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MASTER

ORNL-NSIC-55
Vol. II

DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS

Vol. II
Docket No. 50-296 Through 50-395

NUCLEAR SAFETY INFORMATION CENTER

NSIC

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ORNL-NSIC-55
Vol. II

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Nuclear Safety Information Center

DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS

Vol. II

Docket No. 50-296 Through 50-395

Compiled by Fred A. Heddleson
Reactor Division

JANUARY 1972

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
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TABLE OF CONTENTS

INDEX BY DOCKET NUMBER

INDEX BY DOCKET NUMBER
(continued)

INDEX BY NUCLEAR POWER PLANT NAME

INDEX BY NUCLEAR POWER PLANT NAME
(continued)

INDEX BY UTILITY NAME

INDEX BY UTILITY NAME
(continued)

INDEX BY UTILITY NAME
(continued)

FOREWORD

The Nuclear Safety Information Center, established in March 1963 at the Oak Ridge National Laboratory under the sponsorship of the U.S. Atomic Energy Commission, is a focal point for the collection, storage, evaluation, and dissemination of nuclear safety information. A system of keywords is used to index the information cataloged by the Center. The title, author, installation, abstract, and keywords for each document reviewed are recorded at the central computer 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
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15. Environmental Surveys, Monitoring, and Radiation Exposure of Man
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
20. Effects of Thermal Modifications on Ecological Systems
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DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS

Vol. II

Docket No. 50-296 Through 50-395

ABSTRACT

Design data, safety features, and site characteristics are summarized for forty-seven commercial nuclear power plants 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. A small aerial perspective is also presented for each plant site. Plants covered in this volume are Browns Ferry, Docket Number 50-296, and all subsequent plants finishing with Virgil C. Summer, Docket Number 50-395.

INTRODUCTION

The data summaries for this report were taken from the Preliminary Safety Analysis Reports (PSAR) and Final Safety Analysis Reports (FSAR) generated for the U.S. Atomic Energy Commission licensing authorities by applicants wishing to build and operate nuclear power plants. These reports consist of 800 to 2000 pages of information which describe the reactor, the reactor site, the power generation system, auxiliaries, and other aspects of importance in the safety assessment of reactor design, 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. Therefore, this compilation of summary data should be useful.

The U.S. Atomic Energy Commission has issued a guide for organization of material, and this guide is generally followed now for all PSAR's and FSAR's. The suggested organization is as follows:

I. Introduction

II. Site

III. Reactor

IV. Reactor Coolant System

V. Containment System

VI. Engineered Safety Features

VII. Instrumentation and Control

VIII. Electrical Systems

IX. Auxiliary and Emergency Systems

X. Steam and Power Conversion System

XI. Radioactive Wastes and Radiation Protection

XII. Conduct of Operation

XIII. Initial Tests and Operation

XIV. Safety Analyses

XV. Technical Specifications

XVI. Appendices

In 1967, the Advisory Committee on Reactor Safety (ACRS) requested that the Nuclear Safety Information Center compile design data on light-water power reactors in a concise tabular format for use by their Committee. Since that time, tables have been prepared for each power reactor and made available on a limited distribution basis to ACRS, several USAEC Headquarters Offices, and the NSIC staff. The data summaries, which contain about 150 of the most important reactor facts, have proven to be quite useful to these groups and numerous requests have been received for summaries from other organizations that became aware of their existence. Consequently, a decision was made to issue the summaries in report form so that they would become more widely available. This publication is designated as Volume II because it covers commercial power reactors with docket numbers larger than and including 50-296 (Browns Ferry No. 3). Volume I, which will be published later, will cover power reactors up to and including docket number 50-295. Data for the earlier reactors had been compiled in an obsolete format that is being converted to the format presently being used. In addition, data for the older reactors are now being taken from the FSARs rather than the PSARs used earlier since in most cases the FSARs are now available. In the index by sequential docket number, some numbers are missing. The missing docket numbers are for experimental reactors and/or for those not producing commercial power.

Organization of Information

Reactor summaries appear sequentially according to docket number. Some general information such as name, size, location, utility, etc. is listed at the top of the first page, followed by information organized as follows:

A. Thermal-Hydraulic Data - Tabulations of data values on the thermal-hydraulic design characteristics of the reactor core and coolant systems.

B. Nuclear Data - Tabulations of data values on nuclear aspects of the reactor core.

C. Safety-Related Design Criteria - Listing of data on exclusion distance, populations, design wind speed, seismic design, etc.

D. Engineered Safety Features - Data on containment design values, containment system descriptions, emergency core cooling systems.

E. Other Safety-Related Features - Descriptions of auxiliary safety features such as leak detection, long term emergency cooling, flow restrictors, failed fuel detection, emergency power, etc.

F. Miscellaneous - Other important information such as site features, emergency plans, environmental monitoring, radwaste treatment, waste heat system, etc.

G. Circulating Water System and Site Features - Information on site topography, population, elevations, cooling water source, circulation rate, cooling towers, etc.

Parameters are related to rated power output for a single unit unless otherwise noted. For instance, in a case 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 last sheet of information, G. CIRCULATING WATER SYSTEM AND SITE FEATURES, was recently added as supplementary data. However, since the information appeared to be quite useful, it has been compiled and is included for each reactor. The sketch at the bottom of this sheet is an aerial perspective with notes describing the reactor and site features. The terms and features used on it are explained in Fig. 1. In most cases, the size of the reactor building and turbine building has been increased over true size to better show their relationship to the site.

LEGEND — Parameters are related to each single unit unless otherwise noted.

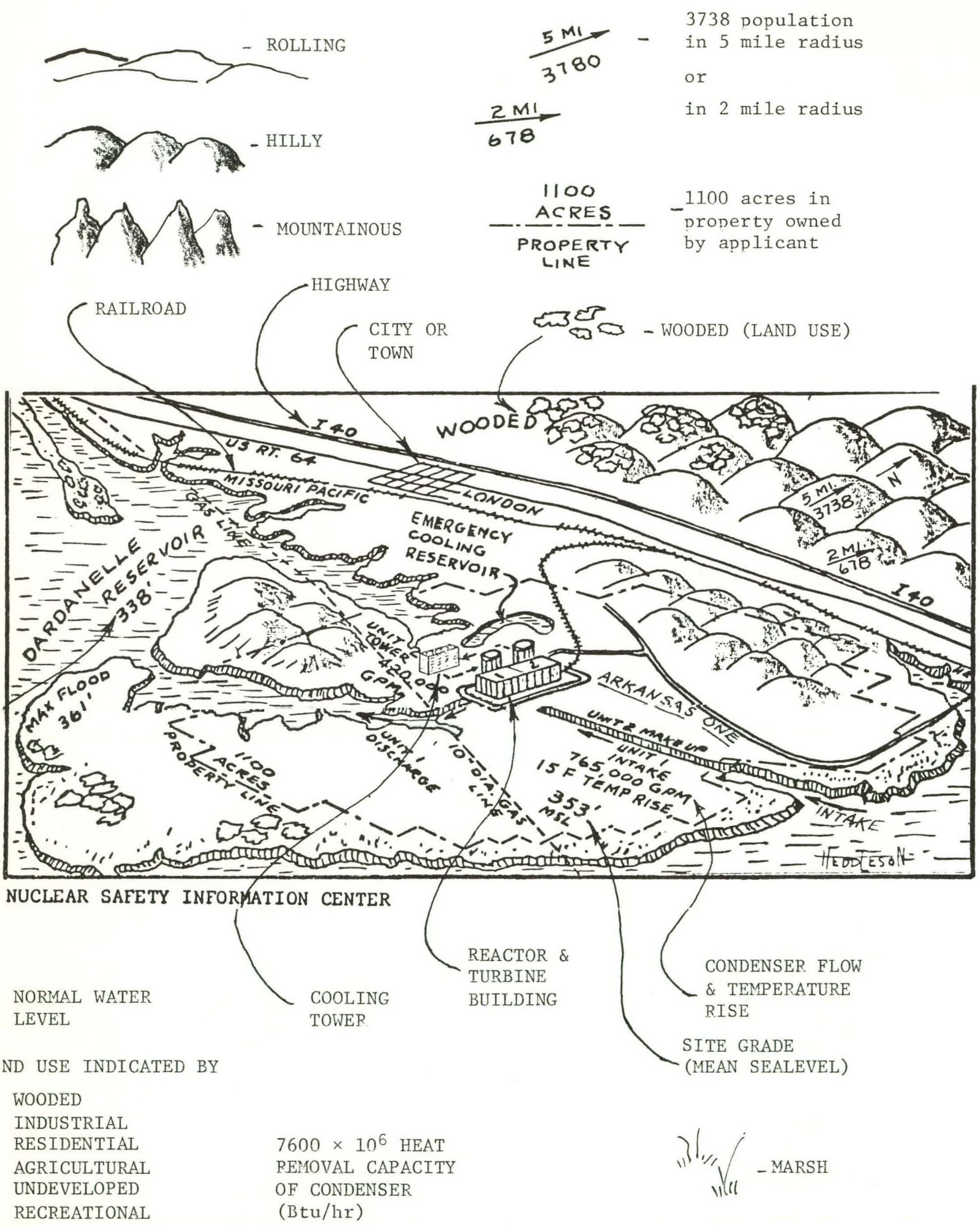


Fig. 1. Explanation of Terms for Site Sketch.

Accuracy of Data

All information presented in this publication have been taken from the Preliminary or Final Safety Analysis Reports, the applicant's Environmental Report, or the AEC Environmental Impact Statement. In some cases, a data value may be presented which has changed or is invalid for some other reason. There are some values taken from the PSAR that have changed but the FSAR is not yet available for the revised value.

If values are found which are 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 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.

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

$$Q/A\Delta t_{1m} \equiv h$$

where Q is the heat removed per unit time from fuel surface area A, and Δt_{1m} 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.

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 — System where cooling towers, cooling ponds, etc. are used for cooling with all heat removed by the towers, etc. Water is recirculated in the closed loop.

Circulating Water System — System which provides cooling water to the main condensers.

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 drywell pressure following loss of coolant.

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 a housing ruptures.

Control-Rod Velocity Limiter — An integral part of a control rod 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.

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 that govern reactor design.

Docket No. — The number assigned by the AEC Division of Reactor Licensing to a particular reactor.

Doppler Coefficient — The reactivity change due to Doppler broadening of ^{238}U resonance absorption cross section per degree F 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 a 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 — 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, and the like.

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.

Exclusion Distance — The distance from the centerline 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 — The long square tube or box enclosing the fuel assembly and providing 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.

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.

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 exlcusion 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 or from steam generator 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.

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.

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/gm, and fuel rod rupture will occur about 400 cal/gm. Thus the 280 cal/gm, 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 — Load-following or base-loaded plant.

Prim Ctmt — Primary Containment.

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 drywell, 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 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 — Leaktight 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 remove residual heat from the reactor core, the suppression pool, or the containment atmosphere.

River Flow — The average flow past the site.

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. Computer system performs the averaging function.

Secondary Containment — Reactor building which is designed to be 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.

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.

Shutdown Boron, ppm — 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 B 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 Chamber.

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 × 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 — Whether or not turbine centerline is perpendicular to a centerline through the reactor, or whether both have the same centerline. The interest is in the possibility of ejected turbine blades being missiles that could strike or penetrate 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.

BROWNS FERRY, 50-296 (BWR)

Page 1

Project Name: Browns Ferry Nuclear Plant, Units 1, 2, & 3
Location: Limestone Co., Ala.
Owner: TVA
NSS Vendor: General Electric

Reactor: Browns Ferry
A-E: TVA
Vessel Vendor: Babcock & Wilcox
Docket No.: 50-296 (also 50-259, -260)
Containment Constructor: TVA

A. THERMAL-HYDRAULIC	
Thermal Output, MWt	3293
Electrical Output, MWe	1098
Total Heat Output for Safety Design, MWt	3440
Steam Flow Rate, lb/hr	13.38×10^6
Total Core Flow Rate, lb/hr	102.5×10^6
Coolant Pressure, psig	1020
Heat Transfer Area, ft^2	66,098
Max Power per Fuel Rod Unit Lgth, kw/ft	18.35
Maximum Heat Flux, Btu/hr-ft^2	424,400
Average Heat Flux, Btu/hr-ft^2	163,234
Maximum Fuel Temperature, °F	4430
Average Fuel Rod Surface Temp °F	560
MCHFR	$\geq$1.9
Total Peaking Factor	2.6
Avg Power Density, Kw/ℓ	50.732

Data from FSAR.

B. NUCLEAR	
H_2O/UO_2 Volume Ratio	2.43
Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Moderator Temp Coef Hot, No Voids	-17.0×10^{-5}
Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Moderator Void Coef Operating	-1.6×10^{-3}
Doppler Coefficient, Cold	-1.3×10^{-5}
Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Doppler Coefficient, Operating	-1.3×10^{-5}
Initial Enrichment, %	2.19
Average Discharge Exposure, MWD/Ton	19,000
Core Max Void Within Assembly, %	79
k_{eff}, All Rods In	---
k_{eff}, Max Rod Out	<0.99
Control Rod Worth, One Rod, Normal Sequence	0.01 Δk
Curtain Worth, %	---
Burnable Poisons, Type and Form	372 Flat Boron - SST
Number of Control Rods	185 Cruciform
Number of Part-Length Rods (PLR)	None

Compiled by: Fred Heddleson
Date: August 1971

TX-4377
(8-70)

Reactor: Browns Ferry

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		~0.75
Low Population Zone Dist., Mi.		7
Metropolis	Distance	Population
Huntsville, Ala.	30	143,000('69)
Design Basis Earthquake Accel., g		0.20
Operating Basis Earthquake Accel., g		0.10
Earthquake Vertical Shock, % of Horizontal		---

Design Winds in mph:

At 0 - 50 ft	100
50 - 150 ft	120
150 - 400 ft	140
Tornado	300 mph tang
ΔP = ---psi/ ---sec	

Is intent of 70 design criteria satisfied? Yes, see Sect. A.1 of Appendix.

Peak Fuel Enthalpy on Rod Drop: 280 cal/gm

Recirculation Pumping System & MCHFR: Recirculation rate effects the type of boiling and thus the MCHFR. Core heat-transfer surface area and coolant flow rate set to ensure that MCHFR is not less than 1.9 at rated conditions.

Protective System: Initiates a rapid, automatic shutdown. This action is taken in time to prevent fuel cladding damage or other damage following abnormal transients. This system overrides all operator actions and process controls.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	56	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	56	Second Ctmt Design Press	2 inches water Table 1.7-4
Calc Max Internal Press, psig	46.6	Second Ctmt Leak Rate, %/day	100

Type of Construction: Pressure suppression type containment with a steel drywell shaped like a light bulb encircled by a steel torus. Drywell is enclosed in reinforced concrete. Drywell free volume is 159,000 ft^3 and suppression chamber free volume is 119,000 ft^3.

Design Basis: Designed to withstand pressure and temperature resulting from LOCA with some metal-water reaction without loss of integrity. Leakage will be less than specified by 10CFR100 off-site dose guide lines.

Vacuum Relief Capability: Designed for 2 psig external pressure. Relief devices let air flow from suppression chamber to the drywell and from the reactor building to the suppression chamber.

Post-Construction Testing: Leakage rate tests will be run at 47 psig and other pressures to establish leakage rate/pressure ratios.

Penetrations: Electrical penetrations are double sealed and individually testable. Some piping penetrations are double sealed and some are not.

Reactor: Browns Ferry

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Consists of 2 independent loops each having two 50% capacity pumps, one spray sparger above the core, piping, etc. Initiated by low water level in the reactor or high pressure in the drywell. Each pump delivers 3125 at 122 psig.

Auto-Depressurization System: Uses six pressure relief valves to vent steam to the suppression pool to reduce coolant system pressure so LPCIS and core spray can operate. Functions when HPCIS cannot maintain reactor water level.

Residual-Heat-Removal System (RHRS): Consists of four main pumps and 4 heat exchangers arranged in two loops plus eight service water pumps. There are three modes of operation which are: 1) shutdown cooling which can complete cooldown to 125F in 20 hrs., 2) suppression pool cooling which pumps suppression pool water thru the heat exchangers for cooling. This part of the system cools containment by diverting part of the flow through spray headers in the drywell, and 3) Low Pressure Coolant Injection which is discussed below. Pumps are rated 10,000 gpm each @ 20 psid and heat exchangers 70×10^6 Btu/hr each.

High-Pressure Coolant-Injection System: Provides a means to inject water into the coolant system in case of small leaks. One turbine-driven pump provides 5000 gpm flow. Pump takes suction from the condensate storage tank and suppression pool. Initiated by low water in the reactor or by high pressure in containment.

Low-Pressure Coolant-Injection System: As an operating mode of Residual Heat Removal System, LPCI uses the pump loops of the RHRS to inject cooling water at low pressure into an undamaged reactor recirculation loop. LPCI is actuated by conditions indicating a breach in the coolant system. Four pumps, each rated 10,000 gpm @ 20 psid supply sufficient water to flood the core and prevent melting.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: RHR pumps at one reactor unit can pump from the suppression pool of another reactor. Piping sized for 5000 gpm flow. Also, raw water can be supplied at rate of 3250 gpm @ 65 psig.

Main-Steam-Line Flow Restrictors: A venturi type flow restrictor installed in each steam line close to reactor vessel. They limit loss of coolant to 200% of rated flow from reactor vessel in case of steam line break outside primary containment and prevent uncovering of the core.

Control-Rod Velocity Limiters: Attachment on each control rod to limit velocity at which a control rod can fall out of the core. The rate of reactivity insertion resulting from a rod drop accident is limited by this action. The limiters contain no moving parts, nor does it effect scram. Limits fallout velocity to 5 ft/sec.

Control-Rod-Drive-Housing Supports: Housing supports are located underneath reactor vessel near the control rod housings. Supports limit travel of a control rod to about 2" if that control rod housing is ruptured. Supports prevent a nuclear excursion as a result of a housing failure, thus protecting the fuel barrier.

Standby Liquid-Control System: Provides a redundant, independent, and different way from control rods to bring nuclear fission reaction to subcriticality and to maintain subcriticality as the reactor cools. Boric acid injected into the coolant system.

Reactor: Browns Ferry

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: Atmosphere inerting not mentioned. Primary containment is held at about 135 F during operation. Atmosphere is purged before personnel entry.

Reactor Core Isolation Cooling System (RCICS): The reactor core isolation cooling system (RCICS) provides makeup water to the reactor vessel whenever the vessel is isolated. The RCICS uses a steam driven turbine-pump unit and operates automatically in time and with sufficient coolant flow to maintain adequate reactor vessel water level. System can deliver 616 gpm @ 1120 psid.

Reactor Vessel Failure:	
Missile & Reactor Forces -	Section 4.2.3 says, "The reactor vessel shall be designed and fabricated to a high standard of quality to provide assurance of extremely low probability of failure."
Core Cooling Capability -	
Containment Floodability -	Can flood primary containment to a level above reactor core.

Reactor-Coolant Leak-Detection Systems: Leaks are detected by: (a) increased pressure and temperature in containment; (b) monitoring flow in equipment drain sump and floor drain sump; and (c) monitoring cooling water temperature to and from drywell coolers. Total leakage rate limit is set at 50 gpm with a limit of 15 gpm for unidentified leakage.

Failed-Fuel Detection Systems: Monitors for gross release of fission products from the fuel and, upon indication of such failure, initiates action to limit fuel damage and contain the released fission products. Four gamma sensitive detectors monitor the main steam lines. Detectors are located near the main steam lines in the space between the primary containment and secondary containment walls.

Emergency Power: Standby ac power supplied by four diesel-generator sets, each rated at 2850 kW for 2000 hours or 3050 kW for short-term loading. Three diesels can supply power for one unit under DBA conditions plus necessary loads for safe shutdown of other two units. The diesel generators start up and reach rated speed within ten seconds.

Rod-Block Monitor: Designed to prevent fuel damage as a result of a single rod withdrawal error. System has two RBM channels, each of which uses input signals from a number of LPRM channels. A trip signal from either RBM channel can initiate a rod block.

Rod Worth Minimizer: The rod worth minimizer function of the computer prevents rod withdrawal under low power conditions if the rod to be withdrawn is not in accordance with a preplanned pattern. The effect of the rod block is to limit the reactivity worth of the control rods by enforcing adherence to the preplanned rod pattern.

Reactor: Browns Ferry

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Weather data collection started February 1967 using a 300 ft high tower. Data are digitally recorded and placed on paper punch tape. Seismographs not mentioned.

Plant Operating Mode: Load following accomplished by varying the recirculation flow to the reactor.

Site Features: Located on the north shore of Wheeler Lake at river mile 294. Size of site is 840 acres with a site grade of 565' MSL. The site area is sparsely populated having 208 in a 2 mile radius and 3128 in 5 mile radius. The site and area are relatively flat. Most land is used for agriculture.

Turbine Orientation: Centerlines of turbines and centerlines of respective reactors coincide, so ejected turbine blades probably would not strike containment.

Emergency Plans: Emergency plans are written to cover situations that may possibly lead to injury of personnel or the public. In particular, there is a Radiological Emergency plan where the assistance of local and state agencies would be used. The shift engineer will initiate emergency measures when his judgement dictates such action.

Environmental Monitoring Plans: The preoperational program will set a baseline on distribution of natural and manmade radioactivity in the plant site. With this baseline, it will then be possible to determine, when the plant becomes operational, what contribution, if any, the power plant is making to the environment. Sample collection and analysis was initiated in April 1968 and will continue indefinitely. Air will be monitored for particulates, and for gross beta. Other sampling will include milk, vegetation, soil, drinking water, sediment, and marine biota.

Radwaste Treatment: The liquid waste system collects, treats, stores, and disposes of all radioactive liquid wastes. Processed liquid wastes may be returned to the condensate system or discharged through the circulating water discharge canal. The gaseous waste system collects, processes and delivers to the main stack, gases from the main condenser air ejector, startup vacuum pump and gland seal condenser. A 30-min. holdup time allows N-16 and 0-19 to decay and then pass through high efficiency off-gas filters before stack release. Solid wastes are collected, dewatered, and shipped offsite.

Stack Height: 600 ft reinforced concrete.

Waste Heat System: All three units use a once thru system with a flow of 630,000 gpm through condenser of each unit with a temperature rise of 25 F. An additional flow of 30,000 gpm for each units' auxiliaries is required. Heated water is discharged through a specially designed diffuser pipe which extends across the river channel. This diffuser pipe provides good mixing. River flow at the site averages 42,400 cfs.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Browns Ferry Nuclear Plant

THERMAL OUTPUT, MWt 3293	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-296, 50-259, 50-260

NEARBY BODY OF WATER Wheeler Lake at River Mile 294 — NORMAL LEVEL 556' (MSL) — MAX PROB FLOOD LEVEL 561' (MSL)

SIZE OF SITE 840 ACRES — SITE GRADE ELEVATION 565' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat to Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 208 (1970) IN 5 MI RAD 3128 (1970)

NEAREST CITY OF 50,000 POPULATION Huntsville, Alabama

DISTANCE FROM SITE 30 MILES — POPULATION 146,000 (1970)

LAND USE IN 5 MILE RADIUS Agricultural - 70%

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through

WATER TAKEN FROM Wheeler Lake — FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG 47 F — SUMMER AVG 80 F — AVG 64 F

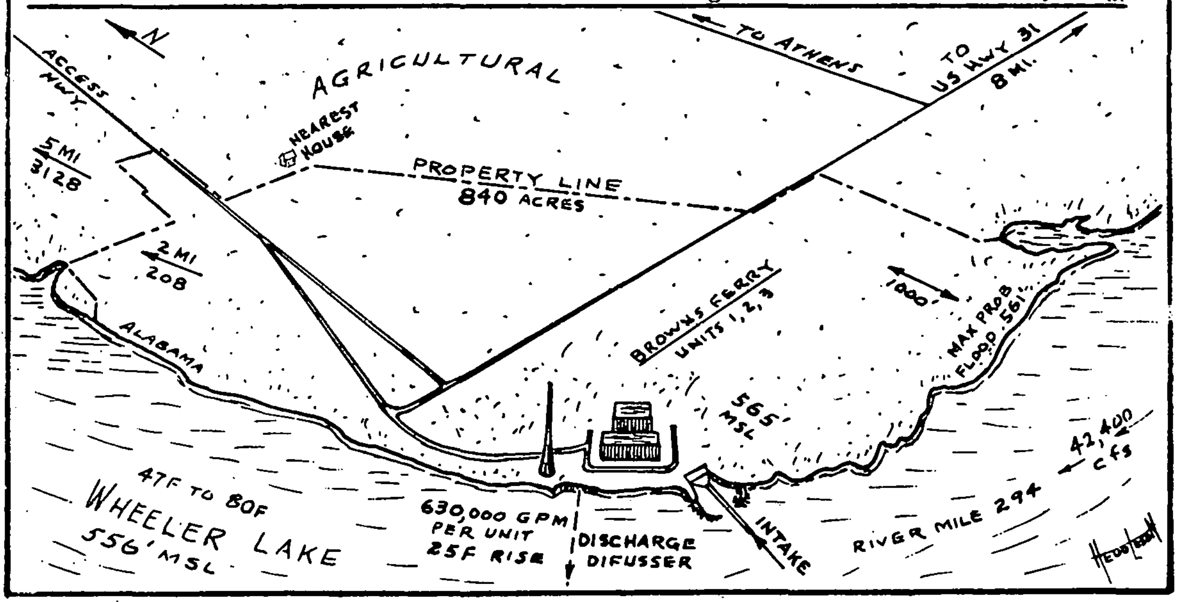
RIVER FLOW 42,400 (cfs) avg. — QUANTITY OF MAKEUP WATER * 30,000 (gpm)

TOTAL FLOW THROUGH CONDENSERS 630,000 (gpm)/unit — TEMPERATURE RISE 25 F

HEAT REMOVAL CAPACITY OF CONDENSERS 7770 X 10^6 (Btu/hr) — * Auxiliaries/unit

COOLING TOWERS None

OTHER INFORMATION Diffuser discharge system provides perforated metal pipes which extend across the river for efficient mixing. Flow for 3 units-198,000 gpm



COOPER, 50-298 (BWR) Page 1

Project Name: Cooper Nuclear Station

Location: Nemaha Co., Nebraska
Owner: Nebraska Public Power District
NSS Vendor: General Electric

Reactor: Cooper
A-E: Burns & Roe
Vessel Vendor: Not specified
Docket No.: 50-298
Containment Constructor: Burns & Roe

A. THERMAL-HYDRAULIC	
Thermal Output, MWt	2381
Electrical Output, MWe	778
Total Heat Output for Safety Design, MWt	2846
Steam Flow Rate, lb/hr	9.81×10^6
Total Core Flow Rate, lb/hr	74.5×10^6
Coolant Pressure, psig	1020
Heat Transfer Area, ft^2	47,494
Max Power per Fuel Rod Unit Lgth, kw/ft	18.5
Maximum Heat Flux, Btu/hr-ft^2	427,820
Average Heat Flux, Btu/hr-ft^2	164,500
Maximum Fuel Temperature, °F	4380
Average Fuel Rod Surface Temp °F	558
MCHFR	$\geq$1.9
Total Peaking Factor	2.6
Avg Power Density, Kw/ℓ	51.2

Data from FSAR.

B. NUCLEAR	
H_2O/UO_2 Volume Ratio	2.41
Moderator Temp Coef Cold, Δk/k/°F	-3.5×10^{-5}
Moderator Temp Coef Hot, No Voids	-11.6×10^{-5}
Moderator Void Coef Hot, No Voids, Δk/k/%	-8.7×10^{-4}
Moderator Void Coef Operating	-1.05×10^{-3}
Doppler Coefficient, Cold	-1.3×10^{-5}
Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Doppler Coefficient, Operating	$\leq 1.3 \times 10^{-5}$
Initial Enrichment, %	2.17
Average Discharge Exposure, MWD/Ton	19,000
Core Average Void Within Assembly, %	---
k_{eff}, All Rods In	---
k_{eff}, Max Rod Out	<0.99
Control Rod Worth, %	---
Curtain Worth, %	---
Burnable Poisons, Type and Form	Gadolina-Urania in 4 fuel rods
Number of Control Rods 137	Cruciform
Number of Part-Length Rods (PLR)	No reference

Compiled by: Fred Heddleson
Date: July 1971

TX-4377
(8-70)

Reactor: Cooper

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	Could not find	
Low Population Zone Dist., Mi.	" " "	
Metropolis	Distance	Population
Lincoln, Neb.	60	146,000 ('69)
Design Basis Earthquake Accel., g	0.20	
Operating Basis Earthquake Accel., g	0.10	
Earthquake Vertical Shock, % of Horizontal	50	

Design Winds in mph:

At 0 - 50 ft	100
50 - 150 ft	120
150 - 400 ft	140
Tornado	300 mph tang + 60 trans
ΔP =	3 psi/ 3 sec

Is intent of 70 design criteria Satisfied? Yes

Peak Fuel Enthalpy on Rod Drop: 280 cal/gm

Recirculation Pumping System & MCHFR: Flow rate effects the type of boiling and heat transfer and thus the MCHFR. Recirculation pumping rate changes as required.

Protective System: Initiates an automatic shutdown if monitored nuclear system variables exceed pre-established limits.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	56	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	56	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	46	Second Ctmt Leak Rate, %/day	100

Type of Construction: A pressure suppression system consisting of a drywell, pressure suppression chamber, connecting vent system, isolation valves, vacuum relief system, and cooling systems. Drywell is a steel pressure vessel in the shape of a light bulb, and the pressure suppression chamber is torus-shaped.

Design Basis: Designed to withstand the forces from a circumferential break of the recirculation piping and to provide hold-up for decay of radioactive material released. System also stores water to condense steam released from the break of the largest size steam line.

Vacuum Relief Capability: Designed for 2 psig external pressure. Drywell and suppression pool can be vented separately. Vented gases go to atmosphere through the plant vent or through the gas treatment system if necessary.

Post-Construction Testing: Pneumatic pressure test at 1.25 design pressure, with leakage rate test at 46 psig.

Penetrations: Most penetrations are double barrier type and individually testable. Only the type 2 process line penetrations are single sealed.

Reactor: Cooper

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Consists of two independent pump loops (4500 gpm each @ 113 psid) that deliver cooling water to spray spargers over the core. Actuated by indication of a breach in nuclear system, but water is delivered to the core only after vessel pressure is reduced. System cools the fuel by spraying water into the core. Either core spray is capable of preventing fuel clad melting following LOCA.

Auto-Depressurization System: Acts to rapidly reduce reactor vessel pressure if HPCIS fails to maintain reactor vessel water level. Relief valves open upon conditions indicating both that a break in the nuclear system has occurred and that the HPCIS is not delivering sufficient cooling water.

Residual-Heat-Removal System (RHRS): Designed for 4 modes of operation. Shutdown Cooling is an integral part of RHRS being used during normal shutdown and cooldown. Reactor water temperatures can be reduced to 125F in about 20 hours. Containment Cooling provides containment spray for reducing pressure after LOCA. Water is pumped through RHRS heat exchangers to spray headers in the drywell and above the suppressing pool. Also, containment cooling function pumps water from the suppression pool through the heat exchangers for cooling. Low Pressure Coolant Injection Mode is described below, and the Reactor Core Isolating Cooling System is described on the next page. The RHRS has 4 pumps and 2 heat exchangers.

High-Pressure Coolant-Injection System: Provides and maintains an adequate coolant inventory to prevent fuel clad melting as a result of small breaks. The HPCIS has one turbine-pump powered by reactor steam rated 4250 gpm @ 1120 psid. Pump takes suction from condensate storage tank and suppression pool.

Low-Pressure Coolant-Injection System: An operating mode of (RHRS) with four 1/3 capacity pumps rated 7700 gpm each @ 20 psid. LPCI is actuated by indication of break in the coolant system. LPCI operation, together with the core shroud and jet pump arrangement, provides for core reflooding following LOCA, in time to prevent fuel clad melting. Pumps take suction from suppression pool.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: The Residual Heat Removal System has a cross connection to the Raw Water System for an almost unlimited supply of cooling water.

Main-Steam-Line Flow Restrictors: Venturi type flow restrictors installed in each steam line close to the reactor vessel that limit loss of coolant from reactor vessel before the main steam line isolation valves are closed, in case of a main steam line break outside primary containment.

Control-Rod Velocity Limiters: Limits velocity at which a control rod can fall out of the core should it become detached from its control rod drive. Also limits rate of reactivity insertion.

Control-Rod-Drive-Housing Supports: Located underneath reactor vessel near control rod housing. Supports limit travel of a control rod if that control rod housing is ruptured. Supports prevent a nuclear excursion as a result of a housing failure.

Standby Liquid-Control System: Provides a method independent of control rods to bring nuclear fission reaction to subcriticality and to maintain as reactor cools. Provides an orderly and safe shutdown if not enough control rods can be inserted to accomplish shutdown in the normal manner. Sized for shutdown from full power to cold condition.

Reactor: Cooper

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: Designed for nitrogen inerting if necessary. Applicant plans to operate with air atmosphere, but will have the capability to inert.

Reactor Core Isolation Cooling System (RCICS): Provides makeup water to reactor vessel following isolation in order to prevent the release of radioactive materials to the environs because of inadequate core cooling. The RCICS consists of 1 steam driven turbine-pump unit (400 gpm @ 1500 psig), valves and piping to deliver makeup water. Steam supply comes from the reactor vessel. Turbine exhaust dumps to the suppression pool. Pump takes suction from the emergency condensate storage tank with backup from the suppression pool. The pump discharges into the feedwater line.

Reactor Vessel Failure: Section 2.6 says "...vessel designed, built, and operated

Missile & Reactor Forces - within its design limits has an extremely low probability of failure due to any known mechanism."

Core Cooling Capability -

Containment Floodability - Primary containment can be flooded.

Reactor-Coolant Leak-Detection Systems: Leakage limit from unidentified sources if 15 gpm; from both unidentified and identified, it is 59 gpm. Leakage is measured and indicated by the integrated sump flow, drywell pressure and temperature, drywell humidity, and the drywell air cooler temperatures.

Failed-Fuel Detection Systems: Consists of gamma radiation monitors located external to the main steam lines just outside of primary containment. The monitors are designed to detect a gross release of fission products from the fuel. Upon detection of high radiation, the trip signals generated by the monitors are used to initiate a reactor scram and isolation of radioactive material released from the fuel.

Emergency Power: Provides two independent 4160 volt diesel generators as on-site sources of ac power to safely shutdown the reactor, maintain the safe shutdown condition, and operate all auxiliaries necessary for station safety. Each diesel-generator unit is rated for 4000 kW continuous operation. Units start automatically and will accept load in 10 sec and supply rated load in 30 sec. Each unit has a day tank with 9 hrs fuel supply. The main storage tank has fuel for 1-unit operation for 5 days.

Rod-Block Monitor: Has two RBM channels each of which uses input signals from a number of LPRM channels. A trip signal from either RBM channel initiates a rod block. One RBM channel may be bypassed without loss of subsystem function. The minimum number of LPRM inputs required for each RBM channel to prevent an instrument inoperative alarm is 4 when using 8 LPRM assemblies, 3 when using 6 LPRM assemblies, and 2 when using 4 LPRM assemblies.

Rod Worth Minimizer: The rod worth minimizer function of the computer prevents rod withdrawal under low power if the rod to be withdrawn is not in accordance with a preplanned pattern. The effect of the rod block is to limit the reactivity worth of the control rods by enforcing adherence to the preplanned rod pattern.

Reactor: Cooper

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A 325-ft tower is used for environmental and meteorological data gathering. Tower was completed in 1969. Found no reference to station seismographs.

Plant Operating Mode: Load following

Site Features: Located on 1090 acres on the west side of the Missouri River in Nebraska. The land is flat and sparsely populated. In a 2-mile radius there are 41 inhabitants, and in a 5-mile radius, there are 1050. Land use is agricultural. Within 3 miles of the plant, there are 2 small towns, Brownsville (243) and Nemaha (232).

Turbine Orientation: Ejected turbine blades could strike containment structure. Centerlines are about 185 ft apart.

Emergency Plans: Provides procedures and organization of plant and off-site personnel to limit any emergency. The plan describes authority and responsibilities of personnel and equipment. The Emergency Director is responsible for coordinating District, local, state and federal agencies. Station emergencies are classified radiological or non-radiological. In non-radiological, actions will limit and/or prevent the effects; and in radiological, action planned to hold effects to a minimum.

Environmental Monitoring Plans: A study of preoperational environmental radiation levels was initiated in late 1970, which includes sampling and laboratory radioactivity analyses of airborne particulates, airborne iodine, fresh water marine life, marine sediments, milk, and crops. Background levels are also being established. Sampling is concentrated within a few miles of the station; however, selected sampling is also conducted at locations up to 10 miles from the station. Studies will be continued after station startup. Comparison of operational and preoperational data will permit detection of any increase in radiation levels in the environment.

Radwaste Treatment: Systems designed to control release of radioactive material to 10CFR20 limits. Liquid waste system provides for collections, segregation, treatment, storage and disposal. Processed liquid wastes of high purity may be returned to the condensate system or discharged through the circulating water canal. The liquid waste system is designed for 2 units, so it is overlarge. Solid wastes are collected, dewatered, and prepared for storage in containers for off-site shipment. The gaseous radwaste system collects, processes, holds for decay, and releases to the atmosphere.

Stack Height - 325'

Waste Heat System: Water is taken from the Missouri River for a once through system. Flow through the single unit's condenser is 631,000 gpm which is about 1/3 average river flow. Temperature rise is 18F. Intake is at shore line, and discharge is through a short canal to the shore line about 1400 feet below the intake.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Cooper Nuclear Station

THERMAL OUTPUT, MWt 2381

TYPE OF NUCLEAR STEAM SYSTEM BWR

DOCKET NO. 50-298

NEARBY BODY OF WATER Missouri River

NORMAL LEVEL 880' (MSL)

MAX PROB FLOOD LEVEL 899' (MSL)

SIZE OF SITE 1090 ACRES

SITE GRADE ELEVATION 903' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat

TOTAL PERMANENT POPULATION IN 2 MI RAD 41 (1970) IN 5 MI RAD 1050 (1970)

NEAREST CITY OF 50,000 POPULATION Lincoln, Nebraska

DISTANCE FROM SITE 60 MILES POPULATION 146,000 (1969)

LAND USE IN 5 MILE RADIUS Agricultural

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once Through

WATER TAKEN FROM Missouri River FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG 34 F SUMMER AVG 73 F AVG - F

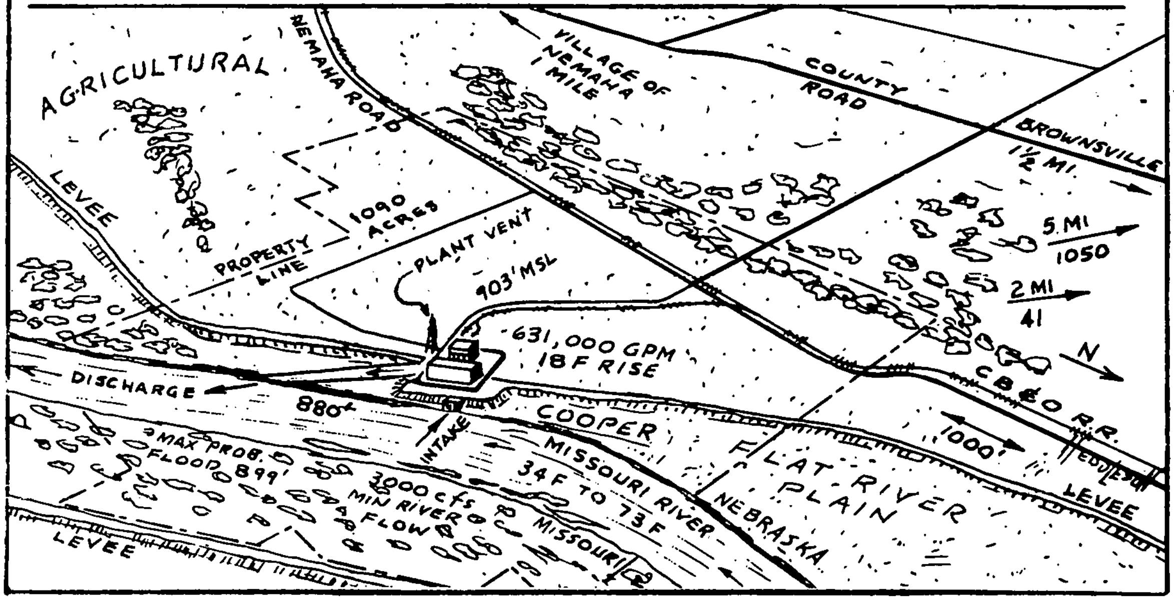
RIVER FLOW 3000 (cfs) min. QUANTITY OF MAKEUP WATER --- (gpm)

TOTAL FLOW THROUGH CONDENSERS 631,000 (gpm) TEMPERATURE RISE 18 F

HEAT REMOVAL CAPACITY OF CONDENSERS 5367.6×10^6 (Btu/hr)

COOLING TOWERS None

OTHER INFORMATION Intake and discharge are at shore line.



POINT BEACH, 50-301 (PWR) Page 1

Project Name: Point Beach Nuclear Plant Units 1 and 2
Location: W. shore of Lake Michigan*
Owner: Wis. Elec. Pwr. & Wis-Mich. Power
NSS Vendor: Westinghouse
*30 mi. SE of Green Bay

Reactor: Point Beach
A-E: Bechtel
Vessel Vendor: Babcock & Wilcox
Docket No.: 50-301 (also 50-266)
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1518	H_2O/U, Cold	4.20
Electrical Output, MWe	524	Avg 1st-Cycle Burnup, MWD/MTU	15,100
Total Heat Output for Safety Design, MWt	1518	First Core Avg Burnup, MWD/MTU (Equil)	33,000
Total Heat Output, Btu/hr	5181×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	2.27
DNBR, Nominal	2.11	Region-2 Enrichment, %	3.03
Total Flow rate, lb/hr	66.7×10^6	Region-3 Enrichment, %	3.40
Eff Flowrate for Heat Trans lb/hr	63.7×10^6	k_{eff}, Cold, No Power, Clean	1.211
Eff Flow Area for Heat Trans, ft^2	27.0	k_{eff}, Hot, Full Power Xe and Sm	1.113
Avg Vel Along Fuel Rods, ft/sec	15.0	Total Rod Worth, % BOL	9.42
Avg Mass Velocity lb/hr-ft^2	2.37×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1598
Nominal Core Inlet Temp, °F	552.5	Shutdown Boron, No Rods, Clean, Hot, ppm	1676
Avg Rise in Core, °F	60.0	Boron Worth, Hot, % Δk/k/ppm	1/130
Nom Hot Channel Outlet Temp, °F	642.9	Boron Worth, Cold, % Δk/k/ppm	1/98
Avg Film Coeff, Btu/hr ft^2, °F	5600	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.3 \text{ to } -3.5) \times 10^{-4}$
Avg Film Temp Diff, °F	31.0	Moderator Press Coeff, Δk/k/psi	$(-0.3 \text{ to } 3.5) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	28,715	Moderator Void Coeff Δk/k/g/cm^2	-0.10 to -0.30
Avg Heat Flux, Btu/hr ft^2	175,800	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -1.6) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	491,000	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	5.7	Burnable Poisons, Type and Form	Borosilicate Glass
Max Thermal Output, kw/ft	16.0	Number of Control Rods 33×16	528
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 4×16	64
No. Coolant Loops	2		

Data from FSAR

Compiled By: Fred Heddleson
Date: July 1971

Reactor: Point Beach

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.74 Radius	**Design Winds in mph:**
Low Population Zone Dist., Mi.	5.6	At 0 - 50 ft elev 108
Metropolis / Distance / Population: Green Bay, Wis. 27 85,000 (69)		50 - 150 ft 130
Design Basis Earthquake Accel., g	0.12	150 - 400 ft 150
Operating Basis Earthquake Accel., G	0.06	Tornado 300 mph tang. + 60 trans.
Earthquake Vertical Shock, % of Horizontal	67	ΔP = 3 psi/ - sec

Is intent of 70 Design Criteria satisfied? Yes, each section of FSAR discusses manner in which design meets intent of criteria.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	60	Calculated Max Internal Press, psig	53
Max Leak Rate at Design Press, %/day	0.4		

Type of Construction: A 3 1/2' thk right cylinder with a 9' thk flat base slab and a 3' thk shallow domed roof. A 1/4-in. thick welded steel liner is attached to the inside face of the concrete shell to insure a high degree of leaktightness. The base liner is installed on top of the structural slab and is covered with concrete. The cylindrical wall and dome are prestressed and post-tensioned. The concrete base slab is reinforced with high-strength reinforcing steel. The slab is supported on H piles driven to refusal in the underlying bed rock.

Design Basis: Designed to withstand the internal pressure accompanying a LOCA and to be virtually leak tight providing adequate radiation shielding for both normal operation and accident conditions. Designed to withstand combined loadings of DBA and maximum potential seismic conditions.

Vacuum Relief Capability: Designed for 2 psi differential - vacuum breakers not required, and so, are not provided.

Post-Construction Testing: Will be pressure tested at 69 psig. Leakage rate test will be performed at 60 psig for 24 hrs.

Penetrations: Designed with double seals for individually testing.

Weld Channels: Seams in floor liner under concrete fill and all wall and dome seams are pressurized using leak detection channels. Channels are divided into areas, so leakage location can be identified.

Reactor: Point Beach

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Designed to spray 2400 gpm of borated water into containment when coincidence of 2 sets of 2 out of 3 (Hi Hi) containment pressure signals occur in coincidence with a safety injection signal, or a manual signal. Either of 2 subsystems are capable of delivering 1/2 of this flow, or 1200 gpm. Also, the system removes elemental iodine from containment atmosphere in event of a LOCA.

Containment Cooling: The air recirculating cooling function, during normal operation, uses 3 of 4 air cooling units (2 fans/unit) distributing filtered and cooled air throughout containment. Each air handling unit transfer 1.57×10^6 Btu/hr to the service water system during normal plant operation and 50.0×10^6 Btu/hr for DBA conditions when supplied with 1000 gpm cooling water at 70°F inlet temperature.

Containment Isolation System: Isolation valves are provided as necessary for all fluid system lines penetrating containment to assure two barriers for redundance against leakage of radioactive fluids to the environment in event of LOCA. These barriers are in the form of isolation valves. In addition to satisfying containment isolation criteria, the valving is designed to facilitate normal operation and maintenance of the systems.

Containment Air Filtration: A charcoal filter system draws contaminated air from containment, passes the air through roughing filter, HEPA and charcoal filters, and then returns the air to containment. Purge system has no charcoal filters.

Penetration Room: No rooms labeled as such on drawings.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Post-accident purging provides a safe and reliable method for controlling potential hydrogen accumulation.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Two tanks, each containing 7500 gallons of borated water are pressurized by nitrogen to 700 psig. These tanks are connected to the coolant system by piping with 2 check valves in series for each tank. When pressure in the coolant system drops below 700 psig, the check valves open, and accumulator contents are injected into the reactor vessel. One tank will fill the reactor vessel to a level half-way upon the core.

High-head Safety Injection: Two high-head safety injection pumps take suction from the refueling water storage tank. When injection first starts, initiated by the Safety Injection Signal, concentrated boric acid from the boric acid tank is injected into the coolant system. Each pump is rated 700 gpm @ 1150 psig and can supply water lost by a break up to 4" size. Steam dump can be employed to reduce reactor pressure so low-head pumps can be run to pump more water into the reactor.

Low-head Safety Injection: This system and the Residual Heat Removal System are the same. Two pumps are provided, each rated 1560 gpm @ 120 psig. These pumps operate when coolant pressure has dropped to the 600 psig range, after accumulators have functioned. These pumps take suction from the refueling water storage tank, and if this supply is exhausted, recirculation phase starts with water pumped from the containment sump. Three heat exchangers are provided - one for each loop and one on standby. Units are rated 24.15×10^6 Btu/hr each.

Reactor: Point Beach

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Provided by equipment which continuously monitors containment air activity and humidity, and runoff from condensate collecting pans under fan coil units. Criterion is detection of deviations from normal including air particulate activity, radiogas activity, humidity, condensate runoff and for gross leakage, liquid inventory in containment sump.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: Two diesel-generator sets are provided as 2 independent systems separately housed. The units are General Motors model 999-20, each rated 2850 kW continuous at 900 rpm. These units each have 2 air starting motors with compressed air tanks for 5 starts. Each unit has a 550 gal. day tank and a single storage tank with 12,000 gal. supply. Another supply of fuel provides continuous operation of one engine for nearly 20 days.

Control of Axial Xenon Oscillations:

Burnable Shims - Boron in the coolant.

Part-Length Control Rods - Yes, provide to suppress xenon oscillations that might occur in the axial dimension.

In-Core Instrumentation - Out-of-core instrumentation provided to obtain information on power distribution. In-core detectors are used for calibration.

Unborated Water Control: Because of the procedures involved in the dilution process, an erroneous dilution is considered unlikely. Nevertheless, if an unintentional dilution of boron in the reactor coolant does occur, numerous alarms and indications are available to alert the operator to the condition. The maximum reactivity addition due to the dilution is slow enough to allow the operator to determine the cause of the addition and to take corrective action before excessive shutdown margin is lost.

Long-Term Cooling - Internal or External Systems: Long term cooling is accomplished by the Decay Heat Removal System which recirculates water from the containment sump. Redundant piping and components insure that an operable system will be available. Heat exchangers in the system can cool the recirculated borated water.

Reactor: Point Beach

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Began measurement of windspeed and direction in April 1967 using a 150' high tower. Data is recorded. Seismographs not mentioned.

Plant Operating Mode: Load following

Site Features: Plant located on the west shore of Lake Michigan in the town of Two Creeks on a site consisting of 1260 acres. The land is flat to rolling and used mostly for agriculture (dairy farms and vegetable canning). Point Beach State Forest is just south of the site. In a 2-mi radius there will be 270 inhabitants in 1975 and in 5-mi radius there will be 1439. Site grade is 597.5' MSL about 18 ft above normal lake level.

Turbine Orientation: Ejected turbine blades could strike containment. Centerlines are 216 ft apart.

Emergency Plans: Plans will be written to cover all emergencies affecting personnel or public health and safety. These plans will vary in scope depending on the seriousness of the accident and the extent of contamination or radioactivity release. Overall responsibility for safe operation of the plant and public health and safety lies with the General Supt.; and all communications with, or release of information to, the general public will be made by him, or his alternate.

Environmental Monitoring Plans: A preoperational program was started in Nov. 1967. Monitored variables include air, water, shoreline silt, soil, vegetation, milk, and algae samples. The preoperational program will test equipment, sampling and analytical procedures, investigate suitability of sampling points, and provide a radiological background base line from which possible changes in levels following plant operations can be detected and evaluated. Monthly milk samples from a local dairy are processed by the Radiation Protection Section of the Wisc. Dept. of Health and Social Services. Samples are being analyzed by an industrial laboratory.

Radwaste Treatment: Provides equipment to collect, process, and prepare for disposal within limits of 10CFR20 all radioactive liquid, gaseous and solid wastes. Liquid wastes are evaporated and/or dimineralized. Treated water from demineralizers or the evaporator will be monitored and discharged via condenser discharge. Evaporator concentrates and demineralizer resins are solidified, drummed and shipped off-site with other solid wastes for disposal. Gaseous wastes are held for decay and discharged through the plant vent.

Stack Height - Runs up through roof of secondary containment - ∿175' high.

Waste Heat System: Once through system taking water from Lake Michigan 1750' from shore in water 22' deep, and discharging through 2 flumes 150' from shore. When ambient lake temperature is 40F or higher, condenser circulating water flow will be 350,000 gpm/unit with 19.3F temp rise. When ambient lake temp is below 40F, flow will be 214,000 gpm/unit with a temp rise of 31.5F.

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Point Beach Nuclear Plant Units 1 & 2
THERMAL OUTPUT, MWt 1518	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-266 50-301

NEARBY BODY OF WATER Lake Michigan
NORMAL LEVEL 580' (MSL)
MAX PROB FLOOD LEVEL 590' (MSL)

SIZE OF SITE 1260 ACRES
SITE GRADE ELEVATION 597.5' (MSL)

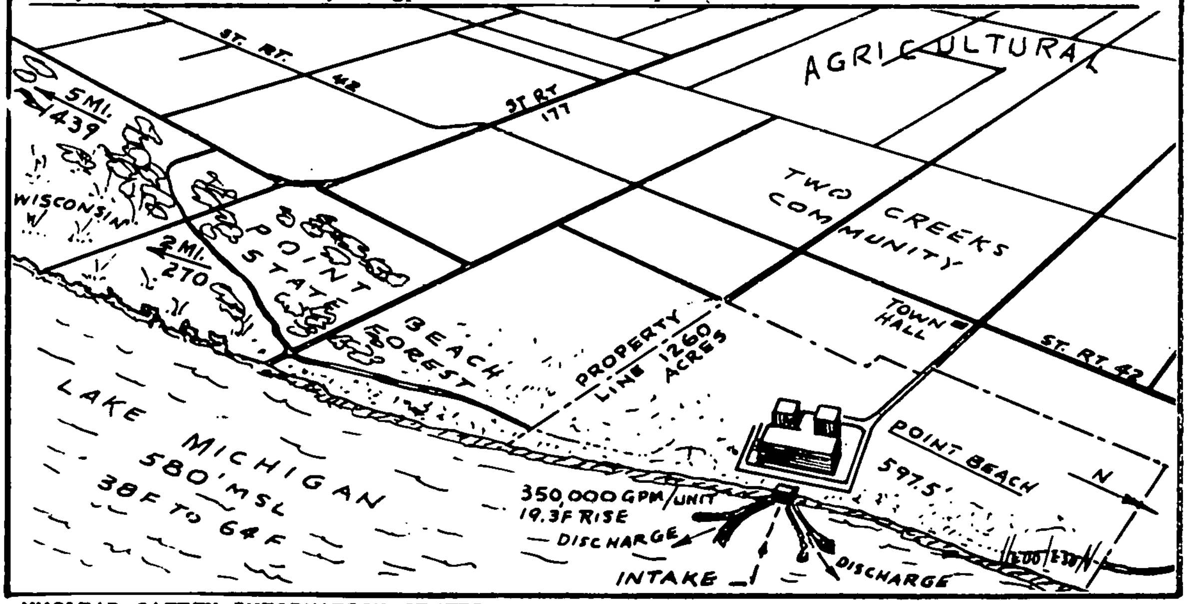
TOPOGRAPHY OF SITE Flat to Rolling
OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 270 (1975) IN 5 MI RAD 1439 (1975)
NEAREST CITY OF 50,000 POPULATION Green Bay, Wisconsin
DISTANCE FROM SITE 27 MILES POPULATION 85,000 (1969)

LAND USE IN 5 MILE RADIUS Agricultural - dairy farming and vegetable canning

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through
WATER TAKEN FROM Lake Michigan FOR Condenser Cooling
WATER BODY TEMPERATURES - WINTER AVG 38 F SUMMER AVG 64 F AVG - F
RIVER FLOW NA (cfs) avg * QUANTITY OF MAKEUP WATER - (gpm)
* TOTAL FLOW THROUGH CONDENSERS 350,000 (gpm) TEMPERATURE RISE 19.3F
* HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) * Per unit See Below
COOLING TOWERS None

OTHER INFORMATION Lake temp above 40F use above figures. For lake temp below 40F, flow will be 214,000 gpm/unit with a temp rise of 31.5 F.



CRYSTAL RIVER, 50-302 (PWR) Page 1

Project Name: Crystal River #3 Nuclear Gen. Plant
Location: Citrus Co., Florida*
Owner: Florida Power Corp.
NSS Vendor: Babcock & Wilcox
*On Gulf of Mexico, 70 mi N of Tampa.

Reactor: Crystal River
A-E: Gilbert Associates
Vessel Vendor: Babcock & Wilcox
Docket No.: 50-302
Containment Constructor: Not Specified.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2452	H_2O/U, Cold	2.85
Electrical Output, MWe	855	Avg 1st-Cycle Burnup, MWD/MTU	12,850
Total Heat Output for Safety Design, MWt	2544	First Core Avg Burnup, MWD/MTU	---
Total Heat Output, Btu/hr	8359×10^6	Maximum Burnup, MWD/MTU	55,000
System Pressure, psia	2200	Region-1 Enrichment, %	1.93
DNBR, Nominal	2.21	Region-2 Enrichment, %	2.54
Total Flow rate, lb/hr	131.3×10^6	Region-3 Enrichment, %	2.83
Eff Flowrate for Heat Trans lb/hr	124.2×10^6	k_{eff}, Cold, No Power, Clean	1.202
Eff Flow Area for Heat Trans, ft^2	49.19	k_{eff}, Hot, Full Power Xe and Sm	1.093
Avg Vel Along Fuel Rods, ft/sec	15.73	Total Rod Worth, %	10.9
Avg Mass Velocity lb/hr-ft^2	---	Shutdown Boron, No Rods, Clean, Cold, ppm	1337
Nominal Core Inlet Temp, °F	555	Shutdown Boron, No Rods, Clean, Hot, ppm	1442
Avg Rise in Core, °F	50.1	Boron Worth, Hot, % Δk/k/ppm	1/100
Nom Hot Channel Outlet Temp, °F	643.1	Boron Worth, Cold, % Δk/k/ppm	1/75
Avg Film Coeff, Btu/hr ft^2, °F	5000	Full Power Moderator Temp Coeff, Δk/k/°F	(-.11 to -3.56) $\times 10^{-4}$
Avg Film Temp Diff, °F	31	Moderator Press Coeff, Δk/k/psi	(-5 to 3) $\times 10^{-6}$
Active Heat Trans Surf Area, ft^2	49,734	Moderator Void Coeff Δk/k/% Void	---
Avg Heat Flux, Btu/hr ft^2	163,725	Doppler Coefficient, Δk/k/°F	(-1.1 to -1.7) $\times 10^{-5}$
Max Heat Flux Btu/hr ft^2	510,300	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	5.4	Burnable Poisons, Type and Form	Al_2O_3-B_4C in Zircaloy 4 tube
Max Thermal Output, kw/ft	16.83	Number of Control Rods 61×16	976
Max Clad Surface Temp, °F	654	Number of Part-Length Rods (PLR)	8 assemblies.
No. Coolant Loops	2		

Data from FSAR

Compiled By: Fred Heddleson
Date: May 1971

Reactor: Crystal River

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.83 rad.	Design Winds in mph:	
Low Population Zone Dist., Mi.	5.0	At 0 - 50 ft elev	110
Metropolis / Distance / Population: Tampa, Fla. / 75 mi. / 308,000 1969		50 - 150 ft	179
Design Basis Earthquake Accel., g	0.10	150 - 400 ft	
Operating Basis Earthquake Accel., G	0.05	Tornado	300 mph tang.
Earthquake Vertical Shock, % of Horizontal	67	ΔP = 3 psi/ - sec	

Is intent of 70 Design Criteria satisfied? Yes, Section 1.4 states plant was designed and constructed taking consideration of criteria, and the features that meet each criterion are discussed.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	55	Calculated Max Internal Press, psig	50.4
Max Leak Rate at Design Press, %/day	0.25		

Type of Construction: A cylindrical reinforced concrete structure bearing on a sound foundation. The foundation slab is reinforced with steel reinforcing. The cylindrical walls are prestressed with a post-tensioning tendon system in the vertical and horizontal directions. The dome roof is prestressed utilizing a three-way post-tensioning tendon system. The inside surface of the structure has a carbon steel liner (3/8" thick) to ensure a high degree of leak-tightness for containment.

Design Basis: Designed to ensure that leakage of radioactivity will not exceed design value under LOCA conditions for double-ended rupture of max size pipe break; and for dead loads from tornado, earthquake, etc.

Vacuum Relief Capability: Designed for 2.5 psig external pressure. Found no reference to vacuum breakers.

Post-Construction Testing: Pressure test at 63.3 psig. Leakage-rate tests at design pressure and 1/2 design pressure. Leakage-rate tests will be run periodically thereafter.

Penetrations: All penetrations are double sealed and individually testable.

Weld Channels: Test channels were installed on inside of liner along seal welds that would be inaccessible after final construction. A plug connection for testing is available on each channel segment.

Reactor: Crystal River

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: The reactor building spray system is designed to furnish building atmosphere cooling to limit post-accident building pressure to less than the design value and to reduce the building to nearly atmospheric pressure. In addition, alkaline sodium thiosulfate in the spray is provided in more than adequate quantities to remove the fission product iodine inventory from the containment atmosphere. Two pumps and complete independent system for each can each supply 1800 gpm @ 200 psig taking suction from the borated-water storage tank.

Containment Cooling: Designed to hold temp between 60F and 110F under normal operation and to remove heat under emergency conditions where max temp would be 281F. Capacities are 4.3×10^6 Btu/hr and 240×10^6 Btu/hr respectively (cooling) and 615,000 Btu/hr heating. Ventilation or exhaust rate is 50,000 cfm for 1.5 air changes/hr.

Containment Isolation System: Leakage through all fluid penetrations not serving accident consequence limiting systems is minimized by a double barrier so that no single credible failure or malfunction can result in loss of isolation or intolerable leakage. The installed double barriers take the form of closed piping systems with isolation valves both inside and outside the Reactor Building.

Containment Air Filtration: Air exhausted is passed through roughing, HEPA filters, and charcoal filters before discharge through the plant vent.

Penetration Room: There is a penetration area with fans, etc.

Organic-Iodide Filter: None mentioned.

Hydrogen Recombiner: Building purge system will be used to control hydrogen concentration. A concentration of 3.5% H_2 would be reached 9 weeks after LOCA.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Two tanks, each holding 7000 gallons of borated water, are maintained at 600 psig by nitrogen pressurizing. When system pressure drops below 600, two check valves in series open and also discharge contents of the tanks into the reactor. Volume is sufficient to cover the core to the 3/4 point assuming that reactor vessel was empty.

High-head Safety Injection: System is initiated by low reactor-coolant system pressure, or high containment pressure. Borated water is injected by 2 pumps that serve also as charging pumps. One pump can deliver 500 gpm @ 600 psig. One pump has capacity to prevent fuel damage for smaller sized leaks. These pumps can be operated in series with the decay heat removal system, if desired.

Low-head Safety Injection: Two pumps will deliver 6000 gpm to reactor vessel at 100 psig, taking suction from the borated water storage tank. These pumps are part of the decay heat removal system. This system and the accumulators are designed to flood the core and cover it with water to prevent fuel damage even for double-ended rupture of the largest sized pipe.

Reactor: Crystal River

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Leakage indicated by changes in containment sump water levels, monitoring of makeup tank level, and changes in radioactivity of containment atmosphere.

Failed-Fuel-Detection Systems: Found no reference to this system.

Emergency Power: Turbine-generator -- a) designed to stay in operation, supplying power to auxiliary busses; b) four 230 kv transmission lines -- one from Curlew, one from Ulmerton, and two from Central Florida; c) either Unit 1 or 2 at the Crystal River Plant; d) two quick-starting 3000 kw diesel-generator units. Engineered safety features supplied from two separate busses, each of which can be supplied from any of the four sources of power, and each capable of independently supplying power for safe shutdown.

Control of Axial Xenon Oscillations:

Burnable Shims - Chemical shim shall be used in conjunction with control rods to compensate for equilibrium xenon conditions.

Part-Length Control Rods - Called Axial Power Shaping Rod Assembly. There are eight assemblies.

In-Core Instrumentation - One per fuel assembly.

Unborated Water Control: The highest rate of dilution can be handled by the automatic control system, which inserts rods to maintain the power level and thus limit the reactor coolant system temp rise. If an interlock failure occurred while the reactor was under manual control, these reactivity additions would cause a high reactor coolant temperature trip or a high-pressure trip. In any event, the thermal power will not exceed the design overpower condition, and the system pressure will not exceed code allowable limits. Therefore, moderator dilution accidents will not cause damage to the reactor coolant system.

Long-Term Cooling - Internal or External Systems: Decay heat removal system can reduce the coolant system below 280F during plant cooldown. During this operating mode, coolant is drawn from the coolant system, circulated through the decay heat removal coolers by the decay heat removal pumps and then injected back into the coolant system. Heat received by this system is rejected to the decay heat closed cycle cooling water system and from there to the decay heat sea water system. Components in these two systems are redundant for reliability purposes. Long-term core cooling accomplished by recirculation of borated water that has collected in the containment sump.

Reactor: Crystal River

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Data has been collected since 1968 with instruments on a 150' tower. Seismographs not mentioned.

Plant Operating Mode: Load following.

Site Features: Located on 4738 acres of flat marshland along the Gulf of Mexico. Site grade is 18'- 6" MSL with very little threat of flooding. Population is very sparse (920 in 5 mi. radius in 2015). Surrounding area is mostly wooded and flat. US-19 runs N-S about 4 1/2 miles east of plant.

Turbine Orientation: Ejected turbine blades could strike the containment structure. Centerlines are about 160' apart.

Emergency Plans: Plans cover emergencies such as fire, bodily injury, radiation and contamination accidents, natural disasters, and a reactor accident. Plant is self-sufficient to cope with any emergency; but outside agencies such as the Florida Div. of Health, the Florida Highway Patrol, the Coast Guard, the local Civil Defense Unit, area hospitals and the AEC will be called upon as needed.

Environmental Monitoring Plans: Divided into preoperational and operational phases. Preoperational measurements will be a baseline to which operational levels of radioactivity in the environment can be compared. Measurement of activity in media contacted by air and water can serve as the earliest means of detection of changes in levels. Therefore, evaluation of appropriate environmental media and transfer pathways through the environment will take place in this program. Most samples will be screened by counting for gross beta and periodically for gross alpha activity. Gamma ray spectrum analysis will be the principal measurement technique utilized for all samples. The operational program will be modified as experience dictates.

Radwaste Treatment: Designed to collect, store, and process wastes on the basis of 1% failed fuel elements. The liquid and gaseous radwaste systems are designed to reduce activity so concentration in routine releases is significantly less than the regulatory limits. These effluents are continuously monitored and the discharge is terminated if the concentration exceeds the monitor setpoint. Solid wastes are packaged in DOT approved containers for off-site shipment.

Stack Height - Vent runs up side of containment structure.

Waste Heat System: Once-through system is used taking condenser cooling water from the Gulf of Mexico and discharging back into the Gulf. Flow through condenser is 600,000 gpm with a temp rise of 18F. An additional quantity of 37,000 gpm is used for misc. cooling. Heat removal capacity of condenser is 5530×10^6 Btu/hr. Two coal-fired plants are already on the site. Their total capacity is 900 MWe using 635,000 gpm for condensers with 11F temp rise. All 3 plants will use same intake and discharge ducts.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Crystal River Unit 3 Nuclear Generating Plant
THERMAL OUTPUT, MWt 2452	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-302

NEARBY BODY OF WATER Gulf of Mexico NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 12' (MSL)

SIZE OF SITE 4738 ACRES SITE GRADE ELEVATION 18'-6" (MSL)

TOPOGRAPHY OF SITE Flat mangrove swamps and Marshland

OF SURROUNDING AREA (5 MI RAD) Flat

TOTAL PERMANENT POPULATION IN 2 MI RAD 0 (1967) IN 5 MI RAD 77 920 (1967 2015)

NEAREST CITY OF 50,000 POPULATION Gainesville, Florida

DISTANCE FROM SITE 52 MILES POPULATION 55,000 (1969)

LAND USE IN 5 MILE RADIUS Wooded-60%, and 20% Pasture land

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through

WATER TAKEN FROM Gulf of Mexico FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

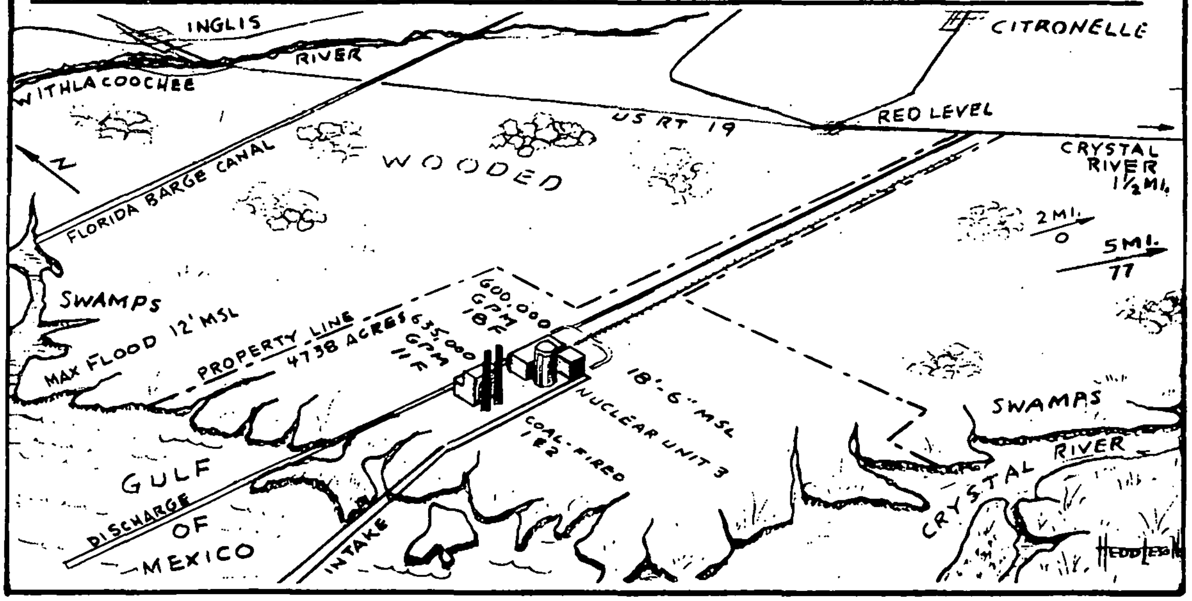
RIVER FLOW NA (cfs) avg. **QUANTITY OF MAKEUP WATER 37,000* (gpm)

**TOTAL FLOW THROUGH CONDENSERS 600,000 (gpm) TEMPERATURE RISE 18 F

**HEAT REMOVAL CAPACITY OF CONDENSERS 5530×10^6 (Btu/hr) * Misc Cooling ** Per Unit

COOLING TOWERS None

OTHER INFORMATION Two coal-fired plants on this site. All units use same intake and discharge canals. Intake is 16,000 ft long and discharge canal is 13,000 ft.



ZION STATION, 50-304 (PWR) Page 1

Project Name: Zion Station, Units 1 & 2
Reactor: Zion
A-E: Sargent & Lundy
Location: NE Illinois, 40 mi N of Chicago
Vessel Vendor: Babcock & Wilcox
Owner: Commonwealth Edison Co.
Docket No.: 50-304 (also 50-295)
NSS Vendor: Westinghouse
Containment Constructor: Not specified.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3250	H_2O/U, Cold	4.09
Electrical Output, MWe	1085	Avg 1st-Cycle Burnup, MWD/MTU	14,040
Total Heat Output for Safety Design, MWt	3391	First Core Avg Burnup, MWD/MTU (Equil)	21,800
Total Heat Output, Btu/hr	$11{,}090 \times 10^6$	Maximum Burnup, MWD/MTU Peak pellet	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	2.25
DNBR, Nominal	2.02	Region-2 Enrichment, %	2.80
Total Flow rate, lb/hr	135.9×10^6	Region-3 Enrichment, %	3.30
Eff Flowrate for Heat Trans lb/hr	128.9×10^6	k_{eff}, Cold, No Power, Clean	1.183
Eff Flow Area for Heat Trans, ft^2	51.4	k_{eff}, Hot, Full Power Xe and Sm	1.092
Avg Vel Along Fuel Rods, ft/sec	15.3	Total Rod Worth, %	9.53
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.52×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1265
Nominal Core Inlet Temp, °F	530.2	Shutdown Boron, No Rods, Clean, Hot, ppm	1408
Avg Rise in Core, °F	66.8	Boron Worth, Hot, % Δk/k/ppm	1/85
Nom Hot Channel Outlet Temp, °F	631.7	Boron Worth, Cold, % Δk/k/ppm	1/70
Avg Film Coeff, Btu/hr ft^2, °F	5800	Full Power Moderator Temp Coeff, Δk/k/°F	$(-0.3 \text{ to } -3.2) \times 10^{-4}$
Avg Film Temp Diff, °F	35.6	Moderator Press Coeff, Δk/k/psi	$(+0.3 \text{ to } 4.0) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff $\Delta k/k/g/cm^2$	-0.1×10^{-5}
Avg Heat Flux, Btu/hr ft^2	207,900	Doppler Coefficient, Δk/k/°F	-1.7×10^{-5}
Max Heat Flux Btu/hr ft^2	579,600	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1.6 design min.
Avg Thermal Output, kw/ft	6.7	Burnable Poisons, Type and Form	Borosilicate Glass in SST
Max Thermal Output, kw/ft	18.8	Number of Control Rods 53×20	1060
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 8×20	160
No. Coolant Loops	4		

Data from FSAR.

Compiled By: Fred Heddleson
Date: June 1971

Reactor: Zion

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.25 rad.		Design Winds in mph:
Low Population Zone Dist., Mi.	---	At 0 - 50 ft elev	100
Metropolis / Distance / Population: Kenosha, Wis. / 8 mi. / 78,063 ('70)		50 - 150 ft	120
Design Basis Earthquake Accel., g	---	150 - 400 ft	140
Operating Basis Earthquake Accel., G	0.08	Tornado	300 mph tang + 60 trans.
Earthquake Vertical Shock, % of Horizontal	62.5	ΔP =	3 psi/ -sec

Is intent of 70 Design Criteria satisfied? Yes, Appendix A states "...plant will be designed, constructed, and operated so as to comply with the applicant's understanding of the intent... ."

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	47	Calculated Max Internal Press, psig	42
Max Leak Rate at Design Press, %/day	0.1		

Type of Construction: A 3'-6" thick concrete cylinder with a shallow domed roof (2'-8") and a flat foundation slab. The cylindrical portion is prestressed by a post-tensioning system consisting of horizontal and vertical tendons. The dome has a three-way post-tensioning system. The foundation slab is conventionally reinforced with high-strength reinforcing steel. The entire structure is lined with one-quarter inch welded steel plate to provide vapor tightness.

Design Basis: The two basic criteria are: 1) The integrity of the liner plate is guaranteed under all loading conditions. 2) The structure has a low-strain elastic response such that its behavior may be completely predictable under the required loadings. (Section 5.1.2.4)

Vacuum Relief Capability: No reference found.

Post-Construction Testing: Tested at 54 psig for 1 hr, pressured in increments to 35, 40, 47, and 50 psig. Leakage rate test will be run at 47 psig.

Penetrations: Double sealed with containment welds backed by steel channels. These are continuously pressurized. No periodic testing is required.

Weld Channels: All liner plate welds are covered with test channels.

Reactor: Zion

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Designed to spray borated water with NaOH into the containment atmosphere to reduce containment pressure and remove iodine from the containment. The system will limit off-site and site boundary doses to within 10CFR100 limits with a single active failure at any time.

Containment Cooling: Fan coolers designed to filter, cool and dehumidify containment during both normal and abnormal conditions. During normal operation 4 of 5 cooler-filter units dissipate 12×10^6 Btu/hr. During post-accident conditions, 3 of the 5 units will remove a heat load of 243×10^6 Btu/hr. Under post-accident conditions moisture eliminators remove not less than 95% of the free water particles 10 micron and larger.

Containment Isolation System: Incorporates valves and controls on piping systems penetrating the containment structure. Valves are arranged to provide two barriers between the reactor coolant system or containment atmosphere and the environment. Manual operation is required for immediate isolation. Automatic isolation is initiated by a containment isolation signal.

Containment Air Filtration: Exhaust air is passed through HEPA filters and discharged to 2 vents which run up the sides of the containment structures. If air is contaminated, it can be routed through charcoal filters which are normally bypassed.

Penetration Room: Penetration rooms are available for cables and piping.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: When hydrogen concentration reaches 3% the purge system will be run 1 hr per day to control further increase in concentration. It will take 120 days after LOCA to reach 4%.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four accumulators each containing 6400 gallons of borated water inject their contents into each of 4 cold legs of the reactor vessel. Accumulator pressure is held at 650 psig by nitrogen gas under pressure. Accumulators function when the coolant system pressure drops below 650 psig.

High-head Safety Injection: Two pumps each rated 400 gpm @ 1100 psig deliver borated water to cold legs of reactor from the refueling water storage tank. When operation first starts, the pump sweeps the contents of the concentrated boric acid tank into the cold legs. System operates for small breaks to prevent fuel damage.

Low-head Safety Injection: Two low head residual heat removal pumps take suction from the refueling water storage tank and deliver borated water to the same four hot legs used by the high head safety injection pumps. The low head residual heat removal pumps each deliver 3000 gpm only when the reactor coolant system is depressurized to below about 170 psig.

Reactor: Zion

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Missile & Reactor Forces -	Discussed in Sect. 1.5.6 as a possibility, describing how the Post LOCA Protection System (PLOCAP) can flood the containment cavity for core flooding.
Core Cooling Capability -	Almost 1,000,000 gallons of water, total, is available for core cooling
Containment Floodability -	

Reactor-Coolant Leak-Detection Systems: Provided by equipment which monitors containment air activity and humidity. The basic design creterion is detection of deviations from normal containment environmental conditions including air particulate activity, radiogas activity, humidity and in addition, gross leakage, the liquid inventory in the process systems and containment sump.

Failed-Fuel-Detection Systems: Instruments for prompt detection of delayed neutrons in the coolant are being tested in the Ginna reactor. Failed fuel detection is currently performed by periodic analyses of coolant samples for activity.

Emergency Power: Five diesel-generator sets supply power to emergency electrical busses. Two generators serve one unit, and two generators serve the other unit. The fifth diesel-generator can serve either unit. Diesel-generator sets are rated at 5000 kVA each. They are started with compressed air and will accept load in 10 sec and carry rated load in 30 seconds. Each unit has a day tank and a storage tank with 50,000 gallon of fuel - sufficient fuel for 7 days operation at rated load.

Control of Axial Xenon Oscillations:

Burnable Shims - Boron in the coolant

Part-Length Control Rods - Yes, 8 assemblies for control of axial power distribution

In-Core Instrumentation - Out-of-core detectors (long Ion chambers) will be used for monitoring both axial and radial power distribution. In-core detectors will not be installed.

Unborated Water Control: Because of procedures involved in the dilution process, an erroneous dilution is considered unlikely. Nevertheless, if it does occur, numerous alarms and indications alert the operator to the condition. The maximum reactivity addition due to the dilution is slow enough the allow the operator to determine the cause and take corrective action before excessive shutdown margin is lost. These corrective actions are detailed in operating instructions and are familiar to the plant operator. It is incredible for the operator to ignore all the alarms.

Long-Term Cooling - Internal or External Systems: Accomplished by the decay heat removal system pump, heat exchangers, piping, etc. operating in the recirculation mode. Borated water is pumped from the containment sump and cooled in the heat exchangers.

Reactor: Zion

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Collection of meteorological data started January 1970.

Seismographs not mentioned.

Plant Operating Mode: Load following

Site Features: Plant is located on 250 acres along the western shore of Lake Michigan near the Illinois-Wisconsin boundary. The site is adjacent to or in the city of Zion. Population is heavy - 25,665 population estimated for a 2 mile radius in 1985 and 106,615 in a 5 mile radius. The site and surrounding areas are flat. Some areas near the lake are marshy. Site grade is 591' MSL, about 10 feet above normal lake level. Surrounding land is used for residential, industrial, agricultural, and recreational.

Turbine Orientation: Ejected turbine blades could strike containment. Centerlines are 225 ft apart

Emergency Plans: Emergency and evacuation procedures have been developed which implement Commonwealth Edisons Generating Stations Emergency Plan. These procedures assure continuing coordination with local, State, and Federal agencies. Participating groups are familiarized with their part in any emergency or evacuation. Periodic reviews are held to assure their familiarity and to maintain a current personnel list. Periodic drills are held at the Station.

Environmental Monitoring Plans: A program was started in March 1970 to collect samples for evaluation of pre-operational conditions. The pre-operational program will establish sampling stations and frequency requirements. The operational program will be designed from experience gained before operation. Samples collected include sediment, bottom organisms, fish, milk, soil, vegetation, and rainfall.

Radwaste Treatment: Provides equipment to collect, process, and prepare for disposal within limits of 10CFR20 all radioactive liquid, gaseous and solid wastes. Liquid wastes are evaporated and/or demineralized. Treated water from demineralizers or the evaporator may be recycled in the plant or may be discharged via condenser discharge. Evaporator concentrates and demineralizer resins are solidified, drummed and shipped off-site with other solid wastes for disposal. Gaseous wastes are held for decay and discharged through the plant vent.

Stack Height - On side of containment - 8' dia., top at 772'6", 180' above grade

Waste Heat System: A once-through system pumps water from Lake Michigan (intake 2600 ft from shore) and returns the water through multi-port diffusers 760 ft from shore. A quantity of 735,000 gpm per unit is pumped through condensers where temperature rise is 20F. Since lake water temperature rarely reaches 65F, temperature of water returned to the lake will never exceed 85F.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Zion Station

THERMAL OUTPUT, MWt 3250

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-295
50-304

NEARBY BODY OF WATER Lake Michigan

NORMAL LEVEL 582' (MSL)

MAX PROB FLOOD LEVEL 591' (MSL)

SIZE OF SITE 250 ACRES

SITE GRADE ELEVATION 591' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat

TOTAL PERMANENT POPULATION IN 2 MI RAD 18,380 (1965) 25,665 (1985) IN 5 MI RAD 56,100 (1965) 106,615 (1985)

NEAREST CITY OF 50,000 POPULATION Waukegan, Ill.

DISTANCE FROM SITE 6 MILES POPULATION 64,665 (1970)

LAND USE IN 5 MILE RADIUS Residential, Industrial, Agricultural, and Recreational

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through

WATER TAKEN FROM Lake Michigan FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG 65 F AVG - F

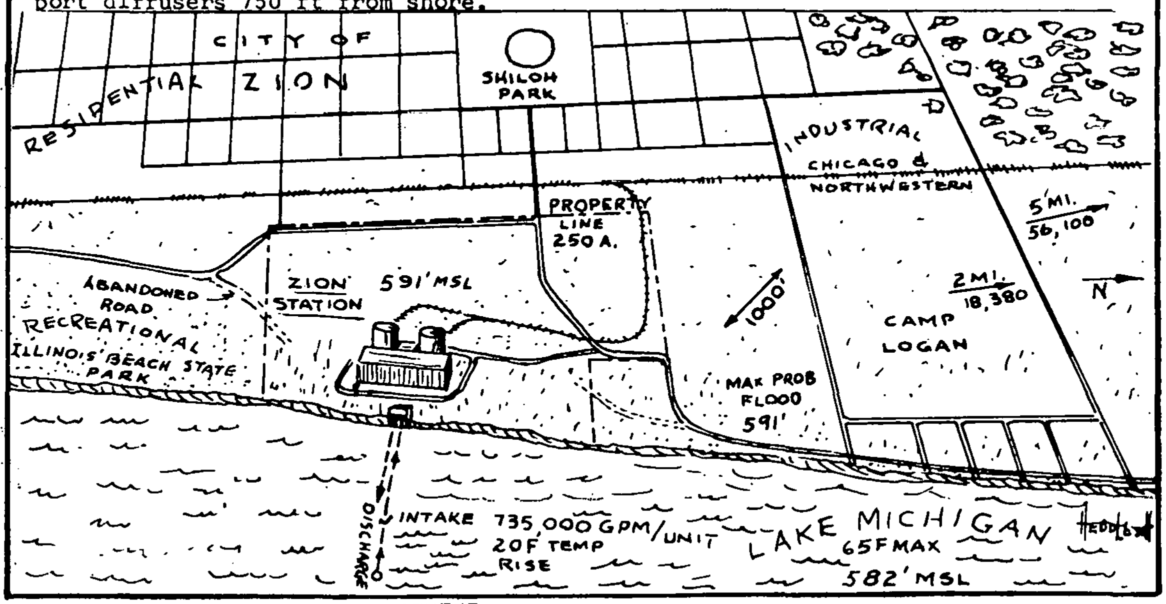
RIVER FLOW NA (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

* TOTAL FLOW THROUGH CONDENSERS 735,000 (gpm) /unit TEMPERATURE RISE 20 F

* HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) * per unit

COOLING TOWERS None

OTHER INFORMATION Water intake is 2600 ft from shore. Discharged through multi-port diffusers 750 ft from shore.



