 mi NNW. Numerous parks, beaches, fishing camps, and boat docks are within the 10 mi radius. Harry's Dairy, 6 mi SE, has 40 milk cows. I-65 runs NW-SE about 8 mi SW of the plant, US 31 is 6 mi SW, and US 231 runs N-S 10 mi E of the site. The L & N Railroad parallels US 31 from which a spur will be run into the plant. Four natural gas pipelines run generally E-W about 3 mi N. The river is not navigable so no hazardous barge traffic exists.</p>	
<p><u>Nearby Body of Water:</u> Coosa River</p> <p>Normal Level 252' (MSL) Max Prob Flood Level 324' (MSL)</p>	
<p>Size of Site 2800 Acres Site Grade Elevation 463' (MSL)</p>	
<p><u>Topography of Site:</u> Flat to Rolling of Surrounding Area (5 mi rad): Moderately Rolling</p>	
<p><u>Total Permanent Population:</u> In 2 mi radius 89 ; 10 mi 6487</p>	
<p><u>Date of Data:</u> 1970 In 5 mi radius 1206 ; 50 mi 481,115</p>	
<p><u>Nearest City of 50,000 Population:</u> Montgomery, Alabama</p>	
<p><u>Dist. from Site</u> 27 Miles, Direction S, Population 133,386</p>	
<p><u>Land Use in 5-Mile Radius:</u> Forests used for pulpwood and timber</p>	
<p><u>Meteorology:</u> Prevailing wind direction SW Avg. speed 6.8 mph</p>	
<p>Stability Data - On a yearly average there are 6 days estimated for high potential of air pollution.</p>	
<p>Meteorological Measurements -</p>	
<p>Data collection started in Sept. -73 using a 195' tower.</p>	

B. SITE DATA (Continue)			REACTOR: BARTON	
Exclusion Distance, 0.5 mi rad. from Miles end reactors			Design Winds in mph:	
Low Population Zone 2 mi radius			At 0 - 50 ft elev 80	
Distance, Miles			50 - 150 ft 95	
<u>Metropolis</u>	<u>Distance</u>	<u>Population</u>	150 - 400 ft 110	
Montgomery, Ala.	27	201,325	Tornado 290 mph tang. + 70 trans.	
Safe Shutdown Earthquake Acceleration, g 0.13			$\Delta P = \underline{3} \text{ psi} / \underline{1.5} \text{ sec}$	
Operating Basis Earthquake Acceleration, g 0.07				
Earthquake Vertical Shock, % of Horizontal 65				
C. CONTAINMENT AND STRUCTURES				
Drywell Design Pressure, psig 30			Primary Containment Leak Rate, %/day ---	
Suppression Chamber Design Pressure, psig 15			Secondary Containment Design Pressure, psig 15	
Calculated Max Internal Pressure, psig 21.4			Secondary Containment Leak Rate, %/day design 0.1	
<p><u>Type of Construction:</u> Mark III type using drywell/pressure suppression concept in a dry containment structure. The cylindrical suppression pool surrounds the drywell but is inside the steel-lined reinforced concrete containment vessel which is cylindrical with a domed roof. A steel framed building with metal siding surrounds the containment structure leaving space between the two structures. This space is maintained at a slightly negative pressure to provide in-leakage. Free volume of containment is 1.433×10^6 cu ft. Drywell free volume is 272,600 cu ft. Suppression pool water volume is 144,700 cu ft.</p>				
<p><u>Design Basis:</u> Containment designed to limit or prevent any release of radioactivity to the environment, especially after a LOCA when pressure and temperature extremes in containment would increase the possibility of leakage. Engineered Safety Features are designed to function so that temperature and pressure are mitigated and reduced.</p>				
<p><u>Vacuum Relief Capability:</u> Vacuum Relief valves are provided between the drywell and containment to prevent sucking suppression pool water into the drywell.</p>				
<p><u>Post-Construction Testing:</u> Structure will be pressurized in steps holding the pressure for 1 hour at each level while measuring deflections. Max. test pressure is 115% of design pressure. Leakage rate test will be performed before operation and periodically thereafter.</p>				
<p><u>Penetrations:</u> Information given on only electrical penetrations, and details on these were lacking.</p>				
<p><u>Weld Channels:</u> Liner seams that are inaccessible for testing after construction are provided with a leak chase system consisting of channels welded over seams with taps extended for testing.</p>				

C. CONTAINMENT & STRUCTURES (Contd) REACTOR: BARTON

Containment Heat Removal System: Steam dumped into containment in case of LOCA will vent to the suppression pool. As steam condenses there, the suppression pool water will be heated. It will be pumped back to the reactor vessel, or suppression pool through the Residual Heat Removal heat exchangers for cooling. System is designed to limit suppression pool to a max. of 185 °F. A reactor vessel head spray can be operated to condense steam in the vessel before it is vented to containment.

Standby Gas Treatment System: Consists of two 100% capacity systems with prefilter, cooling coil, demister, electric heater, HEPA filter, charcoal filter, HEPA filter, and fan plus ducts controls etc. Fans maintain .25 in. water vacuum in the enclosure building, auxiliary bldg, and auxiliary fuel handling area. All air exhausted after an accident passes thru this system for cleanup.

Combustible Gas Control: Containment air will be mixed with drywell air after LOCA to dilute hydrogen. Also, a recombiner will limit long term hydrogen buildup. A backup system can purge containment.

Containment Floodability: Drywell can be flooded - one of the functions of the Nuclear Service Water System.

Strong Motion Accelerometer: Tri-axial accelerometers will be installed in the lower part of containment and at a higher elevation in the structure. A third unit will be located in the field.

Turbine Orientation: Turbine and reactor are on the same centerline. It is unlikely that ejected blades could strike containment.

D. REACTOR COOLANT

Reactor Vessel Failure: Possibilities are considered, but suitable design and operational limits are established that avoid conditions where failure could occur.

Reactor Vessel Design: Material - Low alloy steel SA533 Gr. B
 Shell ID, in. 238 Shell thickness, in. 5.7
 Overall height, ft/in. about 74' Cladding thickness, in. 1/8

Leak-Detection System: Small leaks are detected by temperature and pressure changes, fill-up rate of drain sumps, and fission product concentrations. Changes in water level and/or flow rates are best indication of large leaks. Large leak detection initiates automatic isolation, small leaks initiate an alarm in the control room. The total leakage rate limit is set at 25 gpm.

Failed-Fuel-Detection System: Four gamma radiation monitors are located external to the main steam lines just outside containment. On detection of high radiation, the reactor will be scrammed and main steam line isolation valves will close.

Long-Term Cooling: The Nuclear Service Water System can supply water from the ultimate heat sink pond or the river to remove long term heat from the reactor. Residual Heat Removal System could circulate and cool the water.

E. REACTOR CHARACTERISTICS		REACTOR: BARTON	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3579	Moderator Temp Coef Cold, $\Delta k/k/^{\circ}F$	$+4 \times 10^{-5}$
Electrical Output, MWe (net)	1159	Moderator Temp Coef Hot, No Voids	-14×10^{-5}
Total Heat Output, Safety Design, MWt	3758	Moderator Void Coef Hot, No Voids, $\Delta k/k/\%$	$\sim -5 \times 10^{-4}$
Steam Flow Rate, lb/hr	15.39×10^6	Moderator Void Coef Operating	$\sim -20 \times 10^{-5}$
Total Core Flow Rate, lb/hr	105×10^6	Doppler Coefficient, Cold	-1.7×10^{-5}
Feedwater Flow Rate, million lb/hr	15.358×10^6	Doppler Coefficient, Hot, No Voids	-1.05×10^{-5}
Feedwater Temperature, $^{\circ}F$	420	Doppler Coefficient, Operating	-1.1×10^{-5}
Coolant Pressure, psig	1040	Initial Enrichment, %	2.07
Heat Transfer Area, ft^2	73,409	Average Discharge Exposure, MW/Ton	12,000 to 12,000
Max Power per Fuel Rod Unit Lgth, kw/ft	13.4	Control Rod Worth,	0.01 Δk
Maximum Heat Flux, Btu/hr- ft^2	354,100	Burnable Poisons, Type and Form	Gd ₂ O ₃ mixed with UO ₂
Average Heat Flux, Btu/hr- ft^2	159,570	Number of Moveable Control Rods	177
Maximum Fuel Temperature, $^{\circ}F$	3325	No. of In-Core Neutron Detectors (Fixed)	164
Average Fuel Rod Surface Temp., $^{\circ}F$	~ 565	No. of In-Core Detector Assemblies	41
MCHFR	1.9	Number of Fuel Assemblies	732
Coolant Enthalpy at Core Inlet, Btu/lb	527.9	Fuel Rod Array	8 x 3
Total Peaking Factor	2.22	No. Fuel Rods Per Fuel Assembly	63
Avg Power Density, Kw/l	56.0	MISCELLANEOUS:	
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	BWR/6 238-732 G.E. Design Fuel rod cladding - Zircaloy-2 Uranium weight 304,600 ^g	
Core Max. Exit Voids Within Assembly, %	76		
Number of Recirculation Loops	2		
Pipe Diameter, in.	22/24		
Recirculation Pump Flow, gpm	35,400		
Number of Jet Pumps in Reactor	20		
Number of Main Steam Lines	4		
Pipe Diameter, in.	26		

G.E.

F. EMERGENCY CORE COOLING SYSTEMS REACTOR: BARTON

High-Pressure Core Spray: Consists of one motor-driven pump, 1550 gpm at 1147 psid or 6110 gpm at 200 psid, piping, valves, etc., the pump and motor located outside containment. Suction is from the RCIC condensate storage tank, or the suppression pool. Piping inside the reactor vessel has spray nozzles which spray water over the core. Low water level or high drywell pressure starts the pump. System is designed to cool the core sufficiently to limit cladding temperatures to less than 2300 F.

Auto-Depressurization System: If the RCIC and HPCS cannot maintain reactor water level, the ADS causes steam to be released to the suppression pool through pressure relief valves so pressure in the vessel is lowered to where low pressure emergency core cooling systems can operate. ADS will not reduce pressure unless LPCS and LPCI pumps are operating.

Low-Pressure Core Spray: Consists of one pump (6110 gpm at 128 psid), spray sparger in the reactor vessel above the core, piping, etc. Suction is taken from the suppression pool. Pump is actuated by low water in the reactor vessel or high pressure in the drywell. System can spray enough water on the core to hold cladding temperatures below 2300 F.

Low-Pressure Coolant-Injection System: This is one of the independent operating subsystems of the RHRs. It is actuated by low water level in the reactor or high pressure in the drywell. There are 3 pumps (each rated 7100 gpm at 20 psid) with associated valves, piping, etc. that take suction from the suppression pool, thus providing closed loop recirculation capability. Water enters the reactor vessel thru 3 nozzles.

G. MISCELLANEOUS

Residual-Heat-Removal System (RHRs): The system has 3 pumps rated 7100 gpm each at 20 psid, 2 heat exchangers rated 45×10^6 Btu/hr each, piping, etc. There are 5 modes of operation:

1. Shutdown cooling to 125 F in 20 hours after reactor shutdown.
 2. Use heat exchangers to condense steam from the reactor vessel.
 3. Low-Pressure Coolant-Injection System - described above.
 4. Containment Heat Removal System - discussed at top of page 3.
 5. Provides supplemental cooling for fuel handling pool.
- The heat exchangers are cooled by RHR service water.

Radwaste System: Liquid wastes will be collected, treated (filtered, evaporated, and demineralized) and recycled. Processing will be on a batch basis with release rates lower than 5 ci/yr. Main source of gaseous waste is offgas from the main condenser air ejectors. A refrigerated charcoal filtration system will be used. Processed gases will be monitored before release to the atmosphere at a rate of 100,000 μ ci/yr after 30 min. decay. Solid wastes will be shipped in 170 cu ft and 55 gallon containers to offsite disposal stations.

Plant Vent: Located a max. of 140'-6" above grade on roofs of turbine bldg., auxiliary bldg., and radwaste bldg.

