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ORNL-NSIC-55
Vol. I

DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS

Vol. I
Docket No. 50-3 Through 50-295

FRED A. HEDDLESON

NUCLEAR SAFETY INFORMATION CENTER

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Nuclear Safety Information Center

DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS

Vol. I

Docket No. 50-3 Through 50-295

Fred A. Heddleson
Reactor Division

DECEMBER 1973

OAK RIDGE NATIONAL LABORATORY
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FOREWORD

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8. Sources of Energy Release Under Accident Conditions
9. Nuclear Instrumentation, Control, and Safety Systems
10. Electrical Power Systems
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16. Meteorological Considerations
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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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Post Office Box Y
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DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS

Vol. I

Docket No. 50-3 Through 50-295

ABSTRACT

Design data, safety features, and site characteristics are summarized for thirty-two 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. An aerial perspective is also presented for each plant. Those covered in this volume are Indian Point #1, Docket Number 50-3, and all subsequent plants finishing with Zion, Docket Number 50-295.

INTRODUCTION

The data summaries for this report were taken from the Preliminary Safety Analysis Reports (PSAR), Final Safety Analysis Reports (FSAR), and the Environmental Report 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 and General Description of the Site

II. Site Characteristics

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

In 1967, the Advisory Committee on Reactor Safety (ACRS) requested that the Nuclear Safety Information Center 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. Volume II was published in January 1972 covering commerical power reactors with docket numbers larger than and including 50-296 (Browns Ferry No. 3). Volume I, this publication, will cover power reactors up to and including docket number 50-295 (Zion Station). 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 commerical 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. General — Other important information such as site features, emergency plans, environmental monitoring, radwaste treatment, waste heat system, etc.

G. Site Data — Information on site topography, population, evaluations, cooling water source, circulation rate, cooling towers, etc.

The seventh page of each report is an aerial perspective sketch of the plant.

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. Aerial perspective presents a graphic description of the reactor and site features. The terms and features used on it are explained in Figure 1. In most cases, the size of the reactor building and turbine building on the sketch has been increased over true size to better show their relationship to the site.

LEGEND - Parameters refer to each single reactor unit except as noted.

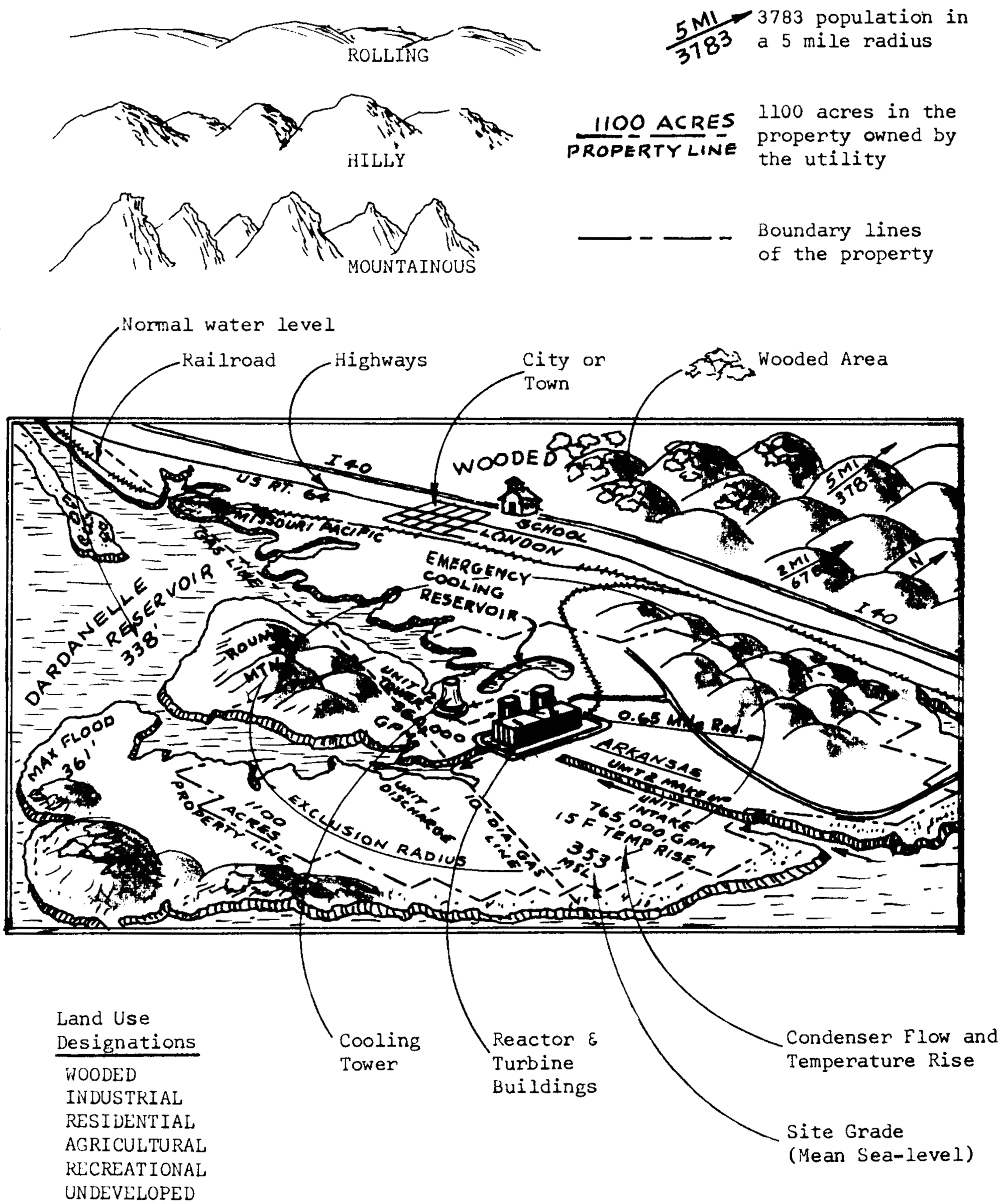

Fig. 1. Explanation of Terms for Site Sketch

Accuracy of Data

All information presented in this publication has 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.

If values are found which are not correct, NSIC would like to be informed.

Acknowledgement

The contribution of Dr. Carlos Bell, formerly of ORNL but now with the University of North Carolina at Charlotte, in compiling the original data collections for many of the reactors in this volume is gratefully acknowledged.

Thanks are also due to the following utility personnel who contributed data and updated the compilations for their particular plant:

James E. Ferland, Millstone
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B. B. Stephenson, Quad-Cities
Albert Burt, Nine Mile Point
W. P. Worden, Dresden
Ivan R. Finfrock, Jr., Oyster Creek
Paul Matthew, Humbolt Bay

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.