KEWAUNEE, 50-305 (PWR) Page 1

Project Name: Kewaunee Nuclear Power Plant
Reactor: Kewaunee
A-E: Pioneer Service & Engg.
Location: Kewaunee Co., Mich.
Vessel Vendor: Babcock & Wilcox
Owner: Wisconsin Public Service Corp.
Docket No.: 50-305
NSS Vendor: Westinghouse
Containment Constructor: Chicago Bridge & Iron

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1650	H_2O/U, Cold	3.85
Electrical Output, MWe	560	Avg 1st-Cycle Burnup, MWD/MTU	15,200
Total Heat Output for Safety Design, MWt	1721	First Core Avg Burnup, MWD/MTU Equilib	33,000
Total Heat Output, Btu/hr	5631×10^6	Maximum Burnup, MWD/MTU	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	2.27
DNBR, Nominal	2.20	Region-2 Enrichment, %	3.03
Total Flow rate, lb/hr	68.2×10^6	Region-3 Enrichment, %	3.40
Eff Flowrate for Heat Trans lb/hr	65.2×10^6	k_{eff}, Cold, No Power, Clean	1.237
Eff Flow Area for Heat Trans, ft^2	27	k_{eff}, Hot, Full Power Xe and Sm	1.131
Avg Vel Along Fuel Rods, ft/sec	14.8	Total Rod Worth, % (T 3.2-3)	7.51
Avg Mass Velocity lb/hr-ft^2	2.42×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1671
Nominal Core Inlet Temp, °F	535.5	Shutdown Boron, No Rods, Clean, Hot, ppm	1615
Avg Rise in Core, °F	66.4	Boron Worth, Hot, % $\Delta k/k$/ppm	1/125
Nom Hot Channel Outlet Temp, °F	635.1	Boron Worth, Cold, % $\Delta k/k$/ppm	1/95
Avg Film Coeff, Btu/hr ft^2, °F	5700	Full Power Moderator Temp Coeff, $\Delta k/k$/°F	$(+0.3 \text{ to } -3.5) \times 10^{-4}$
Avg Film Temp Diff, °F	33.5	Moderator Press Coeff, $\Delta k/k$/psi	$(-0.3 \text{ to } +3.5) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	28,714	Moderator Void Coeff $\Delta k/k/g/cm^2$	-0.10 to +0.30
Avg Heat Flux, Btu/hr ft^2	191,000	Doppler Coefficient, $\Delta k/k$/°F	$(-1.0 \text{ to } -1.6) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	534,800	Shutdown Margin, Hot One Rod Stuck, % $\Delta k/k$	---
Avg Thermal Output, kw/ft	6.18	Burnable Poisons, Type and Form	Borosilicate glass tubes in SST
Max Thermal Output, kw/ft	17.3	Number of Control Rods 33×16	528
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 4×16	64
No. Coolant Loops	2		

Data from FSAR.

Compiled By: Fred Heddleson
Date: April 1971

Reactor: Kewaunee

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.- Could not find.	Design Winds in mph:
Low Population Zone Dist., Mi. ---	At 0 - 50 ft elev 100
Metropolis / Distance / Population Green Bay, Wis. 27 mi. 85,000 1969	50 - 150 ft 120
Design Basis Earthquake Accel., g 0.12	150 - 400 ft 140
Operating Basis Earthquake Accel., G 0.06	Tornado 300 mph tang + 60 trans.
Earthquake Vertical Shock, % of Horizontal 67	ΔP = 3 psi/ sec

Is intent of 70 Design Criteria satisfied? Yes, Section 1.8 states "plant was designed, constructed, and will be operated to comply with intent of criteria as understood by applicant."

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	46	Calculated Max Internal Press, psig	42.2
Max Leak Rate at Design Press, %/day *	0.5	*Tested after construction and leakage was 0.02 at 46 psig.	

Type of Construction: Reactor containment vessel is a cylindrical steel pressure vessel with hemispherical dome and ellipsoidal bottom fabricated from steel plate about 1 1/2" thick. This vessel is enclosed by a reinforced concrete shield building having vertical cylindrical walls with a shallow-dome roof. There is an annular space of 5 ft between the two structures.

Design Basis: Designed to maintain containment integrity if a double-ended pipe rupture should occur in the largest sized primary system pipe with leakage of fission products not exceeding the design leakage - so public would be protected from the consequences of radioactive contamination.

Vacuum Relief Capability: Designed for 0.8 psi differential pressure. Automatic pressure-relief devices are provided to prevent excessive vacuum.

Post-Construction Testing: A pressure test will be run at 51.8 psig. After initial tests at 5 and 41.4 with soap bubbles. Leakage rate tests performed at 46 psig for 24 hrs. Periodic leakage tests will be run during life of plant.

Penetrations: Double sealed and individually testable.

Weld Channels: Weld channels not mentioned, however, all welds were radiographed.

Reactor: Kewaunee

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Designed to spray 2600 gpm of borated water into Containment when coincidence of two sets of 2-out-of-3 containment pressure signals occurs, or a manual initiation signal is given. Either of two subsystems are independently capable of delivering one-half flow, or 1300 gpm, the required design flow.

Containment Cooling: Sized so any 3 of the 4 fan-coil units will provide adequate heat removal from Containment during operation, and to maintain interior air temperatures below 104°F in accessible areas during hot standby operation. The fan-coil cooling units will also be utilized for emergency cooling under post-accident conditions. Purge system can provide 1 1/2 air changes per hour.

Containment Isolation System: Leakage through fluid-line penetrations not serving accident-consequence-limiting systems is minimized by a double-barrier. The double-barriers are closed pipe systems, with isolation valves. The double-barrier arrangement provides two reliable low-leakage barriers between containment and the environment. The automatic closure is initiated by a Safety Injection Signal or by manual initiation.

Containment Air Filtration: Consists of demister section, electric-heating elements, HEPA filters, impregnated charcoal, and another HEPA section. Charcoal filters are protected with a deluge system to prevent excessive temperature.

Penetration Room: Not indicated as such on plans.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Hydrogen will be controlled by venting. Research is underway to develop a simpler method than recombiner.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Two tanks, each containing 8600 gallons of borated water, will dump their contents into each of the two cold legs of the reactor when system pressure drops below 700 psig. Operation is automatic — two check valves in series open when reactor pressure drops below 700 psig.

High-head Safety Injection: Two charging pumps deliver borated water to the reactor vessel, first from the boric acid tank and then from the refueling water storage tank. Pumps start on injection signal and have capacity (800 gpm @ 2500, each) to flood core sufficiently for small breaks.

Low-head Safety Injection: Two residual heat removal system pumps deliver large quantities of borated water to the reactor vessel when pressure drops to 600 psig. One pump has the capacity (2000 gpm @ 600 psig) to cover the core for all size pipe breaks. These pumps can also recirculate borated water which has accumulated in the sump.

Reactor: Kewaunee

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No known service failures have resulted under conditions permitted by vessel design limits.

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Provided by equipment which continuously monitors containment air activity and humidity, and runoff from condensate collecting pans under fan coil units. Criterion is detection of deviations from normal including air particulate activity, radiogas activity, humidity, condensate runoff and for gross leakage, liquid inventory in containment sump.

Failed-Fuel-Detection Systems: Monitored by a gamma-sensitive detector on reactor coolant let-down line, after the let-down heat exchanger. Further research is being done.

Emergency Power: Two quick-start diesel generators are provided to supply adequate power for plant safety in the event of loss of station and off-site ac power. Each generator is capable of supplying the power requirements of one complete set of engineered safety features.

Control of Axial Xenon Oscillations:

Burnable Shims - Provided to control excess reactivity during first cycle. Borosilicate glass tubes in 304 SST rods.

Part-Length Control Rods - Four assemblies are used (absorber in bottom 3') to shape axial power distribution and control axial xenon oscillation.

In-Core Instrumentation - A fixed in-core flux detector system will be used as developed by misc. tests (Section 1.6.9).

Unborated Water Control: Because of the procedures involved in the dilution process, an erroneous dilution is considered unlikely. Nevertheless, if an unintentional dilution of boron in the reactor coolant does occur, numerous alarms and indications are available to alert the operator to the condition. The maximum reactivity addition due to the dilution is slow enough to allow the operator to determine the cause of the addition and take corrective action before excessive shutdown margin is lost.

Long-Term Cooling - Internal or External Systems: Long-term cooling is accomplished using one of the two residual heat removal system pumps and accompanying heat exchanger. Borated water from the sump can be circulated through the heat exchanger and then into the reactor vessel. Different flow paths are available for redundancy.

Reactor: Kewaunee

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Meteorological observations were started in 1968 and have been recorded continuously since then. A 150' high tower is used for measurements. A strong-motion triaxial seismograph is installed on foundation slab with readout in control room.

Plant Operating Mode: Load following

Site Features: Located on the west shore of Lake Michigan on 907 acre site. Site grade is 605' well above possible flooding. Normal lake level is 577'. The site area and surrounding land is flat to rolling. Point Beach Nuclear plant is 4 1/2 south. Point Beach State Park is 8 to 11 miles south. There is a cemetary on the plant property about 3000 ft from the reactor. State route #42 runs through the property.

Turbine Orientation: Ejected turbine blades could strike containment structure. Turbine and reactor centerlines are 190 ft apart.

Emergency Plans: Training will be given to both on-site and off-site personnel to familiarize them with procedures. Periodic drills will be held for employees to keep them up-to-date. Special fire-fighting training will be given and fire drills will be conducted.

Environmental Monitoring Plans: Preoperational monitoring started in 1969. Over two years of data will be available before plant startup. This information will show possible changes due to plant operation. Monitored variables include ambient gamma background, air particulates, lake water (suspended and dissolved solids), on-site well water, milk, slimes, vegetation, lake-bottom sediment and organisms, soil and fish.

Radwaste Treatment: Liquid wastes are collected and processed through evaporators and filters as required. Evaporator condensate is sampled to determine activity and monitored during discharge to the lake via condenser circulating water discharge. Solid wastes are drummed and shipped off-site for disposal. Gaseous wastes are collected and held for decay until their level is low enough for discharge.

Stack Height - Vent is on top of containment structure.

Waste Heat System: A once-through cooling system will be used taking water from Lake Michigan and discharging back to the lake through a sheet piling type structure at the shore line. Intake will be taken 1750 ft from shore in water 15 ft deep. Circulating water quantity will be 420,000 gpm with 19F temperature rise.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Kewaunee Nuclear Power Plant

THERMAL OUTPUT, MWt 1650

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-305

NEARBY BODY OF WATER Lake Michigan (west shore)

NORMAL LEVEL 577'(MSL)

MAX PROB FLOOD LEVEL 586'(MSL)

SIZE OF SITE 907 ACRES

SITE GRADE ELEVATION 606'(MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Flat to Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 193 (1985) IN 5 MI RAD 2275 (1985)

NEAREST CITY OF 50,000 POPULATION Green Bay, Wisconsin

DISTANCE FROM SITE 27 MILES POPULATION 85,000 (1969)

LAND USE IN 5 MILE RADIUS Agricultural & Dairy Farming

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once Through

WATER TAKEN FROM Lake Michigan FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG 34 F SUMMER AVG 67 F AVG - F

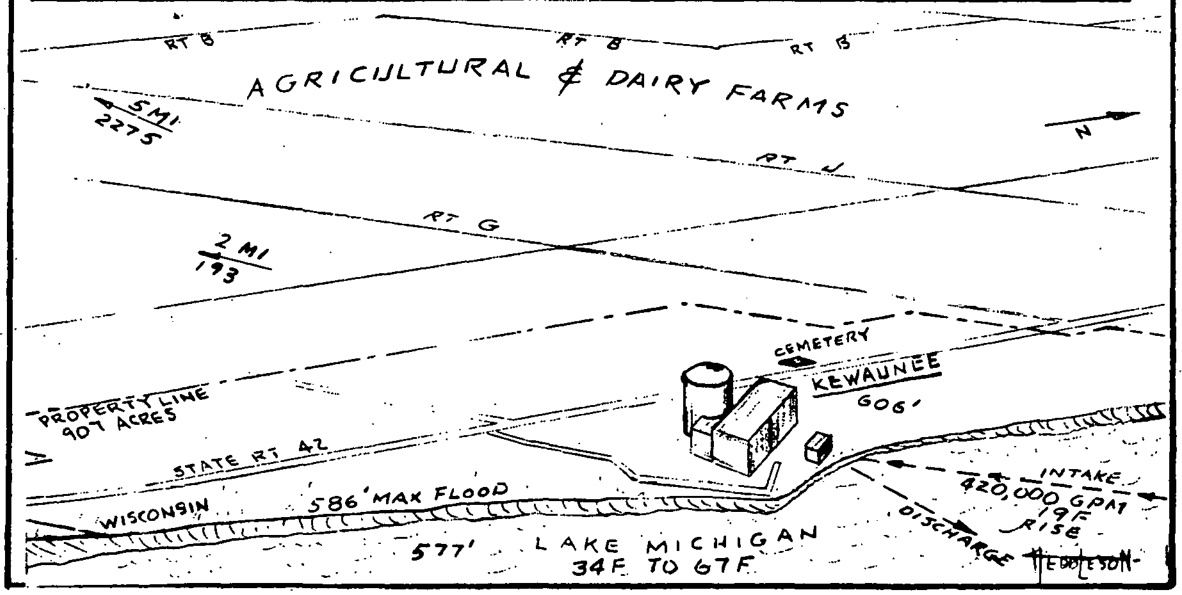
RIVER FLOW NA (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 420,000 (gpm) TEMPERATURE RISE 19 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS None

OTHER INFORMATION Point Beach Nuclear Plant is 4.5 mi S. Intake crib is 15' deep located 1750' from shore. Discharge is at shoreline into a sheep piling box.



NUCLEAR SAFETY INFORMATION CENTER

PRAIRIE ISLAND, 50-306 (PWR) Page 1

Project Name: Prairie Island Nuclear Generating Plant, Units 1&2
Location: Goodhue Co., Minn.*
Owner: Northern States Power Co.
NSS Vendor: Westinghouse
*6 miles NW of Red Wing, Minn.

Reactor: Prairie Island
A-E: Pioneer Service & Engg. Co.
Vessel Vendor: Babcock & Wilcox
Docket No.: 50-306 (also 50-282)
Containment Constructor: Northern States Power

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1650	H_2O/U, Cold	3.85
Electrical Output, MWe	560	Avg 1st-Cycle Burnup, MWD/MTU	15,200
Total Heat Output for Safety Design, MWt	1721	First Core Avg Burnup, MWD/MTU (Equi)	33,000
Total Heat Output, Btu/hr	5631×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	2.27
DNBR, Nominal	2.20	Region-2 Enrichment, %	3.03
Total Flow rate, lb/hr	68.2×10^6	Region-3 Enrichment, %	3.40
Eff Flowrate for Heat Trans lb/hr	65.2×10^6	k_{eff}, Cold, No Power, Clean	1.237
Eff Flow Area for Heat Trans, ft^2	27	k_{eff}, Hot, Full Power Xe and Sm	1.131
Avg Vel Along Fuel Rods, ft/sec	14.8	Total Rod Worth, %	7.51
Avg Mass Velocity lb/hr-ft^2	2.42×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1671
Nominal Core Inlet Temp, °F	535.5	Shutdown Boron, No Rods, Clean, Hot, ppm	1615
Avg Rise in Core, °F	66.4	Boron Worth, Hot, % Δk/k/ppm	1/125
Nom Hot Channel Outlet Temp, °F	635.1	Boron Worth, Cold, % Δk/k/ppm	1/95
Avg Film Coeff, Btu/hr ft^2, °F	5700	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.3 \text{ to } -3.5) \times 10^{-4}$
Avg Film Temp Diff, °F	33.5	Moderator Press Coeff, Δk/k/psi	$(-0.3 \text{ to } +3.5) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	28714	Moderator Void Coeff	-0.10 to +0.30 Δk/k/g/cm^3
Avg Heat Flux, Btu/hr ft^2	191,000	Doppler Coefficient, Δk/k/°F	$(-1.0 \text{ to } -1.6) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	534,800	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	6.18	Burnable Poisons, Type and Form	Borosilicate Glass Rods
Max Thermal Output, kw/ft	17.3	Number of Control Rods 29 × 16	464
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 4 × 16	64
No. Coolant Loops	2		

Data from FSAR.

Compiled By: Fred Heddleson
Date: June 1971

Reactor: Prairie Island

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.44	Design Winds in mph:	
Low Population Zone Dist., Mi.	1 1/2	At 0 - 50 ft elev	100
Metropolis / Distance / Population Minneapolis-St. Paul / 30 / 1,865,000		50 - 150 ft	120
Design Basis Earthquake Accel., g	0.12	150 - 400 ft	140
Operating Basis Earthquake Accel., G	0.06	Tornado	300 mph tang + 60 trans
Earthquake Vertical Shock, % of Horizontal	67	ΔP =	3 psi/ 3 sec

Is intent of 70 Design Criteria satisfied? Yes, plant will be designed, constructed, and operated so as to comply with applicant's understanding of the intent of the criteria (Sect. 1.8).

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	41.4	Calculated Max Internal Press, psig	42.6
Max Leak Rate at Design Press, %/day	0.5 design — actual test was 0.02.		

Type of Construction: There are 2 separate structures--a reactor containment vessel surrounded by a shield bldg. The containment vessel is a cylindrical steel pressure vessel about 1 1/2-in. thick with hemispherical dome and ellipsoidal bottom. The shield building is a 2'6" reinforced concrete right circular cylinder with a 2' shallow dome roof. An annular space of 5' is provided between the 2 structures with 7-ft clearance between the roofs. The containment vessel is supported on a grout base put in after vessel construction was complete and tested.

Design Basis: Designed to contain fission products with leakage not exceeding design value after LOCA, so that radiation doses to the public do not exceed limits set by AEC. Structures designed to withstand all credible natural disasters such as tornado, earthquake and flood without loss of integrity.

Vacuum Relief Capability: Automatic vacuum relief devices will prevent external pressure from exceeding the design limit of 0.8 psi.

Post-Construction Testing: Tested at 1.25 design pressure (which gives a test pressure of 51.8 psig). Leak tested finding a value of 0.02 as shown above.

Penetrations: All except cold penetration lines are double sealed and testable. Cold penetrations are single sealed.

Weld Channels: Weld channels not discussed. Bottom seal welds were soap bubble tested at 5 psig before grout placement.

Reactor: Prairie Island
D2. CONTAINMENT SAFETY FEATURES
Containment Spray System: Designed to spray 2400 gpm of borated water into containment when coincidence of two sets of two out of three (Hi Hi) containment pressure signals occurs, or on manual initiation. Either of 2 subsystems are independently capable of delivering 1/2 flow, or 1200 gpm. Designed for heat removal capacity to maintain post-accident containment pressure below the design pressure of 46 psig. System can operate over a prolonged period of time.
Containment Cooling: Four fan-coil units operate to hold temp below 104F during normal plant operation or these same units can operate in conjunction with the Spray System for cooling after LOCA. Each unit has 50×10^6 Btu/hr capacity. All 4 units running have capacity to remove heat from LOCA.
Containment Isolation System: Isolation valves are provided as necessary for all fluid system lines penetrating containment to assure two barriers for redundance against leakage of radioactive fluids to the environment in event of LOCA. These barriers are in the form of isolation valves. In addition to satisfying containment isolation criteria, the valveing is designed to facilitate normal operation and maintenance of the systems.
Containment Air Filtration: Any air leaving the containment vessel must pass through complete filtration before leaving the shield building. This includes particulate, HEPA, and charcoal.
Penetration Room: None shown as such on plans.
Organic-Iodide Filter: No reference found.
Hydrogen Recombiner: Containment venting are regarded as satisfactory.
D3. SAFETY INJECTION SYSTEMS
Accumulator Tanks: Two tanks, each holding 8600 gallons of borated water under 700 psig pressure applied by nitrogen cover gas, inject their contents into the coolant system when the coolant system pressure drops below 700 psig. Two check valves, in series, are the only operating parts. If contents of one tank spills on the floor, the other tank will still fill the reactor vessel halfway up on the core.
High-head Safety Injection: Two high-head safety injection pumps take suction from the refueling water storage tank. When injection first starts, initiated by the Safety Injection Signal, concentrated boric acid from the boric acid tank is injected into the coolant system. Each pump is rated 800 gpm @ 2485 psig and can supply water lost by a break up to 2" size. When contents of refueling water storage is exhausted, water can be pumped from containment sump.
Low-head Safety Injection: This system and the Residual Heat Removal System are the same. Two pumps are provided, each rated 2000 gpm @ 600 psig. These pumps operate when coolant pressure has dropped to the 600 psig range, after accumulators have functioned. These pumps take suction from the refueling water storage tank, and if this supply is exhausted, recirculation phase starts with water pumped from the containment sump.

Reactor: Prairie Island

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Indication in control room of leakage is provided by continuous monitoring of containment air activity and humidity, and by runoff of condensate from cooling coils of air recirculation units. Basic criterion is detection of deviations from normal including air particulate activity, radiogas activity, humidity, condensate runoff. Gross leakage is indicated by liquid inventory in the process systems and containment sump.

Failed-Fuel-Detection Systems: For initial operation, gamma-sensitive detector on reactor coolant let-down line, after the let-down heat exchanger, will be used. Studies are underway on fission chamber detectors biased against "pile-up," hoping for improved sensitivity methods.

Emergency Power: Two diesel generator sets, installed with Unit 1, provide emergency power for engineered safety features sized and cross-connected to serve both units. Each generator, rated at 3000 kW continuous, is sized to start and carry the LOCA loads for one unit plus the shutdown requirements of the other unit. Each unit has its own independent air starting system consisting of air compressor and 2 accumulators each capable of cranking engine for 20 seconds. A day tank for each diesel provides fuel for 8 hrs of operation. A large storage tank has fuel supply for 2 weeks operation of both engines.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid in the coolant compensates for slow changes in reactivity.

Part-Length Control Rods - Yes, will be used to control neutron flux distribution oscillations.

In-Core Instrumentation - Out-of-core detectors will be used instead of In-core. Studies show out-of-core are satisfactory.

Unborated Water Control: Because of procedures involved in the dilution process, an erroneous dilution is considered unlikely. Nevertheless, if an unintentional dilution of boron in the coolant does occur, numerous alarms and indications are available to alert the operator of the condition. Maximum reactivity addition due to the dilution is slow enough to allow the operator to determine cause of addition and take corrective action before excessive shutdown margin is lost.

Long-Term Cooling - Internal or External Systems: Accomplished by the Residual Heat Removal system consisting of 2 loops each containing one pump and one heat exchanger. Suction of pumps would be the containment sump. Each pump rated 2000 gpm @ 600 psig. Each heat exchanger rated 26×10^6 Btu/hr.

Reactor: Prairie Island

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Data has been collected since May 1968 with instruments on a 140-ft tower. A central recording acceleograph with three detectors will be installed to measure ground motion, reactor building motion and motion of major equipment.

Plant Operating Mode: Load following

Site Features: Plant located on the west bank of the Mississippi River on a sort of island (Prairie Island) comprising 560 acres. One of the river locks is just below the plant site so a fairly stable pool (elev 674' MSL) is maintained. Plant grade is 694'. Maximum probable flood is 704'. The immediate site is flat to rolling with hilly terrain further away. Land use is agricultural — dairy farming and vegetable canning. Population (1970) in a 2-mile radius was 374, and in 5 miles it was 3267.

Turbine Orientation: Ejected turbine blades could strike containment. Centerlines are 190 ft apart.

Emergency Plans: Plans have been developed to cover on-site and off-site emergencies. Off-site plans have been coordinated with local authorities so as to safeguard the public. Plans specify responsibilities, lines of authority, communication, notification, and protective measures. Plans will be reviewed periodically.

Environmental Monitoring Plans: An environmental radiation monitoring program was initiated in May 1970. This program will be continued after plant operation begins. Measurements are being taken of the radioactivity present in air, surface and well water, raw milk, vegetation, aquatic plants, fish and other selected specimens. An ecological study of the Mississippi River in the areas of the plant was also begun in May 1970. Meteorological and water quality data has been gathered since May 1968.

Radwaste Treatment: Waste disposal system, common to both units, collects, processes, and prepares wastes for disposal with radioactivity levels as low as practical below 10CFR20 limits. Liquid wastes are collected, processed, and discharged to the river via the condenser circulating water discharge. The evaporator residues and other solid wastes are drummed and shipped from the site for disposal in an authorized location. Gaseous wastes are collected and stored for decay before discharge to the environment.

Stack Height - Plant vent is probably from top of containment.

Waste Heat System: A once-through system is used with 4 mechanical draft cooling towers available for variable cycles to cool the water before return to the river if cooling is required. River flow at the plant is 15,020 average with winter water temperature average of 38F and summer average near 75. Circulation through each unit condenser is 294,000 gpm with a temperature rise of 27F.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Prairie Island Nuclear Generating Plant

THERMAL OUTPUT, MWt 1650

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-282 50-306

NEARBY BODY OF WATER Mississippi River

NORMAL LEVEL 674' (MSL)

MAX PROB FLOOD LEVEL 704' (MSL)

SIZE OF SITE 560 ACRES

SITE GRADE ELEVATION 694' (MSL)

TOPOGRAPHY OF SITE Flat to Rolling in the river valley

OF SURROUNDING AREA (5 MI RAD) Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 374 (1970) IN 5 MI RAD 3267 (1970)

NEAREST CITY OF 50,000 POPULATION Minneappolis-St. Paul

DISTANCE FROM SITE 30 MILES POPULATION 1,865,000 (-70)

LAND USE IN 5 MILE RADIUS Agricultural - dairy farming and vegetable canning

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through with variable cycle towers

WATER TAKEN FROM Mississippi River FOR Condensers

WATER BODY TEMPERATURES - WINTER AVG 38 F SUMMER AVG 75 F AVG - F

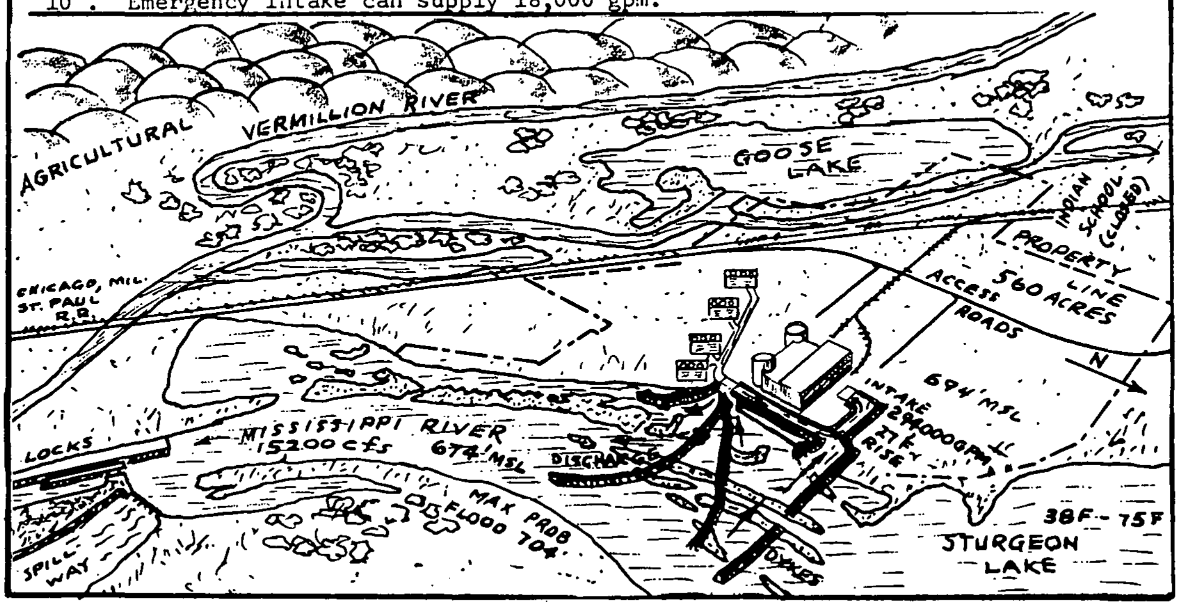
RIVER FLOW 15,020 (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 294,000 (gpm) /unit TEMPERATURE RISE 27 F

*HEAT REMOVAL CAPACITY OF CONDENSERS 3880 X 10^6 (Btu/hr) /unit *Per unit

COOLING TOWERS 4 mechanical draft towers for both units to cool water before discharge back to river on a variable cycle depending upon temp.

OTHER INFORMATION Total heat rejection to circulating water system is 8900 X 10^6. Emergency intake can supply 18,000 gpm.



MAINE YANKEE, 50-309 (PWR) Page 1

Project Name: Maine Yankee Atomic Power Station
Reactor: Maine Yankee
A-E: Stone & Webster
Location: Wiscasset, Maine
Vessel Vendor: Combustion Engineering
Owner: Maine Yankee Atomic Power Co.
Docket No.: 50-309
NSS Vendor: Combustion Engineering
Containment Constructor: Stone & Webster

A. THERMAL-HYDRAULIC	
Thermal Output, MWt	2440
Electrical Output, MWe	830
Total Heat Output for Safety Design, MWt	2570
Total Heat Output, Btu/hr	8.328×10^6
System Pressure, psia	2235
DNBR, Nominal	2.45
Total Flow rate, lb/hr	122×10^6
Eff Flowrate for Heat Trans lb/hr	---
Eff Flow Area for Heat Trans, ft^2	---
Avg Vel Along Fuel Rods, ft/sec	13.9
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.29×10^6
Nominal Core Inlet Temp, °F	540
Avg Rise in Core, °F	---
Nom Hot Channel Outlet Temp, °F	636
Avg Film Coeff, Btu/hr ft^2, °F	5,300
Avg Film Temp Diff, °F	33
Active Heat Trans Surf Area, ft^2	47,400
Avg Heat Flux, Btu/hr ft^2	171,400
Max Heat Flux Btu/hr ft^2	502,300
Avg Thermal Output, kw/ft	5.75
Max Thermal Output, kw/ft	16.9
Max Clad Surface Temp, °F	657
No. Coolant Loops	3

Data from FSAR.

B. NUCLEAR	
H_2O/U, Cold	1.59
Avg 1st-Cycle Burnup, MWD/MTU	12,895
First Core Avg Burnup, MWD/MTU	30,000
Maximum Burnup, MWD/MTU	---
Region-1 Enrichment, %	2.01
Region-2 Enrichment, %	2.40
Region-3 Enrichment, %	2.95
k_{eff}, Cold, No Power, Clean	1.163
k_{eff}, Hot, Full Power Xe and Sm	1.066
Total Rod Worth, %. Cold BOL	8.7
Shutdown Boron, No Rods, Clean, Cold, ppm	846
Shutdown Boron, No Rods, Clean, Hot, ppm	722
Boron Worth, Hot, % Δk/k/ppm	81
Boron Worth, Cold, % Δk/k/ppm	63
Full Power Moderator Temp Coeff, Δk/k/°F	$(-0.40 \text{ to } -1.96) \times 10^{-4}$
Moderator Press Coeff, Δk/k/psi	$(+0.65 \text{ to } +2.39) \times 10^{-6}$
Moderator Void Coeff Δk/k/% Void	$(-0.41 \text{ to } -1.43) \times 10^{-3}$
Doppler Coefficient, Δk/k/°F	---
Shutdown Margin, Hot One Rod Stuck, % Δk/k	1 or greater
Burnable Poisons, Type and Form	$B_4C\text{-}Al_2O_3$
Number of Control Rods	* 385 or 425
Number of Part-Length Rods (PLR) 8 × 5	40

* Some places given as 77 assemblies and in others as 85.

Compiled By: Fred Heddleson
Date: April 1971

Reactor: Maine Yankee

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.38 rad.	Design Winds	
Low Population Zone Dist., Mi.	---	At 0 - 50 ft elev	35 psf
Metropolis / Distance / Population Portland, Me. / 34 mi. / 70,000 (69)		50 - 150 ft	
Design Basis Earthquake Accel., g	0.10	150 - 400 ft	
Operating Basis Earthquake Accel., G	0.05	Tornado	300 mph tang. + 60 frans.
Earthquake Vertical Shock, % of Horizontal	67	ΔP =	3 psi/ sec

Is intent of 70 Design Criteria satisfied? Yes — Appendix A states, "...Maine Yankee has been designed and constructed in accordance with the intent of these criteria."

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	55	Calculated Max Internal Press, psig	49.5
Max Leak Rate at Design Press, %/day	0.1		

Type of Construction: Reinforced concrete cylinder 4'-6" thick with a spherical dome 2'-6" thick. Foundation mat is 10 ft thick. Inside surface of concrete is lined with steel shell for leak tightness. Liner is 3/8" thick carbon steel.

Design Basis: Designed to withstand pressure and temperatures resulting from most critical LOCA and other loads such as seismic and tornado with leakage rate less than 0.1% per day with a max metal-water reaction of 2% of fuel elements.

Vacuum Relief Capability: Designed for max negative pressure of 7.5 psi below atmosphere outside. Found no reference to vacuum breakers.

Post-Construction Testing: Pressure tested at 63.25 psig for one hour and then lowered to 55 psig for 24 hours. Leakage rate tests will be conducted at design pressure and 50% of that. Periodic tests will be run thereafter. A leakage-monitoring system is provided.

Penetrations: Some are single sealed and some double sealed. Double are testable. Heated fluid penetrations have cooling water sleeves around them.

Weld Channels: Installed along all seam welds with zoned areas and pressure taps for testing.

Reactor: Maine Yankee

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Designed to spray borated water from the refueling water tank into containment following LOCA, depressurizing containment to about 10 psig in 24 hrs. Sodium hydroxide is added to the spray solution to remove radioactive iodine from the atmosphere. There are two completely independent systems with pumps which each handle 3700 gpm at 130 psig.

Containment Cooling: Six 1/5th capacity fan-coil units hold temp below 112 F during operation and heat to prevent temp lower than 50 F. Ductwork distributes cooled, recirculated air to the areas of heat-producing equipment. Coils are cooled with component cooling water at design temperature of 85 F.

Containment Isolation System: Isolation valves are installed on all penetrations, 2 on each line with a valve inside and one outside of containment for double barrier against leakage. Automatic valves are actuated by high containment pressure. All remotely operated valves have position indicators in the control room.

Containment Air Filtration: Purge system can provide one air change per hour for containment. Exhausted air passes through a prefilter, particulate filter, and a charcoal filter bank.

Penetration Room: None shown as such on plans.

Organic-Iodide Filter: None mentioned.

Hydrogen Recombiner: Sect. 14.19.2.3 states that hydrogen buildup is sufficiently slow so that controlled venting can prevent combustible mixture from being a problem. Venting will cause no undue hazard in boundary doses.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Three tanks, each holding 9150 gallon of borated water, will dump their contents into each of the 3 main coolant loops when system pressure drops below 185 psig. Tanks are pressurized with nitrogen gas. Two tanks provide sufficient water to recover the core following LOCA. Operation of these injection tanks is fully automatic with no moving parts except a check valve.

High-head Safety Injection: Three pumps are available, but only 2 will be used to inject borated water into headers. These pumps are also used for normal makeup charging. Each pump capacity is 150 gpm at 2850 psig. Upon safety injection actuation signal (SIAS), pump suction switches to refueling water tank. Two pumps can make up the loss through a broken 1 1/2-in. line. SIAS results from containment pressure of 5 psig or from low pressurizer pressure of 1700 psig.

Low-head Safety Injection: Two pumps, each with capacity of 3000 gpm at 600 psig, can flood the core when pressure has dropped in the system. There is one spare pump which can function with this system, or with the containment spray system. This system, or the HPSI system can be used for long term cooling.

Reactor: Maine Yankee

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: No reference found.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: Two independently isolated diesel-generator systems each rated at 3560 kVA can supply emergency power. One system has capacity to supply power requirements of required engineered safety features. Diesel are fast starting using compressed air tanks. A day tank provides 4 hr of fuel for full-load operation, and two on-site tanks can supply fuel for full-load operation of one diesel for 8 days.

Control of Axial Xenon Oscillations:

Burnable Shims - $B_4C-A\ell_2O_3$ included to lower BOL dissolved boron required. Batch B fuel has 1280 shims, batch C has 816.

Part-Length Control Rods - Eight rods used for power shaping.

In-Core Instrumentation - Rhodium and vanadium neutron detectors provide information on neutron flux in core.

Unborated Water Control: Excessive boron dilution probability is very small, considering equipment and controls and administrative procedures provided for the operation. If an unintentional dilution of boron does occur, numerous alarms are available to alert the operator. The maximum reactivity addition due to the dilution is slow enough to allow the operator to determine the cause and to take corrective action before shutdown margin is completely lost.

Long-Term Cooling - Internal or External Systems: When the 336,000 gallon capacity of the refueling water tank is exhausted, injection pumps and spray pumps will take suction from the containment sump and recirculate the borated water through the reactor and the residual heat exchangers for long term heat removal. If more water is needed, the water storage pond on the site provides an additional supply.

Reactor: Maine Yankee

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A 149-ft tower was installed at elevation 45'. Wind speed and direction measured at top. Temperatures are measured at 3 levels. A recording rain gage is also installed. Seismographs not mentioned.

Plant Operating Mode: Load following in response to turbine demand.

Site Features: Site consists of 740 acres surrounded on the east and south by Back River and Montsweag Bay - all tidal estuary waters. The Atlantic Ocean is about 15 miles south. Site grade is 20' MSL. The site and surrounding area is rolling and wooded. Within 2 mi radius there are 379 permanent residents and within 5 miles there are 6500, 1800 of these living in Wiscasset. Fresh water for the plant is piped 2 miles from a 185 acre-feet pond on Montsweag Brook NE of the plant.

Turbine Orientation: Ejected turbine blades could strike containment structure. Centerlines are about 185' apart.

Emergency Plans: An emergency plan outlining actions and responsibilities of employees and off-site support groups is in final stages. Liason is now being established with federal, state and local agencies. There will be 3 classes of emergencies — local, site, and general which might arise from fire, weather conditions, equipment failures, or other conditions.

Environmental Monitoring Plans: A program has been planned in cooperation with Maine Water & Air Environmental Improvement Comm. and the State Department of Health and Welfare. There will be 2 phases — preoperational and operational. Preoperational was started 2 years before operation to establish background levels. Operational phase will demonstrate that 10 CFR 20 is being met and to monitor effects of releases. Samples of air particulates, river and bay water, ground water, vegetation, marine biota and bottom sediments will be collected.

Radwaste Treatment: System designed to collect, store, process, monitor and dispose of all solid, liquid, and gaseous radioactive wastes. Criteria is to protect the public in accordance with 10 CFR 20. Liquids will be collected and processed through demineralizers, filters, and evaporators. Liquid effluents when safe will be discharged into the service water system. Gases will be released to the vent stack or held for decay before release. Solid wastes will be drummed and shipped off-site.

Stack Height - About 160 ft high (estimated).

Waste Heat System: A once-through system is used taking water from Back River and discharging into Montsweag Bay. About 426,000 gpm are pumped through the condenser. This whole area is an estuary affected by tidal flow. Water temperatures range from a winter average of 37 F to a summer average of 57 F.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Maine Yankee Atomic Power Station

THERMAL OUTPUT, MWt 2440

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-309

NEARBY BODY OF WATER Montsweag Bay and the Atlantic Ocean about 15 miles south

NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 20' (MSL)

SIZE OF SITE 740 ACRES

SITE GRADE ELEVATION 20' (MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 379 (1970) IN 5 MI RAD 6500 (1970)

NEAREST CITY OF 50,000 POPULATION Portland, Maine

DISTANCE FROM SITE 34 MILES POPULATION 70,000 (1969)

LAND USE IN 5 MILE RADIUS Wooded except for some idle farm land

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through

WATER TAKEN FROM Back River FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG 37 F SUMMER AVG 57 F AVG - F

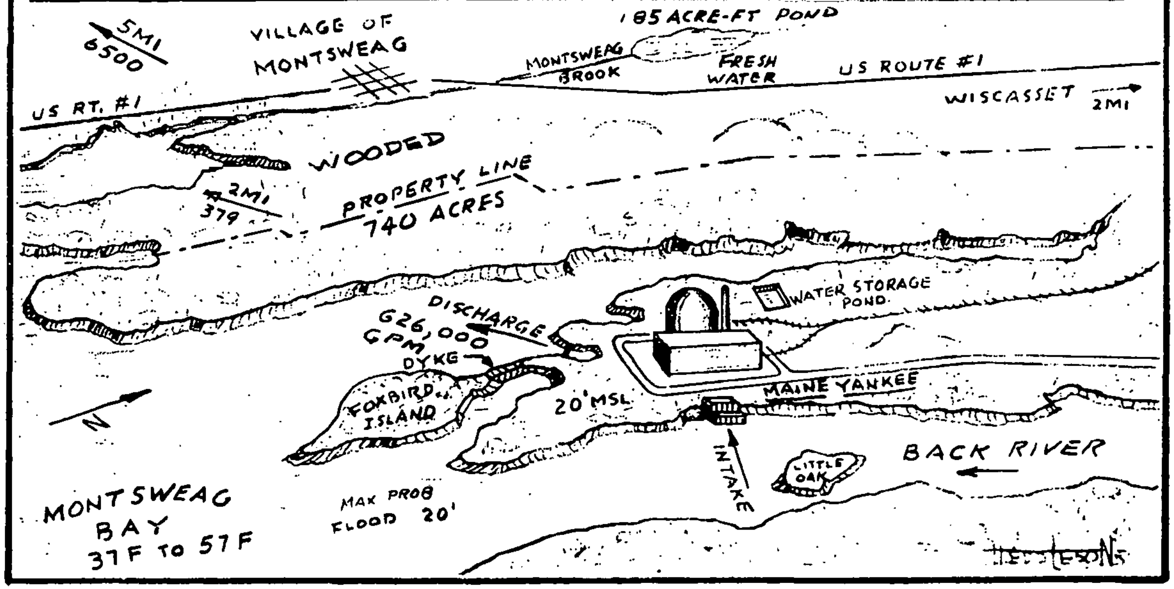
RIVER FLOW NA (cfs) Tidal Flow *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 426,000 (gpm) TEMPERATURE RISE 25.6F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS None

OTHER INFORMATION Fresh water is brought from Montsweag Brook 2 miles NE by an 8" pipe having 200 gpm capacity for a period of 26 weeks of dry weather.



SALEM, 50-311 (PWR) Page 1

Project Name: Salem Nuclear Generating Station, Units 1 & 2
Location: Salem Co., N. J.
Owner: Public Service Elec. & Gas
NSS Vendor: Westinghouse

Reactor: Salem
A-E: Public Service Electric
Vessel Vendor: Not specified.
Docket No.: 50-311 (also 50-272)
Containment Constructor: Public Serv. Elec.

A. THERMAL-HYDRAULIC	
Thermal Output, MWt	3250
Electrical Output, MWe	1050
Total Heat Output for Safety Design, MWt	3391
Total Heat Output, Btu/hr	$11{,}090 \times 10^6$
System Pressure, psia	2250
DNBR, Nominal	1.81
Total Flow rate, lb/hr	135×10^6
Eff Flowrate for Heat Trans lb/hr	122.8×10^6
Eff Flow Area for Heat Trans, ft^2	47.9
Avg Vel Along Fuel Rods, ft/sec	15.7
Avg Mass Velocity lb/hr-ft^2	2.56×10^6
Nominal Core Inlet Temp, °F	539
Avg Rise in Core, °F	68.6
Nom Hot Channel Outlet Temp, °F	646.0
Avg Film Coeff, Btu/hr ft^2, °F	5970
Avg Film Temp Diff, °F	34.7
Active Heat Trans Surf Area, ft^2	52,200
Avg Heat Flux, Btu/hr ft^2	207,000
Max Heat Flux Btu/hr ft^2	583,000
Avg Thermal Output, kw/ft	6.7
Max Thermal Output, kw/ft	18.9
Max Clad Surface Temp, °F	657
No. Coolant Loops	4

B. NUCLEAR	
H_2O/U, Cold	3.48
Avg 1st-Cycle Burnup, MWD/MTU	12,000
First Core Avg Burnup, MWD/MTU	21,800
Maximum Burnup, MWD/MTU	50,000
Region-1 Enrichment, %	2.20
Region-2 Enrichment, %	2.70
Region-3 Enrichment, %	3.20
k_{eff}, Cold, No Power, Clean	1.225
k_{eff}, Hot, Full Power Xe and Sm	1.106
Total Rod Worth, %	7
Shutdown Boron, No Rods, Clean, Cold, ppm	1500
Shutdown Boron, No Rods, Clean, Hot, ppm	1500
Boron Worth, Hot, % Δk/k/ppm	1/85
Boron Worth, Cold, % Δk/k/ppm	1/70
Full Power Moderator Temp Coeff, Δk/k/°F	$(-0.2 \text{ to } -3.0) \times 10^{-4}$
Moderator Press Coeff, Δk/k/psi	$(+0.2 \text{ to } +3.0) \times 10^{-6}$
Moderator Void Coeff Δk/k/% Void	$(-0.2 \text{ to } -3) \times 10^{-3}$
Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -2) \times 10^{-5}$
Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Burnable Poisons, Type and Form	Pyrex glass in SST tubes
Number of Control Rods 53×20	1060
Number of Part-Length Rods (PLR) 8×20	160

Compiled By: Fred Heddleson
Date: July 1971

Reactor: Salem

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.8 radius	Design Winds in mph:	
Low Population Zone Dist., Mi.	5	At 0 - 50 ft elev	108
Metropolis / Wilmington, Del.	Distance: 20 mi. / Population: 92,500 (69)	50 - 150 ft	131
Design Basis Earthquake Accel., g	0.15	150 - 400 ft	160
Operating Basis Earthquake Accel., G	0.08	Tornado	300 mph
Earthquake Vertical Shock, % of Horizontal	67	ΔP = 3 psi/ - sec	

Is intent of 70 Design Criteria satisfied? Yes, Section 1.4 states that "... general design criteria are followed in the design of this plant."

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	47	Calculated Max Internal Press, psig	43
Max Leak Rate at Design Press, %/day	0.1		

Type of Construction: A reinforced concrete vertical right cylinder 4 1/2 ft thick with a flat base and a hemispherical dome (3 1/2 ft thk). A welded steel liner with a minimum thickness of 1/4-in. is attached to the inside face of the concrete shell to insure leak-tightness. The flat concrete base mat is 16-ft thick with the bottom liner plate located on top of mat. Bottom liner plate will be covered with a minimum of 2-ft of concrete, the top of which will form the floor of the containment.

Design Basis: Containment structure and penetrations, with the aid of containment heat removal systems, are designed to limit below 10CFR100 values, radiation doses resulting from leakage of radioactive fission products from containment under conditions that would result from the largest credible energy release following a LOCA, including a margin to cover the effects of metal-water or other undefined energy source.

Vacuum Relief Capability: Designed for 3.5 psig external pressure. No reference found to vacuum breakers.

Post-Construction Testing: Pressure tested at 54 psig for 15 min and at 47 psig for 2 hr. Leakage rate test will be run at 47 psig. Periodic testing will be made of penetratons for leaks.

Penetrations: All penetrations are double-barrier type and are individually testable.

Weld Channels: All containment liner welds are covered by steel channels, as well as seam welds between liner and penetrations.

Reactor: Salem

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: The Containment Spray System provides a spray of cool, borated water containing a solution of sodium hydroxide to the containment atmosphere. The spray acts as a heat sink and a means of reducing the halogen fission products concentration.

Containment Cooling: Temperatures are held at 120F or below during operation by 4 of 5 fan-coil filtering units which continuously circulate and cool the air. Filters remove particulates to keep containment air clean. Max capacity of units under accident conditions is 80×10^6 Btu/hr for each unit.

Containment Isolation System: Two isolation valves, one on each side of the containment wall for each penetration provide double-barrier protection against leakage of fission products. Valves operate automatically on a high containment pressure signal.

Containment Air Filtration: Fan-coil cooling units have HEPA filters. Any air removed from containment passes through charcoal filters before going to the plant vent.

Penetration Room: Piping penetration room and an electrical penetration room provided for each reactor at elevation 84'.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Hydrogen formation is so low (less than 1%) that no instrumentation to measure or detect it will be provided.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four accumulators, each containing 6500 gallons of borated water, will automatically dump their contents into the reactor coolant system when system pressure drops to 650 psig. Tanks are held under pressure of nitrogen gas. Two check valves in series operate to release the water.

High-head Safety Injection: Two 100% capacity safety injection pumps operate to keep core covered for small breaks. Pumps take suction from the refueling water storage tank; however, drawing concentrated boric acid first from the boron injection tank. Pump capacity is 700 gpm at 1750 psig.

Low-head Safety Injection: Two 100% capacity residual heat removal pumps take suction from the refueling water storage tank. These pumps operate to flood the core for large breaks where depressurization has occurred. Each pump is rated 3000 gpm at 150 psig.

Reactor: Salem

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Provided by equipment which monitors containment air activity and humidity. The basic design criterion is detection of deviations from normal containment environmental conditions including air particulate activity, radiogas activity, humidity and in addition, gross leakage, the liquid inventory in the process systems and containment sump.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: Two sets of three emergency power diesel generators are provided, one set for each unit. Within a set of three, the diesel generators will share the fuel oil storage and transfer system. This system consists of two 30,000 gallon fuel oil storage tanks and two fuel oil transfer pumps. Each fuel oil transfer pump normally pumps from its own storage tank, but cross-connections are provided for added flexibility.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid solution in the coolant system.

Part-Length Control Rods - Yes, there are 8 assemblies of 20 rods each.

In-Core Instrumentation - Installed to yield information on neutron flux distribution.

Unborated Water Control: If either boric acid flow or demineralized water flow deviates from the control set point during coolant boration, dilution or normal leakage makeup, alarms warn the operator to deactivate the makeup system manually. Should a condition arise when coolant boron is changing without the operator's knowledge, RCC group position indication is a positive means of detecting any significant change when the reactor is critical and at power.

Long-Term Cooling - Internal or External Systems: Recirculation of borated water from containment sump is accomplished by one of the 2 residual heat removal loop pumps, each rated at 3000 gpm for 150 psig. Water is circulated thru the residual heat removal loop heat exchangers for cooling.

Reactor: Salem

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Data available from a tower located 10 miles away. Tower located at Burlington site has been moved to Salem. It is 300' high. No reference found on seismographs.

Plant Operating Mode: Load following

Site Features: Located on a 700 acre site on the eastern shore of the Delaware River estuary. The site is an artificial island formed by hydraulic fill. The area is sparsely inhibited, no residents in a 2-mi radius and 1184 in a 5-mi radius. The site is flat and the surrounding area is flat marshland.

Turbine Orientation: Ejected turbine blades could strike containment structure. Center lines are about 210 ft apart.

Emergency Plans: No reference found.

Environmental Monitoring Plans: A program will be started at least 2 years before operation to determine existing backgrounds. The program will include sampling of the sensitive indicators such as air, water, soil, and others which contribute toward human exposure by way of the food chain (milk, vegetables, marine life, and animal life).

Radwaste Treatment: Provides equipment to collect, process, and prepare for disposal within limits of 10CFR20 all radioactive liquid, gaseous and solid wastes. Liquid wastes are collected and may be evaporated. After cleaning and filtering, evaporator condensate is discharged via the condenser discharge. Evaporator residues are stored, drummed and shipped off-site for disposal in the same manner other solid wastes are handled. Gaseous wastes are collected and stored until the activity level is low enough for discharge to the environment.

Stack Height - No height found.

Waste Heat System: A once-through cooling system will be used taking water from the Delaware River. A quantity of 1,100,000 gpm per unit will be circulated with water going back into the estuary with 13.6F rise in temp. Average river flow is 15,000 cfs, however, this is insignificant since tidal flow average is 400,000 cfs.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Salem Nuclear Generating Station

THERMAL OUTPUT, MWt 3250

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-272 50-311

NEARBY BODY OF WATER Delaware River estuary

NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 8.5' (MSL)

SIZE OF SITE 700 ACRES

SITE GRADE ELEVATION 10.5' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat

TOTAL PERMANENT POPULATION IN 2 MI RAD 0 (1967) IN 5 MI RAD 1184 (1967)

NEAREST CITY OF 50,000 POPULATION Wilmington, Delaware

DISTANCE FROM SITE 20 MILES POPULATION 92,500 (1969)

LAND USE IN 5 MILE RADIUS Tidal marshes and grasslands

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through

WATER TAKEN FROM Delaware River FOR condenser cooling

WATER BODY TEMPERATURES - WINTER AVG -- F SUMMER AVG -- F AVG -- F

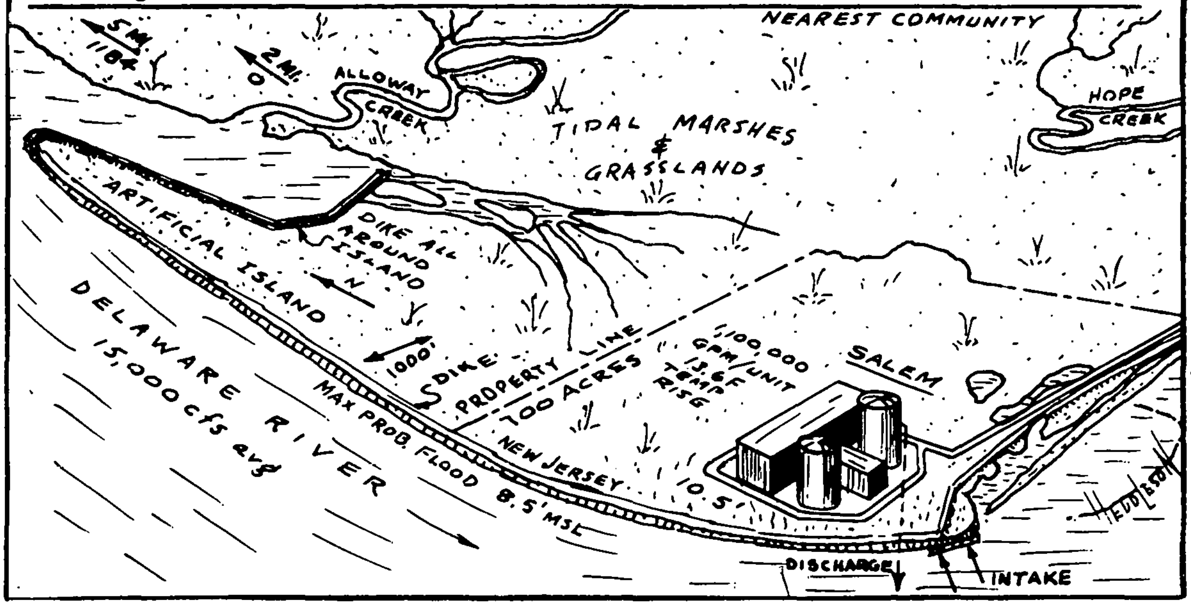
RIVER FLOW 15,000 (cfs) avg. QUANTITY OF MAKEUP WATER --- (gpm)

TOTAL FLOW THROUGH CONDENSERS 1,100,000 (gpm)/unit TEMPERATURE RISE 13.6 F

HEAT REMOVAL CAPACITY OF CONDENSERS --- (Btu/hr)

COOLING TOWERS None

OTHER INFORMATION River is 2 miles wide at site where tidal flow is 400,000 cfs average.



RANCHO SECO, 50-312 (PWR) Page 1

Project Name: Rancho Seco Nuclear Generating Station Unit 1
Location: SE Sacramento County*
Owner: Sacramento Municipal Utility
NSS Vendor: Babcock & Wilcox
Reactor: Rancho Seco
A-E: Bechtel Corp.
Vessel Vendor: Babcock & Wilcox
Docket No.: 50-312
Containment Constructor: C. H. Leavell Co. & Dravo

*25 miles SE of Sacramento.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2772	H_2O/U, Cold	2.88
Electrical Output, MWe	963	Avg 1st-Cycle Burnup, MWD/MTU	14,250
Total Heat Output for Safety Design, MWt	2772	First Core Avg Burnup, MWD/MTU	---
Total Heat Output, Btu/hr	9461×10^6	Maximum Burnup, MWD/MTU	55,000
System Pressure, psia	2185	Region-1 Enrichment, %	---
DNBR, Nominal	1.75 (W-3)	Region-2 Enrichment, %	2.57 core avg.
Total Flow rate, lb/hr	137.8×10^6	Region-3 Enrichment, %	---
Eff Flowrate for Heat Trans lb/hr	129.5×10^6	k_{eff}, Cold, No Power, Clean	1.252
Eff Flow Area for Heat Trans, ft^2	49.17	k_{eff}, Hot, Full Power Xe and Sm	1.123
Avg Vel Along Fuel Rods, ft/sec	16.52	Total Rod Worth, %	11.1
Avg Mass Velocity lb/hr-ft^2	---	Shutdown Boron, No Rods, Clean, Cold, ppm	1585
Nominal Core Inlet Temp, °F	557	Shutdown Boron, No Rods, Clean, Hot, ppm	1446
Avg Rise in Core, °F	53.6	Boron Worth, Hot, % Δk/k/ppm	1/100
Nom Hot Channel Outlet Temp, °F	649.5	Boron Worth, Cold, % Δk/k/ppm	1/75
Avg Film Coeff, Btu/hr ft^2, °F	5000	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.9 \text{ to } -3.0) \times 10^{-4}$
Avg Film Temp Diff, °F	35	Moderator Press Coeff, Δk/k/psi	-5.0×10^{-7} to $+3.0 \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	49,734	Moderator Void Coeff Δk/k/% Void	Fig. 3.2-3
Avg Heat Flux, Btu/hr ft^2	185,090	Doppler Coefficient, Δk/k/°F	$(-1.1 \text{ to } -1.7) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	576,885	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	6.105	Burnable Poisons, Type and Form 68×16	Al_2O_3-B_4C in Zircaloy-4 rods
Max Thermal Output, kw/ft	19.03	Number of Control Rods 61×16	976
Max Clad Surface Temp, °F	654	Number of Part-Length Rods (PLR) 8×16	128
No. Coolant Loops	2		

Data from FSAR.

Compiled By: Fred Heddleson
Date: May 1971

Reactor: Rancho Seco

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi. 0.4 rad.	Design Winds in mph:
Low Population Zone Dist., Mi. 4.7	At 0 - 50 ft elev 90
Metropolis / Distance / Population Sacramento / 26 mi. / 265,000 1969	50 - 150 ft 105
Design Basis Earthquake Accel., g 0.25	150 - 400 ft 125
Operating Basis Earthquake Accel., G 0.13	Tornado ---
Earthquake Vertical Shock, % of Horizontal 68	ΔP = - psi/ - sec

Is intent of 70 Design Criteria satisfied? Yes, Section 1.4 states that "principal safety features that meet each criterion are summarized."

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig 59	Calculated Max Internal Press, psig 52
Max Leak Rate at Design Press, %/day 0.1	

Type of Construction: A reinforced-concrete structure in the shape of a cylinder with a shallow domed roof and a flat foundation slab. The 3¼" cylindrical portion is prestressed by a post-tensioning system consisting of horizontal and vertical tendons. The dome has a three-way post-tensioning system. The foundation slab is reinforced with conventional reinforcing steel. A 1/4" welded steel liner is attached to the inside face of the concrete shell to insure leaktightness.

Design Basis: Designed for all credible load conditions including the 2 most critical conditions caused by the double-ended largest pipe break and an earthquake. Designed to sustain the initial effects of such without loss of integrity, and together with safety features to retain fission products as long as required to protect the public from consequences of leaked radioactivity.

Vacuum Relief Capability: Designed for 2 psi differential. No reference found to vacuum relief valves.

Post-Construction Testing: A strength test will be run at 1.15 × design pressure, and held for 1 hr. Leakage rate tests shall be run at 59 psig for 24 hrs and then at about 26 psig.

Penetrations: Electrical penetrations are double sealed and testable. All other penetrations are single barrier with most having a forged fluid head welded to the pipe and liner plate.

Weld Channels: No reference found to weld channels. A vacuum box placed over seams is used for testing welds.

Reactor: Rancho Seco

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Sprays borated water into the containment atmosphere to reduce post-accident temp and pressure; and reduce, by NaOH additive, the level of fission products. System consists of 2 spray trains which are initiated, after a 5 minute delay, by containment pressure of 30 psig. Cooling capacity is 240×10^6 Btu/hr with both sprays operating (3000 gpm @ 175 psig) taking pump suction from the borated water storage tank, but later from the emergency sump.

Containment Cooling: Consists of four 25% capacity cooling units, each with a cooling coil, sized for emergency service and a direct-driven fan. Two units are equipped with activated charcoal filters for air cleanup and removal of fission products. All units operate under post-accident conditions. Heat is rejected to the nuclear service cooling water system. Each unit can remove 60×10^6 Btu/hr. Air circulation is assisted by four 25,000 cfm capacity upper-dome distributors.

Containment Isolation System: Designed to minimize leakage of radioactive materials through pipes penetrating containment walls in event of a LOCA. Double barrier protection is provided to insure that no single, credible failure or malfunction shall result in loss of isolation. The installed double barriers take the form of closed piping systems with isolation valves on both sides of containment wall. Isolation occurs on low reactor pressure or high containment pressure.

Containment Air Filtration: Two of the emergency cooling units have charcoal filters - see above. The purge and exhaust has prefilters, HEPA, and charcoal filters.

Penetration Room: Yes, electrical penetrations at one level and containment penetration and valve area on another level.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Hydrogen concentration does not reach control limit until 770 hours after MCA. A purge of 16 cfm will then keep concentration at a safe limit - see Appendix 14C.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Two tanks each contain 7000 gallons of borated water under pressure of nitrogen gas at 600 psig. When pressure in the coolant system drops below 600 psig, two check valves, in series, open allowing tank contents to be injected into the reactor vessel. If no water remains in the vessel, contents of the 2 tanks will cover the core to the 3/4 point.

High-head Safety Injection: There are 3 makeup or Hi-pressure charging pumps, one of which can supply 500 gpm @ 600 psig to prevent core damage for small leaks or pipe breaks. System is initiated by low reactor coolant system pressure or high containment pressure. Pump suction is taken from the borated water storage tank. When continuous high-pressure injection is required, decay heat removal pumps can supply water to the high-head pumps from the emergency sump.

Low-head Safety Injection: Two of the decay heat removal system pumps take suction from the borated water storage tank and can jointly supply 6000 gpm @ 100 psig to the reactor vessel. One pump operating is sufficient to maintain core cooling. When supply of borated water is exhausted, suction will be switched over to the containment sump and water will then be pumped through decay heat removal heat exchangers for cooling.

Reactor: Rancho Seco

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Leakage of coolant into containment will be detected by one or both of the following. All leakage is collected in sumps. By monitoring the East Decay Heat Removal Pump Room sump liquid level and frequency of operation, leakage can be estimated. If coolant leakage is suspected, a sample of leakage can be obtained and checked for radioactivity. Measurement of makeup tank level can provide an indication of leakage. Also, changes in containment radioactivity indicate leakage.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: Two quick-starting auxiliary diesel-generator units connected to the nuclear service buses. The nameplate rating of each auxiliary generator is 2750 kW at 0.8 power factor.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid in reactor coolant

Part-Length Control Rods - Used for axial power shaping

In-Core Instrumentation - There are 36 in-core detectors which readout in the control room.

Unborated Water Control: The highest rate of dilution can be handled by the automatic control system, which inserts rods to maintain the power level and thus limit coolant temperature rise. If an interlock failure occurred while the reactor was under manual control, these reactivity additions would cause a high reactor coolant temperature trip or a high-pressure trip. In any event, the thermal power will not exceed the design overpower condition, and the system pressure will not exceed code allowable limits. Therefore, moderator dilution accidents will not cause damage to the reactor coolant system.

Long-Term Cooling - Internal or External Systems: Accomplished by Decay Heat Removal System which can circulate borated water which has collected in the containment sump. This water will be passed through system heat exchangers for cooling.

Reactor: Rancho Seco

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A 200' high tower used to measure wind speed and direction, and temperatures, record them on digital tape. Seismographs not mentioned.

Plant Operating Mode: Load following.

Site Features: Located on a flat to rolling site in SE part of Sacramento County about 26 miles SE of Sacramento. Surrounding land is rolling. There is no major water source near the plant. Water for makeup will be pumped in from Folsom South Canal (5 miles). The surrounding land use is mostly for cattle grazing. Population in a 2-mi radius is 93, 5 miles is 352.

Turbine Orientation: Ejected turbine blades could strike containment structure. Centerlines are 118'-6" apart.

Emergency Plans: A set of Emergency Plan Procedures have been prepared that provide complete details for responding to specific types of emergencies. These procedures also provide data, details and instructions, personnel assignments, names and numbers for emergency callout, criteria for evaluation, and other specific information which would be required during an emergency.

Environmental Monitoring Plans: Program measures and determines the environmental radioactivity level from station operation. Program divided into preoperational and operational phases. Preoperational phase measures natural radiation levels around the station, detects natural variances and trends in levels, and provides base data to which operational program levels can be compared. The same measurements will continue in the operational phase. Sampling was started in Oct. 1970. Minor changes in sample collection and/or type of sample may be made in the operational phase as preoperational results become available. Sampling will cover airborne particulates, water, mud, silt, vegetation, soil, milk, fish, and rabbits.

Radwaste Treatment: System collects, segregates, processes, and disposes of radioactive solids, liquids, and gases in compliance with 10CFR20. Liquid and solid wastes are processed in batches for off-site disposal. Gaseous waste released to the environment is monitored and discharged with suitable dilution. Gaseous waste system can store gas generated during operation. Decay tanks are periodically sampled, and released at rates consistent with environmental conditions. Most all of the liquid waste is processed for recycling through plant processes. Some is shipped off-site.

Stack Height - Plant vent is on top of containment.

Waste Heat System: Two hyperbolic cooling towers will be used. Blowdown will be 13,000 gpm which will go into the Hadseville Creek. No information is given on flow quantities or condenser temperature rise.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Rancho Seco Nuclear Generating Station Unit 1
THERMAL OUTPUT, MWt 2772	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-312

NEARBY BODY OF WATER NONE   NORMAL LEVEL - (MSL)

MAX PROB FLOOD LEVEL NA (MSL)

SIZE OF SITE 2480 ACRES   SITE GRADE ELEVATION 165 (MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 93 (1970) IN 5 MI RAD 352 (1970)

NEAREST CITY OF 50,000 POPULATION Sacramento, Calif

DISTANCE FROM SITE 26 MILES   POPULATION 265,000 (1969)

LAND USE IN 5 MILE RADIUS Agricultural - grazing land

CIRCULATING WATER SYSTEM   TYPE OF SYSTEM Closed loop using cooling towers

WATER TAKEN FROM Folsom South Canal (5 mi. E of site) FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG - F   SUMMER AVG - F   AVG - F

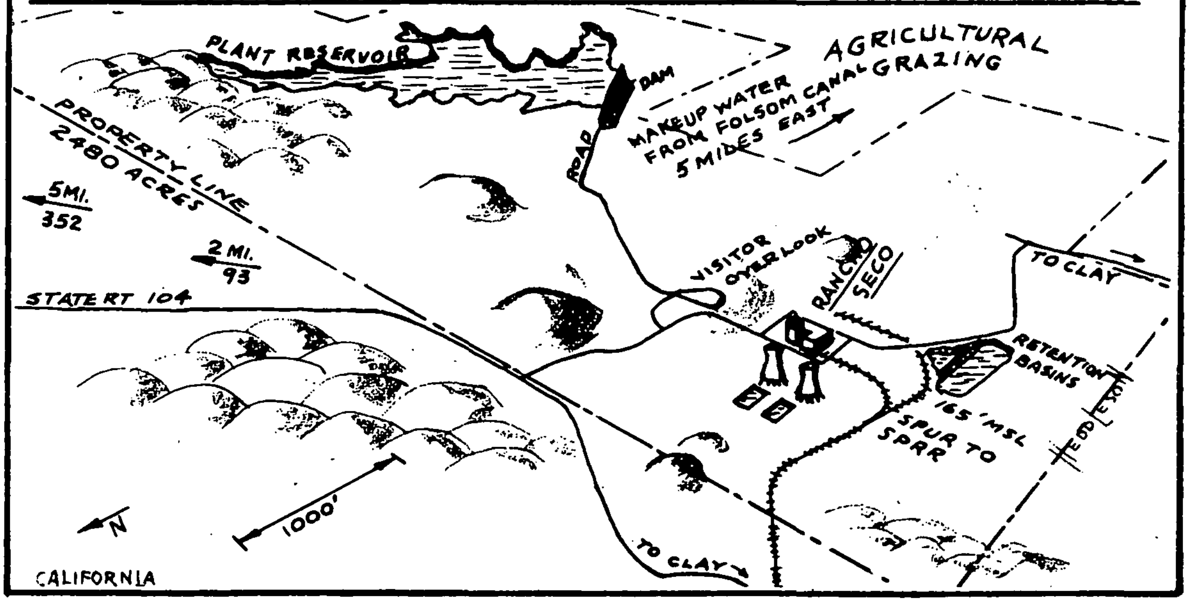
RIVER FLOW 3450 (cfs) Folsom Canal *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS - (gpm)   TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr)   *Per Unit

COOLING TOWERS Two hyperbolic towers with 13,000 gpm blowdown

OTHER INFORMATION If Folsom Canal is not complete, water will then be secured from Lake Notoma on the American River 20 miles away.



NUCLEAR SAFETY INFORMATION CENTER

ARKANSAS ONE, 50-313 (PWR) Page 1

Project Name: Arkansas Nuclear One, Unit 1
Location: Pope Co., Ark.
Owner: Arkansas Power & Light
NSS Vendor: Babcock & Wilcox

Reactor: Arkansas One, #1
A-E: Bechtel Corporation
Vessel Vendor: Babcock & Wilcox
Docket No.: 50-313
Containment Constructor: None specified.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2568	H_2O/U, Cold	2.88
Electrical Output, MWe	880	Avg 1st-Cycle Burnup, MWD/MTU	14,400
Total Heat Output for Safety Design, MWt	2568	First Core Avg Burnup, MWD/MTU	---
Total Heat Output, Btu/hr	8765×10^6	Maximum Burnup, MWD/MTU	44,950
System Pressure, psia	2200	Region-1 Enrichment, %	---
DNBR, Nominal	2.0	Region-2 Enrichment, %	First cycle avg. 2.62
Total Flow rate, lb/hr	131.3×10^6	Region-3 Enrichment, %	---
Eff Flowrate for Heat Trans lb/hr	124.2×10^6	k_{eff}, Cold, No Power, Clean	1.237
Eff Flow Area for Heat Trans, ft^2	49.19	k_{eff}, Hot, Full Power Xe and Sm	1.109
Avg Vel Along Fuel Rods, ft/sec	15.7	Total Rod Worth, %	11.1
Avg Mass Velocity $lb/hr\text{-}ft^2$	---	Shutdown Boron, No Rods, Clean, Cold, ppm	1512
Nominal Core Inlet Temp, °F	554	Shutdown Boron, No Rods, Clean, Hot, ppm	1553
Avg Rise in Core, °F	49.3	Boron Worth, Hot, % Δk/k/ppm	1/100
Nom Hot Channel Outlet Temp, °F	647.1	Boron Worth, Cold % Δk/k/ppm	1/75
Avg Film Coeff, Btu/hr ft^2, °F	5000	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.28 \text{ to } -3.0) \times 10^{-4}$
Avg Film Temp Diff, °F	31	Moderator Press Coeff, Δk/k/psi	-3.0×10^{-7} to $+3.0 \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	49,734	Moderator Void Coeff Δk/k/% Void	---
Avg Heat Flux, Btu/hr ft^2	171,470	Doppler Coefficient, Δk/k/°F	$(-1.1 \text{ to } -1.7) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	534,440	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	5.66	Burnable Poisons, Type and Form 1088	Al_2O_3-B_4C in Zircaloy-4
Max Thermal Output, kw/ft	17.63	Number of Control Rods 61 × 16	976
Max Clad Surface Temp, °F	654	Number of Part-Length Rods (PLR) 8 × 16	128
No. Coolant Loops	2		

Data from FSAR.

Compiled By: Fred Heddleson
Date: May 1971

Reactor: Arkansas One, #1

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.65 rad.	**Design Winds in mph:**
Low Population Zone Dist., Mi.	4.0	At 0 - 50 ft elev
Metropolis / Distance / Population: Little Rock, 57 mi., 136,000 (69)		50 - 150 ft: "The provisions in ASCE paper 3269 for gust factors and variation of wind velocity with height do not apply" (p 5-3).
Design Basis Earthquake Accel., g	0.20	150 - 400 ft
Operating Basis Earthquake Accel., G	0.10	Tornado 300 mph tang. plus 60 trans.
Earthquake Vertical Shock, % of Horizontal	67	ΔP = 3 psi/ 3 sec

Is intent of 70 Design Criteria satisfied? Section 1.4 discusses the criteria items and how Arkansas One, #1 conforms to their intent.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	59	Calculated Max Internal Press, psig	53.1
Max Leak Rate at Design Press, %/day	0.2		

Type of Construction: A fully continuous reinforced-concrete structure in the shape of a cylinder on a flat foundation slab with a shallow domed roof. The 3'-9" cylindrical portion is prestressed by a post-tensioning system consisting of horizontal and vertical tendons. The 3'-3" dome has a three-way post-tensioning system. The foundation slab is reinforced with high-strength reinforcing steel. A 1/4" thick welded steel liner is attached to the inside face of the concrete shell.

Design Basis: Designed for all credible conditions of loading, including normal loads, LOCA loads, test loads, thermal loads, earthquake loads, etc. The critical loads are caused by LOCA and earthquake. Designed to hold leakage to design limit after LOCA.

Vacuum Relief Capability: Designed for 2 1/2 psi vacuum.

Post-Construction Testing: A pressure test will be conducted pneumatically at 115% design pressure. Leakage rate test will be run at design pressure for 24 hrs. No leakage monitoring system is installed.

Penetrations: Electrical penetrations are double sealed and individually testable. Other penetrations are single barrier.

Weld Channels: Weld channels are installed at liner plate seams where liner plate is not accessible for inspection.

Reactor: Arkansas One, #1

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: After LOCA the system sprays a chemical solution into containment atmosphere to reduce the energy and to remove fission product iodine. System consists of 2 pumps (each rated 2000 gpm @ 150 psig), 2 spray headers, plus piping, valves, instruments, and controls. Sodium thiosulfate is supplied for iodine removal, and sodium hydrozide is included for pH adjustment of the borated water. Both spray paths have 100% heat removal and 200% iodine removal capacity.

Containment Cooling: For normal operation, temp is held between 60F and 110F. Same units provide both normal and emergency cooling coils and a one-speed fan. For normal operation, chilled water is circulated through 3 units. In emergency cooling, 4 units operate with heat rejected to the service water system. Each unit can remove 60×10^6 Btu/hr under peak temp conditions.

Containment Isolation System: Leakage through all fluid penetrations not serving accident-consequences-limiting system is minimized by a double barrier so that no single, credible failure or malfunction results in a loss-of-isolation or intolerable leakage. The installed double barriers are isolation valves both inside and outside the reactor.

Containment Air Filtration: Purge system supply passes through roughing filter and heater. Exhaust is prefiltered and then passed through an absolute filter.

Penetration Room: Electrical penetration room at elev 386' and piping penetration rooms at elev 360'.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: No reference to hydrogen handling could be found.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Two tanks, each containing 7000 gallons of borated water under 600 psig pressure will release their contents automatically when system pressure drops below 600 psig. Two check valves, in series, are the only working parts. The contents are discharged into the reactor vessel to flood the core and prevent fuel damage.

High-head Safety Injection: A part of the makeup and purification system, two of the 3 charging pumps have capacity to replace coolant lost by small leaks. Suction is taken from the borated water storage tank. Initiated by low reactor coolant system pressure or high containment pressure, each pump can deliver about 450 gpm @ 2000 psig.

Low-head Safety Injection: Two pumps and 2 heat exchangers of the decay heat removal system can inject borated water from the borated water storage tank to flood the core. Initiated by low coolant system pressure or high containment pressure, both pumps can deliver about 6000 gpm @ 100 psig.

Reactor: Arkansas One, #1

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Changes in reactor building sump water level are an indication of total leakage. The level alarms (computer) and readout are located in the control room. Makeup, as a result of leakage, is initially supplied from the makeup tank inventory. Monitoring of the makeup tank level will provide a direct indication of leakage. Changes in leakage rate into containment may cause changes in control room indication of reactor building atmosphere gas radioactivities.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: Two diesel generators are provided, one connected to each 4160 volt Engineered Safeguard Bus. Each diesel generator is rated 4160 volts, 2750 kW continuous with a maximum rated starting time of 15 seconds from admission of starting air to rated voltage and frequency. The rating of each diesel generator is sufficient to carry the Engineered Safeguard Bus loads for the DBA and still drive the turbine emergency oil pump, turbine turning gear and additional motor operated valves.

Control of Axial Xenon Oscillations:

Burnable Shims - Al_2O_3-B_4C in Zircaloy-4 tubes

Part-Length Control Rods - Yes, 16 assemblies.

In-Core Instrumentation -

Unborated Water Control: Flow of dilution water to makeup-tank must be initiated by operator. Addition valve can be opened only when control rods are withdrawn to a preset position and timing device to limit integrated flow has been set. Dilution water is added at low rates. Flow of dilution water is automatically stopped by the timer. During dilution, warning lights show on the control console. These factors preclude a serious accident.

Long-Term Cooling - Internal or External Systems: Accomplished by continued recirculation of borated water that collects in the sump when there has been a pipe break. For shut down, same system, Decay Heat Removal System, can circulate coolant and cool it in decay heat removal heat exchangers.

Reactor: Arkansas One, #1

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A 190 ft tower measures windspeed, direction, temperatures, and precipitation. Sensor outputs are recorded. Data from this tower and a lower tower has been collected for over 2 years. Two triaxial strong-motion accelerographs will be mounted on the outside surface of the reactor building wall.

Plant Operating Mode: Load Following.

Site Features: Plant is located on a peninsula jutting out into the waters of Dardanelle Reservoir on the Arkansas River. The site consists of 1100 acres with the immediate plant site being flat (site grade 353 ft MSL) and surrounding area being hilly and mostly wooded. The Dardanelle Reservoir covers 37,000 acres and is owned by the U.S. Government. About 3700 people live in a 5 mile radius of the plant. I-40 runs by about 1 1/2 miles from the site.

Turbine Orientation: Ejected turbine blades could strike containment. Centerlines are 184 ft apart.

Emergency Plans: A plan is being developed which will cover fires, injury and illness, radiation and contamination accidents and other conditions that may arise from nuclear or non-nuclear accidents. Outside agencies such as State Police, local fire departments, State Welfare Department, and others will be directed by the State Department of Health to control off-site emergencies.

Environmental Monitoring Plans: First objective is to determine existing levels of background radioactivity before radioactive materials are delivered to site. This work will start one year before fuel delivery. During this preoperational program, procedures will be established. The second objective is to determine the effect of plant releases. Samples will be taken of the air environment, water, and land environments. The program will be flexible to allow for needed changes.

Radwaste Treatment: Liquid wastes are collected, processed, and reprocessed if necessary and then released to the discharge canal at a controlled rate. Gaseous wastes are diluted and discharged through HEPA filters to the station vent, or if high in activity, they are diverted to holdup tanks for decay and then released through filters. Solid wastes are collected, prepared for offsite disposal and stored until a suitable shipment is on hand.

Stack Height - Could not determine.

Waste Heat System: A once-through cooling system is used taking water from the Dardanelle Reservoir. About 765,000 gpm is used for unit #1. The #2 unit adjacent to #1 will use a cooling tower for heat rejection.

UTILITY Arkansas Power & Light Co.

REACTOR NAME Arkansas Nuclear One, Unit 1

THERMAL OUTPUT, MWt 2568

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-313

NEARBY BODY OF WATER Dardanelle Reservoir of the Arkansas River

NORMAL LEVEL 338' (MSL)

MAX PROB FLOOD LEVEL 361' (MSL)

SIZE OF SITE 1100 ACRES

SITE GRADE ELEVATION 353' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 678 (1967) IN 5 MI RAD 3738 (1967)

NEAREST CITY OF 50,000 POPULATION Little Rock, Arkansas

DISTANCE FROM SITE 57 MILES POPULATION 136,000 (1969)

LAND USE IN 5 MILE RADIUS Wooded

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once Through

WATER TAKEN FROM Dardanelle Reservoir FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

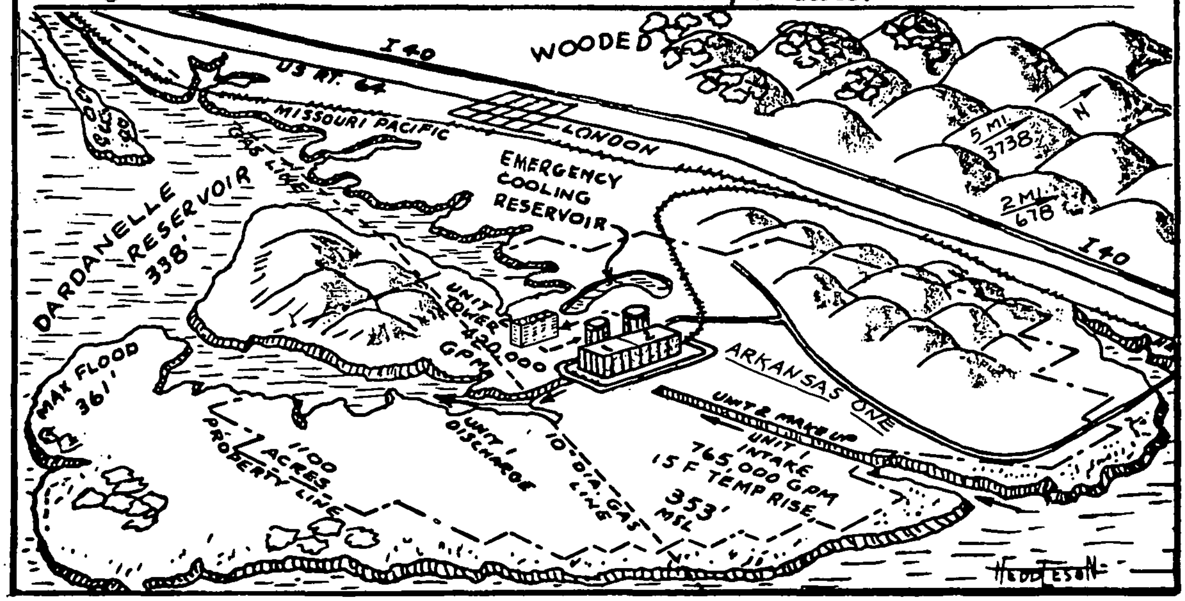
RIVER FLOW 40,000 (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 765,000 (gpm) TEMPERATURE RISE 15 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS Unit 2 has cooling towers

OTHER INFORMATION Cooling water from unit 1 is discharged back into reservoir through an 80 acre cove. The Reservoir size is 37,000 acres.