G. MISCELLANEOUS (Continued) REACTOR: BARTON	
<p>Emergency Power: Each reactor will have 3 5730kW (continuous) diesel-generator sets. Each of the generators will be connected to a separate load group such that either of 2 load groups will have capacity to provide power req'd for reactor shutdown. Each set will be totally independent with separate day tank (4 hrs) and 5 underground storage tanks with 7 day fuel supply for each diesel.</p>	
<p>Emergency Plans: Required for protecting the health and safety of the general public, people visiting the plant and plant employees. Plans describe the organization and facilities both on site and offsite that will be used to deal with accidents. Organization and training of personnel are described mentioning state and local agencies that will be involved including medical facilities and doctors at offsite locations. The intent of plans is to first mitigate the accident, get it under control, and then proceed with further steps.</p>	
<p>Environmental Monitoring: Programs are already underway which will be intensified into a preoperational program 2 years before operation starts. Areas of study are water quality, aquatic communities (fish, microorganisms, amphibians, reptiles, etc) ground water, air particulates, geology, soils, mammals, birds, invetebrates, and vegetation. A preoperational radiological monitoring program will establish natural bases before operation starts.</p>	
H. CIRCULATING WATER SYSTEM	
<p>Type of System: Closed system using cooling towers</p>	
<p>Water Taken From: Coosa River for makeup of evaporation and blowdown. Consumptive use - 18,000 gpm</p>	
<p>Intake Structure: On west bank of Coosa river 2600 ft N of plant and 212 ft below plant site grade. Trash racks, traveling screens and pumps will be housed in the structure. Approach velocity in the intake will be 0.5 fps.</p>	
<p>Water Body Temperatures: Winter minimum 51 °F; Summer maximum 86 °F</p>	
<p>River Flow 0 (cfs) minimum; 9400 (cfs) average</p>	
<p>Service Water Quantity 31,000 gpm/reactor and 16,000 (2 values)</p>	
<p>Flow Thru Condenser 583,100 (gpm)/reactor Temp. Rise ~29 °F</p>	
<p>Heat Dissipated to Environment 8500×10^6 (Btu/hr)/reactor</p>	
<p>Heat Removal Capacity of Condenser 8366×10^6 (Btu/hr)/reactor</p>	
<p>Discharge Structure: Total discharge for 4 units will be 73,000 gpm, which will be discharged to an energy dissipation box and thence thru a 3.5' dia. pipe 60' out into the river.</p>	
<p>Cooling Tower(s): Description & Number - 1 natural draft tower per reactor.</p>	
<p>Blowdown 18,000 gpm/reactor Evaporative loss 18,000 gpm/reactor</p>	

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A. GENERAL

PROJECT NAME: Palo Verde Nuclear Generating Station, Units 1, 2, and 3
 LOCATION: Maricopa Co. (SW Arizona) about 39 mi W of Phoenix.
 OWNER: Arizona Public Service Co., Salt River Project, et others
 OWNER'S ADDRESS & CONTACT: Mr. E. E. Van Brunt, Jr., Mgr. Nucl. Ser.
 ARCHITECT/ENGINEER: Bechtel Arizona Public Service
 P.O. Box 21666
 REACTOR MANUFACTURER: Comb. Engg. Phoenix, Arizona 85036
 CONTAINMENT CONSTRUCTOR: Bechtel
 TURBINE MANUFACTURER: G.E. DATE: July 1975
 ESTIMATED STARTUP DATE: 1982 COMPILED BY: Fred Heddleson
 NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA Unit 2 33° 23' 16" N N 3,695,875 M
 112° 51' 52" E E 326,325 M

Site Description: The site is a desert environment relatively flat with a few hills. Site elevations range from 890 to 975 with the top of the hills being from 1100 to 1200. The Gila River is about 8 mi SE. About 5 mi NW the Palo Verde Hills rise up to 2172' msl. Interstate I-10 when completed will pass within 7 mi of the site NNE. Buckeye-Salome Rd passes within 2 mi NE. The nearest community is Wintersburg 3 mi N. Buckeye (pop 2600) is 18 mi W. There are 2 schools 7.5 mi from the site, 1 SSE and the other N. Two dairy farms are located about 9.5 mi E with a total of 650 cows. The Ward Ranch with 150 beef cattle is 3.5 mi SW. A large cattle operation having 33,000 head of beef cattle is 10 mi SSE. The Southern Pacific RR passes within 4 mi SSE from which a spur will be built. Phoenix Valley West, a proposed residential community, if built, will be 2.5 mi E of the site.

Nearby Body of Water: Normal Level --- (MSL)
 Gila River Max Prob Flood Level 776' (MSL)

Size of Site 3800 Acres Site Grade Elevation 951'-957' (MSL)

Topography of Site: Flat with numerous hills.

of Surrounding Area (5 mi rad): Flat with Palo Verde hills NW

Total Permanent Population: In 2 mi radius 2 ; 10 mi 1555

Date of Data: 1970 In 5 mi radius 211 ; 50 mi 508,000

Nearest City of 50,000 Population: Phoenix

Dist. from Site 39 Miles, Direction E, Population 581,562

Land Use in 5-Mile Radius: Open desert with 10% used for agriculture which requires irrigation. Cotton is the crop usually grown.

Meteorology: Prevailing wind direction SW Avg. speed 6 mph

Stability Data - Neutral to stable conditions.

Meteorological Measurements - Measurements at site started in August 1973 at 35' and 200' levels.

B. SITE DATA (Continued)		REACTOR: PALO VERDE	
Exclusion Distance, Miles	0.57 mi. rad.	Design Winds in mph:	
Low Population Zone Distance, Miles	3.5 radius	At 0 - 50 ft elev	90
Metropolis	Distance	50 - 150 ft	105
Phoenix	Population	150 - 400 ft	125
	39 city limits 967,522	Tornado 240 mph sum of vectors	
Safe Shutdown Earthquake Acceleration, g	0.20	ΔP = 1.33 psi / 3 sec	
Operating Basis Earthquake Acceleration, g	0.10		
Earthquake Vertical Shock, % of Horizontal	66 2/3		
C. CONTAINMENT AND STRUCTURES			
Design Pressure, psig	60	Free Volume, cu ft	2.7×10^6
Calculated Max Inter- nal Pressure, psig	51.5	Max Leak Rate at Design Pressure, %/day	0.1
<p><u>Type of Construction:</u> Prestressed concrete cylinder with 4' thick walls and a hemispherical dome 3' thick. The 10.5' thick base mat is a flat, circular slab of reinforced concrete. The interior is lined with welded steel plate 1/4" thick. Housed within containment and supported by the base mat and the reinforced concrete and structural steel internal structures that support the reactor and reactor coolant system.</p>			
<p><u>Design Basis:</u> Designed to maintain structural and leaktight integrity under the most severe loading conditions--including combined effects of permanent loads, LOCA loads, and either earthquake or tornado loads; and to contain released fission products with a leak rate below design leak rate levels.</p>			
<p><u>Vacuum Relief Capability:</u> Not Applicable.</p>			
<p><u>Post-Construction Testing:</u> Will have a structural integrity test at 115% of design pressure per Reg. Guide 1.18 except as noted in Appendix 3J. Leakage rate tests will be run to measure leakage and will be run periodically thereafter.</p>			
<p><u>Penetrations:</u> "Single-barrier piping penetrations are provided for all piping passing through the walls of containment."</p>			
<p><u>Weld Channels:</u> Leak chase channels are provided at seam welds where welds will be inaccessible so they can be leak tested later.</p>			

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: PALO VERDE

C-80 Containment Spray System: Consists of 2 independent systems, either one capable of 100% capacity for cooling after LOCA. Borated water is sprayed downward from the top of containment to cool the atmosphere. There are 2 pumps, each rated 3500 gpm at 650 psig. Pumps take suction from the refueling water storage tank. Also sodium hydroxide is added to the spray water for removal of iodine.

Containment Cooling: Fan-coil units provide cooling for normal operation only. They will maintain the containment space at or below 120 F during operation and below 100 F when shut down.

Containment Air Filtration: This system operates in conjunction with backup purge of the hydrogen recombiners and consists of filters, heaters, fans, mist eliminator, charcoal adsorber, valves, controls, etc.

Combustible Gas Control: Two portable hydrogen recombiners will hold hydrogen levels below 3% by volume following LOCA. Either unit has 100% capacity to maintain safe conditions. Also there is a purge.

Containment Floodability: Found no reference.

Strong Motion Accelerometer: Will be described in FSAR. Will be provided in accord with availability and state of technology at that time.

Turbine Orientation: Turbine and reactor are on the same centerline. Ejected turbine blade would probably NOT strike containment.

D. REACTOR COOLANT

C-80 Reactor Vessel Failure: By analysis per ASME Code, the vessel is adequate for all normal operating and transient conditions during the life of the facility. Inservice Inspection gives further assurance.

C-80 Reactor Vessel Design: Material SA-533 Gr.B, Class 1 steel
 Shell ID, in. 182 1/4 Shell Thickness 9 1/2" in core reg.
 Overall Height, ft/in. 48'-3/8" Cladding Thickness, in. 1/8 min.

Reactor-Coolant Leak-Detection System: Four methods - sump level method, makeup flow rate, particulate activity, and detection of airborne gaseous isotopes. Temperature measurements at various points in containment help to locate point of leakage. Average unidentified leakage is assumed to be 29 gpd.

C-80 Failed-Fuel-Detection System: Process radiation monitor provides a continuous recording in the control room of reactor coolant gross gamma radiation. Increasing trends in fission product activity is an indication of fuel element cladding failures. Monitor has sufficient sensitivity to detect less than 1% failed fuel.

E. REACTOR CHARACTERISTICS		REACTOR: PALO VERDE	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, Mwt	3817	H ₂ O/U, Hot	2.09
Electrical Output, MWe (net)	1235	Avg 1st-Cycle Burnup, MWD/MTU	13,740
Total Heat Output, Safety Design, MW _s	4100	Maximum Burnup, MWD/MTU	less than 55,000
Total Heat Output, Btu/hr	$13,000 \times 10^6$	Region-1 Enrichment, %	1.9
System Pressure, psia	2250	Region-2 Enrichment, %	2.4
DNBR, Nominal	2.22	Region-3 Enrichment, %	2.9
Total Flowrate, lb/hr	164×10^6	k _{eff} , Cold, No Power, Clean	1.169
Eff Flowrate for Heat Trans, lb/hr	157.4×10^6	k _{eff} , Hot, Full Power, Xe and Sm	1.071
Eff Flow Area for Heat Trans, ft ²	60.84	Total Rod Worth, %	7.3 - 8.9
Avg Vel Along Fuel Rods, ft/sec	16.6	Shutdown Boron, No Rods-Clean-Cold, ppm	990
Heat Generated in Fuel, %	0.965	Shutdown Boron, No Rods-Clean-Hot, ppm	1010
Hot Channel Factors, F _q	---	Boron Worth, Hot, ppm/% Δp	84
Nominal Core Inlet Temp, °F	565	Boron Worth, Cold, ppm/% Δp	65
Avg Rise in Core, °F	58	Full Power Moderator Temp Coeff, Δk/k/°F	-2.5×10^{-4} EOL
Nom Hot Channel Outlet Temp, °F	653	Moderator Pressure Coeff, Δk/k/psi	(+0.06 to +2.6) $\times 10^{-6}$
Avg Film Coeff, Btu/hr ft ² -°F	6300	Moderator Void Coeff, Δk/k/% Void	(-0.03 to -1.22) $\times 10^{-3}$
Avg Film Temp Diff, °F	30	Doppler Coefficient, Δk/k/°F	(-1 to -1.8) $\times 10^{-3}$
Active Heat Trans Surf Area, ft ²	63,000	Shutdown Margin, Hot 1 rod stuck, Δk/k	1
Avg Heat Flux, Btu/hr ft ²	182,200	Burnable Poisons, Type and Form	Al ₂ O ₃ - B ₄ C
Max Heat Flux, Btu/hr ft ²	425,700	Number of Control Rods	81
Avg Thermal Output, kw/ft	5.34	Number of Part-Length Rods (PLR)	8
Max Thermal Output, kw/ft	12.5	Number of Fuel Assemblies	241
Max Clad Surface Temp, °F	656	Overall Dimensions, inches	7.6" x 8" x 168"
No. Coolant Loops	2	Number of Fuel Rods	56,476
Combustion Engineering "System 80" Design. Data from CESSAR is indicated C-80.		Fuel Rod Cladding Material	Zircaloy-4
		Weight of Uranium, Equilibrium	102,780 kg

C-80

	F. SAFETY INJECTION SYSTEMS	REACTOR: PALO VERDE
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C-80	<p>Core Flooding System: Four tanks are provided to flood the core with borated water in case of LOCA and a drop in system pressure to 600 psig. Tanks are pressurized to 600 psig with nitrogen gas. Check valves open automatically to dump contents into the reactor vessel. Each tank holds about 14,000 gallons of liquid.</p>
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C-80	<p>High-Pressure Injection System: There are 2 pumps each rated 700 gpm at 1370 psig. They are used to inject borated water into the system if small breaks should occur. Pumps take suction from the refueling water storage tank. One pump has sufficient capacity to keep the core covered for small breaks. These pumps are used also for long term cooling.</p>
------	---

C-80	<p>Low-Pressure Injection System: There are 2 pumps in this system each rated 4200 gpm at 150 psig. These pumps inject large quantities of borated water into the core after LOCA. Pumps take suction from the refueling water storage tank. These pumps also function to provide shutdown cooling, by pumping through the heat exchangers.</p>
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	G. MISCELLANEOUS	
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C-80	<p>Decay Heat Removal System: Long term decay heat removal uses one of the 2 high-pressure safety injection pumps and recirculates borated water from the containment sump, passing the water through the shutdown cooling heat exchangers for cooling. Each pump is rated about 1200 gpm at 500 psig. Both pumps could be used if necessary, but one pump has the required capacity.</p>
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	<p>Radwaste System: Liquid waste system is designed for the dry site so that no liquids will be discharged to the environment. Some liquids will be solidified, some will be filtered for particulate and ionic impurity removal. Evaporator condensate flows thru ion exchangers before being recycled as reactor makeup water. Gaseous wastes of low level will be released thru the plant vent. High-activity, hydrogen rich gases from reactor coolant will be compressed and held for decay; after which they will be released thru filters properly diluted. Solid wastes will be collected, mixed with chemical binders as required, and shipped offsite for removal.</p>
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	<p>Plant Vent: A cylindrical vent runs up the side of the containment building.</p>
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G. MISCELLANEOUS (Continued) REACTOR: PAJO VERDE

Emergency Power: Each reactor system will have 2 diesel generators each rated 5275 kW continuously. Each generator is connected to a separate load group, one redundant to the other. The diesel generator sets are completely independent, separately housed with independent auxiliaries. Each diesel will have a day tank with 4 hr fuel supply and a storage tank with 7 days supply.