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

BWR — Boiling water reactor.

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

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

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

Closed-Loop Cooling — 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; or fan coil cooling units that recirculate the air.

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

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

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

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

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

Docket No. — The number assigned by the 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.

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

Exclusion Distance — The distance from the 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.

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

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

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

Hot — At temperatures corresponding to full power operation.

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

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

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

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

LOCA — Loss of coolant accident.

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

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

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

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

MCHFR — See Minimum Critical Heat Flux Ratio.

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

MWD — Energy in megawatt-days.

Main Steam Lines — Piping which passes steam from the reactor 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. Population figures are the 1970 total metropolitan area census.

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

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

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

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

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

NSS Vendor — Supplier of the nuclear steam supply system.

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

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

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

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

PWR — Pressurized water reactor.

Peak Enthalpy on Rod Drop — Melting of UO_2 occurs between 220 and 280 cal/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.

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

Primary Containment (System) — Housing for the reactor primary system designed to prevent the release of radioactive materials to the environment in the remote event of accident. In a BWR the system includes the 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, gaseous, or liquid wastes which contain radioactive materials.

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

Reactor Building — 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 in cfs (cubic feet per second).

Rod-Block Monitor — This subsystem hinders control rod withdrawal errors to prevent fuel damage. Two RBM monitoring channels are provided. Output signals from selected groups of Low-Power-Range Monitoring (LPRM) subsystem amplifiers are averaged to control rod movement. 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; sometimes called a strong motion accelerometer.

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

"Shutdown" — A condition of the reactor in which the core is subcritical and power is not being generated.

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.

INDIAN POINT #1, 50-3

Project Name: Indian Point Nuclear Unit No. 1

Location: West Chester Co., N.Y.

Owner: Consolidated Edison Co. of N.Y.

A-E: Consolidated Edison Co.
Vessel Vendor: Babcock & Wilcox
NSS Vendor: Babcock & Wilcox
Containment Constructor: Consolidated Edison

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	615	H_2O/U, Cold	3.25
Electrical Output, MWe	260	Avg 1st-Cycle Core Burnup, MWD/MTU B	10,650
Total Heat Output, Safety Design, MWt	615	First Core Avg Core Burnup, MWD/MTU B	17,900
Total Heat Output, Btu/hr	2099×10^6	Maximum Burnup, MWD/MTU (assembly)	27,000
System Pressure, psia	1550	Region-1 Enrichment, %	2.86
DNBR, Nominal	2.73	Region-2 Enrichment, %	3.26
Total Flowrate, lb/hr	57×10^6	Region-3 Enrichment, %	4.08
Eff Flowrate for Heat Trans, lb/hr	48.5×10^6	k_{eff}, Cold, No Power, Clean	1.226
Eff Flow Area for Heat Trans, ft^2	16.1	k_{eff}, Hot, Full Power, Xe and Sm	1.118
Avg Vel Along Fuel Rods, ft/sec	17.7	Total Rod Worth, %	14.5
Avg Mass Velocity, lb/hr-ft^2	2.96×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	2100
Nominal Core Inlet Temp, °F	479.6	Shutdown Boron, No Rods-Clean-Hot, ppm	1560
Avg Rise in Core, °F	35.4	Boron Worth, Hot, % Δk/k/ppm	0.00833
Nom Hot Channel Outlet Temp, °F	567.3	Boron Worth, Cold, % Δk/k/ppm	0.01
Avg Film Coeff, Btu/hr ft^2-°F	6950	Full Power Moderator Temp Coeff, Δk/k/°F	-4.0×10^{-4}
Avg Film Temp Diff, °F	18.7	Moderator Pressure Coeff, Δk/k/psi	4.0×10^{-6}
Active Heat Trans Surf Area, ft^2	15,200	Moderator Void Coeff, Δk/k/% Void	-3.0×10^{-3}
Avg Heat Flux, Btu/hr ft^2	133,600	Doppler Coefficient, Δk/k/°F	-2.1×10^{-5}
Max Heat Flux, Btu/hr ft^2	462,000	Shutdown Margin, Hot 1 rod stuck, %Δk/k	0.5
Avg Thermal Output, kw/ft	3.63	Burnable Poisons, Type and Form	None
Max Thermal Output, kw/ft	12.5	Number of Control Rods	21
Max Clad Surface Temp, °F	1100	Number of Part-Length Rods (PLR)	None
No. Coolant Loops	Four	Compiled by: Consolidated Edison & Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: Indian Point #1

Exclusion Distance, Miles	0.265
Low Population Zone Distance, Miles	0.684

Metropolis	Distance	Population
New York City	24 mi South	11,528,649

Design Basis Earthquake Acceleration, g	None
Operating Basis Earthquake Acceleration, g	0.10 g
Earthquake Vertical Shock, % of Horizontal	50% i.e., 0.05 g
Is Intent of 70 Design Criteria Satisfied?	Yes

Design Winds in mph:

At 0 — 50 ft elev ---

50 — 150 ft

150 — 400 ft

Tornado ---

ΔP = --psi/ --sec

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT	Design Pressure, psig: 25.0 (27.5 max)
Max Leak Rate at Design Pressure, %/day: 0.1% by weight	Calculated Max Internal Pressure, psig: ---

Type of Construction:

Free standing steel sphere conforming to the requirements of ASME Boiler & Pressure Vessel Code, Section VIII. The vessel plate is ASTM A201, Grade B Firebox Steel. The containment sphere is supported by a concrete biological shield which provides an annular space.

Design Basis:

The containment vessel design was based upon a 25 psig (27.5 psig maximum) internal pressure, 1.25 psig external differential pressure, −30°F minimum to +230°F maximum environmental temperature range. Steel plate specimens were satisfactorily impact tested at −50°F.

Vacuum Relief Capability: Capable of limiting the external over internal pressure to 1.25 psi.

Post-Construction Testing:

Containment vessel leakage and containment annulus pressure are measured at maximum intervals of 4±0.5 years.

Penetrations:

All penetrations through containment for pipe, electrical conductors, ducts and personnel airlock are of the double barrier type. The remaining access hatches are of the single barrier type.

Weld Channels:

None

D2. CONTAINMENT SAFETY FEATURES	Reactor: Indian Point #1

Containment Spray System: The containment vessel has an external spray system capable of limiting pressure in the containment vessel to 27.5 psig. It is also capable of reducing internal pressure 16 psi the first 24 hours following maximum credible accident. External spray heads are located around the upper portion of the containment vessel. Sprays impinge on the containment vessel surface.