NUCLEAR SAFETY INFORMATION CENTER

DONALD C. COOK, 50-315 & 50-316 (PWR) Page 1

Project Name: Donald C. Cook Nuclear Plant 1 & 2
Location: Berrien Co., Michigan
Owner: Indiana & Michigan Electric Co.
NSS Vendor: Westinghouse

Reactor: Cook
A-E: American Electric Power
Vessel Vendor: Westinghouse
Docket No.: 50-315, 50-316
Containment Constructor: AEP

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3250	H_2O/U, Cold	4.09
Electrical Output, MWe	1090	Avg 1st-Cycle Burnup, MWD/MTU	14,000
Total Heat Output for Safety Design, MWt	3391	First Core Avg Burnup, MWD/MTU	21,800 (T 1.2-1) 33,500(p3.2.3-24)
Total Heat Output, Btu/hr	$11,090 \times 10^6$	Maximum Burnup, MWD/MTU	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	2.25
DNBR, Nominal	1.97	Region-2 Enrichment, %	2.80
Total Flow rate, lb/hr	135.6×10^6	Region-3 Enrichment, %	3.30
Eff Flowrate for Heat Trans lb/hr	129.5×10^6	k_{eff}, Cold, No Power, Clean	1.183
Eff Flow Area for Heat Trans, ft^2	51.4	k_{eff}, Hot, Full Power Xe and Sm	1.092
Avg Vel Along Fuel Rods, ft/sec	15.5	Total Rod Worth, %	BOL 8.15 EOL 7.96
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.5×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1408
Nominal Core Inlet Temp, °F	536.3	Shutdown Boron, No Rods, Clean, Hot, ppm	1265
Avg Rise in Core, °F	65.7	Boron Worth, Hot, % Δk/k/ppm	1% / 85 ppm
Nom Hot Channel Outlet Temp, °F	667.5	Boron Worth, Cold, % Δk/k/ppm	1%/70 ppm
Avg Film Coeff, Btu/hr ft^2, °F	5850	Full Power Moderator Temp Coeff, Δk/k/°F	$(-0.3 \text{ to } -3.2) \times 10^{-4}$
Avg Film Temp Diff, °F	35.4	Moderator Press Coeff, Δk/k/psi	$(+0.3 \text{ to } +4.0) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff Δk/k/% Void	$(-0.1 \text{ to } -0.8) \times 10^{-5}$
Avg Heat Flux, Btu/hr ft^2	207,900	Doppler Coefficient, Δk/k/°F	$(-1.0 \text{ to } -1.7) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	579,600	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	6.7	Burnable Poisons, Type and Form	Borosilicate in SST tubes
Max Thermal Output, kw/ft	18.8	Number of Control Rods 53 X 20	1060
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 8 X 20	160
No. Coolant Loops	4		

Data from FSAR

Compiled By: Fred Heddleson
Date: April 1971

Reactor: Cook

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.38	Design Winds in mph:	
Low Population Zone Dist., Mi.	2.0	At 0 - 50 ft elev	90 sustained
Metropolis / Distance / Population		50 - 150 ft	115 "
Design Basis Earthquake Accel., g	0.20	150 - 400 ft	145 "
Operating Basis Earthquake Accel., G	0.10	Tornado 300 mph tang. + 60 trans.	
Earthquake Vertical Shock, % of Horizontal	67	ΔP = 3 psi/ 3 sec	

Is intent of 70 Design Criteria satisfied? Yes, Sect. 1.4 states that "plant has been designed to comply with applicant's understanding of the intent of criteria."

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press., psig	12	Calculated Max Internal Press, psig	12
Max Leak Rate at Design Press, %/day	0.25		

Type of Construction: Ice condenser containment is a domed, steel-lined, reinforced concrete cylinder anchored to a reinforced concrete foundation slab. Interior divided into 3 compartments - the lower or reactor compartment, the ice condenser compartment, and the upper compartment which accommodates air displaced from the other two in case of accident.

Design Basis: Designed to withstand the internal pressures and temperatures accompanying a LOCA with leakage limited to the design value given above. Structure designed to maintain full integrity during earthquakes or tornados. The ice condenser design intended to hold LOCA induced temp and pressure to lower levels.

Vacuum Relief Capability: Designed for 2 psi vacuum.

Post-Construction Testing: Will be pressure tested at 115 percent of design pressure for one hour. Leakage rate test will be run at 12 psig and periodically, thereafter.

Penetrations: Designed with double seals (p 1.4-15)

Weld Channels: All containment welds are backed by a steel channel (p 1.4-15)

Reactor: Cook

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Primary function is to spray water into the containment space in event of LOCA, to limit pressure buildup. Second purpose is to remove iodine isotopes from the atmosphere. Two independent systems are provided, each containing a pump, spray headers in upper and lower compartment delivering 2000 gpm to upper and 900 gpm to lower.

Containment Cooling: Each compartment has its own system maintaining temp below 120 F in lower compartment and below 100 F in the upper compartment. Upper compartment has 4 fan-coil units each handling 25,000 cfm. The lower compartment has 4 units each rated 72,000 cfm. Other booster fans help to cool lower compartment.

Containment Isolation System: Incorporates valves and controls on piping systems penetrating containment. These valves provide two barriers between containment atmosphere and the environment. System designed so failure of one valve to close will not prevent isolation, and no manual operation is required for immediate isolation. Automatic isolation is initiated by a containment isolation signal.

Containment Air Filtration: Two 8000 cfm fan-filter units remove air and pass it through HEPA and charcoal filters. Auxiliary charcoal filters are available if activity level is high.

Penetration Room: No reference found

Organic-Iodide Filter: None mentioned

Hydrogen Recombiner: Hydrogen pocketing is prevented by drawing air out of spaces where hydrogen buildup could occur.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks each containing 6400 gallons of borated water under nitrogen gas pressure will automatically force their contents into each of 4 cold legs of reactor when coolant system pressure drops below 600 psig. Three of units can adequately flood the core to prevent fuel melting.

High-head Safety Injection: Two charging pumps inject borated water into the cold legs when pressure first begins to drop. Suction is taken from the refueling water storage tank, however concentrated boric acid is injected from another tank. Pumps are rated 150 gpm at 2800 psig.

Low-head Safety Injection: Two pumps each rated at 4000 gpm at 170 psig flood the core when pressure drops below 170 psig. Suction is first taken from the refueling water storage tank. When water in this tank is exhausted, the recirculation phase starts and water is then pumped from the containment sump.

Reactor: Cook

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Containment compartment is monitored for air activeity and humidity which will indicate leakage. Basic criteria is detection of change from normal conditions including air particulate activity, radiogas activity, humidity, and in addition liquid inventory in the sump which indicates gross leakage.

Failed-Fuel-Detection Systems: Currently performed by periodic analysis of coolant samples for activity. A research program is underway at Ginna to evaluate instrumentation for prompt detection of fuel failure using delayed neutrons.

Emergency Power: Two diesel-generator sets are available for each reactor unit. Each generator has sufficient capacity to operate all equipment necessary for one unit safety features following LOCA.

Control of Axial Xenon Oscillations:

Burnable Shims - Borosilicate in SST rods. Rods will be fixed in first core to reduce concentrations of boric acid required.

Part-Length Control Rods - 8 assemblies can be inserted into the core to control axial power distribution.

In-Core Instrumentation - Fixed in-core neutron detectors will be used for monitoring power distribution in the core.

Unborated Water Control: The Chemical and Volume Control System is designed to limit, even under various postulated failure modes, the potential rate of dilution to a value which, after indication through alarms and instrumentation, provides the operator sufficient time to correct the situation in a safe and orderly manner.

Long-Term Cooling - Internal or External Systems: Injection pumps taking suction from the containment sump can perform long-term cooling by using the residual heat removal heat exchangers to remove heat from the circulated water.

F. MISCELLANEOUS	Reactor: Cook
Windspeed, Direction Recorders, and Seismographs: A 200 ft high tower and meteorological station was installed on site in 1966 and has been recording data since then. Seismographs not mentioned.	
Plant Operating Mode: Load following.	
Site Features: Plant is located on a 650 acre site on the eastern shore of Lake Michigan 11 mi. SW of Benton Harbor. Site grade is 608 which is about 20 ft above max. flooding. Populations expected in 1980 will be 1100 in 2 mi radius and 8700 in 5 mi radius. Land use is mostly agricultural. The site is rolling sand dunes. Interstate 94 has right-of-way through the eastern side of the site	
Turbine Orientation: Ejected turbine blades could strike containment structure. Center lines are approximately 250 ft apart.	
Emergency Plans: Procedures provide necessary prearrangement and organization to deal with any foreseeable emergency. Plant is designed so no credible nuclear accident would create undue hazard to the public. However, organization for emergency action is prearranged. All personnel are thoroughly familiar with the emergency plan, and practice drills are held for training.	
Environmental Monitoring Plans: An environmental radiation monitoring program formulated for the site and the surrounding area has been initiated and data collection will start prior to plant operation. The intensity of the survey and the number and type of samples collected depends on the magnitude of radioactive release from the plant.	
Radwaste Treatment: Liquid wastes are collected, monitored, and condensed or demineralized as necessary. Treated water from demin. or evaporator will be recycled for plant use or will be discharged via the condenser water discharge. Solid wastes, including evaporator concentrates and spent demin. resins are drummed and shipped off-site for disposal. Gaseous wastes are collected and held for radioactive decay before release thru plant vent. Discharges of all wastes to the environment is controlled to keep off-site dose within 10CFR20 limits. Stack Height - Plant vent located on top of containment structure.	
Waste Heat System: A once through system is used taking water from Lake Michigan thru 3 cribs 2250 ft from shore in 25 ft deep water. Discharge back to lake is 1250 ft from shore line. A total of 1,600,000 gpm is circulated for both units (about 800,000 gpm for each) with a temperature rise of 21F. About 8,000 gpm is used for auxiliaries.	

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Donald C. Cook Nuclear Nuclear Plant, Units 1 & 2
THERMAL OUTPUT, MWt 3250	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-315 50-316

NEARBY BODY OF WATER Lake Michigan (eastern shore) 11 miles SW Benton Harbor

NORMAL LEVEL 580' (MSL)

MAX PROB FLOOD LEVEL 591' (MSL)

SIZE OF SITE 650 ACRES

SITE GRADE ELEVATION 608' (MSL)

TOPOGRAPHY OF SITE A strip of sand dunes line the beach - Rolling

OF SURROUNDING AREA (5 MI RAD) Flat to Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 1096 (1980) IN 5 MI RAD 8671 (1980)

NEAREST CITY OF 50,000 POPULATION South Bend, Indiana

DISTANCE FROM SITE 26 MILES POPULATION 133,770 (1965)

LAND USE IN 5 MILE RADIUS Agricultural & Wooded

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through

WATER TAKEN FROM Lake Michigan FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG 34 F SUMMER AVG 74 F AVG 54 F

RIVER FLOW NA (cfs) Avg. **QUANTITY OF MAKEUP WATER * 8000 (gpm)

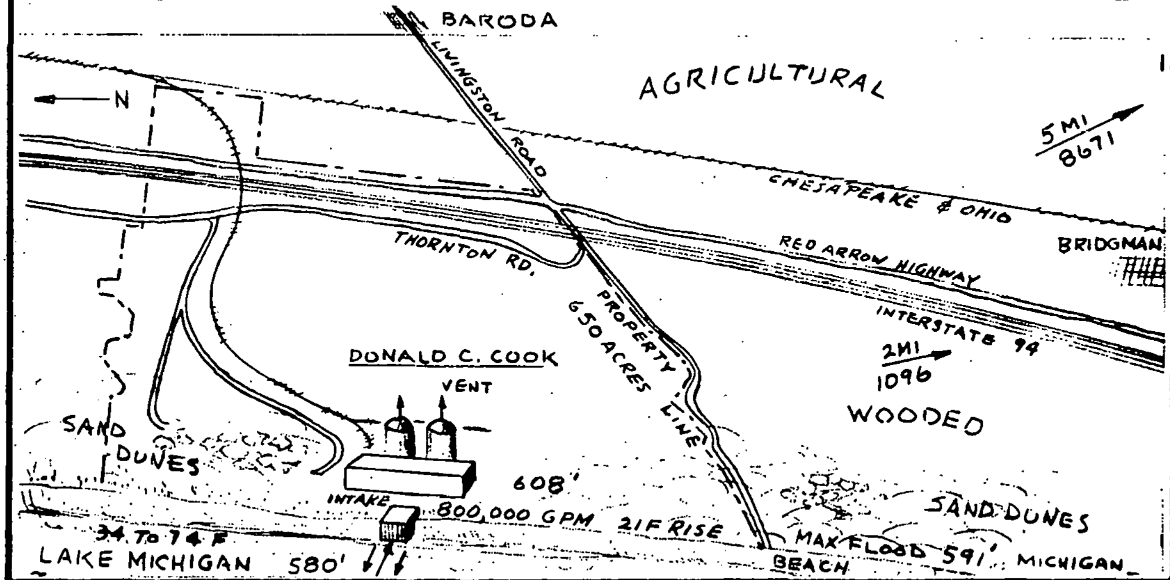
**TOTAL FLOW THROUGH CONDENSERS 800,000 (gpm) TEMPERATURE RISE 21 F

**HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr)

* Misc uses
** Per Unit

COOLING TOWERS None

OTHER INFORMATION Intake thru 3 cribs 2250' from shore in 25' deep water, and dischar is 1250' from shoreline. Three 16' dia pipes used for intake (both units)



CALVERT CLIFFS, 50-317 & 50-318 (PWR) Page 1

Project Name: Calvert Cliffs Nuclear Power Plant Units 1 and 2
Location: Calvert Co., Maryland
Owner: Baltimore Gas & Electric
NSS Vendor: Combustion Engineering

Reactor: Calvert Cliffs
A-E: Bechtel
Vessel Vendor: Combustion Engineering
Docket No.: 50-317, 50-318
Containment Constructor: Not specified.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2570	H_2O/U, Cold	1.63
Electrical Output, MWe	875	Avg 1st-Cycle Burnup, MWD/MTU	13,775
Total Heat Output for Safety Design, MWt	2700	First Core Avg Burnup, MWD/MTU	22,550
Total Heat Output, Btu/hr	8737×10^6	Maximum Burnup, MWD/MTU	50,000
System Pressure, psia	2200	Region-1 Enrichment, %	2.09
DNBR, Nominal	2.18	Region-2 Enrichment, %	2.51
Total Flow rate, lb/hr	122×10^6	Region-3 Enrichment, %	2.99
Eff Flowrate for Heat Trans lb/hr	117.5×10^6	k_{eff}, Cold, No Power, Clean	1.169
Eff Flow Area for Heat Trans, ft^2	53.2	k_{eff}, Hot, Full Power Xe and Sm	1.081
Avg Vel Along Fuel Rods, ft/sec	13.6	Total Rod Worth, %	11.3 Hot 8.5 Cold
Avg Mass Velocity lb/hr-ft^2	2.20×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	985
Nominal Core Inlet Temp, °F	543.4	Shutdown Boron, No Rods, Clean, Hot, ppm	991
Avg Rise in Core, °F	54	Boron Worth, Hot, % Δk/k/ppm	87
Nom Hot Channel Outlet Temp, °F	643	Boron Worth, Cold, % Δk/k/ppm	70
Avg Film Coeff, Btu/hr ft^2, °F	5240	Full Power Moderator Temp Coeff, Δk/k/°F	$(-0.32 \text{ to } -1.96) \times 10^{-4}$
Avg Film Temp Diff, °F	33.5	Moderator Press Coeff, Δk/k/psi	$(+0.65 \text{ to } +2.39) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	48,400	Moderator Void Coeff Δk/k/% Void	$(-0.41 \text{ to } -1.43) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	176,000	Doppler Coefficient, Δk/k/°F	$(-1.46 \text{ to } -1.02) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	527,900	Shutdown Margin, Hot One Rod Stuck, % Δk/k	2.0 to 2.4
Avg Thermal Output, kw/ft	5.94	Burnable Poisons, Type and Form	Boron Carbide in Alumina Pellets
Max Thermal Output, kw/ft	17.8	Number of Control Rods 77 × 5	385
Max Clad Surface Temp, °F	657	Number of Part Length Rods (PLR) 8 × 5	40
No. Coolant Loops	3		

Data from FSAR

Compiled By: Fred Heddleson
Date: April 1971

Reactor: Calvert Cliffs

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.67 rad.	Design Winds in mph:	
Low Population Zone Dist., Mi.	---	At 0 - 50 ft elev	Could not find values.
Metropolis / Distance / Population Washington, D.C. / 45 mi / ---		50 - 150 ft	
Design Basis Earthquake Accel., g	0.15	150 - 400 ft	
Operating Basis Earthquake Accel., G	0.08	Tornado	
Earthquake Vertical Shock, % of Horizontal	67	ΔP = psi/ sec	

Is intent of 70 Design Criteria satisfied? Yes. Appendix 1A states that "Design and construction has proceeded based upon the intent of these criteria."

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	50	Calculated Max Internal Press, psig	48.5
Max Leak Rate at Design Press, %/day	0.33		

Type of Construction: Post-tensioned reinforced concrete cylinder and dome connected to and supported by a massive reinforced concrete foundation with the entire interior lined with 1/4-in. thick welded steel plate.

Design Basis: Designed to limit release of radioactivity in case of LOCA. Design based upon operation of Engineered Safety Features to help mitigate an accident.

Vacuum Relief Capability: Designed for 3 psi vacuum. Vacuum breakers are not provided.

Post-Construction Testing: Will be pressure tested at 115% of design pressure. Leakage rate tests will be run at 50% and 100% of design pressure. No leakage monitoring system is provided.

Penetrations: All penetrations are single sealed and not practical for individual testing.

Weld Channels: Not used. Welds will be tested with a small vacuum box.

Reactor: Calvert Cliffs

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Removes heat by spraying cool borated water through the containment atmosphere. Heat is transferred to the component cooling system through the shutdown heat exchangers. Two pumps supply 1400 gpm at 160 psig.

Containment Cooling: Four fan-coil cooling units use service water in coils to cool containment air. Three units are used normally with one in standby. Max temp is limited to 120F. A 100 hp motor circulates 110,000 cfm for 2.27×10^6 Btu/hr heat removal.

Containment Isolation System: Leakage through all fluid penetrations not serving engineered safety features is minimized by double barrier isolation valves. Isolation occurs on a signal of 4 psig in containment structure. Valves which isolate penetrations directly open to the containment structure, such as the purge valves and sump drain valves, will also be automatically closed on an isolation signal.

Containment Air Filtration: Air passed through HEPA filters and charcoal filters.

Penetration Room: Yes, there is, with an appropriate ventilation system.

Organic-Iodide Filter: None mentioned.

Hydrogen Recombiner: No reference found.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks each holding 7500 gallons will dump borated water into each of the 4 reactor vessel inlet pipes. Operation is automatic when pressure drops below 200 psig.

High-head Safety Injection: Three pumps can each deliver 350 gpm at 1750 psig to make up water loss through small leaks. Suction is first taken from refueling water tank (borated) and when this supply is about exhausted, from the containment sump.

Low-head Safety Injection: Two pumps each with capacity of 3000 gpm at 500 psig. These pumps can reflood the core when pressure in system has dropped to their operating limits. Suction is first taken from refueling water storage tank (borated).

Reactor: Calverts Cliffs

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Detected by increased pressure and temperature in containment, monitoring containment sump, increased airborne activity, monitoring service-water temperatures, pressurizer level, and sensors on relief valves. Leakage at reactor vessel head closure can be indicated by pressure rise between double o-ring seals.

Failed-Fuel-Detection Systems: Detectors will be used which allow less than 5 minutes time for detection of fission products after fuel rod rupture.

Emergency Power: Three 2500 kW diesel-generator sets provide independent sources of emergency power. Two generators have capacity to operate all essential auxiliaries for one reactor under LOCA conditions and safely shut down the other reactor. Each unit has a day tank good for about 20 hrs of operation and a storage tank has fuel capacity for 16 days with all three units operating at full power.

Control of Axial Xenon Oscillations:

Burnable Shims - Yes

Part-Length Control Rods - Yes

In-Core Instrumentation - Yes, for evaluating gross core power distribution.

Unborated Water Control: The probability of erroneous dilution is very small because of controls and procedures provided. If dilution should occur, alarms will alert operator so there is plenty of time for corrective action.

Long-Term Cooling - Internal or External Systems: Shutdown cooling heat-exchangers in operation with containment spray pumps provide long term cooling capabilities.

Reactor: Calverts Cliffs

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Three inland stations were set up as well as a station on Calvert Cliffs. Wind data and temperatures were obtained. Seismographs not mentioned.

Plant Operating Mode: Load Following

Site Features: Located on west side of Chesapeake Bay on 1135 acres along Calvert Cliffs. Topography is rolling. Site grade is 45', well above any flood hazard. The surrounding land is used mostly for agriculture and remaining land is wooded. With a 2-mi radius there are 1461 inhabitants; in 5-mi radius there are 4376. Calvert Cliffs State Park is 2 1/2 miles south of plant site.

Turbine Orientation: Ejected turbine blades could strike containment. Reactor and turbine centerlines are about 230 ft apart.

Emergency Plans: Describes immediate and followup action to be taken by plant personnel to minimize exposure of persons to radiation from an accidental release of radioactivity. Organization and responsibilities are delineated. State Police, local sheriff, Coast Guard, AEC, etc., will be notified and asked for assistance as needed.

Environmental Monitoring Plans: Objectives of program are to establish preoperational levels of radioactivity in the plant environment to verify adequacy of control of radioactive releases. Sampling is being conducted to determine these values. The factors considered in development of this program include review of plant environment, review of the rad waste systems, evaluation of nuclides anticipated in normal discharges, and those vectors in the environment that could transport radioactivity from its source to man.

Radwaste Treatment: Liquid wastes are collected and processed by degassing, ion exchangers, and evaporators. If level is then low enough, the effluent will be released to the cooling tower blowdown discharge to the river. Max annual discharge is 1375 curies. Gaseous waste is collected, held for decay and released through the plant vent when activity is low enough. Max annual discharge is 8215 curies/yr. Solid wastes are shipped offsite for disposal.

Stack Height - Not given.

Waste Heat System: A once-through cooling system will be used taking water from Chesapeak Bay. Intake will draw in deep, cool water from 560 feet out in bay. Water will be discharged 850 ft from shore. Condenser cooling water will be 1,200,000 gpm per unit having 10F temp rise which will hold discharge temp below 90F.

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Calvert Cliffs Nuclear Power Plant Units 1 & 2
THERMAL OUTPUT, MWt 2570	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-317 50-318

NEARBY BODY OF WATER Chesapeake Bay (west side) NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 28' (MSL)

SIZE OF SITE 1135 ACRES SITE GRADE ELEVATION 45' (MSL)

TOPOGRAPHY OF SITE Rolling (from sea level to 137')

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 1461 (1965) IN 5 MI RAD 4376 (1965)

NEAREST CITY OF 50,000 POPULATION Washington, D.C.

DISTANCE FROM SITE 45 MILES POPULATION 764,000 (1969)

LAND USE IN 5 MILE RADIUS Agricultural and Wooded

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through

WATER TAKEN FROM Chesapeake Bay FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG 85 F AVG - F

RIVER FLOW NA (cfs) avg. **QUANTITY OF MAKEUP WATER * 62,000 (gpm)

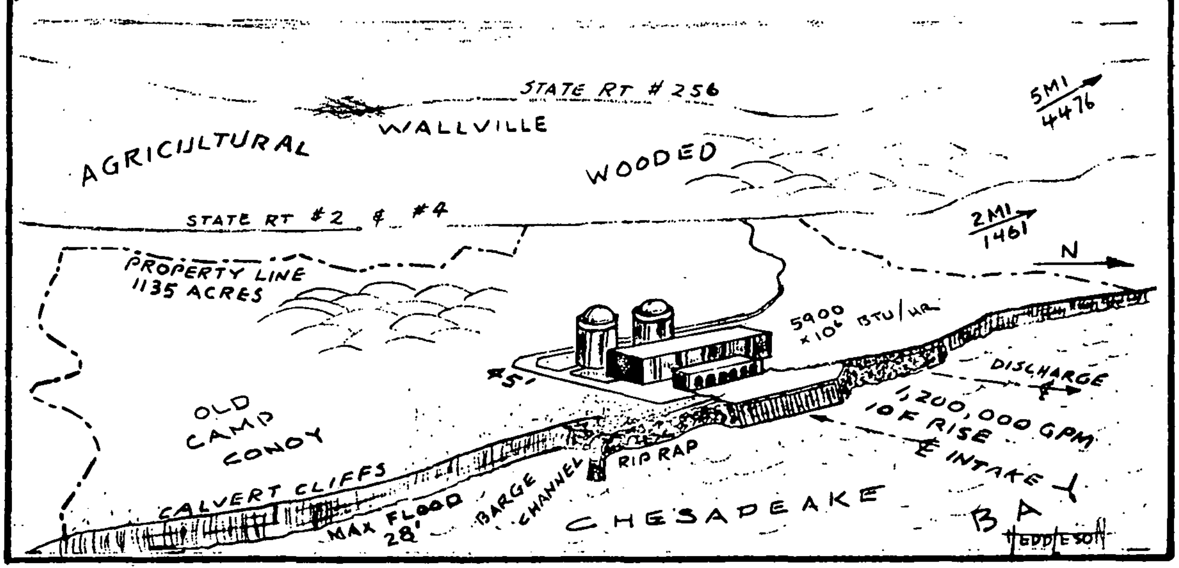
**TOTAL FLOW THROUGH CONDENSERS 1,200,000 (gpm) TEMPERATURE RISE 10 F

**HEAT REMOVAL CAPACITY OF CONDENSERS 5900×10^6 (Btu/hr) * Misc. heat exchangers

** Per Unit

COOLING TOWERS None

OTHER INFORMATION Discharge temp will be less than 90F even in summer. Discharge is 850 ft out in Bay. Intake draws deep cool water from 560 ft out.



BELL STATION, 50-319 (BWR) Page 1

Project Name: Bell Station
Reactor: Bell
A-E: United Engineers & Constructors
Location: Cayugalake, N. Y.
Vessel Vendor: Not specified
Owner: N.Y. State Electric & Gas Corp
Docket No.: 50-319
NSS Vendor: General Electric
Containment Constructor: UE&C

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2436	H_2O/UO_2 Volume Ratio	2.41
Electrical Output, MWe	866	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output for Safety Design, MWt	2550	Moderator Temp Coef Hot, No Voids	-17.0×10^{-5}
Steam Flow Rate, lb/hr	10.48×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	75.5×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1005	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	48,451	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.30	Doppler Coefficient, Operating	$\leq 1.3 \times 10^{-5}$
Maximum Heat Flux, Btu/hr-ft^2	428,308	Initial Enrichment, %	2.23 w/o
Average Heat Flux, Btu/hr-ft^2	164,734	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	36.9
Average Fuel Rod Surface Temp °F	558	k_{eff}, All Rods In	<0.96
MCHFR	>1.9	k_{eff}, Max Rod Out	<0.99
Total Peaking Factor	2.60	Control Rod Worth, %	---
Avg Power Density, Kw/ℓ	---	Curtain Worth, %	---
		Burnable Poisons, Type and Form 248	Curtains-flat SST w/Nat Boron
		Number of Control Rods 137	137 Cruciform Assembly
		Number of Part-Length Rods (PLR)	None mentioned

Compiled by: Fred Heddleson
Date: April 1971

TX-4377
(8-70)

Reactor: Bell

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.53 rad.	Design Winds in mph:	
Low Population Zone Dist., Mi.	5.5	At 0 - 50 ft	80 mph sustained
Metropolis / Distance / Population: Syracuse, N.Y. / 40 / 216,000 1969		50 - 150 ft	
Design Basis Earthquake Accel., g	0.10	150 - 400 ft	
Operating Basis Earthquake Accel., g	0.05	Tornado 300 mph tang + 60 trans. ΔP = 3 psi/ - sec	
Earthquake Vertical Shock, % of Horizontal	---	Is intent of 70 design criteria Satisfied?	Yes

Peak Fuel Enthalpy on Rod Drop: 280 cal/gm

Recirculation Pumping System & MCHFR: ---

Protective System: This system, independent from process control, shall be provided to automatically initiate appropriate action whenever plant conditions approach pre-established limits.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	62	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	62	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	46	Second Ctmt Leak Rate, %/day	100

Type of Construction: Drywell is a steel-lined reinforced concrete pressure vessel with vertical right cylinders and truncated cones shaped similar to the conventional steel containment. Pressure suppression chamber is a steel-lined reinforced concrete pressure vessel equivalent to a torus with the minor diameter approximately a square in cross-section.

Design Basis: Designed to limit release of fission products in event of LOCA to conformance with 10CFR100. Also must be capable of holding pressures and temperatures following LOCA without loss of containment integrity.

Vacuum Relief Capability: Designed for 2 psi vacuum with capability for air passage from reactor building to suppression chamber and from suppression chamber to drywell through vacuum breakers.

Post-Construction Testing: Pneumatic tests will be run at 115% of design pressure and leakage rate tests will be run.

Penetrations: Electrical penetrations are double sealed and testable. Other penetrations are not detailed.

Reactor: Bell

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Provided to circulate water from pressure suppression pool to the reactor vessel. Water is distributed to reactor core by spray headers mounted inside the plenum above the core to cool the core in event of LOCA. This system, together with core shroud arrangement, provides for core-reflooding after LOCA.

Auto-Depressurization System: Relief valves function as an automatic depressurizer, under certain conditions, following LOCA. An additional function of these valves will be to open and remain open when signalled to do so, following LOCA.

Residual-Heat-Removal System (RHRS): Consists of 3 subsystems, namely: 1) Low Press Coolant Injection (see description below); 2) Containment Spray Cooling System to limit suppression pool temp to 170F. This system circulates suppression pool water through RHRS heat exchangers for cooling, and spray cooling of containment atmosphere, and 3) Shutdown Cooling System to remove decay heat during normal shutdown.

High-Pressure Coolant-Injection System: Assures adequate inventory in reactor vessel for a spectrum of LOCA smaller than those for which cooling is provided by core spray cooling system and reactor core low-pressure coolant injection system. System designed to function without auxiliary electrical power supplies other than station battery system.

Low-Pressure Coolant-Injection System: Three of 4 pumps will reflood core to 2/3 of height. Only 1 is necessary to maintain level. Can reflood for breaks 0.2 sq ft for liquid or 0.18 sq ft for steam.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: There is a cross-connection between one RHR service water pump and RHR piping permitting introduction of water from Cayuga Lake into primary containment.

Main-Steam-Line Flow Restrictors: A venturi-type restrictor is located in each main line to limit steam flow when a line breaks.

Control-Rod Velocity Limiters: A static device designed to limit rod velocity in case of a free fall. Rod velocity for scram motion is not affected.

Control-Rod-Drive-Housing Supports: If housing fails, supports limit the distance that the housing and rod can fall from the reactor.

Standby Liquid-Control System: If rods cannot be inserted, operator can inject boron to shut down reactor.

Reactor: Bell

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: Temp will be held below 150F. An inert atmosphere can be maintained to help control hydrogen-oxygen reaction following LOCA.

Reactor Core Isolation Cooling System (RCICS): Provided to remove decay heat when feedwater system capability is lost and other normal heat removal systems requiring auxiliary power for operation are not available. System consists of primary relief valves which pass steam directly to suppression chamber and a steam turbine-driven makeup pump which supplies makeup from the condensate storage tank. Steam to drive the turbine comes from the main steam line header and exhausts to the suppression chamber pool.

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: No reference except in Amendment 1 referring to sump monitoring.

Failed-Fuel Detection Systems: No reference found.

Emergency Power: Three diesel-generator sets are provided, any 2 of which can supply all required loads essential for safe shutdown of reactor after DBA. A day tank will supply each unit with fuel for 8 hours operation. A common fuel tank has fuel for 7 days operation at required load.

Rod-Block Monitor: No reference found.

Rod Worth Minimizer: Monitors operator rod selection patterns and reinforces good procedures. Thus control rods worths are limited during startup and low power operation.

Reactor: Bell

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: No references found.

Plant Operating Mode: ---

Site Features: Plant is located on the east bank of Cayuga Lake about 15 miles from the lower tip of the lake. The plant site consists of 900 acres having an existing fossil fuel power plant (Milliken Station) on the site. The land rises from the lake (382' MSL normal pool) with site grade ranging from 395' to 435'. One mile back elevations are about 500'. Land use is agricultural. Population in 2 mile radius is 432 and in 5 mile radius 5516.

Turbine Orientation: ---

Emergency Plans: Emergencies classed as Radiation type or Non-radiation type. Employees will be trained and drilled in handling these emergencies. Local and state agencies will be contacted for assistance as needed.

Environmental Monitoring Plans: Monitoring program will be started about 2 years before startup as follows: Atmospheric monitoring, surveillance of water and sediments, foods, biota, milk, and soil. Measurements of gross beta-gamma and isotopes of SR-90, CS-137, etc. will be made.

Radwaste Treatment: After treatment, liquid waste is released to the circulating water system discharge canal. Gaseous waste is collected and held for decay until it can be released safely from the vent stack. Solid wastes are collected, treated as required, and packaged for shipment to off-site disposal areas. All operations are conducted to conform with 10CFR20.

Stack Height - 330 ft.

Waste Heat System: A once-through system is used for condenser cooling using water from Lake Cayuga. Three pumps send 555,000 gpm through condensers with a temperature rise of 20F. Water intake is about 100 ft out in lake taking water from near the bottom. Water is returned to the lake surface at about surface temperature.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Bell Station

THERMAL OUTPUT, MWt 2436

TYPE OF NUCLEAR STEAM SYSTEM BWR

DOCKET NO. 50-319

NEARBY BODY OF WATER Lake Cayuga

NORMAL LEVEL 382' (MSL)

MAX PROB FLOOD LEVEL 390' (MSL)

SIZE OF SITE 900 ACRES

SITE GRADE ELEVATION 395' (MSL) 435'

TOPOGRAPHY OF SITE Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 432 (1960) IN 5 MI RAD 5516 (1960)

NEAREST CITY OF 50,000 POPULATION Syracuse, New York

DISTANCE FROM SITE 40 MILES POPULATION 216,000 (1969)

LAND USE IN 5 MILE RADIUS Agricultural

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through

WATER TAKEN FROM Lake Cayuga FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG 35 F SUMMER AVG 72 F AVG - F

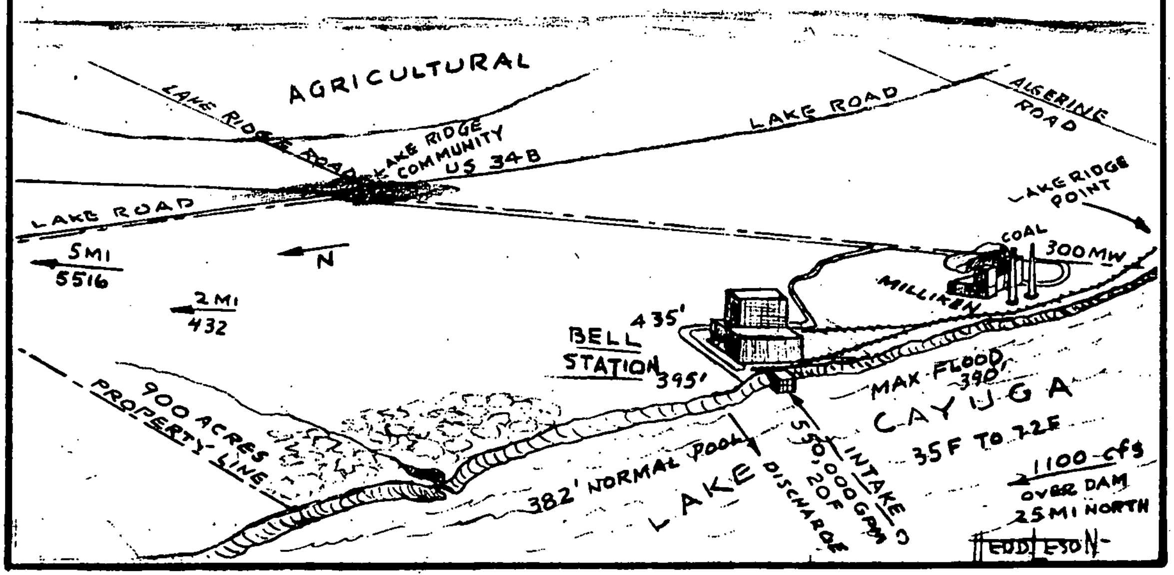
RIVER FLOW 1100 (cfs) over dam *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 555,000 (gpm) TEMPERATURE RISE 20 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS None

OTHER INFORMATION Intake from lake bottom 100 ft out. Water returned by surface discharge at shore line about the temp of surface water. Coal-fired units at site.



NUCLEAR SAFETY INFORMATION CENTER

THREE MILE ISLAND, 50-320 (PWR) Page 1

Project Name: Three Mile Island Nuclear Station Units 1 and 2
Location: Goldsboro, Penn. (Daupin Co.)
Owner: Metropolitan Edison Co.-Unit 1*
NSS Vendor: Babcock & Wilcox
* Jersey Central Power & Light - Unit 2

Reactor: Three Mile Island
A-E: Gilbert Associates - Unit 1**
Vessel Vendor: Babcock & Wilcox
Docket No.: 50-320 (also 50-289)
Containment Constructor: United Engr. & Const.
**Burns & Roe - Unit 2

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2535 - #1 2452 - #2	H_2O/U, Cold	2.85
Electrical Output, MWe	871 - #1 845 - #2	Avg 1st-Cycle Burnup, MWD/MTU	14,250
Total Heat Output for Safety Design, MWt	2568 - #1 2772 - #2	First Core Avg Burnup, MWD/MTU	28,800
Total Heat Output, Btu/hr	8.765×10^6	Maximum Burnup, MWD/MTU	55,000
System Pressure, psia	2200	Region-1 Enrichment, %	2.29 †
DNBR, Nominal	2.0	Region-2 Enrichment, %	2.64 †
Total Flow rate, lb/hr	131.3×10^6	Region-3 Enrichment, %	2.90 †
Eff Flowrate for Heat Trans lb/hr	124.2×10^6	k_{eff}, Cold, No Power, Clean	1.244
Eff Flow Area for Heat Trans, ft^2	49.19	k_{eff}, Hot, Full Power Xe and Sm	1.109
Avg Vel Along Fuel Rods, ft/sec	15.7	Total Rod Worth, %	10.6
Avg Mass Velocity lb/hr-ft^2	†2.53×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1547
Nominal Core Inlet Temp, °F	554	Shutdown Boron, No Rods, Clean, Hot, ppm	1333
Avg Rise in Core, °F	49.3	Boron Worth, Hot, % Δk/k/ppm	1/100
Nom Hot Channel Outlet Temp, °F	647.1	Boron Worth, Cold, % Δk/k/ppm	1/75
Avg Film Coeff, Btu/hr·ft^2, °F	5,000	Full Power Moderator Temp Coeff, Δk/k/°F	$(-0.4 \text{ to } -3.0) \times 10^{-4}$
Avg Film Temp Diff, °F	31	Moderator Press Coeff, Δk/k/psi	$+4.0 \times 10^{-7}$ to $+3 \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	49,734	Moderator Void Coeff Δk/k/% Void	$+1 \times 10^{-4}$ to -3×10^{-3} †
Avg Heat Flux, Btu/hr ft^2	171,470	Doppler Coefficient, Δk/k/°F	$(-1.1 \text{ to } -1.7) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	534,440	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	5.656	Burnable Poisons, Type and Form 1088	$Al_2O_3 - B_4C$ Zircaloy-4
Max Thermal Output, kw/ft	17.63	Number of Control Rods 61 × 16	976
Max Clad Surface Temp, °F	654	Number of Part-Length Rods (PLR)	---
No. Coolant Loops	2	† From PSAR for Unit 2.	

Data are taken from FSAR for Unit 1. Plants are nearly identical. Known differences are shown.

Compiled By: Fred Heddleson
Date: February 1971

Reactor: Three Mile Island

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.38 rad.	Design Winds in mph:	
Low Population Zone Dist., Mi.	2	At 0 - 50 ft elev	80
Metropolis / Harrisburg, Pa. — Distance 10 mi. — Population 73,500		50 - 150 ft	105
Design Basis Earthquake Accel., g	0.12	150 - 400 ft	135
Operating Basis Earthquake Accel., G	0.06	Tornado	300 mph tang.
Earthquake Vertical Shock, % of Horizontal	66	ΔP =	3 psi/ sec

Is intent of 70 Design Criteria satisfied? Yes

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	55 - Unit 1 60 - Unit 2	Calculated Max Internal Press, psig	53.6
Max Leak Rate at Design Press, %/day	0.2		

Type of Construction: Reactor Building has reinforced-concrete cylindrical walls, a flat foundation mat, and a shallow dome roof. The foundation slab is reinforced with mild-steel reinforcing. Cylindrical walls are prestressed with a post-tensioning system in the vertical and horizontal directions. The dome roof is prestressed with a three-way post tensioning system. The inside is lined with a carbon steel liner to ensure leak tightness.

Design Basis: Designed to contain radioactive material which might be released from the core following a LOCA at a maximum leak rate of 0.2%. The prestressed concrete shell ensures that the structure has an elastic response to all loads and that the structure strains within such limits so that the integrity of the liner is not prejudiced.

Vacuum Relief Capability: Designed for 2.5 psig external pressure during normal operation.

Post-Construction Testing: Will be pressure tested at 63.3 psig and tested for determination of leakage rate before operation begins. Leakage rate tests will be run periodically during life of plant.

Penetrations: Electrical penetrations will be continuously pressurized with nitrogen for leak monitoring. Mechanical penetrations have double barriers designed for leakage tests at 63.3 psig and for normal pressurization to 60 psig during operation.

Weld Channels: Provided along seam welds that are inaccessible. Also located on seal welds on the inside face of the liner. All are testable.

Reactor: Three Mile Island

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Designed to furnish cooling to limit post-accident pressure to less than design value, and to reduce containment pressure to near atmospheric pressure in 24 hrs. Sodium thiosulfate (alkaline) in spray removes fission product iodine from containment atmosphere. Suction from borated water storage tank until supply is exhausted, then recirculated from sump. Two pumps each have 1500 gpm capacity at 285 psig.

Containment Cooling: Designed to maintain temp between 60 F and 110 during normal operation (4.3×10^6 Btu/hr cooling, 1.2×10^6 Btu/hr heating) and to remove heat during emergency conditions (LOCA) to hold temp below 281 F and pressure below 53.6 psig (240×10^6 Btu/hr cooling).

Containment Isolation System: Leakage through all fluid penetrations not serving accident consequence limiting systems is minimized by double barriers so that no single failure can result in loss of isolation or intolerable leakage. Isolation valves are installed on pipe penetrations both inside and outside containment. Closure is automatic.

Containment Air Filtration: Supply air filtered (85% eff.) and exhaust air filtered through roughing, HEPA, and charcoal filters before discharge to atmosphere.

Penetration Room: None shown on drawings.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Analyses show that hydrogen concentration generated after LOCA can be adequately limited by using the reactor building purge.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Two tanks each dump 7000 gal. of borated water into reactor cold legs when reactor pressure drops to 600 psig. Tanks are pressurized by nitrogen. System floods core to prevent full damage.

High-head Safety Injection: Injection of borated water from the borated-water storage-tank is initiated when reactor pressure drops to 1500 psig, or a reactor building pressure of 4 psig. This system prevents uncovering the core for small coolant leaks, operating normally as part of the Makeup and Purification System. Three pumps can operate, each with a capacity of 550 gpm at 1500 psig.

Low-head Safety Injection: Decay-Heat Removal System provides this function. Pumps (2) start at 1500 psig reactor pressure or 4 psig reactor building pressure taking suction from the borated water storage tank which provides at least 25 minutes of water supply. Each pump can deliver 3000 gpm at 100 psig.

Reactor: Three Mile Island

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Three main systems are available: (1) Containment sump level sensitive to 670 gal, make up tank coolant level, and pressurizer level sensitive to 31 gal; (2) Cooling coil condensate flow sensitive to 0.3 gpm; and (3) Measurement of containment atmosphere radioactivity.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: Two automatic, fast start-up diesel-generator sets are available; either one with capacity to carry required engineered safeguards load. Units are rated at 300 kW at 0.8 power factor for 2000 hrs and no maintenance. Sufficient fuel is stored for one unit to run at accident power requirements for 7 days.

Control of Axial Xenon Oscillations:

Burnable Shims - Boron added to the coolant.

Part-Length Control Rods - None mentioned.

In-Core Instrumentation - 36 detectors monitor core flux and readout in the control room.

Unborated Water Control: Dilution cycle must be initiated by operator who must preset the desired dilution batch size before dilution will start. Dilution cycle will stop automatically when flow has integrated to the preset batch size. Interlocks on control rods automatically terminate dilution cycle if regulating rod group is inserted into core to the 75% withdrawn position.

Long-Term Cooling - Internal or External Systems: Long term cooling is accomplished by recirculating injected borated water that has collected in the containment sump. The decay heat removal system does this job and can supply up to 6000 gpm with 2 pumps operating at 100 psig.

Reactor: Three Mile Island

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Wind speeds and other meteorological data have been recorded with a 100 ft high tower since 1967. Seismographs not mentioned.

Plant Operating Mode: Load following - matching megawatt generation to unit load demand.

Site Features: Located on Three Mile Island in the Susquehanna River 10 miles SE of Harrisburg, Pa. Site is level with rolling to hilly terrain on both sides of the river. Site grade is 304 ft (MSL) with max probable flood estimated at 303'-6". Land use is mostly agricultural. Olmsted State Airport is 2-1/2 miles from the plant and ∿1 1/2 miles from the extended runway centerline. In a 2 mi radius there was 2700 inhabitants and 28,660 in the 5 mi radius (1969 population).

Turbine Orientation: Ejected turbine blades could strike containment structure.

Emergency Plans: Personnel will be familiar with the emergency plan, and practice drills will be held for training. This plan covers fire, reactor accidents and radiological incidents, and medical treatment of contaminated personnel and co-ordination of off-site activities with state officials. Agencies will be famil-iarized with the Nuclear Station and with their role in an emergency situation.

Environmental Monitoring Plans: A program was started in January 1968 to measure background levels, etc. in well and river water, river sediment, fish, soil, and vegetation. Milk and other human food has been analyzed for radionuclides. A special pre-operational program will be started 15 to 18 months before operation which will be a model for the program to be followed after operation starts.

Radwaste Treatment: Liquid wastes are collected and processed through the evapora-tor and the condensate passed through a demineralizer. Liquid is then reused or released to the river diluted by the cooling tower blow down. Gaseous wastes are collected and compressed for storage and decay. After proper decay, gases are released through the plant vent. Solid wastes are collected, storaged and packaged in DOT approved containers.

Stack Height - Vent on top of reactor bldg - 200 ft above grade.

Waste Heat System: Closed-system cooling will be used with 2 hyperbolic natural draft cooling towers to remove the heat. A smaller mechanical-draft tower will cool the blowdown and other plant effluents which are ∿12,000 gpm. River average flow is 34,000 cfs. There are 6 circulating water pumps with combined capacity of 444,000 gpm.

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Three Mile Island Nuclear Station Units 1 & 2

THERMAL OUTPUT, MWt #1 2535 #2 2452

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-289 50-320

NEARBY BODY OF WATER Susquehanna River

NORMAL LEVEL 277' (MSL)

MAX PROB FLOOD LEVEL 303' (MSL)

SIZE OF SITE 625 ACRES

SITE GRADE ELEVATION 304' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Rolling to Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 2700 (1969) IN 5 MI RAD 28,659 (1969)

NEAREST CITY OF 50,000 POPULATION Harrisburg, Pa.

DISTANCE FROM SITE 10 MILES POPULATION 73,500 (1969)

LAND USE IN 5 MILE RADIUS Agricultural

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed Loop

WATER TAKEN FROM Susquehanna River FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG 36 F SUMMER AVG 75 F AVG 56 F

RIVER FLOW 34,000 (cfs) avg. *QUANTITY OF MAKEUP WATER 12,000 (gpm)

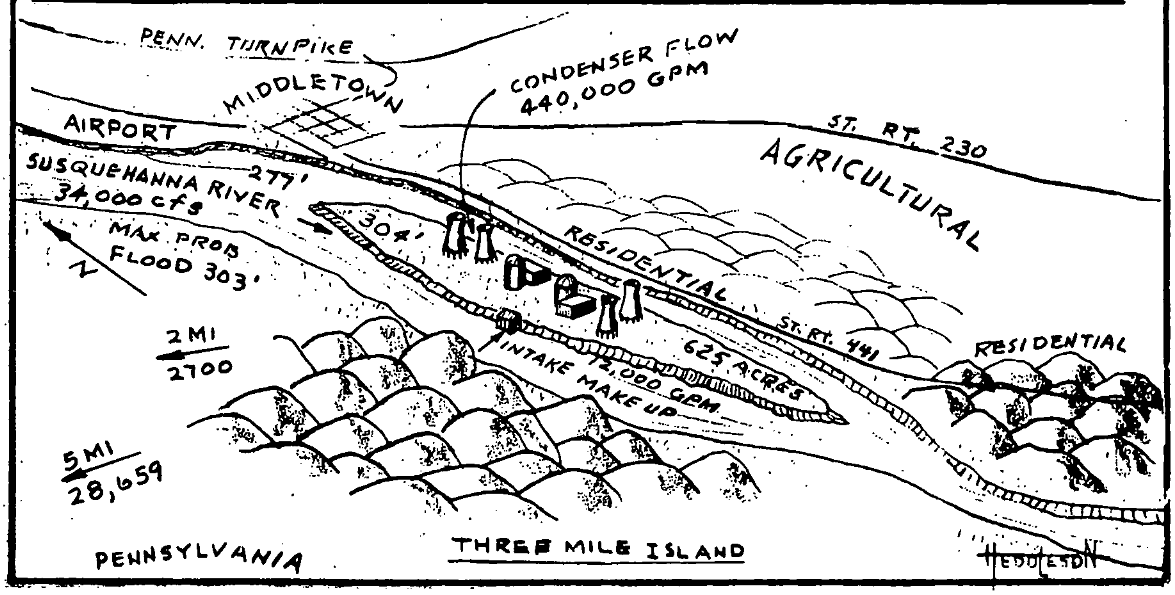
*TOTAL FLOW THROUGH CONDENSERS 444,000 (gpm) TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS Two hyperbolic natural draft towers with an additional mechanical draft tower to cool blow-down being returned to river.

OTHER INFORMATION

Blow-down will range from 2000 gpm to 45000 gpm



EDWIN I. HATCH, 50-321 & 50-366 (BWR) Page 1

Project Name: Edwin I. Hatch Nuclear Plant, 1 & 2
Reactor: Hatch
A-E: Southern Services, Inc. (Bechtel Assisting)
Location: Baxley, Georgia
Vessel Vendor: Not stated
Owner: Georgia Power Company
Docket No.: 50-321, 50-366
NSS Vendor: General Electric Company
Containment Constructor: Not stated

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2436	H_2O/UO_2 Volume Ratio	2.41
Electrical Output, MWe	813	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output for Safety Design, MWt	2436***	Moderator Temp Coef Hot, No Voids	-39.0×10^{-5}
Steam Flow Rate, lb/hr	10.0×10^6 - #1 †10.5×10^6 - #2	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	78.5×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1005* 1020**	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	48,451	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.5	Doppler Coefficient, Operating	$<-1.3 \times 10^{-5}$
Maximum Heat Flux, Btu/hr-ft^2	428,308	Initial Enrichment, %	---
Average Heat Flux, Btu/hr-ft^2	164,740	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	---
Average Fuel Rod Surface Temp °F	---	k_{eff}, All Rods In	0.96
MCHER	1.9	k_{eff}, Max Rod Out	<0.99
Total Peaking Factor	2.6	Control Rod Worth, %	0.01 Δk normal 0.03 Δk abnormal
Avg Power Density, Kw/ℓ	∿51 †	Curtain Worth, %	---
		Burnable Poisons, Type and Form	Flat sheets, SST w/nat Boron 5400 ppm
		Number of Control Rods	137 rods 248 curtains
		Number of Part-Length Rods (PLR)	---

† Data from PSAR for Unit 2.
* Table 1.7-1
** Table 3.1-1
*** Sect. 14.4.3.4 for LOCA, assumption is that reactor has been operating at design power (2436) for 1000 days prior to line break.

All this data was taken from FSAR for Unit 1. Unit 2 is almost the same. Where data is different, it is so indicated.

Compiled by: Fred Heddleson FSAR
Date: October 1970 April 71

TX-4377
(8-70)

Reactor: Hatch

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		0.81	Design Winds in psf:	Class I	Class II
Low Population Zone Dist., Mi.		---	At 0 - 50 ft	28 (105 mph)	26 (100 mph)
Metropolis	Distance	Population			
Savannah, Ga.	65 mi	208,000	50 - 150 ft	44	40
Design Basis Earthquake Accel., g		0.15	150 - 400 ft	66	62
Operating Basis Earthquake Accel., g		0.08	Tornado 300 mph tangential & 60 mph horizon ΔP = 3 psi/ 3 sec		
Earthquake Vertical Shock, % of Horizontal		66	Is intent of 70 design criteria Satisfied? Sect F gives conformance ref.		

Peak Fuel Enthalpy on Rod Drop: 280 calories per gram. At this value, pressure-rise rates are less than 50 psi/sec.

Recirculation Pumping System & MCHER: Pump speed can be varied for some control of power level thru effects of coolant flow on moderator void content to maintain MCHFR not less than 1.9 at rated conditions.

Protective System: Initiate rapid, automatic shutdown in time to prevent fuel-cladding damage following abnormal operational transients. This system overrides all operation actions and process controls.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	56	Prim Ctmt Leak Rate, %/day	1.2
Supprn Chamb Design Press, psig	56	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	46.5	Second Ctmt Leak Rate, %/day	100

Type of Construction: Drywell is a steel pressure vessel in the shape of a light bulb, and the pressure-suppression chamber is a torus-shaped steel pressure vessel located below and around the drywell. Drywell is enclosed in reinforced concrete.

Design Basis: Designed to accomplish 4 functions (Sect. 5.2.4.1):
a. To accommodate press & temp associated with equipment failures.
b. To accommodate & mitigate effects of potential metal-water reactions in LOCA.
c. To provide barrier against leakage of fission products following an accident.
d. To provide strength to withstand missiles and jets forces.

Vacuum Relief Capability: Two groups of vacuum breakers prevent primary containment from exceeding 2 psi of vacuum. One is torus-to-drywell group; the other, the reactor bldg-to-torus group. Venting air moves from bldg to torus and then from torus to drywell preventing excessive vacuum.

Post-Construction Testing: Penumatic test at 1.25 times design pressure of 56 psig. Pressurized to peak calculated press and tested for leakage rate.

Penetrations: Electrical penetrations, personnel hatches, and equipment hatches are double-sealed and testable. All others are single-sealed.

Reactor: Hatch

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: System has 2 independent loops, each with one 100% cap pump, a spray sparger above the core, piping and controls. System is actuated by low water level in reactor or high press in drywell. Water is taken from suppression pool. One loop can operate for any size of pipe rupture to limit fuel-clad temp after LOCA. Each pump delivers 4725 gpm @ 132 psid. Backup system is LPCI.

Auto-Depressurization System: Provides automatic depressurization for small breaks with maloperation of HPCI system so LPCI and core spray system can operate. Six press relief valves vent steam to the suppression pool. Valves open upon coincident signals of reactor low water and drywell high press after 2 min delay.

Residual-Heat-Removal System (RHRS): Designed to remove decay heat and residual heat from reactor, supplement spent fuel cooling, and condense reactor steam when main condenser is not available. System uses the 4 pumps of the LPCI system. Five modes of operation are (1) LPCI, (2) Containment Spray, (3) Condense steam while reactor is isolated from main condenser, (4) Remove heat from suppression-pool water, (5) Shutdown cooling. There are 2 independent loops each with 2 pumps and one heat exchanger. Each pump is rated 7700 gpm @ 450 psig. Heat exchanger capacity is 30.8×10^6 Btu/hr.

High-Pressure Coolant-Injection System: Steam-turbine-driven pump supplies 4250 gpm @ 1120 psid to feedwater pipe. Suction taken from condensate storage tank where 100,000 gal are reserved for HPCI. Suppression pool is backup supply. System starts when water level reaches a pre-selected height above the core to prevent fuel clad damage in case of small pipe rupture.*

Low-Pressure Coolant-Injection System: A subsystem of RHRS for flooding core when other systems cannot do it. Starts automatically on low water level in reactor or high press in drywell. Same signals start core spray. Three of four pumps operate, each supplying 7710 gpm @ 20 psid to the reactor to prevent fuel-clad damage. Max press against which LPCI will operate is 150 psig.

* Water pumped into 1 loop. Instrumentation detects the undamaged path.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: A cross-tie line is provided between the RHR service water system and the LPCI system so that service water may be pumped directly into the reactor vessel or into the containment via the containment spray headers.

Main-Steam-Line Flow Restrictors: Venturi-type flow restrictors installed in each main steam line between relief valve and isolation valve. Limits loss of coolant in case of main line break. Also prevents uncovering core before isolation valve closes. Limits steam flow to 200% of rated flow.

Control-Rod Velocity Limiters: Design of elements inside the control-rod-guide tube limits drop-out velocity to <5 ft/sec over full length of the stroke. Velocity of rod insertion is not affected. This feature prevents against a high reactivity rate of change in the event of a control-rod-drop accident.

Control-Rod-Drive-Housing Supports: Located underneath reactor vessel just under control-rod housing to limit travel or catch the control rod if housing ruptures. Will prevent a nuclear excursion even if housing fails & drops from the reactor. Under operating conditions, housing can drop only 1/4 in. in case of failure.

Standby Liquid-Control System: A redundant system for reactivity control; used when control rods cannot shutdown reactor. By manual initiation, sodium pentaborate solution is pumped into the reactor coolant. About 1 to 2 hr required for complete injection. System can be used to maintain shutdown if required.

Reactor: Hatch

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: Primary containment can be filled with nitrogen during normal operation. Oxygen content can be maintained below 4.9%. Purging can be accomplished in four hours.

Reactor Core Isolation Cooling System (RCICS): During reactor shutdown, if flow from main feed system is lost, RCICS pumps water into reactor with a steam-driven turbine pump unit which receives its steam supply from the reactor vessel. RCICS starts automatically on receipt of reactor-vessel low-water level signal; or system can be started manually. Pump suction is taken from condensate storage tank with suppression-pool for backup. At shutdown, steam flows to the main condenser, or if the condenser is isolated, thru relief valves to suppression pool.* If feedwater pumps cannot replace fluid removed from vessel, RCICS supplies 416 gpm @ 1135 psia.

Reactor Vessel Failure: Failure consequences not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

* Steam is passed through heat exchanger and condensate sent on to pool.

Containment Floodability - Primary containment might be flooded if a breach of primary barrier cannot be sealed.

Reactor-Coolant Leak-Detection Systems: Normal leakage from seals, etc., is piped to sump and is measurable. Other leakage received in sump which cannot be identified is abnormal leakage and must be kept low. Unidentifiable leakage limit is 15 gpm. Abnormal leakage is indicated by changes in drywell press or temp, & flow indicators for floor drain sump and equipment drain sump. High water levels in sumps and starting of each pump is enunciated in the control room.

Failed-Fuel Detection Systems: Four gamma-sensitive instrument channels monitor steam lines. Detectors are located near main lines just downstream of the outboard main line isolation valves in the space between primary and secondary containment walls. When a significant increase in radiation is detected, reactor is scrammed and isolation valves close. Output trip signals of each monitor channel are combined in a one-out-of-two-twice logic to reduce spurious scrams.

Emergency Power: Apparently, 5 diesel-generator sets are available, two exclusively for Hatch 1, two for Hatch 2, and one unit shared. These are described under Auxiliary System (Sect. 8.3) and Standby AC Supply (Sect. 8.4). Units start automatically on signals indicating reactor low water level, or high drywell pressure, or loss of voltage on bus. Units can be loaded 10 seconds after starting. A day tank has 4-hour fuel supply and other fuel on the site will run 4 diesels for 7 days. Units are rated at 2850 kW.

Rod-Block Monitor: Designed to prevent local fuel damage resulting from a single rod-withdrawal error. The subsystem provides a warning signal to the operator. The RBM subsystem has 2 RBM channels, each of which uses input signals from a number of LPRM channels. A trip signal from either RBM channel can initiate a rod block. At less than 30% power RBM is bypassed. A signal from RBM inhibits control rod withdrawal.

Rod Worth Minimizer: A function of the computer which assists the operator in startup, shutdown, and low power (less than 10%) control-rod procedures. Prevents operator from establishing control-rod patterns not consistent with pre-stored sequences. RWM operates to maintain max rod worth below 0.01 Δk.

Reactor: Hatch

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: 150-ft tower erected for measuring wind speed and direction and temperatures. Data will be recorded on charts or punched paper tape.

FSAR makes no reference to permanent seismograph.

Plant Operating Mode: Load-following, with recirculation flow control.

Site Features: Site consists of 2244 acres on south side of Altamaha River about 1 mile east of US Hwy #1. Site grade is 129' (MSL) which is 25 ft above max probable flood level. The site and surrounding area is gently rolling with 260' the max elev in a 5 mi radius. Average river flow is 13,000 cfs with temperatures of 50 F avg winter low and 84 F avg summer high. Area is sparsely populated with only 678 residents in a 2 mi radius. Nearest town is Baxley (11 mi) with 4800 (1967) people. Surrounding land is primarily wooded (70%). Nearest railroad is 10 mi, but a spur has been constructed to the plant.

Turbine Orientation: Center line of turbines about 170 ft from center line of two reactors (Hatch 1&2). Turbine locations preclude blade ejection from striking primary containment, except by deflection.

Emergency Plans: Emergencies will be either radiological or nonradiological. Radiological emergencies will be onsite or offsite. Personnel will be trained to handle accidents, and drills will be held. A medical assistance plan is being prepared so doctors trained in radiological procedures will be available on call.

Environmental Monitoring Plans: The purpose of such a program is to measure environment radioactive materials that might have been released from the plant. Measurements will be taken at numerous stations so that normal backgrounds can be established that are unaffected by the plant; and the close-in stations can indicate plant-effected levels. A preoperational program will start about 1 yr before fuel loading. Samples to be collected will include air particulates, precipitation, external radiation, milk, river water, river benthos, river fish, and well water. The sampling program will be variable depending upon time, amount of activity measured, and plant conditions.

Radwaste Treatment: Liquid wastes will be collected and processed to reduce activity. Low levels will be released diluted by the condenser cooling water. The average activity discharged will be $\sim 6.5 \times 10^{3}$† microcuries/day. Solid wastes will be collected, dewatered and placed in 55-gal drums for shipment offsite for disposal. Gaseous wastes will be collected, stored for decay, and processed for disposal thru the vent stack. Activity in gases released thru stack will be ~600† microcuries per second.

Stack Height - 150 m above ground (reinforced concrete). Top @ 620' MSL.

Waste Heat System: Circulating water system uses a closed-loop design with mechanical draft cooling towers. Two or more pumps circulate water from the cooling tower basin thru condensers and back to cooling towers. Makeup water will be taken from the Altamaha River. Makeup water and other required water will be a maximum of 32,000 gpm, of which about 20,000 gpm will be returned to river. No information presented on quantity of flow thru condensers, or temp rise across condenser, and temp rise of water returned to the river.

Page 6

UTILITY Georgia Power Co.

REACTOR NAME Edwin I. Hatch Nuclear Plant, Units 1 & 2

THERMAL OUTPUT, MWt 2436

TYPE OF NUCLEAR STEAM SYSTEM BWR

DOCKET NO. 50-321
50-366

NEARBY BODY OF WATER Altamaha River

NORMAL LEVEL 72' (MSL)

MAX PROB FLOOD LEVEL 104' (MSL)

SIZE OF SITE 2100 ACRES

SITE GRADE ELEVATION 129' (MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Flat to Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 107 (1972) IN 5 MI RAD 840 (1972)

NEAREST CITY OF 50,000 POPULATION Savannah, Georgia

DISTANCE FROM SITE 67 MILES POPULATION 208,000 (1970)

LAND USE IN 5 MILE RADIUS Wooded-70%

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed loop using cooling towers

WATER TAKEN FROM Altamaha River FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG 50 F SUMMER AVG 84 F AVG 67 F

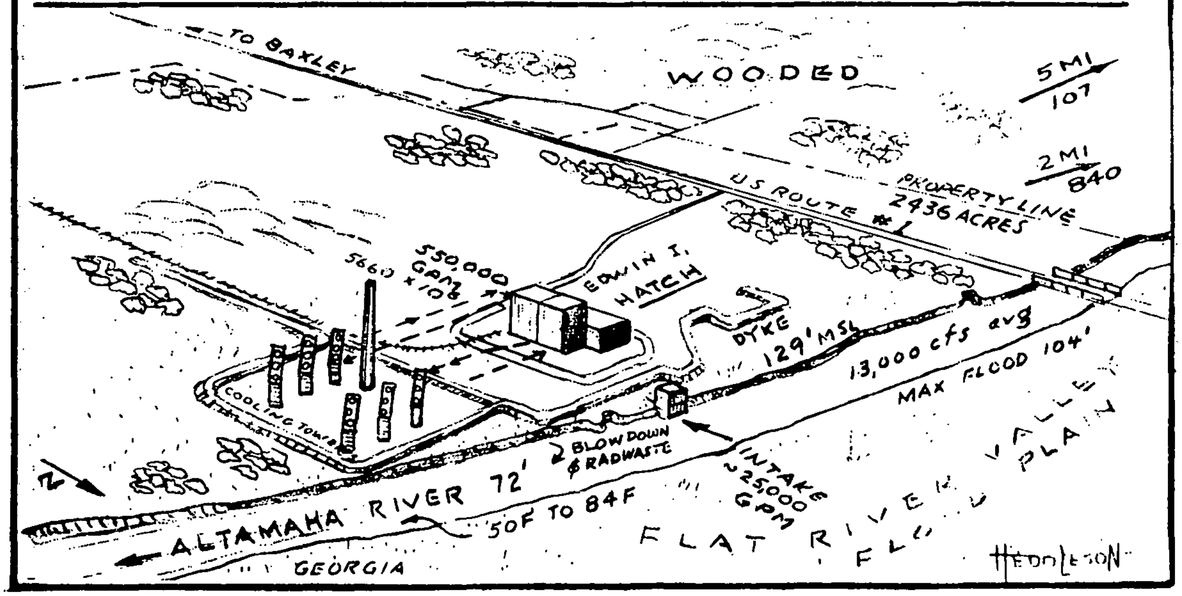
RIVER FLOW 13,000 (cfs) avg. *QUANTITY OF MAKEUP WATER ~32,000 (gpm)

*TOTAL FLOW THROUGH CONDENSERS ~555,000 (gpm) TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS 5660 X 10^6 (Btu/hr) *Per Unit

COOLING TOWERS Three mechanical-draft towers. Evaporative loss is 12,000 gpm.

OTHER INFORMATION Blowdown returned to river is 20,000 gpm.



NUCLEAR SAFETY INFORMATION CENTER

SHOREHAM, 50-322 (BWR) Page 1

Project Name: Shoreham Nuclear Station

Location: Long Island Northshore*

Owner: Long Island Lighting Company

NSS Vendor: General Electric

Reactor: Shoreham

A-E: Stone and Webster

Vessel Vendor: Not specified

Docket No.: 50-322

Containment Constructor: Not specified

A. THERMAL-HYDRAULIC	
Thermal Output, MWt	2,436
Electrical Output, MWe	849
Total Heat Output for Safety Design, MWt	2,550
Steam Flow Rate, lb/hr	10.47×10^6
Total Core Flow Rate, lb/hr	75.5×10^6
Coolant Pressure, psig	1,005
Heat Transfer Area, ft^2	48,451
Max Power per Fuel Rod Unit Lgth, kw/ft	18.37
Maximum Heat Flux, Btu/hr-ft^2	428,308
Average Heat Flux, Btu/hr-ft^2	164,734
Maximum Fuel Temperature, °F	4,380
Average Fuel Rod Surface Temp °F	558
MCHFR	1.9
Total Peaking Factor	2.60
Avg Power Density, Kw/ℓ	51.2

*N. of Brookhaven

B. NUCLEAR	
H_2O/UO_2 Volume Ratio	2.41
Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Moderator Temp Coef Hot, No Voids	-39.0×10^{-5}
Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Moderator Void Coef Operating	-1.5×10^{-3}
Doppler Coefficient, Cold	-1.3 10^{-5}
Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Doppler Coefficient, Operating	-1.3×10^{-5}
Initial Enrichment, %	2.29
Average Discharge Exposure, MWD/Ton	16,680
Core Average Void Within Assembly, %	43.1
k_{eff}, All Rods In	<0.96
k_{eff}, Max Rod Out	<0.99
Control Rod Worth, %	0.029Δk cold
Curtain Worth, %	-
Burnable Poisons, Type and Form	Boron-SST 248 flat curtains
Number of Control Rods	137
Number of Part-Length Rods (PLR)	None

Compiled by: Fred A. Heddleson

Date: June 1969

TX-4377

(8-70)

Reactor: Shoreham

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.17	
Low Population Zone Dist., Mi.	5	
Metropolis	Distance	Population
New Haven, Conn.	22 mi.	152,000 (60)
Design Basis Earthquake Accel., g	0.15 g	
Operating Basis Earthquake Accel., g	0.07 g	
Earthquake Vertical Shock, % of Horizontal	2/3 Horizontal	

Design Winds in mph:

At 0 - 50 ft	100 - 25 lb/sq ft
50 - 150 ft	- 40 lb/sq ft
150 - 400 ft	- 60 lb/sq ft

Tornado - 300 horizontal

ΔP = 3 psi/ 3 sec

Is intent of 70 design criteria Satisfied? Yes (P G-1-1)

Peak Fuel Enthalpy on Rod Drop: 280 cal/gm

Recirculation Pumping System & MCHFR: MCHFR margin will be from 1.9 to 1.0 with variable conditions of recirculation flow, feedwater flow and temp. At 320F to 420F feedwater temp, reactor can meet thermal margin requirements (P III-3-5 to -7).

Protective System: Will override other systems to initiate required safety action, shutting down reactor, closing isolation valves, and starting up emergency engineered safety features.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	+ 56	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	+ 56	Second Ctmt Design Press, psig	- 0.25
Calc Max Internal Press, psig	+ 35	Second Ctmt Leak Rate, %/day	100

Type of Construction: Composite steel-lined reinforced concrete pressure-suppression primary containment in the form of a conical frustrum over a cylindrical section, with drywell in the upper conical section and the suppression chamber in the lower cylindrical section.

Design Basis: Designed to reliably limit release of radio-active materials in the case of an accident such as LOCA, to withstand site-dependent loads such as caused by winds and earthquakes, and to do these without loss of integrity of containment and structure.

Vacuum Relief Capability: Containment vacuum - 2 psig. The vacuum capabilities of containment system will withstand vacuum effects of any credible accident (P V-2-13).

Post-Construction Testing: At 1.15 times design pressure with leak-rate test at 48 psig. Leakage tests will be run at other pressures for later evaluation. Detailed post-operational tests will be established later.

Penetrations: Double and individually testable (P V-2-10).

Reactor: Shoreham

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Has 2 independent loops each with one 100% capacity pump (4,725 gpm) and one spray sparger in reactor vessel above core. Water pumped from suppression pool. Pumps start automatically on low reactor water level or hi containment pressure plus low pressure in coolant system. One loop operating will prevent fuel-clad melting (P VI-2-10).

Auto-Depressurization System: Depressurizing signals are simultaneous hi drywell press. and low reactor water level. For some line breaks, depressurizing lowers pressure to point where LPCI system can operate to flood the core, especially where high-pressure pumps cannot keep up with leakage.

Residual-Heat-Removal System (RHRS): Made up of 3 subsystems: (1) LPCIS, in conjunction with other systems, will cover core a minimum of 2/3 ht. (2) Containment spray-cooling systems using heat exchangers to cool water. Heat exchangers cooled with water from Long Island Sound. (3) Reactor shutdown cooling system, which is designed for removing decay and sensible heat from core during normal shutdown.

High-Pressure Coolant-Injection System: One steam-turbine-driven pump (4,240 gpm @ 1,120 psia) delivers water to feedwater line from the 100,000-gal condensate storage tank. If all this supply is exhausted, then from suppression pool. Pump started by low reactor water level or high containment pressure. System prevents clad melting in event of feedwater loss or a small line break.

Low-Pressure Coolant-Injection System: A mode of Residual Heat Removal System started by coincidence of low-water level in reactor or high press in drywell with low press in nuclear system. At least 3 of 4 pumps used taking water from suppression pool (7700 gpm @ 20 psid for each pump).

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: Condensate storage tank provides water for containment flooding. The standby coolant supply connection to RHRS provides the capability of continuous flow (P VI-2-41).

Main-Steam-Line Flow Restrictors: Venturi in each main line between reactor and first isolation valve. Will limit steam flow in severed line to <200% of rated flow.

Control-Rod Velocity Limiters: Large clearance piston on bottom of each control rod. Has stream-lined profile in scram direction but limits free-fall velocity to <5 ft/sec.

Control-Rod-Drive-Housing Supports: Horizontal beams below reactor vessel arranged to catch & stop CRD housing if one should break loose from reactor vessel & fall. About 2-in. travel is max. in hot condition. The 2-in. fall would cause no damage.

Standby Liquid-Control System: Sodium pentaborate is injected by 2 high-pressure pumps through a ring sparger in the bottom of the core shroud; manually operated from control room. Will shut down reactor with control-rod system inoperable.

Reactor: Shoreham

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: None (P V-2-10).

Reactor Core Isolation Cooling System (RCICS): Removes decay heat from core and provides makeup water to reactor. If main heat sink (main condenser) is lost because of failure or closing of steam-line isolation valves, RCIC causes relief valves to vent steam from system to suppression pool. If water level drops in core, RCIC turbine-pump starts and pumps water into reactor from condensate storage tank or RHRS heat exchanger condensate.

Reactor Vessel Failure:

Missile & Reactor Forces -	Vessel and supports designed to withstand forces created by full blowdown of any nozzle with reactor at design pressure concurrent with earthquake loads.
Core Cooling Capability -	Reactor internals are designed for pressures and stresses induced by LOCA or steam line break
Containment Floodability -	Not mentioned.

Reactor-Coolant Leak-Detection Systems: There are 5 detection means: 1) leakage to equip drain tank, 2) floor chain sump, 3) drywell air temp rise, 4) temp rise in closed cooling water system, 5) pressure rise in drywell.

Failed-Fuel Detection Systems: Not mentioned.

Emergency Power: Three isolated 2,850-kw diesel generators supply a-c power. Any 2 can carry all emergency loads. Fuel-oil supply for 7 days full-load operation. Units start automatically on signal of low reactor water, or high drywell pressure, or on loss of bus voltage.

Rod-Block Monitor: Operates in conjunction with station computer and Rod-Worth-Minimizer to block rod withdrawal that could cause fuel damage. Latching relays limit rod movements.

Rod Worth Minimizer: Station computer monitors control-rod movements using interlocks to prevent patterns in disagreement with planned sequences; so, rod worths are limited to low values. Component failure and/or operator error cannot cause fuel enthalpy to exceed 280 cal/gm because of rod-worth-minimizer.

Reactor: Shoreham

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Meteorological facility has been installed on 135-ft-tall tower. No seismographs mentioned.

Plant Operating Mode: Load following, with recirculation flow control.

Site Features: Area is hilly, varying from beach level on Long Island Sound to an elevation of 200 ft about 2 mi from the site. Station grade is +40 ft. Located on Long Island Sound back about 1000 ft from shore line. Site consists of 450 acres with site grade of 20'. The area is flat to rolling with areas 2 miles or more from plant becoming hilly. Along the ocean, land is residential and recreational, but further back, it is undeveloped except for BNL.

Turbine Orientation: Ejected blades could strike containment shell.

Emergency Plans: Detailed procedures will be prepared to cope with emergency situations. Responsibilities will be assigned and practice drills held. Outside help (police and fire) will be called if needed. The Station Manager is responsible for emergency procedures.

Environmental Monitoring Plans: Meteorological studies started in 1967 to define local peculiarities and to define dispersion conditions. These records will be related to the long-term records of BNL. An ecology program involving the wetlands and offshore waters has been started. These, too, will relate to extensive studies of BNL.

Radwaste Treatment: Off-gas holdup tank provides 10-hr holdup at atmospheric pressure, providing decay factor of between 2 and 16. At pressure, 3 days holdup provided for decay factor of 30 (ref. to 30-min decay). Favorable dispersion conditions will be used for gas release from stack. Release rates as high as 0.5 curies/sec will cause no dose rate at site boundary exceeding 10cfr20. Liquid waste will be filtered, demineralized, and evaporated as required. Waste-liquid will be mixed with circulating water before discharge to Long Island Sound. Solid wastes will be drummed and held for decay before off-site disposal.

Stack Height - 200 ft above ground (roof-top vent).

Waste Heat System: Cooling water is taken from Long Island Sound, pumped through the condenser and returned to the Sound. Flow is 600,000 gpm with 19.5 F temp rise. Maximum inlet temperatures during the summer will be in the mid 70.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Shoreham Nuclear Power Station

THERMAL OUTPUT, MWt	TYPE OF NUCLEAR STEAM SYSTEM	DOCKET NO.
2436	BWR	50-322

NEARBY BODY OF WATER Long Island Sound — NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 16' (MSL)

SIZE OF SITE 450 ACRES — SITE GRADE ELEVATION 20' (MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling to Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 3300 (1980) IN 5 MI RAD 12,300 (1980)

NEAREST CITY OF 50,000 POPULATION New Haven, Conn.

DISTANCE FROM SITE 22 MILES — POPULATION 152,000 (1960)

LAND USE IN 5 MILE RADIUS Residential and Recreational along the ocean, but Undeveloped otherwise except for Brookhaven National Laboratory

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through

WATER TAKEN FROM Long Island Sound — FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG 36 F — SUMMER AVG 74 F — AVG 54 F

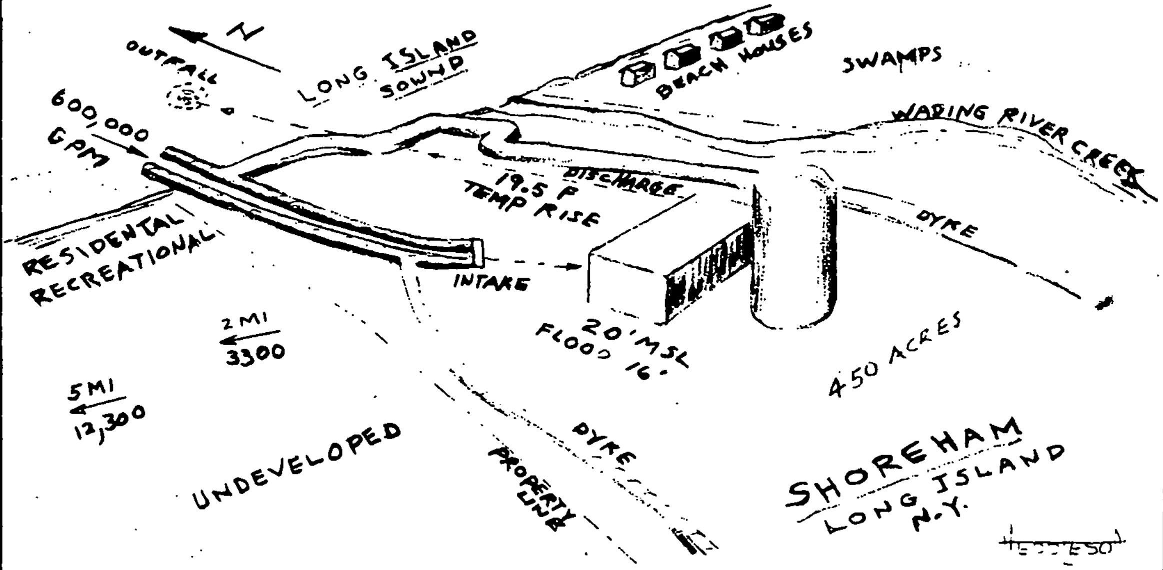
RIVER FLOW NA (cfs) avg. — *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 600,000 (gpm) — TEMPERATURE RISE 19.5 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) — *Per Unit

COOLING TOWERS None

OTHER INFORMATION



DIABLO CANYON, 50-323 (PWR) Page 1

Project Name: *Diablo Canyon Nuclear 1&2
Location: San Luis Obispo Co.**
Owner: Pacific Gas & Electric
NSS Vendor: Westinghouse
**150 mi NW of Los Angeles

Reactor: Diablo Canyon
A-E: PG&E
Vessel Vendor: Combustion Engineering
Docket No.: 50-323 (also 50-275)
Containment Constructor: Not specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3250	H_2O/U, Cold	3.48
Electrical Output, MWe	1109	Avg 1st-Cycle Burnup, MWD/MTU	12,000
Total Heat Output for Safety Design, MWt	3580	First Core Avg Burnup, MWD/MTU	21,800
Total Heat Output, Btu/hr	$11{,}090 \times 10^6$	Maximum Burnup, MWD/MTU	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	2.20
DNBR, Nominal	1.81 (W-3)	Region-2 Enrichment, %	2.70
Total Flow rate, lb/hr	135×10^6	Region-3 Enrichment, %	3.20
Eff Flowrate for Heat Trans lb/hr	122.8×10^6	k_{eff}, Cold, No Power, Clean	1.225
Eff Flow Area for Heat Trans, ft^2	47.9	k_{eff}, Hot, Full Power Xe and Sm	1.106
Avg Vel Along Fuel Rods, ft/sec	15.7	Total Rod Worth, %	7.79
Avg Mass Velocity lb/hr-ft^2	2.56×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1500
Nominal Core Inlet Temp, °F	539	Shutdown Boron, No Rods, Clean, Hot, ppm	1500
Avg Rise in Core, °F	68.6	Boron Worth, Hot, % Δk/k/ppm	1/85
Nom Hot Channel Outlet Temp, °F	646.0	Boron Worth, Cold, % Δk/k/ppm	1/70
Avg Film Coeff, Btu/hr ft^2, °F	5970	Full Power Moderator Temp Coeff, Δk/k/°F	$(-0.2 \text{ to } -3.0) \times 10^{-4}$
Avg Film Temp Diff, °F	34.7	Moderator Press Coeff, Δk/k/psi	$(+0.2 \text{ to } +3.0) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff Δk/k/% Void	$(-0.2 \text{ to } -3.0) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	207,000	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -2) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	583,000	Shutdown Margin, Hot One Rod Stuck, % Δk/k	---
Avg Thermal Output, kw/ft	6.7	Burnable Poisons, Type and Form	Pyrex glass tubes Boron in SST
Max Thermal Output, kw/ft	18.9	Number of Control Rods 53 × 20	1060
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 8 × 20	160
No. Coolant Loops	4		

*PSAR for Unit 2 (50-323) used for data. Units 1&2 are essentially the same.