Emergency Plans: Plan will describe actions to be taken by plant personnel to minimize effects of an accident. Emergencies are categorized on the basis of severity covering personnel injuries, personnel contamination or radiation exposure, fire, sabotage, civil disturbances and station abnormalities requiring evacuation. A detailed plan will be presented in the FSAR.

Environmental Monitoring: Preoperational monitoring will cover ground water, air, geological and seismic features, subsurface investigation, terrestrial ecological sampling including flora and fauna, biotic communities, mammal studies, bird, reptile and their habitats. Radiological monitoring to establish preoperational baselines. Since the site is an arid region, no sampling of surface waters will be performed.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using 3 cooling towers for each reactor unit.

Water Taken From: Phoenix City sewage treatment plant for makeup - 19,000 gpm/reactor.

Intake Structure: Not applicable

Water Body Temperatures: Winter minimum ---°F; Summer maximum ---°F

River Flow --- (cfs) minimum; --- (cfs) average

Service Water Quantity 80 gpm/reactor to Essential Spray Ponds

Flow Thru Condenser 587,000 (gpm)/reactor Temp. Rise 30 °F

Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 8400 x 10⁶ (Btu/hr)/reactor

Discharge Structure: Blow down from cooling towers will be discharged into blowdown treatment facility which will discharge 60 gpm into evaporation ponds.

Cooling Tower(s): Description & Number: - 3 mech. draft towers for each unit.
Blowdown 1030 gpm/reactor Evaporative loss 17,860 gpm/reactor

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CLINCH RIVER BREEDER REACTOR PLANT

SUMMARY DATA ON CLINCH RIVER LIQUID METAL FAST BREEDER REACTOR

FOR VOL-V OF ORNL-NSIC-55

"DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS"

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FOREWORD

This report is the first summary on a Liquid Metal Fast Breeder Reactor (LMFBR) to be prepared in the NSIC-55 series on summary data for commercial nuclear power plants. This report is nearly 3 times as long as the normal report but additional information has been included to show unusual features especially in the area of safety. All data was taken from the PSAR and Environmental Report; figures used from these reports bear the original figure numbers. Written material has been considerably condensed.

This report will be updated as information presented is changed - revised pages will be distributed as changes are documented.

A. GENERAL	
PROJECT NAME: Clinch River Breeder Reactor Project	
LOCATION: Roane Co, E Tenn, 25 mi W of Knoxville, in town of Oak Ridge	
OWNER: Project Management Corp, TVA, ERDA, & Commonwealth Edison	
ADDRESS and CONTACT:	Peter S. Van Nort, General Manager
ARCHITECT/ENGINEER: Burns & Roe	Project Management Corp. 179 W. Washington Street Chicago, Ill. 60602
REACTOR MANUFACTURER: Westinghouse	
CONTAINMENT CONSTRUCTOR: Chi, Bridge & Iron	
TURBINE MANUFACTURER: ---	DATE: September 1975
ESTIMATED STARTUP DATE: 1983	COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER	
B. SITE DATA	<div>35° 53' 24" N 3,974,709 N</div> <div>84° 22' 57" W 736,262 E</div>
<p><u>Site Description:</u> On a peninsula surrounded by Clinch River on E, S, and W; bounded by ERDA reservation on NE and the Clinch River Consolidated Industrial Park on NW. Gaseous Diffusion Plant is 3 1/2 mi NNW, ORNL is 4 mi NE, and Melton Hill dam is 4.5 mi E. Hensley family cemetery on the south end of site and not far away is an Indian Mound. Towns within 10 mi are Lenior City (5324) 9 mi SE, Kingston (4142) 7 mi W, Harriman (8734) 9.5 mi WNW, and Oak Ridge (28,319) 9 mi NNE. Numerous recreational sites are within 5 mi, the closest being a camp ground in 2 mi and a stockcar race track 3 mi S. Nearest school is Edgewood 3.5 mi WSW. Nearest hospital is Harriman. Nearest dairy herd of 45 cows is 4 mi W. Interstate 40 runs E-W 1 1/4 mi S. State route 58, 1 1/2 mi NW is the access highway. A rail spur will be run in from the Gaseous Diffusion Plant. Oak Ridge Hospital is 12 1/2 miles.</p>	
<p><u>Nearby Body of Water:</u> Watts Bar Lake Normal Level <u>741'</u> (MSL) on the Clinch River. Max Prob Flood Level <u>809.2</u> (MSL)</p>	
<p>Size of Site <u>1364</u> Acres Site Grade Elevation <u>815'</u> (MSL)</p>	
<p><u>Topography of Site:</u> Flat to Rolling of Surrounding Area (5 mi rad): Rolling with parallel ridges</p>	
<p><u>Total Permanent Population:</u> In 2 mi radius <u>335</u> ; 10 mi <u>49,547</u> Date of Data: <u>1980</u> In 5 mi radius <u>2740</u> ; 50 mi <u>748,032</u></p>	
<p><u>Nearest City of 50,000 Population:</u> Knoxville Dist. from Site <u>25</u> Miles, Direction <u>E</u>, Population <u>174,587</u></p>	
<p><u>Land Use in 5-Mile Radius:</u> Mostly wooded and unused except for the ERDA reservation and some cattle grazing.</p>	
<p><u>Meteorology:</u> Prevailing wind direction <u>SSW</u> Avg. speed <u>4.4 mph</u> Stability Data - Pasquill type E is most ^{NFE} common. Meteorological Measurements - Data collection started July -73 with a 200 ft tower. Data from ORNL 4.5 mi away covers from 1964.</p>

Figure 2.6-1 LOCATIONS OF WEATHER STATIONS NEAR SITE

Figure 2.1-8. AEC Boundary Relative to Clinch River Site

1. REACTOR CONTAINMENT BUILDING
 2. REACTOR SERVICE BUILDING
 3. RADWASTE AREA
 4. PLANT SERVICE BUILDING
 5. CONTROL BUILDING
 6. DIESEL GENERATOR BUILDING
 7. INTERMEDIATE BAY
 8. STEAM GENERATOR BUILDING
 9. MAINTENANCE BAY
 10. REACTION PRODUCTS SEPARATION EQUIPMENT BAY
 11. TURBINE GENERATOR BUILDING
 12. SHOPS AND WAREHOUSE
 13. GATE HOUSE
 14. TRAINING CENTER BUILDING
 15. PARKING LOT
 16. EMERGENCY COOLING TOWER
 17. COOLING TOWER
 18. C.W. PUMP HOUSE
 19. GENERATING YARD
 20. START-UP YARD
- SAFETY-RELATED (CATEGORY 1) STRUCTURES

Figure 3.1-4 LAYOUT OF PLANT STRUCTURES IN RELATION TO THE SECURITY BARRIER

B. SITE DATA (ccntd)			REACTOR: CLINCH RIVER BREEDER	
Exclusion Distance, Miles		0.42	<u>Design Winds in mph:</u>	
Low Population Zone Distance, Miles		5	At 0 - 50 ft elev 90	
<u>Metropolis</u>	<u>Distance</u>	<u>Population</u>	50 - 150 ft 105	
Knoxville, Tn.	25 mi	400,337	150 - 400 ft 125	
Safe Shutdown Earthquake Acceleration, g		0.18	Tornado 290 mph Rot. + 70 trans.	
Operating Basis Earthquake Acceleration, g		0.09	ΔP = 3 psi/ 2 sec	
Earthquake Vertical Shock, % of horizontal		66 2/3		
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig		10	Free Volume, cu ft 4.29×10^6	
Calculated Max Internal Pressure, psig		2	Max Leak Rate at Design Pressure, %/day 0.1	
<p><u>Type of Construction:</u> Free standing, structurally independent steel cylinder with hemispherical or hemi-ellipsoidal top, and flat bottom. Lower walls have 3 ft of concrete on inside and outside up to 1 ft above ground level. Steel walls are 1 1/2" thick, 186 ft ID and 160 ft from bottom to spring line. Lower level concrete walls and flat bottom are covered with 1/4" thick steel liner.</p>				
<p><u>Design Basis:</u> The structure, including access openings and penetrations, will be designed with sufficient conservatism to accommodate, without exceeding design leakage rate, peak pressure and temperature associated with postulated accident conditions. Design will also provide capability to withstand earthquakes and tornados of magnitudes specified above. Design temp. is 250°F.</p>				
<p><u>Vacuum Relief Capability:</u> Containment will have vacuum relief valves if required by the design (Sect. 3.8.2.1). External design pressure is 0.5 psig.</p>				
<p><u>Post-Construction Testing:</u> Leakage rate tests will be run in accordance with App. J of 10CFR50 at end of construction and periodically thereafter. A pneumatic pressure test will be run at 11.5 psig in accordance with NE-6300 of ASME-III.</p>				
<p><u>Penetrations:</u> All penetrations will be leak testable and will have isolation valves on each side of containment, as determined by final design.</p>				
<p><u>Weld Channels:</u> Before concrete is placed over the bottom liner plate, leak tightness will be verified. Then channels will be placed over seam welds, and channels leak tested by pressurization.</p>				

C. CONTAINMENT & STRUCTURES (Contd)**REACTOR: CLINCH RIVER BREEDER**

Heating, Ventilating & Air Conditioning: Heating, ventilating, and air conditioning HVAC System is a non-safety related system designed to provide filtered and conditioned air to the operating floor and atmospheric areas below the operating floor, to permit personnel occupancy and to ensure operability of all equipment. Designed to: (a) Maintain 85°F on the operating floor, 75°F in the Instrumentation and Control Cubicles and 95°F below the operating floor, during normal operation; (b) Maintain 120°F within the building under single failure of an HVAC System component or upon loss of cooling from the Auxiliary Coolant Fluid System or Normal Chilled Water System; (c) Maintain the required ventilation rate to dilute the cover gas leakage on the operating floor and to dilute radioactive gas leakage from the inerted cells below the operating floor; and (d) Minimize the spread of airborne radioactive materials below the operating floor, in the event of a leak from an inerted cell. Four Unit Coolers are provided on the Operating Floor to supplement the cooling capacity of the Outside Air System. During normal operation, the unit cooler fans are drawing air from the Operating Floor atmosphere through their cooling coils and then discharging the cooled air back to the Operating Floor. A special system to remove heat after the Design Basis Accident is not required.

Containment Air Purification and Cleanup System: An air purification and cleanup system for mitigation of post-accident radiological consequences is not considered necessary at this time, but such systems are subject to continuing evaluation. If a design basis accident causes a release of radioactivity to the containment atmosphere, the containment isolation will be effected and radioactive materials will be contained. Building cleanup procedures following a sodium fire accident will require personnel to be equipped with protective clothing, and auxiliary breathing air to avoid inhalation of particulates that may be dislodged from walls and equipment during the cleanup operation.

Seismic Instrumentation Program: Triaxial Time - History Accelerograph will consist of 4 strong motion triaxial sensors, 1 triaxial seismic trigger, 1 central recorder and control unit and 1 tape playback unit. The strong motion triaxial sensors will be installed at the following locations: (a) "Free field" to record the undisturbed free field motion, (b) On the foundation mat of Containment, (c) On the structure of the Containment Building, at a higher elevation vertically above the sensor on the mat, and (d) On the structure of the Steam Generator Bldg.

Sodium Fire Protection System: System provides the means of detecting, alarming, containing, and extinguishing sodium and/or NaK fires. Design is based on use of the following: (a) Catch pans to contain spilled sodium or NaK to prevent chemical reactions with structural concrete; (b) Fire suppression decks installed above the bottom of the catch pans as an oxygen depletion zone that limits the amount of oxygen; and (c) Nitrogen flooding distribution piping, installed beneath the fire suppression deck, to allow nitrogen flooding of the space between the deck and the liquid surface. The design objective is to flood the space with nitrogen at a rate sufficient to prevent oxygen re-entry through the deck openings. Catch pans, fire suppression decks, and nitrogen flood piping are installed in normally air atmosphere cells, containing sodium or NaK process equipment or piping, where spills might occur. Spaces housing primary and EVST sodium and NaK systems and piping are equipped with steel liners and an inert (nitrogen) atmosphere.