Containment Cooling:

Containment cooling under accident conditions is accomplished by the containment external spray system.

Containment Isolation System: The Containment Isolation System consists of two isolation valves, arranged in series outside the sphere, a containment isolation panel (located in the central control room), the containment access doors, and incident detection and activation devices.

Containment Air Filtration:

Not applicable.

Penetration Room:

Not applicable.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks:

None

High-head Safety Injection: The proposed ECCS for Indian Point Unit No. 1 will incorporate two 100% capacity high-head safety injection systems, each having two high-head pumps. One (or two) of the four high-head pumps is (are) normally used to provide reactor water make-up. In the event of a LOCA, one (or two) pump(s) is (are) immediately available to supply full-head core cooling. The low primary coolant pressure signal activates the remaining pumps. The high-head pumps take suction from 3 clean water storage tanks. At design conditions the high head pumps can each deliver 200 gpm water at 1800 psig. Water delivery is through the reactor vessel head.

Low-head Safety Injection: During low-head system operation, water from the containment sump is pumped into the reactor via the reactor vessel head. Water returns to the sump via the break. Three 100% capability low-head systems will be provided. The low-head system can deliver 1200 gpm at 360 psig.

E. OTHER SAFETY-RELATED FEATURES

Reactor: Indian Point #1

Reactor Vessel Failure: The possibility of vessel failure has been minimized through the system design, materials selection, inspection and testing.

Containment Floodability:

Not applicable.

Reactor-Coolant Leak-Detection System:

The levels of the containment particulate and gas radioactivity, containment dewpoint, and time required to fill the containment sump are monitored to detect any primary coolant system leaks.

Failed-Fuel-Detection System:

No Failed-Fuel Detection System as such, but primary coolant activity monitoring can supply information of possible fuel failure.

Emergency Power:

(1) Station batteries
(2) Steam-driven turbine generator
(3) Emergency diesels to be installed with the proposed emergency core-cooling system.

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Reactor core is designed to preclude the existence of divergent xenon induced power oscillations and any power oscillations which might arise from coupled thermal-hydraulic effects.

Boron Dilution Control: The system incorporates storage facilities totaling 500 cf of 190°F, 19% boric acid solution (5400 lb boric acid) and pumping facilities for transferring the solution to either the primary loop (2 pumps each capable of 5 gpm) or to the clean water storage tanks (1 pump at 50 gpm). The quantity of boric acid is sufficient to produce about 30,000 cf of 4,000 ppm boric acid solution.

Long-Term Cooling: The Decay Heat Cooling System is placed into service when the Primary Coolant System temperature is $\leq$260°F temperature to 140°F and operates continuously to maintain this temperature as long as required. The system is designed to remove 20×10^6 Btu/hr with both decay heat pumps and cools the system to 140°F in about 27 hours.

Organic-Iodide Filter: None

Hydrogen Recombiner: None

F. GENERAL — Reactor: Indian Point #1

Windspeed, Direction Recorders, and Seismographs:

There exists on the site a 100-ft tower with wind speed and direction recorders.

Plant Operation Mode:

Base loaded.

Site Description: Located on the east bank of the Hudson River about 24 miles north of the north boundary of New York City and about 45 miles north of the river-ocean junction. The Hudson River is characterized by steep banks rising up from the river forming a deep N-S valley which significantly effects the weather. The site level varies from 10-ft MSL to 140 ft.

Turbine Orientation:

Emergency Plans:

Environmental Monitoring Plans:

Environmental Monitoring includes chemical, radiation, and biological sampling. The biological studies are part of a massive Hudson River Studies Program.

Radwaste Treatment:

Twelve-gpm evaporator used to treat liquid waste after about one week holdup. Demineralizers (2) used to treat steam generator blowdown prior to release.

Plant Vent: Stack about 275 ft high.

G. SITE DATA

Reactor: Indian Point #1

Nearby Body of Water: Hudson River

Normal Level 0.6 ft (MSL)

Max Prob Flood Level 7.4 ft (MSL)

Size of Site 239 Acres   Site Grade Elevation avg 70 ft (MSL)

Topography of Site: Rise from Hudson to 150 ft, most frequent elevation 100 ft

of Surrounding Area (5 mi rad): Steep valley terrain rises rapidly; peaks 800–1300 msl

Total Permanent Population: In 2 mi radius 9,300; 10 mi 218,200

Date of Data: June 1972   In 5 mi radius 53,000; 50 mi 16,762,000

Nearest City of 50,000 Population: White Plains

Dist. from site 16 Miles, Direction SSE, Population 50,300

Land Use in 5 Mile Radius: Mostly residential and recreational with some industrial and agricultural.

Meteorology: Prevailing wind direction NNE / SSW   Avg. speed 7 mph

Stability Data - Stable 33%   Neutral 41%   Unstable 26%

Miscellaneous Items Close to the Site: Peekskill, N.Y., is 2.5 miles NE and New York City boundary is 24 miles south. Penn Central RR runs by the site less than one mile east with U.S. Hwy 9W running near the railroad. Adjacent to the site on the south is an industrial area. Several parks are located within a ten-mile radius.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Hudson River

Intake Structure:

Two intake bays with two openings in each bay; each opening measures 11'2" horizontal and 20'6" vertical. Average intake velocity ~1 ft/sec.

Water Body Temperatures: Winter minimum 32 °F   Summer maximum 79 °F

River Flow 3,500 (cfs)* minimum; 20,000 (cfs) average

Service Water Quantity 38,000 gpm/reactor   *Freshwater flow.