Compiled By: Fred Heddleson
Date: February 1971

Reactor: Diablo Canyon

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		0.50	Design Winds in mph:		psf
Low Population Zone Dist., Mi.		6	At 0 - 50 ft elev -	70.7	20
Metropolis	Distance	Population	50 - 150 ft	86.5	30
Santa Barbara	100 mi	69,500 (69)			
Design Basis Earthquake Accel., g		0.20*	150 - 400 ft	100.0	45
Operating Basis Earthquake Accel., G		0.15	Tornado - Not given		
Earthquake Vertical Shock, % of Horizontal		66	ΔP = - psi/ - sec		

Is intent of 70 Design Criteria satisfied? Yes, each section discusses the criteria items that are applicable.

D. ENGINEERED SAFETY FEATURES

*Interpretation of value difficult. These shown are 'best guess'

D1. CONTAINMENT

Design Press, psig	47	Calculated Max Internal Press, psig	41
Max Leak Rate at Design Press, %/day	0.1		

Type of Construction: Steel-lined reinforced concrete cylinder with hemispherical roof supported on base slab of reinforced concrete. Concrete side walls are 3'-6" thick and dome is 2'-6" thick. Steel liner is 3/8 and 1/4 inch thick.

Design Basis: Designed for two major loading conditions: 1) Failure of coolant system creating high pressure and elevated temperature in containment, 2) Failure of coolant system coincident with earthquake or tornado winds; so that all radioactivity released from core after LOCA can be contained.

Vacuum Relief Capability: Designed for 3.5 psig vacuum.

Post-Construction Testing: Pressure tested at 54 psig. Leakage rate tests will be performed at 47 psig.

Penetrations: All penetrations, including access openings, and vent ducts are provided with testable double containment.

Weld Channels: Liner welds are covered with steel channels for leak testing.

Reactor: Diablo Canyon

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Two pumps take suction from the refueling water storage tank to each supply 2600 gpm @ 300 psig of borated water with NaOH additive for iodine removal. Water is sprayed into the containment atmospere for temp and pressure control after a LOCA.

Containment Cooling: Five fan-cooler units operate to maintain temp below 120F during operation. Incoming air passes through a roughing filter during normal operation. In case of accident, dampers shift to directing air through an extra filtration unit. At normal operating conditions, each unit can remove 3.14×10^6 Btu/hr.

Containment Isolation System: Two barriers are provided by isolation valve to leakage of radioactivity from the containment. Isolation valves close with automatic safety injection actuation, and when containment spray is actuated.

Containment Air Filtration: Air can be passed through roughing filter and HEPA, plus a moisture eliminator coupled with air coolers. The purge air system can remove 50,000 cfs through filters.

Penetration Room: Fig. 1-5 shows a penetration area around containment at ground elevation of 85 ft.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Page 12-94 of Safety Evaluation of large pipe brake states that "hydrogen is assumed to burn as it is produced."

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four accumulators, each holding 6400 gallons of borated water dump their contents into each of the 4 cold legs when reactor pressure drops to 650 psig. Tanks are pressured with nitrogen. Action is passive, check valve opening at the 650 level.

High-head Safety Injection: Two centrifugal charging pumps driven by electric motors can each supply 150 gpm @ 2800 psig of borated water from the refueling water storage tank, first sweeping concentrated boric acid from the boric acid tank and then pumping borated from the refueling water storage tank.

Low-head Safety Injection: Safety injection pumps (intermediate range of 1700 psig down to 1520 psig) supply 400 gpm @ 1700 psig. Low head pumps are the Residual Heat Removal Pumps and supply 3000 gpm at 600 psig from the refueling water storage tank only when reactor pressure has dropped to 170 psig.

Reactor: Diablo Canyon

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Any increase in observed normal parameters will indicate a change in containment, and equipment provided is capable of monitoring these changes. The design objective is detection of deviations in air particulate activity, radiogas activity and in addition, in the case of gross leakage, the liquid inventory in the process systems and containment sumps.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: There are two diesel-generator sets for each unit with one extra generator set shared by both units. Generators are rated 4.16 kv, 3 phase, 60 cycle, 2500 kw, 0.8 pf. Individual diesel generators are physically isolated from each other, and from other equipment.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid solution in the coolant.

Part-Length Control Rods - 160 in core, not moving for power control but contributing to shutdown margin.

In-Core Instrumentation -

Unborated Water Control: When boric acid concentration is being reduced, the rate of change of K_{eff} attainable is so low that there is ample time for corrective action before criticality is reached. If plain demineralized water should be injected by boric acid pumps, reactivity changes is well within the reactivity control range provided by control rod cluster motion. Therefore Protective System provides adequate protection.

Long-Term Cooling - Internal or External Systems: Long-term cooling could be provided using the Residual Heat Removal System pumps and heat exchangers. Water would be pumped from the sump, through heat exchangers to the reactor coolant system. Heat exchangers are cooled by the service water system using ocean water.

Reactor: Diablo Canyon

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Data collection system has been installed at site for meteorological data. Data has been collected since mid-1967. The 250' high tower is mounted on top of a hill at 914' level. Unit 1 has a strong motion accelerometer.

Plant Operating Mode: Load following.

Site Features: Located on 750 acres along the Pacific Ocean about 150 miles NW of Los Angeles. Land rises steeply from the ocean with site being hilly. Site grade is 85 ft. MSL. Area surrounding the site is hilly and mountainous and very sparsely populated. Only 14 live in a 5 mile radius and 4500 in a 10 mile radius. Land is undeveloped.

Turbine Orientation: Centerlines about 170 ft apart - ejected turbine blades could strike containment structure.

Emergency Plans: Five diesel-generator sets, 2 for each unit, and one shared are available.

Environmental Monitoring Plans: Program will be started about 2 years before beginning of operation to learn about naturally occurring radioactivity to furnish a base for post-operational testing. Samples will be taken of air, milk, vegetables, sea water, kelp, sea food products and bottom sediment. Sampling program at Humbolt Bay will be used for further guidance.

Radwaste Treatment: Liquid wastes are collected and processed by filtration or evaporization. The evaporator condensate may be reused as reactor plant makeup water or discharged to the ocean via the condenser discharge in accordance with 10CFR20 limits. The evaporator residues are stored, packaged and shipped from the site for disposal. Gaseous wastes are collected and stored until radioactivity level is low enough for discharge in accordance with 10CFR20 limits. Solid wastes are packed in 55 gal. drums and shipped off-site for disposal.

Stack Height - No reference found.

Waste Heat System: Once-thru cooling taking water from the Pacific Ocean and returning it to the ocean. A total of 867,000 per unit is required, all but 4000 of this being used to cool the condenser. Heat rise in condenser is 18F.

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME: Diablo Canyon Nuclear Units 1 & 2

THERMAL OUTPUT, MWt: 3250

TYPE OF NUCLEAR STEAM SYSTEM: PWR

DOCKET NO.: 50-275, 50-323

NEARBY BODY OF WATER: Pacific Ocean

NORMAL LEVEL: 0 (MSL)

MAX PROB FLOOD LEVEL: 18' (MSL)

SIZE OF SITE: 750 ACRES

SITE GRADE ELEVATION: 85' (MSL)

TOPOGRAPHY OF SITE: Hilly

OF SURROUNDING AREA (5 MI RAD): Hilly to Mountainous

TOTAL PERMANENT POPULATION IN 2 MI RAD: 4 (1970) IN 5 MI RAD: 14 (1970) In 10 Mi: 4443 (1970)

NEAREST CITY OF 50,000 POPULATION: Santa Barbara, Calif.

DISTANCE FROM SITE: 100 MILES POPULATION: 69,5000 (1969)

LAND USE IN 5 MILE RADIUS: Undeveloped, Wooded

CIRCULATING WATER SYSTEM TYPE OF SYSTEM: Once through

WATER TAKEN FROM: Pacific Ocean FOR: Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG: 52 F SUMMER AVG: 62 F AVG: - F

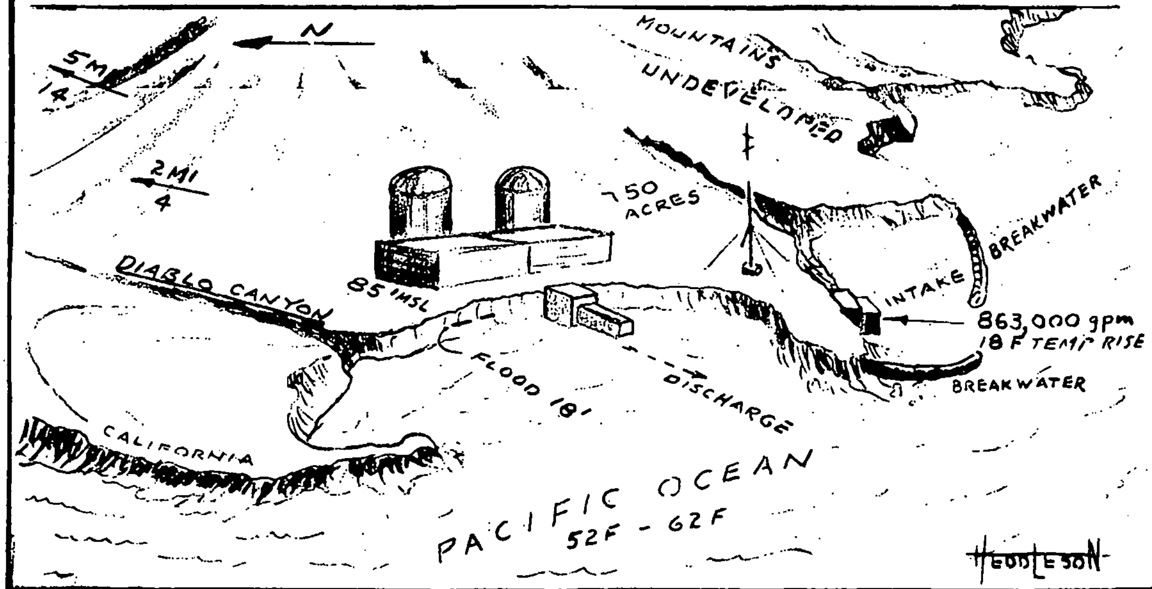
RIVER FLOW: NA (cfs) avg. *QUANTITY OF MAKEUP WATER: - (gpm)

*TOTAL FLOW THROUGH CONDENSERS: 863,000 (gpm) TEMPERATURE RISE: 18 F

*HEAT REMOVAL CAPACITY OF CONDENSERS: - (Btu/hr) *Per Unit

COOLING TOWERS: None

OTHER INFORMATION:



BRUNSWICK, 50-324 & 50-325 (BWR) Page 1

Project Name: Brunswick Steam Electric Plant 1&2
Location: Brunswick Co., N.C.
Owner: Carolina Power and Light
NSS Vendor: General Electric

Reactor: Brunswick
A-E: United Engineers & Constructors
Vessel Vendor: Combustion Engineering
Docket No.: 50-324, 50-325
Containment Constructor: Brown & Root

A. THERMAL-HYDRAULIC	
Thermal Output, MWt	2436
Electrical Output, MWe	847
Total Heat Output for Safety Design, MWt	2550
Steam Flow Rate, lb/hr	10.4×10^6
Total Core Flow Rate, lb/hr	75.5×10^6
Coolant Pressure, psig	1005
Heat Transfer Area, ft^2	48,451
Max Power per Fuel Rod Unit Lgth, kw/ft	18.5
Maximum Heat Flux, $Btu/hr\text{-}ft^2$	428,308
Average Heat Flux, $Btu/hr\text{-}ft^2$	164,740
Maximum Fuel Temperature, °F	4380
Average Fuel Rod Surface Temp °F	558
MCHFR	>1.9
Total Peaking Factor	2.60
Avg Power Density, Kw/ℓ	51.2

B. NUCLEAR	
H_2O/UO_2 Volume Ratio	2.41
Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Moderator Temp Coef Hot, No Voids -17	-39.0×10^{-5}
Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Moderator Void Coef Operating	-1.5×10^{-3}
Doppler Coefficient, Cold	-1.3×10^{-5}
Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Doppler Coefficient, Operating	-1.3×10^{-5}
Initial Enrichment, %	2.25
Average Discharge Exposure, MWD/Ton	19,000
Core Average Void Within Assembly, %	43.1
k_{eff}, All Rods In	0.95
k_{eff}, Max Rod Out	0.99
Control Rod Worth, %	---
Curtain Worth, %	---
Burnable Poisons, Type and Form 248	Flat sheets, SST Natural Boron
Number of Control Rods (cruciform)	137
Number of Part-Length Rods (PLR)	---

Compiled by: Fred Heddleson and Carlos Bell
Date:

TX-4377
(8-70)

Reactor: Brunswick

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.57	Design Winds in mph:	
Low Population Zone Dist., Mi.	2.0	At 0 - 50 ft	130
Metropolis / Distance / Population Wilmington, N.C. / 20 mi. / 53,500 ('69)		50 - 150 ft	150
Design Basis Earthquake Accel., g	0.16	150 - 400 ft	180
Operating Basis Earthquake Accel., g	0.08	Tornado 300 mph tang. + 60 trans. ΔP = 3 psi/ 3 sec	
Earthquake Vertical Shock, % of Horizontal	66	Is intent of 70 design criteria Satisfied?	Yes

Peak Fuel Enthalpy on Rod Drop: 250 cal/gm

Recirculation Pumping System & MCHFR: Designed such that MCHFR will always exceed 1.0 even for any failure.

Protective System: Designed to prevent fuel damage on any type of single malfunction or error.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig (Changed from 62 to 53)	53	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	53	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	46	Second Ctmt Leak Rate, %/day	100

Type of Construction: Drywell will be steel-lined reinforced concrete pressure vessel consisting of a series of right cylinders and truncated cones forming a shape similar to the inverted light bulb. The pressure suppression chamber will be a steel-lined reinforced concrete torus.

Design Basis: Designed for dead loads, live loads, and loads associated with site environment such as earthquake, wind loads, etc. Designed to limit off-site exposure doses in case of LOCA so that doses will be less than limits of 10CFR100.

Vacuum Relief Capability: Design vacuum is 2 psig.

Post-Construction Testing: Provisions shall be made for preoperational pressure and leak rate testing of the primary containment system and for leak testing at periodic intervals after the plant has commenced operation. Provision shall also be made for leak testing selected penetrations.

Penetrations: Some are double sealed, some single. PSAR states that all are testable.

Reactor: Brunswick

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Designed to circulate water from pressure suppression pool to reactor vessel. Water will be distributed directly to the reactor core by spray headers mounted inside and above the reactor core to cool the reactor core in the event of LOCA. Two 100% capacity pumps can each supply 4625 gpm @ 145 psid.

Auto-Depressurization System: Relief valves open on simultaneous signals of high drywell pressure, low HPCIS flow and loss of reactor water level to depressurize the system, thus dropping the pressure so low-pressure coolant injection system will be able to cool reactor core.

Residual-Heat-Removal System (RHRS): Consists of these three subsystems:

1) Low Pressure Coolant Injection (described below)
2) Containment Sprays System which will limit drywell pressure by spray cooling after LOCA, and also by circulating water through heat exchangers will limit suppression pool temp to 170F.
3) Reactor Shutdown Cooling System to remove decay heat and sensible heat from reactor core during normal shutdown.

High-Pressure Coolant-Injection System: One steam-turbine-driven constant-flow pump assembly supplies borated water from the condensate storage tank through the reactor feedwater system from condensate storage tank or suppression pool. Clad melting prevented for breaks < 0.5 ft^2. Pump supplies 4220 gpm @ 1120 psid and operates at pressures from 1120 down to 150 psid.

Low-Pressure Coolant-Injection System: Four 1/3 capacity pumps can each supply 7700 gpm @ 20 psid to flood core and prevent fuel melting. System starts on low water level in reactor or high pressure in drywell with low pressure in coolant system. When circulating through RHRS heat exchangers, this LPCIS is a mode of RHRS.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: Interconnections between discharge of RHRS-service water pumps and discharge RHRS pumps provide an infinite supply of water for cooling reactor.

Main-Steam-Line Flow Restrictors: Venturi in each main steam line between reactor vessel and first isolation valve limits steam flow in a broken line to <200% of its rated flow.

Control-Rod Velocity Limiters: Large clearance piston on bottom of each control rod assembly limits free fall velocity to <5 fps but does not limit scram velocity.

Control-Rod-Drive-Housing Supports: Horizontal beams below reactor vessel with attached rods and support bars limit downward travels of a broken loose housing to 3 inches.

Standby Liquid-Control System: Sodium-pentaborate injected through a ring sparger by two pumps can inject enough poison in 100 minutes to shut down reactor with no rods inserted.

Reactor: Brunswick

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: Average operating temp will be 135F with 150F max. Nitrogen can be introduced into containment to minimize H_2-O_2 reactions after LOCA.

Reactor Core Isolation Cooling System (RCICS): To remove decay heat should reactor feedwater system capability be lost and other normal removal systems which require plant auxiliary electrical power systems for operation are not available. The system will consist of the reactor system relief valves which will pass steam directly to the suppression chamber and a steam turbine driven makeup pump which will supply makeup from the condensate storage tank. Steam to drive the turbine will come from the main steam line header and will exhaust to the suppression chamber pool.

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Third supplement to PSAR in answer to comment 4.4 states that leak detection will be by totalizing flow from the drywell floor drain sump and equipment drain tank.

Failed-Fuel Detection Systems: Monitors on each main steam line when measuring high activity level signals a scram and causes isolation valves to close.

Emergency Power: Four buses and 4 diesel generators (2750 kw) constitute a standby power system common to both units. If off-site power is lost, the four buses with their associated diesels will operate as four isolated systems and shutdown loads from both reactors will be powered from the same buses. Therefore, there will be a minimum of interaction between units. Fuel oil supply available for 7 days of operation.

Rod-Block Monitor: Prevents control rod withdrawal error and consequent fuel damage. Uses LPRM signals which block rod withdrawal on high trip in RBM channel. Monitor bypassed at low power.

Rod Worth Minimizer: Monitors rod withdrawal and insertion sequences during startup and low power operation and blocks certain movements. Rod worths limited to those which would result in fuel enthalpies of 250 cal/gm on rod drop.

Reactor: Brunswick

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Sensors to be placed on 300-ft high tower at the site. Convenience of readout not discussed. Seismographs not mentioned.

Plant Operating Mode: Load following.

Site Features: Located on a 1200 acre site ~5 mi off the Atlantic Ocean and about 1 3/4 miles west of Cape Fear River. Site is typical flat coastal plain sparsely populated with local land either undeveloped or used for limited farming. In 2 mi radius there is 621 population and in 5 mi radius, 3509. Wilmington, N.C. (20 miles away NNE) is the nearest town with more than 50,000 population.

Turbine Orientation: Ejected turbine blades could strike containment if they were slightly deflected. Centerlines are about 215 ft apart.

Emergency Plans: Plans will be formulated so that emergencies can be handled in an efficient manner with a minimum of exposure to personnel and the general public. Periodic drills will be run so each individual will be familiar with his duties. A plan will be developed for local hospital treatment of contaminated personnel. Outside assistance will be called for when needed.

Environmental Monitoring Plans: A preoperational environmental radioactivity monitoring program will be initiated and conducted at the site. Data collection will be conducted approximately one year prior to plant startup to measure radioactivity present in the environs. The program will be continued after operation to assure prompt detection and evaluation of any changes in radioactivity.

Radwaste Treatment: Gaseous, liquid, and solid waste control will be provided to limit the release of radioactive material from the site within applicable regulations. Gaseous waste from each unit will be released via the common 100 meter stack. Liquid and solid waste from each unit will be processed in the common radwaste facility. There will be a separate process off-gas system for each unit, each with independent monitoring. Combined gas effluent from both units will also be monitored and 10CFR20 limits will apply to aggregate releases. Liquid and solid wastes will be processed in a common facility, liquid being released through the circulating water system and solid waste being packaged for off-site disposal.

Stack Height — 100 Meters

Waste Heat System: Condenser cooling water will be taken from Cape Fear River and discharged to the Atlantic Ocean about 2000 ft offshore. The ocean discharge is a change from the original plan for discharge back to the river. Condensers will use 675,000 gpm each with 17F temp rise. Condenser capacity is 5600×10^6 Btu/hr.

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Brunswick Steam Electric Plant Units 1 & 2
THERMAL OUTPUT, MWt 2436	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-324 50-325

NEARBY BODY OF WATER Cape Fear River (1 3/4 mi) NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 19.4'(MSL)

SIZE OF SITE 1200 ACRES SITE GRADE ELEVATION 20' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat

TOTAL PERMANENT POPULATION IN 2 MI RAD 621 (1966) IN 5 MI RAD 3509 (1966)

NEAREST CITY OF 50,000 POPULATION Wilmington, N.C.

DISTANCE FROM SITE 20 MILES POPULATION 53,500 (1969)

LAND USE IN 5 MILE RADIUS Less than half for Agriculture, the balance is either Swamps or Wooded

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through

WATER TAKEN FROM Cape Fear River FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

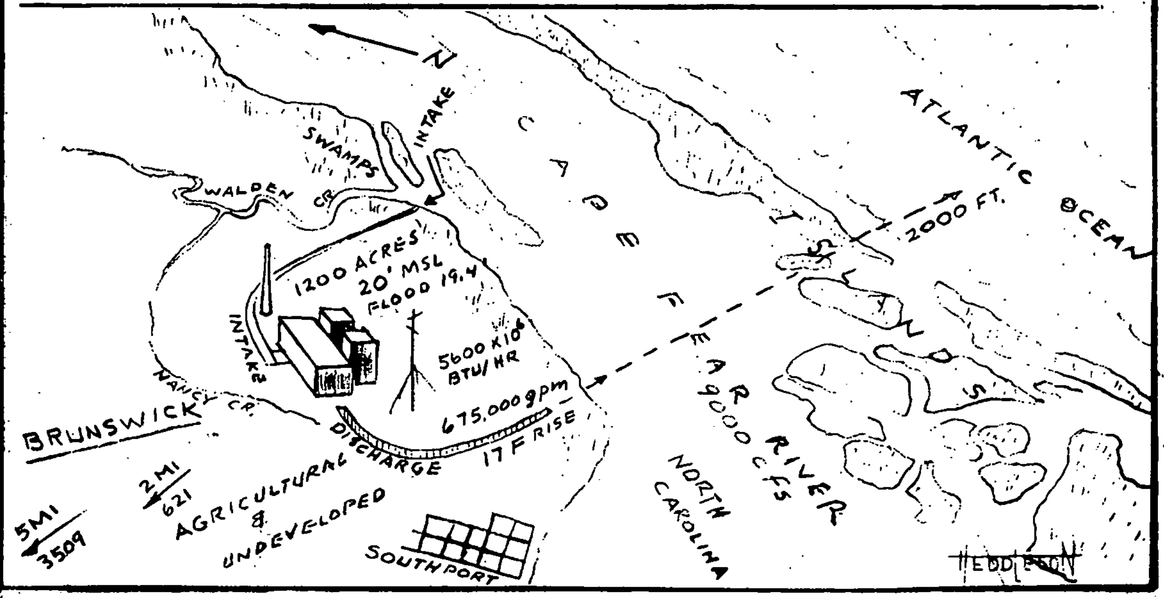
RIVER FLOW 9000 (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 675,000 (gpm) TEMPERATURE RISE 17 F

*HEAT REMOVAL CAPACITY OF CONDENSERS 5600×10^6 (Btu/hr) *Per Unit

COOLING TOWERS None

OTHER INFORMATION Cooling water taken from Cape Fear River and Discharged 2000' off shore in the Atlantic Ocean.



NUCLEAR SAFETY INFORMATION CENTER

SEQUOYAH, 50-327 & 50-328 (PWR) Page 1

Project Name: Sequoyah Nuclear Plant, Units 1&2
Reactor: Sequoyah
A-E: TVA
Location: Hamilton Co., Tenn.*
Vessel Vendor: Westinghouse
Owner: TVA
Docket No.: 50-327, 50-328
NSS Vendor: Westinghouse
Containment Constructor: TVA
*12 mi NE of Chattanooga

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3423	H_2O/U, Cold	3.48
Electrical Output, MWe	1129	Avg 1st-Cycle Burnup, MWD/MTU	13,780
Total Heat Output for Safety Design, MWt	3594	First Core Avg Burnup, MWD/MTU	24,400
Total Heat Output, Btu/hr	$11{,}639 \times 10^6$	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	2.20
DNBR, Nominal	2.00	Region-2 Enrichment, %	2.70
Total Flow rate, lb/hr	134×10^6	Region-3 Enrichment, %	3.20
Eff Flowrate for Heat Trans lb/hr	127.3×10^6	k_{eff}, Cold, No Power, Clean	1.225
Eff Flow Area for Heat Trans, ft^2	51.4	k_{eff}, Hot, Full Power Xe and Sm	1.148
Avg Vel Along Fuel Rods, ft/sec	15.4	Total Rod Worth, %	7
Avg Mass Velocity lb/hr-ft^2	2.49×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1460
Nominal Core Inlet Temp, °F	545	Shutdown Boron, No Rods, Clean, Hot, ppm	1560
Avg Rise in Core, °F	67.8	Boron Worth, Hot, % Δk/k/ppm	1%/85 ppm
Nom Hot Channel Outlet Temp, °F	643.6	Boron Worth, Cold, % Δk/k/ppm	1%/70 ppm
Avg Film Coeff, Btu/hr ft^2, °F	5770	Full Power Moderator Temp Coeff, Δk/k/°F	$(-0.2 \text{ to } -3.0) \times 10^{-4}$
Avg Film Temp Diff, °F	37.7	Moderator Press Coeff, Δk/k/psi	$(+0.2 \text{ to } +3.0) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff Δk/k/% Void	$(-0.2 \text{ to } -3.0) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	217,200	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -2) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	579,600	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	7.0	Burnable Poisons, Type and Form	---
Max Thermal Output, kw/ft	18.8	Number of Control Rods 53×20	1060
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 8×20	160
No. Coolant Loops	4		

Compiled By: Fred Heddleson
Date: February 1971

Reactor: Sequoyah

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		0.36	Design Winds in mph:
Low Population Zone Dist., Mi.		7	At 0 - 50 ft elev 95
Metropolis	Distance	Population	50 - 150 ft 110
Chattanooga, Tn.	12 mi.	130,000 ('60)	
Design Basis Earthquake Accel., g		0.14	150 - 400 ft 130
Operating Basis Earthquake Accel., G		0.07	Tornado 300 mph tang. + 60 trans.
Earthquake Vertical Shock, % of Horizontal		71	ΔP = 3 psi/ 3 sec

Is intent of 70 Design Criteria satisfied? Yes, see Section 1.4.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	10.8	Calculated Max Internal Press, psig	7.5
Max Leak Rate at Design Press, %/day	0.5		

Type of Construction: Containment is a free-standing steel vessel designed to resist seismic loads. The shield building is a reinforced concrete structure of right cylinder configuration with a shallow dome roof. The annular space between the two structures houses the ice condenser.

Design Basis: Containment vessel designed to withstand the internal pressure of LOCA and be virtually leak tight. Also, structures are designed to resist all external loads such as winds, tornados, snow, external missiles and earthquakes.

Vacuum Relief Capability: Designed for 0.5 psig external pressure. Vessel is vented to eliminate pressure surges using purge connections to relieve pressure buildup.

Post-Construction Testing: Tested at 5 psig using soap bubble inspection, then again at 12 psig. Leakage rate tests shall be run after construction is complete and periodically thereafter.

Penetrations: Cold pipe penetrations have double seals. Electrical penetration assemblies can be pressure tested.

Weld Channels: Used on bottom liner plate seams. Weld channels are leak tested by pressurizing.

Reactor: Sequoyah

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Heat removal capacity of each spray system (2) is sized to hold containment pressure below design after all ice has melted and residual heat continues to be generated. Four pumps (2 per system) deliver 2600 gpm @ 300 psig to the spray headers from the refueling water storage tank. When this supply is exhausted, suction for recirculation mode is taken from containment sump.

Containment Cooling: Upper compartment uses 3 recirculating vent units plus one standby. Temperatures are held between 60F and 110F. The lower compartment has 3 normally operating units plus one standby which hold temperatures between 60F and 110F.

Containment Isolation System: Provides a means for isolating various pipes passing through containment walls to prevent release of radioactivity to the outside environment. Each penetration has two valves on the line — one on the inside and one on the outside of containment. Valves close automatically.

Containment Air Filtration: Purged air from upper and lower compartment passes through both HEPA and charcoal filters. Air from the Instrument room is passed through charcoal filters before leaving containment.

Penetration Room: No reference found on drawings.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: No reference found.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks, each holding 6350 gallons of borated water are connected into the four cold legs of the reactor. Tanks are pressurized to 650 psig with nitrogen gas. When reactor pressure falls below 650 psig, check valves open automatically dumping contents of the accumulators into the reactor to prevent fuel melting.

High-head Safety Injection: Two centrifugal pumps each having a capacity of 150 gpm at 2800psi inject borated water as makeup for small leaks or as first injection system to operate after LOCA. Suction is taken from the boron injection tank sweeping concentrated boric acid into the coolant system, and later suction is taken from the refueling water storage tank.

Low-head Safety Injection: Two centrifugal pumps each having a capacity of 400 gpm @ 1700 psig operate after high-head injection system. As the pressure drops, the Residual Heat Removal pumps begin to operate at ~600 psig discharging 3000 gpm (each for 2 pumps) taking borated water from the refueling water storage tank.

Reactor: Sequoyah

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Containment air activity and humidity monitored continuously for changes in conditions indicating leakage. Also monitored are air particulate activity, radiogas activity, liquid inventory in process systems, and the containment sump.

Failed-Fuel-Detection Systems: There is a rod burst program being studied and a failed fuel monitoring research program (1.6-20). No later reference found.

Emergency Power: System consists of three 6900-volt, 3-phase, 60-cycle diesel generators with a capacity of 2850 kw each. The three generator sets are physically separated and electrically isolated from each other. If one of the three diesel generators should fail to start or carry load, the system continues to provide two unparalleled channels of emergency power to the plant, which have a combined capacity to provide a safe shutdown.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid in the coolant.

Part-Length Control Rods - 8 assemblies of 20 rods each will be inserted in the core during operation. These assemblies will not trip but remain in place.

In-Core Instrumentation - Designed to give information on neutron flux distribution.

Unborated Water Control: There are three modes of adding boric acid solution: 1) Automatic makeup, 2) Dilution, 3) Boration. Each mode has certain automatic control or monitoring to prevent over dilution.

Long-Term Cooling - Internal or External Systems: Long term cooling is furnished by Containment Spray System or the Residual Heat Removal System described on page 3.

Reactor: Sequoyah

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Data from other sites being used for preliminary studies. A meteorological tower will be installed at the site one year before operation starts. Seismographs not mentioned.

Plant Operating Mode: Load following.

Site Features: Located on the west side of Chickamauga Lake (TVA reservoir) about 12 miles NE of Chattanooga, Tenn., on 525 acres. Site is rolling with site grade of 705'. Normal reservoir pool stage is 682.5. Area surrounding the site is hilly. The site lies in a wide valley about 10 miles wide. Land usage is mostly rural undeveloped, but residential areas are creeping in. The lake is used extensively for recreation. Population in 1980 will be 1440 in 2 mi radius, and 11,420 in 5 mi radius.

Turbine Orientation: It is unlikely that blades ejected from a turbine could strike the containment structure.

Emergency Plans: Written procedures pertinent to reactor operation, handling of radioactive material, and fuel-handling operations will be prepared to cover all normal and reasonable foreseeable emergency conditions.

Environmental Monitoring Plans: A study of radiation levels will be started about 2 years before startup and will continue through startup (1973) and operation. The program will be coordinated with similar programs conducted by Oak Ridge National Laboratory, the nationwide fallout sampling and water quality networks, and the radiological health programs of the States of Tennessee, Georgia, and possibly Alabama. It will include measurement of direct gamma radiation and sampling of airborne radioactivity, fallout particulate matter, rainfall, surface water, aquatic biota, public water supplies, water supply wells, soil, vegetation, and milk.

Radwaste Treatment: Liquid wastes will be collected, processed by filtration or evaporation and held for reuse or discharged through the condenser discharge. Gaseous wastes will be collected, held for decay until low enough in activity for release in accordance with 10CFR20.

Stack Height - Could not find.

Waste Heat System: A once-through cooling system will be used taking water from Chickamauga Lake, passing through condensers with 29F temp rise and back into the lake through a lagoon. Total flow for each of two reactors is 535,000 gpm. Mean river flow is 36,500 cps. At mean flow, there will be a rise in temp of less than 2F, after mixing.

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES	REACTOR NAME Sequoyah Nuclear Plant

THERMAL OUTPUT, MWt 3423	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-327 50-328

NEARBY BODY OF WATER Chickamauga Lake — NORMAL LEVEL 682.5'(MSL)

MAX PROB FLOOD LEVEL 702' (MSL)

SIZE OF SITE 525 ACRES — SITE GRADE ELEVATION 705' (MSL)

TOPOGRAPHY OF SITE Rolling

OF SURROUNDING AREA (5 MI RAD) Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 1440 (1980) 770 (1960) IN 5 MI RAD 11420 (1980) 6105 (1960)

NEAREST CITY OF 50,000 POPULATION Chattanooga, Tenn.

DISTANCE FROM SITE 12 MILES — POPULATION 130,000 (1960)

LAND USE IN 5 MILE RADIUS Residential, Recreational, with balance Undeveloped

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through using a lagoon

WATER TAKEN FROM Chickamauga Lake — FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG 42 F — SUMMER AVG 83 F — AVG 62 F

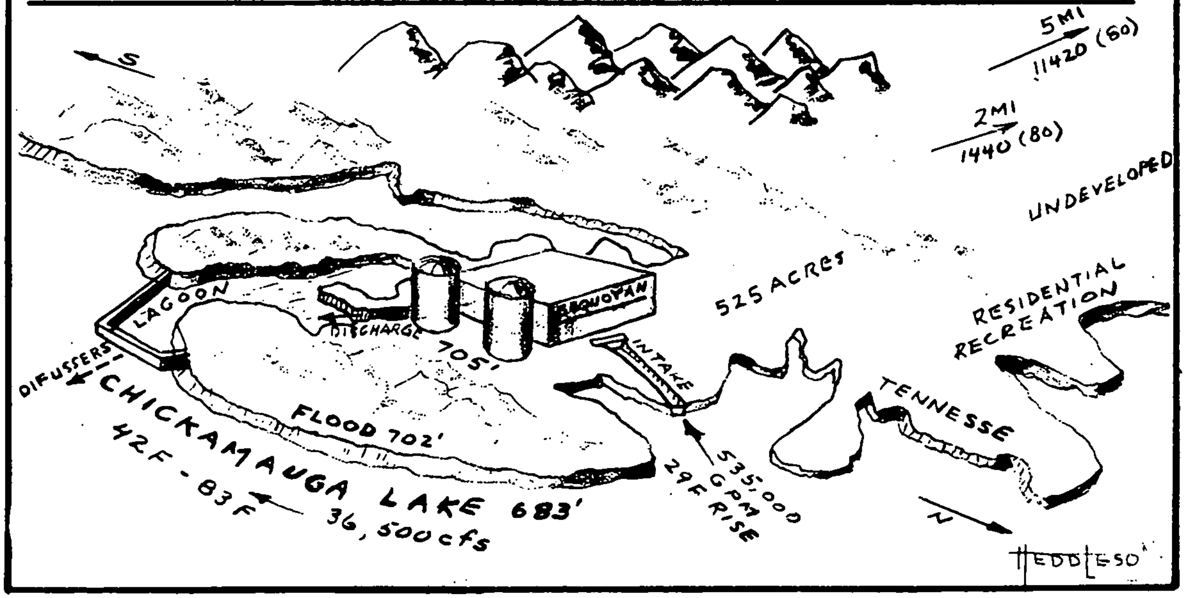
RIVER FLOW 36,500 (cfs) avg. — *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 535,000 (gpm) — TEMPERATURE RISE 29 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) — *Per Unit

COOLING TOWERS None

OTHER INFORMATION Water flows from lagoon back into lake through multiport diffusers across the bottom of the main channel.



NUCLEAR SAFETY INFORMATION CENTER

MIDLAND, 50-329 & 50-330 (PWR) Page 1

Project Name: Midland Nuclear Power Plant, 1&2
Location: Midland Co., Michigan
Owner: Consumers Power Company
NSS Vendor: Babcock & Wilcox Co.

Reactor: Midland
A-E: Bechtel
Vessel Vendor: Babcock & Wilcox
Docket No.: 50-329, 50-330
Containment Constructor: Not specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2452	H_2O/U, Cold	2.85
Electrical Output, MWe	818*	Avg 1st-Cycle Burnup, MWD/MTU	13,540
Total Heat Output for Safety Design, MWt	2552	First Core Avg Burnup, MWD/MTU	27,490 (equil)
Total Heat Output, Btu/hr	8369×10^6	Maximum Burnup, MWD/MTU	55,000 design 33,000 hot bundle
System Pressure, psia	2200	Region-1 Enrichment, %	2.30
DNBR, Nominal	2.21	Region-2 Enrichment, %	2.30
Total Flow rate, lb/hr	131.3×10^6	Region-3 Enrichment, %	2.64
Eff Flowrate for Heat Trans lb/hr	124.2×10^6	k_{eff}, Cold, No Power, Clean	1.271
Eff Flow Area for Heat Trans, ft^2	49.19	k_{eff}, Hot, Full Power Xe and Sm	1.218
Avg Vel Along Fuel Rods, ft/sec	15.7	Total Rod Worth, %	8.0
Avg Mass Velocity lb/hr-ft^2	2.52×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	810
Nominal Core Inlet Temp, °F	555	Shutdown Boron, No Rods, Clean, Hot, ppm	450
Avg Rise in Core, °F	49.3	Boron Worth, Hot, % Δk/k/ppm	1/100
Nom Hot Channel Outlet Temp, °F	647.1	Boron Worth, Cold, % Δk/k/ppm	1/75
Avg Film Coeff, Btu/hr ft^2, °F	5000	Full Power Moderator Temp Coeff, Δk/k/°F	$(0 \text{ to } -3) \times 10^{-4}$
Avg Film Temp Diff, °F	31	Moderator Press Coeff, Δk/k/psi	4.0×10^{-7} to 3.0×10^{-6}
Active Heat Trans Surf Area, ft^2	49,734	Moderator Void Coeff Δk/k/% Void	4.0×10^{-4} to -3.0×10^{-3}
Avg Heat Flux, Btu/hr ft^2	163,725	Doppler Coefficient, Δk/k/°F	$(-1.1 \text{ to } -1.7) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	510,300	Shutdown Margin, Hot One Rod Stuck, % Δk/k	Adequate (p 1-15)
Avg Thermal Output, kw/ft	5.4	Burnable Poisons, Type and Form	$Al_2O_3B_4C$ 72 units
Max Thermal Output, kw/ft	16.83	Number of Control Rods 49 × 16	784
Max Clad Surface Temp, °F	654	Number of Part-Length Rods (PLR)	---
No. Coolant Loops	2		

*Unit 2 electrical output is 818 MWe, Unit 1 will be 492 MWe plus 4×10^6 lb/hr of process steam to Dow Chemical.

Compiled By: Carlos Bell
Date: ---

Reactor: Midland

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		0.28	Design Winds in mph:	
Low Population Zone Dist., Mi.		1.0	At 0 - 50 ft elev	85
Metropolis	Distance	Population	50 - 150 ft	100
Saginaw, Mich.	22 mi.	98,265 ('60)		
Design Basis Earthquake Accel., g		0.10	150 - 400 ft	115
Operating Basis Earthquake Accel., G		0.05	Tornado	300 mph tang. + 60 trans.
Earthquake Vertical Shock, % of Horizontal		66	ΔP =	3 psi/ - sec

Is intent of 70 Design Criteria satisfied? Yes, discussed in Section 1C Appendix.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	67	Calculated Max Internal Press, psig	60
Max Leak Rate at Design Press, %/day	0.1		

Type of Construction: Reactor building a steel-lined, prestressed, post-tensioned concrete vertical cylinder with flat bottom and shallow-domed roof. Dome is 3-way post-tensioned. Steel liner plate an integral part of reactor building.

Design Basis: Designed for all credible conditions including normal loads, LOCA loads, test loads, and adverse environmental loads including earthquake, tornados, uplift, etc. The two most critical conditions are LOCA and earthquake. Structure is designed to maintain integrity without excessive leakage of radioactivity in any of the above cases of loading.

Vacuum Relief Capability: Designed for 3-psi differential bursting pressure. External pressure of 2 1/2-psi load outside to inside.

Post-Construction Testing: Soap-bubble test at 5 psi (p 5-50). Following construction, tested at 115% design pressure (p 5-53). No continuous leakage-monitoring system provided (p 5-53).

Penetrations: Electrical penetrations are double sealed and testable. All other penetrations are single sealed.

Weld Channels: Found no reference to weld channels, but liner seam welds will be tested with vacuum box and soap.

Reactor: Midland

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: There are 2 reactor-building spray pumps each 1300 gpm. Design capacity of system is 200×10^6 Btu/hr, which, from 35 sec following LOCA, equals the decay heat rate minus the heat-removal rate of the building heat sinks.

Containment Cooling: Four reactor-building coolers, each with 21,000 cfm air flow at accident conditions (T1-2). Two reactor-building cooling systems.

Containment Isolation System: Closes all penetrations, not required for operation of the engineered safeguards system, to minimize leakage of radioactive materials to the environment. In addition, all isolation valves, upon loss of actuating power, fail closed except those required for engineered safeguards. Reactor building isolation occurs on a signal of high pressure in the reactor building.

Containment Air Filtration: Air passes through a roughing filter, HEPA filter, an electric heater, and then a charcoal filter before passing to the vent stack.

Penetration Room: All penetrations are grouped and in penetration areas except the following: permanent equipment hatch, personnel-access lock, main steam and feed water lines, and emergency personnel lock.

Organic-Iodide Filter: Reactor building ventilation system "to clean air of gross particulate matter" (p 9-33).

Hydrogen Recombiner: Not found.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Two flooding tanks are each connected to a reactor vessel nozzle. The system provides automatic flooding injection with initiation of flow when reactor coolant system pressure reaches ∿600 psi. Each tank holds about 7000 gallons. The combined coolant content of the two flooding tanks is sufficient to recover the core hot spot within approximately 25 seconds after the largest pipe rupture has occurred.

High-head Safety Injection: Initiated by (a) low reactor coolant system pressure of 1500 psi, or (b) high reactor building pressure during power operation. Either signal will automatically start high-pressure injection flow to the reactor coolant system. Two pumps will each deliver 375 gpm @ 2000 psi. Emergency high-pressure injection will continue until reactor coolant system pressure has dropped to the point where core flooding tanks begin emergency injection.

Low-head Safety Injection: Two pumps with a total capacity of 3300 gpm supply borated water from the borated-water storage tank. When the supply is exhausted, suction is taken from reactor building sump. Decay heat coolers will cool the recirculated flow.

Reactor: Midland

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Based on B&W studies, reactor vessel will maintain its integrity.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems:

(a) Control room instrumentation monitoring rate of makeup water.
(b) Control room instrumentation monitoring additional reactor building activity.
(c) Radwaste instrumentation will indicate a large amount of water flow from the reactor building sump.

Failed-Fuel-Detection Systems: A system is being studied.

Emergency Power: Two diesel-generator sets provide two independent systems of emergency power. Each unit has capacity to meet the power requirements imposed by LOCA when there is no off-site power.

Control of Axial Xenon Oscillations:

Burnable Shims - 72 Zircaloy-4 elements, 144" lg with $A\ell_2O_3B_4C$

Part-Length Control Rods - Nothing found.

In-Core Instrumentation - Neutron flux detectors monitor core performance to provide a history of power distributions.

Unborated Water Control: All water used for emergency injector fluid will be kept at a minimum concentration of 2270 ppm boron. Boron content of reactor coolant is periodically reduced to compensate for fuel burnup. Supplied by makeup and purification system. Flow of dilution water to makeup tank must be initiated by operator.

Long-Term Cooling - Internal or External Systems: Decay-heat-removal pumps (2) and heat exchangers (2) are used after shutdown to reduce reactor temp from 280F to 140F in 14 hours. Pump capacity is 3000 gpm @ 450 psig each and heat exchangers can remove 30×10^6 Btu/hr each. This system can be used for long-term cooling.

F. MISCELLANEOUS	Reactor: Midland

Windspeed, Direction Recorders, and Seismographs: Records for studies from Dow plant across the river and the Saginaw Airport. A site tower was not mentioned. Seismographs not mentioned.

Plant Operating Mode: Load following

Site Features: Located on the south, or west bank, of the Tittabawassee River across from the Dow Chemical plant and the city limits of Midland, Mich. Site consists of ~370 acres with site grade of 634 ft. The site is flat and surrounding country is rolling. Land usage surrounding the site for 5 miles is either industrial and residential on the north and east, or wooded and farming on the south and west. Population in 2 mile radius was 4577 and in 5 miles 19,852 in 1968.

Turbine Orientation: Centerlines of 2 reactors and 2 turbines are ~165 ft apart. Ejected turbine blades could strike containment structures.

Emergency Plans: Prescribes immediate action by plant personnel to minimize exposure of persons to radiation both within the exclusion area and outside the exclusion area from any accidental plant release of sufficient magnitude to pose a hazard. In addition, this plan prescribes action to be taken in order of priority, describes responsibilities of personnel and summarizes personnel and material resources available.

Environmental Monitoring Plans: Could find very little information of this nature.

Radwaste Treatment: System designed to collect, monitor and process all liquid, gaseous, and solid wastes. Controlled releases of liquid and gases will be made to the environment within limits of 10CFR20. Liquids are either stored or held for controlled discharge. Gases are released through the stack. Solid wastes are packaged for offsite disposal.

Stack Height - Not found.

Waste Heat System: Closed cycle cooling using a 14,000 acre cooling pond. The pond provides reserve cooling for storage for 100 days so that no water need be taken from the river for makeup during the three-month period when river flow is low. Normal makeup for evaporation (18,000 gpm) is taken from the Tittabawassee River.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Midland Plant
THERMAL OUTPUT, MWt 2452	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-329 50-330

NEARBY BODY OF WATER Tittabawassee River NORMAL LEVEL < 600' (MSL)

MAX PROB FLOOD LEVEL 632' (MSL)

SIZE OF SITE ~370 ACRES SITE GRADE ELEVATION 634' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 4577 (1968) IN 5 MI RAD 19,852 (1968)

NEAREST CITY OF 50,000 POPULATION Bay City, Michigan

DISTANCE FROM SITE 19 MILES POPULATION 53,604 (1960)

LAND USE IN 5 MILE RADIUS North & East is Industrial and Residential. The South & West is Wooded and Agricultural.

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed cycle using Cooling Pond

WATER TAKEN FROM 14,000 acre-ft cooling pond FOR condenser cooling

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

RIVER FLOW 1450 (cfs) avg. *QUANTITY OF MAKEUP WATER 16,000 (gpm)

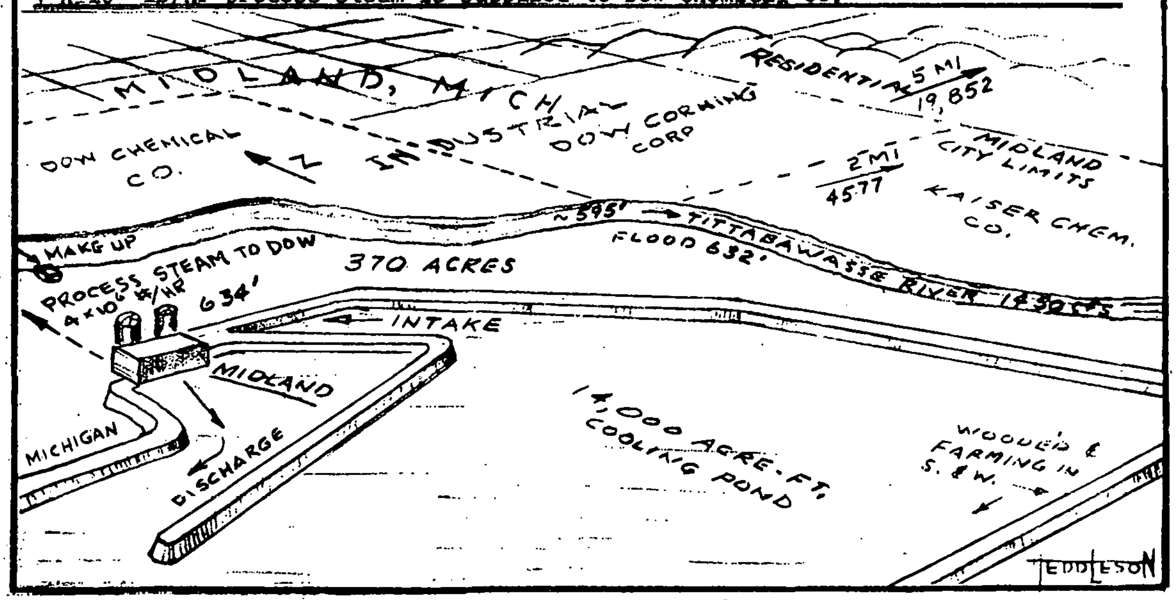
*TOTAL FLOW THROUGH CONDENSERS - (gpm) TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS None. Makeup water taken from river, intake cap is 90,000gpm

OTHER INFORMATION Cooling pond has reserve water for 100 days of operation.

4×10^6 lb/hr process steam is supplied to Dow Chemical Co.



DUANE ARNOLD, 50-331 (BWR) Page 1

Project Name: Duane Arnold Energy Center
Location: Near Palo, Linn County, Iowa
Owner: Iowa Electric & Power Company
NSS Vendor: GE Company

Reactor: Duane Arnold
A-E: Bechtel
Vessel Vendor: CB and I
Docket No.: 50-331
Containment Constructor: Not specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1593	H_2O/UO_2 Volume Ratio	2.41
Electrical Output, MWe	550	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output for Safety Design, MWt	1670	Moderator Temp Coef Hot, No Voids	-39.0×10^{-5}
Steam Flow Rate, lb/hr	6.843×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	48.5×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	31,840	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.5	Doppler Coefficient, Operating	$\leq 1.3 \times 10^{-5}$
Maximum Heat Flux, Btu/hr-ft^2	428,400	Initial Enrichment, %	2.25
Average Heat Flux, Btu/hr-ft^2	163,933	Average Discharge Exposure, MWD/Ton	18,350
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	79
Average Fuel Rod Surface Temp °F	558	k_{eff}, All Rods In	---
MCHFR	≥ 1.9	k_{eff}, Max Rod Out	<0.99
Total Peaking Factor	2.6	Control Rod Worth, %	---
Avg Power Density, Kw/ℓ	50.9	Curtain Worth, %	0.029 (p3.6-17)
		Burnable Poisons, Type and Form	Flat, boron -- SST
		Number of Control Rods	89 cruciform
		Number of Part-Length Rods (PLR)	---

Compiled by: Fred Heddleson and Carlos Bell
Date:

TX-4377
(8-70)

Reactor: Duane Arnold

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.19	Design Winds in mph:	
Low Population Zone Dist., Mi.	6	At 0 - 50 ft	105 or 28 psf
Metropolis / Distance / Population Cedar Rapids, Iowa / 10 mi / 92,035 ('60)		50 - 150 ft	40 psf
Design Basis Earthquake Accel., g	0.12	150 - 400 ft	54 psf
Operating Basis Earthquake Accel., g	0.06	Tornado 300 mph tang ΔP = 3 psi/ 3 sec	
Earthquake Vertical Shock, % of Horizontal	80	Is intent of 70 design criteria Satisfied?	Yes

Peak Fuel Enthalpy on Rod Drop: 280 cal/gm

Recirculation Pumping System & MCHFR: MCHFR — Reactor can operate over range of feedwater temperatures (320–420F) without changes to the thermal margin MCHFR limit.

Protective System: Initiates rapid, automatic shutdown of reactor. Action taken in time to prevent fuel cladding damage and nuclear system process barrier damage following abnormal transients.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	56	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	56	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	45	Second Ctmt Leak Rate, %/day	100

Type of Construction: Primary containment is steel shaped like an inverted light bulb and surrounded by reinforced concrete. A suppression pool shaped like a torus surrounds the drywell and at a lower elevation. The torus is constructed of steel supported on a concrete foundation.

Design Basis: Designed to accommodate, without failure, the pressures and temperatures resulting from double-ended failure of any coolant pipe. Integrity of containment and associated systems designed and maintained so that off-site doses resulting from DBA will be below values of 10CFR100.

Vacuum Relief Capability: Primary containment designed for external pressure differential of 2 psig; vacuum breakers connect suppression chamber and drywell.

Post-Construction Testing: Both drywell and suppression chamber will be strength tested and leak tested together.

Penetrations: Electrical penetrations are double sealed and individually testable. Some penetrations have bellows seals and are testable.

Reactor: Duane Arnold

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Two independent pump loops with flow rated at 3020 gpm at 127 psia; either core-spray loop capable of preventing clad melting following a LOCA.

Auto-Depressurization System: Operates through pressure-relief valves to lower reactor system pressure so low pressure standby cooling systems can operate to flood the core.

Residual-Heat-Removal System (RHRS): The residual heat removal system (RHRS) is a system of pumps, heat exchangers and piping that fulfills the following functions:

1. Removal of decay heat during and after plant shutdown.
2. Injection of water into the reactor vessel following a LOCA rapidly enough to reflood the core and prevent fuel clad melting independent of other core cooling systems.
3. Removal of heat from primary containment following a LOCA to limit the increase in primary containment pressure.

High-Pressure Coolant-Injection System: 1 loop with rated flow at 2980 gpm using turbine pump powered by reactor steam; if HPCIS fails, pressure relief system (auto-depressurization) allows LPCIS and core spray to operate.

Low-Pressure Coolant-Injection System: An operating mode of RHRS to supply large quantities of water to the reactor core at low-pressures. Suction is taken from suppression pool. Four 1/3 cap. pumps are available, each rated 4800 gpm @ 20 psia.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: The condensate storage tank and suppression pool are main sources of water. In recirculation cooling phase, water is pumped from containment sumps.

Main-Steam-Line Flow Restrictors: Installed in each steam line close to the reactor vessel.

Control-Rod Velocity Limiters: Attached to each control rod; limits reactivity insertion rate.

Control-Rod-Drive-Housing Supports: Located under reactor vessel near rod housing; limits rod travel if housing breaks; may be removed and inspected on shutdown.

Standby Liquid-Control System: Redundant, independent, and different system than control rods to achieve and maintain subcriticality - 13.4% sodium pentaborate.

Reactor: Duane Arnold
E. OTHER SAFETY-RELATED FEATURES (cont'd)
Containment Atmospheric Control System: Makeup air can be supplied to compensate for atmospheric density changes. Temp in drywell will average 135F with 150F max in other areas.
Reactor Core Isolation Cooling System (RCICS): Operates automatically to supply the reactor vessel with enough water so that operation of the core standby cooling systems (engineered safeguards) are not required even for a complete loss of feedwater flow. The system uses a steam driven turbine-pump.
Reactor Vessel Failure: (No specific considerations found) Missile & Reactor Forces - Primary containment protected against internal and external missiles and pipe motion. Core Cooling Capability - Containment Floodability - Can flood drywell to a level above reactor core.
Reactor-Coolant Leak-Detection Systems: Leakage is either identified or unidentified. Identified leakage is expected from seals, etc. and can be measured. Unidentified is measured by temperatures, pressure, humidity, and monitoring of sump pumps. Unidentified leakage limit is set at 15 gpm which is far below 150 gpm which is the minimum leakage from a crack that is large enough to propigate.
Failed-Fuel Detection Systems: The main steam line radiation monitoring system consists of four gamma radiation monitors located external to the main steam lines just outside of the primary containment. The monitors are designed to detect a gross release of fission products from the fuel. Upon detection of high radiation, the trip signals generated by the monitors are used to initiate a reactor scram and isolation of radioactive material released from the fuel.
Emergency Power: Two diesel generators, each rated at 2850 kw; each alone is capable of supplying power to shut down and maintain plant in a safe condition. Two 125-v dc systems, each with its own static battery charger, circuit breakers, and buses; spare battery charger; in addition, 2 independent 24/48-v buses each supplied by a center-grounded 48-v battery and a charger fed from a vital power bus; normal auxiliary power is the startup auxiliary transformer, and the power for this is the 161 bus in the main substation; there are 3 incoming 161-kv lines, 2 incoming 345-kv lines, 2 auxiliary transformers.
Rod-Block Monitor: Reactor manual control system includes controls that restrict rod movement (rod block) under certain conditions as a backup to procedural control. RBM subsystem prevents fuel damage.
Rod Worth Minimizer: For manual control; patterns and sequences with reactivity changes low enough to prevent nuclear system process barrier damage.

Reactor: Duane Arnold

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Meteorological equipment to be erected to record wind data, etc. Seismographs not mentioned.

Plant Operating Mode: Load following by adjusting recirculating pump speeds.

Site Features: Located on the west side of the Cedar River where it flows north to south. Site grade is 757 which is about 20 feet above normal river level, but about 9 feet below max probable flood. Site is flat with rolling hills to the west, but hilly on east side of river. The area is sparsely populated (about 275 in 2 mile radius) with farming being major land usage. Cedar Rapids (∿100,000 population) is ten miles south.

Turbine Orientation: Centerline distance between turbine and containment is ∿220 ft. Ejected turbine blades could strike containment.

Emergency Plans: Emergency plans will be formulated with appropriate public agencies so that problems which may arise during any emergency involving personnel, on site or off-site can be handled in an orderly effective manner. Training for all will be given and periodic practice drills will be held.

Environmental Monitoring Plans: A continuing environmental radiation monitoring survey program is scheduled to commence no later than one year prior to commercial operation. The program will enable determination of the magnitude and source nature of naturally occurring radioactivity at the plant site and surrounding areas. The program will include measurements of the air, aquatic life, soil and vegetation and water in the plant vicinity. This program will be planned in co-operation with federal, state and local agencies.

Radwaste Treatment: Liquid wastes are collected, stored, and/or treated for disposal through the service water effluent or returned to the condensate system. Solid wastes are collected, processed, and packed into 55 gal. drums for disposal off-site. Gaseous wastes are collected, processed, held for decay and discharged through the elevated release point.

Stack Height - 100 meters

Waste Heat System: Limited information available. Closed system cooling using mechanical draft cooling towers is indicated. Flow through condenser will be ∿260,000 gpm. Heat removal capacity of condenser is $3{,}681 \times 10^6$ Btu/hr. Average river flow at site is 3,065 cfs.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Duane Arnold Energy Center

THERMAL OUTPUT, MWt 1593

TYPE OF NUCLEAR STEAM SYSTEM BWR

DOCKET NO. 50-331

NEARBY BODY OF WATER Cedar River

NORMAL LEVEL ~735' (MSL)

MAX PROB FLOOD LEVEL 766' (MSL)

SIZE OF SITE 480 ACRES

SITE GRADE ELEVATION 757' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Rolling west of river, Hilly east of river

TOTAL PERMANENT POPULATION IN 2 MI RAD 275 (1970) IN 5 MI RAD 2730 (1970)

NEAREST CITY OF 50,000 POPULATION Cedar Rapids, Iowa

DISTANCE FROM SITE 10 MILES POPULATION 92,035 (1960)

LAND USE IN 5 MILE RADIUS Agricultural (80%), other lands are Wooded

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed loop using cooling towers

WATER TAKEN FROM Cedar River FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

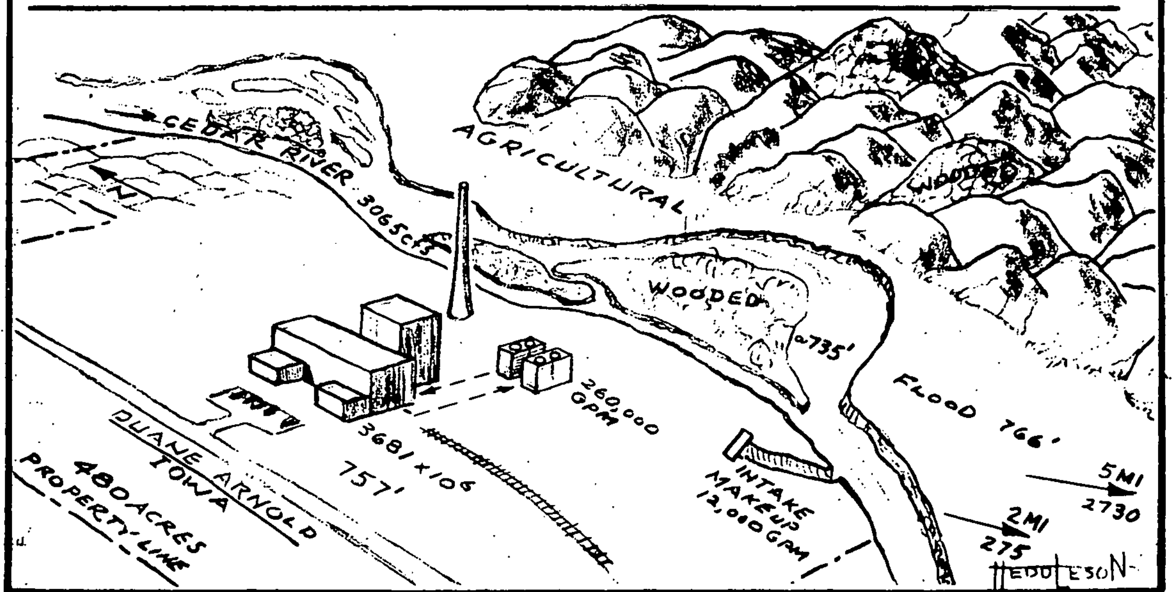
RIVER FLOW 3,065 (cfs) avg. *QUANTITY OF MAKEUP WATER 12,000 (gpm)

*TOTAL FLOW THROUGH CONDENSERS 260,000 (gpm) TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS $3,681 \times 10^6$ (Btu/hr) *Per Unit

COOLING TOWERS Drawings indicate the use of two mechanical-draft towers.

OTHER INFORMATION



FITZPATRICK, 50-333 (BWR) Page 1

Project Name: James A. Fitzpatrick Nuclear Power Plant
Location: Scriba, Oswego Co., N.Y.
Owner: Pwr. Authority of the State of NY
NSS Vendor: G.E.

Reactor: Fitzpatrick
A-E: Stone & Webster
Vessel Vendor: G.E.
Docket No.: 50-333
Containment Constructor: Chicago Bridge

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2436	H_2O/UO_2 Volume Ratio	2.41
Electrical Output, MWe	815	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output for Safety Design, MWt	2550	Moderator Temp Coef Hot, No Voids	-39.0×10^{-5}
Steam Flow Rate, lb/hr	10.47×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-5}
Total Core Flow Rate, lb/hr	75.5×10^6	Moderator Void Coef Operating	-1.6×10^{-5}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	48.451	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.5	Doppler Coefficient, Operating	$\leq 1.3 \times 10^{-5}$
Maximum Heat Flux, Btu/hr-ft^2	429,000	Initial Enrichment, %	2.23
Average Heat Flux, Btu/hr-ft^2	164,734	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	43.1
Average Fuel Rod Surface Temp °F	558	k_{eff}, All Rods In	0.96
MCHFR	≥ 1.9	k_{eff}, Max Rod Out	<0.99
Total Peaking Factor	2.6	Control Rod Worth, %	0.01 ΔK_{eff}
Avg Power Density, Kw/ℓ	51.2	Curtain Worth, %	---
		Burnable Poisons, Type and Form	Flat curtains - boron/SST
		Number of Control Rods	137
		Number of Part-Length Rods (PLR)	---

Compiled by: Fred Heddleson
Date: February 1969

TX-4377
(8-70)

	Reactor: Fitzpatrick
C. SAFETY-RELATED DESIGN CRITERIA	

Exclusion Distance, Mi. 0.57	Design Winds in mph:
Low Population Zone Dist., Mi.	At 0 - 50 ft 90
Metropolis / Distance / Population Syracuse, N.Y. 36 Mi. 216,038 (60)	50 - 150 ft 105
Design Basis Earthquake Accel., g 0.15	150 - 400 ft 125
Operating Basis Earthquake Accel., g 0.08	Tornado 300 mph tang. + 60 trans. ΔP = 3 psi/3 sec
Earthquake Vertical Shock, % of Horizontal 66	Is intent of 70 design criteria Satisfied? Yes (P 1.5-1)

Peak Fuel Enthalpy on Rod Drop:

280 cal/gm

Recirculation Pumping System & MCHFR: Reactor power level is controlled by a combination of control rod positioning and reactor coolant recirculation flow.

Protective System: Two trip systems. High neutron flux (120%) monitored in both systems will scram reactor. Shutdown also on reactor high pressure, low water level, or loss of power to protective system, M-G sets

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	56	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	56	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	46	Second Ctmt Leak Rate, %/day	100

Type of Construction: Pressure-suppression-steel-primary containment (drywell & suppression chamber) surrounded by reactor building for secondary containment. Drywell is steel surrounded by reinforced concrete and the suppression chamber is a steel torus in a concrete chase.

Design Basis: To provide capability in event of postulated LOCA to limit fission-product release so that off-site doses would be held below 10CFR100 limits. Design-basis accident is a double-ended pipe rupture.

Vacuum Relief Capability: Primary Containment designed for 2 psig external press. Relief valves prevent vacuum from exceeding 2 psig. Vacuum breaker valves vent supprn chamber to drywell.

Post-Construction Testing: Drywell and suppression chamber tested pneumatically for leakage at 56 psig. Penetrations tested same. Reactor bldg is leak-checked with bldg at negative 0.25 in. H_2O.

Penetrations: There are both double and single sealed penetrations. All those with resilient seals or gaskets have provision for individual testing (p 5.1-31)

Reactor: Fitzpatrick

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Two independent loops, each with centrifugal pumps and reactor-vessel spray sparger ring. Pump capacity is 4625 gpm @ 120 psid. Water supply is the suppression pool. Low water level in the reactor or high pressure in the drywell initiates the system. LPCIS starts from the same signals. A-C pump motors have separate bus standby power.

Auto-Depressurization System: Reduces reactor pressure by use of pressure-relief valves so the LPCI & core spray systems will begin operation. Auto-depress. system is operated auromatically upon coincident signals of reactor low water level, high drywell pressure and HPCIS low discharge.

Residual-Heat-Removal System (RHRS): To adequately cool core after LOCA, to cool supprn pool, and to provide redundancy for core standby cooling system. RHRS consists of 2 loops, each with one heat exchanger, 2 main pumps, and 2 service-water pumps. All designed to Class-I seismic criteria. The shutdown cooling system, reactor-vessel head spray, and containment cooling are part of RHRS.

High-Pressure Coolant-Injection System: There is one loop with 4220 gpm capacity at 1120 to 150 psi diff press. Water comes from the 100,000 gal condensate storage tank or the supprn pool. A steam turbine using reactor steam drives a constant flow pump which injects water tryough the feedwater piping. This system will operate until the LPCIS starts.

Low-Pressure Coolant-Injection System: Four pumps each with a capacity of 7700 gpm @ 20 psid start when pressure drops low enough and begin to inject borated water into the reactor to flood the core.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: Comprised of 4 systems: the HPCIS, the automatic depressurization system, the core spray system, and the low pressure coolant injection system(LPCIS) a mode of RHRS.

Main-Steam-Line Flow Restrictors: Installed in each main line near reactor to limit loss of water from the reactor in case of steam-line rupture. It is a venturi-type restrictor with 0.6 ratio of diameters.

Control-Rod Velocity Limiters: An integral part of the bottom of each control rod, restricting withdrawal velocities so reactivity addition rate is limited to a safe value.

Control-Rod-Drive-Housing Supports: Protects against further damage, preventing significant nuclear transient if a drive housing breaks or separates from the bottom of the reactor vessel. The drive housing falls 1/4 inch and is caught there by the supports.

Standby Liquid-Control System: Provides redundant capability for reactivity control, independent of control rods, to achieve or maintain reactor subcritical. Sodium pentaborate (13.4 %) is used.

Reactor: Fitzpatrick

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: Two fan-coil units hold temp below 150 F during normal operation. A purge system provides ventilation for maintenance operations and purges containment if radioactivity level is above limits. Three air changes per hour for drywell and suppression pool are possible. Nitrogen purge connections are available for future if needed.

Reactor Core Isolation Cooling System (RCICS): Provides core cooling during shutdown, removing decay heat by pumping makeup water into the reactor vessel. Used in case of loss of flow from the feedwater system and/or especially if reactor is isolated from its normal heat sink. RCIC delivers design flow in 30 sec from a storage tank with reserved volume sufficient for 8 hr use. This supply is shared with HPCIS. Suppression pool is backup supply. If RCIC can't maintain core cooling, the standby core cooling system starts.

Reactor Vessel Failure: Considered incredible (p 5.1-11)

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: There is a seal-ring leak-detection system for reactor vessel, and leakage at pump seals is monitored.

Failed-Fuel Detection Systems: Main steam-line monitoring system will indicate failed fuel by high radiation readings in any main steam line. This system can initiate reactor shutdown. Four channels do the monitoring.

Emergency Power: Two completely independent auxiliary ac power systems are available. Either one alone can supply power required to shut down and maintain plant in safe condition. Each system has two 4160-v diesel generators installed in separate rooms. Each has 4160-v switch gear and a 600-v unit substation. Diesel fuel is available for 7 days of continuous operation. The estimated total load is 4250 hp.

Rod-Block Monitor: This subsystem hinders control rod with-drawal 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. Computer system performs the averaging function. (Sect. 7.4.4.3)

Rod Worth Minimizer: Computer-programmed sequences that assist the operator in manual control so rod movements are sequenced to achieve minimum rod-worth changes. (Section 7.8.3.3)

Reactor: Fitzpatrick

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Aerovane wind instrument mounted on a 203-ft tower used for 1963-64 meteorological studies at the site. U.S. weather bureau at Oswego (7 miles) has weather data. Seismographs not mentioned.

Plant Operating Mode: Almost always will be base loaded.

Site Features: Located on the shore of Lake Ontario near its SE corner about 3000 ft east of Nine Mile Point Nuclear Station. The site is gently rolling with a site grade of 271' MSL which is well above the normal lake lever of about 246'. The land usage around the site is varied (Industrial, residential, recreational, and agricultural) Population within 5 mile radius is 1977 (1960 pop).

Turbine Orientation: Blades ejected from turbine cannot strike the containment structure.

Emergency Plans: Station operating staff will prepare written procidures to be used in all normal and emergency conditions. In the event of an unlikely, yet credible accident situation involving release of radioactivity to the public domain, personnel will follow procedures established by drills and training.

Environmental Monitoring Plans: A program established for Nine Mile Point Nuclear Plant will continue and probably be expanded in scope. The aim of the program is to demonstrate conformance to 10CFR20. The Final Safety Analysis Report for Nine Mile Point stated that the environment of the area has the capacity to safely absorb all the activity that can credibly be released during routine operations of both nuclear plants. Detailed studies of lake currents are under way to deter- the probable path and dilution of liquid effluents. Water temperature will be measured and effects of operation on fish invertigated.

Radwaste Treatment: Gaseous, liquid and solid waste disposal facilities wil be designed so that discharge of effluents and off-site shipment will be in accordance with 10CFR20 and DOT regulations. Process and discharge streams will be appropriately monitored and such automatic features incorporated as may be necessary to maintain releases below the permissible limits of 10CFR20.

Stack Height - 385 ft unlined reingorced concrete

Waste Heat System: A once-through cooling system will be used taking water from, and discharging back to, Lake Ontario. Atotal of 371,000 gpm will be used with 31.5 F temperature rise. New York State requires surface temperature of lake be raised no more than 3 F beyond a radius of 300 ft of discharge.

G. CIRCULATING WATER SYSTEM & SITE FEATURES	REACTOR NAME James A. Fitzpatrick Nuclear Power Plant	
THERMAL OUTPUT, MWt 2436	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-333

NEARBY BODY OF WATER Lake Ontario — NORMAL LEVEL 246' (MSL)

MAX PROB FLOOD LEVEL - (MSL)

SIZE OF SITE - ACRES — SITE GRADE ELEVATION 271' (MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 297 (1960) IN 5 MI RAD 1977 (1960)

NEAREST CITY OF 50,000 POPULATION Syracuse, New York

DISTANCE FROM SITE 36 MILES — POPULATION 216,138 (1960)

LAND USE IN 5 MILE RADIUS Industrial, Residential, & Recreational; however 40% of land in Oswego County is used for farming

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through

WATER TAKEN FROM Lake Ontario — FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG 37 F — SUMMER AVG 67 F — AVG - F

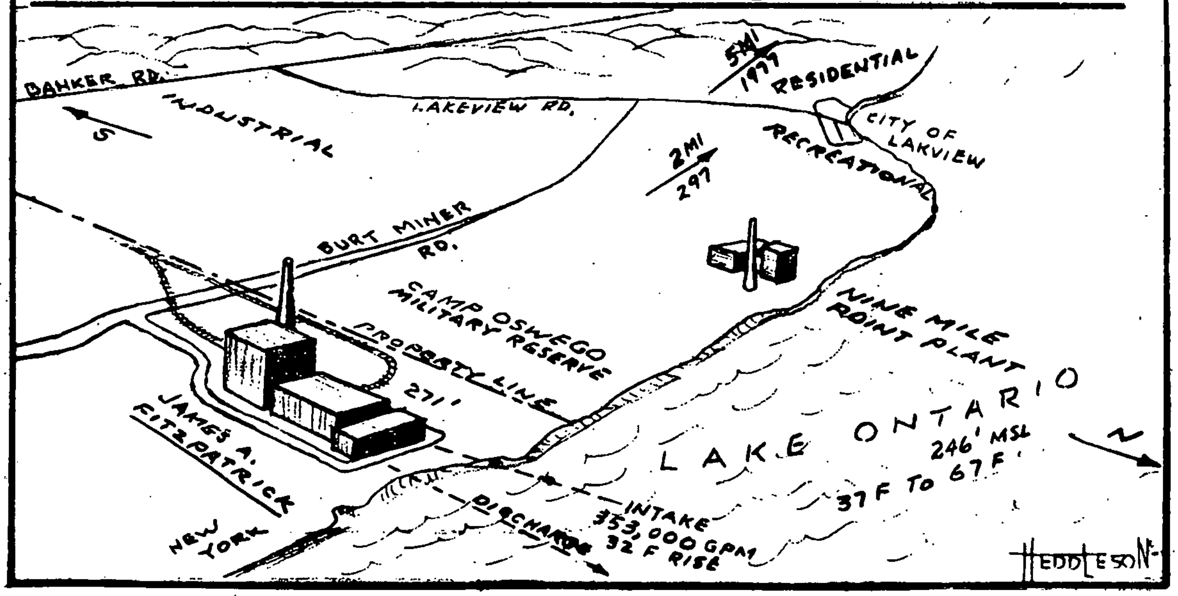
RIVER FLOW NA (cfs) avg. — *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 353,000 (gpm) — TEMPERATURE RISE 32 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) — *Per Unit

COOLING TOWERS None

OTHER INFORMATION New York State requires surface temperature of water be raised no more than 3 F beyond a radius of 300 ft of discharge.



BEAVER VALLEY, 50-334 (PWR) Page 1

Project Name: Beaver Valley Power Station
Reactor: Beaver Valley
A-E: Stone & Webster
Location: Beaver Co., Penn.*
Vessel Vendor: Westinghouse
Owner: Duquesne Light Company
Docket No.: 50-334
NSS Vendor: Westinghouse
Containment Constructor: Stone & Webster
* 25 mi NW Pittsburgh

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output. MWt	2660	H_2O/U, Cold	4.18
Electrical Output, MWe	847	Avg 1st-Cycle Burnup, MWD/MTU	14,500
Total Heat Output for Safety Design, MWt	2774	First Core Avg Burnup, MWD/MTU	24,000
Total Heat Output, Btu/hr	9051×10^6	Maximum Burnup. MWD/MTU	
System Pressure, psia	2250	Region-1 Enrichment, %	2.0
DNBR, Nominal	1.85	Region-2 Enrichment, %	2.6
Total Flow rate, lb/hr	100.7×10^6	Region-3 Enrichment, %	3.2
Eff Flowrate for Heat Trans lb/hr	95.5×10^6	k_{eff}, Cold, No Power, Clean	1.207
Eff Flow Area for Heat Trans, ft^2	41.8	k_{eff}, Hot, Full Power Xe and Sm	1.137
Avg Vel Along Fuel Rods, ft/sec	14.2	Total Rod Worth, %	
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.30×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1460
Nominal Core Inlet Temp, °F	543.5	Shutdown Boron, No Rods, Clean, Hot, ppm	1560
Avg Rise in Core, °F	70.2	Boron Worth, Hot, % Δk/k/ppm	1% for 85 ppm
Nom Hot Channel Outlet Temp, °F	643.6	Boron Worth, Cold, % Δk/k/ppm	1% for 70 ppm
Avg Film Coeff, Btu/hr ft^2, °F	5420	Full Power Moderator Temp Coeff, Δk/k/°F	$+0.3 \times 10^{-4}$ to -3.5×10^{-4}
Avg Film Temp Diff, °F	35.2	Moderator Press Coeff, Δk/k/psi	-3.0×10^{-6} to $+3.5 \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	42,460	Moderator Void Coeff Δk/k/% Void	$+0.5 \times 10^{-3}$ to -2.5×10^{-3}
Avg Heat Flux, Btu/hr ft^2	207,600	Doppler Coefficient, Δk/k/°F	-1.0×10^{-5} to -1.6×10^{-5}
Max Heat Flux Btu/hr ft^2	543,300	Shutdown Margin, Hot One Rod Stuck, % Δk/k	2.9 EOL
Avg Thermal Output, kw/ft	6.2	Burnable Poisons, Type and Form	Borosilicate Glass
Max Thermal Output, kw/ft	17.9	Number of Control Rods 45 × 20	900
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 8 × 20	160
No. Coolant Loops	3		

Compiled By: Fred Heddleson
Date: February 1969

Reactor: Beaver Valley

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.23 rad	Design Winds in:	psf	Gust Coef.
Low Population Zone Dist., Mi.	3.6	At 0 - 50 ft elev	21	1.7
Metropolis: Pittsburgh, Pa.; Distance: 22; Population: 604,332 (60)		50 - 150 ft	30	1.4
Design Basis Earthquake Accel., g	0.125	150 - 400 ft	40	1.0
Operating Basis Earthquake Accel., G	0.06	Tornado	300 mph tang. + 60 trans.	
Earthquake Vertical Shock, % of Horizontal	66	ΔP = 3 psi/ 3 sec		

Is intent of 70 Design Criteria satisfied? Yes

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	45	Calculated Max Internal Press, psig	42.2
Max Leak Rate at Design Press, %/day	0.1		

Type of Construction: Steel-lined, reinforced concrete cylinder with hemispherical dome and flat reinforced-concrete foundation mat.

Design Basis: Designed to limit release of fission products in case of LOCA caused by double-ended pipe rupture. Containment will be maintained at subatmospheric pressure during normal operation.

Vacuum Relief Capability: Max. design vacuum is 8.7 psia. Inner steel shell designed to withstand max. vacuum that can be attained.

Post-Construction Testing: Air-pressure test conducted on containment using 115% of containment pressure. Held for 1 hr. Leakage rates are checked for 3 pressures after construction as well as periodically after operation.

Penetrations: "Similar to those in reactor power stations now being licensed. A preliminary evaluation of these features indicates no leakage paths to environment. As final design is performed, a more detailed analysis is made to establish this preliminary evaluation conclusively." (page 5.5-1).

Weld Channels: All welded seams in the mat, cylindrical liner wall, hemispherical dome, and liner penetrations are covered with continuously welded test channels. A pressurized halogen gas is put into the test channels, and the liner welds are examined for leaks, using a halogen gas detector.

Reactor: Beaver Valley

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Made up of two system. One is the Quench Spray, other is the Recirc. Spray. These two, operating together, reduce containment temp and return containment pressure to subatmospheric. Recirculation Spray maintains sub-atmospheric pressure and transfers heat to the river cooling water. Quench Spray, with chemical additives reduces concentration of airborne fission products. Quench Spray System uses two full-capacity dual-drive pumps.

Containment Cooling: Recirculation spray cools containment by spraying cooled water into the containment space. Water is recirculated through heat-exchangers, which are cooled by river water.

Containment Isolation System: A means of isolating primary containment by closing off penetrations through containment walls. This closing of valves occurs automatically to prevent release of radioactivity in the event of LOCA. Action follows coincident and redundant containment high-pressure signals, or by coincident pressurizer low-level and low-pressure signals.

Containment Air Filtration: Supply air filtered. Exhaust filtering not mentioned. Air exhausted at a point 10-ft higher than turbine-building roof.

Penetration Room: None shown on sketches.

Organic-Iodide Filter: Nothing found.

Hydrogen Recombiner: Not found.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Designed to ASME Section III Class-C code. Three tanks, 1 per loop (carbon steel - stainless steel lined). Design press. 700 psig. Water volume at operating conditions - 925 ft^3 (∿7000 gal.) On pipe rupture, 2 accumulators deliver to the core and one to the broken pipe loop.

High-head Safety Injection: Pumps borated water into reactor from boron injection tank and then from refueling water storage tank. Pump data - 3 available for 150 gpm at 2750 psig. Boron injection tank capacity is 900 gallon.

Low-head Safety Injection: Low-head injection pumps draw water from the refueling water storage tank. Two pumps are available for 3000 gpm at 300-psig flow.

Reactor: Beaver Valley

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces - Pipe-support system designed to preclude damage to other lines and equipment in case of one line break.

Core Cooling Capability - Three systems available for core cooling - safety injection by accumulators, and two independent pumping systems.

Containment Floodability - Found nothing indicating that containment can be flooded.

Reactor-Coolant Leak-Detection Systems: Coolant leaks would be detected by equipment which continuously monitors containment air activity and humidity. Readout is in control room. Coolant leakage which raises containment air activity would be detected by the air-particulate monitor and/or the gas monitor. The humidity instrument detects increases in moisture which might occur if coolant leaked. Operation frequency of containment sump pumps would show change in conditions.

Failed-Fuel-Detection Systems: Reactor coolant monitored using high range and low range detectors. High range would indicate failed fuel. It uses an ion chamber which detected Co-60.

Emergency Power: Two separately independent diesel generators rated at 4100 v, 2850 kw. Generator sets are isolated from each other. Either generator set is capable of powering the engineered-safeguards equipment needed for LOCA. Generators can come up to speed and accept load within 10 seconds. Two completely independent 125-v dc battery systems are available, each consisting of 60-cell lead-acid battery, battery charger and distribution panel.

Control of Axial Xenon Oscillations:

Burnable Shims - Borosilicate glass

Part-Length Control Rods - These are available and operate only by manual control.

In-Core Instrumentation - System gives information on neutron flux distribution & fuel temperatures. Both radial & azimuthal symmetry of power can be evaluated by combining flux & temp info from one quadrant w/similar data from other .