PLANT DESIGN

REACTOR: CLINCH RIVER BREEDER

Reference Design: The CRBRP Reference Design is based on the areas of consideration (all except Parallel Design Options) discussed in the Design Safety Approach in subsection (1.1.2.1).

Level One: The purpose of the first level of design is to assure that the plant is reliable, operable, inspectable, testable, and maintainable. Therefore, a number of plant design decisions were made to incorporate design features which by their very nature avoid the occurrence of accidents or mitigate accident effects should they occur.

Level Two: Errors or malfunctions can occur despite the care and attention provided by first level design. Therefore, the second level provides for a number of protective systems and plant features to protect against malfunctions, and to limit their consequences to definable and acceptable levels.

Level Three: Implementation of level three involves consideration of Extremely Unlikely Faults (Table 1.1-3) in design of the plant. Analyses relating to these faults, for example, pipe leaks, large sodium fires or large sodium-water reactions, are presented in Chapter 15 of the PSAR. The conservative design bases for such low probability natural events as earthquakes, tornadoes, and floods are presented in Chapter 2.

Parallel Design: The Parallel Design provides for design and development of features to minimize accident consequences from events not used as design bases for the Reference Design. The Parallel Design considers a hypothetical core disruptive accident (HCDA) as a design basis, the possibility of sealing the head access area, the provision of an ex-vessel core catcher, and the provision of safety features to mitigate consequences of a loss of piping integrity. The development of these features is on a schedule to permit them to be incorporated into the plant on the current construction schedule. The Parallel Design will be vigorously pursued until the Reference Design is shown to be a suitable basis for licensing.

Features to Accommodate Primary Pipe Rupture: Massive failures of the primary coolant boundary are not considered appropriate as bases for design of the plant because of the properties of the stainless steel piping under the service conditions imposed by CRBRP operation. For rationale behind this position study PSAR sections listed in Table 1.1-5.

REACTOR CHARACTERISTICS		REACTOR: CLINCH RIVER BREEDER	
Thermal Power Rating (mw)	975	PuO ₂ INVENTORY - BOL (kg)	
Gross Electrical Rating (mw)	380	Pu-238	14.7
Gross Plant Efficiency (%)	39	Pu-239	988.0
Maximum Clad Temp.; Hot Channel, 100% Rated Power,	1350	Pu-240	286.0
Maximum Fuel Centerline Temp. (°F)	4780	Pu-241	151.1
Core Barrel Inner Diameter (in.)	150	Pu-242	36.1
Active Core Ht. (in.)	36	UO ₂ INVENTORY - BOL (kg)	
Active Core Equiv. Dia. (in.)	73.63	U-235 Core	35.7
Peak Assembly Linear Power BOL Equil. Core (Kw/ft.)	11.0	Blanket	47.4
Avg. Assembly Linear Power BOL Equil. Core (Kw/ft.)	6.6	U-238 Core	5065
Cover Gas	Argon	Blanket	21673
Peak Discharged Fuel Burn-up (Mwd/Tonne)	80,000	AVERAGE BURNUP (MWD/T)	
Doppler Coeff. - BOL ($-T \frac{dk}{dt}$) nom.		Initial Core	50,000
Core	0.0058	Future Core	100,000
Blankets	0.0015	EFFECTIVE DELAYED NEUTRON Fraction (β)	
Core Peaking Factors		BOL	3.65×10^{-3}
Radial - BOL	1.20	EOL	3.50×10^{-3}
Axial - BOL	1.24	HEAT TRANSPORT SYSTEM	
		Primary System	
		Number Loops	3
		Total Flow Through Reactor (lb./hr.)	41.45×10^6
		Flow Per Loop (gpm)	33,500
		Reactor Outlet Temp. (°F)	995
		Reactor Inlet Temp. (°F)	730
		Intermediate System	
		Number Loops	3
		Coolant Flow Per Loop (gpm)	29,500
		Hot Leg Temp. (°F)	936
		Cold Leg Temp. (°F)	651

REACTOR CHARACTERISTICS (Contd)		REACTOR: CLINCH RIVER BREEDER	
CONTROL ROD SYSTEM		FUEL DATA	
Primary System - BOL		Composition	PuO ₂ /UO ₂
Total Available Worth (\$)	23.04	Number Fuel Assemblies	198
Minimum Available Worth With One Rod Stuck (\$)	21.06	Number Fuel Rods per Fuel Assembly	217
Maximum Worth Required for Shutdown (\$)	18.64	Number Fuel Rods per Blanket Assembly	61
No. Assemblies	15	Diameter Fuel Rods in Fuel Assembly	0.23
No. Pins per Assembly	37	Diameter Fuel Rods in Blanket Assembly	0.52
Pin O.D. (in.)	0.611	Cladding Material	316 SST
Cladding Material	316 SST	Breeding Ratio	1.2
Absorber Ht. (in.)	36	Residence Time of Fuel Assembly in Equil. Core (yr.)	3
Gas Plenum Ht. (in.)	28	Residence Time of Blanket Assembly in Equil. Core (yr.)	6
Absorber Material (First Core)	Natural B ₄ C	Plutonium Inner Enrichment Zone (wt%)	18.7
Secondary System - BOL		Plutonium Outer Enrichment Zone (wt%)	27.1
Total Available Worth (\$)	8.96	RADIAL BLANKET ASSEMBLIES	
Minimum Available Worth With One Rod Stuck (\$)	6.84	Maximum Midwall Cladding Temperature, °F (2σ)	964
Maximum Worth Required For Shutdown (\$)	6.20	Maximum Assembly Mixed Mean Outlet Temp., °F (Nominal)	842
No. Assemblies	4	Maximum Fuel Centerline Temp. (3σ plus overpower)	2267
No. Pins per Assembly	19	Average Linear Power, KW/ft.	2.5
Pin O.D. (in.)	0.660	Peak Linear Power, KW/ft.	4.7
Cladding Material	316 SST	Maximum (3σ plus overpower) Linear Power, KW/ft.	7.1
Absorber Ht. (in.)	36		
Absorber Material (First Core)	75% Enriched B ₄ C		
HEAT TRANSFER AREAS			
Fuel Region/Assembly, ft ²	39.2		
Axial Blanket Region/Assembly, ft ²	30.5		
Radial Blanket Assembly, ft ²	44.3		
Control Assemblies, ft ²	17.8		

HEAT TRANSPORT SYSTEM

REACTOR: CLINCH RIVER BREEDER

Primary Heat Transport System: The Primary Heat Transport System (PHTS) consists of piping and components required to transport heat from the reactor to the Intermediate Heat Exchangers (IHX). The 3 PHTS loops transport radioactive sodium coolant from the reactor vessel to the intermediate heat exchangers which thermally link primary and intermediate loops. As shown in Figure 5.1-1, heated sodium flows from the reactor vessel outlet to the centrifugal pump. Sodium from the pump is circulated through the shell side of the intermediate heat exchanger where heat is transferred to the intermediate sodium. From the IHX primary sodium flows back to the reactor vessel.

Intermediate Heat Transport System: The Intermediate Heat Transport System (IHTS) consists of the piping and components required to transport reactor heat from the Intermediate Heat Exchanger (IHX) to the Steam Generator System. The system is comprised of three essentially identical, independent, cooling loops operating in parallel. As shown in Figure 5.1-1, each intermediate loop contains non-radioactive sodium which is circulated by an intermediate sodium pump from the tube side of the IHX through the steam generator and back to the IHX. No direct sodium interconnections exist between the three loops. Each cold leg of the intermediate loop contains a vertical, single stage, free surface centrifugal pump. The sodium flow rate is controlled by a variable speed pump drive. A pony motor is used to provide 7-1/2% of design flow for operation during start-up, shutdown, hot stand-by and following accident conditions.

Steam Generation System: The Steam Generation System accepts hot sodium from the Intermediate Heat Transport Loops, extracts heat and returns cooler sodium back to the IHX. In addition to providing for the removal of heat from the Intermediate System sodium by the superheater/evaporator components, the system provides the steam supply to the turbines, provides pressure relief protection for a sodium water reaction, water from the Steam/Water Subsystem, and provides for detection of water-to-sodium leakage in the steam generator modules. Feedwater System supplies feedwater to the steam drum where it mixes with and subcools saturated water from the evaporators. The subcooled water flows through the tube side of two evaporators where it is partially vaporized by the higher temperature sodium flowing on the shell side. The steam/water mixture then flows to the steam drum where steam is separated and the water continues to recirculate. Entrained moisture in the steam is removed by dryers and separators, internal to the drum. The dry saturated steam is superheated, to the desired temperature, in the tube side of the superheaters. The superheated steam flows to main steam headers and then to the turbine.

Figure 5.1-1. General Configuration of the Heat Transport and Steam Generation Systems, One of Three Loops

HEAT TRANSPORT SYSTEM (Contd)**REACTOR: CLINCH RIVER BREEDER**

Steam Generator Auxiliary Heat Removal System (SGAHRs): Removes reactor-generated heat following reactor shutdown or trip when the main NSSS heat sink or normal feedwater supply is unavailable. Heat is initially rejected to the environment through a direct steam dump and by condenser tubes heating atmospheric air for long term heat removal. The SGAHRs can also function to remove shutdown heat loads for refueling and other long term outages.

Overflow Heat Removal System (OHRS): Provided to remove decay heat. If the steam generator decay heat removal paths are not available, reactor decay heat will be dumped through the Reactor Overflow System to an overflow heat exchanger. From the heat exchanger the heat flows through the ex-vessel storage tank (EVST) NaK system to air blast heat exchangers where the heat is transferred to the atmosphere.

Water and Sodium Dump System: In order to reduce the amount of water which may be admitted to the Intermediate Heat Transport System (IHTS) in the event of a large sodium/water reaction in an evaporator module, blow-down of the evaporator modules through power relief/safety valves is accelerated by the Water Dump System. Quick opening water dump valves are located at the inlet to each evaporator module. Water dump piping directs the water/steam to a water dump tank. In addition to the above, in the event of a large sodium/water reaction, sodium dump capability is provided for the IHTS and the sodium side of the Steam Generator System. The sodium is drained rapidly to a sodium dump tank.

ENGINEERED SAFETY FEATURES

Reactor Containment - See pages 6 and 7

Containment Isolation System

Habitability Systems

Guard Vessels

Residual Heat Removal System

Containment Isolation Systems: The containment isolation systems close valves in lines penetrating containment to assure that containment provides the required barrier to release of radioactive gas or particulate matter. Closure of valves may be manually or automatically initiated depending on the type of line penetrating containment.

Control Room Habitability System: The Control Room Habitability System is designed to provide a safe, comfortable and appropriately equipped location for personnel controlling plant operations during normal times and during accidents. Features incorporated into this Habitability System to assure these aspects are described below. A thick concrete enclosure and special shield-doors are important features in this habitability system. Another important feature in the Control Room Habitability System is the HVAC system. The HVAC system for the Control Room contains two 100% capacity air conditioning units and two 100% capacity exhaust fans, with one unit each normally operating and the other unit on standby; and two 100% capacity emergency air supply filter units. A third important feature in the Main Control Room Habitability System is its low leakage enclosure. A fourth important feature in the Control Room Habitability System is the capability for operating in two different modes to assure the maintenance of a positive air pressure level in the control room at all times. Other important features in the Control Room Habitability System are the monitors provided to detect the presence of smoke and radioactivity and activate the air cleanup units.

ENGINEERED SAFETY FEATURES (Contd)**REACTOR: CLINCH RIVER BREEDER**

Guard Vessels: Guard vessels surround the lower portion of the reactor vessel, the intermediate heat exchanger, and the primary sodium pumps. The purpose of these outer vessels is to catch and contain any sodium that might leak from the components. The reactor guard vessel is a bottom-supported, right circular cylindrical vessel surrounding the reactor vessel. It will be fabricated from 304 stainless steel. Purpose of this guard vessel is to assure outlet nozzle submergence in sodium in the event of a leak in the reactor vessel nozzles, piping, or piping connections. To do this, the guard vessel extends about 6 ft above the minimum safe sodium level. Also, the guard vessel permits inservice inspection of the reactor vessel by providing a clearance of 7 in. between the two. Continuity detectors and aerosol sampling lines are mounted inside the guard vessel to detect potential leaks. The IHX's and primary sodium pumps are enclosed in structurally independent, free standing guard vessels. These will be fabricated from 304 stainless steel or Cr-4 MO steel. The IHX and primary pump guard vessels enclose the component and its primary system inlet and outlet piping up to a level which will preserve the reactor system minimum safe sodium level in case of component leakage. Inspection ports are provided to facilitate periscope inspection of the component during refueling, maintenance or other shutdown periods.