Flow Thru Condenser 280,000 (gpm)/reactor   Temp. Rise 12.59 °F

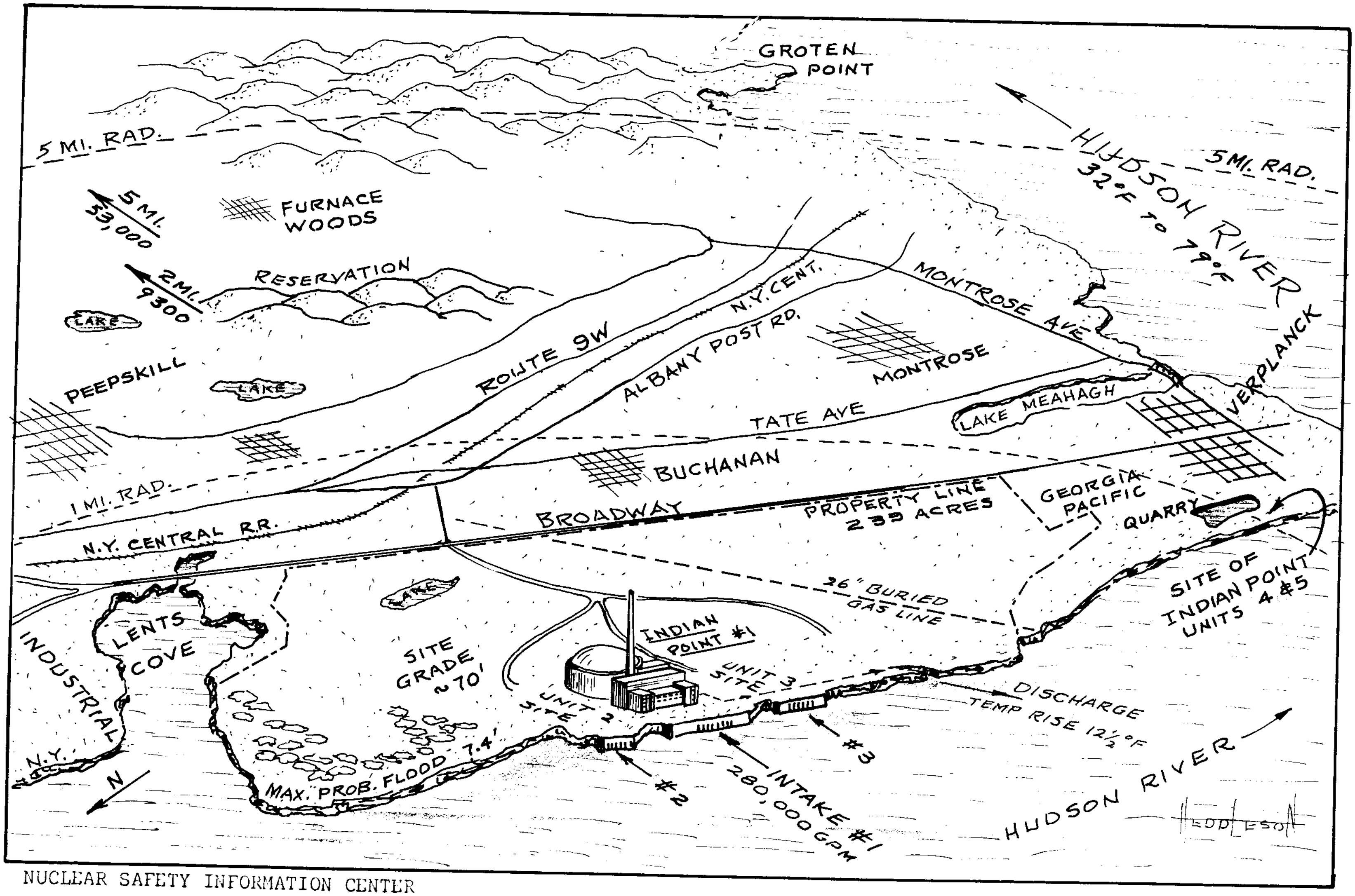
Heat Dissipated to Environment $1{,}915 \times 10^6$ (Btu/hr)/reactor

Heat Removal Capacity of Condenser $1{,}765 \times 10^6$ (Btu/hr)/reactor

Discharge Structure: Discharge canal leading to an outfall structure approximately 270 ft long. Discharged through 12 ports, 4 ft high by 15 ft wide. Ports are submerged 12 ft (center to surface) at mean low water. Min. discharge velocity is 10 fps.

Cooling Tower(s): Description & Number - None

Blowdown ______ gpm/reactor   Evaporative loss ______ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

DRESDEN, 50-10

Project Name: Dresden Nuclear Power Station Unit 1
Location: Grundy Co., Morris, Ill.
Owner: Commonwealth Edison Co.

A-E: General Electric
Vessel Vendor: N.Y. Shipbuilding Co.
NSS Vendor: G.E.
Containment Constructor: Bechtel Corp.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	700	H_2O/UO_2 Volume Ratio	2.13:1
Electrical Output, MWe	210	Moderator Temp Coef Cold, Δk/k/°F	2.2×10^{-5} @100°F
Total Heat Output, Safety Design, MWt	700	Moderator Temp Coef Hot, No Voids	BOC = -10×10^{-5} EOC = -5×10^{-5}
Steam Flow Rate, lb/hr PCI	1.405×10^{6}	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-5} @300°F
Total Core Flow Rate, lb/hr	25.6×10^{6}	Moderator Void Coef Operating	1%
Coolant Pressure, psig	1000	Doppler Coefficient, Cold	$-.9\times10^{-5}$
Heat Transfer Area, ft^2	23,265	Doppler Coefficient, Hot, No Voids	-1.4×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	15.0	Doppler Coefficient, Operating	-1.2×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	360,000	Initial Enrichment, %	1.5
Average Heat Flux, Btu/hr-ft^2	91,820	Average Discharge Exposure, MWD/Ton	10,000
Maximum Fuel Temperature, °F	4900	Core Average Void Within Assembly, %	20
Average Fuel Rod Surface Temp, °F	560	k_{eff}, All Rods In	.85
MCHFR	>1.5	k_{eff}, Max Rod Out	.98
Total Peaking Factor	5.61	Control Rod Worth, %	15
Avg Power Density, Kw/ℓ	28.9	Curtain Worth, %	0
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	Gadolinia Rods
		Number of Control Rods	80
		Number of Part-Length Rods (PLR)	None

Compiled by: Dresden Plant Personnel 8/73
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: Dresden #1

Exclusion Distance, Miles		.5 radius	Design Winds in mph:	
Low Population Zone Distance, Miles		---	At 0 — 50 ft elev	110
Metropolis	Distance	Population	50 — 150 ft	110
Chicago, Illinois	47	6,978,947 (1970)	150 — 400 ft	110
Design Basis Earthquake Acceleration, g		---	Tornado ---	
Operating Basis Earthquake Acceleration, g		---	ΔP = -- psi/ --sec	
Earthquake Vertical Shock, % of Horizontal		---	Is Intent of 70 Design Criteria Satisfied?	---

Recirculation Pumping System & MCHFR: MCHFR must be >1.5 when evaluated at 125% power conditions. The recirculation system consists of 4 GE canned type, 410 hp pumps producing a total of 25.6×10^6 lb/hr flow.

Protective System: Provides protection against conditions that threaten integrity of nuclear system process barrier by scramming the reactor following abnormal operational transients.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Drywell Design Pressure, psig	29.5	Primary Containment Leak Rate, %/day	.5
Suppression Chamber Design Pressure, psig	N/A	Second Containment Design Pressure, psig	N/A
Calculated Max Internal Pressure, psig	N/A	Second Containment Leak Rate, %/day	N/A

Type of Construction:

Spherical steel shell, 190 ft in diameter at the equator and approximately 156 ft above ground level.