Unborated Water Control: (page 7.6.2-1)

A boron recovery system collects radioactive reactor coolant and separates it into stripped liquid and gas. The stripped liquid is evaporated to reclaim boric acid (9.2-1).

Long-Term Cooling - Internal or External Systems: Internal long-term cooling is provided by 2 separate low-pressure safety-injection subsystems. External cooling is provided by the recirculation spray system.

Reactor: Beaver Valley

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Unit located at Shippingport Atomic Power Station near station grade, and units at Greater Pittsburg Airport were used for wind-data studies. No mention of seismographs.

Plant Operating Mode: Load following

Site Features: Located on the south bank of the Ohio River on 420 acre site about 25 mi NW of Pittsburgh. River at this point is about 1 mi wide with 730' elevation set as max probable flood. Site grade has two levels (707' and 735') required because of the hilly nature of the site. Population within 2 mi radius is 7760 (68), a small town existing across the river about 1 1/2 miles away. Close-in to the site, land use is mostly industrial.

Turbine Orientation: Reactor-building centerline is about 300 ft perpendicular to turbine centerline. Ejected blades could strike containment structure.

Emergency Plans: Effective measures will be provided to protect operating personnel and the general public in case of a major accident such as fire or accidental release of radioactivity. Station personnel will be trained and familiar with emergency procedures. The Aliquippa Hospital staff is currently familiar with procedures for handling contaminated and injured personnel.

Environmental Monitoring Plans: Preoperational and post-startup programs will be done to learn the identity and concentrations of radioactive materials in the environment, and to identify probable sources. The program will be designed to verify that radioactivity releases from the station do not represent a hazard to the general public and are within permissible limits. To detect and document any significant increases in environmental radiation levels resulting from operations, and to verify its effectiveness of the radiological control program.

Radwaste Treatment: Provides equipment to collect, process, & prepare for disposal all radioactive liquid, gaseous, and solid wastes. After sampling, some liquid wastes are evaporated. Evaporator condensate is discharged to the river at concentrations below limits of 10CFR20 and other applicable regulations. Evaporator residues and noncombustible solid wastes are drummed, and combustible solid wastes are baled or drummed, for shipment to off-site disposal. Gaseous wastes are collected & stored until radioactivity level permits discharge at concentrations below the limits set forth in 10CFR20.

Stack Height - Height of stack could not be found.

Waste Heat System: A once-through cooling system is used with a mechanical draft, variable cycle, cooling tower that cools water before return to the river. Tower will operate in the summer, or at other times as required, to meet state standards of max river temp of 87 F and a max temp increase of 5 F.

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES	REACTOR NAME Beaver Valley Power Station	
THERMAL OUTPUT, MWt 2660	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-334

NEARBY BODY OF WATER Ohio River — NORMAL LEVEL 664.5' (MSL)

MAX PROB FLOOD LEVEL 707' (MSL)

SIZE OF SITE 420 ACRES — SITE GRADE ELEVATION 707 735 (MSL)

TOPOGRAPHY OF SITE Hilly

OF SURROUNDING AREA (5 MI RAD) Hilly to Mountainous

TOTAL PERMANENT POPULATION IN 2 MI RAD 7760 (1968) IN 5 MI RAD 17,098 (1968)

NEAREST CITY OF 50,000 POPULATION Pittsburgh, Penn.

DISTANCE FROM SITE 22 MILES — POPULATION 604,332 (1968)

LAND USE IN 5 MILE RADIUS Within 2 miles Industrial and Residential, furtner out it is agricultural

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through with cooling tower

WATER TAKEN FROM Ohio River — FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

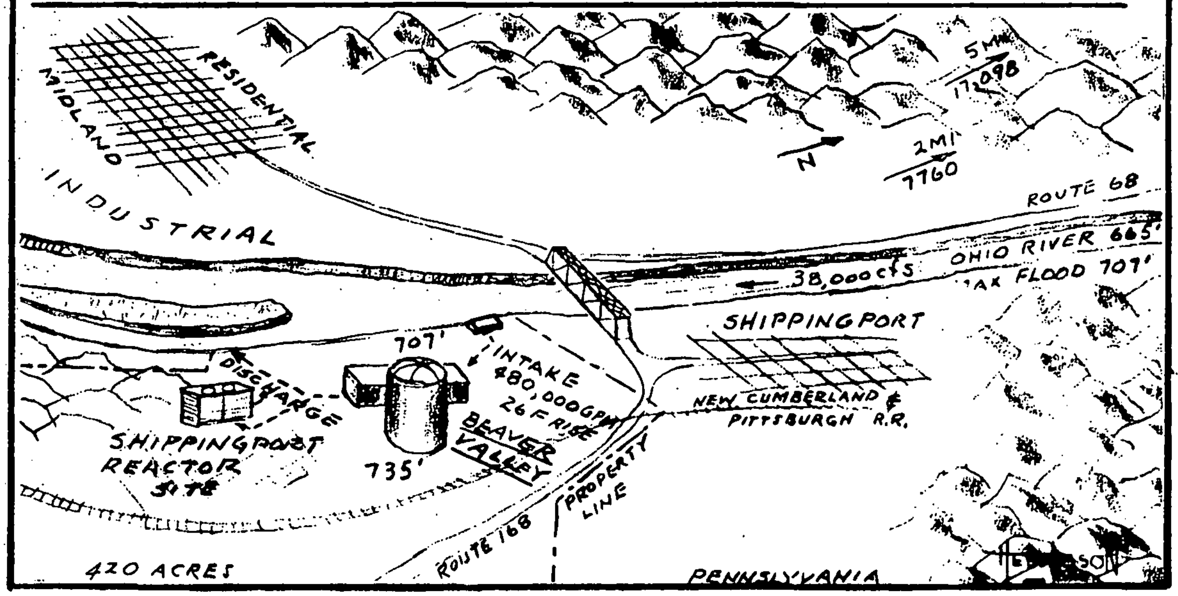
RIVER FLOW 38,000 (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 480,000 (gpm) TEMPERATURE RISE 26 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS Mechanical draft used in variable cycle to cool water before

OTHER INFORMATION return to river. Will operate in summer, or as required



NUCLEAR SAFETY INFORMATION CENTER

HUTCHINSON ISLAND, 50-335 & 50-389 (PWR) Page 1

Project Name: Hutchinson Island Plant, Units 1 & 2
Location: Ft. Pierce, Florida
Owner: Florida Power & Light Co.
NSS Vendor: Combustion Engineering

Reactor: Hutchinson Island
A-E: Ebasco
Vessel Vendor:
Docket No.: 50-335, 50-389
Containment Constructor:

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2440	H_2O/U, Cold	3.35
Electrical Output, MWe	825	Avg 1st-Cycle Burnup, MWD/MTU	11,900
Total Heat Output for Safety Design, MWt	2700	First Core Avg Burnup, MWD/MTU	21,060
Total Heat Output, Btu/hr	8330×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	1.80
DNBR, Nominal	2.15	Region-2 Enrichment, %	2.48
Total Flow rate, lb/hr	122×10^6	Region-3 Enrichment, %	2.93
Eff Flowrate for Heat Trans lb/hr	119.5×10^6	k_{eff}, Cold, No Power, Clean	1.288
Eff Flow Area for Heat Trans, ft^2	53.2	k_{eff}, Hot, Full Power Xe and Sm	1.153
Avg Vel Along Fuel Rods, ft/sec	13.8	Total Rod Worth, %	> 9.0
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.23×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1400
Nominal Core Inlet Temp, °F	550	Shutdown Boron, No Rods, Clean, Hot, ppm	1600
Avg Rise in Core, °F	53	Boron Worth, Hot, % Δk/k/ppm	---
Nom Hot Channel Outlet Temp, °F	652	Boron Worth, Cold, % Δk/k/ppm	---
Avg Film Coeff, Btu/hr ft^2, °F	5100	Full Power Moderator Temp Coeff Δk/k/°F	0 to -2×10^{-4}
Avg Film Temp Diff, °F	32	Moderator Press Coeff, Δk/k/psi	0 to 2×10^{-6}
Active Heat Trans Surf Area, ft^2	50,200	Moderator Void Coeff Δk/k/% Void	0 to -1.6×10^{-3}
Avg Heat Flux, Btu/hr ft^2	162,000	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -1.8)\times10^{-5}$
Max Heat Flux Btu/hr ft^2	501,000	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1.0
Avg Thermal Output, kw/ft	5.6	Burnable Poisons, Type and Form	Chemical Shim (Boric Acid)
Max Thermal Output, kw/ft	17.4	Number of Control Rods	85 Assemblies (425 Rods)
Max Clad Surface Temp, °F	658	Number of Part-Length Rods (PLR)	
No. Coolant Loops	2		

Compiled By: H. B. Piper and G. L. West
Date:

Reactor: Hutchinson Island

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi. 0.97 rad.	Design Winds in mph:
Low Population Zone Dist., Mi. 5 (2-23)	At 0 - 50 ft elev
Metropolis / Distance / Population West Palm Beach, Fla. 45 mi 61,000 (69)	50 - 150 ft 194 mph
Design Basis Earthquake Accel., g 0.05 (2-79)	150 - 400 ft
Operating Basis Earthquake Accel., G ---	Tornado 337
Earthquake Vertical Shock, % of Horizontal	ΔP = - psi/ - sec

Is intent of 70 Design Criteria satisfied? Yes

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig 39.6	Calculated Max Internal Press, psig 44
Max Leak Rate at Design Press, %/day 0.05 (14.15-4)	

Type of Construction: Steel cylindrical vessel with hemispherical dome and ellipsoidal bottom, surrounded by concrete shielding building.

Design Basis: Double-ended break of the largest coolant pipe with unobstructed discharge from both ends. Pressure and temperature behavior is calculated taking into account heat sources, sinks, and engineered safety features.

Vacuum Relief Capability: There is a vacuum relief designed to limit differential pressure to 0.75 psi (5-5).

Post-Construction Testing: Periodic leak-rate tests will be made (5-50). Penetrations with expansion bellows may be tested at any time (5-49).

Penetrations: Double and individually testable.

Weld Channels: None.

Reactor: Hutchinson Island

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Two spray pumps take suction from refueling water tanks. Each of two spray headers can supply 100% of cooling required (6-11).

Containment Cooling: Four cooling units. Three are normally in use (6-13).

Containment Isolation System: High-pressure signal closes all redundant valves in fluid piping not required for emergency safety systems (5-33).

Containment Air Filtration: Two systems including HEPA filters and charcoal absorbers (5-38).

Penetration Room: Electrical penetration rooms shown at 2 different floor levels.

Organic-Iodide Filter: None

Hydrogen Recombiner: None

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks, 200 psig 1000 ft^3 each of borated water (6-5).

High-head Safety Injection: Three, 300 gpm, 2400-ft-head pumps (6-5).

Low-head Safety Injection: Two, 3000 gpm, 350-ft head pumps (6-5).

Reactor: Hutchinson Island

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Indicated by pressure or drain tank level and/or high makeup system flow (4-35).

Failed-Fuel-Detection Systems: Not found.

Emergency Power: Two 240-kv transmission lines (8-8). Two diesel generators each will supply engineered safeguard load (809). Also some battery backup (8-10).

Control of Axial Xenon Oscillations:

Burnable Shims - Dissolved boron (3-25)

Part-Length Control Rods - None

In-Core Instrumentation - Self-powered neutron detectors at 45 locations will provide 225 flux measurements (7-30).

Unborated Water Control: Reactor uses boron as a chemical shim. Chemical and volume coolant system has letdown system for pressure and temperature control; activity and boron monitor; ion exchange bids (9-3).

Long-Term Cooling - Internal or External Systems: Will remove 240×10^6 Btu/hr, using four 50,000-cfm fans with associated cooling coils; 3 units normally in operation (6-13).

Reactor: Hutchinson Island

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Meteorological tower to be erected in mid-1969 to measure winds, temperature, rain gage, humidity, and pressure. No seismographs discussed.

Plant Operating Mode: Load following.

Site Features: Plant is located on a narrow strip of land just off the east coast of Florida, known as Hutchinson Island. Site consists of 1132 acres. The Indian River which is the intercoastal waterway lies between the island and mainland. The site is flat and low (grade elev 18' MSL). Most land within 5 mi of the site is undeveloped or recreational. Population within 5 miles of the site is 1580. Fort Pierce is 8 miles NNE.

Turbine Orientation: ~140 ft west of containment perpendicular to E-W center line of containment (F 1-5). Ejected turbine blades could strike containment.

Emergency Plans: Plans with written procedures will be prepared to cover all foreseeable emergencies such as fire, personal injury and illness, radiation exposure, contamination, and other conditions nuclear or non-nuclear. Practice drills will be held. Outside agencies, such as Police, Fire Department, AEC, etc. will be called upon as required.

Environmental Monitoring Plans: Not found.

Radwaste Treatment: Waste management system is designed to provide treatment and disposal of liquid, gaseous, and solid wastes. Principal criteria is to insure that plant personnel and the general public are protected.

Stack Height - Not found.

Waste Heat System: Water will be taken from the Atlantic Ocean and discharged back to the ocean for a once-through cooling system using 530,000 gpm and heating the water 21 F. Intake and discharge pipes extend out 1200 feet from shore.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Hutchinson Island Plant, Units 1 & 2
THERMAL OUTPUT, MWt 2440	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-335 50-389

NEARBY BODY OF WATER Atlantic Ocean — NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 21' (MSL)

SIZE OF SITE 1132 ACRES — SITE GRADE ELEVATION 18' (MSL)

TOPOGRAPHY OF SITE Flat, much of it covered with water

OF SURROUNDING AREA (5 MI RAD) Flat

TOTAL PERMANENT POPULATION IN 2 MI RAD 140 (1978) IN 5 MI RAD 1580 (1978)

NEAREST CITY OF 50,000 POPULATION West Palm Beach, Florida

DISTANCE FROM SITE 41 MILES — POPULATION 61,000 (1969)

LAND USE IN 5 MILE RADIUS Undeveloped except for limited Residential and Recreational

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through

WATER TAKEN FROM Atlantic Ocean — FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG - F — SUMMER AVG - F — AVG - F

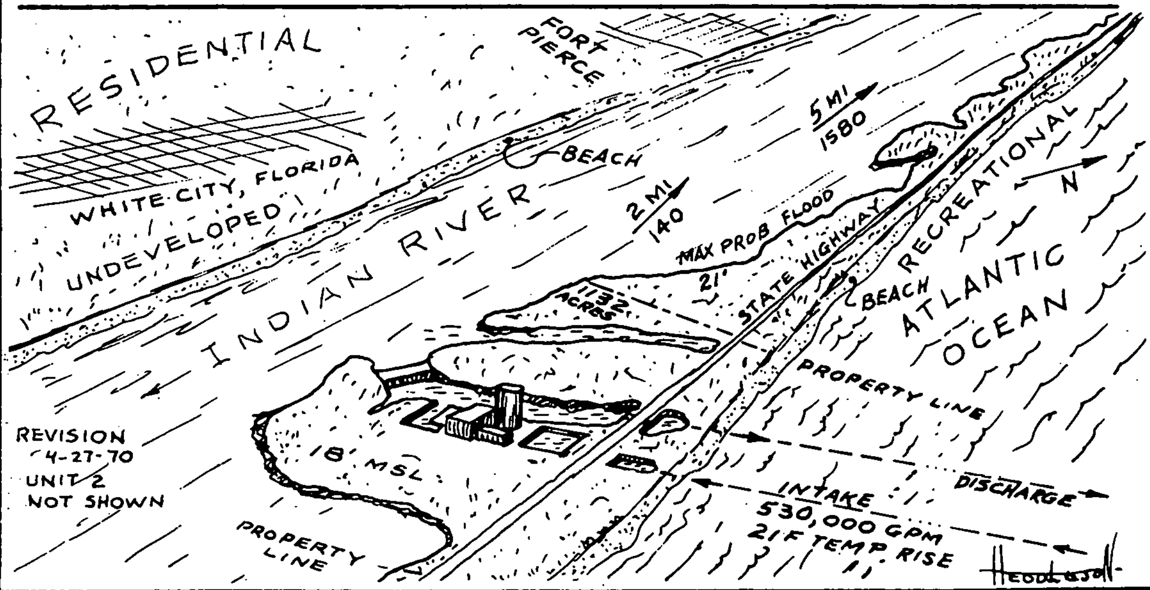
RIVER FLOW NA (cfs) — *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 530,000 (gpm) — TEMPERATURE RISE 21 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) — *Per Unit

COOLING TOWERS None

OTHER INFORMATION After passing through condensers, water will be discharged to the Atlantic Ocean.



MILLSTONE, 50-336 (PWR) Page 1

Project Name: Millstone Nuclear Pwr Sta., Unit 2
Reactor: Millstone, Unit 2
A-E: Bechtel
Location: Waterford, Connecticut
Vessel Vendor: Combustion Engineering
Owner: Connecticut Light & Power Co. et al
Docket No.: 50-336
NSS Vendor: Combustion Engineering
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	Initial Oper. 2560	H_2O/U, Cold	3.35
Electrical Output, MWe	828	Avg 1st-Cycle Burnup, MWD/MTU	11,900
Total Heat Output for Safety Design, MWt	2700	First Core Avg Burnup, MWD/MTU	21,060
Total Heat Output, Btu/hr	8740×10^6	Maximum Burnup, MWD/MTU	28,000
System Pressure, psia	2235 (2250 in T 1-1)	Region-1 Enrichment, %	1.80
DNBR, Nominal	1.95	Region-2 Enrichment, %	2.48
Total Flow rate, lb/hr	122×10^6	Region-3 Enrichment, %	2.93
Eff Flowrate for Heat Trans lb/hr	119.5×10^6 (p 1-14) 118.5×10^6 (p 3-8)	k_{eff}, Cold, No Power, Clean	1.286
Eff Flow Area for Heat Trans, ft^2	53.2	k_{eff}, Hot, Full Power Xe and Sm	1.153
Avg Vel Along Fuel Rods, ft/sec	13.9	Total Rod Worth, %	>9.0
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.23×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1400
Nominal Core Inlet Temp, °F	550	Shutdown Boron, No Rods, Clean, Hot, ppm	1600
Avg Rise in Core, °F	55	Boron Worth, Hot, % Δk/k/ppm	Not found
Nom Hot Channel Outlet Temp, °F	650	Boron Worth, Cold, % Δk/k/ppm	Not found
Avg Film Coeff, Btu/hr ft^2, °F	5260	Full Power Moderator Temp Coeff, Δk/k/°F	0 to -2×10^{-4}
Avg Film Temp Diff, °F	33	Moderator Press Coeff, Δk/k/psi	0 to 2×10^{-6}
Active Heat Trans Surf Area, ft^2	50,200	Moderator Void Coeff Δk/k/% Void	0 to -1.6×10^{-3}
Avg Heat Flux, Btu/hr ft^2	169,600	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -1.8) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	525,800	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1.0
Avg Thermal Output, kw/ft	5.9	Burnable Poisons, Type and Form	Not Specified
Max Thermal Output, kw/ft	18.2 20.4-max overpwr	Number of Control Rods	85 Assemblies 425 Rods
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	Not Mentioned.
No. Coolant Loops	2		

Compiled By: Fred Heddleson
Date: April 11, 1969

Reactor: Millstone, Unit 2

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.4	Design Winds in mph:
Low Population Zone Dist., Mi.	4 (p 2-3)	
Metropolis / Distance / Population: Hartford, Conn. / 41 mi. / 58,700 (69)		Design storm 136 mph (p 2-15)
Design Basis Earthquake Accel., g	0.17 (p 5-4)	
Operating Basis Earthquake Accel., G	0.07	Tornado 300 mph tang. + 60 trans.
Earthquake Vertical Shock, % of Horizontal	66	ΔP = 3 psi/ -sec

Is intent of 70 Design Criteria satisfied? Yes

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	54	Calculated Max Internal Press, psig	54
Max Leak Rate at Design Press, %/day	3.00 (p 5.46)		

Type of Construction: Double containment. Inner structure is prestressed post-tensioned concrete cylinder with dome top and flat base lined with steel plate. Outer enclosure building is limited-leakage steel-framed structure with metal siding and roof deck. Penetrations are leaktight. For LOCA, enclosure-building filtration region is held at small neg. press-exhaust filtered.

Design Basis: Containment and penetrations designed to contain pressures resulting from LOCA in which there is: (a) Max. pipe size double-ended break of reactor coolant; (b) simultaneous loss of external electric power; (c) core cooled by water from safety injection system; (d) air recirculation, CTMT spray system either or both function; (e) safety-injection tanks operate within 30 sec.

Vacuum Relief Capability: Vacuum breakers not required. Designed for 2-psi diff. press. outside to inside. CTMT can be cooled from 120°F to 50°F while sealed off without exceeding press.-diff. limits.

Post-Construction Testing: CTMT tested at 54 psig × 115% for leaktightness. Postoperational tests will be periodic at 50% of LCI press.

Penetrations: All single except refueling tube. Only electrical are testable.

Weld Channels: None installed.

Reactor: Millstone, Unit 2

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Sprays borated water to cool CTMT atmosphere. The spray system air recirculation coolers provides sufficient cooling when only one of the 2 spray pumps is running on emergency electric power. Each pump capacity is 1350 gpm @ 500-ft head. The system starts when CTMT reaches 26 psig. Pumps take suction from refueling water storage tank until that tank is empty. Suction is then transferred automatically to the CTMT sump.

Containment Cooling: The air recirculation system cools CTMT air. Three of the 4 recirculation cooling units (50 hp) have the same heat-removal capacity as the CTMT spray systems (240×10^6 Btu/hr). Water circulates thru the finned tubes and is cooled by one shutdown cooling heat exchanger.

Containment Isolation System: Isolation in nonessential process lines occurs coincident with safety-injection actuation signal. Essential process lines are isolated coincident with CTMT spray actuation signal. All above are double barrier.

Containment Air Filtration: Exhaust from filtration region passed thru charcoal filters to unit stack.

Penetration Room: Space between concrete containment vessel and outer enclosure building is the equivalent penetration room.

Organic-Iodide Filter: Standard type charcoal filters only.

Hydrogen Recombiner: None mentioned.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks, each having 7000-gal capacity of borated water. Design pressure is 250 psig. When pressure in reactor coolant system falls below 200 psig, check-valves open, dumping contents into the reactor coolant system and reactor vessel. Three of 4 tanks will cover the core sufficiently to prevent clad melting or metal-water reaction.

High-head Safety Injection: Three high-pressure pumps each rated for 300 gpm at 1750 psig. One pump running will deliver 225 gpm to the core. System is initiated by either low pressurizer pressure or high CTMT pressure. Supply comes from 350,000 gal. refueling water storage tank (borated water).

Low-head Safety Injection: Two low-pressure pumps are available, each having 3000 gpm capacity at 500 psig. One pump running will deliver 2250 gpm to the core. Supply is same as for high-pressure pumps. With mininum safety-injection system operating, for a 42-in. pipe break, maximum clad temperature occurs 25 sec after break, reaching about 1780°F (see Fig. 14.10-7).

Reactor: Millstone, Unit 2

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: There are several means for detection, such as: (a) Increased press or temp in CTMT; (b) Monitoring CTMT sump; (c) Increased air-borne activity in CTMT; (d) Change in liquid level in pressurizer, etc.; (e) Temp. increase of piping from relief & safety valves; (f) Activity increase indicated by condenser vacuum monitors. No sensitivity data given.

Failed-Fuel-Detection Systems: Studies are being conducted to determine the best location for a continuous gross-gamma monitor. The potential of delayed-neutron monitoring equipment and of single-channel spectrometry for a specific fission product is being evaluated (p 1-26).

Emergency Power: One 345-kv line from misc. outside sources. Two diesel generators are available, one of which can supply minimum required engineered safeguards. Two sets of 125-dc batteries supply emergency service to controls.

Control of Axial Xenon Oscillations:

Burnable Shims - Dissolved boron

Part-Length Control Rods - None

In-Core Instrumentation - Fixed neutron-sensitive detectors are spaced radially and axially in 45 core locations to provide 225 flux measurements.

Unborated Water Control: Concentrated boric acid is stored in 2 tanks. One tank has capacity to bring reactor coolant to cold shutdown concentration. Boron dilution is carried out under strict procedural controls with associated alarms so that unsafe dilution cannot occur.

Long-Term Cooling - Internal or External Systems: Internal cooling by low-pressure safety-injection systems and shutdown heat exchangers. External cooling by air recirculation units removing 240×10^6 Btu/hr.

Reactor: Millstone, Unit 2

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Not mentioned.

Plant Operating Mode: Load-following.

Site Features: Unit 2 of Millstone is adjacent to Unit 1 on 500 acres of land on a peninsula extending into Long Island Sound. Niantic Bay is on the west side from which cooling water is taken. The area is flat with site grade of 14' MSL. The surrounding land is mostly undeveloped except for recreational areas along the Sound. Population within 2 mi radius including summer-beach people is 4711, but within a 5 mi radius, there could be up to 60,000.

Turbine Orientation: Centerline about 150 ft west of containment centerline.

Emergency Plans: Written procedures will be used for emergencies such as fire, injuries or illness, radiation exposure, contamination, etc. Practice drills will be used for training and continued familiarity. Police and Fire Departments can be called for help, as can Coast Guard, AEC, etc. A Radiation Emergency Plan for LOCA is available.

Environmental Monitoring Plans: Radiation-level studies started in 1967 and will continue after operation. Studies include airborne particles, soil and vegetable samples, and marine life.

Radwaste Treatment: Liquid waste demineralized. Gaseous waste held for decay. Solid waste packaged and shipped for off-site disposal.

Stack Height: A steel vent stack extends 12 ft thru the roof and above outer enclosure building, 178 ft above grade. A 375' high stack will serve both Unit 1 and Unit 2.

Waste Heat System: A once-thru system takes water from Niantic Bay of Long Island Sound and discharges it into Twotree Channel of Long Island Sound. Water temperatures of the Sound average in the low 50's for the year (summer ∿68, winter ∿39). Unit 2 will use 540,000 gpm with a 22.5°F temp rise. Both 1 and 2 will use 970,000 gpm with 22.5°F temp rise.

G. CIRCULATING WATER SYSTEM & SITE FEATURES	REACTOR NAME Millstone Nuclear Power Station, Unit 2	
THERMAL OUTPUT, MWt 2560	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-336

NEARBY BODY OF WATER Niantic Bay (Long Is. Sd) NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 18' (MSL)

SIZE OF SITE 500 ACRES SITE GRADE ELEVATION 14' (MSL)

TOPOGRAPHY OF SITE Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD *4711 (1965) IN 5 MI RAD *58,700 (1965)

NEAREST CITY OF 50,000 POPULATION Hartford, Conn. *includes summer people

DISTANCE FROM SITE 41 MILES POPULATION 158,000 (1969)

LAND USE IN 5 MILE RADIUS Undeveloped-73%, Recreational-11%, Agricultural-9%, Residential-5%

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through using a quarry

WATER TAKEN FROM Niantic Bay FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG 39 F SUMMER AVG 68 F AVG 50 F

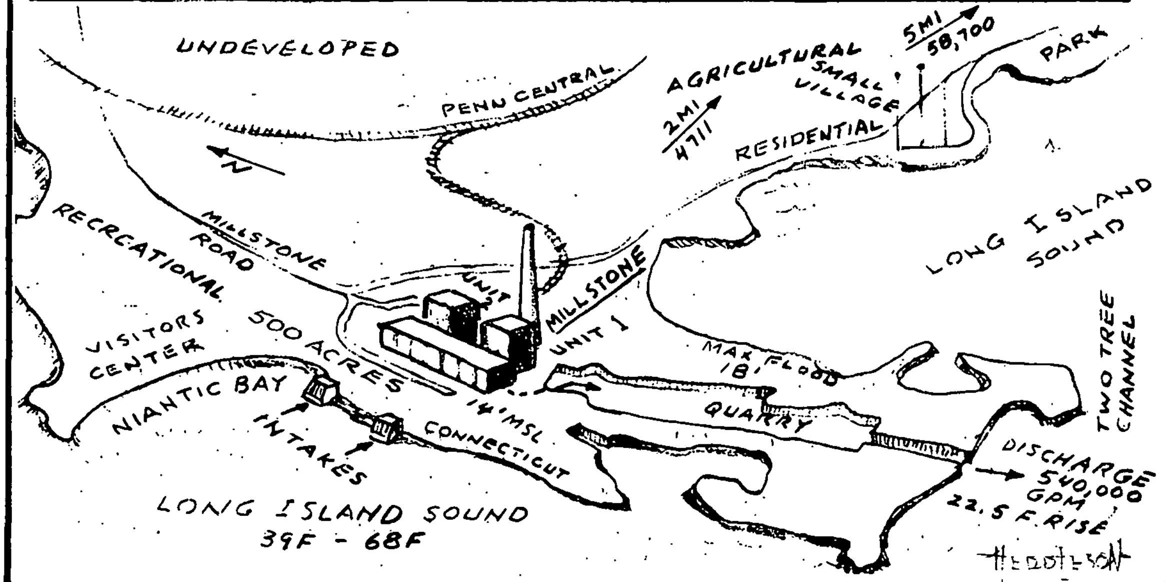
RIVER FLOW NA (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 540,000 (gpm) TEMPERATURE RISE 22.5 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS None

OTHER INFORMATION Condenser cooling water discharged into Two Tree Channel of Long Island Sound. Total condenser cooling for both units is 970,000 gpm.



NORTH ANNA, 50-338 & 50-339 (PWR)

Page 1

Project Name: North Anna Power Station, 1&2

Location: Louisa Co., Virginia†
Owner: Virginia Elec. & Power Co.
NSS Vendor: Westinghouse
† 40 mi. NNW of Richmond

Reactor: North Anna
A-E: Stone & Webster
Vessel Vendor: Not Specified
Docket No.: 50-338, 50-339
Containment Constructor: Stone & Webster

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2652	H_2O/U, Cold	*4.18
Electrical Output, MWe	892	Avg 1st-Cycle Burnup, MWD/MTU	*14,500 **13,500
Total Heat Output for Safety Design, MWt	2766	First Core Avg Burnup, MWD/MTU	*24,000
Total Heat Output, Btu/hr	$*8328 \times 10^6$	Maximum Burnup, MWD/MTU MWD/MTU	31,500
System Pressure, psia	*2250	Region-1 Enrichment, %	*2.0
DNBR, Nominal	*1.85	Region-2 Enrichment, %	*2.6
Total Flow rate, lb/hr	100.7×10^6	Region-3 Enrichment, %	*3.2
Eff Flowrate for Heat Trans lb/hr	$*96.2 \times 10^6$	k_{eff}, Cold, No Power, Clean	**1.190
Eff Flow Area for Heat Trans, ft^2	*41.8	k_{eff}, Hot, Full Power Xe and Sm	**1.085
Avg Vel Along Fuel Rods, ft/sec	*14.2	Total Rod Worth, %	*7.0
Avg Mass Velocity $lb/hr\text{-}ft^2$	$*2.30 \times 10^6$	Shutdown Boron, No Rods, Clean, Cold, ppm	*1460 **1350
Nominal Core Inlet Temp, °F	*543.5	Shutdown Boron, No Rods, Clean, Hot, ppm	*1560 **1310
Avg Rise in Core, °F	*70.2	Boron Worth, Hot, % Δk/k/ppm	~85
Nom Hot Channel Outlet Temp, °F	*644.6	Boron Worth, Cold, % Δk/k/ppm	~70
Avg Film Coeff, Btu/hr ft^2, °F	*5370	Full Power Moderator Temp Coeff, Δk/k/°F	* $(0.3 \text{ to } -3.5)10^{-4}$
Avg Film Temp Diff, °F	*38.7	Moderator Press Coeff, Δk/k/psi	* $(-0.3 \text{ to } 3.5)10^{-6}$
Active Heat Trans Surf Area, ft^2	*42,460	Moderator Void Coeff Δk/k/% Void	* -0.1 to 0.3 Δk/k per gm/cm^3
Avg Heat Flux, Btu/hr ft^2	*207,600	Doppler Coefficient, Δk/k/°F	* $(-1.0 \text{ to } -1.6)10^{-5}$
Max Heat Flux Btu/hr ft^2	*543,300	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1.0
Avg Thermal Output, kw/ft	*6.7	Burnable Poisons, Type and Form	Borosilicate Glass in SST Tube
Max Thermal Output, kw/ft	*17.9 20.0 peak power	Number of Control Rods	*900 + PLR
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	*160
No. Coolant Loops	3		

*Table 1.3.1
**Table 3.3-1

Compiled By: Fred Heddleson
Date: April 1969

Reactor: North Anna

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.83	Design Winds in psf:	
Low Population Zone Dist., Mi.	1 1/4	At 0 - 50 ft elev	27
Metropolis / Distance / Population Richmond, Va. / 40 mi. / 216,451(68)		50 - 150 ft	36
Design Basis Earthquake Accel., g	0.150	150 - 400 ft	40
Operating Basis Earthquake Accel., G	0.075	Tornado	300 tang. + 60 trans (mph)
Earthquake Vertical Shock, % of Horizontal	Not given	ΔP =	3 psi/ 3 sec

Is intent of 70 Design Criteria satisfied? Yes

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	45	Calculated Max Internal Press, psig	42.5
Max Leak Rate at Design Press, %/day	0.1		

Type of Construction: Steel-lined, heavily reinforced concrete structure with vertical cylindrical wall and hemispherical-dome roof supported on a flat reinforced concrete-foundation base mat.

Design Basis: Containment designed for highest pressure which results from a double-ended rupture of the largest pipe of the reactor coolant system (reactor vessel hot-leg). For DBA it is assumed that (a) loss of station power occurs and emergency power is supplied by one diesel generator, (b) minimum Engineered Safeguards are activated (accumulators, safety injection, and CTMT spray).

Vacuum Relief Capability: 3.7 to 5.7 psi vacuum during operation, but no relief capability mentioned. Steam-jet ejector used to pull vacuum down during startup. Vacuum then maintained by small vacuum pumps.

Post-Construction Testing: CTMT leakage continuously monitored. Penetrations and isolation valves tested for leakage.

Penetrations: ---

Weld Channels: Yes, installed over seam welds, pressurized to 50 psig with Freon-air mixture and tested during construction.

Reactor: North Anna

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Two systems: Quench Spray - 2 headers, each with its own pump. Pumps (2000 gpm ea) are dual-drive (steam & electric), pumping chilled water (45 F) from refueling-water storage tank. One of the 2 systems will supply full capacity for depressurization. Recirculation Spray - This system starts after refueling-water storage tank is near depletion. Four pumps are available for pumping from CTMT sump. Two pumps must run full design capacity. This system can run continuously for days for heat removal.

Containment Cooling: Air recirculation system cools CTMT air. Three cooling units of 75,000-cfm capacity each will maintain 105 F max. operating temp. Water circulated through cooling coils will be chilled by refrigeration system.

Containment Isolation System: Provides 2 barriers between outside atmosphere and (1) CTMT atmosphere and (2) reactor coolant system. All valves operate automatically, and positions are indicated in the control room. Leak tightness of valves can be monitored.

Containment Air Filtration: Two complete and independent filter systems (prefilter, absolute filter, and charcoal filter). One system will handle 1 liter/hr leakage with 1% failed fuel elements.

Penetration Room: None

Organic-Iodide Filter: Standard-type charcoal filters only.

Hydrogen Recombiner: None mentioned.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Three tanks of 7000-gal capacity each are maintained at 650 psig with nitrogen. Tanks operate when reactor-coolant-system pressure drops below 650 psig, spilling borated water into each coolant loop. If one loop runs water out on CTMT floor, the other two loops carry water to the reactor vessel to cover the core.

High-head Safety Injection: Three charging pumps each with 150-gpm capacity at 2500-psig draw borated water from the refueling water storage tank. One pump delivers through piping that charges 900 gal of 20,000 ppm borated water immediately into one hot leg. One charging pump supplies 100% design capacity.

Low-head Safety Injection: Two pumps with suction from refueling water storage tank injects into system at 300 psig. One pump supplies 3000 gpm or 100% design capacity.

Reactor: North Anna

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Missile & Reactor Forces - Core Cooling Capability - Containment Floodability -	Three modes of failure investigated in conjunction with safety injection of water following LOCA. Three modes are: ductile failure, brittle failure, and fatigue failure. In each analysis, vessel design was found adequate, and no credible failure is thought possible.

Reactor-Coolant Leak-Detection Systems: Several methods, as follows: (a) CTMT air particulate monitoring system (see below), (b) CTMT gas monitor, (c) Unusual quantity of makeup water for pressurizer, (d) CTMT sump water level, (e) CTMT pressure, temp, and humidity instrumentation. CTMT air-particulate monitor response time is a function of percent of failed fuel & rate of leakage - 1000 cc leakage with 1% failed fuel will be detected in one min. (See Fig. 4.2.7.1-1).

Failed-Fuel-Detection Systems: None mentioned. Section 3.5.2.2 indicates failure of fuel rod unlikely.

Emergency Power: Three diesel generators will function as follows to supply pwr for engineered safeguards needed following an incident: Generator No. 1 will be exclusively for reactor No. 1; generator No. 2 will be exclusively for reactor No. 2; and generator No. 3 will function as back-up for either No. 1 or No. 2 generator. Generator will start automatically on loss of normal power and accept loads in 10 sec. In 25 sec, one generator will carry all required loads (p. 8.5-1). However, Section 1.2.8 says 2 gas-turbine-driven generators will supply emergency power.

Control of Axial Xenon Oscillations:

Burnable Shims - Borosilicate glass in control rods and soluble boron in reactor coolant.

Part-Length Control Rods - Yes; a total of 160 single rods in 8 assemblies.

In-Core Instrumentation - Yes; used to periodically calibrate and verify the information provided by out-of-core instrumentation.

Unborated Water Control: Boric acid tanks will always have quantity adequate for reactor shutdown. Injection rate provides for shutdown in 15 min with no rods inserted using half of the pumping capacity available. Transfer pumps transfer boric acid from storage tanks to the high-pressure charging-pump suction for injection into reactor coolant. Charging pumps are used by the safety-injection system. Liquid from the letdown line is collected in the boric acid recovery system for processing. Check valves prevent back-flow of borated water from reactor coolant to other systems.

Long-Term Cooling - Internal or External Systems: Internal - Recirculation spray system and the low-head safety-injection system. External - By air-recirculation units.

Reactor: North Anna

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Tower (140' above grade) to be located on a peninsula extending into the reservoir. No seismographs mentioned.

Plant Operating Mode: Load-following (10.1-1); base loading, initially (10.2-1).

Site Features: Site consists of 1075 acres on the south side of the North Anna River. A dam is being built 5 miles downstream which will form a 13,000 acre reservoir 1.7 miles long. By using a system of dykes, a large cooling pond of 3400 acres will be formed near the plant site. The area around the plant is rolling, sparsley populated and mostly wooded. Richmond, Va. is the closest city of 50,000 or more population. It is 40 miles.

Turbine Orientation: Turbine centerline perpendicular to condenser tubes. Both turbines on same centerline about 200 ft north of centerline of CTMT structures.

Emergency Plans: Detailed written procedures for emergency nuclear situations will be prepared for prearrangement and organization of personnel to handle any foreseeable station emergency. All station personnel will be made familiar with emergency plans thru training and practice drills.

Environmental Monitoring Plans: A site meteorological program will be initiated and conducted for one year before startup (p. 2.2.1-1).

Radwaste Treatment: System designed to collect and separate liquid, gaseous, and solid wastes. Activity levels will be based on 1.0% of fuel rods in core having cladding defects. Liquid Wastes will be stored for decay, then evaporated. Condensate will be filtered and discharged thru the circulating water system. Gaseous Wastes will be suitably diluted before discharge. Solid Wastes will be drummed and shipped offsite for disposal.

Stack Height -- No stack mentioned.

Waste Heat System: A once-thru cooling system will be used taking condenser cooling water from the reservoir and discharging it to the cooling pond lagoon, and then back to the reservoir. PSAR says water re-entering the reservoir will be very near reservoir temp. Reservoir has cooling capacity for 4000 Mw(e) of power generation. About 900,000 gpm will be used for condenser cooling with a temp rise of 14 F across condensers.

H. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME North Anna Power Station Units 1 & 2

THERMAL OUTPUT, MWt 2652

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-338 50-339

NEARBY BODY OF WATER North Anna River Reservoir

NORMAL LEVEL 250' (MSL)

MAX PROB FLOOD LEVEL 258' (MSL)

SIZE OF SITE 1075 ACRES

SITE GRADE ELEVATION 271' (MSL)

TOPOGRAPHY OF SITE Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN MI RAD 172 (1968) IN 5 MI RAD 1040 (1968)

NEAREST CITY OF 50,000 POPULATION Richmong, Virginia

DISTANCE FROM SITE 40 MILES POPULATION 216,451 (1968)

LAND USE IN 5 MILE RADIUS Wooded-60%, and Agricultural-30%

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through using a cooling pond

WATER TAKEN FROM North Anna Reservoir FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG 48 F SUMMER AVG 83 F AVG 65 F

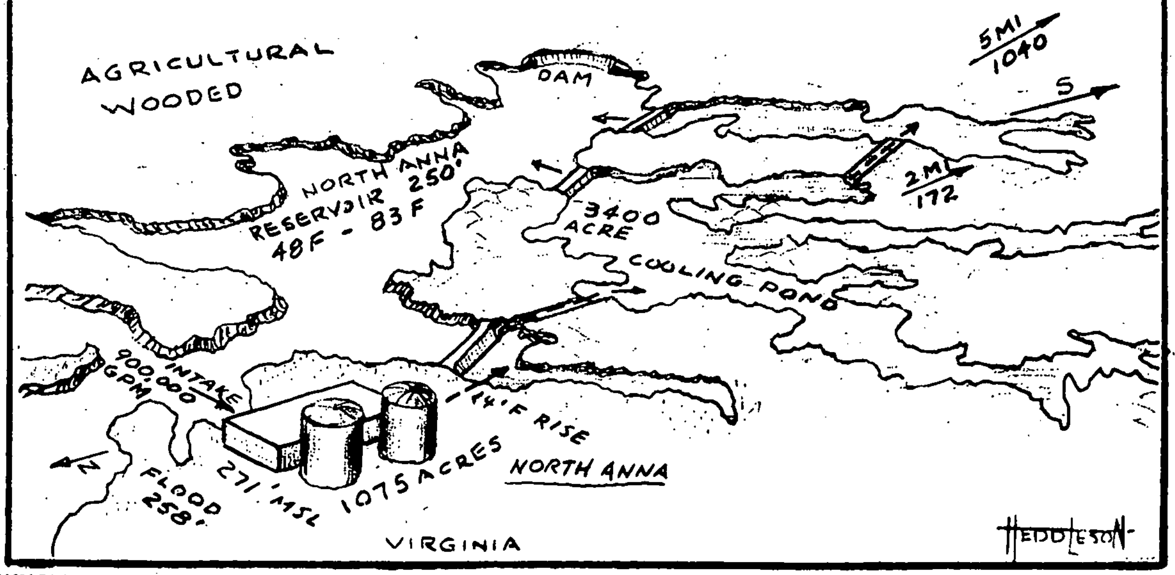
RIVER FLOW 375 (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 900,000 (gpm) TEMPERATURE RISE 14 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS None

OTHER INFORMATION Cooling water flows from 3400 acre cooling pond back into the North Anna Reservoir. Cooling pond and reservoir has capacity for 4000 MWe.



SEABROOK, 50-340 (PWR) Page 1

Project Name: SEABROOK NUCLEAR STATION UNIT 1 Reactor: Seabrook-1
A-E: Ebasco Services
Location: Hampton Harbor, N.H.* Vessel Vendor: Not specified.
Owner: Public Service Co. of N.H. Docket No.: 50-340
NSS Vendor: Westinghouse Containment Constructor: Not specified.
* 40 mi. NE Boston, Mass.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2652	H_2O/U, Cold	4.18
Electrical Output, MWe	920	Avg 1st-Cycle Burnup, MWD/MTU	13,500
Total Heat Output for Safety Design, MWt	2774	First Core Avg Burnup, MWD/MTU	24,200
Total Heat Output, Btu/hr	9051×10^6	Maximum Burnup, MWD/MTU	33,000 (p 3-17)
System Pressure, psia	2250	Region-1 Enrichment, %	2.0
DNBR, Nominal	1.85	Region-2 Enrichment, %	2.6
Total Flow rate, lb/hr	100.7×10^6	Region-3 Enrichment, %	3.2
Eff Flowrate for Heat Trans lb/hr	96.2×10^6	k_{eff}, Cold, No Power, Clean	1.207
Eff Flow Area for Heat Trans, ft^2	41.8	k_{eff}, Hot, Full Power Xe and Sm	1.137
Avg Vel Along Fuel Rods, ft/sec	14.2	Total Rod Worth, %	7
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.30×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1460
Nominal Core Inlet Temp, °F	543.5	Shutdown Boron, No Rods, Clean, Hot, ppm	1560
Avg Rise in Core, °F	70.2	Boron Worth, Hot, % $\Delta k/k$/ppm	1% per 85 ppm
Nom Hot Channel Outlet Temp, °F	644.6	Boron Worth, Cold, % $\Delta k/k$/ppm	1% per 70 ppm
Avg Film Coeff, Btu/hr ft^2, °F	5370	Full Power Moderator Temp Coeff, $\Delta k/k$/°F	$(+0.3 \text{ to } -3.5) \times 10^{-4}$
Avg Film Temp Diff, °F	38.7	Moderator Press Coeff, $\Delta k/k$/psi	$(-0.3 \text{ to } +3.5) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	42,460	Moderator Void Coeff $\Delta k/k$/% Void	$(+0.5 \text{ to } -2.5) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	207,600	Doppler Coefficient, $\Delta k/k$/°F	$(-1.0 \text{ to } -1.6) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	543,300	Shutdown Margin, Hot One Rod Stuck, % $\Delta k/k$	1.0
Avg Thermal Output, kw/ft	6.7	Burnable Poisons, Type and Form	Boric Acid in Coolant & Borosilicate Glass Rods
Max Thermal Output, kw/ft	17.9	Number of Control Rods	900
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	160
No. Coolant Loops	3		

Compiled By: F. A. Heddleson
Date: June 1969

Reactor: Seabrook-1

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.57 rad.	**Design Winds in mph:** At 30 ft level, 100 mph fastest mile with gust factors from ASCE Paper # 3269.
Low Population Zone Dist., Mi.	1.5 (p2-9)	
Metropolis / Distance / Population: Boston, Mass. / 40 mi. / 628,215 (70)		
Design Basis Earthquake Accel., g	0.17	
Operating Basis Earthquake Accel., G	0.08 (p2-67)	Tornado - 300 mph tang. + 60 trans.
Earthquake Vertical Shock, % of Horizontal	66	ΔP = 3 psi/ 3 sec

Is intent of 70 Design Criteria satisfied? Yes

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	54	Calculated Max Internal Press, psig	48
Max Leak Rate at Design Press, %/day	0.5		

Type of Construction: The inner steel containment vessel is 2 in. thick, cylindrical, with hemispherical dome and ellipsoidal bottom. It is surrounded by a reinforced concrete shield building, all placed on reinforced concrete foundation mat.

Design Basis: Designed to contain pressures and temperatures resulting from LOCA (double-ended rupture of largest pipe) when external electric power fails and engineered safety features start in 25 sec (except for accumulators which operate when reactor vessel pressure drops to preset value).

Vacuum Relief Capability: Automatic devices will prevent CTMT vessel from exceeding design pressure. Two vacuum breakers, in series, are used. Design external pressure differential is 0.75 psi (p5-7).

Post-Construction Testing: Vessel will be pressure-tested at 5, 60.7, 48.6, and 54 psig (leakage measured at these pressures). Post-operational tests will be performed to measure leakage rate and leak-tight integrity. Test frequency will be consistent with leakage rate approved.

Penetrations: Double sealed (p5-36) and individually testable.
None have water seals.

Weld Channels: None mentioned.

Reactor: Seabrook-1

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Two pumps of 1300-gpm capacity each at 450-ft head pumps borated water from the refueling water storage tank into the 2 spray headers. Two pumps can provide 100% cooling capacity. Two of the 4 CTMT cooling units & 1 pump can provide 100% cooling capacity. When low limit is reached in refueling water storage tank, spray pump suction can be transferred to the discharge of the residual heat removal heat exchanger.

Containment Cooling: There are 4 cooling units limiting max. temp. to 120 F. Each unit has 40,000 cfm capacity using 100 hp motor. Three of the 4 units operating can maintain design limits.

Containment Isolation System: High pressure in CTMT causes isolation system to close all fluid line penetrations not required for safety features to operate. High radiation or high CTMT pressure causes purge-line valves to close. Valves associated with safety feature can be closed manually.

Containment Air Filtration: Two airborne radioactive removal units are available. Each consists of fan, HEPA filters, and impregnated charcoal absorbers rated at 10,000 scfm.

Penetration Room: Two separate electrical penetration rooms and two piping penetration rooms shown in Fig. 1-12.

Organic-Iodide Filter: Standard impregnated-type charcoal filters only.

Hydrogen Recombiner: In case of LOCA, cladding would remain below the melting temp. Metal-water reaction would be limited to less than 1%. Hydrogen recombiner not mentioned.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: There are 3 tanks, each holding approx. 7000 gal. of borated water. When reactor system pressure drops below 650 psig, accumulators spill water into coolant loops. Nitrogen gas is used for overpressure. Two accumulators have sufficient water to cover 1/2 the core.

High-head Safety Injection: Three pumps of 150 gpm capacity each at 2750 psig take water from the refueling water storage tank and inject it into the coolant loops. Injection is through 2 headers, one of which contains the boric acid tank for high-concentration injection of boric acid. After LOCA, one high-head pump with other safety features operating will limit cladding temperatures and metal-water reaction, and ensure that the core will remain intact.

Low-head Safety Injection: Two low-head pumps of 3750 gpm each at 600 psig supply core cooling after other two injection systems have operated. One pump has capacity to perform the required low-head system function. Suction is taken from the refueling water storage tank until its' low limit is reached. Suction is then switched to the containment sump and flow is passed through the residual heat exchangers before entering the reactor vessel.

Reactor: Seabrook-1

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Nothing mentioned.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Leakage is indicated by changes in containment radioactivity, which is monitored continuously. Gross leakage will be evidenced by changes of liquid level in the containment sump.

Failed-Fuel-Detection Systems: Nothing found to indicate such a system.

Emergency Power: There are two 345-kv transmission lines to the switchyard and two full-capacity diesel generators. If off-site power is unavailable, either of two independent diesel generators can supply power needed for all engineered safety features.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid in coolant and borosilicate glass sealed in stainless-steel tubes.

Part-Length Control Rods - Yes

In-Core Instrumentation - Yes, used periodically to calibrate and verify information provided by out-of-core instrumentation.

Unborated Water Control: Boric acid injection can bring plant to 1% shutdown in 16 minutes with no rods inserted (using one of two pumps).

Long-Term Cooling - Internal or External Systems: Borated water from the containment sump can be recirculated through the residual heat exchangers and the core for extended periods. The low-head safety-injection pump provides this service.

Reactor: Seabrook-1

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Tower to be constructed at least 1 year before operation. No seismographs mentioned.

Plant Operating Mode: Load following, automatically when output exceeds 15% of nominal power.

Site Features: Site is two miles inland from the Atlantic Ocean. It is very flat since it is at the edge of the tidal marsh that surrounds Hampton Harbor. Site grade is +20'. Site consists of 650 acres. The plant location is about 2 miles east of US Hwy #1. Inlet to Hampton Harbor is about 1000 ft wide. Recreational beaches line the ocean front. Daytime summer population could reach 120,000 within 5 mi radius due to beach traffic.

Turbine Orientation: Turbine center-line is perpendicular to condenser tube bundles.

Emergency Plans: Plans and procedures will be developed for handling emergencies. Employees will be given assigned responsibilities and practice drills will be used. These plans will cover situations involving the plant site, or off-site.

Environmental Monitoring Plans: Two recording tide gages have been installed. Preliminary temperature and salinity measurements have been made. Further studies on biological aspects, bathymetric work, etc., will be made. Preoperational radioactivity monitoring will be done. Samples of water, soil, air particulates, farm and dairy products, fish, shell fish, and other harbor organisms will be collected. Post-operational monitoring of similar nature will continue.

Radwaste Treatment: Radioactive liquids are processed and retained inside the Chem & Vol control recycle train. Processed liquid, suitable for release, is discharged into the circulating water discharge. Radioactive gases are held up in gas decay tanks before disposal. Gases are discharged at a controlled rate from holdup tanks so as not to contaminate the environment. Solid wastes are packaged in 55-gallon drums and shipped off-site for disposal. Max dose rate for unshielded drums is 1 R/hr at one meter. Dose rates higher require lead shielding from drum. Annual liquid discharge 246,510 gal. with 3.61×10^3 curies of tritium and 45.8 mc of other. Annual gaseous discharge - 8809c; Annual solids - 150 to 300 drums.

Waste Heat System: Once-thru system taking 420,000 gpm from Hampton Harbor, pumping thru condensers, which will heat water 30 F, and discharging about 1/2 mi from shore in the Atlantic Ocean.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Seabrook Nuclear Station, Unit 1
THERMAL OUTPUT, MWt 2652	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-340

NEARBY BODY OF WATER Atlantic Ocean — NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 16.5' (MSL)

SIZE OF SITE 650 ACRES — SITE GRADE ELEVATION 20' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) ---

TOTAL PERMANENT POPULATION IN 2 MI RAD 2,828 (1968) IN 5 MI RAD 24,325 (1968)

NEAREST CITY OF 50,000 POPULATION Lawrence, Mass.

DISTANCE FROM SITE 20 MILES — POPULATION 71,000 (1960)

LAND USE IN 5 MILE RADIUS Undeveloped, mostly marshland

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through

WATER TAKEN FROM Hampton Harbor — FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG - F — SUMMER AVG - F — AVG - F

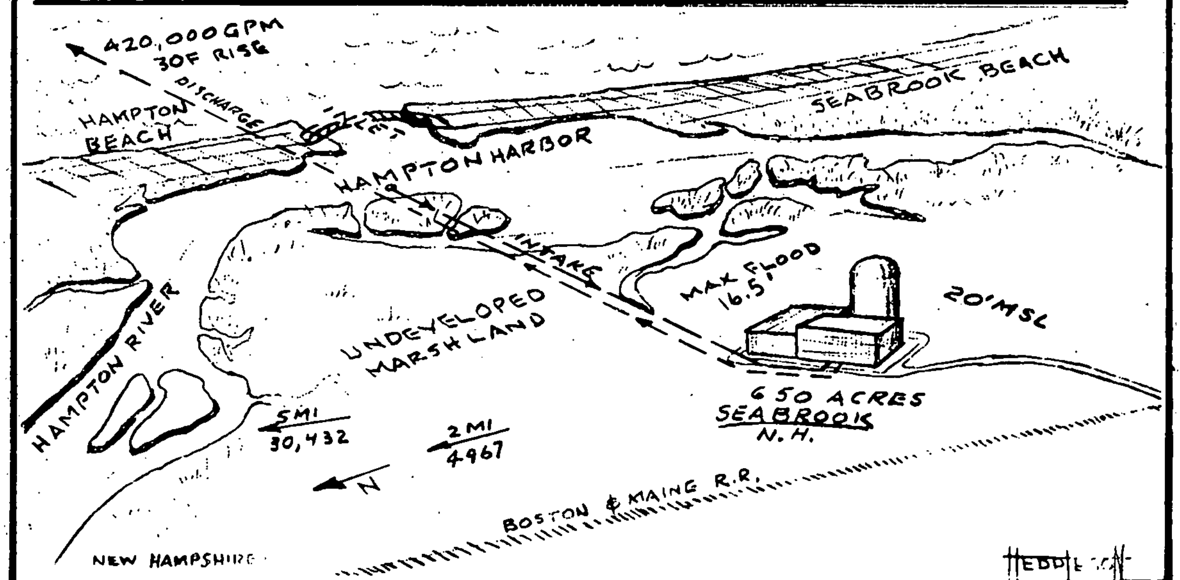
RIVER FLOW NA (cfs) avg. — *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 420,000 (gpm) — TEMPERATURE RISE 30 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) — *Per Unit

COOLING TOWERS None

OTHER INFORMATION Cooling water discharged into ocean 4000 ft from shore. This project was deferred in November 1969.



ENRICO FERMI, 50-341 (BWR) Page 1

Project Name: Enrico Fermi Atomic Power Plant #2
Location: Lagoona Beach, Monroe Co Mich.
Owner: Detroit Edison Company
NSS Vendor: General Electric

Reactor: Enrico Fermi #2
A-E: Detroit-Edison w/Sargent & Lundy
Vessel Vendor: GE responsibility
Docket No.: 50-341
Containment Constructor: Ralph Parsons Co. responsibility

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3293	H_2O/UO_2 Volume Ratio	2.41
Electrical Output, MWe	1150	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output for Safety Design, MWt	3428	Moderator Temp Coef Hot, No Voids	-17.0×10^{-5}
Steam Flow Rate, lb/hr	14.16×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	102.5×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.2×10^{-5}
Heat Transfer Area, ft^2	66,100	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.4	Doppler Coefficient, Operating	-1.3×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	425,000	Initial Enrichment, %	2.25
Average Heat Flux, Btu/hr-ft^2	163,229	Average Discharge Exposure, MWD/Ton	19,250
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	--
Average Fuel Rod Surface Temp °F	558	k_{eff}, All Rods In	--
MCHFR	≥ 1.9	k_{eff}, Max Rod Out	> 0.99
Total Peaking Factor	2.6	Control Rod Worth, %	0.01Δk w/rod worth minimizer
Avg Power Density, Kw/ℓ	50.8	Curtain Worth, %	---
		Burnable Poisons, Type and Form	Flat Boron SST Curtains
		Number of Control Rods	185
		Number of Part-Length Rods (PLR)	None

Compiled by: Fred A. Heddleson
Date: July 1969

TX-4377
(8-70)

Reactor: Enrico Fermi #2

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi. - 0.41 (F.1.5-1d)		Design Winds in mph:	
Low Population Zone Dist., Mi. - 0.44		At 0 - 50 ft	80
Metropolis / Distance / Population		50 - 150 ft	-
Design Basis Earthquake Accel., g	0.10	150 - 400 ft	-
Operating Basis Earthquake Accel., g	0.05	Tornado	300 tang w/60 trans
		ΔP =	3-psi/ 3-sec
Earthquake Vertical Shock, % of Horizontal	70	Is intent of 70 design criteria Satisfied?	Yes, page F-1

Peak Fuel Enthalpy on Rod Drop: 360 cal/gm limit, but 280 is probable peak during operation (P. 3-72).

Recirculation Pumping System & MCHFR: Maintains MCHFR between limits of 1.0 and 1.9 (Sect. 3.7.6.1, 3.7.6.2).

Protective System: Initiates shutdown of reactor in time to prevent-fuel-clad damage following abnormal operational transients. This system overrides all operator & process controls.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	56	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	56	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	45	Second Ctmt Leak Rate, %/day	100

Type of Construction: Pressure-suppression, with a steel drywell, spherical lower portion, and cylindrical upper section, all encased in reinforced concrete. Suppression-pool torus is steel shell. Secondary containment has reinforced concrete walls up to refueling floor, and steel construction above.

Design Basis: To provide the capability, in case of LOCA resulting from rupture of main coolant line, to limit release of fission products so that radiation doses do not exceed values specified in 10CFR100.

Vacuum Relief Capability: Primary containment max, design vacuum - 2 psi. Drywell vacuum is relieved thru vacuum breakers with air from suppression chamber, it in turn drawing air from secondary containment.

Post-Construction Testing: Primary containment tested at 1.15 design press. after construction. Penetrations and isolation valves given special tests.

Penetrations: Penetrations are both double and single. Not all are individually testable. Electrical, personnel access, access hatches, and bellows-sealed penetrations are testable.

4

Reactor: Enrico Fermi #2

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Two independent 100%-cap'y pumps and piping systems can each deliver 6250 gpm @ 122 psid from suppression pool to a spray sparger above the core. System operates automatically on signals of low water level in reactor or high pressure in the drywell. One system can prevent clad melting for the max. sized break.

Auto-Depressurization System: When feedwater pumps, RCICS, & HPCIS cannot maintain proper reactor water level, safety relief valves on steam lines open, venting steam to suppression pool so reactor is depressurized. LPCI & core spray systems then begin operation.

Residual-Heat-Removal System (RHRS): System consists of 2 heat exchangers, 4 main pumps (3 of which supply 100% cap'y) & 4 service-water pumps. Four modes of operation: (1) Shutdown cooling - water pumped from reactor thru heat exchangers for cooling & returned to reactor. Can complete cooldown to 125F in 24 hr & maintain. (2) Containment cooling - water pumped from suppression pool thru heat exchangers & back to pool. Flow can be diverted thru drywell spray headers. Pool maintained at 170F or below. (3) Condensing mode - steam removed from reactor & condensed in heat exchangers. (4) LPCI mode - main pumps transfer water from suppression pool to reactor to maintain core flooding sufficient to prevent fuel clad melting.

High-Pressure Coolant-Injection System: One 100% cap'y steam turbine-driven pump supplies 5000 gpm @ 1120 psid to feedwater piping system. Suction taken from 125,000-gal condensate storage tank or suppression pool. This system prevents fuel melting in the case of small line breaks.

Low-Pressure Coolant-Injection System: Four 1/3 cap pumps (10,000 gpm @ 20 psid each) supply water to the reactor thru the jet pumps to flood the core when other systems cannot maintain flooding. LPCI operates from 0 to 300 psi taking water from the suppression pool. This system is part of Residual Heat Removal Systems described above.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: RHRS main pumps and service water pumps discharge lines are cross-connected for infinite supply of water to flood reactor.

Main-Steam-Line Flow Restrictors: Ventur-type flow restrictor in each steam line close to the reactor limits steam flow in a ruptured lined.

Control-Rod Velocity Limiters: Large-clearance piston on bottom of each control rod limits free-fall velocity to <5 ft/sec, a value which cannot result in nuclear system process barrier damage.

Control-Rod-Drive-Housing Supports: Horizontal beams below reactor vessel are arranged to catch & stop CRD housing if one breaks and falls. About 2 in. travel is max. in hot condition. The 2-in. free fall cannot cause damage to any radioactive-material barrier.

Standby Liquid-Control System: Sodium pentaborate injected by manual initiation to shut down reactor or maintain it subcritical with all control rods pulled out. Two independent systems available, either of which can inject $-0.17\Delta k$ reactivity worth in one hour ($-0.12\Delta k$ required for shutdown).

Reactor: Enrico Fermi #2

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: Not discussed.

Reactor Core Isolation Cooling System (RCICS): Starts automatically on signal of reactor-vessel low-water level to prevent need for operation of any core-standby cooling system. Removes decay heat and provides makeup water into feedwater line if feedwater pumps are inoperative, and/or if isolation valves have closed, isolating reactor from main condenser heat sink. One steam-turbine-driven pump delivers 616 gpm from main condenser condensate storage tank, RHRS heat exchangers, or suppression pool, allowing 8 hr of operation.

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Pump & valve seal-leakage and leakage from reactor-vessel head-flange gasket are measured and are identifiable. Other leakage to drywell sumps cannot be identified. 15 gpm leakage can be detected, and 50-gpm is total leakage-rate limit. Leakage is detected by high-water alarms in 2 sumps, and by integrating factors such as ventilation cooling-water temperatures, drywell temp., pressure & humidity, & starts & running times of sump pumps.

Failed-Fuel Detection Systems: Four gamma monitors are located near the main steam lines just outside primary containment. They detect a gross release of fission products from the fuel. Signals generated by monitors can initiate reactor scram and isolation of released material.

Emergency Power: Four diesel generators can supply power for critical loads if normal power is lost. Three storage-battery systems will supply control & emergency power for control systems & power for some motors necessary for safe shutdown. Two of the 4 diesels can supply the required ac power for shutdown. Max. power for critical loads estimated at 6523 HP. Diesels can be loaded in 10 sec. Fuel-oil storage provides 48 hr of operation, and delivery is possible in 24 hr.

Rod-Block Monitor: To prevent fuel damage as a result of rod withdrawal error. Two RBM channels, either of which can initiate a rod block using signals from LPRM channels. Because MCHFR cannot reach 1.0 until rod is half way withdrawn, the highest rod-block setpoint halts rod motion before local fuel damage can occur.

Rod Worth Minimizer: A function of on-line computer which prevents rod withdrawal above 30% power conditions if that rod is not in accordance with pre-planned pattern.

Reactor: Enrico Fermi #2

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: There is an on-site weather station that measures wind speed and direction. No seismographs mentioned.

Plant Operating Mode: Load-following.

Site Features: Generally low and marshy, partially wooded. Elevation is ∿575 ft and will be filled to 583 ft in the immediate station area. Population in 10 mi radius is 52,000. 70% of Monroe County land is used for farming. The area is one of most seismically stable in the USA. Cooling water will be taken from Lake Erie. Monroe municipal water intake from Lake Erie is about 2 miles from the site.

Turbine Orientation: Centerline ∿245 ft off reactor centerline.

Emergency Plans: Detailed written procedures will cover all anticipated accidents. Personnel will be trained and practiced. A unified site-emergency plan will be developed covering both plants on the site using State Police, Red Cross, Coast Guard, and University of Michigan Hospital.

Environmental Monitoring Plans: Monitoring started in 1958, including, at present, sampling and analysis of air-borne particles, rain, river water, tap water, sediment, and fish, plus beta-gamma ambient measurements.

Stack Height: 100 meters.

Radwaste Treatment: Liquid Waste - Collected and processed on batch basis for disposal with condenser effluent in circulating-water discharge canal. Batches with high radioactivity processed in waste concentrator, and concentrate sent to concentrated-waste storage tank. Valving-redundency instrumentation protects against accidental discharge. Gaseous Waste - Collected & treated if necessary to reduce radioactivity level to safe concentrations for release from stack. Off-gases from main condenser held up for 30 min for decay & then released thru highly efficient filters. Solid Wastes - Collected, processed, & packaged for storage. After sufficient decay, packages are shipped offsite for disposal.

Waste Heat System: A once-through system is employed using Lake Erie water. Four pumps move 832,000 gpm thru condenser which has 7530 × 10^6 Btu/hr heat removal capacity.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Enrico-Fermi Atomic Power Plant Unit 2
THERMAL OUTPUT, MWt 3293	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-341

NEARBY BODY OF WATER Lake Erie — NORMAL LEVEL 572' (MSL)

MAX PROB FLOOD LEVEL 584' (MSL)

SIZE OF SITE ∽ 925 ACRES — SITE GRADE ELEVATION ~ 575' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat to Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 4967 (1980) IN 5 MI RAD 30,432 (1980)

NEAREST CITY OF 50,000 POPULATION Detroit, Michigan

DISTANCE FROM SITE 25 MILES POPULATION 1,493,000 (-80)

LAND USE IN 5 MILE RADIUS Agricultural-70%

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Closed cycle using towers and pond

WATER TAKEN FROM Lake Erie FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

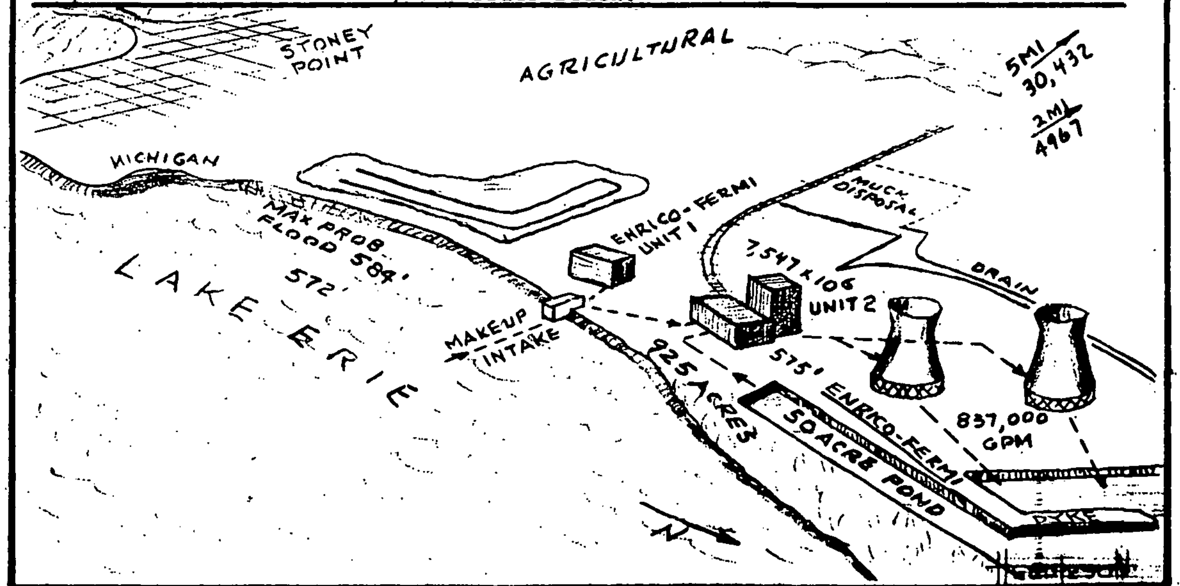
RIVER FLOW NA (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 837,000 (gpm) TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS 7,547 X 10^6 (Btu/hr) *Per Unit

COOLING TOWERS Two natural draft hyperbolic towers ∽350' dia X 450' high.

OTHER INFORMATION Cooling towers will discharge into cooling pond which is separated from the lake by a barrier beach.



INDIAN POINT, 50-342 & 50-343 (BWR) — Page 1

Project Name: Indian Point Nuclear Units 4&5
Location: Westchester Co., New York
Owner: Consolidated Edison Co. of N.Y.
NSS Vendor: General Electric

Reactor: Indian Point 4&5
A-E: Consolidated Edison Co.
Vessel Vendor: G.E. responsibility
Docket No.: 50-342, 50-343
Containment Constructor: Consolidated Edison

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3293	H_2O/UO_2 Volume Ratio	241
Electrical Output, MWe	1115	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output for Safety Design, MWt	3440	Moderator Temp Coef Hot, No Voids	-39.0×10^{-5}
Steam Flow Rate, lb/hr	14.17×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	102.5×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	66,100	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.4	Doppler Coefficient, Operating	$\leq -1.3 \times 10^{-5}$
Maximum Heat Flux, Btu/hr-ft^2	425,000	Initial Enrichment, %	2.2
Average Heat Flux, Btu/hr-ft^2	163,229	Average Discharge Exposure, MWD/Ton	19,250
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	-
Average Fuel Rod Surface Temp °F	558	k_{eff}, All Rods In	-
MCHFR	≥ 1.9	k_{eff}, Max Rod Out	<0.99
Total Peaking Factor	2.6	Control Rod Worth, %	~0.01Δk
Avg Power Density, Kw/ℓ	50.8	Curtain Worth, %	-
		Burnable Poisons, Type and Form	Flat, boron - stainless steel
		Number of Control Rods	185
		Number of Part-Length Rods (PLR)	None

Quote from p. 15.7-1:

"The inclusion in the design of...cryogenic offgas system, double containment, and core standby cooling system pump rooms - features...not included before - is in accordance with Consolidated Edison's continuing effort to design, build and operate...without endangering ...the public."

Compiled by: Fred A. Heddleson
Date: August 1969

TX-4377
(8-70)

Reactor: Indian Point 4&5

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi. - 0.2 min to 0.8		Design Winds in psf
Low Population Zone Dist., Mi. 0.50(P2.3-2)		At 0 - 30 ft 15 100 mph max 30 - 50 ft 18 sustained 50 - 100 ft 24 100 - up 27
Metropolis / New York City	Distance: 25 mi / Population: ---	
Design Basis Earthquake Accel., g	0.15	Tornado - 300 mph tangential, w/60-mph translational ΔP = psi/ sec
Operating Basis Earthquake Accel., g	0.10	
Earthquake Vertical Shock, % of Horizontal	70%	Is intent of 70 design criteria Satisfied? Yes, Section 15, p 15.7-1

Peak Fuel Enthalpy on Rod Drop: 360 cal/gm is high limit, but 280 is probable peak during operation (P 3.6-17).

Recirculation Pumping System & MCHFR: Core heat-transfer surface area and coolant flow rate are designed to ensure MCHFR to be not less than 1.9 at rated conditions (P 3.7-12).

Protective System: Initiates rapid, automatic shutdown in time to prevent fuel-cladding damage following abnormal transients. Overrides all operator & process controls.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	56	Prim Ctmt Leak Rate, %/day	1.0
Supprn Chamb Design Press, psig	56	Second Ctmt Design Press, psig	10.0
Calc Max Internal Press, psig	45	Second Ctmt Leak Rate, %/day	1.0

Type of Construction: Primary containment is the light-bulb shape steel vessel with steel torus. Secondary containment is reinforced concrete with a leaktight steel liner cylindrical in shape with hemispherical top.

Design Basis: Primary system to withstand equipment failures including double-ended break of largest pipe without loss of integrity. Primary and secondary containment shall prevent release of radioactive materials that exceed volume limits of 10CFR100.

Vacuum Relief Capability: Drywell and suppression chamber designed for 2-psi vacuum. Vacuum-relief vents from secondary to primary containment, or from suppression chamber to drywell. Self-actuating vacuum breakers open at 1 psid.

Post-Construction Testing: Drywell and suppression chamber at 125% design pressure, then again at design pressure; secondary containment at 10 psig. Primary containment leakage-rate tests at 56 psig. Periodic leakage-rate tests will be performed during life of plant at a reduced pressure.

Penetrations: Some of both double and single penetrations. Only those with resilient seals or expansion bellows are individually testable.

Reactor: Indian Point 4&5

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Two independent loops, each having 2 pumps and 1 spray sparger above core. Design flow is 3125 gpm @ 122 psid, with water from suppression pool. Low water level in reactor vessel or high pressure in drywell initiates system to prevent fuel-clad melting. Low-Pressure Coolant-Injection starts from same signals and operates independently to achieve same objectives.

Auto-Depressurization System: When feedwater pumps, RCICS, and HPCIS cannot maintain proper reactor water level, safety relief valves on steam lines open, venting steam to suppression pool so the reactor is depressurized. The LPCI and core spray systems then begin operation.

Residual-Heat-Removal System (RHRS): System consists of 2 heat exchangers, 4 main pumps (1/3 cap each) & 3 service-water pumps arranged into 2 cross-connected loops. Four modes of operation: (1) Shutdown cooling - water pumped from reactor thru heat exchangers for cooling & returned to reactor, cooldown to 125F in 20 hr & maintain. (2) Containment cooling - water pumped from suppression pool thru heat exchangers & back to pool to keep pool at 170F or below. (3) Condensing mode - steam removed from reactor and condensed in heat exchangers. (4) LPCI mode - water pumped from suppression pool to reactor for core flooding sufficient to prevent fuel clad melting, ∿30,000 gpm @ 20 psid.

High-Pressure Coolant-Injection System: One 100%-cap'y steam turbine-driven constant-flow pump supplies 5000 gpm @ 1180 psia to feedwater piping system (suction taken from 125,000-gal condensate storage tank or suppression pool) to limit fuel melting for small line breaks where depressurizing does not occur. Starts on reactor low-water level or high drywell pressure.

Low-Pressure Coolant-Injection System: Part of the Residual Heat Removal System and uses 3 of 4 pumps (1/3 cap each) to pump water into reactor at lower pressures (0 to 300 psid). Water is taken from the suppression pool. Pump cap is 10,000 gpm @ 20 psid.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: Service water used to cool Residual-Heat-Removal heat exchangers. However, no reference found indicating a connection of service water into RHRS piping for unlimited cooling water supply.

Main-Steam-Line Flow Restrictors: Venturi-type restrictor in each line limit loss of water from reactor vessel in case of line rupture, or steam flow in severed line restricted to <200% of rated flow.

Control-Rod Velocity Limiters: Large-clearance piston on bottom of each control rod limits drop-out velocity to <5 ft/sec. Velocity of rod insertion is not affected. This feature protects against a high reactivity rate of change in the event of a control-rod-drop accident.

Control-Rod-Drive-Housing Supports: Located underneath reactor vessel just under control-rod housing to limit travel or catch the control rod if housing ruptures. Will prevent a nuclear excursion even if housing fails and drops from the reactor. Under operating conditions, housing can drop only 1/4 in. in case of failure.

Standby Liquid-Control System: A redundant system for reactivity control used when control rods cannot shut down reactor. By manual initiation, sodium pentaborate solution is pumped into the bottom of the reactor. About 1 hr required for complete injection. System can be used to maintain shutdown if required.

Reactor: Indian Point 4&5

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: Containment inerting is unwarranted. Hydrogen is not a safety problem (P 5.9-1).

Reactor Core Isolation Cooling System (RCICS): Starts automatically on signal of reactor-vessel low-water level to prevent need for operation of any core-standby cooling system. Can also be started manually. Removes decay heat and provides makeup water into feedwater line if feedwater pumps are inoperative, and/or if isolation valves have closed, isolating reactor from main condenser heat sink. One steam-turbine-driven pump delivers 616 gpm from main condenser condensate storage tank, RHRS heat exchangers, or suppression pool, allowing 8 hr of operation.

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Pump & valve seal-leakage in primary containment and leakage from reactor-vessel head-flange gasket are measured and are identifiable. Other leakage to drywell sumps cannot be identified. 15 gpm is limit for unidentified, and 50 gpm is total leakage-rate limit. Leakage is detected by high-water alarms in 2 sumps, and by the flow recorder, which plots time versus discharge flow rates.

Failed-Fuel Detection Systems: Four gamma-radiation monitors located near steam lines just outside primary containment designed to detect release of fission products from the fuel. High radiation initiates scram and system isolation.

Emergency Power: Four 3000-kw diesel-generators are provided, 3 of which will be adequate to start and carry all essential loads. These units and their switch gear are separated and independent. A supply of fuel will be maintained for 6 days of continuous operation.

Rod-Block Monitor: To prevent fuel damage as a result of rod-withdrawal error. Monitor bypassed at >30% power. Two RBM channels, either of which can initiate a rod block using signals from LPRM channels. Because MCHFR cannot reach 1.0 until rod is halfway withdrawn, the highest rod-block setpoint halts rod motion before local fuel damage can occur.

Rod Worth Minimizer: On-line computer prevents rod withdrawal at low power if rod being withdrawn is not in accordance with planned pattern, thus limiting reactivity worth of rods by enforcing adherence to planned pattern.

Reactor: Indian Point 4&5

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Anemometers and temperature instruments located on three towers in N-S line. Max distance covered is 4 1/2 miles. No seismographs mentioned.

Plant Operating Mode: Load-following.

Site Features: 23 miles north of N.Y. City boundary, 1500 meters south of Indian Point 1. Site is flat, with adjacent areas hilly. Adjacent to Hudson River. Surrounding land usage mostly residential. In 1975, 420 people will live within 1/2 mile of the plant, 21,800 within a 2 mile radius, and 100,000 people within a 5 mile radius. The size of the site is 130 acres.

Turbine Orientation: Condenser tubes perpendicular to turbine axis.

Emergency Plans: Emergency procedures for Indian Point 1 will be followed along with others developed for this plant. Meetings with local public agencies have been held and will continue to be held to promote cooperation. Internal practices will be held to train personnel. Arrangements have been made for the assistance of N.Y. University Hospital and Peekskill Hospital.

Environmental Monitoring Plans: Detailed meteorology data has been collected for a long time. Environmental monitoring began in 1958 to sample air, water, and soil, including radioactivity measurements in fresh water, river water, river sediment, fish, aquatic vegetation, vegetation, soil, and air in the vicinity of the site.

Radwaste Treatment: The liquid waste system collects, processes and either returns to process system or discharges to river within 10CFR20 limits. The solid waste system collects solid wastes which are stored, processed, and packaged for off-site disposal. The gaseous waste system uses cryogenics for removal, containment, and safe release of radioactive gases present in main condenser air ejector exhaust. Steam will dilute the gases to below combustible limit of hydrogen ($\sim$4%).

Stack Height -

Waste Heat System: Circulating water system is now set up as a once-thru system taking water from the Hudson River and returning it there. Condenser flow per nuclear unit is 858,000 gpm with 16.8 F temp rise. Heat removal capacity of condenser is 7214 × 10^6 Btu/hr. Thermal studies are being conducted to determine if once-thru system will meet New York State requirements.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Indian Point Nuclear Generating Units 4 & 5
THERMAL OUTPUT, MWt 3293	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-342 50-343

NEARBY BODY OF WATER Hudson River — NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 14.5' (MSL)

SIZE OF SITE 130 ACRES — SITE GRADE ELEVATION 15' (MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 21,700 (1975) IN 5 MI RAD 99,000 (1975)

NEAREST CITY OF 50,000 POPULATION White Plains, New York

DISTANCE FROM SITE 17 MILES — POPULATION 50,000 (1960)

LAND USE IN 5 MILE RADIUS Residential and Recreational

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through using a quarry

WATER TAKEN FROM Hudson River — FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

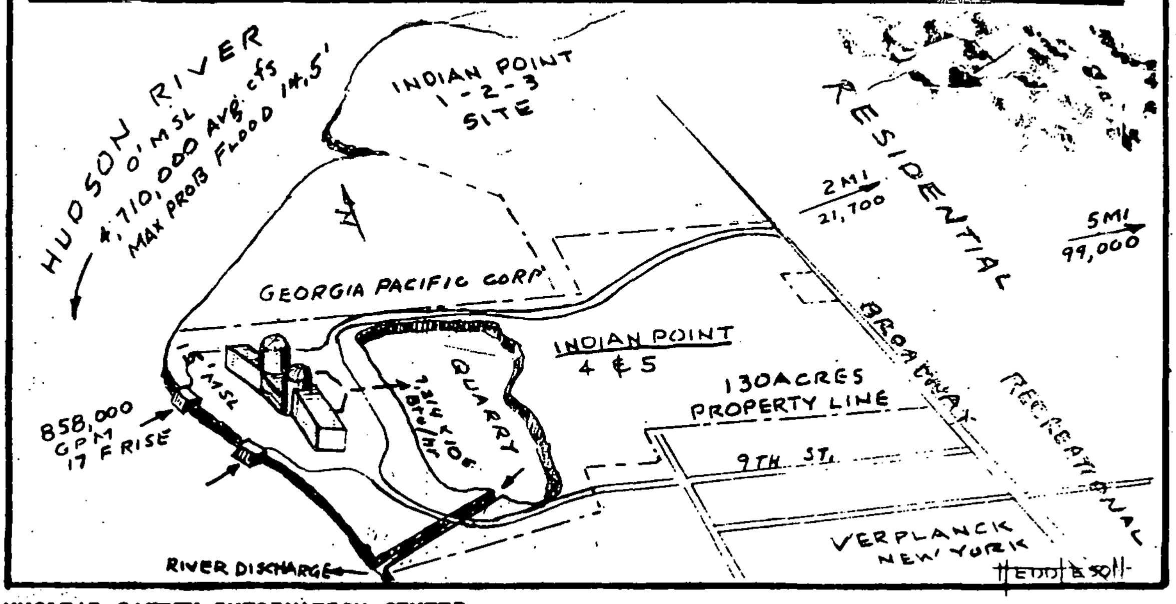
RIVER FLOW * (cfs) avg. †QUANTITY OF MAKEUP WATER - (gpm)

†TOTAL FLOW THROUGH CONDENSERS 858,000 (gpm) TEMPERATURE RISE 16.8 F

†HEAT REMOVAL CAPACITY OF CONDENSERS 7,214 X 10^6 (Btu/hr) †Per Unit

COOLING TOWERS None *80,000,000 gpm max tidal flow - runoff avg 4,710,000

OTHER INFORMATION Cooling water flows through the quarry and back into the Hudson River.