Residual Heat Removal System: Pony motor flow and/or natural circulation in primary and intermediate loops transports heat to steam generator system. Normal method of heat rejection is turbine bypass to the condenser. When this path is unavailable: Short term heat rejection accomplished by direct steam dump from steam drum to atmosphere. Removes up to ~180 Mwt (18% rated power); Long power rejection of decay heat accomplished by condensing of steam in an air cooled condenser. Removes up to 4.5% rated power (45 Mwt). As a backup when these systems are unavailable, decay/residual heat is removed by cooling of the reactor overflow sodium by a Na/NaK heat exchanger. NaK heat load rejected to atmosphere by a NaK/air heat exchanger. Removes between 3-6 Mwt.

MISCELLANEOUS

Reactor Vessel Design: Material SST 304

Shell ID. 20'-3" Shell Thickness 2 3/8"

Overall Height, ft/in. 57'

Leak Detection Systems: The multiple methods of leak detection are: Radiation monitoring, Aerosol monitoring, Continuity detectors (cables), and Contact detectors (spark plugs). Audible alarms are sounded in the control room upon indication of a leak, and location of the leak is visually displayed to the operator. The Steam Generator Leak Detection System monitors: (1) sodium exiting from each evaporator and superheater; (2) bulk sodium in the IHTS cold leg, and (3) argon cover gas in the IHTS pump tank. Monitoring is by hydrogen and oxygen meters.

MISCELLANEOUS (Contd)

REACTOR: CLINCH RIVER BREEDER

Refueling System: Reactor core is designed to be refueled annually (at equilibrium) after the first refueling at six months. At each annual refueling, after equilibrium, 66 core assemblies (33%) will be replaced. There is no shuffling or relocation of core assemblies during refueling. The blanket assemblies are designed to remain in the core for six years. A portion of the blanket assemblies are replaced at each annual refueling. There is shuffling of the blanket assemblies. The refueling system includes an in-vessel fuel transfer subsystem, an ex-vessel fuel handling subsystem, and the irradiated fuel handling subsystem. In-vessel fuel handling transfers core components between their normal positions in the core and positions accessible by the Ex-Vessel Transfer Machine. The Ex-Vessel Transfer Machine transfers reactor assemblies between the transfer position within the reactor vessel and transfer positions within the ex-vessel fuel storage tank, the fuel handling cell, and equipment storage positions. The irradiated fuel handling subsystem provides for storage of spent fuel, the fuel handling cell and its equipment for post-irradiation inspection and preparation for shipping fuel to the reprocessing plant. The non-irradiated fuel handling subsystem provides for receiving and unloading of new core components. New components are loaded into the ex-vessel storage tank until a reactor load of new fuel has been accumulated. New fuel is then transferred from the ex-vessel storage tank via the ex-vessel transfer machine in sodium filled core component pots.

Radwaste Systems: Liquid Radwaste System processes low and intermediate level liquid radwaste by evaporation and demineralization, producing purified or decontaminated water for reuse or discharge. Resultant concentrated liquid radwaste is sent to Solid Radwaste system for solidification. SRS processes and packages solid radwaste for shipment to AEC burial sites. The Radioactive Argon Processing System and the Cell Atmospheric Processing System purify contaminated gases and ensure that all gaseous releases are as low as practicable.

Average Tritium Production (Ci/day),	89
Design Basis Quantity of Low and Intermediate Level Waste (gal/yr)	360,000
Estimated Dose at Site Boundary from Liquid Effluents Discharged to River (mrem/yr)	Total body gamma 5.4×10^{-3} beta skin 1.4×10^{-8}
Solid Radwaste System Design Basis Quantities (lbs/yr)	
Non-Sodium Waste	242,000
Sodium & Sodium Containing Waste	16,500
Radioactive Gaseous Releases at Expected Service Condition of 0.1% Failed Fuel (Ci/yr)	
Noble gases	5.1
Tritium	3.2
Estimated Maximum Total Annual Dose from Gaseous Effluents	0.2 mrem/yr @ 1% Failed Fuel, Calculated for People Living in Close Proximity to Site Boundary.

Plant Vent: Containment - 882' MSL, Service Bldg - 892',
Turbine Bldg - 915', Condenser Air Ejector Exhaust - 915'

MISCELLANEOUS (Contd)

REACTOR: CLINCH RIVER BREEDER

Shutdown and Control Systems: Two independent and diverse systems. Primary system has 15 rods, collapsible roller nut drives, gravity insertion. Alternate shutdown system has 4 rods. They have separate sensors, transmitters comparators and logic, ball nut screw drive, hydraulic assisted insertion, below the hand release. Primary rods release at roller nut. Either system capable of reactor shutdown with most reactive rod stuck.

Post Accident Heat Removal System (Core Catcher): For a core meltdown following a design basis core disruptive accident it can be postulated that the molten fuel debris on the bottom head of the reactor vessel could melt-through the reactor vessel and guard vessel. The main purpose of a Post Accident Heat Removal (PAHR) system in the form of an Ex-Vessel Core Catcher (EVCC) is to retain the molten fuel debris in a coolable geometry having a subcritical configuration. A sacrificial bed/barrier concept is being investigated on the basis of its potential to assure subcriticality of the molten fuel debris and to provide effective decay heat removal. The main objective is to design a system that can meet the requirements using standard equipment and commercially available materials which are compatible with molten fuel and stainless steel in a liquid sodium environment. Several EVCC concepts which provide a means for containing the molten fuel debris permanently and removing the decay heat are described below. Recent work considered the use of basalt as a sacrificial bed material. The feasibility of using basalt depends strongly upon the solubility of molten core debris in the bed material and the resultant reduction of volumetric heat generation rates. Two scoping studies have been performed for a completely passive concept. Calculations for a 1000 MWe water reactor with oxide fuel indicates the decay heat would melt 1×10^6 to 4×10^6 ft³ of sand before melting would cease (2.3 years). In another concept for a 1000 MWe water reactor a layer of iron 10 feet in diameter and 700 feet deep, would have been melted by the decay heat in approximately 83 days. Also suggested is the use of depleted UO₂ as a sacrificial bed material. UO₂ material would not be displaced as it melted and would act as an insulator to slow the growth of the melt-front. Several concepts for sacrificial beds with active cooling systems have been considered. ANL suggested a basaltic material in a cooled container. ARD has studied an insulated composition bed of UO₂, ThO₂, and tungsten cooled by a natural circulation system. More recently ANL has studied sacrificial beds of MgO and Al₂O₃ as well as UO₂, ThO₂ and basalt. One of the simplest concepts is a cooled crucible to contain the molten core debris and cool it at the moment of contact. This involves severe thermal shock to the crucible and large cooling requirements at the moment of melt-through. A third concept suggested by ANL utilizes catch trays in a pool of sodium below the reactor. The burial concept which allows core debris to penetrate the reactor containment building will not be considered. The ex-vessel core catcher concept that will be further investigated is the sacrificial bed concept. This concept has merits and advantages over other concepts such as a crucible or multiple catch trays. The continuing information produced by ANL and GE Ex-Vessel PAHR programs will be used to establish preliminary design. At that time final design will be started and continued along with the final materials development and scale model testing to completion at the end of 1977.

G. MISCELLANEOUS (Contd)

REACTOR: CLINCH RIVER BREEDER

Emergency Power: On-site power is split into 2 independent load groups each with one diesel-generator set rated 3800 kW continuously. Diesels start automatically and generators start accepting load in 10 sec. Diesels are independent in all respects with separate day tanks and underground fuel storage for 7 days operation.

Emergency Plans: TVA's plans contain delegation of authority and responsibility, and plans of action to protect the public, plant employees, and equipment in case of unusual incidents; for local level for control of fire, personnel injury, tornadoes and high winds, and incidents that could result in release of radioactivity. TVA Radiological Emergency Plan (REP) for CRBRP will contain the overall TVA REP, the Nuclear Emergency Medical Assistance Plan, and the CRBRP Annex which will contain four documents: Division of Power Production REP, Site REP, Environs Emergency Plan (EEP), and State of Tennessee REP.

Environmental Monitoring: Purpose is to establish a baseline reference, from which effects of construction and operation of the plant can be evaluated. Specific monitoring and studies will cover physical and chemical parameters of surface waters, radiological, terrestrial, limnological, fish, geology, and the soils. Aquatic communities will be investigated as well as terrestrial mammals and vegetation. The program will be altered as required to improve the program.

H. WATER SYSTEMS

Circulating Water System: Closed system using cooling tower.

Water Taken From: Clinch River for plant makeup, at max power about 7100 gpm, 4400 gpm avg. consumptive use.

Intake Structure: Located on the W shore just S of River mile 18, housing 2 100% cap 10,000 gpm pumps. Water intake is 70 ft from shore, 5 ft off river bottom thru perforated pipes. Max. approach velocity is 0.4 fps.

Water Body Temperatures: Winter minimum 41°F; Summer maximum 68°F

River Flow NA (cfs) minimum; 4800 (cfs) average

Service Water Quantity 32,000 gpm/reactor

Flow Thru Condenser 185,200 (gpm)/reactor Temp. Rise 25 °F

Heat Dissipated to Environment 2730×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser 2326×10^6 (Btu/hr)/reactor

Discharge Structure: Blowdown is routed to the Clinch River and released through a single port high velocity sub-surface discharge 4 ft below water surface near river mile 16.

Cooling Tower(s): Description & Number — One mech. draft tower 400' 1g.
Blowdown 2700 gpm/reactor Evaporative loss 4350 gpm/reactor

NOTE: COOLING TOWER FLOWRATES ARE ANNUAL AVERAGES AT MAX. POWER OPERATION

Figure 3.3-1 WATER USAGE DIAGRAM FOR THE CRRP

NUCLEAR SAFETY INFORMATION CENTER

A. GENERAL

PROJECT NAME: Marble Hill Nuclear Generating Station 1 and 2
 LOCATION: SF Indiana, Jefferson Co., NNE of Louisville, Ky 30 miles
 OWNER: Public Service Co. of Indiana (65%), N. Ind. Pub Ser (20%)
 OWNER'S ADDRESS & CONTACT: Dr. James Conghlin, Vice Pres. - Nuclear
 Public Service Indiana
 ARCHITECT/ENGINEER: Sargent & Lundy 1000 E. Main Street
 REACTOR MANUFACTURER: Westinghouse Plainfield, Ind. 46168
 CONTAINMENT CONSTRUCTOR: ---
 TURBINE MANUFACTURER: --- DATE: October 1975
 ESTIMATED STARTUP DATE: 1982 COMPILED BY: Fred Heddleson
 NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA Lat 38° 36' 0" N 4,273,350 m N
 Long 85° 26' 53" W 635,150 m E

Site Description: Located 2400' west of the Ohio River and 6 mi ENE of New Washington (pop 500). Site is about 350' above the river on a flat bluff. Other towns near the site are Bedford, Ky (780) 7 mi E; Hanover, Ind. (3018) 7.8 mi N; and Madison (13,081) 10.7 mi NNE. Several small (less than 500) unincorporated communities within 5 mi are Paynesville 3 mi WNW; Saluda 4.5 mi NW; Bethlehem 4.5 mi SSE; and Wise Landing 3.7 mi SE. The nearest school is in New Washington. Nearest hospital is in Madison. Clifty Falls State Park is 10.7 mi NNE and attracts about 50,000 visitors each year. Within 5 mi there are 349 dairy cows, the nearest farm being 1.4 mi ENE. Indiana St Rt #62 is the closest major highway, 4.2 mi W of site. U.S. hwy 421 is 7 mi E. Nearest railroad is the Chessie System 10.2 mi W from which a spur will be built. A new residential-recreational Community is tentatively planned 2 mi S.

Nearby Body of Water: Normal Level 420' (MSL)
 Max Prob Flood Level 4517' (MSL)

Size of Site 987 Acres Site Grade Elevation 775' (MSL)

Topography of Site: Level - on a bluff overlooking the river
of Surrounding Area (5 mi rad): Variable but hilly along the river

Total Permanent Population: In 2 mi radius 288 ; 10 mi 18,609

Date of Data: 1974 In 5 mi radius 2350 ; 50 mi 1,242,650

Nearest City of 50,000 Population: Jeffersonville - New Albany
 Dist. from Site 27 Miles, Direction SW, Population 58,410

Land Use in 5-Mile Radius: Farmland in flat valley and wooded (~25%)
 on steep slopes

Meteorology: Prevailing wind direction SSW Avg. speed ~7
 Stability Data -- Pasquill class D 56% of time

Meteorological Measurements - Data has been collected since Jan. 1974
 at 33' and 199' levels.