Design Basis:

Designed to withstand pressure equal to or exceeding the internal pressure that would be created by the most probable kinds of potential reactor-rupture accidents.

Vacuum Relief Capability

None

Post-Construction Testing: All seams were radiographed, the personnel lock and equipment hatch were leak checked. A pressure test was conducted on the sphere for air tightness check.

Penetrations: The equipment hatch and personnel lock are testable. The steam lines are also leak checked.

D2. EMERGENCY CORE COOLING SYSTEMS Reactor: Dresden #1

Core Spray Cooling System:

A single, circular core spray sparger with 64 spray nozzles will be located above the reactor core and designed to deliver 2100 gpm. The required core spray flow will be maintained by two of three 50% capacity pumps. Suction will be from the fire protection system.

Auto-Depressurization System:

None

Residual-Heat-Removal System (RHRS):

High-Pressure Coolant-Injection System:

None

Low-Pressure Coolant-Injection System:

See core spray system.

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors:

None

Control-Rod Velocity Limiters:

None

Control-Rod-Drive-Housing Supports:

Provided to prevent ejection of a control rod from the reactor in the event a control rod drive housing should fail.

Standby Liquid-Control System:

A manually operated, liquid poison system provides means of shutting the reactor down in the unlikely event that a large number of control rods should fail at the same time.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: Dresden #1

Standby Coolant System:

See core spray system.

Containment Atmospheric Control System:

None.

Reactor Core Isolation Cooling System (RCICS): The emergency condenser is provided to cut in automatically whenever the main condenser is unavailable and the need for dissipation of heat from the reactor is required to avoid a buildup of pressure in the reactor. It cuts in whenever a high pressure reactor scram signal is initiated, whenever both primary steam valves are 25% closed and whenever a loss of safety system voltage occurs.

Reactor Vessel Failure:

None

Containment Floodability:

None

Reactor-Coolant Leak-Detection System:

Any reactor coolant leak would be detected through the use of the dew cell system and with the use of the continuous air monitor.

Failed-Fuel Detection Systems:

None

Emergency Power:

A 500 Kw, 480 v diesel-driven generator is used on loss of off-site power to provide power to the essential loads on the 480 v system. Battery power furnishes 125 v dc for controls, emergency lighting, and isolation valves.

Rod-Block Monitor:

None

Rod-Worth Minimizer:

None

F. GENERAL Reactor: Dresden #1

Windspeed, Direction Recorders, and Seismographs:

A tower erected at the site continuously records windspeed, direction, temperature, dew point and rain fall. Seismograph is installed in unit 2 or 3.

Plant Operation Mode:

Base loaded.

Site Description:

Site is about 47 miles SW of Chicago where the Des Plaines and Kankakee Rivers come together; adjacent to the Dresden lock on the Illinois River. The site is comparatively level with maximum variation of 25-ft elevation. The area around the site is mostly agricultural and industrial.

Turbine Orientation: Turbine located slightly off centerline of turbine building. Ejected blades could not strike containment.

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: Environmental monitoring is contracted to outside organization. Included in the routine sampling are:

1. 17 sample stations for airborne particulate and iodine samples. Filters are changed weekly at each station. These stations also have ion chambers which are read weekly and TLD's read quarterly.
2. Weekly samples include surface water and milk.
3. Fallout-Airborne solids & liquids-monthly; soil-annually; feedcrops -annually; foodstuffs-3 times per year.
4. Well water-quarterly, bottom sediments-semi-annually; slime-quarterly; aquatic animals-quarterly.

Radwaste Treatment:

System collects, processes, controls and disposes of potentially radioactive waste. Liquids from the reactor process systems or liquids which have become contaminated are processed according to their purity before being released either for return to the plant as condensate, sent to the discharge canal or immobilized in drums for eventual disposal offsite, solid wastes are processed for disposal offsite.

Plant Vent:

300-ft-high stack.

G. SITE DATA — Reactor: Dresden #1

Nearby Body of Water: Illinois River and Kankakee River — Normal Level 505' (MSL); Max Prob Flood Level 508' (MSL)

Size of Site 953 Acres — Site Grade Elevation 516' (MSL)

Topography of Site: Flat

of Surrounding Area (5 mi rad): Rolling prairie

Total Permanent Population: In 2 mi radius 50 ; 10 mi 25,000

Date of Data: 1968 In 5 mi radius 2600 ; 50 mi ___

Nearest City of 50,000 Population: Joliet, Illinois

Dist. from site 14 Miles, Direction NE , Population 75,000

Land Use in 5 Mile Radius:

Agriculture

Meteorology: Prevailing wind direction NE Avg. speed 10 mph

Stability Data - Gases would be rapidly diluted and dispersed.

Miscellaneous Items Close to the Site: South of the site is the General Electric Company's Nuclear Power Plant Training Center. Also located in the same area is G.E.'s Midwest Fuel Recovery Plant. Other activities are the Illinois Clay Products Company (Refractories and Brick Products) and some agricultural operations. A large abandoned strip mine is located in the area also.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Illinois River.

Intake Structure:

Canal from the Illinois River to the crib house which contains a screen for removing debris from the water prior to being pumped through plant.