TROJAN, 50-344 (PWR)

Page 1

Project Name: Trojan Nuclear Plant
Location: Columbia Co., Oregon*
Owner: Portland Gen. Elec. Co.
NSS Vendor: Westinghouse
*30 mi north of Portland

Reactor: Trojan
A-E: Bechtel Corporation
Vessel Vendor: Westinghouse responsibility
Docket No.: 50-344
Containment Constructor: Bechtel respons.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3423 (P 1.1-1) 3411 (T 1.3-1)	H_2O/U, Cold	3.48
Electrical Output, MWe	1151	Avg 1st-Cycle Burnup, MWD/MTU	14,800
Total Heat Output for Safety Design, MWt	3570	First Core Avg Burnup, MWD/MTU	24,200
Total Heat Output, Btu/hr	$11,640 \times 10^6$	Maximum Burnup, MWD/MTU (Design Equilibrium)	33,000
System Pressure, psia	2250	Region-1 Enrichment, %	2.04
DNBR, Nominal	1.89	Region-2 Enrichment, %	2.58
Total Flow rate, lb/hr	132.7×10^6	Region-3 Enrichment, %	3.20
Eff Flowrate for Heat Trans lb/hr	126.5×10^6	k_{eff}, Cold, No Power, Clean	1.225
Eff Flow Area for Heat Trans, ft^2	51.4	k_{eff}, Hot, Full Power Xe and Sm	1.148
Avg Vel Along Fuel Rods, ft/sec	15.5	Total Rod Worth, %	7
Avg Mass Velocity lb/hr-ft^2	2.47×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1420
Nominal Core Inlet Temp, °F	552.5	Shutdown Boron, No Rods, Clean, Hot, ppm	1420
Avg Rise in Core, °F	67.1	Boron Worth, Hot, % Δk/k/ppm	85
Nom Hot Channel Outlet Temp, °F	647	Boron Worth, Cold, % Δk/k/ppm	70
Avg Film Coeff, Btu/hr ft^2, °F	5770	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.04 \text{ to } -3.0)\times 10^{-4}$
Avg Film Temp Diff, °F	37.7	Moderator Press Coeff, Δk/k/psi	$(-0.4 \text{ to } +3.0) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff Δk/k/% Void	$+0.5 \text{ to } -2.5\times10^{-3}$
Avg Heat Flux, Btu/hr ft^2	217,200	Doppler Coefficient, Δk/k/°F	$(-1.0 \text{ to } -2.0)10^{-5}$
Max Heat Flux Btu/hr ft^2	579,600	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1.0 to 1.6 (P 3.1.3-2)
Avg Thermal Output, kw/ft	7.0	Burnable Poisons, Type and Form	Borosilicate glass in S.S. tubes
Max Thermal Output, kw/ft	18.8	Number of Control Rods	1060 + PLR
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	160
No. Coolant Loops	4		

Compiled By: Fred A. Heddleson
Date: September 1969

Reactor: Trojan

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.41 rad.	Design Winds in mph:	
Low Population Zone Dist., Mi.	2.5(Radius)	At 0 - 30 ft elev - 105	
Metropolis / Portland	Distance / 31	Population / 377,800(80)	(ASCE Paper 3269)
Design Basis Earthquake Accel., g	0.25		
Operating Basis Earthquake Accel., G	0.15	Tornado - ---	
Earthquake Vertical Shock, % of Horizontal	66	ΔP = -- psi/ -- sec	

Is intent of 70 Design Criteria satisfied? Yes

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	60	Calculated Max Internal Press, psig	53
Max Leak Rate at Design Press, %/day	0.2		

Type of Construction: Reinforced concrete, cylindrical walls with hemispherical roof and flat foundation slab. Cylindrical section prestressed by a two-way post-tensioning system. Roof dome has two-way post-tensioning system. Inside face of concrete shell is steel-lined.

Design Basis: Designed for all credible conditions of loading, including LOCA, earthquake, storms, and LOCA coincident with earthquake, such that structure will maintain integrity under the conditions named.

Vacuum Relief Capability: Vacuum breakers are not required (P 5.1-6).

Post-Construction Testing: Leak rate test at 60 psig for 24 hr (P 5.1-74). Continuous leakage monitoring system is unnecessary and not provided.

Penetrations: Electrical penetrations are double sealed. All other penetrations are single. Electrical penetrations are the only ones individually testable. None have water seal backup.

Weld Channels: Some installed in base slab liner (P 5.1-74). Pressurized for testing.

Reactor: Trojan

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: There are 2 independent systems each having two pumps, one spray header, spray nozzles, and necessary piping. The sodium hydroxide additive tank is common to both. Each system is designed to spray approximately 2600 gpm of borated water into the containment atmosphere to cool, reduce pressure, and wash out iodine, removing 225×10^6 Btu/hr of heat. Two sets of 2-out-of-4 high-high containment pressure signals initiate startup.

Containment Cooling: Four air coolers, each capable of 3.6×10^6 Btu/hr heat removal use 95 F component cooling water circulated through coils. Three units operate to maintain 120 F or lower temperature.

Containment Isolation System: Provides double barriers to release of activity outside of containment by use of two isolation valves on penetrating lines. Valves close automatically or manually. Safety injection initiation or high radiation in containment signals closure of all valves except those required for operation of engineered safety features.

Containment Air Filtration: Exhausted through high efficiency particulate filters to the central exhaust plenum and then to the vent stack (P 9.7.2-4).

Penetration Room: Yes, Electrical Penetration Area and Piping Penetrations Area provided. These are two separate rooms.

Organic-Iodide Filter: Not discussed.

Hydrogen Recombiner: Total metal-water reaction in core will be limited to less than 1%. Hydrogen recombiner not discussed.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks, each with 6350 gallons of borated water, are maintained at 650 psig by nitrogen over-pressure. When reactor system pressure drops below accumulator pressure, 2 check valves open to dump water into the 4 cold legs of the reactor vessel.

High-head Safety Injection: Two centrifugal charging pumps driven by electric motors deliver 150 gpm each of borated water at 2800 psig from the refueling-water storage tank. Eicher pump and piping system can supply 100% design capacity to recharge for small leaks. Safety-injection pumps (2) are available to pump borated water into the system at 1700 psig with 400 gpm each.

Low-head Safety Injection: Performed by residual-heat-removal pumps (P 6.1-7), which inject 3000 gpm of borated water at 600 psig. Normal operating pressure at shutoff is 170 psig.

Reactor: Trojan

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Containment air is monitored continuously for changes in air activity and humidity, including air-particulate activity, radiogas activity, and humidity. Gross leakage is indicated by liquid inventory. Total expected leakage from all sources will be about 1800 cc/hr to the atmosphere and 50 cc/hr to the sump tank. However, sump pumps have a capacity of 50 gpm and discharge to waste-holdup tanks.

Failed-Fuel-Detection Systems: Not discussed.

Emergency Power: Two diese-engine generators and two 125-v dc station batteries furnish emergency power. One diesel generator has capacity to carry all engineered-safety-feature loads. Emergency generators will be ready to start loading 10 sec after the starting signal is received, with full load applied 30 sec after signal. Diesel generators are isolated and separated by walls. Fuel supply is available for 1 day of full-load operation plus 6 days of hot-shutdown operation.

Control of Axial Xenon Oscillations:

Burnable Shims - Borosilicate glass in S.S., plus soluble boron in reactor coolant.

Part-Length Control Rods - Yes; 160 rods in 8 assemblies.

In-Core Instrumentation - Yes, to periodically calibrate and verify out-of-core instrumentation.

Unborated Water Control: Boric acid is pumped from boric tanks by one of two boric acid transfer pumps to the suction of one of three charging pumps which inject boric acid into reactor coolant. Boric acid can be injected at a rate which takes plant to 1% shutdown in hot condition with no rods inserted in less than 16 min. Safeguards to prevent dilution of borated water by unborated water were not discussed.

Long-Term Cooling - Internal or External Systems: Residual-heat-removal pumps and heat exchangers provide long-term internal cooling of core. Two pumps can circulate 3000 gpm each at 600 psig.

Reactor: Trojan

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: On-site measurements will be obtained to confirm data taken at Kelso (6 mi) and Portland (31 mi). No seismographs mentioned.

Plant Operating Mode: Load following when output is approximately 15% of nominal power and higher.

Site Features: Located on the Columbia River with site grade 45 to 90 ft. Valley width ∿2 mi. Surrounding area is hilly. Columbia River is deep-sea access to Portland. US highway Rt. 30 passes within 2800 ft of reactor, and a railroad right-of-way is within 600 ft. Site consists of ∿625 acres. Closest town is Prescott, 1/2 mile north of site. Within 5-mi radius, population is under 2000. Major portion of surrounding area is federally controlled forests. Highest structure on the site will be a 492-ft high cooling tower.

Turbine Orientation: Turbine centerline is about 180 ft off centerline of reactor. Turbine blades could be thrown tangentially toward containment.

Emergency Plans: A site-emergency plan will be prepared which describes appropriate action within the plant to limit consequences of an incident. Liaison will be established with federal, state, and local agencies responsible for public safety. Off-site surveillance will be organized which can assess extent and significance of radioactive releases. All of plant staff will have specific duties assigned to them in the plan.

Environmental Monitoring Plans: The surveillance program of Hanford operations will be used for records on the past. An environment-monitoring program for the site will be started 2 years before plant operation. Media samples will be ground water, surface water, air particulates, soil, crops, milk, fish, shell-fish, and river-bottom sediment. Analysis will include alpha, beta, K-40, gamma spectral analysis, as well as specific nuclide identification.

Radwaste Treatment: Treatment systems designed to collect, store, process, and monitor solid, liquid, and gaseous wastes. Systems permit controlled release of liquid and gaseous wastes within limits of 10CFR20. Fission products removed from reactor coolant by decay, processing, or bleeding to waste-disposal system. Gaseous fission products removed in gas stripper. Liquid wastes are collected, processed, analyzed, and released to cooling-tower outfall at a controlled release rate. Gaseous wastes are discharged through high-efficiency filters or are collected, compressed, stored for decay, and later released at a controlled rate. Solid wastes are packaged, stored, and shipped off-site for burial.

Stack Height: Steel stack vents just above containment roof.

Waste Heat System: 350,000 gpm total flow thru a closed loop system using a hyperbolic cooling tower. Makeup water will be taken from the Columbia River.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Trojan Nuclear Plant

THERMAL OUTPUT, MWt 3423

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-344

NEARBY BODY OF WATER Columbia River

NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 44' (MSL)

SIZE OF SITE 623 ACRES

SITE GRADE ELEVATION 45' (MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Hilly to Mountainous

TOTAL PERMANENT POPULATION IN 2 MI RAD 541 (1980) IN 5 MI RAD 7,445 (1980)

NEAREST CITY OF 50,000 POPULATION Portland, Oregon

DISTANCE FROM SITE 31 MILES POPULATION 377,800 (1968)

LAND USE IN 5 MILE RADIUS Wooded

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed loop using cooling tower

WATER TAKEN FROM Columbia River FOR Makeup

WATER BODY TEMPERATURES*- WINTER AVG - F SUMMER AVG - F AVG - F

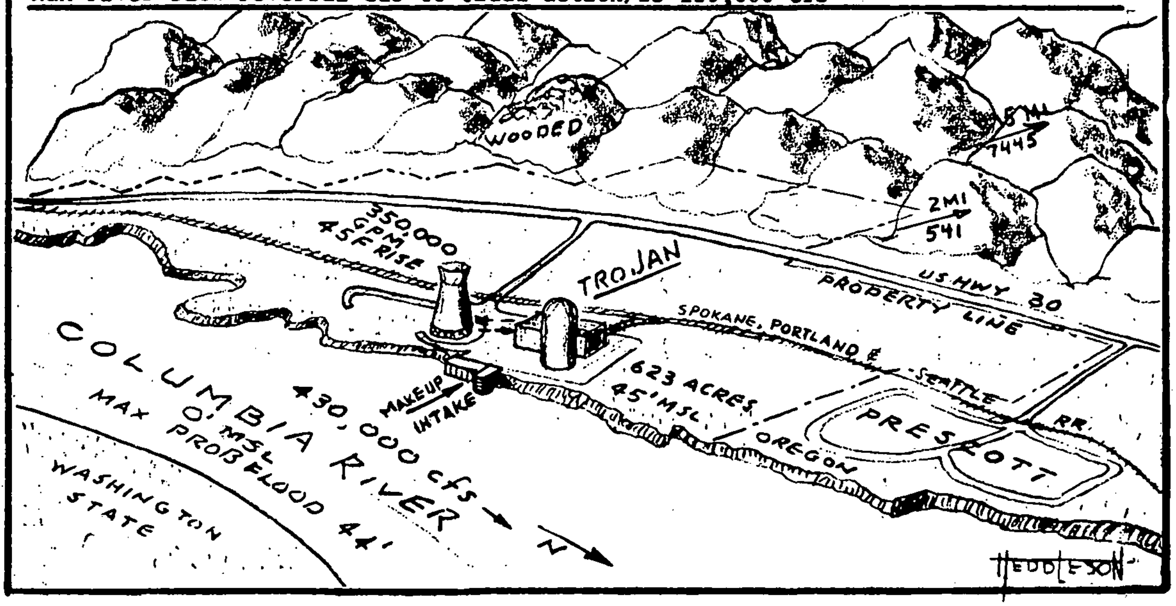
RIVER FLOW 430,000 (cfs) avg. *QUANTITY OF MAKEUP WATER 1125 to 5850 (gpm)

*TOTAL FLOW THROUGH CONDENSERS 350,000 (gpm) TEMPERATURE RISE 45 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS One natural-draft hyperbolic variable-cycle tower 492' high.

OTHER INFORMATION Blowdown - 1125 gpm at 65 F in winter, 5850 gpm at 101F summer.
Max river flow reversal due to tidal action is 129,000 cfs



DAVIS-BESSE, 50-346 (PWR)

Page 1

Project Name: Davis-Besse Nuclear Power Station
Location: Ottawa Co., Ohio*
Owner: Toledo Edison & Cleveland Elec.Ill
NSS Vendor: Babcock & Wilcox Co.
*21 mi. E. of Toledo

Reactor: Davis-Besse
A-E: Bechtel
Vessel Vendor: B&W
Docket No.: 50-346
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2,633	H_2O/U, Cold	2.85
Electrical Output, MWe	872	Avg 1st-Cycle Burnup, MWD/MTU	13,686
Total Heat Output for Safety Design, MWt	2772	First Core Avg Burnup, MWD/MTU	--
Total Heat Output, Btu/hr	$8,987 \times 10^6$	Maximum Burnup, MWD/MTU (Design, p 3-1)	55,000
System Pressure, psia	2,200	Region-1 Enrichment, %	2.32
DNBR, Nominal	1.92	Region-2 Enrichment, %	2.32
Total Flow rate, lb/hr	131.32×10^6	Region-3 Enrichment, %	2.68
Eff Flowrate for Heat Trans lb/hr	124×10^6	k_{eff}, Cold, No Power, Clean	1.276
Eff Flow Area for Heat Trans, ft^2	49.19	k_{eff}, Hot, Full Power Xe and Sm	1.088
Avg Vel Along Fuel Rods, ft/sec	15.7	Total Rod Worth, %	8.0
Avg Mass Velocity lb/hr-ft^2	2.52	Shutdown Boron, No Rods, Clean, Cold, ppm	1316
Nominal Core Inlet Temp, °F	557	Shutdown Boron, No Rods, Clean, Hot, ppm	1284
Avg Rise in Core, °F	52.9	Boron Worth, Hot, % Δk/k/ppm	1/100
Nom Hot Channel Outlet Temp, °F	648.8	Boron Worth, Cold, % Δk/k/ppm	1/75
Avg Film Coeff, Btu/hr ft^2, °F	5000	Full Power Moderator Temp Coeff, Δk/k/°F	0 to -3.0×10^{-4}
Avg Film Temp Diff, °F	31	Moderator Press Coeff, Δk/k/psi	$+4\times10^{-7}$ to $+3.0\times10^{-6}$
Active Heat Trans Surf Area, ft^2	49,734	Moderator Void Coeff Δk/k/% Void	-4.0×10^{-4} to $+3.0\times10^{-3}$
Avg Heat Flux, Btu/hr ft^2	175,810	Doppler Coefficient, Δk/k/°F	$(-1.1$ to $1.7)10^{-5}$
Max Heat Flux Btu/hr ft^2	538,730	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1.0
Avg Thermal Output, kw/ft	5.8	Burnable Poisons, Type and Form	$Al_2O_3B_4C$ in Zircaloy-4
Max Thermal Output, kw/ft	17.8	Number of Control Rods	784
Max Clad Surface Temp, °F	650	Number of Part-Length Rods (PLR)	128
No. Coolant Loops	2		

Compiled By: Fred A. Heddleson
Date: September 1969

Reactor: Davis-Besse

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.45 rad.	
Low Population Zone Dist., Mi.	2.0	
Metropolis	Distance	Population
Toledo, Ohio	20	429,000(80)
Design Basis Earthquake Accel., g	0.15	
Operating Basis Earthquake Accel., G	0.06 (p 2-18)	
Earthquake Vertical Shock, % of Horizontal		

Design Winds in psf:

0– 30	25	Natural Bureau of Standards recommendations
30– 50	30	
50–100	40	
100–500	45	
Tornado	300 mph	

Is intent of 70 Design Criteria satisfied? Yes

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	40	Calculated Max Internal Press, psig	36 (Fig. 14-49)
Max Leak Rate at Design Press, %/day	0.5		

Type of Construction: Free-standing steel containment vessel with cylindrical walls, hemispherical head and ellipsoidal bottom surrounded by reinforced-concrete shield building. Except for concrete foundation, there will be no rigid ties between the two structures.

Design Basis: Protection of the public from consequences of double-ended break of largest reactor-coolant pipe, assuming coolant loss from break. Also, protection from radiological consequences of this assumed break. Containment system along with engineered safety features will ensure public exposure, in case of accident, to be less than guidelines of 10CFR100.

Vacuum Relief Capability: Max. external pressure differential allowed is 0.34 psi. Automatic vacuum relief provided by 2 vacuum breakers in series in each of two lines connecting containment to annulus. One valve actuated by differential pressure signal independent of electrical power. Second valve is self-actuating (p 5-5)

Post-Construction Testing: During and after construction, pressure tested at 5, 40, and 45 psig. Leakage-rate test at 40 psig after previous tests. Periodic leakage-rate tests will be conducted to verify leak tightness.

Penetrations: Electrical and hot piping are double and individually testable. Cold piping are single and not testable. Water seals are not used.

Weld Channels: None mentioned.

Reactor: Davis-Besse

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Two half-capacity pumps, two half-capacity spray headers, valves, piping, and instrumentation comprise the system. High containment pressure and emergency injection-actuation signal start the pumps, which take suction first from the borated-water storage tank and then the containment sump. Pumps deliver 1300 gpm each.

Containment Cooling: Air recirculation cooling system consists of three fan-cooler units. Each unit is a finned-tube cooling coil and a direct driven fan. Containment air maintained at maximum of 120 F during operation and a minimum of 40 F during shutdown. In case of LOCA, any two units capable of cooling containment atmosphere to reduce the pressure. A purge system provides clean, fresh air to containment.

Containment Isolation System: Leakage thru all penetrations not serving accident-consequence-limiting systems minimized by double barriers in the form of isolation valves installed in pipes inside and outside containment wall. Isolation initiated on signal of hi pressure in containment. On loss of power, valves fail closed. Switches and position-indicating lights provided in control room.

Containment Air Filtration: Space between containment shell and shield building and penetration rooms maintained at slight vacuum during accident conditions. Exhaust from these areas would be through HEPA and charcoal filters. Two completely independent systems (fans & filters) are available, one of which has 100% capacity.

Penetration Room: There are several rooms at different levels.

Organic-Iodide Filter: None mentioned.

Hydrogen Recombiner: Since limited metal-water reaction is expected, recombiner not discussed.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Two tanks, each holding 7000 gal. of coolant, are pressurized with nitrogen to 600 psig. Except during normal cooldown, when the pressure in the reactor system drops below 600 psig, check valves open to dump contents of tanks into the reactor vessel. The 14,000 gal. of coolant can completely cover the core even if all liquid is lost from the reactor vessel.

High-head Safety Injection: Provided by makeup and purification system to prevent uncovering core for small- and intermediate-sized pipe breaks. System designed to hold clad temperatures below 2300F. Source of water is borated-water storage tank. Emergency injection will occur when system pressure reaches 1500 psig or a containment pressure of 4 psi during operation. Pumps will deliver about 400 gpm at 1600 psi.

Low-head Safety Injection: This system starts when reactor pressure is about 135 psi or containment pressure of 4 psi. Two pumps are available, one of which can deliver 3000 gpm of borated water at 100 psi. This system doubles as the decay-heat-removal system.

Reactor: Davis-Besse

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Rupture is incredible (p 4-19).

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Leakage can be detected by:
(1) Pressurizer makeup-water tank level deviation,
(2) Increase in activity in containment,
(3) Changes in building humidity and water level in the sump.

Failed-Fuel-Detection Systems: Not discussed.

Emergency Power: Two independent diesel-generators and their auxiliaries, installed in separate rooms, will (either one) supply power needs to operate engineered safety features. A supply of diesel oil for 10 days operation of both units at half power will be provided.

Control of Axial Xenon Oscillations:

Burnable Shims - Burnable poison rods and soluble boron in coolant.

Part-Length Control Rods - Yes

In-Core Instrumentation - Yes - one instrument position for each fuel assembly (177 total).

Unborated Water Control: A series of check valves, automatic valves, and manual valves are arranged to prevent backflow of reactor coolant into the borated-water storage tank and boric acid addition tank.

Long-Term Cooling - Internal or External Systems: Decay-Heat-Removal System has two pumps and two decay-heat coolers. Reactor coolant is circulated from one reactor outlet line thru the decay-heat coolers and back into the reactor vessel. Design flow, both pumps and coolers operating, will lower reactor coolant temp from 280F to 140F in 14 hr. This same system is used for low-pressure injection in case of LOCA, and also to maintain 140F or lower temp during refueling.

Reactor: Davis-Besse

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A 300-ft-high tower has collected data since fall 1968. Wind speed, direction, and directional variation are recorded at three elevations. No seismographs mentioned.

Plant Operating Mode: Load-following.

Site Features: Located on south shore of Lake Erie about 16 ft above mean low water level. Surrounding area is flat. Site consists of about 900 acres. Eastern half of site is marshland, and western half is farm land. Land use is agricultural with military installations and firing ranges. Two areas having summer cottages are within one mile of plant (summer and winter populations of 800 and 200 respectively).

Turbine Orientation: Turbine center-line is 220 ft east of containment center-line; turbine could throw blades tangentially toward containment.

Emergency Plans: An emergency plan will be developed before operation. It will cover accidents such as fire, medical, injury, radiation and contamination, and others resulting from operational malfunctions and natural disasters. Outside agencies such as Ohio State Highway Patrol, U.S. Coast Guard, local authorities and the AEC, etc., will be called upon as needed. All station personnel will be familiar with procedures.

Environmental Monitoring Plans: A preoperational monitoring program will be started at least 18 months before startup and will continue after startup. Collected samples will be lake and well water, soil, air particulate, farm products, lake biota, and bottom sediments. Air radiation dosimeters are planned for on-site and for nearby communities.

Radwaste Treatment: Liquid waste is collected and processed. Boric acid and demineralized water is a by-product and will be saved. Liquid wastes remaining will be released in batches, passing thru a monitor before release into circulating water outlet. Gaseous wastes will be compressed and stored for decay, retaining time up to 30 days. It will be released through high efficiency filters and discharged to atmosphere. Solid wastes will be collected, packaged, and shipped offsite for disposal.

Stack Height -

Waste Heat System: A closed-loop cooling system with 450-ft-high hyperbolic natural-draft wet cooling tower will be used. Makeup water will come from Lake Erie. Flow thru the condenser will be 685,000 gpm with 18 F temp rise.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Davis-Besse Nuclear Power Station

THERMAL OUTPUT, MWt 2633

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-346

NEARBY BODY OF WATER Lake Erie

NORMAL LEVEL 570' (MSL)

MAX PROB FLOOD LEVEL 584' (MSL)

SIZE OF SITE 900 ACRES

SITE GRADE ELEVATION 583' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat

TOTAL PERMANENT POPULATION IN 2 MI RAD 731 (1980) IN 5 MI RAD 2328 (1980)

NEAREST CITY OF 50,000 POPULATION Toledo, Ohio

DISTANCE FROM SITE 20 MILES POPULATION 429,000 (1980)

LAND USE IN 5 MILE RADIUS Agricultural-75%, with marshland around the site

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed loop using cooling tower

WATER TAKEN FROM Lake Erie FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

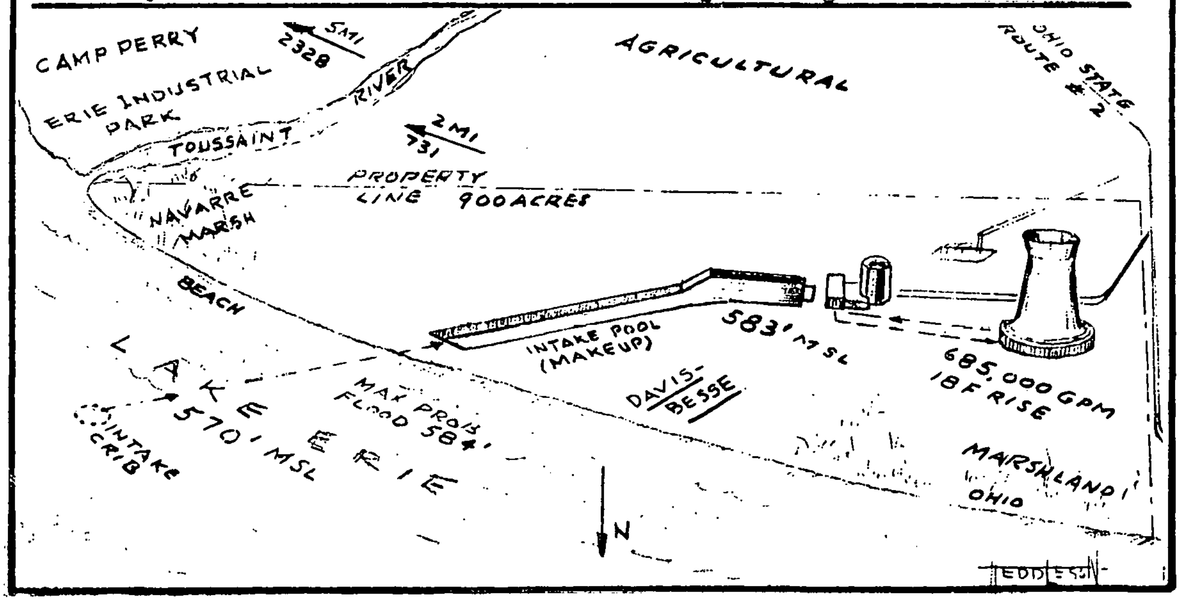
RIVER FLOW NA (cfs) avg. †QUANTITY OF MAKEUP WATER - (gpm)

†TOTAL FLOW THROUGH CONDENSERS * 685,000 (gpm) TEMPERATURE RISE * 18F

†HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) †Per Unit

COOLING TOWERS One natural-draft hyperbolic tower 450' high

OTHER INFORMATION * Original proposal was for a once through system with flow and temperature rise as shown above. Flow through cooling tower not known.



FARLEY, 50-348 & 50-364 (PWR) Page 1

Project Name: Joseph M. Farley Nuclear Plant, Units 1 & 2
Location: Houston Co., Ala.*
Owner: Alabama Power Company
NSS Vendor: Westinghouse
* 16.5 mi E. of Dothan

Reactor: Farley
A-E: Southern Services, Inc., & Bechtel
Vessel Vendor: Westinghouse Responsibility
Docket No.: 50-348 & 50-364
Containment Constructor: Not yet determined.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2660	H_2O/U, Cold	4.18
Electrical Output, MWe	861	Avg 1st-Cycle Burnup, MWD/MTU	13,500* 13,100**
Total Heat Output for Safety Design, MWt	2774	First Core Avg Burnup, MWD/MTU	24,200* 23,200**
Total Heat Output, Btu/hr	9051×10^6	Maximum Burnup, MWD/MTU (Design Equilibrium)	32,500
System Pressure, psia	2250	Region-1 Enrichment, %	2.0
DNBR, Nominal	1.85	Region-2 Enrichment, %	2.6
Total Flow rate, lb/hr	100.7×10^6	Region-3 Enrichment, %	3.2
Eff Flowrate for Heat Trans lb/hr	92.6×10^6	k_{eff}, Cold, No Power, Clean	1.207
Eff Flow Area for Heat Trans, ft^2	41.8	k_{eff}, Hot, Full Power Xe and Sm	1.137* 1.094**
Avg Vel Along Fuel Rods, ft/sec	14.2	Total Rod Worth, %	7
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.30×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1460
Nominal Core Inlet Temp, °F	543.5	Shutdown Boron, No Rods, Clean, Hot, ppm	1560
Avg Rise in Core, °F	70.2	Boron Worth, Hot	1% per 85 ppm
Nom Hot Channel Outlet Temp, °F	645	Boron Worth, Cold	1% per 70 ppm
Avg Film Coeff, Btu/hr ft^2, °F	5370	Full Power Moderator Temp Coeff, $\Delta k/k/°F$	$(0.3 \text{ to } -3.5)\times 10^{-4}$
Avg Film Temp Diff, °F	38.7	Moderator Press Coeff, $\Delta k/k/psi$	$(-0.3 \text{ to } 3.5)\times 10^{-6}$
Active Heat Trans Surf Area, ft^2	42,460	Moderator Void Coeff $\Delta k/k/\%$ Void	$(+0.35 \text{ to } -1.7) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	207,600	Doppler Coefficient, $\Delta k/k/°F$	$(-1.0 \text{ to } -1.6) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	579,600	Shutdown Margin, Hot One Rod Stuck, % $\Delta k/k$	1.0
Avg Thermal Output, kw/ft	6.7	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Thermal Output, kw/ft	18.8	Number of Control Rods	45 × 20 = 900
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	8 × 20 = 160
No. Coolant Loops	3		

* Table 1-1
** Table 3-1

Compiled By: Fred A. Heddleson
Date: November 1969

Reactor: Farley

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		0.78	Design Winds in mph:	
Low Population Zone Dist., Mi.		2	At 0 - 50 ft elev	115
Metropolis	Distance	Population	50 - 150 ft	140
Albany, Ga.	60	65,000 (69)		
Design Basis Earthquake Accel., g		0.10	150 - 400 ft	170
Operating Basis Earthquake Accel., G		0.05	Tornado - 300 mph tangential, 60 mph forward	
Earthquake Vertical Shock, % of Horizontal		66%	ΔP = psi/ sec	

Is intent of 70 Design Criteria satisfied? Yes

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	54	Calculated Max Internal Press, psig	
Max Leak Rate at Design Press, %/day	0.3 at 47.7 psig		

Type of Construction: Prestressed concrete vertical cylindrical structure with shallow-domed roof and flat base. Interior will be lined with 1/4-in.-thick steel plate.

Design Basis: Designed for all credible conditions of loading, including normal loads, LOCA loads, test loads, and loads due to adverse environmental conditions, meeting all these conditions and maintaining integrity against release of radioactivity to the outside atmosphere in excess of allowable limits.

Vacuum Relief Capability: Designed for 2-psi differential. Purge valves and vacuum breakers are not required (Sect. 5.1.2.9).

Post-Construction Testing: Entire containment will be held at 115% design pressure for 1 hr. Leak-rate tests will be conducted at 100% of design pressure and at successively lower pressures. Postoperational leak-rate tests will be run at 50% of peak LOCA pressure.

Penetrations: Single penetrations. Electrical, personnel & equipment hatch, & refueling tube are individually testable. No water seal backup.

Weld Channels: Not mentioned. However, vacuum box will be used to inspect welds with soap bubbles under 5-psi differential.

Reactor: Farley

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Borated water mixed with 30% sodium hydroxide is sprayed into containment atmosphere to limit rise of temp. and press. following LOCA. System has capacity to maintain temp. and press. below design conditions even for double-ended rupture of largest pipe. Na OH is for postaccident iodine control. Automatically initiated by coincidence of Safety Injection actuation and high containment press. Two pumps (1450 gpm at 470-ft head) take suction from refueling storage tank or from discharge of RHR heat exchanger.

Containment Cooling: Four fan-coil cooler units circulate and cool the air so temperature during operation is held below 120F. Service water thru coils is heat-removal agent. Three units have capacity to maintain design temp. after LOCA.

Containment Isolation System: Isolation valves are installed on all penetrations, inside and outside containment shell, to provide double barriers to release of radioactivity. Safety injection signal causes nonessential process-line valves to close. Essential process-line valves close coincidentally with containment spray actuation.

Containment Air Filtration: Air exhausted from penetration rooms can be passed thru particulate filters, absolute filters, and charcoal filters before discharge to the vent stack. Air from Fuel-Handling Area, Radwaste Area, and containment space passes thru particulate and absolute filters.

Penetration Room: Yes. Leakage into penetration rooms is collected, filtered, and exhausted thru vent stack.

Organic-Iodide Filter: No reference found in PSAR.

Hydrogen Recombiner: No reference found in PSAR.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Three tanks discharge borated water independently into three coolant-system cold-legs when reactor pressure drops below 600 psig. Two check valves, in series, are the only moving parts. Each tank supplies 7000 gallon, 14,000 gallon of which covers the core to limit fuel-rod-cladding temp. and to limit metal-water reaction. Tanks are pressurized with nitrogen.

High-head Safety Injection: Three high-head pumps (150 gpm @ 2750 psig each) deliver borated water from refueling storage tank to the 3 hot-legs and 3 cold-legs of coolant loops. This system's purpose is to make up water lost by small breaks to prevent depressurization. Pumps start on safety injection actuation signal.

Low-head Safety Injection: Two separate systems each with pump, piping, heat exchanger, and accessories. Each pump delivers 3750 gpm @ 600 psig to flood core after accumulators have performed their function to make up water lost thru large break. Pumps first draw borated water from the refueling water storage tank for injection phase and then switch over to water in containment sump for circulation phase. In circulation phase, water is cooled by residual-heat exchanger.

Reactor: Farley

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: By two radiation-sensitive instruments: air-particulate monitor is the most sensitive, with the containment radio-gas monitor as backup. Also, by measuring the increased coolant makeup water and monitoring containment sump level.

Failed-Fuel-Detection Systems: No reference found in PSAR.

Emergency Power: Power is available from startup auxiliary transformer as redundant off-site power. Also two diesel generators provide emergency power for engineered safety features and essential auxiliaries. One unit can supply emergency power needs. Fuel oil is available for 48-hr operation at rated power.

Control of Axial Xenon Oscillations:

Burnable Shims - Yes (chemical)

Part-Length Control Rods - Yes

In-Core Instrumentation - Yes, used periodically to calibrate and verify out-of-cour instruments.

Unborated Water Control: Boric acid from boric acid tank is blended with reactor makeup water in the blender and composition is determined by preset flow rates of boric acid and reactor makeup water. Two separate operations are required. First, operator must switch from automatic makeup mode to dilute mode. Second, start button must be depressed. Omitting either step would prevent dilution. So, possibility of adding unborated water is very small.

Long-Term Cooling - Internal or External Systems: Long-term core cooling accomplished by continued operation of low-head safety-injection pumps in the circulation phase (see D3); then operated as the Residual-Heat-Removal System. This system begins operation when reactor coolant is 350F at 350 psig and operates 20 hr to reduce temp. to 140F.

Reactor: Farley

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: On-site meteorology program will start in 1970 or 71. Wind speed and direction will be measured at 100 ft min. ht. No seismographs mentioned.

Plant Operating Mode: Reactor power adjusted in response to turbine load demand.

Site Features: Area is gently rolling, with site (155-ft gr. elev.) flat to rolling and near the Chattachoochee River. Sparsely populated - nearest house is 4500 ft from plant, and ∿2300 residents in 5-mi radius. Land use is 50% farming and 50% forest. Private landing strip on site provided for plant personnel. Cooling towers will cool circulating water, and a reservoir will store makeup water pumped from river. Area has high incidence of tornadoes.

Turbine Orientation: Turbine centerline is ∿145 ft west of containment centerline. Turbine blades could be thrown toward containment.

Emergency Plans: Course of action planned for on-site and off-site emergencies to safeguard plant personnel and the public in case of accidental release of activity. Plans stress good communication and liason among all involved, particularly Federal, State, and local agencies. An outline of authority and responsibility is presented, stating that all plant personnel will have specific duties.

Environmental Monitoring Plans: Plans now being formulated for pre- and post-operational testing. Sampling stations will be located to measure representative natural radioactive backgrounds and closer to the plant to measure effects of liquid and gaseous releases. Three levels of sampling activity are planned, and the actual level used will depend upon results found after the first year of post-operational testing (Section 2.9).

Radwaste Treatment: Designed to collect, store, process, and monitor solid, liquid and gaseous wastes; permitting controlled release of liquids and gases within limits of 10CFR20. Liquid wastes collected in sumps and tanks are identified and activity measured, then processed as required, and released thru a monitored line into water discharged from the plant.

Waste gases are collected in vent header flowing from there to one of two gas compressors which discharge to waste-gas-decay tank. Tank contents released to environment in accordance with 10CFR20.

Waste Heat System: Closed-loop system with 3 mechanical-draft cooling towers. Water will be pumped from the Woodruff Reservoir of the Chattahoochee River into a 1639 acre-feet storage pond. Water from this storage pond will serve as make-up supply for the system. River flow average is 10,600 cfs.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Joseph M. Farley Nuclear Plant, Units 1 & 2

THERMAL OUTPUT, MWt 2660

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-348 50-364

NEARBY BODY OF WATER Chattahoochee River Woodruff Reservoir

NORMAL LEVEL 76' (MSL)

MAX PROB FLOOD LEVEL 144' (MSL)

SIZE OF SITE 800 ACRES

SITE GRADE ELEVATION 155' (MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 486 (1975) IN 5 MI RAD 2300 (1975)

NEAREST CITY OF 50,000 POPULATION Columbus, Georgia

DISTANCE FROM SITE 87 MILES POPULATION 116,800 (1960)

LAND USE IN 5 MILE RADIUS Agricultural and Wooded

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed loop using cooling towers

WATER TAKEN FROM Woodruff Reservoir FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

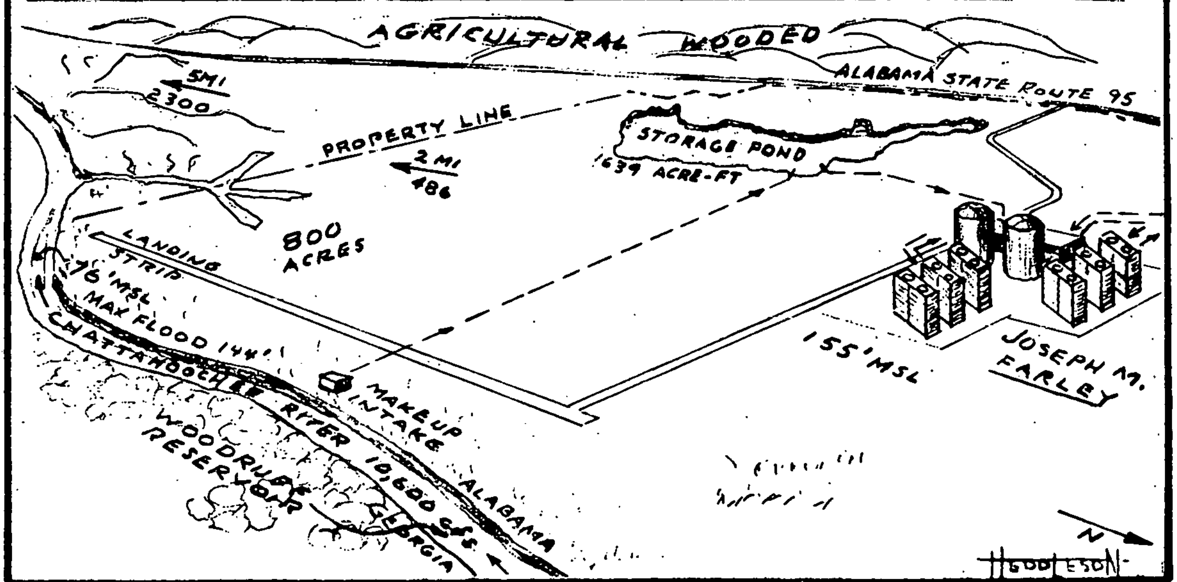
RIVER FLOW 10,600 (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS - (gpm) TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS Three mechanical-draft towers with makeup from a 1639 acre-

OTHER INFORMATION feet storage pond. Storage pond supplied from reservoir.



LIMERICK, 50-352 & 50-353 (BWR) Page 1

Project Name: Limerick Generating Sta - 1 & 2
Reactor: Limerick
A-E: Bechtel
Location: Montgomery Co., Penn.*
Vessel Vendor: Chicago Bridge & Iron
Owner: Philadelphia Electric
Docket No.: 50-352, 50-353
NSS Vendor: General Electric
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3293	H_2O/UO_2 Volume Ratio	2.43
Electrical Output, MWe	1100	Moderator Temp Coef Cold, Δk/k/°F	---
Total Heat Output for Safety Design, MWt	3440	Moderator Temp Coef Hot, No Voids	---
Steam Flow Rate, lb/hr	14.156×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	106.5×10^6	Moderator Void Coef Operating	-1.7×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.18×10^{-5}
Heat Transfer Area, ft^2	66,100	Doppler Coefficient, Hot, No Voids	-1.15×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.35	Doppler Coefficient, Operating	-1.19×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	425,060	Initial Enrichment, %	2.19
Average Heat Flux, Btu/hr-ft^2	163,230	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4430	Core Average Void Within Assembly, %	---
Average Fuel Rod Surface Temp °F	560	k_{eff}, All Rods In	---
MCHER	≥ 1.9	k_{eff}, Max Rod Out	< 0.99
Total Peaking Factor	2.6	Control Rod Worth, Δk_{eff}	0.012 max**
Avg Power Density, Kw/ℓ	50.8	Curtain Worth, %	0.012
		Burnable Poisons, Type and Form	372 flat, boron-ss curtains
		Number of Control Rods	185 cruciform
		Number of Part-Length Rods (PLR)	None mentioned

*20 mi NW of Philadelphia

**At rated power (Fig. 3.6-4); max possible rod worth is 0.38Δk (page 3.6-16).

Compiled by: Fred Heddleson
Date: July 1970

TX-4377
(8-70)

Reactor: Limerick

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.47	Design Winds in mph:	
Low Population Zone Dist., Mi.	---	At 0 - 50 ft	- 90
Metropolis / Distance / Population Reading, Pa. / 20 / 107,800 (80)		50 - 150 ft	- 105
Design Basis Earthquake Accel., g	0.12	150 - 400 ft	- 125
Operating Basis Earthquake Accel., g	0.06	Tornado ΔP = 3 psi/ 3 sec	- 300
Earthquake Vertical Shock, % of Horizontal	66	Is intent of 70 design criteria Satisfied?	Appendix H

Peak Fuel Enthalpy on Rod Drop: The specified control-rod withdrawal sequences to be used are designed to limit rod worth, so that the drop of any control rod from the core to the position of its drive results in a peak fuel enthalpy of not more than 280 cal/g.

Recirculation Pumping System & MCHER:
Pump speeds are adjusted to change coolant flow rate to accomplish load following. MCHFR is effected by flow rate.

Protective System: Initiates a rapid, automatic shutdown of reactor. Action taken in time to prevent excessive fuel cladding damage or process-barrier damage following abnormal operational transients. System overrides all operator actions and process controls.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	48	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	48	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	38.2	Second Ctmt Leak Rate, %/day	100

Type of Construction: The drywell is in the form of a truncated cone, & the cylindrical pressure-suppression chamber is immediately below. These two units comprise a structurally integrated reinforced-concrete pressure vessel, lined with welded steel plate. Drywell & supprn chamb separated by reinforced-conc floor.

Design Basis: Primary containment designed to withstand pressures & temp induced by rupture of reactor coolant system, up to and including a recirculation line - without loss of integrity; namely, to withstand effects of metal-water reactions, permit total flooding, rapidly condense steam escaping from ruptured system, limit leakage of contaminants, and withstand jet forces and missiles.

Vacuum Relief Capability: Primary containment is vented thru ventilation purge connections, which are normally closed when reactor temperature exceeds 212 F. System designed for 2-psi vacuum differential.

Post-Construction Testing: Before initial loading, containment will be tested at 1.15 design pressure (55). Pressure will then be reduced to calculated peak (38.2) to verify leakage-rate design. Integrity of containment will be tested during the life of the plant.

Penetrations: Personnel and access hatches are double; all others are single. Electrical, personnel, and access hatches are testable.

Reactor: Limerick

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Two independent pump loops deliver cooling water to spray spargers over core. System actuated by breach in nuclear-system process barrier, but water is delivered to core only after reactor pressure is reduced. System has capability to cool fuel with sprayed water. Either core spray loop is capable of preventing fuel clad melting following LOCA. Four 50% capacity pumps can each deliver 3125 gpm @ 122 psid from suppression pool.

Auto-Depressurization System: Acts rapidly to reduce reactor pressure in LOCA where HPCIS fails to maintain reactor-vessel water level. Depressurization enables LPCI systems to start & deliver cooling water to reactor.

Residual-Heat-Removal System (RHRS): System consists of 4 heat exchangers (70×10^6 Btu/hr ea), 4 main pumps (3 of which supply 100% cap'y) & 4 service-water pumps arranged into 2 cross-connected loops. Three modes of operation: 1. Shutdown cooling - water pumped from reactor thru heat exchangers for cooling & returned to reactor. Can complete cooldown to 125F in 20 hr & maintain. 2. Containment cooling-water pumped from suppression pool thru heat exchangers & back to pool so pool will be maintained at 170F or below. Flow (5%) can be diverted thru drywell spray hdrs. 3. LPCI mode - main pumps transfer water from suppression pool to reactor to maintain 2/3 core flooding sufficient to prevent fuel clad melting. ∿30,000 gpm@20psid.

High-Pressure Coolant-Injection System: Provides and maintains coolant inside reactor to prevent fuel-clad damage as results of small breaks in process barrier. The HPCIS turbine-pump, powered by reactor steam, delivers 5000 gpm @ 1120 psid to the reactor vessel from condensate storage tank or suppression pool.

Low-Pressure Coolant-Injection System: Four pumps (1/3 cap ea for 10,000 gpm @ 20 psid) serve as part of RHRS to operate at lower pressures, ∿0 to 300 psi, to flood the core and limit rise of fuel-clad temp. Starts automatically on low-water level in reactor, or high drywell press.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: The Residual-Heat-Removal Service-Water System is cross tied to the RHRS to provide an additional source of water for postaccident containment flooding.

Main-Steam-Line Flow Restrictors: Venturi-type flow restrictors installed in each steam line close to reactor. Limits loss-of-coolant in case of main steam line break. Also prevents uncovering core before steam-line-isolation.

Control-Rod Velocity Limiters: Protects against high reactivity insertion rate in case of control-rod-drop accident by limiting rod velocity. Velocity limited in one direction but does not effect scram rate. Accomplished with large clearance piston and baffle inside control rod guide tube.

Control-Rod-Drive-Housing Supports: Located underneath reactor vessel just under control-rod housing to limit travel or catch the control rod if housing ruptures. Will prevent a nuclear excursion even if housing fails and drops from the reactor. Under operating conditions, housing can drop only 1/4 in. in case of failure.

Standby Liquid-Control System: A redundant system for reactivity control used when control rods cannot shut down reactor. By manual initiation, sodium pentaborate solution is pumped into the bottom of the reactor. About 2 hr required for complete injection. System can be used to maintain shutdown if required.

Reactor: Limerick
E. OTHER SAFETY-RELATED FEATURES (cont'd)
Containment Atmospheric Control System: No system mentioned for nitrogen purging or recombining hydrogen in primary containment.
Reactor Core Isolation Cooling System (RCICS): Starts automatically on signal of reactor-vessel low-water level to prevent need for operating of any core-standby cooling system. Can also be started manually. Removes decay heat and provides makeup water into feedwater line if feedwater pumps are inoperative, and/or if isolation valves have closed, isolating reactor from main condenser heat sink. One steam-turbine-driven pump delivers 616 gpm from condensate storage tank or suppression pool.
Reactor Vessel Failure: No references to vessel failure. Missile & Reactor Forces - Core Cooling Capability - Containment Floodability - Primary containment can be filled with water to a level above reactor core.
Reactor-Coolant Leak-Detection Systems: Pump and valve seals, & reactor-vessel head-flange gasket leakage are measurable & identifiable. Unidentifiable leakage which could signal piping system cracks is detected by unusual pressure rise, increase in containment temp, and/or containment sump-pump operation which is monitored by a flow integration and recorder.
Failed-Fuel Detection Systems: Four gamma-radiation monitors located near steam lines just outside primary containment designed to detect release of fission products from the fuel. High radiation initiates scram and system isolation.
Emergency Power: Four 3000-kw diesel-generators are provided, three of which are adequate to start and carry all essential loads. These units and their switch gear are separated and independent. A supply of fuel will be maintained for 6 days of continuous operation. A day tank supplies fuel for 2 1/2 hr of operation. Units start automatically on loss of offsite power, low-water level in reactor, or high drywell pressure.
Rod-Block Monitor: To prevent fuel damage as a result of single rod-withdrawal error. Monitor bypassed at <30% power. Two RBM channels, either of which can initiate a rod block using signals from LPRM channels. Because MCHFR cannot reach 1.0 until rod is halfway withdrawn, the highest rod-block setpoint halts rod motion before local fuel damage can occur.
Rod Worth Minimizer: On-line computer prevents rod withdrawal at low power if rod being withdrawn is not in accordance with planned pattern, thus limiting reactivity worth of rods by enforcing adherence to planned pattern.

Reactor: Limerick

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A 350-ft-high tower will be erected to measure wind speeds, temperatures, and other meteorological data. No seismographs mentioned.

Plant Operating Mode: Recirculation flow to the reactor is varied to accomplish load following.

Site Features: 587A, gently rolling along the Schuylkill River. Site elevation varies from 100' to 280' with reactors at ∿220' and hyperbolic cooling towers at 260'. Reactors will be 850' from edge of river, which has limited use by pleasure boaters. Railroad right-of-way will be 500' from reactor. Population (1968) within 5 mi of site was 66,600. Max population is in northwesterly direction being ∿30,000 within 5 mi of site. Prevailing wind direction is NW. Land use is mostly rural within 10 mi of site. Site is well above max flood level (by 100 ft). Nearest town is Pottstown 2 to 4 mi NW from site.

Turbine Orientation: Could not be found.

Emergency Plans: Procedures will be written and practiced for familiarity. State police, local fire department, local hospital, and other public agencies will be involved. Plant personnel will be trained in use of procedures and practices, and training drills will be held. Proper communication systems will be used for emergency warning. Nuclear-medicine consultants at University of Penn. is developing emergency medical plans.

Environmental Monitoring Plans: Preoperational studies will be made to measure radioactivity of the air, river, rain and snow, well water, vegetation, garden vegetables, river-bottom silt, soil, fish, milk, and aquatic biota. An independent lab has been engaged to gather water-quality data on the river. One item that will be measured is river temperature.

Radwaste Treatment: Liquid and solid wastes are routed to radwaste building for collection, processing, sampling and disposal. Gaseous wastes are routed to off-gas building for hold-up and filtration before release. Solid wastes are packaged for shipment offsite. The Liquid and Gaseous Radwaste Systems will reduce activity such that concentrations in routine discharges are significantly less than regulatory limits. Effluents are continuously monitored, and discharge is automatically stopped if concentrations exceed limits.

Stack Height - Roof top vent, steel pipe, 200 ft above ground.

Waste Heat System: Circulating water system takes 107 cfs max from river. About 54 cfs is needed to make up for evaporation in the 4 hyperbolic, natural-draft cooling towers. The other 53 cfs is returned to river as cooling-tower blowdown and/or dilution. Average river flow is 1816 cfs. Main condenser heat removal capacity is 7800 × 10^6 Btu/hr. Two or more circulating pumps (250,000 gpm each) pump thru a closed loop of the cooling towers.

G. CIRCULATING WATER SYSTEM & SITE FEATURES	REACTOR NAME Limerick Generating Station, units 1 & 2	
THERMAL OUTPUT, MWt 3293	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-352 50-353

NEARBY BODY OF WATER Schuykill River — NORMAL LEVEL 110' (MSL)

MAX PROB FLOOD LEVEL 144' (MSL)

SIZE OF SITE 587 ACRES — SITE GRADE ELEVATION 220' (MSL)

TOPOGRAPHY OF SITE Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 5258 (1968) IN 5 MI RAD 66,600 (1968)

NEAREST CITY OF 50,000 POPULATION Reading, Penn.

DISTANCE FROM SITE 20 MILES — POPULATION 107,790 (1968)

LAND USE IN 5 MILE RADIUS Agricultural and Undeveloped

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Closed loop using cooling towers

WATER TAKEN FROM Schuykill River — FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG 42 F — SUMMER AVG 82 F — AVG - F

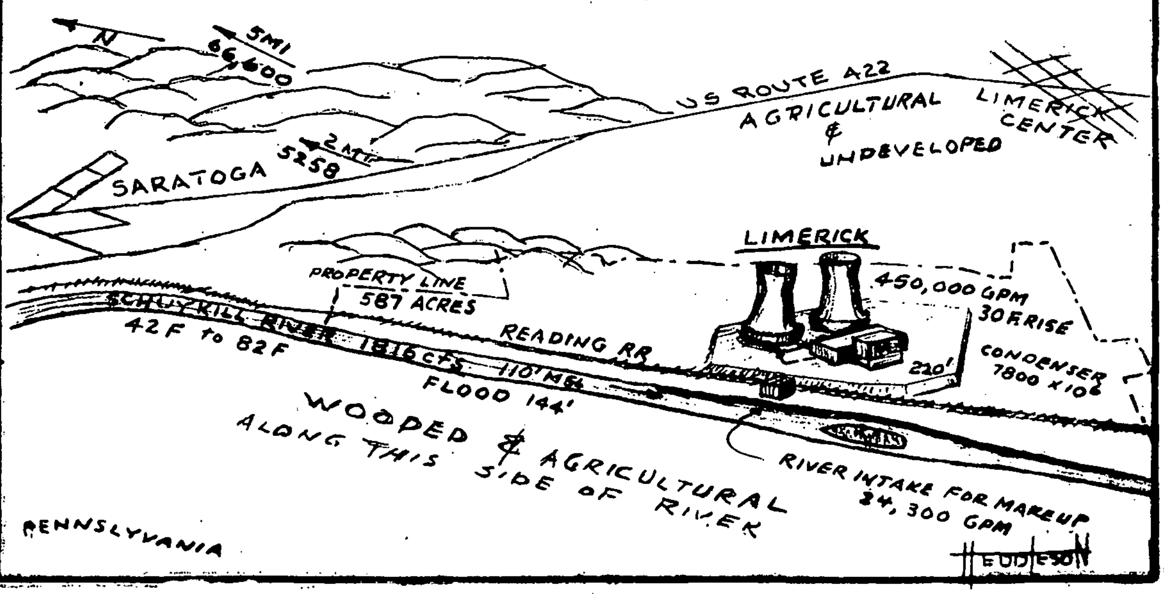
RIVER FLOW 1816 (cfs) avg. — *QUANTITY OF MAKEUP WATER 24,300 (gpm)

*TOTAL FLOW THROUGH CONDENSERS 450,000 (gpm) — TEMPERATURE RISE 30 F

*HEAT REMOVAL CAPACITY OF CONDENSERS 7800×10^6 (Btu/hr) — *Per Unit

COOLING TOWERS One hyperbolic natural-draft towers 475 wide X 500' high,

OTHER INFORMATION Application filed with Delaware River Comm. for water from that river.during low flow in Schuykill. 16 mi of pipe required + creek usage.



NEWBOLD ISLAND, 50-354 & 50-355 (BWR) Page 1

Project Name: Newbold Island Nuclear Generating Station 1 & 2
Location: Burlington Co., N.J.*
Owner: Public Service Electric & Gas Co.
NSS Vendor: General Electric Company

Reactor: Newbold Island
A-E: Public Service Electric
Vessel Vendor: Not discussed
Docket No.: 50-354, 50-355
Containment Constructor: Public Serv. Elec

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3293	H_2O/UO_2 Volume Ratio	2.43
Electrical Output, MWe		Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output for Safety Design, MWt	3440	Moderator Temp Coef Hot, No Voids	-17.0×10^{-5}
Steam Flow Rate, lb/hr	14.2×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	106.5×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	66,1000	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.35	Doppler Coefficient, Operating	-1.3×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	425,060	Initial Enrichment, %	2.25
Average Heat Flux, Btu/hr-ft^2	163,230	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4430	Core Average Void Within Assembly, %	---
Average Fuel Rod Surface Temp °F		k_{eff}, All Rods In	See curve 3.6-14
MCHFR	≥ 1.9	k_{eff}, Max Rod Out	0.99
Total Peaking Factor	2.6	Control Rod Worth, %	0.01Δk max
Avg Power Density, Kw/ℓ	50.8	Curtain Worth, %	---
		Burnable Poisons, Type and Form	Boron in 372 flat ss curtains
		Number of Control Rods	185
		Number of Part-Length Rods (PLR)	None mentioned

*On Island in Delaware River.

Compiled by: Fred Heddleson
Date: July 1970

TX-4377
(8-70)

Reactor: Newbold Island

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.32	Design Winds in mph:		
Low Population Zone Dist., Mi.	1	At 0 - 50 ft	108	sustained (Table 1.6-4)
Metropolis / Distance / Population Trenton, N.J. / 6.4 / 114,167 (60)		50 - 150 ft	--	
Design Basis Earthquake Accel., g	0.15	150 - 400 ft	--	
Operating Basis Earthquake Accel., g	0.08	Tornado	300	
		ΔP = psi/ sec		
Earthquake Vertical Shock, % of Horizontal	---	Is intent of '70 design criteria Satisfied? Yes (See Pg. 15.2-1)		

Peak Fuel Enthalpy on Rod Drop: Not more than 280 calories per gram.

Recirculation Pumping System & MCHFR: Pumping rate can be varied to change flow rates thru core. Type of boiling is altered by rate of flow and thus MCHFR also is changed.

Protective System: Initiates a rapid, automatic shutdown of reactor. Action taken in time to prevent excessive fuel cladding damage and process barrier damage following abnormal operational transients. System overrides all operator actions and process controls

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	56	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	56	Second Ctmt Design Press, psig	3
Calc Max Internal Press, psig	47	Second Ctmt Leak Rate, %/day	10

Type of Construction: Primary containment — steel shell in form of inverted lightbulb enclosed in reinforced concrete. Drywell interconnection to torus-type steel pressure-suppression chamber supported by reinforced concrete pad. Secondary containment-cylindrical, reinforced concrete shell (2.5 ft thick) w/spherical dome.

Design Basis: Designed to withstand LOCA with 4 sq ft break area, simultaneously with forces imposed by the design-basis earthquake, and also to maintain design leak tightness during such an accident so that radioactive release will cause no off-site dose in excess of values specified in 10 CFR 100.

Vacuum Relief Capability: A vacuum relief system will be designed to prevent a negative pressure differential on either the dyrwell or suppression chamber. The design value will be 2 psid.

Post-Construction Testing: Tested at 125% design pressure using 20% freon and a halide leak detector. After holding for 1 hr at 125% design pressure, pressure will be reduced to design pressure for soapsuds inspection. Leak-rate tests will be performed during the plant lifetime.

Penetrations: Electrical and steam are double and testable. All others are single.

Reactor: Newbold Island

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Two independent loops, each having 1 pump and 1 spray sparger above core. Design flow is 6250 gpm at 122 psid each, with water from suppression pool. Low water level in reactor vessel or high pressure in drywell initiates system to prevent fuel-clad melting. Low-Pressure Coolant-Injection System starts from same signals and operates independently to achieve same objectives.

Auto-Depressurization System: When feedwater pumps, RCICS, and HPCIS, cannot maintain proper reactor water level, safety relief valves on steam lines open, venting steam to suppression pool so the reactor is depressurized. The LPCI & core-spray systems then begin operation. Relief valves (5) open & stay open on coincident signals of high dry-well-pressure.

Residual-Heat-Removal System (RHRS): System consists of 2 heat exchangers, 4 main pumps (each 1/3 cap), and service-water system to cool heat exchangers. Four major modes of operation are: (1) LPCI Mode - main pumps transfer water from condensate storage tank or suppression pool to reactor to maintain core flooding to hold clad temp <2700F. ∿30,000 gpm. (2) Containment-Spray Mode - water pumped from suppression pool thru heat exchangers to spray headers in drywell to condense steam. (3) Reactor Isolation Mode - suppression-pool water is pumped thru residual heat exchangers to maintain pool temperature below 170F. (4) Shutdown Cooling Mode - used to remove decay & residual heat from core.

High-Pressure Coolant-Injection System: Steam turbine-driven constant-flow pump supplies 500 gpm @ 1140 psia to feedwater piping system. Suction taken from condensate storage tank or suppression pool. This system prevents fuel melting in the case of small line breaks where rapid depressuring does not occur. Reactor low-water level or high drywell pressure signals automatically start system.

Low-Pressure Coolant-Injection System: Four 1/3 cap pumps flood the core at low pressures (0 to 300 psi). Each pump can supply 10,000 gpm @ 20 psid from the suppression pool. These pumps are classed as part of the Residual Heat Removal System.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: Fig. 6.4-3 shows piping connection so that Essential Service Water System could supply water (from the river) the the drywell spray system or to the reactor coolant recirculation system, or for containment flooding. Four low-head pumps are available.

Main-Steam-Line Flow Restrictors: Venturi-type restrictor in each of 4 main lines limits loss flow from reactor vessel in case of line rupture; steam flow in severed line restricted to ∿200% of rated flow.

Control-Rod Velocity Limiters: Two nearly mated conical elements that act as a large-clearance piston and baffle inside the control-rod-guide tube over the length of the control-rod stroke limits drop-out velocity to <5 ft/sec. Velocity of rod insertion is not affected. This feature protects against a high reactivity rate of change in the event of a control-rod-drop accident.

Control-Rod-Drive-Housing Supports: Located underneath reactor vessel just under control-rod housing to limit travel or catch the control rod if housing ruptures. Will prevent a nuclear excursion even if housing fails & drops from the reactor. Under operating conditions, housing can drop only 1/4 in. in case of failure.

Standby Liquid-Control System: A redundant system for reactivity control used when control rods cannot shut down reactor. By manual initiation, sodium pentaborate solution is pumped into the reactor. About 1 to 2 hr required for complete injection. System can be used to maintain shutdown if required.

Reactor: Newbold Island

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: Containment inerting is unwarranted since hydrogen poses no problem; however, required nozzles, piping, and connections will be installed tc facilitate later purging installation, if required.

Reactor Core Isolation Cooling System (RCICS): Starts automatically on signal of reactor-vessel low-water level, or can be started manually. Removes decay heat and provides makeup water into feedwater life if feedwater pumps are inoperative, and/or if isolation valves have closed, isolating reactor from main condenser heat sink. One steam-turbine-driven pump delivers 616 gpm at 1500 psig from either condensate storage tank, RHRS heat exchangers, or suppression pool. Turbine is driven with decay heat steam from reactor vessel.

Reactor Vessel Failure: Has an extremely low probability of failure due to any known failure mechanism. (Sect. 4.2.5).

Missile & Reactor Forces -

Core Cooling Capability - not discussed relative to vessel failure.

Containment Floodability - an analysis will be made to establish capability of system to withstand flooding.

Reactor-Coolant Leak-Detection Systems: Leakage is designated as "Identified" or "Unidentified". Four variables are available for detecting leaks: sump flows, drywell pressure, drywell temperature, and air sampling. Detailed system design will evaluate these methods.

Failed-Fuel Detection Systems: Four gamma-sensitive monitors located near main steam lines just outside primary containment will detect significant increases in radiation levels which could be caused by gross fuel failure. Detection of increased radiation levels will initiate a scram and closure of steam-line-isolation valves, and also, a trip signal is transmitted to the Gaseous Radwaste System.

Emergency Power: Four diesel-generator sets are provided. They are sized so any three can supply all necessary power for one unit under design basis accident. Each unit is physically separated from the others. A 7-day fuel supply is available on the site. Units will start and receive load within 10 seconds after receiving the starting signal.

Rod-Block Monitor: Operates in conjunction with on-line computer and rod worth minimizer system to block rod withdrawal that could cause damage to the fuel.

Rod Worth Minimizer: A function of the on-line computer which prevents rod withdrawal under low power conditions if rod to be withdrawn is incorrect for the pre-planned pattern.

Reactor: Newbold Island

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Tower facility will be installed on or adjacent to the site. No seismographs mentioned.

Plant Operating Mode: Inherently high moderator-to-Doppler coefficient permits use of coolant for from load-following.

Site Features: Site is on Newbold Island (530 acres) in the Delaware River. The site is above all probable flood levels except for the probable max hurricane water level, which could be 4 ft above site grade. Area surrounding site mostly commercial, industrial, and residential. Center of Philadelphia is 26 mi from site. Trenton, N.J. is 5 to 8 miles. High-population areas are westerly and northeasterly. Wind directions are variable.

Turbine Orientation: Ejected blades could possibly strike containment shell.

Emergency Plans: Written procedures will be prepared and personnel will be trained in these procedures. Periodic tests and reviews will be conducted. Off-site emergency plans will be formulated in cooperation with state government, police, fire departments, etc.

Environmental Monitoring Plans: Programs will be conducted before and after operation to evaluate radiation levels and ecology of the site, and to determine effects, if any, of the station on the radiation levels and ecology. Monitoring program will include sampling of atmospheric, land and aquatic environment, using indicators such as air, water, soil, and sediment, as well as potable water, milk, vegetables, and marine life. Sampling will be conducted on-site, and off-site in all directions in N.J., and Penn., and up and down-stream of the Delaware River. An ecological study will establish before and after biological and physiocochemical conditions in the vicinity of the station.

Radwaste Treatment: Designed to control release or radioactive effluents by methods such as collection, filtration, holdup for decay, dilution, and concentration. Liquids will be collected, treated and stored, and released to the water dio charge canal for dilution. Solids will be collected and processed for storage in drums. Gaseous wastes are collected and held for decay, being released within established limits. Design bases for 30 second decay is annual average rate of 100,000 μc/sec. With 3 day holdup of Krypton and 25 day holdup of Xenon, rate is about 115 μc/sec.
Stack Height - Radioactive gases vented thru elevated exhaust duct. Ht of vent not found.

Waste Heat System: Circulating water system will circulate 585,000 gpm thru condenser & natural draft hyperbolic cooling tower. Temp rise not given. 20,000 gpm makeup will be provided, probably from river. Two cooling towers will be used for each unit. Avg river flow at Trenton is 11,680 cfs. Mean tidal flow at Burlington (6 mi down river) is about 45,000 cfs.

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Newbold Island Nuclear Generating Station
THERMAL OUTPUT, MWt 3293	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-354, 50-355

NEARBY BODY OF WATER Delaware River — NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 30.5' (MSL)

SIZE OF SITE 530 ACRES — SITE GRADE ELEVATION 25.0' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat to Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 4900 (1960) IN 5 MI RAD 162,000 (1980) 92,000 (1960)

NEAREST CITY OF 50,000 POPULATION Levittown, Penn.

DISTANCE FROM SITE 4 MILES — POPULATION 70,000 (1960)

LAND USE IN 5 MILE RADIUS Residential & Industrial

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Closed loop using cooling towers

WATER TAKEN FROM Delaware River — FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG - F — SUMMER AVG - F — AVG - F

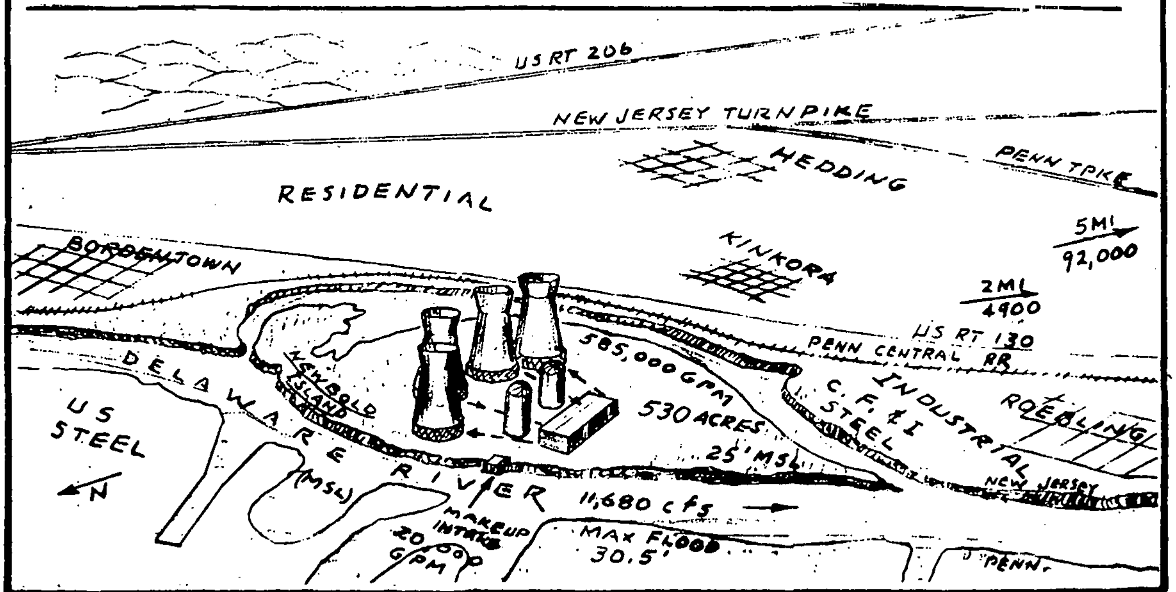
RIVER FLOW 11,680 (cfs) 45,000 tidal — *QUANTITY OF MAKEUP WATER 20,000 (gpm)

*TOTAL FLOW THROUGH CONDENSERS 585,000 (gpm) — TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) — *Per Unit

COOLING TOWERS Two natural-draft hyperbolic towers (4 total for both units)

OTHER INFORMATION



HENDLESON

ZIMMER, 50-358 & 50-359 (BWR) Page 1

Project Name: Zimmer Nuclear Power Station 1&2†
Reactor: Zimmer
A-E: Sargent & Lundy
Location: Clermont Co., Ohio*
Vessel Vendor: Not specified, but GE's
Owner: Cincinnati Gas & Elec.**et al
Docket No.: 50-358, 50-359 resp.
NSS Vendor: General Electric
Containment Constructor: Not specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2436	H_2O/UO_2 Volume Ratio	2.41
Electrical Output, MWe	~840	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output for Safety Design, MWt	2550	Moderator Temp Coef Hot, No Voids	-39.0×10^{-5}
Steam Flow Rate, lb/hr	10.48×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	78.5×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	48,451	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.5	Doppler Coefficient, Operating	-1.3×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	428,308	Initial Enrichment, %	1.8
Average Heat Flux, Btu/hr-ft^2	164,734	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4480	Core Average Void Within Assembly, %	38***
Average Fuel Rod Surface Temp °F	558	k_{eff}, All Rods In	---
MCHFR	$\geq$1.9	k_{eff}, Max Rod Out	0.977****
Total Peaking Factor	2.6	Control Rod Worth, %	0.01 Δk
Avg Power Density, Kw/ℓ	51.2	Curtain Worth, %	---
		Burnable Poisons, Type and Form	248 flat, boron stainless steel
		Number of Control Rods	137
		Number of Part-Length Rods (PLR)	None

*25 mi. SE of Cincinnati

**Cincinnati G&E 37%
Columbus & S. Ohio 32%
Dayton Power & Light 31%

***Fig. 3.6-6
****Fig. 3.6-1
†Application for Unit 2 withdrawn.

Compiled by: Fred A. Heddleson
Date: August 1970

TX-4377
(8-70)

Reactor: Zimmer Nuclear Power Sta.

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi. 0.13	Design Winds
Low Population Zone Dist., Mi. 4	At 0 - 50 ft 35 psf; 50 - 150 ft 45 psf; 150 - 400 ft 53 psf (Derived from ASCE paper 3269. Pressures include positive & negative pressure, gusts, and shape factor.)
Metropolis: Cincinnati, Ohio; Distance: 25 mi.; Population: 600,000 (70)	
Design Basis Earthquake Accel., g 0.10	Tornado 300 mph
Operating Basis Earthquake Accel., g 0.05	ΔP = 3 psi/ 3 sec
Earthquake Vertical Shock, % of Horizontal 70 to 80	Is intent of 70 design criteria Satisfied? Yes, see page F.1-1

Peak Fuel Enthalpy on Rod Drop: Drop of any rod from core to the position of its drive results in peak fuel enthalpy not more than 360 cal/g. Analyses show 280 cal/g is probably max.

Recirculation Pumping System & MCHFR: Core is sized with heat transfer area and a coolant flow rate (recirculation pump speed) to ensure that MCHFR is not less than 1.9 at rated conditions (page 3.7-12).

Protective System:

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	45	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	45	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	36	Second Ctmt Leak Rate, %/day	100

Type of Construction: Primary ctmt - a steel-lined prestressed-concrete pressure-suppression system. Drywell to be located directly above suppression chamber in form of a frustum of a cone. The suppression chamber to be cylindrical and separated from drywell by reinforced concrete slab.

Design Basis: To provide the capability, in the event of the postulated design basis loss-of-coolant accidents, to limit the release of fission products to the plant site environs so that off-site doses would be in compliance with the values specified in 10CFR100.

Vacuum Relief Capability: No vacuum relief to be provided between inside of primary containment and reactor building. Containment structure has ability to accommodate subatmospheric pressures of approximately 5 psi absolute.

Post-Construction Testing: After construction and before operation, primary containment will be pressure-tested pneumatically at 45 psig. Leakage rate will then be measured. Leakage tests will be run periodically thereafter. Penetrations will be tested for leakage during plant life.

Penetrations: Steam lines and electrical penetrations are double sealed and individually testable. Personnel access is double sealed. All other penetrations are single.

Reactor: Zimmer Nuclear Power Sta.

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Two systems available, one high pressure and the other low pressure. (HPCS and LPCS respectively). Each system consists of one pump and one loop with capabilities as follows:

HPCS 1300 gpm @ 1130 to 4725 psid from cond. tank or pool
LPCS 4725 @ 119 psid from suppression pool or cond. tank

Auto-Depressurization System: In case RCICS & HPCS cannot maintain reactor water level, this system acts to reduce pressure so flow from LPCI or LPCS can enter reactor to cool core and limit clad temp. Six of the relief valves open to reduce pressure when small breaks occur. Valves stay open until reset by operator.

Residual-Heat-Removal System (RHRS): System consists of 3 (1/3 cap.) pumps rated 5050 gpm @ 270 psia, 2 heat exchangers (30.8 × 10^6 Btu/hr ea)., & service-water pumps arranged into 3 loops not interconnected. There are 5 modes of operation as follows: (1) Shutdown cooling & Reactor-vessel heat spray - can complete cooldown to 125 F in 20 hr & maintain. (2) Suppression pool cooling - keeps pool temp below 170 F. (3) Low-pressure coolant injection - supplies water to flood core when reactor pressure drops to ~20 psid; water from suppression pool. (4) Containment spray sprays water into drywell to condense steam. (5) Reactor core isolation cooling - see system description on page 4.

High-Pressure Coolant-Injection System: In case of small breaks, the high-press. core spray injects into the reactor thru spray nozzles (described above under Core Spray System). HPCS designed to prevent clad temp from exceeding 2700 F. HPCS operates on signals of low water level or high drywell pressure.

Low-Pressure Coolant-Injection System: Automatically refloods core to limit clad temp rise after LOCA. Core can be completely flooded in ~200 sec with max temp of 2000 F. Three 1/3 cap pumps (5050 gpm @ 20 psid each) take water from suppression pool.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: "Prime source of liquid for cooling reactor after LOCA shall be a stored source located in primary containment." No other source mentioned, but flow diagram 10.8-1 shows connections to "flood reactor."

Main-Steam-Line Flow Restrictors: Venturi-type flow restrictors installed in each line close to reactor. Limits loss-of-coolant in case of main steal line break. Also prevents uncovering core before steam-line-isolation valves close. Steam flow limited to 200% of rated flow.

Control-Rod Velocity Limiters: Two nearly mated conical elements that act as a large-clearance pistion & baffle inside the control-rod-guide tube over the length of the control-rod stroke limits drop-out velocity to <5 ft/sec. Velocity of rod insertion is not affected.

Control-Rod-Drive-Housing Supports: Located underneath reactor vessel just under control-rod houcing to limit travel or catch the control rod if housing ruptures. Will prevent a nuclear excursion even if housing fails & drops from the reactor. Under operating conditions, housing can drop only 1/4 in. in case of failure.

Standby Liquid-Control System: A redundant system for reactivity control used when control rods cannot shutdown reactor. By manual initiation, sodium pentaborate solution is pumped into the reactor. About 1 to 2 hr required for complete injection. System can be used to maintain shutdown if required.

Reactor: Zimmer Nuclear Power Sta.

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: No reference found in PSAR except to report of P. W. Ianni (APED-5454).

Reactor Core Isolation Cooling System (RCICS): Starts automatically on signal of reactor-vessel low-water level to prevent need for operating of any core-standby cooling system. Can also be started manually. Removes decay heat and provides makeup water into feedwater line if feedwater pumps are inoperative, and/or if isolation valves have closed, isolating reactor from main condenser heat sink. One steam-turbine-driven pump delivers 400 gpm @ 1135 psig from condensate storage tank or suppression pool.

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Unidentified leakage rate max is set at 15 gpm, with the total of identified and unidentified at 50 gpm. Leakage is detected by measurements of drywell pressure and temp, floor drain and sump-pump operation, & gross beta activity in drywell and suppression chamber.

Failed-Fuel Detection Systems: Four gamma-radiation monitors located near steam lines just outside primary containment designed to detect release of fission products from the fuel. High radiation initiates scram and system isolation.

Emergency Power: There will be six diesel-generator sets for both reactor units, two of the six shared between the two units. There will be sufficient capacity to shut down both reactors simultaneously on emergency power. Diesels will start automatically, and generators will accept loads in 10 sec. Fuel, in underground tanks, provides for 7 days of operation.

Rod-Block Monitor: To prevent fuel damage as a result of single rod-withdrawal error. Monitor bypassed at <30% power. Two RBM channels, either of which can initiate a rod block using signals from LPRM channels. Because MCHFR cannot reach 1.0 until rod is halfway withdrawn, the highest rod-block setpoint halts rod motion before local fuel damage can occur.

Rod Worth Minimizer: Assists operator with backup control-rod-monitoring routine enforcing established startup, shutdown, & low-power-level control-rod procedures. Computer helps operator select control-rod patterns consistent with prestored RWM sequences. RWM sequences stored in computer memory based on control-rod-withdrawal procedures designed to minimize individual control rod worths to acceptable levels.

Reactor: Zimmer Nuclear Power Sta.

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A meteorological tower will be installed at the site with sufficient height to take measurements at the layer of air where releases will be made. Temporary station now in operation, no seismographs mentioned.

Plant Operating Mode: Load-following.

Site Features: Site comprises 491 acres on E. side of Ohio River. Plant site on level flood plane about 1/2 mi wide. Normal river pool is 455', site grade to be 520', which is just above max possible flood level of 517'. Surrounding area is hilly, used for farming and forests. Highway-52 passes within 1/2-mi of reactors. Moscow (700 pop) is 1/2 mi from site. Within 5 mi of site, 1985 pop to be 5800.

Turbine Orientation: Turbine & reactor centerlines are parallel & 220' apart. Ejected turbine blades would probably miss containment.

Emergency Plans: Procedures will be prepared for 2 conditions - on-site and off-site. Details not yet available, but things to be covered are authority and responsibility, incidents, fires, accidents, training, communication, medical facilities, and liason with off-site authorities.

Environmental Monitoring Plans: Radiological program will start 2 yr before start-up and will run at least 2 yr after. Purpose is to establish natural background levels at the nuclear station and at off-site locations. The program will continually monitor the plant environs to ensure that the radioactivity released from the plant is well below established limits. Pre-operational monitoring will include collection and radiometric analysis of airborne particles, well water, surface water, precipitation, bottom sediments, bottom organisms, fish, milk, vegetation, soil, misc. food stuffs, & ambient gamma radiation. Post-operational program will be similar.

Radwaste Treatment: Liquid & solid radwaste systems are common to both units. Liquid waste will be collected, treated, stored, or held up, & released diluted with the service water discharged. Max liquid waste concentration will be 10^{-7} microcuries/mℓ. Solid wastes will be collected and stored in 55 gal. drums using a homogenized slurry that solidifies. Drums will be shipped off-site for disposal. Gaseous waste systems will be independent for each unit, but using a common stack. Low levels will be released without treatment. Other levels will be treated and/or held up before release. Condenser off-gases will be held up & then filtered. 800 micro-curies/sec will be released during operation.

Waste Heat System: Heat rejection to condenser will be 7054×10^6 Btu/hr, with water from circulating system entering at 94 F and leaving at 114. Total flow will be 450,000 gpm thru the condenser in a closed-loop system using a natural draft cooling tower. Makeup water comes from Ohio River, which has avg flow of 96,800 cfs and 7-day min of 10,000 cfs. Service-water system also uses river water.