B. SITE DATA (Continued)			REACTOR: MARBLE HILL	
Exclusion Distance, Miles	0.42		Design Winds in mph: #/sq ft	
Low Population Zone Distance, Miles	2		At 0 - 50 ft elev 90 33.6	
Metropolis	Distance	Population	50 - 150 ft 105 43.2	
Louisville, Ky	30 mi	826,553 (1970)	150 - 400 ft 125 50.5	
Safe Shutdown Earthquake Acceleration, g	0.12		Tornado 290 mph tang + 70 trans.	
Operating Basis Earthquake Acceleration, g	0.06		ΔP = 3 psi/ 1.5 sec	
Earthquake Vertical Shock, % of Horizontal	66		#/sq ft is sum of positive and negative pressures	
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig	50		Free Volume, cu ft	2.934 × 10 ⁶
Calculated Max Internal Pressure, psig	43.1		Max Leak Rate at Design Pressure, %/day	0.1
<p><u>Type of Construction:</u> Reinforced concrete cylindrical walls (post tensioned) 3 1/2-ft thick with shallow dome on a reinforced concrete base foundation slab. A steel liner, 1/4-in. thick, forms a virtually leak-tight containment. This is a 3-buttresses system, with an ID of 140', 222' high, and a 12' thick foundation slab.</p>				
<p><u>Design Basis:</u> Designed to withstand LOCA with loss of fission products to the atmosphere well within AEC limits. Designed also to withstand all natural loads (snow, wind, seismic) without loss of integrity; with either of above in combination.</p>				
<p><u>Vacuum Relief Capability:</u> When pressure drops 0.1 psig below atmospheric, relief valve opens to let air in to relieve the vacuum condition.</p>				
<p><u>Post-Construction Testing:</u> Leak-rate tests will be run at 50 psig and 25 psig. Structural acceptance test will be run at 115% of design pressure.</p>				
<p><u>Penetrations:</u> Has double sealed penetrations, each one individually tested.</p>				
<p><u>Weld Channels:</u> None mentioned; however, a thorough inspection of welds will be made using radiography, magnetic particle liquid penetrant, and vacuum soap box.</p>				

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: MARBLE HILL

W Containment Spray System: Two 100% capacity systems will be used, each with 1 pump, drawing water from the refueling water storage tank and spraying it into containment thru nozzles high above the operating deck. Rate of flow total will be 3290 gpm per pump of borated water, with 30% solution of NaOH to remove Iodine. When supply from the refueling water storage tank is exhausted, water is recirculated from the containment sump.

W Containment Cooling: Four fan-coil coolers operate during normal operation or after LOCA. For normal operation, 2 units run and dissipate 13.5×10^6 Btu/hr. In emergency conditions, 2 units will remove 264×10^6 Btu/hr of heat. Units have moisture separators to prevent coils from becoming flooded. Each unit handles 90,000 cu ft/min in normal operation. at 50,000 at 50 psi after LOCA.

Containment Air Filtration: A recirculation system uses pre-filters, HEPA filters, and charcoal filters to clean up the air. Purge air enters through a similar filter system.

Combustible Gas Control: Two 50-cfm thermal recombiners are available to heat incoming air stream to 1200°F and recombine hydrogen.

Containment Floodability: Found no reference.

Strong Motion Accelerometer: Three units will be installed - one in the field and 2 in containment. A central recording unit will be installed in the field at same location as other unit.

Turbine Orientation: Ejected blades could strike containment.

D. REACTOR COOLANT

Reactor Vessel Failure: After LOCA, safety injection of water will not effect the integrity of the reactor vessel.

W Reactor Vessel Design: Material SA533 GrA, B, or C, Cl 1 or 2
 Shell ID, in. 173 Shell Thickness 8 1/2 in.
 Overall Height, ft/in. 43'-10" Cladding Thickness, in. 1/8 min.

Reactor-Coolant Leak-Detection System: Leakage will be detected by make-up water for pressurizer, containment air monitoring which is the most sensitive detection device, containment humidity, pressure, temperature and containment sump water level. Maximum unidentifiable leakage limit is 1 gpm max. Identifiable leakage limit is 10 gpm.

Failed-Fuel-Detection System: Similar to Zion plant where reactor coolant water is analyzed periodically for radioactivity. Instruments for prompt detection of delayed neutrons in the coolant are being tested at the Ginna plant.

E. REACTOR CHARACTERISTICS		REACTOR: MARBLE HILL	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, Mwt	3411	H ₂ O/U, Cold	2.41
Electrical Output, Mwe (net)	1130	Avg 1st-Cycle Burnup, MWD/MTU	~14,000
Total Heat Output, Safety Design, MWT	3565	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	$11,642 \times 10^6$	Region-1 Enrichment, % W/O	2.10
System Pressure, psia	2250	Region-2 Enrichment, % W/O	2.60
DNBR, Nominal	2.08	Region-3 Enrichment, % W/O	3.10
Total Flowrate, lb/hr	140.3×10^6	k _{eff} , Cold, No Power, Clean	1.225 to 1.60
Eff Flowrate for Heat Trans, lb/hr	134×10^6	k _{eff} , Hot, Full Power, Xe and Sm	<1.25
Eff Flow Area for Heat Trans, ft ²	51.1	Total Rod Worth, % Δρ	3.26
Avg Vel Along Fuel Rods, ft/sec	16.7	Shutdown Boron, No Rods-Clean-Cold, ppm	1435
Heat Generated in Fuel, %	2.62×10^6	Shutdown boron, No Rods-Clean-Hot, ppm	1178
Hot Channel Factors, Fq	2.32	Boron Worth, Hot, % Δk/k/ppm	~12/120 ppm
Nominal Core Inlet Temp, °F	558.1	Boron Worth, Cold % Δk/k/ppm	~12/60 ppm
Avg Rise in Core, °F	62.7	Full Power Moderator Temp Coeff, Δk/k/°F	-5×10^{-5}
Non Hot Channel Outlet Temp, °F	~450	Moderator Pressure Coeff, Δk/k/psi	(-0.0% to +3.0) $\times 10^{-6}$
Avg Film Coeff, Btu/hr ft ² -°F	~4900	Moderator Void Coeff, Δk/k/% Void	Negative
Avg Film Temp Diff, °F	~36.2	Doppler Coefficient, Δk/k/°F	Negative at all power levels
Active Heat Trans Surf Area, ft ²	56,700	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Heat Flux, Btu/hr ft ²	189,800	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Heat Flux, Btu/hr ft ²	440,300	Number of Control Rods 53 x 24	1272
Avg Thermal Output, kw/ft	5.44	Number of Part-Length Rods (PLR) 8	192
Max Thermal Output, kw/ft	12.6	Number of Fuel Assemblies	193
Max Clad Surface Temp, °F	---	Overall Dimensions, inches	8.426 x 8.426
No. Coolant Loops	---	Number of Fuel Rods 193 x 264	50,952
REACTOR & BUILDINGS ARE IDENTICAL TO THE BYRON PLANT W Information from RESAR 3		Fuel Rod Cladding Material	Zircaloy-4
		Weight of UO ₂ lbs.	222,739

F. SAFETY INJECTION SYSTEMS REACTOR: MARBLE HILL

Core Flooding System: Four accumulator tanks; each holding 7100 gal of borated water under nitrogen pressure inject their contents into the reactor vessel when system pressure drops to 660 psig. One accumulator is connected to each of the cold legs. Mechanical operation of a swing-check valve is the only action required to open the injection path from accumulator to reactor vessel.

High-Pressure Injection System: This system has 2 charging pumps which take suction from the refueling water storage tank. One pump has capacity to handle a LOCA situation. Pumps start automatically on the "S" signal. Pumps can operate in recirculation mode taking suction from the residual heat removal pump discharge. These pumps deliver the flow thru the boron injection tank. Design flow rate per pump is 150 gpm at 2500 psig. Electric motor drive is rated 600 HP.

Safety Injection System: There are 2 pumps each rated 425 gpm at 1160 psig that start automatically on the "S" signal, taking suction from the refueling water storage tank, or the containment sump (in recirculation mode).

G. MISCELLANEOUS

Residual Heat Removal System: Transfers heat from Reactor Coolant System to the Component Cooling System thru the 2 heat exchanger during shutdown. The 2 pumps, each rated 3000 gpm at 165 psig, take suction from the refueling water storage tank when operating as injection pumps after LOCA. This system is also used for long term cooling by recirculating the coolant from the reactor thru the heat exchangers for cooling.

Radwaste System: Shared disposal system provides equipment to collect, process, and prepare for disposal all liquid, gaseous, and solid wastes. After collection, liquid wastes are evaporated and may be demineralized. Treated water from demineralizers or evaporator distillate may be recycled or may be discharged through the blowdown system to the Ohio River. Evaporator concentrates and spent demineralizer resins are solidified, drummed, and shipped off-site with other solid wastes for disposal. Gaseous wastes are collected and held for radioactive decay, then discharged to the atmosphere so controlled that off-site dose is as low as practical.

Plant Vent: Each reactor has a vent stack adjacent to the containment structure. Stacks are 8-ft diam at the bottom and 120-ft high.

G. MISCELLANEOUS (Continued) REACTOR: MARBLE HILL

Emergency Power: Two diesel generators are provided for each unit, each rated 4000 KW for continuous service, ready to accept load in 10 seconds. Units have independent compressed air starting. Each unit has a day tank (90 min capacity at full load), 2 transfer pumps, and a storage tank with 7 days supply for full load continuous operation.

Emergency Plans: Accidents that will be covered include fire, personnel injuries, radiation exposure, and radiological contamination. The plan will be consistent with the Indiana Survival Plan to be developed by the Ind. Dept. of Civil Defense. An offsite emergency control center will be established in Madison, Ind. in case the site is uninhabitable. Local, state, and federal agencies will be contacted for assistance as required. Kings' Daughters Hospital and Clark Memorial hospitals are considering accepting contaminated patients.

Environmental Monitoring: Program will cover aspects of river water and ground water as well as creeks. Fish, reptiles, amphibians, and turtles were counted. Vegetation and soils were sampled. Aquatic organisms were collected. Mammals, and birds were surveyed. A radiological program will be started 2 years before fuel loading, to establish preoperational base line. Programs will be varied as required.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using mechanical draft cooling towers.

Water Taken From: Ohio River for makeup - avg 29,300 gpm

Intake Structure: Built at the river's edge housing pumps for circulating water makeup and other pumps for essential service water makeup plus traveling screens. Inlet velocity is 0.5 fps.

Water Body Temperatures: Winter minimum 33 °F; Summer maximum 74 °F

River Flow ~10,000 (cfs) minimum; 112,300 (cfs) average

Service Water Quantity 30,000 gpm/reactor at Louisville

Flow Thru Condenser 507,000 (gpm)/reactor Temp. Rise 28 °F

Heat Dissipated to Environment 8250×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser --- (Btu/hr)/reactor

Discharge Structure: Blowdown discharge is a concrete structure about 200 ft long tha. discharges water at the river water surface at a velocity less than 2 fps.

Cooling Tower(s): Description & Number - 1 mech. draft 50' x 1200' x 60' high for both units.

Blowdown 2000 gpm/reactor Evaporative loss 12,500 gpm/reactor.

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NUCLEAR SAFETY INFORMATION CENTER

A. GENERAL

PROJECT NAME: Fort Calhoun Station, Unit 2

LOCATION: Eastern Nebraska in Washington Co. (20 mi N. of Omaha)

OWNER: Omaha Public Power and Nebraska Public Power District

OWNER'S ADDRESS & CONTACT: Jack L. Wilkins, Mrg-Engg. & Const.

ARCHITECT/ENGINEER: Gibbs & Hill

Omaha Public Power

1623 Harney Street

REACTOR MANUFACTURER: Westinghouse

Omaha, Neb. 68102

CONTAINMENT CONSTRUCTOR: ---

TURBINE MANUFACTURER: Westinghouse

DATE: January 1976

COMPILED BY: Fred Heddleson

ESTIMATED STARTUP DATE: 1981

NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Lat 41°31'17" N

4,600,500 m N

Long 95°04'41" W

743,800 m E

Site Description: Located on the SW bank of the Missouri River at River Mile 646 about 20 mi NNW of the center of Omaha. Iowa is across the river from the plant. Site is on the flood plain of the river. The river is 600' wide at the site and the flood plain is 8 miles wide. The nearest town is Blair (pop 6200) WNW 3.4 mi. The DeSoto Wildlife Refuge starts about 1 1/2 mi E and covers an area of 8100 acres. This is a very popular attraction having nearly 400,000 visitors in 1974. Wilson Island State Park is 4 mi SE and is used mostly for camping and trailer parking. Chicago & Northwestern RR has one line running E-W thru Blair and another running NW-SE along the SW border of the site. US hwy #30 runs E-W 2 mi N and US #73 runs by the site parallel with the railroad. An operating nuclear power plant (Fort Calhoun #1) is on the site and unit #2 will be adjacent and west of #1.

Nearby Body of Water:

Normal Level 99' (MSL)

Max Prob Flood Level 1014' (MSL)

Size of Site 1159 Acres Site Grade Elevation 1004' (MSL)

Topography of Site: Flat to rolling

of Surrounding Area (5 mi rad): Flat northeast, rolling southwest

Total Permanent Population: In 2 mi radius 161 ; 10 mi 3,900Date of Data: 1970 In 5 mi radius 7814 ; 50 mi 728,527Nearest City of 50,000 Population: Omaha, Neb.Dist. from Site 19.4 Miles, Direction SSE, Population 346,929Land Use in 5-Mile Radius: AgriculturalMeteorology: Prevailing wind direction SSE Avg. speed 11 mph

Stability Data - Calms occur about 32% of the time.