Water Body Temperatures: Winter minimum 40 °F Summer maximum 85 °F

River Flow 3000 (cfs) minimum; 4200 (cfs) average

Service Water Quantity 12,900 gpm/reactor

Flow Thru Condenser 171,200 (gpm)/reactor Temp. Rise --- °F

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

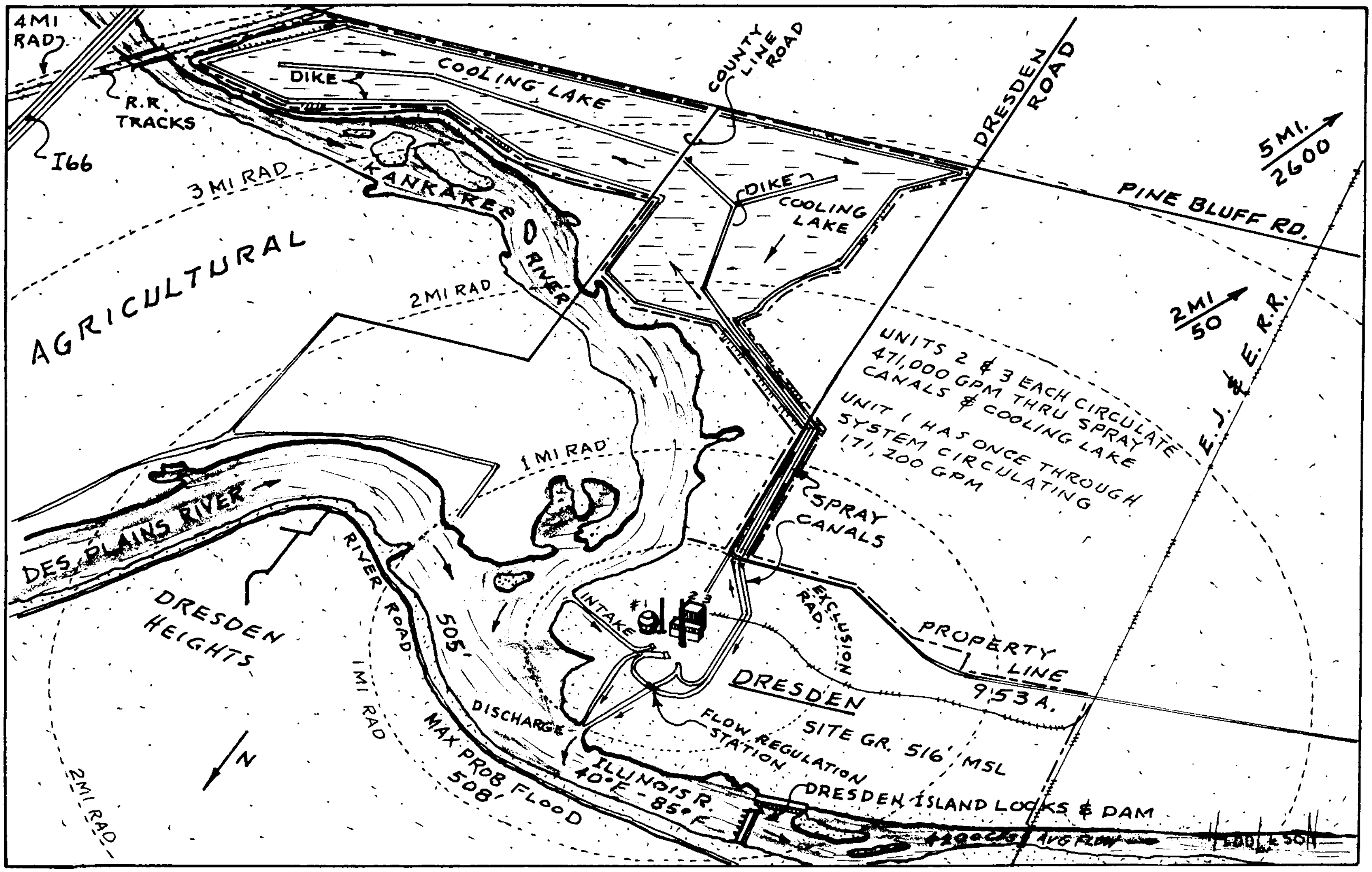
Heat Removal Capacity of Condenser 1.75×10^6 (Btu/hr)/reactor

Discharge Structure:

The water exits the plant and flows down a canal, returning the water to the Illinois River.

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

Blowdown ___ gpm/reactor Evaporative loss ___ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

YANKEE ROWE, 50-29

Project Name: Yankee Atomic Electric Power Station

Location: Rowe, Mass.

Owner: Yankee Atomic Elec. Co.

A-E: Stone & Webster
Vessel Vendor: B&W
NSS Vendor: Westinghouse
Containment Constructor: CB&I

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	600	H_2O/U, Cold	---
Electrical Output, MWe	186	Avg 1st-Cycle Burnup, MWD/MTU	---
Total Heat Output, Safety Design, MWt	618	First Core Avg Burnup, MWD/MTU	---
Total Heat Output, Btu/hr	$2{,}047 \times 10^6$	Maximum Burnup, MWD/MTU	46,000 (one assembly)
System Pressure, psia	2015	Region-1 Enrichment, %	4.0
DNBR, Nominal	~3.0	Region-2 Enrichment, %	4.94 (2nd cycle)
Total Flowrate, lb/hr	40.6×10^6	Region-3 Enrichment, %	4.94 (3rd cycle)
Eff Flowrate for Heat Trans, lb/hr	36.4×10^6	k_{eff}, Cold, No Power, Clean	$K_\infty = 1.3025$
Eff Flow Area for Heat Trans, ft^2	~14.4	k_{eff}, Hot, Full Power, Xe and Sm	$K_\infty \approx 1.19$
Avg Vel Along Fuel Rods, ft/sec	14.7	Total Rod Worth, %	9.27
Avg Mass Velocity, lb/hr-ft^2	2.52×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	2441
Nominal Core Inlet Temp, °F	510	Shutdown Boron, No Rods-Clean-Hot, ppm	2199
Avg Rise in Core, °F	~46	Boron Worth, Hot, % Δk/k/ppm	-4.83×10^{-2}
Nom Hot Channel Outlet Temp, °F	605/594	Boron Worth, Cold, % Δk/k/ppm	-5.92×10^{-2}
Avg Film Coeff, Btu/hr ft^2-°F	6670/5820	Full Power Moderator Temp Coeff, Δk/k/°F	-1.41×10^{-4}
Avg Film Temp Diff, °F	19.3/26.3	Moderator Pressure Coeff, Δk/k/psi	$+1.33 \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	14,276	Moderator Void Coeff, Δk/k/% Void	-1.77×10^{-3}
Avg Heat Flux, Btu/hr ft^2	129,000/ 153,000	Doppler Coefficient, Δk/k/°F	-1.80×10^{-5}
Max Heat Flux, Btu/hr ft^2	309,600/ 335,000	Shutdown Margin, Hot 1 rod stuck, %Δk/k	4.3
Avg Thermal Output, kw/ft	3.36/4.28	Burnable Poisons, Type and Form	None
Max Thermal Output, kw/ft	8.07/9.38	Number of Control Rods	24
Max Clad Surface Temp, °F	642	Number of Part-Length Rods (PLR)	None
No. Coolant Loops	4	Compiled by: Yankee Atomic & Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Yankee Rowe
Exclusion Distance, Miles	0.59		Design Winds in mph:
Low Population Zone Distance, Miles	5		At 0 — 50 ft elev ---
Metropolis	Distance	Population	50 — 150 ft ---
Pittsfield, Mass.		79,727	150 — 400 ft ---
Design Basis Earthquake Acceleration, g	---		Tornado ---
Operating Basis Earthquake Acceleration, g	---		ΔP = -- psi/ -- sec
Earthquake Vertical Shock, % of Horizontal	---		
Is Intent of 70 Design Criteria Satisfied?	---		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	31.5
Max Leak Rate at Design Pressure, %/day	3.0	Calculated Max Internal Pressure, psig	31.6

Type of Construction:

Spherical steel shell 125-ft in diameter with minimum wall thickness of 7/8-in. Primary and secondary shields are within the shell. The spherical shell is supported on braced steel columns.