Stack Height: 125 meters

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Zimmer Nuclear Power Station, Units 1 & 2
THERMAL OUTPUT, MWt 2436	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-358 50-359

NEARBY BODY OF WATER Ohio River — NORMAL LEVEL 455' (MSL)

MAX PROB FLOOD LEVEL 517' (MSL)

SIZE OF SITE 491 ACRES — SITE GRADE ELEVATION 520' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 1496 (1970) IN 5 MI RAD 4885 (1970)

NEAREST CITY OF 50,000 POPULATION Covington, Kentucky

DISTANCE FROM SITE 20 MILES — POPULATION 74,087 (1970)

LAND USE IN 5 MILE RADIUS Agricultural & Wooded

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Closed loop using cooling towers

WATER TAKEN FROM Ohio River — FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG 42 F — SUMMER AVG 83 F — AVG - F

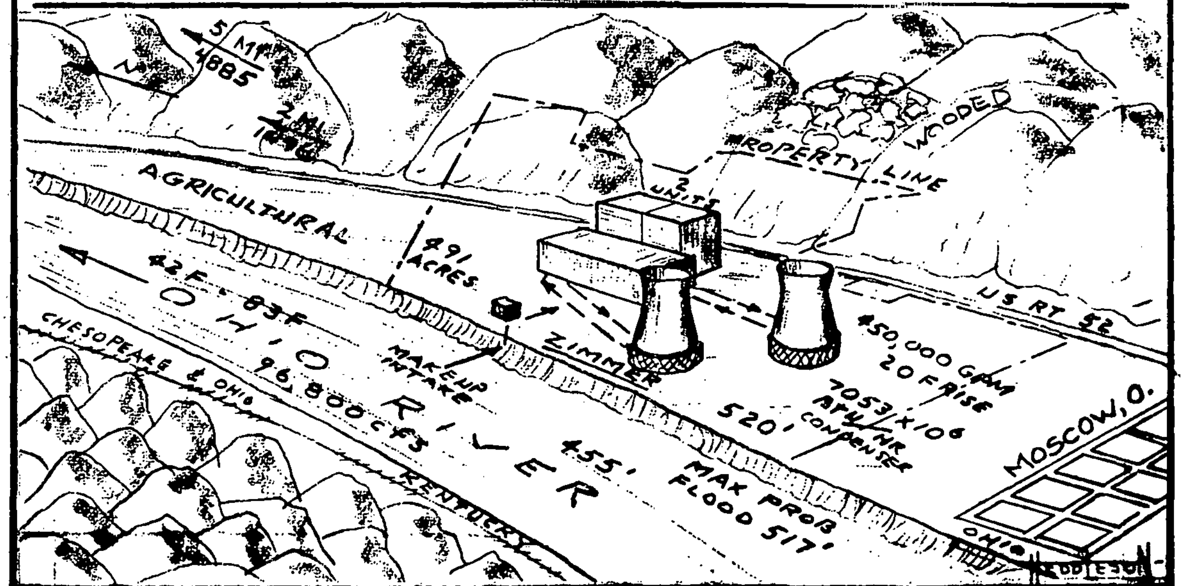
RIVER FLOW 96,800 (cfs) avg. — *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 450,000 (gpm) — TEMPERATURE RISE 20 F

*HEAT REMOVAL CAPACITY OF CONDENSERS 7053×10^6 (Btu/hr) — *Per Unit

COOLING TOWERS One natural-draft hyperbolic tower (two for both units)

OTHER INFORMATION Application for unit #2 withdrawn



SAN ONOFRE, 50-361 & 50-362 (PWR) Page 1

Project Name: San Onofre Nuclear Gen Sta, 2 & 3
Location: San Diego Co., Calif.
Owner: Southern Calif. Edison Co.*
NSS Vendor: Combustion Engineering

Reactor: San Onofre 2 & 3
A-E: Bechtel
Vessel Vendor: Combustion Engineering
Docket No.: 50-361, 50-362
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3390	H_2O/U, Cold	3.35
Electrical Output, MWe	1175	Avg 1st-Cycle Burnup, MWD/MTU	13,138
Total Heat Output for Safety Design, MWt	3410	First Core Avg Burnup, MWD/MTU	21,700
Total Heat Output, Btu/hr	$11,600 \times 10^6$	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	1.9
DNBR, Nominal	2.11	Region-2 Enrichment, %	2.3
Total Flow rate, lb/hr	147.8×10^6	Region-3 Enrichment, %	2.9
Eff Flowrate for Heat Trans lb/hr	142.6×10^6	k_{eff}, Cold, No Power, Clean	1.29
Eff Flow Area for Heat Trans, ft^2	53.2	k_{eff}, Hot, Full Power Xe and Sm(equilibrium)	1.15
Avg Vel Along Fuel Rods, ft/sec	16.6	Total Rod Worth, %	8
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.68×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1400
Nominal Core Inlet Temp, °F	553	Shutdown Boron, No Rods, Clean, Hot, ppm	1600
Avg Rise in Core, °F	60	Boron Worth, Hot, % Δk/k/ppm	-0.013**
Nom Hot Channel Outlet Temp, °F	645	Boron Worth, Cold, % Δk/k/ppm	-0.017**
Avg Film Coeff, Btu/hr ft^2, °F	6160	Full Power Moderator Temp Coeff, Δk/k/°F	0 to -2×10^{-4}
Avg Film Temp Diff, °F	34	Moderator Press Coeff, Δk/k/psi	0 to $+2 \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	55,000	Moderator Void Coeff Δk/k/% Void	0 to -1.6×10^{-3}
Avg Heat Flux, Btu/hr ft^2	205,100	Doppler Coefficient, Δk/k/°F	$(-1$ to $-1.8)\times 10^{-5}$
Max Heat Flux Btu/hr ft^2	549,300	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1.0
Avg Thermal Output, kw/ft	7.1	Burnable Poisons, Type and Form	Boron Chemical Shim
Max Thermal Output, kw/ft	19.0	Number of Control Rods	425
Max Clad Surface Temp. °F	657	Number of Part-Length Rods (PLR)	None
No. Coolant Loops	2		

*South. Calif. Edison -------80%
San Diego Gas and Electric--20%

**Table 3.2-1

Compiled By: Fred Heddleson
Date: September 1970

Reactor: San Onofre 2 and 3

*Conclusive figures not given in PSAR

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi. 0.10 See Amend. 2			Design Winds in mph:
Low Population Zone Dist., Mi. 2*			At 0 - 50 ft elev 90
Metropolis	Distance	Population	50 - 150 ft 105
San Diego	51	722,000	
Design Basis Earthquake Accel., g		0.50	150 - 400 ft 125
Operating Basis Earthquake Accel., G		0.25	Tornado Not discussed
Earthquake Vertical Shock, % of Horizontal		~75	ΔP = psi/ sec

Is intent of 70 Design Criteria satisfied? Section 1.7 discusses criteria and intent of conformance. On page 1.6-1 applicant concludes that they meet all applicable laws and regulations.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	60	Calculated Max Internal Press, psig	52.6
Max Leak Rate at Design Press, %/day	(Page 1.3-16) 0.3 (Page 5.1-74) 0.1		

Type of Construction: Reinforced concrete structure, cylindrical in shape with shallow dome roof on a flat concrete slab, prestressed by post-tensioning system. Walls are 4' thick with 3'-6" thick roof. Concrete shell is steel lined. Dimensions. 130' diameter and 185' high.

Design Basis: Designed for all credible loading including LOCA and earthquakes without loss of integrity. Other loads considered are thermal loads, dead loads, live loads, wind forces, hydrostatic loads, and prestressing loads.

Vacuum Relief Capability: Vacuum breakers not required — designed for 2 psid vacuum (see page 5.1-6).

Post-Construction Testing: Pressure tested at 69 psig for 1 hr. Leak rate determined at 60 psig and lower pressures. Leakage rates will be determined periodically thereafter. Tendon system will be periodically inspected for corrosion.

Penetrations: Electrical type are double sealed and testable. Piping penetrations are single barrier.

Weld Channels: Welds are first tested with vacuum box and soap bubbles. If satisfactory, test channels are installed and welds pressurized for 15 minutes, during which time no drop in pressure is allowed.

Reactor: San Onofre 2 and 3

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Borated water from refueling water storage tank is mixed with NaOH and sprayed into atmosphere to lower temp and press following LOCA. Two independent systems have capacity to hold temp and press below design limits. Two pumps deliver 1750 gpm @ 220 psi (each) to dissipate 280 × 10^6 Btu/hr.

Containment Cooling: Four fan-coil cooling units sized for emergency service can remove a total of 280 × 10^6 Btu/hr. This is a backup system for containment spray. Component cooling water system supplies water to the heat exchangers.

Containment Isolation System: Isolation valves are installed on all penetrations, inside and outside containment shell to provide double barriers against release of radioactivity. Isolation (closing of valves) occurs in conjunction with safety injection, closing all valves not required for operation of engineered safety features. All valves can be operated remotely by manual signal.

Containment Air Filtration: All air is exhausted from containment by the purge exhaust system and then passed thru prefilters, HEPA filters, and activated charcoal filters before discharge from the vent stack. In emergency, ventilation rate is 1/2 air change per hour.

Penetration Room: Two floors just outside reactor bldg. Piping penetrations are on one floor and electrical are on the floor above.

Organic-Iodide Filter: Not mentioned.

Hydrogen Recombiner: None — Accumulation of H^2 will be controlled to hold max limit of 3% by using purge system. (Page 14.4.2-14)

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks discharge borated-water each into one of 4 safety injection nozzles when reactor pressure drops below 200 psig. Each tank dumps 8200 gallons. Tanks are pressured with nitrogen. When tanks dump, core is quickly flooded to limit cladding temp and limit zirconium-water reaction to less than 1%. Three tanks will cover core in about 30 to 40 sec. Clad melting starts ~100 sec after LOCA if core is not cooled.

High-head Safety Injection: The safety-injection-actuation signals starts both high and low head pumps. Three high-head pumps (380 gpm @ 1750 psig) deliver borated water from refueling storage tank to each of 4 cold legs. This system operates to make up water lost by small break, or as first injection system to function after LOCA. These pumps also circulate water from containment sump for long term cooling.

Low-head Safety Injection: Two pumps each delivering 4000 gpm @ 500 psig can flood core to prevent clad melting or limit metal-water reaction. These pumps serve as back-up for containment spray pumps. Pump suction is tanked from refueling storage tank.

Reactor: San Onofre 2 and 3

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Not mentioned

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Total expected leakage from reactor coolant system is 0.3 to 0.5 gpm. Leakage is indicated by changes in temp, press, airborn activity in containment, by monitoring containment sump, and by monitoring component cooling water temp to and from containment atmosphere coolers. Also low-level in pressurizer would indicate leakage.

Failed-Fuel-Detection Systems: A shielded NaI scintillation detector will be installed in a sampling line of the letdown stream of coolant system. It will measure gross gamma or specific isotopes depending upon operation of the 2 spectrometer ratemeters in the control room. Travel time of water from core to point of detection is estimated at 5 minutes.

Emergency Power: Units 2 and 3 are each provided with two diesel generators, each capable of providing sufficient capacity to safely shut down the associated reactor unit during loss of the preferred source of power with or without a LOCA. A common spare diesel generator is provided to operate additional backup equipment over and above the minimum redundancy requirement. Engines will be started with compressed air, capacity provided for five crankings of 15 sec each. On-site fuel storage will be provided for 7 days of operation at full load. Units are isolated from each other.

Control of Axial Xenon Oscillations:

Burnable Shims - Yes, chemical (Boron)

Part-Length Control Rods - No reference found.

In-Core Instrumentation - Fixed neutron-sensitive detector will be spaced in core for flux mapping and temp monitoring so core power evaluations can be made. The detectors will be inserted into center of fuel assemblies.

Unborated Water Control: The shutdown group of control element assemblies must be in the fully withdrawn position before the operator may start diluting the concentration of boric acid in the reactor coolant system. The operator may inject a predetermined amount of demineralized makeup water by operating the system in the "dilute" mode. The concentration of boric acid in the reactor coolant is determined by sample analysis and by the boronometer reading.

Long-Term Cooling - Internal or External Systems: Internally, the Shutdown Cooling System will reduce reactor coolant temp from 300 F to refueling temp in 28 hr. The system uses two low-press safety-injection pumps circulating water thru two shutdown-cooling heat exchangers, and back into reactor coolant system.

Reactor: San Onofre 2 and 3

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Wind measuring system was installed on a 64-ft high pole in 1964 for San Onofre #1.

Seismographs — PSAR makes no reference.

Plant Operating Mode: Load following — In response to load changes automatic control systems maintain press, temp, and liquid level in reactor within control bands

Site Features: Site overlooks Pacific Ocean 62 mi SE of Los Angeles and 51 mi NW of San Diego, entirely within boundaries of US Marine Corp Camp Pendleton (leased from US Govt until 2023). Interstate 5 and Sante Fe RR pass within 1000 ft of site. San Clemente is closest town (∿4 mi) with 18,000 population. Troops will never be quartered closer than 2 mi of site. Land use is mostly undeveloped. Plant will be ∿20' above the ocean with a sea wall up to 28' for protection against tsunami.

Turbine Orientation: Turbine centerline is 216 ft from reactor centerline. Blades ejected from turbine could hit containment structure.

Emergency Plans: The San Onofre Radiological Emergency Plan has been developed to safeguard station personnel, the public, and equipment in event of a major radiological emergency. Plan is based upon Emergency Plan for Unit 1, which has been expanded to include Units 2 & 3. The plan provides guidelines for prompt evaluation of emergencies, orderly evacuation of station personnel & visitors, & performance of follow-up actions to safeguard personnel and equipment.

Environmental Monitoring Plans: Radiological and oceanographic monitoring started in 1964 in conjunction with unit #1 and will continue long after unit 2 and 3 construction to determine prior conditions and any changes due to plant operation. Samples are collected to observe levels of SR90, Krypton, Xenon, radioactive particulates, Iodine, and water. Marine plants and aquatic organisms will be monitored for effects of condenser cooling water discharge. Other misc. programs will be conducted.

Radwaste Treatment: Wastes will be collected, stored, processed, diluted for release or shipped off-site. Liquid wastes after processing will be either shipped off-site or released diluted in the condenser cooling water. Gases will be collected and compressed in tanks to allow for decay and/or released thru filters to vent stack. Solid wastes will be collected and stored in drums for shipment offsite. All waste releases will be well within limits specified by 10CFR20.

Stack Height - ∿180 ft above grade elevation which is 20 ft

Waste Heat System: Circulating water system pumps 800,000 gpm thru the main condenser. Temp rise across condenser is 20 F. Water intake is ∿3200 ft offshore and outfall will be about 2600 ft offshore. Expected max temp rise in ocean water is 10 F at surface just above outfall. An area 2 miles wide will have about 4 F temp rise. (These expected temp rise in ocean are for all 3 plants operating.)

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME San Onofre Nuclear Generating Station, Units 2 & 3
THERMAL OUTPUT, MWt 3390	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-361 50-362

NEARBY BODY OF WATER Pacific Ocean NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 22' (MSL)

SIZE OF SITE 83.6 ACRES Surrounded by Camp Pendleton Marines SITE GRADE ELEVATION * 20' (MSL)

*A sea-wall has top at 28' (MSL)

TOPOGRAPHY OF SITE Rolling

OF SURROUNDING AREA (5 MI RAD) Hilly to Mountainous

TOTAL PERMANENT POPULATION IN 2 MI RAD 500 (1980) IN 5 MI RAD 12,600 (1980)

NEAREST CITY OF 50,000 POPULATION Oceanside, California

DISTANCE FROM SITE 17 MILES POPULATION 39,000 ( )

LAND USE IN 5 MILE RADIUS Military Reservation that is mostly Wooded

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through

WATER TAKEN FROM Pacific Ocean FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG 56 F SUMMER AVG 73 F AVG - F

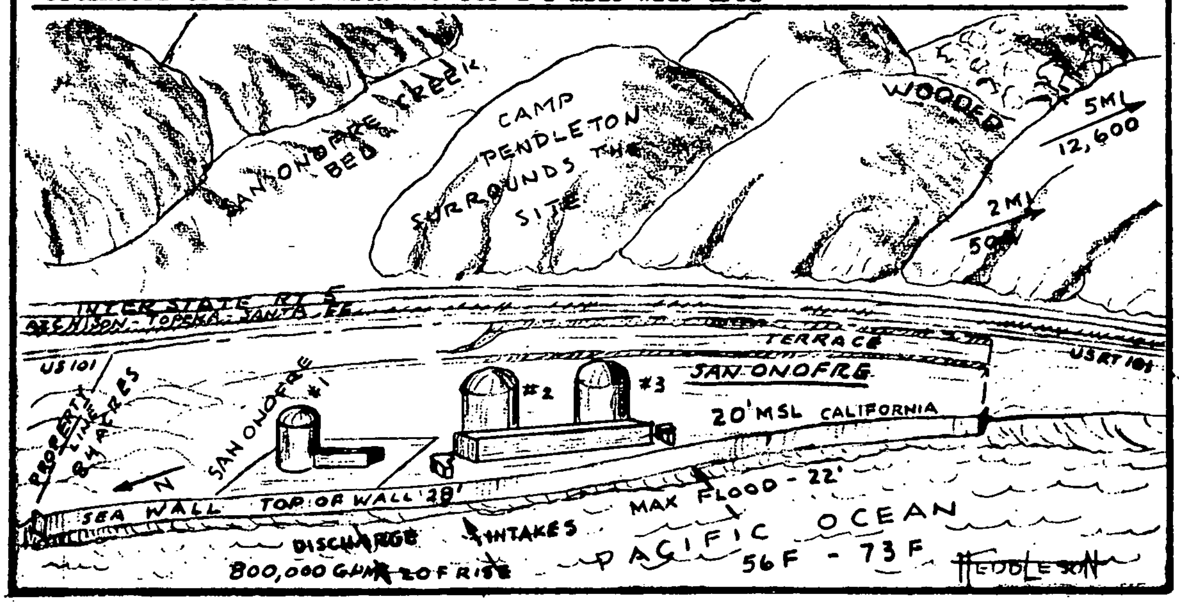
RIVER FLOW NA (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 800,000 (gpm) TEMPERATURE RISE 20 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS None

OTHER INFORMATION For all 3 units, temp rise of ocean surface at discharge is estimated to be 10 F with 4 F for a 2 mile wide area



NUCLEAR SAFETY INFORMATION CENTER

FORKED RIVER, 50-363 (PWR) Page 1

Project Name: Forked River Nuclear Gen. Sta. #1
Reactor: Forked River #1
A-E: Burns & Roe
Location: Ocean Co., N.J.*
Vessel Vendor: Combustion Engineering
Owner: Jersey Central Power & Light Co
Docket No.: 50-363
NSS Vendor: Combustion Engineering
Containment Constructor: Not indicated

*Site of Oyster Creek Nuclear Sta.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3390	H_2O/U, Cold	3.35
Electrical Output, MWe	1184	Avg 1st-Cycle Burnup, MWD/MTU	13,138
Total Heat Output for Safety Design, MWt	3580	First Core Avg Burnup, MWD/MTU	21,700
Total Heat Output, Btu/hr	$11{,}600 \times 10^6$	Maximum Burnup, MWD/MTU (page 3-4)	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	1.90
DNBR, Nominal	2.11	Region-2 Enrichment, %	2.30
Total Flow rate, lb/hr	147.8×10^6	Region-3 Enrichment, %	2.90
Eff Flowrate for Heat Trans lb/hr	142.6×10^6	k_{eff}, Cold, No Power, Clean	1.29
Eff Flow Area for Heat Trans, ft^2	53.2	k_{eff}, Hot, Full Power Xe and Sm	1.23
Avg Vel Along Fuel Rods, ft/sec	16.6	Total Rod Worth, % (Hot)	8.0
Avg Mass Velocity lb/hr-ft^2	2.68×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1400
Nominal Core Inlet Temp, °F	553	Shutdown Boron, No Rods, Clean, Hot, ppm	1600
Avg Rise in Core, °F	60	Boron Worth, Hot, % Δk/k/ppm (coef)	-0.13×10^{-3}
Nom Hot Channel Outlet Temp, °F	645	Boron Worth, Cold, % Δk/k/ppm (coef)	-0.17×10^{-3}
Avg Film Coeff, Btu/hr ft^2, °F	6160	Full Power Moderator Temp Coeff, Δk/k/°F	$(0 \text{ to } -2) \times 10^{-4}$
Avg Film Temp Diff, °F	34	Moderator Press Coeff, Δk/k/psi	$(0 \text{ to } +2) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	55,000	Moderator Void Coeff Δk/k/% Void	$(0 \text{ to } -1.6) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	205,100	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -1.8) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	549,300	Shutdown Margin, Hot, One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	6.9	Burnable Poisons, Type and Form	Boron Chemical Shim
Max Thermal Output, kw/ft	18.5	Number of Control Rods, 5×85	425
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	None mentioned.
No. Coolant Loops	2		

Compiled By: Fred Heddleson
Date: September 1970

Reactor: Forked River #1

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		0.38 radius	Design Winds in mph:	*Extrapolated
Low Population Zone Dist., Mi.		2	At 0 - 50 ft elev	100
Metropolis	Distance	Population	50 - 150 ft	130*
Atlantic City	34	63,000		
Design Basis Earthquake Accel., g		0.22	150 - 400 ft	150*
Operating Basis Earthquake Accel., G		0.11	Tornado	360 mph
Earthquake Vertical Shock, % of Horizontal		65 to 70	ΔP = 3 psi/ 3 sec	

Is intent of 70 Design Criteria satisfied? Section 1.4 discusses conformance to design criteria.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	60	Calculated Max Internal Press, psig	51.5
Max Leak Rate at Design Press, %/day	0.2		

Type of Construction: Reinforced concrete with cylindrical walls (130 ft dia × 157 ft high), with domed roof with 20-ft-thk flat slab. Walls and roof will be prestressed with a post-tensioning system. Inside surface will have 3/8-in-thk steel liner. Walls will be 4 ft thk with 3-ft-thk roof.

Design Basis: Designed to withstand all credible conditions and still maintain leaktightness integrity. Loadings considered — seismic, wind, tornado, external and internal missiles, uplift and buoyant forces, and loads imposed by LOCA. Designed for an external pressure of 2.5 psi greater than internal.

Vacuum Relief Capability: Vacuum breakers will not be used. The 2.5-psi differential provides sufficient protection.

Post-Construction Testing: Leakage rate test will be run as well as a pressure test at 69 psi. Leakage-test pressures will be 60, 30, and 15 just after construction and periodically thereafter. Other pressure proof tests will not be run unless experience at Three Mile Island indicates the need.

Penetrations: All penetrations are double-barrier with captive air spaces with pressures above containment pressure. A Penetration Pressurization System is provided for this function. All units are testable.

Weld Channels: Provided at all base-liner seam welds and at other welds that will be inaccessible. Also provided around piping-penetration welds.

Reactor: Forked River #1

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Borated water from refueling water-storage tank is sprayed into atmosphere to lower temp & press & remove iodine following LOCA. Two independent systems have capacity to hold temp & press below design limits. Two pumps deliver 1750 gpm @ 200 psi (each) to dissipate 240 × 10^6 Btu/hr. Water can be pumped from containment sump and cooled with shutdown heat exchangers. High press in containment along with Safety Injection Actuation signal starts the spray system.

Containment Cooling: Four fan-coil cooling units are available. Three will run during normal operation to hold temp below 110°F. All 4 units will run after LOCA. Three booster fans are installed in duct-work to improve air distribution. During normal operation, coil cooling water is cooled by outside evaporative coolers. After an accident, cooling water will come from component cooling water system. System will be switched into emergency mode by Containment Spray Actuation signal.

Containment Isolation System: Isolation valves are installed on all penetrations, inside & outside containment shell to provide double barriers against release of radioactivity. Isolation (closing of valves) occurs in conjunction with safety injection, closing all valves not required for operation of engineered safety features. Valves in engineered-safety-feature lines can be closed manually.

Containment Air Filtration: All releases pass thru both absolute and charcoal filters before release up the stack.

Penetration Room: Apparently the penetration pressurization system eliminates need for penetration rooms.

Organic-Iodide Filter: No references found.

Hydrogen Recombiner: After LOCA for a 2% zirconium-water reaction, 3% H_2 concentration will occur after 20 days. Controlled purging will be used to maintain concentration below 3%. A recombiner was not mentioned.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks discharge borated-water each into one of 4 safety injection nozzles when reactor pressure drops below 200 psig. Each tank dumps 7500 gal. Tanks are pressurized with nitrogen cover gas. When tanks dump, core is quickly flooded to limit cladding temp and zirconium-water reaction. Three tanks have full capacity to achieve design requirements.

High-head Safety Injection: Safety Injection Actuation signal starts both high- and low-head pumps. Two high-head pumps (380 gpm @ 1750 psig) deliver borated water from refueling storage tank to each of 4 cold legs. Design capacity is adequate to limit metal-water reaction to less than 1% for all break sizes with one high-head and one low-head pump running. The high-head pumps can circulate water from the sump. One additional high-head pump is available as an extra backup pump.

Low-head Safety Injection: Two pumps each delivering 4000 gpm @ 500 psig can flood the core to prevent clad melting or limit metal-water reaction. These pumps serve as back-up for containment spray pumps. Pump suction is taken from refueling storage tank.

Reactor: Forked River #1

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Leakage within containment indicated by: increased pressure and temp, monitoring containment sump levels, increase in air-borne activity as measured by air radiation monitor, monitoring cooling-water temp to and from fan coolers, and by the pressurizer water level.

Failed-Fuel-Detection Systems: Liquid monitors are located in 7 various lines to detect fission-product activity in the primary cooling system. Locations are in auxiliary lines as listed in Table 11-8.

Emergency Power: Two diesel-generator sets will start, accelerate to rated speed, and accept load in 10 sec. Units are started when engineered safety features are actuated, or on loss of off-site power. Loss of voltage on the 4160-v engineered-safety-feature bus will also start the diesels. Fuel is available at the diesel for 1 hr of full-load operation, or in the separate main fuel tank for 7 days' operation of one diesel at full load.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid dissolved into reactor coolant.

Part-Length Control Rods - None mentioned.

In-Core Instrumentation - There will be 40 fixed neutron-sensitive assemblies, spaced radially & axially for flux mapping of the core. Temp will be measured also. Instruments will not be used for control.

Unborated Water Control: Boron dilution is done manually under strict procedural controls. If unborated water is added to the reactor cooling system, a corresponding amount of coolant must be removed (feed and bleed). For dilution to take place, both a boron charging pump and a primary makeup water pump must be running. In addition to automatic controls, several control-room alarms make the probability of erroneous dilution very low.

Long-Term Cooling - Internal or External Systems: Long-term cooling is possible by using the shutdown cooling system, which is designed to reduce reactor temp from 300 F to 135 F in 27 1/2 hr. This system circulates reactor coolant thru two heat exchangers, which are cooled by component cooling water system. Two low-pressure safety injection pumps circulate the reactor coolant. Containment-cooling fan-coil units can also be used for inner-atmosphere temp control. These units are described under Containment Cooling.

Reactor: Forked River #1

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Wind speed and temp have been continuously recorded at 75- and 400-ft levels above grade since 1966.

Plant Operating Mode: Load Following.

Site Features: Located on the Atlantic Coastal plain between two small streams, Oyster Creek and Forked River, 3 mi inland from shore of Barnegat Bay. Site consists of 1425 acres with plants located between Garden State Parkway and State Hwy 9. Nearest town is Forked River (∿2 mi), and nearest area of sizable population is Dover Twp with 30,340. Within 2 mi of plant, population is 1000 in winter with 5700 during the summer, mostly along the shore. Within 40 mi radius, 70% of land is forested, vacant, or farm land. Site grade will be 30 ft, well above max hurricane water level of 21.5 (calculated). Many severe storms have hit the near area, with nearly 40 hurricanes or tornados striking in 35 years. Predominant wind direction is NE, blowing off the ocean.

Turbine Orientation: About 230 ft between centerlines of turbine and containment. Orientation is such that blades could be thrown off turbine and strike containment.

Emergency Plans: Will cover fire, medical, injury, or illness, radiation, and contamination accidents. Oyster Creek #1 plans will be modified to cover Forked River. Outside agencies such as State Police, Fire Depts., AEC, and N.J. Dept. of Health will be called as needed. Toms River Hospital can handle contaminated casualties. Written procedures will be prepared, and practice drills will be held.

Environmental Monitoring Plans: A radiological survey of the environment was started for Oyster creek in 1966. This program will be reexamined to learn pathways by which radioactive materials may cause exposure to people living in the area. A study of thermal discharge concludes that there will be no possible influence on shell fish and fin fish. The depth of clam beds in the area are will below the effect of discharge. Also, fin fish will change their migratory paths around the discharge jet. Boating, swimming, and fishing will not be affected. Table 2-11 shows the monitoring program to be followed for radioactivity sampling. Items to be monitored — air, water, rain, wells, milk, crops, shellfish, and sediment.

Radwaste Treatment: Wastes will be collected, stored, processed, diluted for release, or shipped off-site. Liquid wastes after processing will be either shipped off-site or released diluted in the condenser cooling water. Gases will be collected and compressed in tanks to allow for decay and/or released thru filters to vent stack. Solid wastes will be collected and stored in drums for shipment off-site. All waste releases will be well within limits specified by 10CFR20.

Stack Height - ∿140 ft above grade elev.

Waste Heat System: Condenser cooling water is taken from Barnegat Bay and from Oyster Creek Plant condenser cooling effluent. After passing thru the condenser, the water is pumped into an open receiving tank from which it flows by gravity thru a 16-ft-dia pipe for ∿7 miles, discharging 2000 ft out into the ocean where the water depth is ∿30 ft. Thermal discharge to cooling water will be 12.8×10^6 Btu/hr for both Oyster Creek and Forked River #1. Fellows, Read, & Weber, consultants, say discharge at outfall will cause an area of the ocean 1/2 to 2 sq miles to have an average temp rise of 1.4 F during the summer. Information is lacking on the quantity of flow, temp rise in condenser, condenser heat-removal capacity, and aspects of design of the open receiving tank and gravity-flow considerations.

Page 6

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Forked River Nuclear Station #1
THERMAL OUTPUT, MWt 3390	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-363

NEARBY BODY OF WATER Atlantic Ocean — NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 21.5'(MSL)

SIZE OF SITE 1425 ACRES — SITE GRADE ELEVATION 30' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat

TOTAL PERMANENT POPULATION IN 2 MI RAD 1015 (1968) [5725 summer] IN 5 MI RAD 5881 (1968) [21953 summer]

NEAREST CITY OF 50,000 POPULATION Atlantic City, New Jersey

DISTANCE FROM SITE 34 MILES — POPULATION 60,000 (1960)

LAND USE IN 5 MILE RADIUS Wooded, Undeveloped

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through

WATER TAKEN FROM Barnegat Bay — FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG - F — SUMMER AVG - F — AVG - F

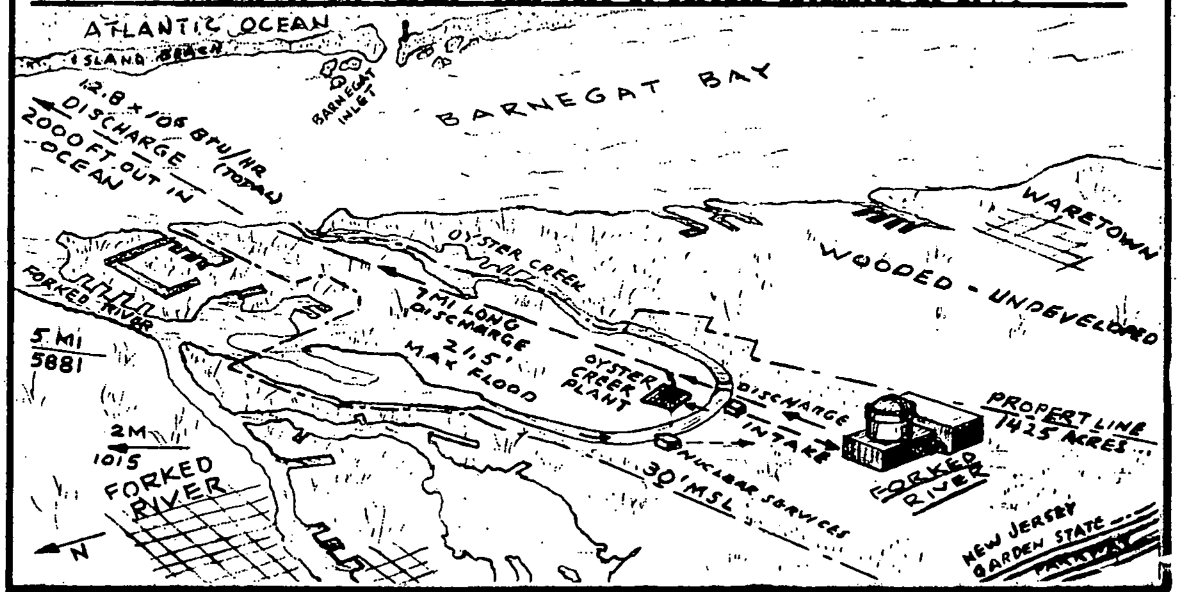
RIVER FLOW NA (cfs) avg. — *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS - (gpm) — TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) — *Per Unit

COOLING TOWERS None

OTHER INFORMATION Forked River & Oyster Creek plants combined will discharge 12.8×10^6 Btu/hr to the ocean. Temp rise at surface estimated at 1.4 F



NUCLEAR SAFETY INFORMATION CENTER

BAILLY, 50-367 (BWR) Page 1

Project Name: Bailly Generating Sta. Nuclear 1
Reactor: Bailly
A-E: Sargent & Lundy
Location: Porter Co., Indiana
Vessel Vendor: Not specified
Owner: Northern Indiana Public Service Co.
Docket No.: 50-367
NSS Vendor: General Electric Co.
Containment Constructor: Not specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1931	H_2O/UO_2 Volume Ratio	* Later
Electrical Output, MWe	685	Moderator Temp Coef Cold, Δk/k/°F	"
Total Heat Output for Safety Design, MWt	2028	Moderator Temp Coef Hot, No Voids	"
Steam Flow Rate, lb/hr	7.925×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	"
Total Core Flow Rate, lb/hr	61.5×10^6	Moderator Void Coef Operating	"
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	"
Heat Transfer Area, ft^2	38,413	Doppler Coefficient, Hot, No Voids	"
Max Power per Fuel Rod Unit Lgth, kw/ft	18.5	Doppler Coefficient, Operating	"
Maximum Heat Flux, Btu/hr-ft^2	428,240	Initial Enrichment, %	"
Average Heat Flux, Btu/hr-ft^2	164,707	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	---
Average Fuel Rod Surface Temp °F	558	k_{eff}, All Rods In	---
MCHFR	≥ 1.9	k_{eff}, Max Rod Out	< 0.99
Total Peaking Factor	2.6	Control Rod Worth, %	---
Avg Power Density, Kw/ℓ	51	Curtain Worth, normal operation max, Δk	0.01
		Burnable Poisons, Type and Form	Flat, Boron -- SST (196)
		Number of Control Rods	109
		Number of Part-Length Rods (PLR)	None

*PSAR says info will be supplied later (Table 1.6-1).

Compiled by: Fred Heddleson
Date: November 1970

TX-4377
(8-70)

Reactor: Bailly

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		0.13	Design Winds in psf		
Low Population Zone Dist., Mi.		1.5	At 0 - 50 ft	40	ASCE Paper 3269
Metropolis	Distance	Population	50 - 100 ft	50	
Gary, Ind.	10	182,000 ('60)	50 - 150 ft	64	
Design Basis Earthquake Accel., g		0.15	150 - 400 ft	73	
Operating Basis Earthquake Accel., g		0.08	Tornado - 300 mph tang., 60 mph trans. ΔP = 3 psi/ 3 sec		
Earthquake Vertical Shock, % of Horizontal		67	Is intent of 70 design criteria Satisfied? Yes, see Sect. F.1.		

Peak Fuel Enthalpy on Rod Drop: 280 cal/g design limit.

Recirculation Pumping System & MCHFR: Rate of recirculation flow affects type of boiling in core, which in turn affects heat flux. Flows will be maintained to prevent MCHFR from reaching fuel-damage limits.

Protective System: Initiates a rapid, automatic shut-down of reactor, following abnormal operation, in sufficient time to prevent fuel damage System over-rides operator action. Design based on fail-safe philosophy.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	45	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	45	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	36	Second Ctmt Leak Rate, %/day	100

Type of Construction: Primary containment will be a steel-lined, prestressed-concrete, pressure-suppression system of the over-and-under configuration. The drywell will be directly above the suppression chamber in the form of a frustum of a cone. Suppression pool will be cylindrical and separated from the drywell by a concrete slab.

Design Basis: The basic objective of the primary containment system is to provide the capability, in the event of the postulated design-basis loss-of-coolant accident, to limit the release of fission products to the plant site environs so that off-site doses would be in compliance with the values specified to 10CFR100.

Vacuum Relief Capability: Vacuum breakers will equalize static pressure between suppression pool and drywell, but no vacuum relief will be provided between primary containment and the reactor-building atmosphere. Concrete containment structure will withstand 5 psig external pressure.

Post-Construction Testing: Leakage-rate tests will run at several pressures. Periodic leakage-rate tests will be run during the life of the reactor. Drywell and suppression chamber will be pneumatically tested at 1.15 the design pressure of 45 psig.

Penetrations: All penetrations are double sealed. Electrical and hot process types can be individually tested. Weld channels are installed around penetrations and at other critical locations.

Reactor: Bailly

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: (HPCS) One piping system with one electric-motor-driven pump provides water to two semicircular spargers inside the reactor vessel. Capacity is 1145 gpm @ 1130 psid for small breaks and supplying up to 3620 gpm @ 200 psid as size of leakage is greater. Water comes from condensate storage or suppression pool. System starts on low-water-level signal or high-drywell press. to limit fuel temperature to 2700 F. See low-pressure core-cooling below.

Auto-Depressurization System: In case RCICS & HPCS cannot maintain reactor water level, this system acts to reduce pressure so flow from LPCI or LPCS can enter reactor to cool core and limit clad temp. Five of the relief valves open to reduce pressure when small breaks occur. Valves stay open until reset by operator.

Residual-Heat-Removal System (RHRS): System consists of 3 (1/3 cap.) pumps rated 4457 gpm @ 20 psid, 2 heat exchangers, and service-water pumps arranged into 3 loops. There are 5 modes of operation: (1) Shutdown cooling & Reactor-vessel head spray - can complete cooldown to 125 F in 20 hr & maintain. (2) Suppression-pool cooling - keeps pool temp below 170 F. (3) Low-pressure coolant injection - supplies water to flood core when reactor pressure drops to ∿20 psid; water from suppression pool. (4) Containment spray - sprays water into drywell to condense steam. (5) Reactor core isolation cooling - see system description on page 4.

High-Pressure Coolant-Injection System: HPCS accomplishes this function. A low-pressure core spray (LPCS) does same job as HPCS except that it starts at 119 psid, dispensing 3620 gpm @ 119 psid thru one system with one pump. Starts on same signals as HPCS.

Low-Pressure Coolant-Injection System: Automatically refloods core to limit clad-temp rise after a large pipe break. Core can be completely flooded in time to limit fuel temp to less than 2700 F. Three 1/3-capacity pumps can supply 4457 gpm @ 20 psid each (water taken from the suppression pool).

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: No reference found in printed text or in cross-connections noted on piping diagrams. Fuel-pool cooling system is only supply other than condensate storage and suppression pool.

Main-Steam-Line Flow Restrictors: Venturi-type flow restrictors in each main steam line between reactor and 1st isolation valve. Limits coolant loss if line breaks outside of primary containment. Also prevents uncovering core before isolation valve closes. Steam flow limited to 200% of rated flow.

Control-Rod Velocity Limiters: Two nearly mated conical elements that act as a large-clearance piston & baffle inside the control-rod-guide tube over the length of the control-rod stroke limits drop-out velocity to <5 ft/sec. Velocity of rod insertion is not affected. This feature protects against a high reactivity rate of change in the event of a control-rod-drop accident.

Control-Rod-Drive-Housing Supports: Structural-steel safety grid under control-rod-drive housing designed to limit travel or stop descent of housing in case it breaks loose from reactor. During operation, housing could fall only about 1/4" plus the compression length of the grid springs (∿2").

Standby Liquid-Control System: A redundant system for reactivity control used when control rods cannot shut down reactor. By manual initiation, sodium pentaborate solution is pumped into the reactor. About 1 to 2 hr required for complete injection. System can be used to maintain shutdown if required.

Reactor: Bailly

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: A purging system is available to reduce residual contamination before personnel access. It can make 3 air changes per hr. Drywell and suppression chamber can both be purged, but only one at a time.

Reactor Core Isolation Cooling System (RCICS): Starts manually or automatically on signal of reactor-vessel low-water level to prevent need for operating core-standby cooling system, or in case feedwater system becomes inoperative. Removes decay heat, provides makeup water into feedwater lines, and does the same if isolation valves have closed, isolating the reactor form main condenser heat sink. One steam-turbine-driven pump delivers 400 gpm to the system from the condensate storage tank, with suppression pool as backup supply.

Reactor Vessel Failure: No reference to such.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability - Objective stated under 5.2.2 is adequate design "to permit filling primary containment with water to a level above the reactor core."

Reactor-Coolant Leak-Detection Systems: Unidentified leakage has a rate of 15 gpm set as the max acceptable rate. The total of identified and unidentified leakage must be under 50 gpm so as not to exceed the capacity of one sump pump. Drywell sumps have two 50 gpm pumps. Leakage can be detected by abnormal changes in drywell pressure and/or temperature, floor drain, and sump-pump operation, and gross beta activity in drywell and suppression chamber.

Failed-Fuel Detection Systems: This system consists of four gamma radiation monitors located external to the main steam lines just outside the primary containment. The monitors are designed to detect a gross release of fission products from the fuel. Upon detection of high radiation, the trip signals generated by the monitors are used to initiate a reactor scram and isolation of radioactive material released from the fuel, by closure of the main steam line isolation valves.

Emergency Power: The standby ac power supply will consist of 3 diesel-generator sets having ample capacity to supply all power required for shutdown of the unit if all off-site power is lost. If one diesel-generator is lost, the other two can do the job. Starting of engines is automatic and generators can accept load in 10 sec. Fuel will be supplied from one tank with capacity for 7 days of full-load operation.

Rod-Block Monitor: To prevent fuel damage as a result of single rod-withdrawal error. Monitor bypassed at <30% power. Two RBM channels, either of which can initiate a rod block using signals from LPRM channels. RBM supplies a trip signal to the reactor manual control system to inhibit control rod withdrawal. The trip is initiated whenever the RBM output exceeds the rod block setpoint.

Rod Worth Minimizer: The rod-worth-minimizer function of the on-line computer prevents rod withdrawal under low power conditions if the rod to be withdrawn is not in accordance with a pre-planned pattern. The effect of the rod block is to limit the reactivity worth of the control rods by enforcing adherence to the pre-planned rod pattern.

Reactor: Bailly

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A tower will be built on the site for meteorological data collection - as close to the lake as possible. Seismographs not mentioned.

Plant Operating Mode: Load-following by varying the reactor recirculation flow rate.

Site Features: Site on shore of Lake Michigan consisting of 350 acres. Site grade is about 40 ft above lake level with very little possibility of flooding. Site is flat and the area surrounding the site within 5 mi is flat to rolling. Population within 2 mi radius is about 1000, and within 5 mi radius about 27,000. The nearest large city is Gary, Indiana, which is 10 mi distance having about 182,000 population. Land use surrounding the site is mostly industrial and recreational, becoming more agricultural as you move out to 3 or more miles from the site. Highway US 12 runs along the SE border and US 20 passes within 2 mi. A NIKE Missile Site, C-32, is located 2 1/2 mi SE of site. Indiana Dunes State Park borders the site on the east side.

Turbine Orientation: Center lines of reactor and turbine are 52'-6" apart, with turbine about 270' from reactor. Ejected blades could not strike containment.

Emergency Plans: Emergencies will be covered by detailed written procedures divided into 2 categories, on-site and off-site. The appropriate Northern Indiana Public Service Co. plant personnel will be trained in these procedures, and routine or periodic drills will be conducted so proficiency can be maintained. Procedures that might involve agencies such as the Red Cross, local hospitals, and civil authorities (police and fire depts.) will be written and finalized later.

Environmental Monitoring Plans: Radiological monitoring will begin at least 2 yr before fuel loading and will continue at least 2 yr after startup The preoperational phase will establish background radiation reference measurements in aquatic and terrestrial ecosystems. Postoperational program will monitor releases in the operational phase. This program will assess the impact, if any, this reactor will have upon the air-land-water environment. Preoperational program will include measurement of ambient gamma radiation and the collection and radiological analyses of airborne particles, surface waters, bottom sediments, bottom organisms, well water, precipitation, soil, vegetation, milk, and other food stuffs.

Radwaste Treatment: Liquid waste system collects, monitors, processes, stores, & returns some wastes to plant for reuse. Excess treated water is discharged. Subsystems handle different categories of liquids. Concentration on released wastes is no more than 10^{-7} μc/ml in water discharge canal. Solid wastes are collected, monitored, processed, and packaged in 55-gal drums for offsite disposal. Gaseous wastes are collected, processed, held for decay, and released thru the stack, passing thru charcoal filters. Design basis for noble gas input averages 100,000 μc/sec (based on 30 minute decay).

Stack Height - 350' above ground - reinforced concrete.

Waste Heat System: The PSAR specifies a once-thru system taking water from Lake Michigan. Condenser uses 607,100 gpm with a temp rise of 14 F. Heat removal capacity of condenser is 4251 × 10^6 Btu/hr. Lake temperatures vary from a low of 45 F average in the winter to a summer high average of 71 F. Water intake is 1500 ft out in the lake with water coming to the shore thru 2 pipes to the intake crib. Water is discharged through a flume to a point in the lake 300 ft from shore. It is probable that a later amendment will change this once-thru system.*

* A 400 feet high natural draft tower will be used.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Bailly Generating Station, Nuclear 1
THERMAL OUTPUT, MWt 1931	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-367

NEARBY BODY OF WATER Lake Michigan

NORMAL LEVEL 579' (MSL)

MAX PROB FLOOD LEVEL 590' (MSL)

SIZE OF SITE 350 ACRES

SITE GRADE ELEVATION ~620' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat to Rolling

TOTAL PERMANENT POPULATION IN 2 MI RAD 995 (1970) IN 5 MI RAD 26,931 (1970)

NEAREST CITY OF 50,000 POPULATION Gary, Indiana

DISTANCE FROM SITE 10 MILES POPULATION 182,000 (1960)

LAND USE IN 5 MILE RADIUS • Industrial & Recreational in 2 mile radius, and mostly Agricultural in 3 to 5 mile radius

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed loop with cooling tower

WATER TAKEN FROM Lake Michigan FOR make up

WATER BODY TEMPERATURES - WINTER AVG 45 F SUMMER AVG 71 F AVG - F

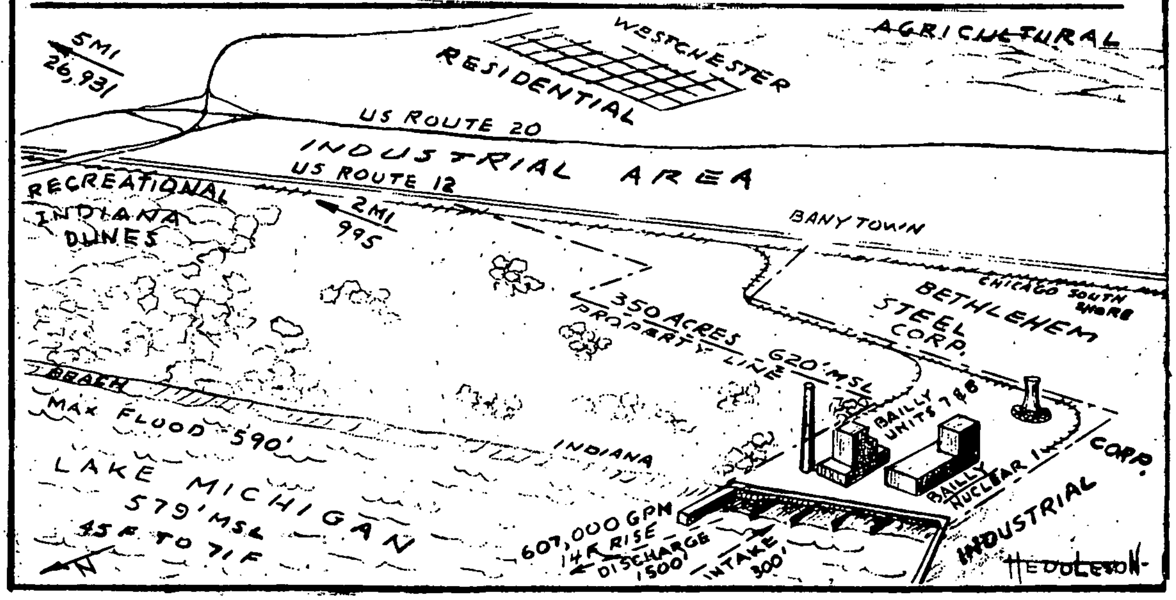
RIVER FLOW NA (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 607,100 (gpm) TEMPERATURE RISE 14 F

*HEAT REMOVAL CAPACITY OF CONDENSERS 4251×10^6 (Btu/hr) *Per Unit

COOLING TOWERS One natural draft tower, 400 feet high

OTHER INFORMATION Intake is 300 feet from shore, and discharge point is 1500 feet from shore.



ARKANSAS ONE, 50-368 (PWR)

Page 1

Project Name: ARKANSAS NUCLEAR ONE, UNIT 2

Reactor: Arkansas One, #2

A-E: Bechtel Corp.

Location: Pope Co., Arkansas
Owner: Arkansas Power & Light
NSS Vendor: Combustion Engineering

Vessel Vendor: Combustion Engineering
Docket No.: 50-368
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2760	H_2O/U, Cold	3.35
Electrical Output, MWe	950	Avg 1st-Cycle Burnup, MWD/MTU	12,000
Total Heat Output for Safety Design, MWt	2900	First Core Avg Burnup, MWD/MTU	22,000
Total Heat Output, Btu/hr	9420×10^6	Maximum Burnup, MWD/MTU (local expos. limit)	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	**2.00
DNBR, Nominal	2.12	Region-2 Enrichment, %	**2.36
Total Flow rate, lb/hr	120.4×10^6	Region-3 Enrichment, %	**2.97
Eff Flowrate for Heat Trans lb/hr	116.2×10^6	k_{eff}, Cold, No Power, Clean	1.272
Eff Flow Area for Heat Trans, ft^2	43.41	k_{eff}, Hot, Full Power Xe and Sm	1.142
Avg Vel Along Fuel Rods, ft/sec	16.8	Total Rod Worth, %	>8*
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.68×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	**1470
Nominal Core Inlet Temp, °F	553	Shutdown Boron, No Rods, Clean, Hot, ppm	**1600
Avg Rise in Core, °F	60	Boron Worth, Hot, % Δk/k/ppm	-0.13×10^{-3}
Nom Hot Channel Outlet Temp, °F	645	Boron Worth, Cold, % Δk/k/ppm	-0.17×10^{-3}
Avg Film Coeff, Btu/hr ft^2, °F	6150	Full Power Moderator Temp Coeff, Δk/k/°F	$(0 \text{ to } -2) \times 10^{-4}$
Avg Film Temp Diff, °F	34	Moderator Press Coeff, Δk/k/psi	$(0 \text{ to } +2) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	44,900	Moderator Void Coeff Δk/k/% Void	$(0 \text{ to } -1.6) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	204,800	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -1.8) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	**548,740	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	**6.9	Burnable Poisons, Type and Form	Boric acid in coolant
Max Thermal Output, kw/ft	**18.5	Number of Control Rods	385
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	None
No. Coolant Loops	2		

**Supplement No. 1

*Table 3.2-1

Compiled By: Fred Heddleson
Date: December 1970

Reactor: Arkansas One, #2

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.65 rad.	Design Winds in mph:	
Low Population Zone Dist., Mi.		At 0 - 50 ft elev	80 mph @ 30 ft, based on ASCE Paper 3269
Metropolis / Distance / Population Little Rock, Ark. / 57 / 128,929		50 - 150 ft	
Design Basis Earthquake Accel., g	0.20	150 - 400 ft	
Operating Basis Earthquake Accel., G	0.10	Tornado	300 mph tangential +60 mph transverse
Earthquake Vertical Shock, % of Horizontal	66	ΔP = 3 psi/ 3 sec	

Is intent of 70 Design Criteria satisfied? Appendix 1B gives response on conformance.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	If value was given, it could not be found.	Calculated Max Internal Press, psig	54
Max Leak Rate at Design Press, %/day	0.1		

Type of Construction: Containment is a fully continuous reinforced concrete structure in the shape of a cylinder with a shallow domed roof and a flat foundation slab. Cylindrical portion is prestressed by a post-tensioning system consisting of horizontal and vertical tendons. Dome has a 3-way post-tensioning system. Foundation slab is reinforced with high-strength reinforcing steel. A welded steel liner is attached to the inside face of the concrete shell to ensure a high degree of leak-tightness.

Design Basis: Designed for all credible conditions of loading, including normal loads, test loads, loads due to LOCA, and environmental loads such as wind, tornado, earthquake, etc. The 2 critical loads are LOCA and earthquake. Containment must maintain integrity in either case with radioactive leakage less than AEC allowable limits.

Vacuum Relief Capability: Supplement 1, p. 6-13 — Designed for 2 psig external pressure. Pressure relief valves open at 1.5-in. water pressure differential.

Post-Construction Testing: One leakage-rate test will be run after completion at 100% of design pressure. Continued leakage monitoring will not be done. Containment will be strength-tested at 115% of design pressure.

Penetrations: Electrical penetrations are double-sealed and testable. All others are single barrier. None use water seals.

Weld Channels: Liner seam welds will first be tested with a vacuum box and soap bubbles at 8 psi. After successfully passing this test, welds will be covered with test channels and pressure tested for 15 minutes with no drop in pressure.

Reactor: Arkansas One, #2

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Two 50% spray systems supply borated water to cool and reduce pressure in containment. System is designed so that with one pump (1750 gpm @ 225 psi), one set of spray nozzles, one shutdown cooling heat exchanger, and 1/2 of containment cooling system in operation, adequate cooling is provided. Pumps take suction initially from the refueling water tank, and later from the containment sump.

Containment Cooling: Normal ventilation system uses cooling units and removes heat from equipment and piping. A separate system purges area with fresh air. Cooling system uses fan-cooled units with chilled water as heat-removal medium, discharging cooled air through ducts for better distribution in the equipment area. Also, air will circulate through the reactor cavity.

Containment Isolation System: Initiated by the automatic containment-isolation signal or by a separate manual signal. The system closes all penetrating lines not required for operation of Engineered Safety Features, to minimize leakage of radioactive materials to the environment. All valves can be manually operated from the control room, where position-indicating lights are provided. Isolation valves have 5 classifications depending upon use.

Containment Air Filtration: Found no reference.

Penetration Room: Two rooms show in Fig. 1-3 on a lower floor plan.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Supplement 1, p. 566 — A purge system will be used (670 cu ft/hr) discharging through filters and plant vent.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: There are four tanks each holding 6375 gallons of borated water which dump immediately into the reactor vessel when operating pressure drops to 215 psig. Tanks are pressurized to 250 psig design press with nitrogen gas. As reactor pressure drops to the pressure of the injection tanks, check valves open automatically to dump the contents. Each tank is connected to one of the four safety injection nozzles.

High-head Safety Injection: Low-pressurizer-pressure signal or a high-containment-pressure signal start the high-head and low-head pumps. Three high-pressure pumps are available (300 gpm@1750 psig), one of which has sufficient capacity to carry out its operation to prevent fuel and cladding damage and to limit metal-water reaction to less than 1%. Two redundant systems are provided. In case of power failure, one system can run from power supplied by emergency diesel-generator set. Suction is taken first from the borated water of the refueling water tank. When this supply is gone, water is recirculated from the containment sump.

Low-head Safety Injection: Low-head pumps are started by the same signals that start the high-head pumps. One low-pressure header and two pumps comprise this system along with the required accessories. One pump can supply 3250 gpm @ 500 psig of borated water from the refueling water tank. In long-term cooling, the low-head pumps are shut off. This system can be cross-connected into the injection header for the containment spray system, making the low-head pumps available for containment spray, or containment spray pumps for low-head system.

Reactor: Arkansas One, #2

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability - See page 3, D3.

Containment Floodability - Reactor cavity can be flooded, but no reference found saying Containment can be flooded.

Reactor-Coolant Leak-Detection Systems: Methods are provided so operator can detect leakage early enough to take preventive action. These methods are: Measurement of increasing pressure or temperature, high flow to sumps indicated by sump monitoring, liquid level in pressurizer, and high flow of makeup liquid to the coolant system. If excessive leakage is indicated, the plant will be shut down for remedial action.

Failed-Fuel-Detection Systems: Quote from page 7-28 of PSAR.

7.8.4.5 Failed Fuel

The failed-fuel radiation monitor will consist of a single channel with provisions for automatic control.

Emergency Power: Two full-capacity diesel-generators supply power to two independent Engineered Safety Features buses. Either generator can supply sufficient power to shut down the reactor in a safe condition. In case of incident, essential loads will be automatically energized in a predetermined sequence with sufficient intervals between each to allow for load pickup. Total required loads in DBA will be less than capacity of one diesel-generator (2750 kw). Seven days' fuel storage will be provided.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid dissolved in coolant.

Part-Length Control Rods - None.

In-Core Instrumentation - In-core monitors provide information on neutron flux distribution.

Unborated Water Control: Because of the equipment and controls and the administration procedures provided for the boron-dilution operation, the probability of erroneous dilution is considered very small. Nevertheless, if an unintentional dilution of boron in the reactor coolant does occur, numerous alarms and indications are available to alert the operator to the condition. The maximum reactivity addition due to the dilution is slow enough to allow the operator to determine the cause of the dilution and take corrective action before shutdown margin is absorbed.

Long-Term Cooling - Internal or External Systems: For long-term cooling, borated water is pumped from the containment sump and recirculated to the reactor to keep the core flooded. Recirculation is automatically initiated by low water level in the refueling water tank. This signal also shuts down the low-head safety injection pumps. During recirculation, although the low-head pumps are normally shut down, they may be aligned to take suction from the sump and discharge to either the shutdown heat exchangers or the reactor vessel. Or, if desired, the low-head pumps can discharge to the containment-spray headers.

F. MISCELLANEOUS

Reactor: Arkansas One, #2

Windspeed, Direction Recorders, and Seismographs: Wind direction and speed have been measured since May 1969 at 30-ft level. Seismograph not mentioned.

Plant Operating Mode: Reactor power adjusted in response to turbine load demand — load-following.

Site Features: The plant is located on a peninsula on the left bank of the Dardanelle Reservoir on the Arkansas River, about 7 river-miles upstream from the dam. The site consists of 1100 acres and is relatively flat with a grade of 353', about 15 ft above the normal reservoir level. Max possible flood is calculated to run to 361', in which case the plant would be shut down. This max flood is estimated on the basis of failure of the Ozark Dam. Area surrounding the plant is hilly to mountainous. Population within 2 mi of the plant is 810, and within 5 mi radius population is 8400. Forests cover nearly all the land surrounding the plant within a 5 mi radius. The nearest sizable city is Hot Springs, Ark., which is 55 mi away with a population of 37,300 (1960).

Turbine Orientation: Turbine centerline is ~190 ft from reactor centerline. Blades ejected from turbine could hit containment.

Emergency Plans: Procedures will be prepared and personnel will be trained in their responsibilities. Communication equipment and monitoring equipment will be available for portable use during emergencies. Outside groups such as State Police, local sheriff's offices, Civil Defense, and medical personnel at Little Rock and Fort Smith hospitals have been contacted and will cooperate. Evacuation plans for close-in residents are being prepared.

Environmental Monitoring Plans: There will be two objectives: 1) determine present levels of background radioactivity in the plant environs (preoperational), and 2) determine the effect of operation of the nuclear units on the environment (operational phase). These programs will be carried out for the air environment, water environment, and land environment. Air particulates will be collected on filters at points up to 20 miles from the plant. The Dardanelle Reservoir, ground water, potable water, sediments, and biota in the reservoir will be collected. Biota include fish, mollusks, algae, and underwater plants. Samples of soil, food crops, vegetation, and small land animals will be collected and analyzed.

Radwaste Treatment: Process treats all radioactive liquid wastes, solid wastes, and gaseous wastes. System designed to process effluent with an activity level based on 1% defective fuel elements. Basic processing methods are storage, filtration, and concentration. Solid wastes are compacted in drums for offsite disposal. Wastes released from the system will be well below limits of 10CFR20, or they will be held for a longer period. In addition, a boron management system uses reconcentration for recovering boron from the liquid effluent.

Stack Height - Could not determine.

Waste Heat System: Closed-loop system is used with one wet cooling tower, probably hyperbolic. An emergency cooling reservoir is provided near the cooling tower. Makeup water can be supplied to the cooling-tower basin by pumping from the Dardanelle Reservoir or by taking it from the emergency cooling reservoir. Makeup pumps are located in the Unit 1 intake canal, and blowdown is discharged into the Unit 1 discharge canal. Makeup water for Unit 2 will be 22,500 gpm, with about 9,000 gpm being returned to the reservoir.. Unit 1 has a once-thru cooling system using 765,000 gpm.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Arkansas Nuclear One, Unit 2

THERMAL OUTPUT, MWt 2760

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-368

NEARBY BODY OF WATER Dardanelle Reservoir of the Arkansas River

NORMAL LEVEL 338' (MSL)

MAX PROB FLOOD LEVEL 361' (MSL)

SIZE OF SITE 1100 ACRES

SITE GRADE ELEVATION 353' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Hilly to Mountainous

TOTAL PERMANENT POPULATION IN 2 MI RAD 678 (1970) IN 5 MI RAD 3738 (1970)

NEAREST CITY OF 50,000 POPULATION Hot Springs, Arkansas

DISTANCE FROM SITE 55 MILES POPULATION 37,286 (1970)

LAND USE IN 5 MILE RADIUS Wooded

*River flow 4,000cfs min to 683,000 cfs max during flood

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed loop using cooling tower

WATER TAKEN FROM Dardanelle Reservoir FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

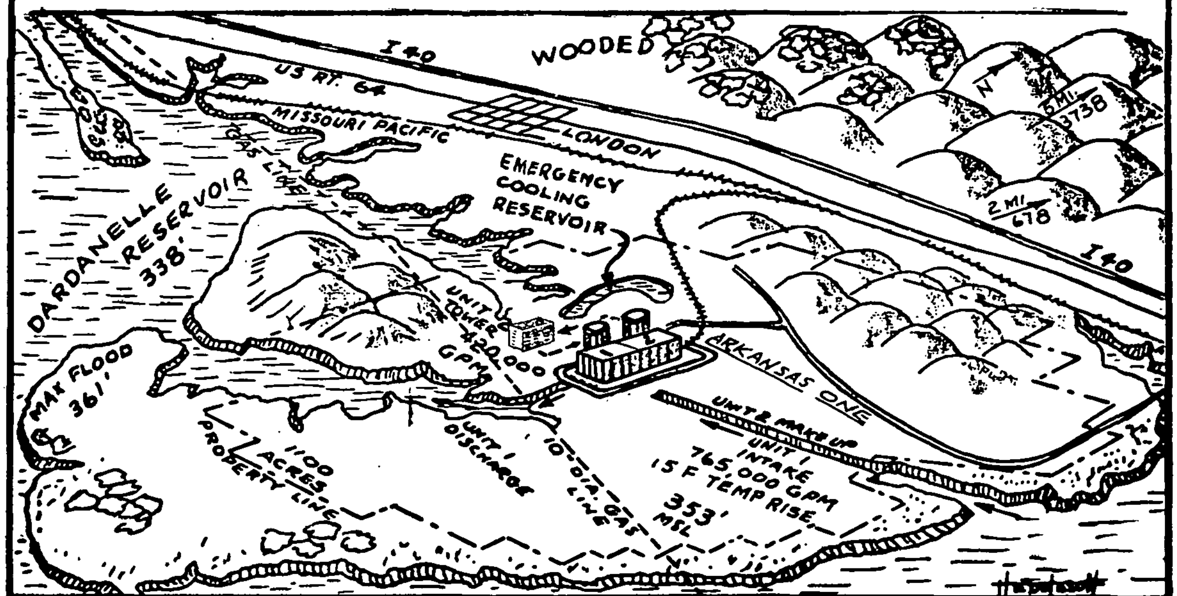
RIVER FLOW ______ (cfs) avg. *QUANTITY OF MAKEUP WATER ~12,000 (gpm)

*TOTAL FLOW THROUGH CONDENSERS ~420,000 (gpm) TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS 3/22/71 tower design not complete. If natural-draft towers are used, three will be installed.

OTHER INFORMATION



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McGUIRE, 50-369 & 50-370 (PWR) Page 1

Project Name: McGuire Nuclear Station Units 1 and 2
Location: Lake Norman, N. C.*
Owner: Duke Power Company
NSS Vendor: Westinghouse
* Mechlenburg County

Reactor: McGuire
A-E: Duke Power Company
Vessel Vendor: Not stated
Docket No.: 50-369, 50-370
Containment Constructor: Duke Power responsibility

A. THERMAL-HYDRAULIC	
Thermal Output, MWt	3411
Electrical Output, MWe	1180
Total Heat Output for Safety Design, MWt	3582
Total Heat Output, Btu/hr	$11,640 \times 10^6$
System Pressure, psia	2250
DNBR, Nominal	1.88
Total Flow rate, lb/hr	138.4×10^6
Eff Flowrate for Heat Trans lb/hr	132.2×10^6
Eff Flow Area for Heat Trans, ft^2	51.4
Avg Vel Along Fuel Rods, ft/sec	16.3
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.58×10^6
Nominal Core Inlet Temp, °F	557.5
Avg Rise in Core, °F	63.7
Nom Hot Channel Outlet Temp, °F	648
Avg Film Coeff, Btu/hr ft^2, °F	6000
Avg Film Temp Diff, °F	36.2
Active Heat Trans Surf Area, ft^2	52,200
Avg Heat Flux, Btu/hr ft^2	217,200
Max Heat Flux Btu/hr ft^2	579,600
Avg Thermal Output, kw/ft	7.0
Max Thermal Output, kw/ft	18.8
Max Clad Surface Temp, °F	657
No. Coolant Loops	4

W — Information obtained from Westinghouse Ref. Safety-Analysis Report (RESAR).

B. NUCLEAR	
H_2O/U, Cold	3.48
Avg 1st-Cycle Burnup, MWD/MTU	14,000
First Core Avg Burnup, MWD/MTU	25,500
Maximum Burnup, MWD/MTU (Equilib) W	50,000
Region-1 Enrichment, %	2.25
Region-2 Enrichment, %	2.80
Region-3 Enrichment, %	3.30
k_{eff}, Cold, No Power, Clean	1.225
k_{eff}, Hot, Full Power Xe and Sm	1.148
Total Rod Worth, %	---
Shutdown Boron, No Rods, Clean, Cold, ppm	< 1500
Shutdown Boron, No Rods, Clean, Hot, ppm	< 1500 W
Boron Worth, Hot, % $\Delta k/k$/ppm	< 700 W
Boron Worth, Cold, % $\Delta k/k$/ppm	< 1200 W
Full Power Moderator Temp Coeff, $\Delta k/k/°F$	$(+0.04 \text{ to } -3) \times 10^{-4}$
Moderator Press Coeff, $\Delta k/k/psi$	$(-0.4 \text{ to } +3) \times 10^{-6}$
Moderator Void Coeff $\Delta k/k/\%$ Void	$(+0.5 \text{ to } -2.5) \times 10^{-3}$
Doppler Coefficient, $\Delta k/k/°F$	$(-1.0 \text{ to } -2.0) \times 10^{-5}$
Shutdown Margin, Hot One Rod Stuck, % $\Delta k/k$	W 1
Burnable Poisons, Type and Form W	Borated glass tubes in SST
Number of Control Rods 53 × 20	1060
Number of Part-Length Rods (PLR) 8 × 20	160

Compiled By: Fred Heddleson
Date: January 1971

Reactor: McGuire

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi. 0.47 rad.		Design Winds in mph:
Low Population Zone Dist., Mi. 5.5		Wind loads will be based upon ASCE Paper 3269 using 95 mph as the fastest mile (Sect. 5.2.3).
Metropolis / Distance / Population Charlotte, N.C. / 17 / 239,049 (70)		
Design Basis Earthquake Accel., g	0.12	
Operating Basis Earthquake Accel., G	0.06	Tornado - 300 tang. + 60 trans.
Earthquake Vertical Shock, % of Horizontal	66 2/3	ΔP = 3 psi/ - sec

Is intent of 70 Design Criteria satisfied? Apparently so; described in detail throughout all sections of PSAR.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	15	Calculated Max Internal Press, psig	7.8 in upper compartment
Max Leak Rate at Design Press, %/day	0.2	After LOCA, initial peak press is 9.1 psig in lower compartment [Fig. 14-5-12 (12.5 psig)]	

Type of Construction: Reactor building is cylindrical reinforced concrete (3' thk) with shallow dome roof on a flat circular foundation slab. Inside this structure, allowing for a 5' wide annulus, is the steel shell containment vessel. The annulus space is used for ice storage for the Ice Condenser System of containment.

Design Basis: Designed to withstand all credible loads, including a LOCA for the largest sized pipe as well as seismic loads without loss of integrity. Nor shall leakage of radioactivity exceed AEC limits that would threaten public safety.

Vacuum Relief Capability: No reference found.

Post-Construction Testing: After the initial structural press. test of the shell, the leakage-rate test will be run at 15 psig. Periodical leakage-rate tests will be conducted during the life of the reactor to verify leaktightness.

Penetrations: Electrical penetrations are double-sealed and testable - so is the 20' diameter equipment hatch. The Fuel-Transfer penetration is double-sealed. All other penetrations are single-sealed.

Weld Channels: Weld channels are used over all seam welds in the 1/4" bottom liner plate. Channels have pressure taps for testing (Fig. 5.5-1). Apparently, bottom-liner-plate seams are the only application for channels.

Reactor: McGuire

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Two independent systems, each having 1 pump, 1 heat exchanger, and 2 spray headers. Systems first use water from the refueling water storage tank, until it is empty, then from the containment sump in a recirculation mode. One system can deliver design flow to hold containment pressure below design limit after all ice has melted and steam generation continues in the core. Pump capacity is 3400 gpm @ 300 psig. Heat exchanger capacity is 8.6×10^7 Btu/hr.

Containment Cooling: Two systems are required, one for upper compartment and one for lower. Upper system consists of four recirculating fan-coil units with filters, ducts, etc. Three units operate and one is in standby for maintaining 110 F max during operation and a min of 60 F otherwise. Lower system has four units (3 operating, 1 standby), maintaining temperature between 60 F and 120 F.

Containment Isolation System: Initiated by 3 psig in containment, to limit leakage thru all fluid penetrations not serving accident-consequence-limiting systems. Two valves on each line close automatically (1 inside containment, 1 outside). All remotely operated valves have position indication in the control room. Isolation valves on penetrations directly to containment close also on a high-radiation signal.

Containment Air Filtration: Annulus ventilated by two 100% cap. fans with air passing thru moisture separator particulate filter, absolute filter, and fire-resistant charcoal filter. Annulus maintained at 0.5 inches of water pressure.

Penetration Room: Yes - at 3 levels for mech. and two levels for electrical.

Organic-Iodide Filter: None mentioned.

Hydrogen Recombiner: None mentioned. Sect. 14 states that 6778 SCF of hydrogen would be generated in the 24 hr after LOCA. This is 0.5% of containment volume. W

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks each with 6400 gal. of borated water and pressurized to 650 psi operating pressure with nitrogen gas are ready to dump their contents into the reactor when reactor pressure drops below 650 psig. Two check valves in series are the only operating parts. Each tank discharges into one of the reactor-coolant system cold legs. W

High-head Safety Injection: Safety Injection System is started by an 'S' signal, which is developed from an abnormal condition in the pressurizer pressure or level, T avg, main steam press or flow or the differential press., and the containment press. When the 'Injection Signal' is given, 3 sets of pumps start - 2 each of centrifugal charging pumps, safety injection pumps, & residual-heat-removal pumps. Charging pumps inject concentrated boric acid first and then borated water from the refueling water storage tank (150 gpm @ 2800 psig). Safety injection pumps deliver 400 gpm @ 1700 psig from refueling water storage tank into the 4 hot legs. W

Low-head Safety Injection: This service is supplied by the Residual-Heat-Removal pumps, which start to deliver borated water from the refueling water storage tank when reactor pressure drops to about 170 psig. These pumps are rated 4500 gpm @ 600 psig. After an incident when the Safety Injection System is started, if all water in the refueling water storage tank is used, the residual-heat-removal pumps are then switched to the recirculation mode and water is circulated through the reactor from the containment sump. W

Reactor: McGuire

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Not a credible accident. W

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Leakage will be measured by monitoring air particulate activity, by a containment gas monitor, by observation of amount of makeup water for the pressurizer, by measurement of temperature increase in controlled leakage lines, by other methods using direct observation. A certain amount of leakage will be allowed thru seals and joints expected to leak. If leakage exceeds 1 gpm, and cannot be identified, the reactor will be shut down. If it is identified, a leakage of 10 gpm will be allowed before shutdown is required. W

Failed-Fuel-Detection Systems: Could not find a reference to fuel-failure detection.

Emergency Power: If normal power supply becomes unavailable, power will then be taken from other off-site sources. However, if no off-site power can be obtained diesel-generator sets could furnish on-site emergency power. Two redundant and independent diesel-generators and associated distributions systems can supply the required power for orderly shutdown. Each diesel-generator unit, separately housed, has fuel supplied in underground tanks to run the unit for 7 days. Generators are rated 4375 KVA. Each unit has an independent air starting system which can provide at least two fast starts.

Control of Axial Xenon Oscillations:

W Burnable Shims - Borated glass tubes contained within 304 SST tubular cladding.

Part-Length Control Rods - Yes, 8 RCC.

In-Core Instrumentation - Thermocouples, and fission-chamber detectors to measure temperatures and neutron flux distribution.

Unborated Water Control: Only one supply of makeup water is available to the coolant system. Inadvertent dilution can be quickly terminated by closing the one valve on the supply line. To dilute, two separate operations are required - operator must switch from automatic makeup mode to the dilute mode, and the start button must be depressed. Omitting either step prevents dilution. In case of error, there is ample time for the operator to recognize the high-count-rate signal and terminate manual dilution. W

Long-Term Cooling - Internal or External Systems: W Recirculation loop of core-cooling system maintains core cooling during long-term postaccident recovery by operation along with Containment Cooling System. From the PSAR-Containment Spray System, along with melting ice, provides long term cooling. The containment spray can operate for a long time circulating borated water from the containment sump.

F. MISCELLANEOUS — Reactor: McGuire

Windspeed, Direction Recorders, and Seismographs: Data on wind has been collected since November 1969 with a tower 131' high, top at elevation 901'.

Plant Operating Mode: Load-following.

Site Features: Site grade is 760' with plant located on Lake Norman very near the Cowans Ford Dam. Lake levels vary from 735' to a max. of 760'. The land owned by Duke Power is about 30,000 acres. Site topography is rolling, although surrounding areas are hilly. Population in a 2-mi radius is 342, and in 5-mi 1490. Land use in a 5-mi radius is about half agricultural, and the remaining land is covered with forests. High wind, hail, and lightning can accompany summer thunderstorms, and dissipating hurricanes can effect the site. Seismology of the site is suitable for a nuclear power plant.

Turbine Orientation: Centerlines of turbines are perpendicular to the common centerline of reactors. Ejected blades could not strike containment except by deflection.

Emergency Plans: Detailed procedures will be prepared and presented in the FSAR. Station personnel will be trained and their responsibilities outlined for emergency situations. Outside agencies will be made familiar with the plant and areas where they could assist. Situations covered will include fire, vehicular accidents, natural disasters, medical injury or illness, radiation and contamination, civil disturbance, and reactor accidents.

Environmental Monitoring Plans: Since 1963 a water-quality and thermal-behavior program has been conducted using Marshall Station to evaluate the effect of warmed effluent discharged into Lake Norman. The biological parameters studied are - fish movement, fish distribution, fish breeding, benthic organisms, planktonic organisms, and periphyton accumulations. These studies provide base-line data for McGuire design. An Environmental Radioactivity Monitoring Program will be put into effect at least one year before operation. Air and water samples will be collected and counted for gross alpha and beta activity. Measurements of gamma dose and dose rate will also be made. Water will be analyzed for tritium.

Radwaste Treatment: Gaseous waste disposal systems collect, hold up as necessary, filter, monitor, release, and record the gaseous effluent from the station. Liquid waste disposal systems provide for collection, storage, treatment, monitoring, disposal, and recording of liquid wastes. Solid radioactive wastes are stored, packaged, and shipped off-site.

Stack Height - Vent stack from roof at elevation 902'. Containment top is 904'.

Waste Heat System: A once-thru system takes cool hypolimnetic water from low depth of the lake, circulates it thru the condensers and returns it to the lake. The flow at Cowans Ford Dam is 2670 cfs. No data on flows thru condensers or condenser heat removal capacity is given in PSAR. The intake structure was built at the time Cowans Ford was built. The intake is concrete and will be 112 ft submerged. Most of the cooling water will be taken in here. Another intake, submerged 40 ft, will supply the remaining water needs.

G. CIRCULATING WATER SYSTEM & SITE FEATURES	REACTOR NAME McGuire Nuclear Station 1 and 2	
THERMAL OUTPUT, MWt 3411	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-369 50-370

NEARBY BODY OF WATER Lake Norman in North Carolina
NORMAL LEVEL 760' (MSL)
MAX PROB FLOOD LEVEL 764' (MSL)

SIZE OF SITE 30,000 ACRES
SITE GRADE ELEVATION 760' (MSL)

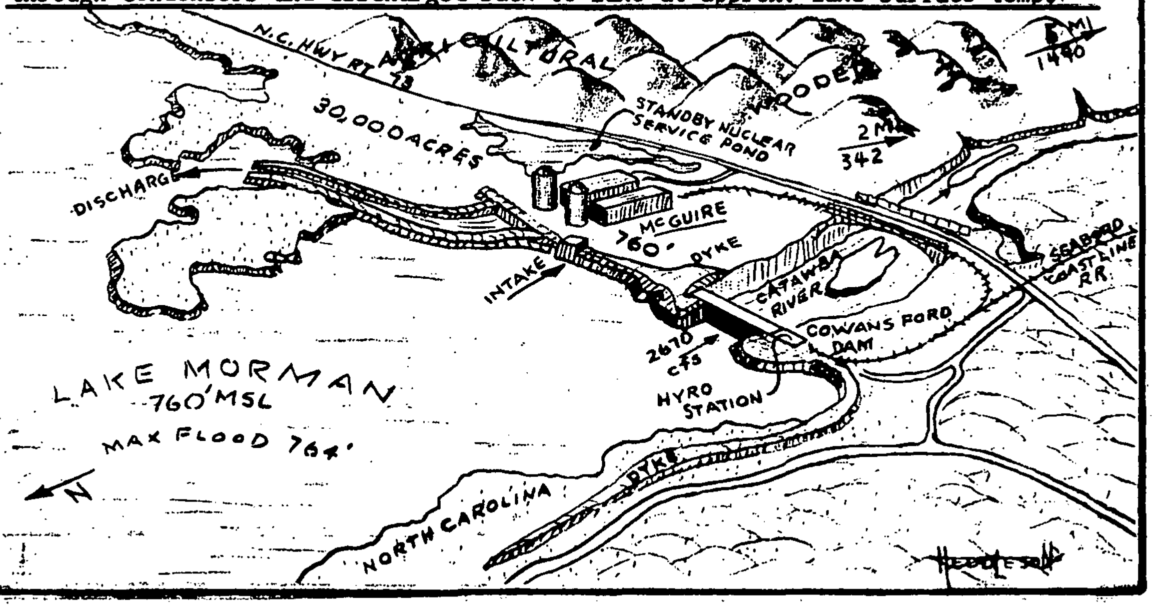
TOPOGRAPHY OF SITE Rolling
OF SURROUNDING AREA (5 MI RAD) Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 342 (1970) IN 5 MI RAD 1490 (1970)
NEAREST CITY OF 50,000 POPULATION Charlette, North Carolina
DISTANCE FROM SITE 17 MILES POPULATION 239,047 (1970)

LAND USE IN 5 MILE RADIUS Agricultural-55%, Wooded the balance

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once through
WATER TAKEN FROM Lake Norman FOR Condenser cooling
WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F
RIVER FLOW 2,670 (cfs) at Cowans Ford Dam *QUANTITY OF MAKEUP WATER - (gpm)
*TOTAL FLOW THROUGH CONDENSERS - (gpm) TEMPERATURE RISE - F
*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit
COOLING TOWERS None

OTHER INFORMATION Cool water taken from 112' and 40' submerged intakes, pumped through condensers and discharged back to lake at approx. lake surface temp.



La SALLE, 50-373 & 50-374 (BWR) Page 1

Project Name: La Salle County Station, Units 1 & 2
Location: Brookfield Twp.*
Owner: Commonwealth Edison Co.
NSS Vendor: General Electric Company
*60 mi SW Chicago

Reactor: La Salle
A-E: CECO with Sargent & Lundy Assistance
Vessel Vendor: Not specified.
Docket No.: 50-373, 50-374
Containment Constructor: CECO

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3293	H_2O/UO_2 Volume Ratio	2.45
Electrical Output, MWe	1078	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output for Safety Design, MWt	3434	Moderator Temp Coef Hot, No Voids	-39.0×10^{-5}
Steam Flow Rate, lb/hr	14.17×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	106.5×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	---	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.5	Doppler Coefficient, Operating	-1.3×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	424,000	Initial Enrichment, %	1.80
Average Heat Flux, Btu/hr-ft^2	126,910	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	74
Average Fuel Rod Surface Temp °F	558	k_{eff}, All Rods In	---
MCHFR	≥ 1.9	k_{eff}, Max Rod Out	<0.99
Total Peaking Factor	2.6	Control Rod Worth, %	No curtains.
Avg Power Density, Kw/ℓ	51	Curtain Worth, %	No curtains.
		Burnable Poisons, Type and Form	Gadolinia-urania in selected fuel rods
		Number of Control Rods	185 assemblies
		Number of Part-Length Rods (PLR)	None

Compiled by: Fred Heddleson
Date: March 1971

TX-4377
(8-70)

Reactor: La Salle

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.34	Design Winds in psf:
Low Population Zone Dist., Mi.	3.7	At 0 - 50 ft 37 50 -100 ft 43 100 -150 ft 50
Metropolis / Distance / Population Chicago, Ill. / ∿60 mi. / 3,460,000 (69)		
Design Basis Earthquake Accel., g	0.15	150 - 200 ft 53
Operating Basis Earthquake Accel., g	0.08	Tornado 300 tang. + 60 trans (mph) ΔP = 3 psi/ 3 sec
Earthquake Vertical Shock, % of Horizontal	.67	Is intent of 70 design criteria Satisfied? Yes, see Section F

Peak Fuel Enthalpy on Rod Drop: 200 rods exceed 170 cal/g with max enthalpy calculated to be 250 cal/g.

Recirculation Pumping System & MCHFR: Speed of recirculation pump is varied on basis of several factors so MCHFR will be held within specified limits.

Protective System: Provides protection against consequences of conditions that threaten integrity of nuclear system process barrier by scramming reactor following abnormal operational transients.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	45	Prim Ctmt Leak Rate, %/day	0.5
Supprn Chamb Design Press, psig	45	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	34	Second Ctmt Leak Rate, %/day	100

Type of Construction: A steel-lined prestressed-concrete pressure suppression system of the over and under configuration. Drywell will be located directly above the suppression chamber in the form of a frustum of a cone. Suppression pool will be cylindrical and separated from the drywell by a reinforced concrete slab.

Design Basis: The basic objective of the primary containment system is to provide the capability, in the event of the postulated design basis loss of coolant accident, to limit the release of fission products to the plant site environs so that off-site doses would be in compliance with the guidelines specified in 10CFR100.

Vacuum Relief Capability: Designed for 2 psig vacuum; but since primary containment will have structural capability to accommodate pressure of 5 psia, no relief valves will be installed. (Section 5.2.3.6)

Post-Construction Testing: Will be pressure tested at 1.15 × 45 psig, and leakage rate test will be run at same pressure. Leakage rate tests will continue to be run periodically after startup.

Penetrations: Double sealed and electrical penetrations are individually testable.