Meteorological Measurements - Data has been taken since 1967 (before unit 1 was constructed).

B. SITE DATA (Continued)			REACTOR: FORT CALHOUN #2		
Exclusion Distance, Miles	0.65	<u>Design Winds in mph:</u> At 0 - 50 ft elev 90 50 - 150 ft 105 150 - 400 ft 125 Tornado 290 mph rot. + 70 trans. $\Delta P = 3 \text{ psi} / 1 \text{ 1/2 sec}$			
Low Population Zone Distance, Miles	3				
<u>Metropolis</u>	<u>Distance</u>				<u>Population</u>
Omaha, Neb.	19.4 (center)				542,646
Safe Shutdown Earthquake Acceleration, g	0.2				
Operating Basis Earthquake Acceleration, g	0.1				
Earthquake Vertical Shock, % of Horizontal	66				
C. CONTAINMENT AND STRUCTURES					
Design Pressure, psig	50	Free Volume, cu ft	2.9 x 10 ⁶		
Calculated Max Internal Pressure, psig	42.1	Max Leak Rate at Design Pressure, %/day	0.1		
<u>Type of Construction:</u> Steel-lined reinforced-concrete structure - a vertical cylinder (walls 4'-6" thk) with hemispherical dome (2'-6" thk). Liner will be 1/4 and 3/8" thk. The flat foundation mat is 12' thk. Inside diameter is 135' and the cylinder height is 195 ft.					
<u>Design Basis:</u> Designed to withstand the internal pressure and temperature resulting from a LOCA and function to reduce the inside pressure to near atmospheric and to remove fission products so that internal and external environmental conditions will be maintained.					
<u>Vacuum Relief Capability:</u> Found no reference.					
<u>Post-Construction Testing:</u> Structural acceptance test will be conducted at 1.15 design pressure, raising pressure to that in 5 steps and reducing in 5 steps. Cracks and deformations will be observed. Leakage rate tests will be run at design pressure and half of design pressure.					
<u>Penetrations:</u> Sketches show penetrations as single barrier without taps for pressure testing.					
<u>Weld Channels:</u> Leak-chase channels will be provided at liner seams which will be inaccessible after construction. They will be used for leakage testing of seams.					

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: FORT CALHOUN #2

Containment Spray System: There will be two 100% capacity systems, each with 2 pumps, 1 heat exchanger, and spray ring headers. Sodium hydroxide borate solution, to help in fission product removal, will be added to the borated water from the refueling water storage tank. Pump capacity will be 3000 gpm each at 250 psig. Heat exchanger capacity for recirculated sump water is 167.5×10^6 .

Containment Cooling: After LOCA, the spray system described above removes the heat. During normal operation three 1/3 capacity fan-coil units hold temp at 120 F or below. One additional unit is in standby. Heat removal capacity per unit is 5.86×10^6 Btu/hr. Coils are cooled with component cooling system water.

Containment Air Filtration: Containment purge consists of two 100% capacity systems each capable of moving 700 cfs and filtering. Components are fan, demister, heater, rough filter HEPA filters and iodine absorbers. System vents thru the plant vent which monitors exhaust air for radioactivity.

Combustible Gas Control: Two electric-type thermal hydrogen recombiners will be located within containment and will hold the hydrogen concentration below 4 v/o. Also a redundant purge will exhaust air to hold down H_2 concentration

Containment Floodability: Found no reference.

Strong Motion Accelerometer: Triaxial strong motion units will be mounted on containment and auxiliary bldg structures along with accessories. Several multielement seismoscopes will be installed in Category I structures.

Turbine Orientation: Turbine and reactor are on the same N-S centerline. Ejected turbine parts could not strike containment structure.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no direct reference to failure. Designed constructed and operated in such manner that failure is incredible.

Reactor Vessel Design: Material SA533 Gr A, B, or C, Class 1 or 2

Shell ID, in. 173 Shell Thickness 8 1/2"

Overall Height, ft/in. 43'-10" Cladding Thickness, in. 1/8 min.

Reactor-Coolant Leak-Detection System: Leakage will be detected by make-up water for pressurizer, containment air monitoring which is the most sensitive detection device, containment humidity, pressure, temperature and containment sump water level. Maximum unidentifiable leakage limit is 1 gpm max. Identifiable leakage limit is 10 gpm.

Failed-Fuel-Detection System: Fission products in excess of normal can be detected in the reactor coolant system which would indicate failure fuel elements.

E. REACTOR CHARACTERISTICS		REACTOR: FORT CALHOUN #2	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3411	H ₂ O/U, Cold	2.41
Electrical Output, MWe (net)	1150	Avg 1st-Cycle Burnup, MWD/MTU	~14,000
Total Heat Output, Safety Design, MWt	3565	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	11642×10^6	Region-1 Enrichment, % w/o	2.10
System Pressure, psia	2250	Region-2 Enrichment, % w/o	2.60
DNBR, Nominal	2.08	Region-3 Enrichment, % w/o	3.10
Total Flowrate, lb/hr	140.3×10^6	K _{eff} , Cold, No Power, Clean	1.225 to 1.60
Eff Flowrate for Heat Trans, lb/hr	134×10^6	K _{eff} , Hot, Full Power, Xe and Sm	<1.25
Eff Flow Area for Heat Trans, ft ²	51.1	Total Rod Worth, %	8.26
Avg Vel Along Fuel Rods, ft/sec	16.7	Shutdown Boron, No Rods-Clean-Cold, ppm	1435
Heat Generated in Fuel, %	97.4	Shutdown Boron, No Rods-Clean-Hot, ppm	1178
Hot Channel Factors, F _q	2.32	Boron Worth, Hot, % $\Delta k/k/ppm$	~12/120 ppm
Nominal Core Inlet Temp, °F	558.1	Boron Worth, Cold, % $\Delta k/k/ppm$	~12/60 ppm
Avg Rise in Core, °F	62.7	Full Power Moderator Temp Coeff, $\Delta k/k/°F$	-5×10^{-4}
Nom Hot Channel Outlet Temp, °F	~650	Moderator Pressure Coeff, $\Delta k/k/psi$	(-0.04 to +3.0) $\times 10^{-6}$
Avg Film Coeff, Btu/hr ft ² -°F	~6000	Moderator Void Coeff, $\Delta k/k/\% \text{ Void}$	Negative
Avg Film Temp Diff, °F	36.2	Doppler Coefficient, $\Delta k/k/°F$	Negative at all power levels
Active Heat Trans Surf Area, ft ²	59,700	Shutdown Margin, Hot 1 rod stuck, % $\Delta k/k$	
Avg Heat Flux, Btu/hr ft ²	189,800	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Heat Flux, Btu/hr ft ²	440,300	Number of Control Rods	1272
Avg Thermal Output, kw/ft	5.44	Number of Part-Length Rods (PLR)	192
Max Thermal Output, kw/ft	12.6	Number of Fuel Assemblies	193
Max Clad Surface Temp, °F	~660	Overall Dimensions, inches	8.426 x 8.426
No. Coolant Loops	4	Number of Fuel Rods	50,942
W signifies that information came from RESAR 3S		Fuel Rod Cladding Material	Zircaloy-4
		Weight of Uranium, lbs.	222,739

F. SAFETY INJECTION SYSTEMS REACTOR: FORT CALHOUN #2

W Core Flooding System: Four accumulator tanks each holding 7100 gal of borated water under nitrogen pressure inject their contents into the reactor vessel when system pressure drops to 660 psig. One accumulator is connected to each of the cold legs. Mechanical operation of a swing-check valve is the only action required to open the injection path from accumulator to reactor vessel.

W High-Pressure Injection System: This system has 2 charging pumps which take suction from the refueling water storage tank. One pump has capacity to handle a LOCA situation. Pumps start automatically on the "S" signal. Pumps can operate in recirculation mode taking suction from the residual heat removal pump discharge. These pumps deliver the flow thru the boron injection tank. Design flow rate per pump is 150 gpm at 2500 psig. Electric motor drive is rated 600 HP.

W Safety Injection System: There are 2 pumps each rated 425 gpm at 1160 psig that start automatically on the "S" signal, taking suction from the refueling water storage tank, or the containment sump (in recirculation mode).

G. MISCELLANEOUS

W Residual Heat Removal System: Transfers heat from Reactor Coolant System to the Component Cooling System thru the 2 heat exchanger during shutdown. The 2 pumps, each rated 3000 gpm at 165 psig, take suction from the refueling water storage tank when operating as injection pumps after LOCA. This system is also used for long term cooling by recirculating the coolant from the reactor thru the heat exchangers for cooling.

Radwaste System: Liquid wastes will be collected and processed for recycle or for release to the river. Bulk of liquids released from the reactor coolant system will be processed by the boron recycle system. There will be 2 main processing systems - one for liquids that will be recycled and one for liquids that will be discharged. Discharge will be in circulating water system to the river. Gaseous wastes will be collected and stored as required. Components in system will be 2 compressors, 2 catalytic hydrogen recombiners, 6 gas decay tanks to accumulate fission product gases, and 2 shutdown decay tanks. No gases will be released to the environment during the life of the plant except in an emergency. Solid wastes will either be solidified and packaged, or low-level misc. compressible wastes will be compressed and bailed for offsite disposal.

Plant Vent: Vent stack runs up the side of the containment structure. Vent elevation will be given in FSAR.

G. MISCELLANEOUS (Continued) REACTOR: FORT CALHOUN #2

Emergency Power: There will be 2 diesel-generator sets, one exclusively for Train A and one exclusively for Train B. One unit can supply sufficient power for operation of minimum engineered safety features. Diesel-generator will be rated about 5500 KW, the actual value being determined later. Fuel oil day tank will have capacity for about 4 hrs operation and the larger storage tank will have 8 days fuel supply.

Emergency Plans: Present emergency plan for unit 1 is in effect. It delineates an organization, classifies emergencies according to severity and assigns responsibilities to personnel and outside authorities. Most effective action is described to mitigate consequences and to safeguard the public. Goal is to return the plant to safe conditions as soon as possible. Blair hospital has agreed to accept contaminated people who have injuries. Training programs and emergency exercises are in effect.

Environmental Monitoring: The present program of monitoring being used for unit 1 will constitute the preoperational plan for unit 2 and will be continued for operational monitoring. Waters of the Missouri River are sampled for water quality, fish, and fish-food organisms. Other studies on the river concern thermal discharges and effects. Well water mud and silt, milk, vegetation, air particulates, and wild life are sampled also. A radiological program measures radioactivity levels in many of the samples.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Missouri River

Intake Structure: Structure is on bank of Missouri R. with heavy steel bar trash racks and 3 traveling screens for each of 4 circulating pumps. Each pump has 1/3 capacity. Water to condenser will be piped in concrete or fiberglass.

Water Body Temperatures: Winter minimum 32 °F; Summer maximum 80 °F

River Flow 2200 (cfs) minimum; 28,850 (cfs) average

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 890,000 (gpm)/reactor Temp. Rise ~20 °F

Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 8000 × 10⁶ (Btu/hr)/reactor

Discharge Structure: Water discharged back to the river will flow through tunnels and discharge into an open structure which will discharge into the river at a velocity of 8.26 fps. At this velocity, good mixing will occur.

Cooling Tower(s): Description & Number - None

Blowdown --- gpm/reactor Evaporative loss --- gpm/reactor

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NUCLEAR SAFETY INFORMATION CENTER

A. GENERAL**PROJECT NAME:** Greene County Nuclear Power Plant**LOCATION:** SE New York on the Hudson River, 35 mi SSW of Albany**OWNER:** Power Authority of the State of New York**OWNER'S ADDRESS & CONTACT:** Mr. George T. Berry, Gen. Mgr.**ARCHITECT/ENGINEER:** Stone & Webster

Power Authority of State of N.Y.

10 Columbus Circle

REACTOR MANUFACTURER: B&W

New York, N.Y. 10019

CONTAINMENT CONSTRUCTOR: ---**TURBINE MANUFACTURER:** ---**DATE:** March 1976**COMPILED BY:** Fred Heddleson**ESTIMATED STARTUP DATE:** 1984**NUCLEAR SAFETY INFORMATION CENTER****B. SITE DATA** Lat. 42°09'00"N, Long. 73°54'-41"W

Site Description: Located on the west bank of the Hudson River about 13 mi N of Kingston, N.Y. and about 1 mi N of the hamlet of Cementon. The site is bounded on the west by the Penn Central RR and US hwy #9W. Within about 1 mi of the site there are 3 major cement companies. Germantown (pop 1872) is 1.5 mi SE, the nearest town with population reported in the census. I-87 is about 2 mi W and a 10" gas pipe line which parallels the highway is 1.5 W. The nearest school is in German-town with an enrollment of 900. About 5 miles from the site there are two towns; Catskill (pop 5317) and Saugerties (pop 4190). The site is at River Mile 108 so the water level of the Hudson River is affected by the tides. Max range of the tides is 4 feet.