Design Basis:

ASME Code Section VIII (unfired pressure vessels) and Code Case No. 1226. Designed to prevent release of radioactivity to the atmosphere in case of rupture of the main coolant system.

Vacuum Relief Capability:

None

Post-Construction Testing:

Integrity Test: 1. Strength Test at 40 psig
2. Leak Test at 15 psig

Penetrations:

Electrical — Cartridge Type
Piping — Fixed Mechanical
Air Locks — Resilient Seals

Weld Channels:

Found no reference

D2. CONTAINMENT SAFETY FEATURES Reactor: Yankee Rowe

Containment Spray System:

None

Containment Cooling:

Normal operation — 4 service water coolers with fans

Containment Isolation System:

Trip valves — pneumatic type

Containment Air Filtration:

None

Penetration Room:

None

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks:

1 tank — 3600 gal. of water — pressurized to 420 psia minimum by a nitrogen header through regulators.

High-head Safety Injection:

3 pumps — taking suction from LPSI pump discharge — 187 gpm/pump, shutoff head 800 psig

Low-head Safety Injection:

3 pumps — 900 gpm/pump with shutoff head 660 psig. Suction from 125,000 gallon storage tank.

E. OTHER SAFETY-RELATED FEATURES

Reactor: Yankee Rowe

Reactor Vessel Failure:

Containment Floodability:

Vapor Containment (V.C.) Recirculating System

Reactor-Coolant Leak-Detection System:

1. V.C. Air Particulate Monitor
2. 24-hr Water Balance
3. V.C. Humidity Detectors
4. Leakage Primary to Secondary — Steam generator blowdown monitors

Failed-Fuel-Detection System:

Bleed line Gamma Guard & Chemistry Sampling.

Emergency Power:

3 Diesels — 400 Kw/Diesel — Independent,
Automatic start on low voltage condition —
480 VAC

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation:

Boron Dilution Control:

3 charging pumps — positive displacement
33 gpm/pump 3000 psig shutoff head

Long-Term Cooling:

V.C. Recirculating System — 2 pumps at 100 gpm/pump, taking suction from V.C. sump.

Organic-Iodide Filter: None

Hydrogen Recombiner: None

F. GENERAL — Reactor: Yankee Rowe

Windspeed, Direction Recorders, and Seismographs:

Weather Tower — Windspeed, direction and temperatures (for inversion). Seismographs not mentioned.

Plant Operation Mode:

Full power — Base loaded.

Site Description:

The site is located in the town of Rowe, Mass., on the East Bank of the Deerfield River at a point approximately 3/4 of a mile south of the Vermont-Mass. border. It is adjacent to the Sherman hydro-electric station of N.E.P.Co. and on Sherman Pond.

Turbine Orientation: East-west such that ejected blades could strike containment.

Emergency Plans:

Now in the process of rewriting and having approved a new emergency plan to comply with App. E 10CFR50.

Environmental Monitoring Plans:

Now in the process of implementing an increased monitoring plan to prove compliance with limits specified in 10CFR50 App. I.

Radwaste Treatment:

Have 5 gpm evaporators with polishing filter for liquid waste. Solidify bottoms with cement in 55 gallon drums and ship to burial ground in N.Y. Combustible wastes are burned in an incinerator; ashes are drummed and buried.

Plant Vent:

15,000 CFM fan on primary vent stack.

G. SITE DATA

Reactor: Yankee Rowe

Nearby Body of Water: Sherman Pond

High Normal Level 1002' (MSL)
Max Prob Flood Level 1009 (MSL)

Size of Site 2000 Acres — Site Grade Elevation 1022 (MSL)

Topography of Site:

of Surrounding Area (5 mi rad): Very hilly.

Total Permanent Population: In 2 mi radius 229; 10 mi 17,654

Date of Data: 1970 Census — In 5 mi radius 1,618; 50 mi 1,397,666

Nearest City of 50,000 Population: Pittsfield

Dist. from site 24 Miles, Direction SW, Population 57,020

Land Use in 5 Mile Radius: ~10% devoted to crops — no crop of commercial importance except maple syrup.

Meteorology: Prevailing wind direction ____ Avg. speed ---

Stability Data - ---

Miscellaneous Items Close to the Site: Sherman Pond, a lake about 1 mi long is adjacent to the site. The Sherman hydro station is close to the site. Vermont Yankee Nuclear Station is about 20 miles ENE away. There are no large cities in this area, Pittsfield being the nearest city of any size. In the winter, skiing is a favorite recreation in this area with numerous ski resorts.

H. CIRCULATING WATER SYSTEM

Type of System: Once through system

Water Taken From: Sherman Pond

Intake Structure:

Suction from ~90 ft below normal pond level, pumped through screen house

Water Body Temperatures: Winter minimum 35 °F — Summer maximum 68 °F

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

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 140,000 (gpm)/reactor — Temp. Rise 24 °F