Reactor: La Salle

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: There are two systems — high-pressure and a low-pressure. See HPCI below for data in the high-pressure. Low-pressure system has one pump rated 6350 gpm @ 125 psi discharging through a spray sparger located over the core. Suction for high-pressure is condensate storage tank and suppression pool. Low-pressure system suction is suppression pool.

Auto-Depressurization System: Acts to rapidly reduce reactor pressure when High-Pressure Core Spray System fails to maintain water level. System depressurizes through nuclear system relief valves so the low-pressure standby cooling systems can operate.

Residual-Heat-Removal System (RHRS): There are 3 modes of operation — 1) shutdown cooling, 2) low-pressure coolant injection following LOCA (see description below), and 3) containment cooling system that limits temperature of suppression pool after LOCA by circulating the water through RHRS heat exchangers, and a spray system in the drywell that removes energy after LOCA. Three pumps in this system have capacity of 7450 gpm and heat exchanger has 46.6×10^6 Btu/hr capacity.

High-Pressure Coolant-Injection System: Maintains coolant inventory in reactor vessel adequate to prevent fuel clad temperature from exceeding 2700 F as a result of small breaks in the coolant system. This system uses one pump rated 1550 gpm @ 1130 psid. La Salle calls it the HIGH PRESSURE CORE SPRAY SYSTEM (see above).

Low-Pressure Coolant-Injection System: Operates as a mode of residual heat removal system to inject cooling water directly into pressure vessel. Three pumps can each inject 7450 gpm @ 20 psid to flood the core and prevent fuel cladding from exceeding 2700 F. Suction is taken from the suppression pool.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: No reference found; however, the 4500 acre cooling pond must provide an almost limitless supply of cooling water when needed.

Main-Steam-Line Flow Restrictors: Limits coolant blowdown rate from a steam line, consists of a venturi-type nozzle insert welded into the line between the reactor and first isolation valve. Limits flow to 200 percent rated flow.

Control-Rod Velocity Limiters: Attached to each control rod to limit the velocity at which a control rod can fall out of the core should it become detached from its control rod drive. The rate of reactivity insertion resulting from a rod drop accident is limited by this action.

Control-Rod-Drive-Housing Supports: Located underneath the reactor vessel near the control rod housing. The supports limit the travel of a control rod in the event that a control rod housing is ruptured. The supports prevent a nuclear excursion as a result of a housing failure, thus protecting the fuel barrier.

Standby Liquid-Control System: Provides a redundant, independent, and different way from the control rods to bring the nuclear fission reaction to subcriticality and to maintain subcriticality as the reactor cools. The system makes possible an orderly and safe shut-down in the event that not enough control rods can be inserted into the reactor core to accomplish shut-down in the normal manner.

Reactor: La Salle

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: A cooling and vent system will hold normal operating temperature to ∿90 F. Both drywell and suppression chamber can be purged with exhausted air filtered and can be passed through the standby gas treatment system.

Reactor Core Isolation Cooling System (RCICS): Provides make-up water to the reactor vessel whenever the vessel is isolated. The RCICS uses a steam driven turbine pump unit and operates automatically in time and with sufficient coolant flow to maintain adequate reactor vessel water level. No further information could be found on Isolation Cooling System.

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Leakage can be detected through 1) Drywell pressure, 2) Drywell temperature, 3) Drainage sump pump operation characteristics, 4) Sampling containment air for gross Beta-gamma count. Max allowable leakage has been set at 15 gpm.

Failed-Fuel Detection Systems: Four gamma radiation monitors located external to the main steamlines just outside of the primary containment are designed to detect a gross release of fission products from the fuel. Upon detection of high radiation, the trip signals generated by the monitors are used to initiate a reactor scram and isolation of radioactive material released from the fuel, by closure of the main steamline isolation valves.

Emergency Power: Five diesel-generator sets are available, two for each reactor unit, and one shared. One diesel-generator can supply required power to shutdown one reactor. Fuel is stored in underground tanks with capacity to run all diesels for 7 days. Each diesel generator is an independent unit with all accessories so that loss of one unit will have no effect on other units.

Rod-Block Monitor: Designed to prevent fuel damage as a result of a single rod withdrawal error under worst permitted conditions of RBM bypass. System has two RBM channels, each of which uses input signals from several LPRM channels. A trip signal from either RBM channel can initiate a rod block.

Rod Worth Minimizer: A function of the process computer that can initiate a rod insert block, a rod withdrawal block, or a rod select block to reinforce procedural controls that limit reactivity worth of control rods under low power conditions.

Reactor: La Salle

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: On-site program is planned for meteorological observations. Measurements will be taken 15 ft above ground. No reference to seismographs found.

Plant Operating Mode: Load-following.

Site Features: Plant located about 3 1/2 miles south of the Illinois River about 60 miles SW of Chicago on a 5000 acre tract in a comparatively level area. Plant grade will be 710 ft (MSL). About 4500 acres of the site will be used for a large cooling pond with level at 700 ft. The plant will take makeup water from the Illinois River which has a max flood height of 488 so plant is well above floods. Area around site is relatively flat with most land used for agriculture. Population is 120 in 2-mile radius and 1035 in 5-mile radius.

Turbine Orientation: Centerline of turbine and reactor are ∿200 ft apart. Turbine blades from one stage, if ejected, could strike the containment structure.

Emergency Plans: The Generating Stations Emergency Plan establishes protective action levels and provides liaison with off-site support groups including Federal, State and local government authorities when such levels are exceeded. Document reviews and control, emergency preparedness assessment and training of plant personnel, including periodic drills, are objectively set forth by the plan.

Environmental Monitoring Plans: Pre-operational program will begin 2 years before commercial fuel loading and will continue for at least 2 years after start-up. Preoperational phase will establish background references in aquatic and terrestrial systems and operational phase will be useful in comparing measured levels with 10CFR20 guidelines. Included will be ambient gamma radiation, airborne particulates, misc. foodstuffs, surface waters, bottom sediments and organisms, periphyton, well water, precipitation, soil, vegetation, eggs, milk, wildlife and fish. The program will be coordinated with local, state, and federal agencies.

Radwaste Treatment: Designed to process wastes generated during power operation, liquid, solid, or gaseous. The gaseous wastes are treated and discharged to the atmosphere. Most of the liquid waste is purified, with the water portion being recycled to the plant and the solid waste barreled. A fraction of the liquid water waste, with very low activity levels, after treatment, is diluted in the discharge system. Concentration of radioactivity in discharges is as low as practicable and, always, is well below regulatory limits. Wet and dry solid wastes are drumed and shipped off-site.

Stack Height - 300' reinforced concrete.

Waste Heat System: A 4500 acre cooling pond will be used. Flow through condenser of each unit will be 645,000 gpm, taken from the cooling pond and returned there. Makeup for losses will come from Illinois River, whose average flow is 10,680 cfs. Condenser heat removal capacity is 7609×10^6 Btu/hr. Water temperature will be raised 24 F in passing through condenser.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME La Salle County Station
THERMAL OUTPUT, MWt 3293	TYPE OF NUCLEAR STEAM SYSTEM BWR	DOCKET NO. 50-373 / 50-374

NEARBY BODY OF WATER Illinois River (3 1/2 mi) NORMAL LEVEL 483 (MSL)

MAX PROB FLOOD LEVEL 488 (MSL)

SIZE OF SITE 5000 ACRES SITE GRADE ELEVATION 710 (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat, except for hills along the river

TOTAL PERMANENT POPULATION IN 2 MI RAD 120 (1975) IN 5 MI RAD 1035 (1975)

NEAREST CITY OF 50,000 POPULATION Joliet, Ill.

DISTANCE FROM SITE 36 MILES POPULATION 75,200 (1969)

LAND USE IN 5 MILE RADIUS Agricultural

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed cycle using cooling pond

WATER TAKEN FROM Cooling pond FOR condenser cooling

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

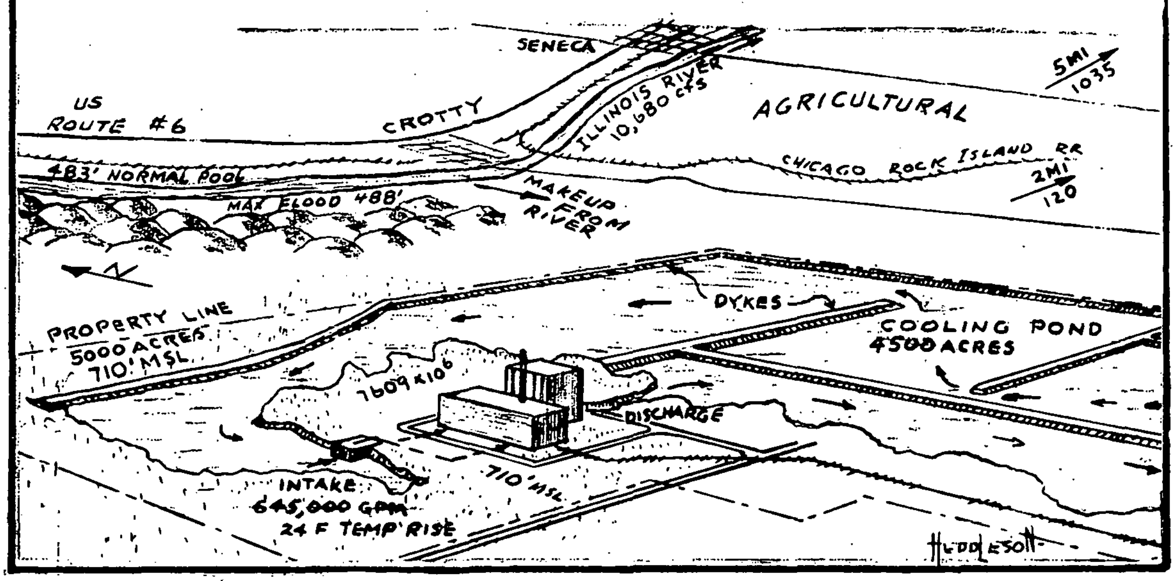
RIVER FLOW 10,680 (cfs) avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 645,000 (gpm) TEMPERATURE RISE 24 F

*HEAT REMOVAL CAPACITY OF CONDENSERS 7609×10^6 (Btu/hr) *Per Unit

COOLING TOWERS None

OTHER INFORMATION Makeup water for the system is taken from Illinois River



NUCLEAR SAFETY INFORMATION CENTER

AGUIRRE, 50-376 (PWR) Page 1

Project Name: Aguirre Nuclear Unit 1

Location: Southern Coast of Puerto Rico
Owner: Puerto Rico Water Resources
NSS Vendor: Westinghouse*

Reactor: Aguirre
A-E: Gibbs & Hill
Vessel Vendor: Not specified
Docket No.: 50-376
Containment Constructor: Burns & Roe Construction Management

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1785	H_2O/U, Cold	15 (T 1.4-1) 3.85 (T3.2.1-1)
Electrical Output, MWe	614	Avg 1st-Cycle Burnup, MWD/MTU	15,200
Total Heat Output for Safety Design, MWt	1865	First Core Avg Burnup, MWD/MTU	25,900
Total Heat Output, Btu/hr	6075×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	2.27
DNBR, Nominal	1.94	Region-2 Enrichment, %	3.03
Total Flow rate, lb/hr	66.3×10^6	Region-3 Enrichment, %	3.40
Eff Flowrate for Heat Trans lb/hr	---	k_{eff}, Cold, No Power, Clean	1.237
Eff Flow Area for Heat Trans, ft^2	27.0	k_{eff}, Hot, Full Power Xe and Sm	1.131
Avg Vel Along Fuel Rods, ft/sec	14.9	Total Rod Worth, % EOL HFP	7.48
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.37×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1671
Nominal Core Inlet Temp, °F	552	Shutdown Boron, No Rods, Clean, Hot, ppm	1615
Avg Rise in Core, °F	69.3	Boron Worth, Hot, % Δk/k/ppm	1/120
Nom Hot Channel Outlet Temp, °F	---	Boron Worth, Cold, % Δk/k/ppm	1/95
Avg Film Coeff, Btu/hr ft^2, °F	---	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.3 \text{ to } -3.5)10^{-4}$
Avg Film Temp Diff, °F	---	Moderator Press Coeff, Δk/k/psi	$(-0.3 \text{ to } +3.5)10^{-6}$
Active Heat Trans Surf Area, ft^2	28,715	Moderator Density Coeff $\Delta k/k/g/cm^3$	-.10 to +.30
Avg Heat Flux, Btu/hr ft^2	206,100	Doppler Coefficient, Δk/k/°F	$(-1.0 \text{ to } 1.6)10^{-5}$
Max Heat Flux Btu/hr ft^2	579,600	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1.0
Avg Thermal Output, kw/ft	6.7	Burnable Poisons, Type and Form	704 Borosilicate glass rods in SST
Max Thermal Output, kw/ft	18.8	Number of Control Rods 29 × 16	464
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 4 × 16	64
No. Coolant Loops	2		

*Applicant has contracted with Westinghouse for a turnkey job. All contractors report to Westinghouse.

Compiled By: Fred Heddleson
Date: March 1971

Reactor: Aguirre

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		Could not find	Design Winds in mph:	
Low Population Zone Dist., Mi.		---	At 0 - 50 ft elev	Designed for 200 mph sustained wind with a 1.3 gust factor in accordance with ASCE Paper 3269.
Metropolis Ponce	Distance 25 mi.	Population 195,000(70)	50 - 150 ft	
Design Basis Earthquake Accel., g		0.2	150 - 400 ft	
Operating Basis Earthquake Accel., G		0.1	Tornado	
Earthquake Vertical Shock, % of Horizontal		66	ΔP = psi/ sec	

Is intent of 70 Design Criteria satisfied? Yes, Appendix I states that plant has been designed and will be constructed and operated in accordance with intent of proposed criteria.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	41.4	Calculated Max Internal Press, psig	46
Max Leak Rate at Design Press, %/day	0.25		

Type of Construction: The shield building is a reinforced-concrete structure of right cylinder configuration with a shallow dome roof. There is a 5-ft annular space between the inside of the 2.5-ft thick shield building and the 1 1/2-in. thick (approx.) containment vessel. Both of these structures will be supported on a concrete foundation founded on sandstone.

Design Basis: Designed to provide protection for the public from the consequences of a LOCA so that containment will withstand the resulting pressure and temperature with no breech of integrity that would allow leakage of radioactivity in excess of AEC regulatory limits. Shield building shall also act as protection for the reactor vessel.

Vacuum Relief Capability: Relief valves and purge system are provided to prevent an excess pressure differential of 0.5 psi from outside to inside. Containment vessel is designed for the 0.5 psi vacuum.

Post-Construction Testing: Soap bubble tests of containment vessel will be run at 5, and 46 psig. Then a pressure test will be run at 52 psig followed by a leakage rate test at 46 psig. Periodic leakage rate tests will be run, since no leakage monitoring system will be installed.

Penetrations: PSAR does not state that penetrations are double sealed and individually testable. Drawings show penetrations as single sealed except for double bellows which can be pressure tested.

Weld Channels: No reference to weld channels found.

Reactor: Aguirre

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Two pumps (rating could not be found) with independent header systems spray borated water from the refueling water storage tank into the containment atmosphere to limit pressure rise, cool the air, and reduce leakage of radioactivity after LOCA.

Containment Cooling: Consists of three subsystems: 1) Recirculation and cooling to limit containment ambient air temp during operation, and to provide cooling after LOCA; 2) Nuclear Detector Well Cooling designed to cool out-of-core neutron detectors and to maintain biological shield concrete below 150 F; 3) Purge System to provide a reduction of radioactivity level following normal full-power operation.

Containment Isolation System: Designed to prevent release of radioactivity from containment through penetrations. So, all penetrations are equipped with isolation valves which operate automatically by the safeguards control system. Valves required to maintain containment integrity are closed, and in event of LOCA, valves required for operation of safeguards are opened.

Containment Air Filtration: Air exhausted from annulus is filtered by particulate filter, HEPA, and charcoal filter. Air exhausted from containment vessel is filtered by HEPA only.

Penetration Room: Electrical penetration rooms at two levels, mechanical penetration room at one level.

Organic-Iodide Filter: None mentioned.

Hydrogen Recombiner: Hydrogen generation discussed in Appendix H. It is expected that hydrogen gas control will be needed, and method used will be determined later.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Two tanks each holding 8650 gallons of borated water dump their contents into the reactor very quickly when coolant system pressure drops below 700 psig. Tanks are pressurized with nitrogen gas to actuate the check valves that close off the dump line.

High-head Safety Injection: Two pumps (PSAR will supply rating later) supply borated water to the coolant system for makeup or small leaks. Pumps take suction from the refueling water storage tank. The boron injection tank located at the discharge of the high-head pumps injects its contents of 12% boric acid into the system also.

Low-head Safety Injection: Two pumps are available as part of the residual heat-removal system, rated at 2500 gpm @ 600 psig. One pump has the capacity to flood the core at low pressure. Suction is taken from the refueling water storage tank. A steam-dump system can help depressurize so the low pressure pumps and accumulators can function.

Reactor: Aguirre

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: The following methods are available to detect leakage during normal operation: 1) Air particulate monitor with a possible sensitivity to 0.013 gpm of leakage; 2) gross beta-gamma monitor which could detect a leak of 2 to 4 gpm; 3) humidity detector; 4) condensate from cooler coils; 5) high-pressure charging pump; 6) sump pumps, and other means.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: Two diesel-generator sets will be provided, either of which can supply minimum safeguards required for DBA. Each of the two units will be housed separately and be an independent system. Engines will be started by compressed air with air capacity for 5 starts. Fuel for 100 hours of full capacity operation of both units will be stored on the site.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid in coolant.

Part-Length Control Rods - Absorber in bottom 3 ft used to shape axial power distribution and to control axial xenon oscillations.

In-Core Instrumentation - Yes, for information on neutron-flux distribution and fuel assembly outlet temperatures.

Unborated Water Control: When adding water to the coolant system, the operator must preselect quantity and concentration. The system is then actuated and operation is then automatic. Preset limits control dilution so excess dilution does not occur.

Long-Term Cooling - Internal or External Systems: Long term cooling can be provided by the low pressure pumps of the Residual Heat Removal System. During the recirculation cooling phase, the Service Water System supplies salt water from the bay to cool the component cooling heat exchangers. Figure 6.4-1 shows a connection between the spray system and the Residual Heat Removal Heat Exchanger.

Reactor: Aguirre

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A 146-ft tower was erected at the site in 1968. Continuous wind records have recorded since then. Temperature measurements will soon be taken. Two seismometers will be installed to measure ground vibration.

Plant Operating Mode: Load following.

Site Features: The plant is located on the southern shore of Puerto Rico on the Bay of Johos. The land here is flat to rolling with much of the area near the water being mangrove swamps. The land rises gradually from the bay or Carribean Sea to a point about 5 miles from the water where hills take shape. The site consists of 317.5 acres with a site grade elevation of 20 (MSL). Most of the land use is for agriculture (sugar cane). In a 2-mi radius from the plant there are 4840 permanent residents and in a 5-mi radius, 28,570. The village of Aguirre is adjacent to the plant property. Population of Central Aguirre is about 1800.

Turbine Orientation: Turbine centerline is ∿182 ft from reactor centerline. Blades ejected from turbine could strike containment. Appendix E discusses this.

Emergency Plans: PSAR outlines emergency plans for radiation release, fire, explosion, hurricane, etc. that establishes authority, responsibilities, and procedures. Medical assistance has been worked out with local medical facilities. Other outside organizations that will cooperate are police and fire departments, health departments and Puerto Rico Nuclear Center.

Environmental Monitoring Plans: Data obtained from the preoperational period will establish natural and other radiation background levels for comparison with data obtained after the plant is placed in operation. Terrestrial and marine stations will be set up for continued monitoring. Territorial stations will include continuous beta, gamma, and air samples, as well as precipitation, soil, and water samples, well water, and bottom sediments. The marine stations will include sampling, environmental measurements and ecological investigations on mollucks or crustacea, sea water, and bottom fish.

Radwaste Treatment: Liquid wastes are collected and processed through the waste evaporator where low-level wastes are monitored for discharge via the condenser circulating water well below 10CFR20 limits. Evaporator residues and other solid wastes are drummed and shipped from the site for ultimate disposal. Gaseous wastes are collected and stored until their radioactivity level is low enough so that discharge to the environment can be made through the station vent on top of the reactor building, below 10CFR20 limits.

Stack Height - Vent from top of reactor building.

Waste Heat System: A once-through system will take water from the Bay of Jobos and discharge back into the bay after passing through the condensers. No information is given in PSAR on quantity of flow, temperature rise, or otherwise. Five 1/4 capacity circulating pumps will be provided.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Aguirre Nuclear Unit 1
THERMAL OUTPUT, MWt 1785	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-376

NEARBY BODY OF WATER Carribean Sea — NORMAL LEVEL 0 (MSL)

MAX PROB FLOOD LEVEL 19.6' (MSL)

SIZE OF SITE 317.5 ACRES — SITE GRADE ELEVATION 20.0' (MSL)

TOPOGRAPHY OF SITE Rolling

OF SURROUNDING AREA (5 MI RAD) Flat to Rolling - Hills begin 5 miles to the N.

TOTAL PERMANENT POPULATION IN 2 MI RAD 4840 (1970) IN 5 MI RAD 28,570 (1970)

NEAREST CITY OF 50,000 POPULATION Guayama

DISTANCE FROM SITE 8 MILES — POPULATION 52,000 (1970)

LAND USE IN 5 MILE RADIUS Agricultural - Sugar cane

CIRCULATING WATER SYSTEM — TYPE OF SYSTEM Once through

WATER TAKEN FROM Bahia De Johos — FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG - F — SUMMER AVG - F — AVG - F

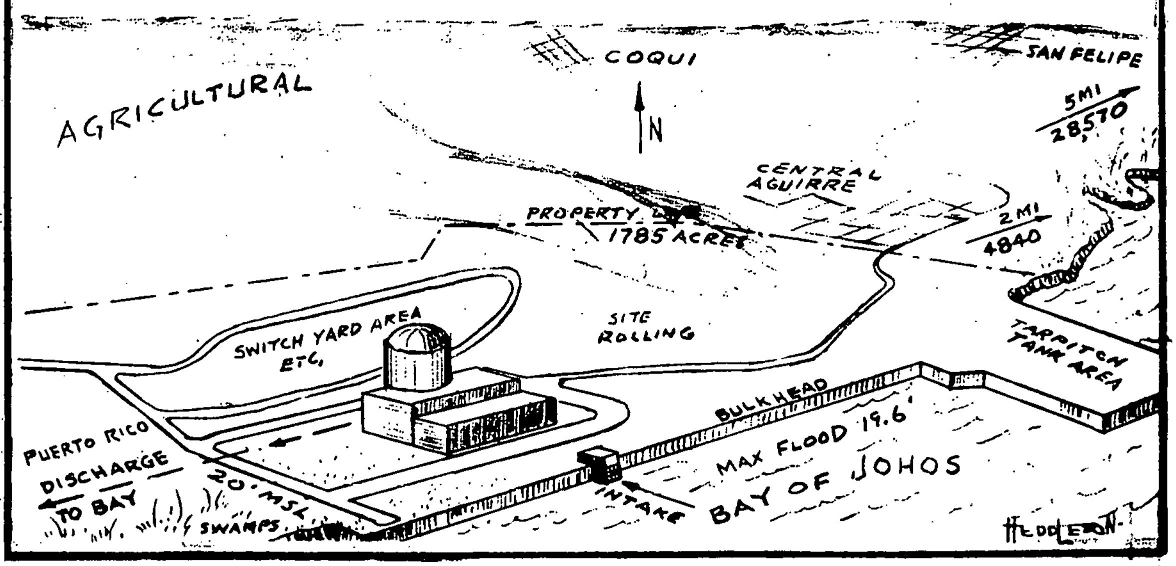
RIVER FLOW NA (cfs) avg. — *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS - (gpm) — TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) — *Per Unit

COOLING TOWERS None

OTHER INFORMATION Five 1/4 capacity pumps are used for circulating water system



WATERFORD, 50-382 & 50-383 (PWR) Page 1

Project Name: Waterford Steam Electric Station
Reactor: Waterford
A-E: Ebasco Services, Inc.
Location: Near Taft, Louisiana *
Vessel Vendor: Combustion Engineering
Owner: Louisiana Light and Power Co.
Docket No.: 50-382, 50-383
NSS Vendor: Combustion Engineering
Containment Constructor: Not Specified

*22 miles west of New Orleans, La.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3390	H_2O/U, Cold	3.35
Electrical Output, MWe	1125	Avg 1st-Cycle Burnup, MWD/MTU	13138
Total Heat Output for Safety Design, MWt	3580	First Core Avg Burnup, MWD/MTU	21700
Total Heat Output, Btu/hr	11.6×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	1.9
DNBR, Nominal	2.11	Region-2 Enrichment, %	2.3
Total Flow rate, lb/hr	147.8×10^6	Region-3 Enrichment, %	2.9
Eff Flowrate for Heat Trans lb/hr	142.6×10^6	k_{eff}, Cold, No Power, Clean	1.29
Eff Flow Area for Heat Trans, ft^2	53.2	k_{eff}, Hot, Full Power Xe and Sm	1.15
Avg Vel Along Fuel Rods, ft/sec	16.8	Total Rod Worth, %	>7.2
Avg Mass Velocity $lb/hr\text{-}ft^2$	2.68×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1400
Nominal Core Inlet Temp, °F	553	Shutdown Boron, No Rods, Clean, Hot, ppm	1600
Avg Rise in Core, °F	60	Boron Worth, Hot, % Δk/k/ppm	-0.13×10^{-3}
Nom Hot Channel Outlet Temp, °F	645	Boron Worth, Cold, % Δk/k/ppm	-0.17×10^{-3}
Avg Film Coeff, Btu/hr ft^2, °F	6160	Full Power Moderator Temp Coeff, Δk/k/°F	0 to -2×10^{-4}
Avg Film Temp Diff, °F	34	Moderator Press Coeff, Δk/k/psi	0 to $+2 \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	55,000	Moderator Void Coeff Δk/k/% Void	0 to -1.6×10^{-3}
Avg Heat Flux, Btu/hr ft^2	205,100	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -1.8) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	549,300	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	6.9	Burnable Poisons, Type and Form	Not Discussed
Max Thermal Output, kw/ft	18.5	Number of Control Rods 61 X 5	305
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 8 X 5	40
No. Coolant Loops	2		

** Units 1 & 2 (at this site) will be coal-fired. These two nuclear units will be designated units 3 & 4

Compiled By: Fred Heddleson
Date: April 1971

Page 2, PWR

Reactor: Waterford

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.		0.57	Design Winds in mph:
Low Population Zone Dist., Mi.		2.0	At 0 - 50 ft elev 200*
Metropolis	Distance	Population	50 - 150 ft * In accordance with ASCE paper 3269
New Orleans, La.	22 mi	665,000 -69	
Design Basis Earthquake Accel., g		0.10	150 - 400 ft
Operating Basis Earthquake Accel., G		0.05	Tornado 300 mph tang. + 60 trans.
Earthquake Vertical Shock, % of Horizontal		67	ΔP = 3 psi/ 3 sec

Is intent of 70 Design Criteria satisfied? Yes, Section 1.7 discusses each criteria item and explains conformance.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	39.6	Calculated Max Internal Press, psig	44
Max Leak Rate at Design Press, %/day	0.5		

Type of Construction: Steel containment vessel surrounded by a reinforced-concrete shield building, cylindrical in shape with hemispherical dome and ellipsodial bottom. A space of about 4 feet will be provided all around between the two vessels.

Design Basis: Designed to contain pressures and temperatures resulting from LOCA accompanied by loss of external power when the largest pipe has a double-ended rupture. Designed based on operation of engineered safety features within 30 seconds after rupture except for accumulators which would function sooner.

Vacuum Relief Capability: Designed for 0.25 psi vacuum using ventilation purge connections for venting. Automatic vacuum relief devices are provided also.

Post-Construction Testing: Pressure tests with soapbubble inspection will be run at 5 and 40 psig. A pressure test at 49.5 psig will then be run. Next, leakage rate tests will be run at 44 psig. Periodic leakage rate tests will be run thereafter. There will be no leakage monitoring system.

Penetrations: Single seals, electrical units are double and testable.

Weld Channels: None mentioned.

Reactor: Waterford

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: Designed to spray borated water downward from upper parts of containment to cool the atmosphere following LOCA. Heat-removal capacity of flow from two pumps (1750 gpm @ 200 psig) will keep pressure and temperature below design limits for the largest size pipe break. This requires a heat-removal capacity of 280 X 10^6 But/hr with steam-air mixture condition of 216 F. System initiated by coincidence of injection signal and high-high containment pressure.

Containment Cooling: Four fan-coil cooling units are provided sized to remove heat generated by the most severe LOCA (234 X 10^6 But/hr). Coils are cooled by water from the component cooling water system (full flow, no modulating valves). Fan circulates 60,000 cfm @ 4" water static pressure using a 175 hp motor. Three units run during normal operation.

Containment Isolation System: To prevent loss of isolation or intolerable leakage, a double barrier minimizes leakage through all fluid penetrations not serving incident consequence limiting systems. High containment pressure initiates isolation, closing isolation valves on penetrations not required for operation of engineered safety feature systems. Also, high radiation signal closes isolation valves on all non-safety feature system lines.

Containment Air Filtration: Two airborn radioactivity removal units handling 10,000 cfm pass air through HEPA filters and impregnated charcoal absorbers. One containment volume can be recirculated every 4 hours.

Penetration Room: There is a penetration area but it is difficult to determine if a penetration room exists.

Organic-Iodide Filter: None mentioned.

Hydrogen Recombiner: Section 14.13 analyzes LOCA and states that metal-water reactions will be less that 1%. Purging will be used to hold hydrogen concentration below 3%. Recombiners not mentioned.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks, each holding 8250gallons of borated water will dump their contentsinto each of the 4 cold legs of the coolant system. This action occurs automatically when reactor pressure drops below 200 psig. Design criteria (limit metal-water reation to less than 1%, and prevent fuel damage) can be met with three of the 4 tanks functioning.

High-head Safety Injection: Three pumps each rated at 380 gpm @ 1950 psig can deliver borated water from the refueling storage tank when the initiation signal of low-low pressurizer pressure or high containment pressure is received. One of the 3 pumps can meet the design criteria mentioned in the paragraph above. The 2 redundant systems operate from individual diesel-generator power if off-site power is lost.

Low-head Safety Injection: Two pumps each rated at 4150 gpm @ 250 psig deliver borated water from the refueling storage tank when the injection signal is received and the system pressure drops sufficiently. These pumps start at the same time high-pressure safety injection pumps start.

Reactor: Waterford

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: Not discussed.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Leaks can be detected by increased temperature or pressure in containment, by monitoring sump-pump operation, increase in airborne activity, by monitoring component cooling water temperatures, pressurizer level and makeup quantities and temperature sensors on safety valves. Excessive leakage detection by any menas will cause plant shut down action.

Failed-Fuel-Detection Systems: A shielded NaI scintillation detector suspended in a pipe-tee well which is located in a sample line tapped off the letdown stream of the coolant system will detect increased activity within 5 minutes. The signal is transmitted to two single-channel spectrometer rate meters in the control room.

Emergency Power: Two independent diesel-generator systems are provided to energize the 4.16 kv buses when off-site power is lost. Each diesel-generator is capable of furnishing required power for efficient shutdown of the plant. Fuel supply for 7 days of full-power operation for one unit will be stored on the site.

Control of Axial Xenon Oscillations:

Burnable Shims - No discussion of this subject found.

Part-Length Control Rods - Eight assemblies of 5 rods each having reduced length neutron absorber used to control power distribution.

In-Core Instrumentation - To provide information on neutron flux distribution.

Unborated Water Control: Because of equipment and controls, and administrative procedures provided, the probability of erroneous boron dilution is very small. Nevertheless, if dilution of boron in the coolant does occur, numerous alarms and indications will alert the operator. The maximum reactivity addition due to the dilution is slow enough to allow the operator to determine the cause and take corrective action before shutdown margin is absorbed.

Long-Term Cooling - Internal or External Systems: Five safety injection pumps are available, and the system may also be aligned to use either containment spray pump to inject cooling water. Both systems are designed for long-term unattended operation. Suction is taken from the containment sump. The containment cooling system will be required only for that time after LOCA which is necessary to reduce containment pressure to near atmospheric.

Reactor: Waterford

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: A tower will be installed to measure wind speed (at top) with 3 levels of temperature measurement and a recording rain gage.

(Seismographs not mentioned)

Plant Operating Mode: Load following.

Site Features: Located on 3600 acres along the Mississippi River about 22 miles west of New Orleans, La. Site grade is +10' MSL; however, a levee (30' MSL top) runs along the river between site and river. Max probable flood is 24'. Site is in an industrial area; however, small villages are very close. Two coal-fired plants will be located on same site. In a 2 mile radius from the plant there are 1685 people, and in 5 miles, 16,095. Back from the river, land is used for farming.

Turbine Orientation: Ejected turbine blades could strike containment shell. Centerlines are about 360 ft apart.

Emergency Plans: A plan will be developed to cover fire, injury, illness, radiation exposure, contamination, and other conditions both nuclear and non-nuclear. Practice drills will be held for familiarization and training. Outside agencies such as Police, Fire Departments, AEC, and other local, state, and federal agencies will be called upon if needed.

Environmental Monitoring Plans: The applicant will conduct an extensive radiological monitoring program. Program divided into 2 parts. One involves continuous monitoring of discharges to the environment for gross and specific radioactivity analysis. This part utilizes in-plant process and area radiation monitoring equipment. The other part involves analyses of environmental samples for radioactivity analyses in the field. Part of this program will be conducted by outside consultants. The programs are interrelated and an attempt will be made to correlate results from one part to the other.

Radwaste Treatment: Will provide means for controlled handling, storage, and disposal of liquid, gaseous, and solid wastes. Radioactive liquids will be treated in ion exchangers and waste concentrators for removal of radioactive materials. Liquid effluent from the Coolant System will first be purified in ion exchangers and then processed in the Boron Management System by filtration, ion exchange, and concentration. All wastes will be released in accordance with 10CFR20. Waste gases will be collected and compressed into gas decay tanks for later release. All solid wastes will be stored in containers for off-site disposal.

Stack Height - Located adjacent to containment and apparently slightly higher.

Waste Heat System: A once through system will be used taking water from the Mississippi and pumping back into the river. River average flow is 493,000 cfs. Total condenser cooling water for the two nuclear units will be nearly 2,000,000 gpm with 16 F temp rise.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Waterford Steam Electric Station
THERMAL OUTPUT, MWt 3390	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-382 50-383

NEARBY BODY OF WATER Mississippi River   NORMAL LEVEL 0 (MSL)
MAX PROB FLOOD LEVEL * 24' (MSL)

SIZE OF SITE 3600 ACRES   * Top of levee is 30' MSL   SITE GRADE ELEVATION 10' (MSL)

TOPOGRAPHY OF SITE Flat

OF SURROUNDING AREA (5 MI RAD) Flat

TOTAL PERMANENT POPULATION IN 2 MI RAD 1685 (1970)   IN 5 MI RAD 16,095 (1970)

NEAREST CITY OF 50,000 POPULATION New Orleans, Louisiana

DISTANCE FROM SITE 22 MILES   POPULATION 665,000 (1969)

LAND USE IN 5 MILE RADIUS Industrial along the river, Agricultural and Residential back from the river

CIRCULATING WATER SYSTEM   TYPE OF SYSTEM Once through

WATER TAKEN FROM Mississippi River   FOR Condenser cooling

WATER BODY TEMPERATURES - WINTER AVG 49 F   SUMMER AVG 82 F   AVG - F

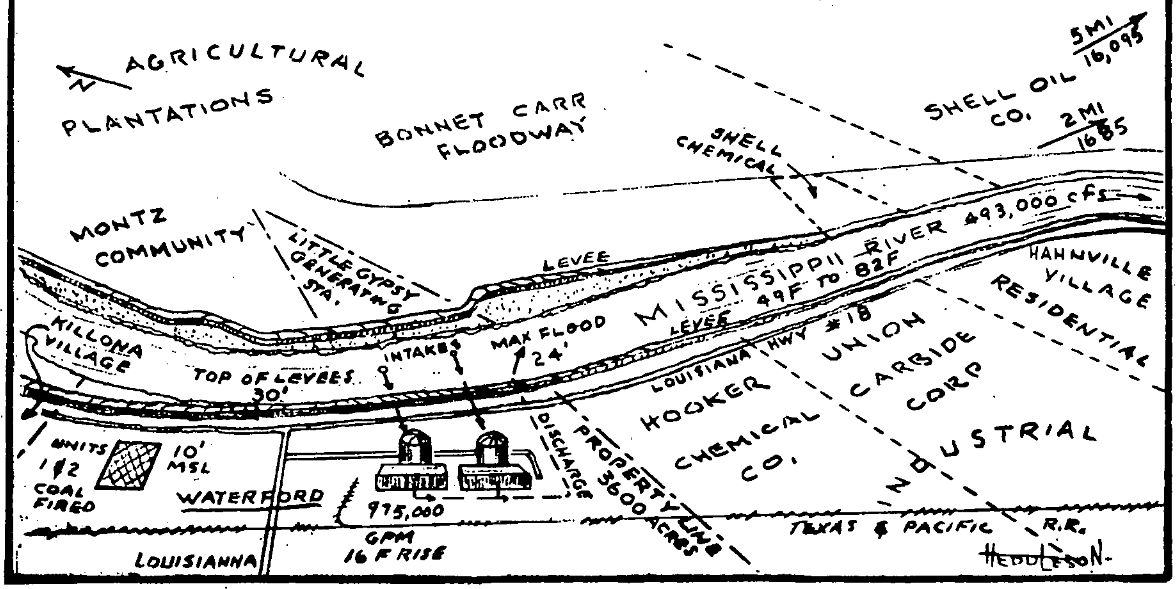
RIVER FLOW 493,000(cfs) avg.   *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS 975,000 (gpm)   TEMPERATURE RISE 16 F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr)   *Per Unit

COOLING TOWERS None

OTHER INFORMATION A two-unit fossil-fuel plant is adjacent to the two nuclear units



SUSQUEHANNA, 50-387 & 50-388 (BWR) — Page 1

Project Name: Susquehanna Steam Electric Station Unit 1 & Unit 2
Location: Luzerne Co., PA
Owner: Pennsylvania Power & Light
NSS Vendor: General Electric

Reactor: Susquehanna
A-E: Bechtel
Vessel Vendor: Not Specified
Docket No.: 50-387, 50-388
Containment Constructor: Bechtel Responsibility

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3293	H_2O/UO_2 Volume Ratio	2.43
Electrical Output, MWe	1140	Moderator Temp Coef Cold, Δk/k/°F	----
Total Heat Output for Safety Design, MWt	3440(14.4.1)	Moderator Temp Coef Hot, No Voids	----
Steam Flow Rate, lb/hr	13.43×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	106.5×10^6	Moderator Void Coef Operating	-1.7×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.18×10^{-5}
Heat Transfer Area, ft^2 (T 3.2.1)	66.1	Doppler Coefficient, Hot, No Voids	-1.15×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.35	Doppler Coefficient, Operating	-1.19×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	425,060	Initial Enrichment, %	2.19
Average Heat Flux, Btu/hr-ft^2	163,230	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4430	Core Average Void Within Assembly, %	79
Average Fuel Rod Surface Temp °F	560	k_{eff}, All Rods In	----
MCHFR	≥1.9	k_{eff}, Max Rod Out	<0.99
Total Peaking Factor	2.6	Control Rod Worth, % max rod	0.01Δk
Avg Power Density, Kw/ℓ	50.8	Curtain Worth, %	----
		Burnable Poisons, Type and Form	372 curtains Boron SST Sheets
		Number of Control Rods	185 movable cruciform assm.
		Number of Part-Length Rods (PLR)	None mentioned

Compiled by: Fred Heddleson
Date: June 1971

TX-4377
(8-70)

Reactor: Susquehanna

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.28	Design Winds in psf:	
Low Population Zone Dist., Mi.	3.0	At 0 - 50 ft 20	80 mph
Metropolis / Distance / Population Wilkes-Barre / 16 / 57,946 (-70)		50 - 150 ft 30	Sustained
Design Basis Earthquake Accel., g	0.10	150 - 400 ft 40	
Operating Basis Earthquake Accel., g	0.05	Tornado 300 mph ΔP = 3 psi/ - sec	
Earthquake Vertical Shock, % of Horizontal	67	Is intent of 70 design criteria Satisfied? Yes, See Section F	

Peak Fuel Enthalpy on Rod Drop: A rod drop at 5 ft/sec (design rate of velocity limiter) could result in a value of 280 cal/gm.

Recirculation Pumping System & MCHER: Adjusting pump speed changes coolant flow rate through the core. This effects changes in core power level, etc.

Protective System: Initiates a rapid, automatic shutdown of reactor following abnormal operational transients. This system overrides operator action and process controls.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT (Ctmt)

Drywell Design Press, psig	48	Prim Ctmt Leak Rate, %/day	0.05
Supprn Chamb Design Press, psig	48	Second Ctmt Design Press, psig	0.25
Calc Max Internal Press, psig	37.9	Second Ctmt Leak Rate, %/day	100

Type of Construction: Drywell is shaped like a truncated cone, with the cylindrical pressure suppression chamber just below. These 2 units form a structurally integrated reinforced concrete pressure vessel, lined with welded steel plate. The drywell and suppression chamber are separated by a reinforced concrete floor.

Design Basis: Designed to contain and suppress steam and steam pressure in event of LOCA, and to limit the release to the public of fission products associated with the accident. In addition to LOCA, the containment structure shall have the capability to withstand extreme environmental conditions such as earthquake without loss of integrity.

Vacuum Relief Capability: Drywell and pressure suppression designed for 5 psi external pressure. Drywell is vented thru ventilation purge connections which are normally closed at temp. above 212 F. Suppression chamber is vented separately.

Post-Construction Testing: Structurally tested at 1.15 times the design pressure. Pressure is then reduced to 37.9 and measurements taken to verify that leakage rate of 0.5 percent by volume in 24 hrs. is not exceeded.

Penetrations: Electrical penetrations are double-sealed with provision for individually testing. All other penetrations are single barrier type.

Reactor: Susquehanna

D2. EMERGENCY CORE COOLING SYSTEMS

Core Spray Cooling System: Consists of 2 independent pump loops that deliver cooling water to spray spargers over the core. This system cools the fuel by spraying water onto core. Four 1/2 capacity pumps each rated 3125 gpm @ 122 psid take suction from suppression pool. One pump loop is capable of preventing excessive fuel clad temperatures. This system operates only after reactor pressure is reduced

Auto-Depressurization System: Acts to rapidly reduce reactor vessel pressure after LOCA when HPCIS fails to automatically maintain reactor vessel water level. Depressurization enables the low pressure cooling systems to begin operation. Steam is vented through pressure relief valves.

Residual-Heat-Removal System (RHRS): Consists of pumps, heat exchangers, and piping for the following functions: a) Removal of decay heat during and after plant shutdown, b) Low pressure coolant injection function as described below, and c) Heat removal from containment following LOCA by pumping water from suppression pool through heat exchanger and back to pool to prevent excessive temperature rise in suppression pool. Also, water is sprayed into containment to reduce the pressure. There are four pumps each rated 10,000 gpm @ 250 psig, two heat exchangers with 41.6 X 10^6 Btu/hr capacity, and the necessary piping, controls, etc.

High-Pressure Coolant-Injection System: Maintains coolant inside reactor vessel to prevent fuel clad damage resulting from small breakes in coolant piping. One steam-turbine driven pump can deliver 5000 gpm at pressures of 150 to 1120 psid. This system operates for small leaks at high pressures so other systems will not have to start. Suction is taken from the condensate storage tank.

Low-Pressure Coolant-Injection System: Four 1/3 cap pumps from the Residual Heat Removal System supply 10,000 gpm @ 20 psid for each pump running, taking suction from the suppression pool. System starts when pressure in reactor drops sufficiently low for pump operation. LPCI operation, together with core shroud and jet pump arrangement provides capability of core reflooding following LOCA in time to prevent excessive fuel clad damage.

E. OTHER SAFETY-RELATED FEATURES

Standby Coolant System: A cross-tie from piping on the discharge of RHR service water pumps to the discharge piping on the shell side of 1 RHRS heat exchanger provides water if post-accident flooding of containment is required. This provides a large source of water for emergency conditions.

Main-Steam-Line Flow Restrictors: A venturi-type flow restrictor installed in each steam line close to reactor to limit loss of coolant in case of line break, and before the isolation valve can close. Flow is limited to 200 percent of normal rated flow.

Control-Rod Velocity Limiters: Limits velocity at which a rod can fall out of the core. It is a part of the bottom assembly consisting of two nearly mated conical elements acting as large clearance piston and baffle inside control rod guide tube. Velocity of rod for scram is not effected.

Control-Rod-Drive-Housing Supports: Located under reactor vessel near control rod housings. Supports limit travel of a control rod if housing ruptures thus preventing nuclear excursion. Max travel in hot operating condition would be 1/4 inch plus spring compression of about 1 inch.

Standby Liquid-Control System: A boron neutron absorber in the coolant provides a redundant, independent, and different way from control rods to shut down reactor. The system makes possible an orderly and safe shutdown in the event that not enough control rods can be inserted.

Reactor: Susquehanna

E. OTHER SAFETY-RELATED FEATURES (cont'd)

Containment Atmospheric Control System: A recirculation system can circulate the reactor building air at a rate equal to one building volume per hour. A small fraction of the volume can be exhausted and filtered. No mention is made of nitrogen inerting.

Reactor Core Isolation Cooling System (RCICS): Provides makeup water to the core during a reactor shutdown in which feedwater flow is not available. The system may be started manually by the operator or automatically upon receipt of a low reactor water level signal. Water is pumped to the core by a turbine-pump driven by reactor steam. Pump suction is taken from the condensate storage tank, or from the suppression pool. Turbine steam exhaust dumps to suppression pool. One pump is provided, rated at 600 gpm @ 1500 psig.

Reactor Vessel Failure:

Missile & Reactor Forces - Two references emphasize the low probability of pressure vessel failure. (Sect. 4.2.5 and 4.2.7.2)

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Detection is based on changes in normal operating conditions, such as increase in containment temperature and pressure, and abnormal sump-pump operation. Leakage limits are less than the capacity of sump pumps and less than the amount of water that can be placed back into the system.

Failed-Fuel Detection Systems: Consists of four gamma radiation monitors located external to main steam lines just outside primary containment. Monitors are designed to detect a gross release of fission products from the fuel. Upon detection of high radiation, an alarm signal is initiated and trip signals generated by the monitors are used to initiate a scram and to isolate the radioactive material released.

Emergency Power: Four units each rated 2950 KW for 2000 hrs. Start and application of loads are automatic, units requiring 10 sec to attain rated voltage and frequency. Units are housed independently in Class I structures with independent buses. Each unit has a 2 1/2 hour capacity day tank and a storage tank for 7 days operation at rated load. Two air reservoirs for starting are provided, each with air for 5 starts.

Rod-Block Monitor: Effective in preventing improper rod withdrawal. If a rod-block signal is received during withdrawal, the control rod is automatically stopped at the next notch position, even if continuous rod withdrawal is in process.

Rod Worth Minimizer: Functions to prevent improper rod withdrawal under low power conditions, thus limiting reactivity worth of control rods by enforcing adherence to preplanned rod pattern. This system operates as a function of the process computer.

Reactor: Susquehanna

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Tower for meteorological measurements was erected in July 1970 on a 45' high pole at 1200' elev. about 2 miles SE of site. Two other towers will be put up at the site. Seismographs not mentioned.

Plant Operating Mode: Load Following

Site Features: Located on the west side of the Susquehanna River about 16 miles SW of Wilkes-Barre. The site is rolling with hills around except for the flat river valley. The center of the site is almost one mile from the river. Site grade is 670' MSL which is about 150 ft. above the river flood plain. The surrounding area is wooded and about half is used for agriculture. In a 2-mile radius there are 1126 inhabitants, and in a 5-mile radius there are about 11,000. There are no major airports within 25 or more miles of the site, Average river flow at site is 13,000 cfs.

Turbine Orientation: Turbine center line precludes any possibility of ejected blades striking containment structure.

Emergency Plans: Formulated with appropriate public agencies so that problems which may arise during any emergency involving personnel, on or off-site, can be handled in an orderly, effective manner. These procedures will be written to include the services of the State Police, the local fire department, a local hospital, and other public agencies.

Environmental Monitoring Plans: Prior to operation, a study will be initiated to obtain background data on the amount, type and source of radiation in the site vacinity. The program will be started on a small scale at least 2 years before operation, and implemented as experience is gained. For all samples, a gross beta, and in most cases a gross alpha, count will be determined. Samples will be collected for airborne particulates, rainfall, surface water in rivers, creeks, and lakes which are nearby, well water, bottom sediments, slime, soil, vegetation, milk, and fish and animals. The entire program will be evaluated before operation begins to determine the best program plan to follow thereafter.

Radwaste Treatment: Designed to confine release of radioactive materials well within the limits of 10CFR20. Liquid wastes will be collected, treated, evaporated, and stored for off-site disposal or released to the environment. Only low level wastes from laundry room or equipment drains will be released. Solid wastes are collected and stored for shipment to off-site disposal. Collected solids will be dewatered, packaged and stored in suitable containers before shipment. Gaseous wastes will be discharged to the reactor vent. The system provides hydrogen-oxygen recombination, filtrations, and holdup of gases for decay before release.

Stack Height - No reference found.

Waste Heat System: A closed loop is used for condenser cooling having one hyperbolic cooling tower per unit. Evaporation loss is 13,000 gpm per unit. No figures were given for flow rate and temperature rise thru condensers. The condenser heat removal rate is 7900 X 10^6 Btu/hr.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Susquehanna Steam Electric Station

THERMAL OUTPUT, MWt 3293

TYPE OF NUCLEAR STEAM SYSTEM BWR

DOCKET NO. 50-387 50-388

NEARBY BODY OF WATER Susquehanna River

NORMAL LEVEL 491' (MSL)

MAX PROB FLOOD LEVEL 546' (MSL)

SIZE OF SITE 1522 ACRES

SITE GRADE ELEVATION 670' (MSL)

TOPOGRAPHY OF SITE Rolling

OF SURROUNDING AREA (5 MI RAD) Hilly with flat river valley

TOTAL PERMANENT POPULATION IN 2 MI RAD 1126 (1970) IN 5 MI RAD 11,044 (1970)

NEAREST CITY OF 50,000 POPULATION Wilkes-Barre, Pa.

DISTANCE FROM SITE 16 MILES POPULATION 57,946 (1970)

LAND USE IN 5 MILE RADIUS Wooded and Agricultural

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed loop uning cooling towers

WATER TAKEN FROM Susquehanna River FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG - F SUMMER AVG - F AVG - F

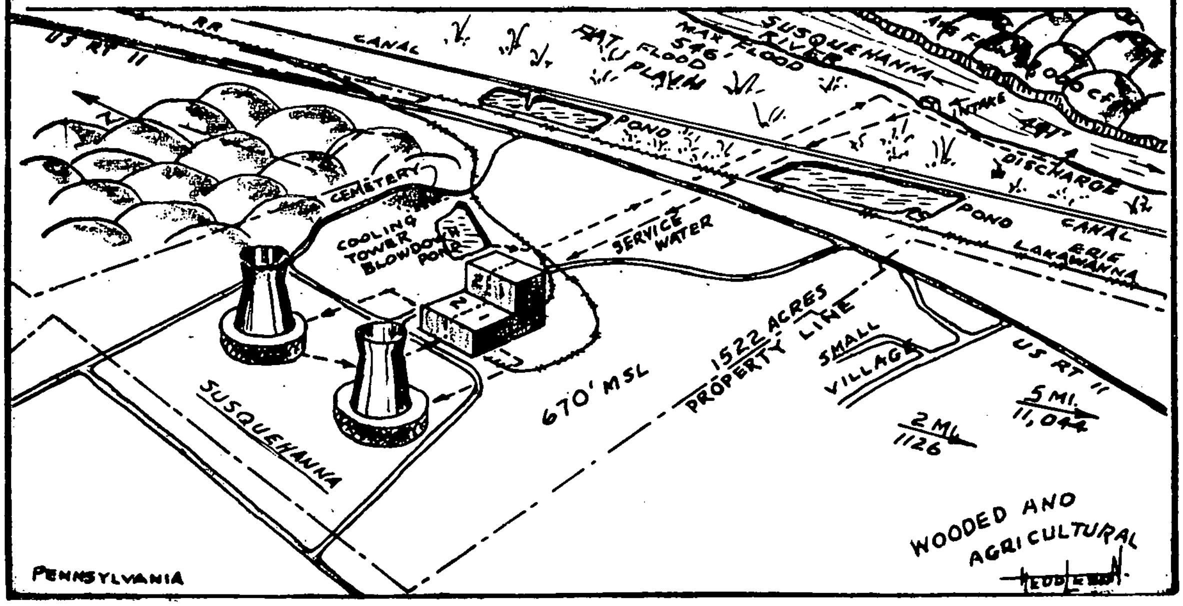
RIVER FLOW 13,000 (cfs) Avg. *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS - (gpm) TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS 7900×10^6 (Btu/hr) *Per Unit

COOLING TOWERS One hyperbolic tower for each unit. Evaporation loss about

OTHER INFORMATION 13,000 gpm per unit. River flood plain 150' lower than site.



WATTS BAR, 50-390 & 50-391 (PWR) — Page 1

Project Name: Watts Bar Nuclear Plant, Units 1 & 2
Location: Rhea County, Tenn.*
Owner: TVA
NSS Vendor: Westinghouse
*45 miles NE of Chattanooga

Reactor: Watts Bar
A-E: TVA
Vessel Vendor: Westinghouse
Docket No.: 50-390, 50-391
Containment Constructor: TVA

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3411	H_2O/U, Cold	3.48
Electrical Output, MWe	1180	Avg 1st-Cycle Burnup, MWD/MTU	14,000
Total Heat Output for Safety Design, MWt	3582	First Core Avg Burnup, MWD/MTU	25,500
Total Heat Output, Btu/hr	$11{,}640 \times 10^6$	Maximum Burnup, MWD/MTU (Equilib)	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	2.03
DNBR, Nominal	1.88	Region-2 Enrichment, %	2.63
Total Flow rate, lb/hr	138.4×10^6	Region-3 Enrichment, %	3.23
Eff Flowrate for Heat Trans lb/hr	132.2×10^6	k_{eff}, Cold, No Power, Clean	1.225
Eff Flow Area for Heat Trans, ft^2	51.4	k_{eff}, Hot, Full Power Xe and Sm	1.148
Avg Vel Along Fuel Rods, ft/sec	16.3	Total Rod Worth, %	9 3/4 BOL
Avg Mass Velocity lb/hr-ft^2	2.58×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	<1500
Nominal Core Inlet Temp, °F	557.5	Shutdown Boron, No Rods, Clean, Hot, ppm	<1100
Avg Rise in Core, °F	63.7	Boron Worth, Hot, % Δk/k/ppm	1/100
Nom Hot Channel Outlet Temp, °F	648	Boron Worth, Cold, % Δk/k/ppm	1/85
Avg Film Coeff, Btu/hr ft^2, °F	6000	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.04 \text{ to } -3.0) \times 10^{-4}$
Avg Film Temp Diff, °F	36.2	Moderator Press Coeff, Δk/k/psi	$(-0.4 \text{ to } +3.0) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff Δk/k/% Void	$(+0.5 \text{ to } -2.5) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	217,200	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -2) \times 10^{-5}$
Max Heat Flux Btu/hr ft^2	579,600	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	7	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Thermal Output, kw/ft	18.8	Number of Control Rods 20×53	1060
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 20×8	160
No. Coolant Loops	4		

Compiled By: Fred Heddleson
Date: June 1971

Reactor: Watts Bar

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	0.50	Design Winds in mph:	
Low Population Zone Dist., Mi. 3		At 0 - 50 ft elev	95
Metropolis / Chattanooga	Distance 45 / Population 154,910('70)	50 - 150 ft	110
Design Basis Earthquake Accel., g	0.18	150 - 400 ft	130
Operating Basis Earthquake Accel., G	0.09	Tornado	300 mph tang. + 60 trans.
Earthquake Vertical Shock, % of Horizontal	67	ΔP =	3 psi/ 3 sec

Is intent of 70 Design Criteria satisfied? Yes, Appendix D states that "plant will be designed, constructed and operated so as to comply with TVA's understanding of the intent..."

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	13.5	Calculated Max Internal Press, psig	9.8
Max Leak Rate at Design Press, %/day	0.5		

Type of Construction: Consists of a freestanding steel containment vessel with compartments for an ice condenser and a separate reinforced concrete shield building. The containment vessel has cylindrical walls, a hemispherical dome, and a bottom liner encased in concrete. The concrete shielding building (separated from the steel plate vessel by a 5' annular space) serves as a biological shield, protection for the inner vessel, and a collection space for fission products.

Design Basis: Designed to limit radiation doses resulting from leakage of radioactive fission products as a result of LOCA including a margin to cover the effects of metal-water reactions or other undefined energy sources.

Vacuum Relief Capability: Containment vessel designed for 0.5 psig with a vacuum relief system for venting.

Post-Construction Testing: Vessel will be pressure tested at 16.9 psig after soap bubble tests at 5 and 12 psig. Leakage rate test will be done at 12 psig for 24 hours. Periodic leakage rate tests will be done after operation starts.

Penetrations: Electrical penetrations are double sealed and testable. Hot penetrations are double sealed and testable. All other penetrations are single barrier.

Weld Channels: Channels will be welded over seams in the bottom liner plate and tested before application of concrete.

Reactor: Watts Bar

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: There are two systems of spray headers for the upper compartment. Each system has two pumps, each rated 3500 gpm @ 300 psig. The spray system is designed to keep the containment pressure below 15 psig, the design pressure, even having metal-water reaction of 33% of the fuel. Two out of 4 high containment pressure signals initiate the system.

Containment Cooling: Compartments are held at different max temperatures, ranging from 110F to 135F. Min temp is 60F. Recirculating fan-coil units are used for cooling. Each unit has filters for air cleanup, including charcoal filters.

Containment Isolation System: Provides means for isolating various pipes passing through containment walls to prevent release of radioactivity to the outside environment in case of LOCA. Each containment penetration not required to function following LOCA has two automatic isolation valve barriers, one located outside containment and one inside.

Containment Air Filtration: Emergency Gas Treatment system filters air vented from containment after an accident. Air passes through a particulate filter, HEPA, and then clean, new charcoal filters.

Penetration Room: Sketches on plant layout do not show penetration rooms labeled as such.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Section 14-1.8 discusses hydrogen generation, but no description is given on how the generated gas is handled.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Passive protection is provided by 4 tanks pressurized with Nitrogen which rapidly discharge their borated water (6350 gallon each) to the coolant system whenever system pressure drops below accumulator pressure of 600 psig. Design capacity is based on assumption that flow from one accumulator spills onto the floor through a ruptured loop and that flow from the other 3 cover the core to one-half the height.

High-head Safety Injection: Two charging pumps operate first each with capacity of 150 gpm at 2800 psig. When pressure drops to 1750 psig, 2 safety injection pumps start. They have capacity of 400 gpm each. These pumps can supply water lost by small breaks. Concentrated boric acid is first injected by the charging pumps. Then suction is taken from the refueling water storage tank.

Low-head Safety Injection: Two pumps of the Residual Heat Removal System start operating at 600 psig and deliver 3000 gpm each from the refueling water storage tank. Core cooling systems are designed to flood the core to prevent or limit excessive damaging fuel temperatures, and limit metal-water reaction to 1%.

Reactor: Watts Bar

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: All analyses performed indicate no possibilities for vessel failure.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: The following methods are used to detect leakage from the coolant system: Air particulate monitor which measures gamma activity of matter, Radioactive gas monitor which measures gaseous gamma activity, Humidity detector, Condensate measurement as collected on cooling coils, Component cooling loop liquid monitor, Charging pump operation, Sump pump operation, and containment sump liquid level.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: Consists of four 6900-volt, 3-phase, 60-cycle diesel generators with a nominal 2000-hr rating of 3800 kw each. The four generator sets are physically separated, electrically isolated from each other, and located above max possible flood. If one of the units fails to start or take load, the remaining 3 units provide ample power to operate the necessary essential auxiliaries for one reactor unit under LOCA conditions and the other reactor unit in the shutdown mode. Each diesel generator supplies power to an independent shutdown board. Two of these boards serve one reactor and the other two boards serve the other reactor.

Control of Axial Xenon Oscillations:

Burnable Shims - Boron chemical-shim dilutes coolant.

Part-Length Control Rods - There are 8 assemblies which are movable.

In-Core Instrumentation - There are thermocouples and fission chamber detectors which measure neutron flux distribution.

Unborated Water Control: For dilution during refueling and startup, there is ample time of 1 hr for operator to see the high count rate signal and manually terminate dilution flow. With reactor in automatic control at full power, the power and temp increase from boron dilution results in insertion of the RCC assemblies and a decrease in the shutdown margin. Rod insertion limit alarms provide operator with 15 min time to determine the cause of dilution, isolate the water source, and initiate reboration. Also, there is ample time of 15 min, in manual control to correct dilution of the coolant.

Long-Term Cooling - Internal or External Systems: Water spilled from a ruptured coolant loop and containment spray and ice condenser drainage are collected, cooled and recirculated through the core. This water is delivered by low head pumps to the reactor when pressure is low. If pressure remains high, recirculated water is delivered to the reactor by high head pumps taking their suction from the discharge of the low head pumps.

Reactor: Watts Bar

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Meteorological data collections at site will be started 3.5 yr before operation (late 1972). Strong motion earthquake recording instrumentation will be installed, one on the base slab, and one on the ground remote from the main structure.

Plant Operating Mode: Load following.

Site Features: Located on the west bank of Chickamauga Lake about 1 mile below Watts Bar Dam. The site is gently rolling and wooded. The surrounding area is rolling to hilly about 65% wooded and 25% agricultural land. In a 2-mi radius, permanent population is 210 with a possible influx of 1825 recreational people. Within a 5-mi radius there are 1805 permanent residents. Site grade is 728'. Lake normal pool is 683. Max probable flood height is 745', which assumes collapse of Watts Bar Dam in addition to other contributing factors.

Turbine Orientation: Ejected turbine blades cannot strike containment structure.

Emergency Plans: Emergency manual contains precautionary planning, delegation of authority and responsibility, and plans of action to protect the public, plant employees, and equipment in case of unusual incidents. Manual will contain plans to control general emergencies such as fire, air raid, personnel injury and unlikely events which could result in release of significant amounts of radioactivity to the public. Outside agencies can be called on for assistance.

Environmental Monitoring Plans: A program will begin 2 years before startup and will continue through startup and operation. The program as outlined herein is subject to change based on evaluation of similar programs at Browns Ferry and Sequoyah nuclear plants. The program will be coordinated closely with other agencies' programs such as the nationwide fallout sampling and water quality networks and the radiological health program of the State of Tenn. The program will include measurements of gamma radiation and sampling of airborne radioactivity, fallout particulate matter, rainfall, surface water, well and public water supplies, soil, vegetation, milk, fish, clams, bottom sediment, plankton, and river water.

Radwaste Treatment: Facilities are designed so discharge of effluents and off-site shipments are in accordance with 10CFR20, 10CFR71, and 10CFR100. Radioactive gases are pumped by compressors to a gas decay tank where they are held for decay. Cover gases of nitrogen for blanketing are reused to minimize gaseous wastes. During normal operation, gases are discharged at a controlled rate through the monitored plant vent. Liquid wastes are processed to remove most radioactive materials. Spent resins, filter cartridges and concentrates from evaporators are packaged for off-site disposal, as are all other solid wastes.

Stack Height - Plant vent is on top of containment structure about 150' above grade

Waste Heat System: Two hyperbolic cooling towers will be provided for a closed loop system. Makeup for blowdown and evaporation will be supplied from the Raw Cooling Water System, which takes its' water from the lake. All liquids released back to the lake go through the 20 acre discharge holding pool. No data on flows are available.

G. CIRCULATING WATER SYSTEM & SITE FEATURES

REACTOR NAME Watts Bar Nuclear Plant

THERMAL OUTPUT, MWt 3411

TYPE OF NUCLEAR STEAM SYSTEM PWR

DOCKET NO. 50-390 50-391

NEARBY BODY OF WATER Chickamauga Lake

NORMAL LEVEL 683' (MSL)

MAX PROB FLOOD LEVEL 745' (MSL)

SIZE OF SITE 1770 ACRES

SITE GRADE ELEVATION 728' (MSL)

TOPOGRAPHY OF SITE Flat to Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling to Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 210* (1970) IN 5 MI RAD 1805 (1970)

NEAREST CITY OF 50,000 POPULATION Chattanooga, Tenn

IS DISTANCE FROM SITE 45 MILES POPULATION 154,910 (1970)

*Peak summer attendance 1825

LAND USE IN 5 MILE RADIUS Wooded - 65%, and Agricultural - 25%

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Closed loop with cooling towers

WATER TAKEN FROM Chickamauga Lake FOR Makeup

WATER BODY TEMPERATURES - WINTER AVG 43 F min SUMMER AVG 82 F max AVG - F

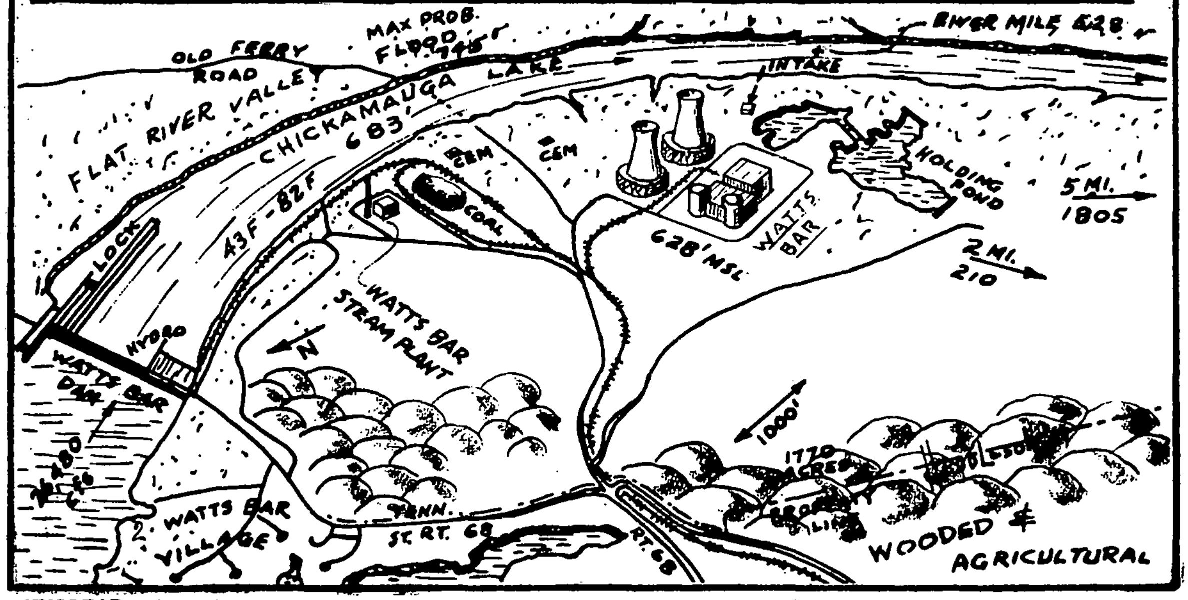
RIVER FLOW 26,480 (cfs) avg *QUANTITY OF MAKEUP WATER - (gpm)

*TOTAL FLOW THROUGH CONDENSERS - (gpm) TEMPERATURE RISE - F

*HEAT REMOVAL CAPACITY OF CONDENSERS - (Btu/hr) *Per Unit

COOLING TOWERS Two hyperbolic towers for the two reactor units

OTHER INFORMATION Tower blowdown and radwaste released to a 20 acre holding pond and released from there to Chickamauga Lake. Watts Bar Dam is close-by.



SUMMER, 50-395 (PWR) Page 1

Project Name: Virgil C. Summer Nuclear Station Unit 1
Location: Fairfield Co., S.C.*
Owner: South Carolina Elec. & Gas Co.
NSS Vendor: Westinghouse
*Site is 26 mi N of Columbia, S.C.

Reactor: Summer
A-E: Gilbert Associates
Vessel Vendor: Not specified
Docket No.: 50-395
Containment Constructor: Not specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2785	H_2O/U, Cold	4.18
Electrical Output, MWe	900	Avg 1st-Cycle Burnup, MWD/MTU	13,700
Total Heat Output for Safety Design, MWt	2914	First Core Avg Burnup, MWD/MTU	23,000
Total Heat Output, Btu/hr	9471×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	2.0
DNBR, Nominal	2.12	Region-2 Enrichment, %	2.7
Total Flow rate, lb/hr	105.4×10^6	Region-3 Enrichment, %	3.35
Eff Flowrate for Heat Trans lb/hr	---	k_{eff}, Cold, No Power, Clean	1.179
Eff Flow Area for Heat Trans, ft^2	41.8	k_{eff}, Hot, Full Power Xe and Sm	1.081
Avg Vel Along Fuel Rods, ft/sec	15.3	Total Rod Worth, %	7
Avg Mass Velocity lb/hr-ft^2	2.41×10^6	Shutdown Boron, No Rods, Clean, Cold, ppm	1360
Nominal Core Inlet Temp, °F	554.5	Shutdown Boron, No Rods, Clean, Hot, ppm	1330
Avg Rise in Core, °F	68	Boron Worth, Hot, Δk/k	8.0
Nom Hot Channel Outlet Temp, °F	---	Boron Worth, Cold, Δk/k	6.0
Avg Film Coeff, Btu/hr ft^2, °F	---	Full Power Moderator Temp Coeff, Δk/k/°F	(+.3 to -4.0) $\times 10^{-4}$
Avg Film Temp Diff, °F	---	Moderator Press Coeff, Δk/k/psi	(-0.3 to +4.0) $\times 10^{-6}$
Active Heat Trans Surf Area, ft^2	42,460	Moderator Dens Coeff cm^3/gpm	-0.1 to +0.3
Avg Heat Flux, Btu/hr ft^2	217,300	Doppler Coefficient, Δk/k/°F	(-1.0 to -1.6) $\times 10^{-5}$
Max Heat Flux Btu/hr ft^2	580,000	Shutdown Margin, Hot One Rod Stuck, % Δk/k	1
Avg Thermal Output, kw/ft	7.0	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Thermal Output, kw/ft	18.8	Number of Control Rods 48×20	960
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 5×20	100
No. Coolant Loops	3		

Compiled By: Fred Heddleson
Date: July 1971

Reactor: Summer

C. SAFETY-RELATED DESIGN CRITERIA

Exclusion Distance, Mi.	1 rad.	**Design Winds in mph:**
Low Population Zone Dist., Mi.	3	At 0 - 50 ft elev 100
Metropolis / Distance / Population: Columbia, S.C. / 26 mi / 113,542 ('70)		50 - 150 ft
Design Basis Earthquake Accel., g	0.12	150 - 400 ft
Operating Basis Earthquake Accel., G	0.10	Tornado 300 mph tang + 60 trans
Earthquake Vertical Shock, % of Horizontal	67	ΔP = 3 psi/ ---sec

Is intent of 70 Design Criteria satisfied? Yes, Section 1.5 states that "...station has been designed to comply with the S.C. Elec. & Gas Co. understanding of the intent of the .... criteria."

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Press, psig	55	Calculated Max Internal Press, psig	51 w/max. Zr-water reaction
Max Leak Rate at Design Press, %/day	0.2		

Type of Construction: Reinforced concrete structure with a 4' cylindrical wall, a flat foundation mat, and a 3' shallow dome roof. Foundation slab and the cylindrical wall is reinforced with conventional mild-steel reinforcing, the wall prestressed with a post-tensioning system in the vertical and horizontal directions. Dome roof is prestressed with a three-way post-tensioning system. The inside surface is lined with 1/4" thk carbon steel.

Design Basis: Designed to contain radioactive material released from the core following a LOCA. The concrete shell ensures that the structure has linear response to all loads, and that the structure strains within such limits so that integrity of the liner is not lost. Design LOCA is based on double-ended rupture of the largest coolant pipe.

Vacuum Relief Capability: Designed for 2.5 psig external pressure.

Post-Construction Testing: Containment will be pressure tested at levels of 30, 55, and 63.3 psig. Leak-rate test will be run at 55 psig and about half of that. Post-operational leakage rate tests will be run periodically.

Penetrations: All are double-barrier sealed and individually testable.

Weld Channels: Test channels will cover seam welds on the base, pits, and weld seam between liner and penetration. Some other critical areas will use test channels.

Reactor: Summer

D2. CONTAINMENT SAFETY FEATURES

Containment Spray System: In the event of a major LOCA the system sprays an alkaline solution into containment to reduce post-accident energy and to remove fission product iodine. The system consists of two pumps (2500 gpm @ 200 psig each), two spray headers, piping, valves, etc. System is sized to furnish 100% design cooling capacity with both spray paths in operation; however, both paths operate independently.

Containment Cooling: System designed to limit temp in containment to a max of 120F during normal operation. There are 3 units, each with 2 fans, cooling coils, roughing filters, etc. Each unit is rated for 1/2 of emergency cooling load. Two of the 3 units are connected for emergency diesel power operation.

Containment Isolation System: Isolation occurs on signals from ESF actuation system; closes fluid penetrations not required for operation of ESF to prevent leakage of radioactive materials to the environment. Fluid penetrations serving ESF have valves which may be closed from the control room. Remotely operated reactor building isolation valves are provided with control devices and position limit indicators in the control room.

Containment Air Filtration: Reactor building air is recirculated through a charcoal filter cleaning system consisting of fan, roughing filters, HEPA filters and charcoal filters. Purge exhaust has roughing and HEPA filters.

Penetration Room: There is a penetration area shown on the mezzanine plan.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Recombiner not mentioned. Table 14.6 shows hydrogen generated by Zr-water reaction as 6162 SCF and will be complete in one day. Analysis in Section 14 assumes H_2 burns as it is generated.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Three tanks each containing 7000 gallons of borated water are pressurized to 650 psig with nitrogen gas. When pressure in the coolant system drops below the accumulator pressure, 2 check valves in series open and borated water from each of the tanks is injected into the 3 cold legs of the reactor.

High-head Safety Injection: Three charging pumps (150 gpm @ 2750 psig each) inject concentrated boric acid and borated water from the refueling water storage tank when the injection signal is received. These pumps can supply coolant lost from a small leak. Pumps deliver water to the 3 hot legs and 3 cold legs through separate headers.

Low-head Safety Injection: Large breaks which rapidly depressurize the system cause the accumulators to function at about 600 psig. The low head pumps then start operation, taking suction from the refueling water storage tank and pump borated water into the reactor. Two pumps of the residual heat removal system serve this function. They are rated 3750 gpm @ 600 psig.

Reactor: Summer

E. OTHER SAFETY-RELATED FEATURES

Reactor Vessel Failure: No reference found.

Missile & Reactor Forces -

Core Cooling Capability -

Containment Floodability -

Reactor-Coolant Leak-Detection Systems: Means shall be provided to detect significant uncontrolled leakage. Positive indications in the control room alert the operator of leakage. Separate systems provide leakage data from the following: a) reactor head to vessel closure joint, and b) in-core instrumentation seal table. Gross leaks might be detected by increases in coolant makeup water required to maintain normal pressurizer level. This is a low precision measurement. Positive indications in the control room of leakage are provided by continuous monitoring of air activity and runoff.

Failed-Fuel-Detection Systems: No reference found.

Emergency Power: Two 7200-v, 3-phase, 60-cycle diesel-generator sets supply on-site emergency power. Units are set up as independent systems each capable of supplying power to one set of engineered safety features. Day tank supplies fuel for 3 hrs operation and fuel can be transferred to the day tanks from buried storage tank. Units are housed in tornado and earthquake proof buildings.

Control of Axial Xenon Oscillations:

Burnable Shims - Boric acid in the reactor coolant.

Part-Length Control Rods - Yes, 5 assemblies will control axial power distribution.

In-Core Instrumentation - Provides information on neutron flux distribution and fuel assembly outlet temperature.

Unborated Water Control: Two separate operations are required for dilution: a) the operator must switch from automatic makeup mode to dilute mode; b) the start button must be depressed. Lights on the control board indicate operation of dilution pumps. Alarms are actuated if boric acid or demineralized water flow rates deviate from preset values. For all these reasons, excessive dilution is most improbable.

Long-Term Cooling - Internal or External Systems: Two pumps of the residual heat removal system pump recirculated borated water from the containment sump. Two heat exchangers can be used to cool the water. Pump capacity is 3750 gpm each at 600 psig.

Reactor: Summer

F. MISCELLANEOUS

Windspeed, Direction Recorders, and Seismographs: Data collected for several years using a tower erected at CVNPA tube-type reactor. A new program will be initiated to verify former data. A 200' tower will be used. Seismographs not mentioned.

Plant Operating Mode: Load following.

Site Features: Will be located on a site being developed by S.C. Elec & Gas consisting of 11,000 acres near Paar, S.C. The complex will consist of Parr reservoir, newly formed Monticello Lake, the Summer facility and pumped storage hydro using the two reservoirs. The area is sparsely inhabited and mostly wooded. Land is rolling to hilly. In a 2-mi radius there are 144 inhabitants and in 5 mi, 1211. A fossil fuel plant and the decommissioned CVTR is at Parr. I-26 runs NW-SE about 10 miles south of the site.

Turbine Orientation: Ejected turbine blades could strike the containment structure. A General Electric Co. report on turbine failure is included at the end of Sect. 5.

Emergency Plans: Objective is to protect personnel and property from potential harm and danger caused by accidental release of radioactivity. Both on and off-site emergencies will be covered with on-site employees, visitors, hospital and ambulance personnel, county, state and local authorities. The Plant Supt. will have responsibility for procedures. Employees will participate in periodic drills, and off-site personnel will do so to the extent practical.

Environmental Monitoring Plans: Prior to operation, an environmental radiological surveillance will be initiated. Selected biota, air, water, soil and foods ingested by man and animals will be monitored. The survey will provide background data on the amount, type and source of radioactivity in the vicinity of the Station. The data will be used to estimate population exposure, verify adequacy of control, demonstrate the quality of the monitoring and suitability of the detection equipment, and provide a source of data for public information. The surveillance program will continue into the operational phase of the station.

Radwaste Treatment: System incorporates features of Westinghouse environmental assurance system to provide for treatment of radioactive liquid, gaseous, and solid wastes. The liquid waste system collects, processes and recycles reactor grade water, removes or concentrates radioactive constituents and processes them until suitable for release or shipment off-site. The gaseous waste system removes fission product gases from the coolant and the boron recycle evaporator and contains these gases during normal operation. Solid wastes are packaged for shipment to off-site disposal.

Stack Height - No reference found to a stack.

Waste Heat System: A once through system will take water from Lake Monticello and discharge back into the lake. Lake Monticello will be 11 sq miles or 7000 acres. Flow through condensers will be 485,000 gpm with 25F temp rise. Temperature variation in Monticello will be from 52F winter average to 91F summer average.

G. CIRCULATING WATER SYSTEM & SITE FEATURES		REACTOR NAME Virgil C. Summer Nuclear Station, Unit 1
THERMAL OUTPUT, MWt 2785	TYPE OF NUCLEAR STEAM SYSTEM PWR	DOCKET NO. 50-395

NEARBY BODY OF WATER Lake Monticello (11 sq. miles - 7000 acres) NORMAL LEVEL 425 (MSL)

MAX PROB FLOOD LEVEL --- (MSL)

SIZE OF SITE 11,000 ACRES including reservoir SITE GRADE ELEVATION ~437 (MSL)

TOPOGRAPHY OF SITE Rolling

OF SURROUNDING AREA (5 MI RAD) Rolling to Hilly

TOTAL PERMANENT POPULATION IN 2 MI RAD 144 (1970) IN 5 MI RAD 1211 (1970)

NEAREST CITY OF 50,000 POPULATION Columbia, S. C.

DISTANCE FROM SITE 26 MILES POPULATION 113,542 (1970)

LAND USE IN 5 MILE RADIUS Wooded - 80%, Agricultural- 10%

CIRCULATING WATER SYSTEM TYPE OF SYSTEM Once Through

WATER TAKEN FROM Lake Monticello FOR Condenser Cooling

WATER BODY TEMPERATURES - WINTER AVG 52 F SUMMER AVG 91 F AVG 72 F

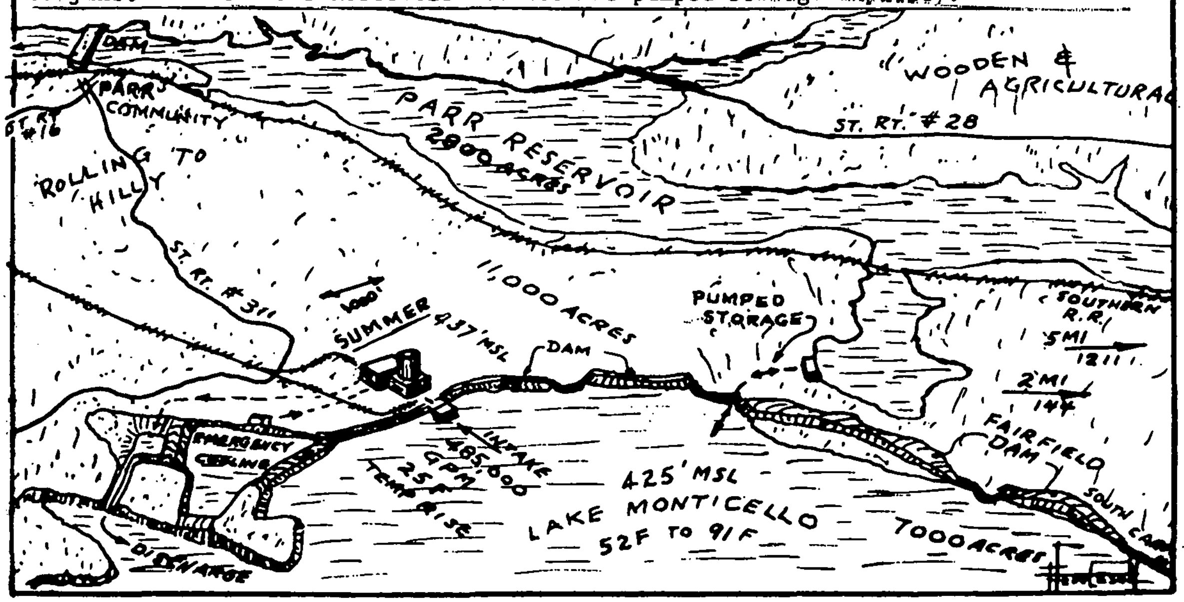
RIVER FLOW NA (cfs) QUANTITY OF MAKEUP WATER --- (gpm)

TOTAL FLOW THROUGH CONDENSERS 485,000 (gpm)/unit TEMPERATURE RISE 25 F

HEAT REMOVAL CAPACITY OF CONDENSERS --- (Btu/hr)

COOLING TOWERS None

OTHER INFORMATION 6.6×10^9 Btu/hr waste heat. Lake Monticello will be used in conjunction with Parr Reservoir for 480 MWe pumped storage capacity.



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