Nearby Body of Water:**Normal Level** sea level(MSL)

Hudson River

Max Prob Flood Level 29.5' (MSL)**Size of Site** 282 **Acres** **Site Grade Elevation** 30' (MSL)**Topography of Site:** Level to Rolling**of Surrounding Area (5 mi rad):** Level to Rolling**Total Permanent Population:** In 2 mi radius 1378 ; 10 mi 45,786**Date of Data:** 1970 In 5 mi radius 7526 ; 50 mi 1,383,978**Nearest City of 50,000 Population:** Albany, N.Y.**Dist. from Site** 35 **Miles, Direction** NNE, **Population** 115,781**Land Use in 5-Mile Radius:** Rural land vacant about 50%, Agricultural about 24%, Residential and Industrial about 3 1/2% each.**Meteorology:** Prevailing wind direction S-Sum. Avg. speed 6 mph**Stability Data** - Calms occur about WNW-Win.
9% of the time.**Meteorological Measurements** - Data collection started in June-73
with a 33' tower

E. SITE DATA (Continued)			REACTOR: GREENE COUNTY	
Exclusion Distance, Miles		0.46 radius	Design Winds in mph: At 0 - 50 ft elev 90 50 - 150 ft 105 150 - 400 ft 125 Tornado 290 mph rot. + 70 trans. $\Delta P = 3 \text{ psi} / 1 \frac{1}{2} \text{ sec}$	
Low Population Zone Distance, Miles		2.5 radius		
<u>Metropolis</u>	<u>Distance</u>	<u>Population</u>		
Albany, N.Y.	35 mi	286,742		
Safe Shutdown Earthquake Acceleration, g		0.2		
Operating Basis Earthquake Acceleration, g		0.1		
Earthquake Vertical Shock. % of Horizontal		66		
C. CONTAINMENT AND STRUCTURES				
Design Pressure, psig		48	Free Volume, cu ft	
			3.44 x 10 ⁶	
Calculated Max Internal Pressure, psig		39.1	Max Leak Rate at Design Pressure, %/day	
			0.2	
<u>Type of Construction:</u> A steel-lined (3/8 to 1/2" thk), heavily reinforced concrete structure with 5'-3' thk cylindrical walls, and 2'-6" thk concrete dome supported on a reinforced concrete mat. Cylindrical portion is 150 ft ID and 246 ft overall height. Foundation mat is about 60 ft below grade. An annulus building surrounds the containment structure and is about 310 ft in diameter and about 60 ft high above grade.				
<u>Design Basis:</u> Designed so that leakage rate will be less than 0.2% by vol of contents per day after LOCA, and in addition the structure is designed to withstand the pressure and temperature conditions resulting from a DBA.				
<u>Vacuum Relief Capability:</u> Found no reference.				
<u>Post-Construction Testing:</u> Will have an integrated leakage rate test in accordance with App. J of 10CFR50 after construction. Also, after construction the structural acceptance test will be run at a pressure 55 psig measuring deflections at several points. Exterior cracking will be mapped.				
<u>Penetrations:</u> Single barrier penetrations are used and sketches show no pressure taps for individual testing.				
<u>Weld Channels:</u> Test channels will be placed over liner seams and penetrations to the liner to permit leak tightness testing during construction.				

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: GREENE COUNTY

Containment Spray System: There are 2 spray systems each having one pump (3500 gpm capacity), 2 spray headers, 2 heat exchangers, pipe, valves, etc. Suction is taken from the Borated Water Storage Tank. Water for spray can be recirculated from the containment sump thru the heat exchangers for cooling. NaOH is added to the spray for I. line removal.

Containment Cooling: Four 1/3 capacity fan-coil units provide cooling during normal operation, or during LOCA. Each unit has 2 fans, one for normal operation and one for emergency conditions. Temp is held at about 55F during normal operation. Cooling capacity after LOCA is 105×10^6 Btu/hr unit. Containment spray and Decay Heat Removal Systems also help cool containment.

Containment Air Filtration: Supplementary leak collection and release system collects air which leaks from containment to the annulus building where it is filtered and cleaned up for release. There are 3 filter banks which includes charcoal filters.

Combustible Gas Control: Two redundant 100% capacity hydrogen recombiners are available to hold hydrogen level in containment below 4 vol %. The system is started manually. A dilution air subsystem provides backup.

Containment Floodability: Found no reference.

Strong Motion Accelerometer: Units will be installed in the containment structure as required by Reg. Guide 1.12. Details will be furnished in the FSAR.

Turbine Orientation: Turbine and reactor are on the same centerline. It is unlikely that ejected turbine parts could strike containment.

D. REACTOR COOLANT

Reactor Vessel Failure: Integrity is assured by correct design and stress analysis, quality control, proper operation, and additional safety margins.

Reactor Vessel Design: Material SA-533 Gr.8, 18-8 cladding

Shell ID, in. 182 Shell Thickness, in. 9 1/8

Overall Height, ft/in. 43'-0" Cladding Thickness in. 1/8

Reactor-Coolant Leak-Detection System: Methods used for detection are: 1. Airborne particulate and gaseous radiation monitoring, 2. containment sump level, 3. Fan-coil cooler heat load, 4. Containment pressure, temperature and humidity, and 5. Reactor coolant system water make up. Sump can detect a 1 gpm leak within 1 hour.

Failed-Fuel-Detection System: A closed loop of piping in the fuel transfer canal which includes a failed fuel detection container, circulating pump, radiation detection system, etc. A suspected fuel assembly, after removal from the reactor is placed in the container and water is circulated thru the closed loop to accumulate the radioactivity. Gas samples are also collected.

E. REACTOR CHARACTERISTICS		REACTOR: GREENE COUNTY	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3500	H ₂ O/U, Cold	2.93
Electrical Output, MWe (net)	1187	Avg 1st-Cycle Burnup, MWD/MTU	19,631
Total Heat Output, Safety Design, MWt	3760	Maximum Burnup, MWD/MTU	55,000
Total Heat Output, Btu/hr	$12,287 \times 10^6$	Region-1 Enrichment, %	2.83 avg.
System Pressure, psia	2250	Region-2 Enrichment, %	---
DNBR, Nominal	1.82	Region-3 Enrichment, %	---
Total Flowrate, lb/hr	150.5×10^6	k _{eff} , Cold, No Power, Clean	1.290
Eff Flowrate for Heat Trans, lb/hr	142.4×10^6	k _{eff} , Hot, Full Power, Xe and Sm	1.148
Eff Flow Area for Heat Trans, ft ²	56.60	Total Rod Worth, % $\Delta k/k$	9.11
Avg Vel Along Fuel Rods, ft/sec	16.2	Shutdown Boron, No Rods-Clean-Cold, ppm	1300
Heat Generated in Fuel, %	97.3	Shutdown Boron, No Rods-Clean-Hot, ppm	915
Hot Channel Factors, Fq	2.65	Boron Worth, Hot, % $\Delta k/k/ppm$	1/105
Nominal Core Inlet Temp, °F	572.3	Boron Worth, Cold, % $\Delta k/k/ppm$	1/80
Avg Rise in Core, °F	59.3	Full Power Moderator Temp Coeff, $\Delta k/k/°F$	(0.12 to -3.0) $\times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	652.7	Moderator Pressure Coeff, $\Delta k/k/psi$	-3×10^{-7} to $+3 \times 10^{-6}$
Avg Film Coeff, Btu/hr ft ² -°F	---	Moderator Void Coeff, $\Delta k/k/\% \text{ Void}$	+0.078 to -0.068
Avg Film Temp Diff, °F	---	Doppler Coefficient, $\Delta k/k/°F$	(-1.49 to -1.98) $\times 10^{-5}$
Active Heat Trans Surf Area, ft ²	63,991	Shutdown Margin, Hot 1 rod stuck, $\Delta k/k$	1
Avg Heat Flux, Btu/hr ft ²	186,820	Burnable Poisons, Type and Form	Sintered Pellets Al ₂ O ₃ -B ₄ C
Max Heat Flux, Btu/hr ft ²	495,678	Number of Control Rods	64
Avg Thermal Output, kw/ft	5.43	Number of Part-Length Rods (PLR)	24
Max Thermal Output, kw/ft	14.41	Number of Fuel Assemblies	205
Max Clad Surface Temp, °F	557	Overall Dimensions, inches	8.536 $\times$ 8.536
No. Coolant Loops	2	Number of Fuel Rods	54,120
		Fuel Rod Cladding Material	Zircaloy-4
		Weight of Uranium, lbs. (as UO ₂)	233,884

F. SAFETY INJECTION SYSTEMS REACTOR: GREENE COUNTY

Core Flooding System: There are 2 accumulator tanks each holding about 10,000 gallons of borated water under a pressure of nitrogen gas. Tanks automatically inject their contents into the reactor when reactor coolant system pressure drops to 600 psig.

High-Pressure Injection System: There are 3 pumps each with a capacity of 700 gpm at 1125 psig. One pump is always in operation as a charging pump and would immediately begin injection to handle a small break. Pumps take suction from the borated water storage tank. The low-pressure injection pumps can be operated as a booster for the high-pressure pumps.

Low-Pressure Injection System: The 2 pumps that function in this system are the Decay Heat Removal pumps described below. These pumps take suction from the borated water storage tank and can recirculate water from the containment sump when the borated water storage tank supply is exhausted. These pumps do not inject until pressure in the coolant system drops to where they will operate. When these pumps start they inject concentrated boric acid into the system.

G. MISCELLANEOUS

Decay Heat Removal System: Performs several functions, some of which are: removes heat from the core during the shutdown operation, provides means of filling and draining the refueling cavity, provides low-pressure injection for core cooling (described above). The system consists of 2 pumps arranged in parallel (cap 5000 gpm at 165 psig each), and 2 heat exchangers. System takes suction from the borated water storage tank. Cooling tower basins have a water supply that would provide operation for 30 days.

Radwaste System: Liquid wastes are collected, classified, and processed by filtration, evaporation, and demineralization. Processed liquids are either recycled in the plant or discharged thru the blowdown lines from the cooling towers. Continuous degasification and purification of reactor coolant letdown includes dehumidification by refrigerant dryers, filtering thru charcoal adsorbers, providing time for decay, and then releasing thru the ventilation vent. Hydrogen is recycled. The solid waste system provides for holdup, packaging, and storage. Wastes are solidified and packed into 50 cu. ft. containers (about 6 per wk) for shipment to offsite disposal areas.

Plant Vent: Vent stack near the side of containment, on top of the annulus building, venting about 125'. Containment spring line is 151'.

G. MISCELLANEOUS (Continued) REACTOR: GREENE COUNTY

Emergency Power: Two completely independent diesel-generator sets are provided such that either one can carry the maximum load of 6700 KW for engineered safety features. Generators can be synchronized to the bus for load testing, but cannot be synchronized to each other. Each engine has a day tank with 2 hr. fuel supply plus a storage tank with fuel for 7 days of full load operation.

Emergency Plans: Plans cover persons within the exclusion area and the low population zone during an emergency. Procedures have been developed, crews will be trained, and responsibilities assigned for the handling of emergency type situations. The Coast Guard will handle the area of the exclusion zone that covers the Hudson River. Other state, federal, and local agencies will be contacted for assistance as required.

Environmental Monitoring: Physical and chemical parameters of the Hudson River waters are being studied to provide preoperational data. Aquatic ecology sampling is included. Other sampling includes ground water, particulates, soil, terrestrial sampling of vegetation and faunal communities, birds, reptiles and amphibians, and insects. Radiological monitoring of background radiation levels was carried out which can serve as a preoperational base. Noise measurements and meteorological data collection are included.

H. CIRCULATING WATER SYSTEM

Type of System: Closed using 2 hyperbolic natural draft cooling towers.

Water Taken From: Hudson River for makeup - 19,700 gpm avg.

Intake Structure: Reinforced concrete 3 bay structure on the shore of the river having trash rack, traveling screen and pump for each bay. Water is pumped thru a 2.5 ft pipe to the turbine building. After being used for cooling there, it goes to main cooling towers for makeup.

Water Body Temperatures: Winter minimum 32 °F; Summer maximum 83 °F

River Flow 882 cfs avg min. 0 (slack tide) (cfs) minimum; 15,000 cfs (cfs) average

Service Water Quantity 17,400 Turbine Plant
15,000 Reactor gpm/reactor

Flow Thru Condenser 700,000 (gpm)/reactor Temp. Rise 24 °F

Heat Dissipated to Environment 8400×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser 8400×10^6 (Btu/hr)/reactor

Discharge Structure: Blowdown from towers flows thru a 30" ID pipe and discharges to the river 200 ft from shore thru a two-port diffuser, which discharge toward the center of the river. Discharge location is about 900 ft downstream of the intake.

Cooling Tower(s): Description & Number - Two towers 380' high, 470' dia. base
Blowdown 7610 gpm/reactor **Evaporative loss** 11,460 gpm/reactor

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