Heat Dissipated to Environment $1,470 \times 10^6$ (Btu/hr)/reactor

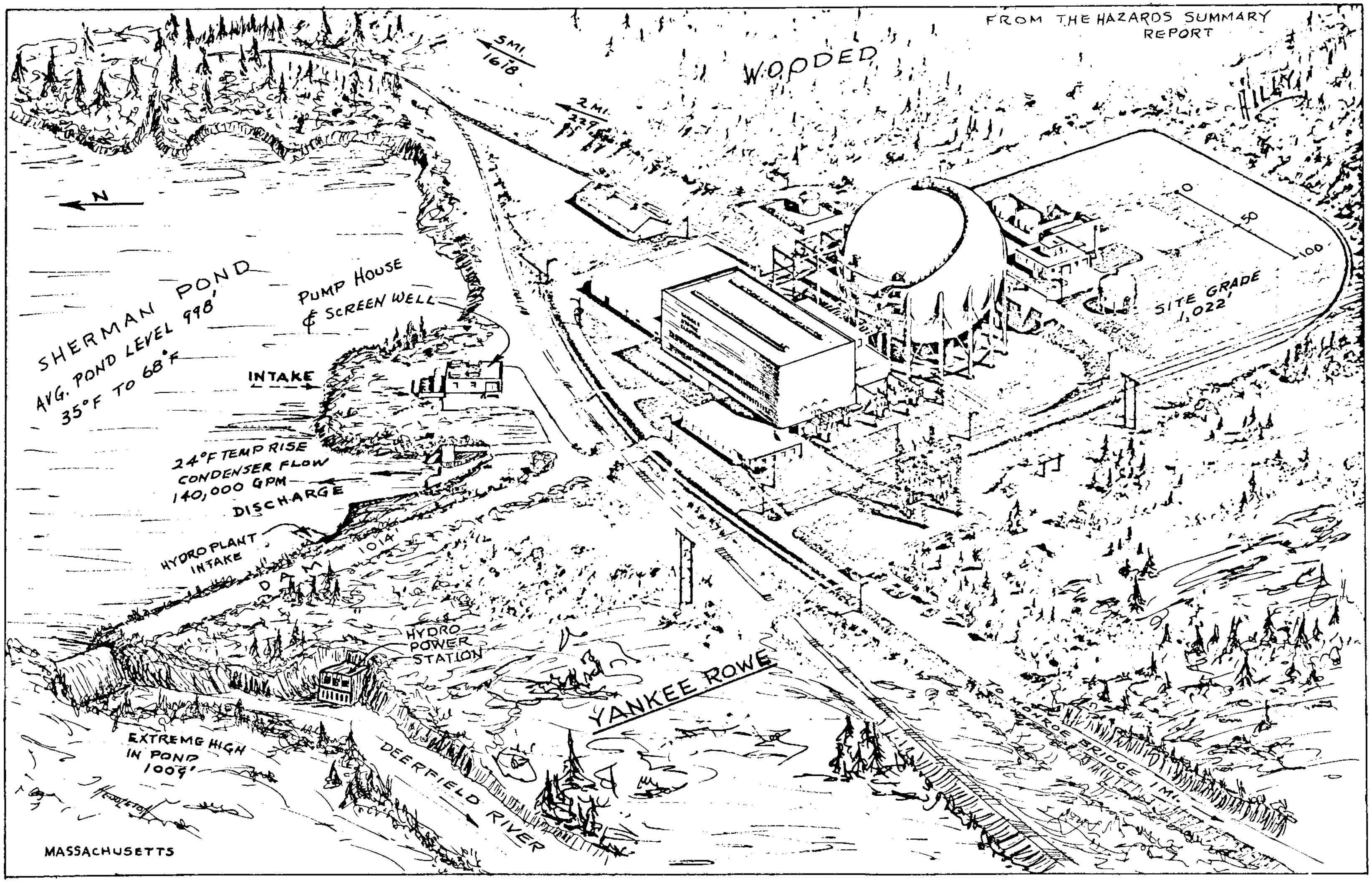
Heat Removal Capacity of Condenser --- (Btu/hr)/reactor

Discharge Structure:

Open seal pit discharging to Sherman Pond

Cooling Tower(s): Description & Number - None

Blowdown ____ gpm/reactor — Evaporative loss ____ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

Page 1 (BWR)

HUMBOLDT BAY, 50-133

Project Name: Humboldt Bay, Unit No. 3

Location: Eureka, California

Owner: Pacific Gas & Electric Co.

A-E: Bechtel Corporation
Vessel Vendor: Combustion Eng., Inc.
NSS Vendor: General Electric Co.
Containment Constructor: Bechtel Corp.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	240	H_2O/UO_2 Volume Ratio	2.60
Electrical Output, MWe	70	Moderator Temp Coef Cold, Δk/k/°F	--
Total Heat Output, Safety Design, MWt	240	Moderator Temp Coef Hot, No Voids	-2.05×10^{-4}
Steam Flow Rate, lb/hr	870,000	Moderator Void Coef Hot, No Voids, Δk/k/%	--
Total Core Flow Rate, lb/hr	10.4×10^6	Moderator Void Coef Operating	-1.15×10^{-3}
Coolant Pressure, psig	1150	Doppler Coefficient, Cold	--
Heat Transfer Area, ft^2	5923	Doppler Coefficient, Hot, No Voids	--
Max Power per Fuel Rod Unit Lgth, kw/ft	15	Doppler Coefficient, Operating	-1.10×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	359,000	Initial Enrichment, %	2.50
Average Heat Flux, Btu/hr-ft^2	129,600	Average Discharge Exposure, MWD/Ton	18,000
Maximum Fuel Temperature, °F	3570	Core Average Void Within Assembly, %	34
Average Fuel Rod Surface Temp, °F	--	k_{eff}, All Rods In	0.925
MCHFR	≥ 1.50	k_{eff}, Max Rod Out	<0.990
Total Peaking Factor	2.77	Control Rod Worth, %	17.3
Avg Power Density, Kw/ℓ	40.1	Curtain Worth, %	None
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	Gd_2O_3 mixed with UO_2
		Number of Control Rods	32
		Number of Part-Length Rods (PLR)	0

8/73

Compiled by: Pacific Gas and Electric Co.
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Humboldt Bay
Exclusion Distance, Miles	0.13 Rad.		Design Winds in mph: All structures designed to withstand maximum weather and other potential loadings in accordance with standard codes. At 0 — 50 ft; 50 — 150 ft; 150 — 400 ft; Tornado; ΔP = - psi/- sec
Low Population Zone Distance, Miles	---		
Metropolis	Distance	Population	
San Francisco-Oakland	230 Mi.	3,109,500	
Design Basis Earthquake Acceleration, g		0.25	
Operating Basis Earthquake Acceleration, g		NA	
Earthquake Vertical Shock, % of Horizontal	---		Is Intent of 70 Design Criteria Satisfied? NA

Recirculation Pumping System & MCHFR:
MCHFR $\geq$1.50
Recirculation pumping system: Not applicable

Protective System: A fail safe system which will override other systems' operations to shutdown the reactor, shut specified containment system isolation valves and to initiate engineering safeguard systems as required to place the plant in a safe shutdown condition.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Primary Containment Leak Rate, %/day: Drywell — 0.1% @ 72 psig. Supp. Chamb. — 1.0% @ 10 psig.
Drywell Design Pressure, psig	72	
Suppression Chamber Design Pressure, psig	25	Second Containment Design Pressure, psig ---
Calculated Max Internal Pressure, psig	Drywell 46; Supp. Cham. 24	Second Containment Leak Rate, %/day — 100% @ 1/4" H_2O

Type of Construction: Drywell: Cylindrical vessel constructed of SA-201 Grade B steel produced to SA-300 specifications in accordance with ASME Boiler and Pressure Vessel Code. Steel vessel is backed with reinforced concrete. Vessel upper and lower heads are lined with concrete. Suppression Chamber: A partial (300°) annular volume around the drywell, constructed with reinforced concrete lined with welded steel plates. The lower portion of the suppression chamber which is filled with water is segmented by baffle plates into forty-six segments.

Design Basis: The drywell and suppression chamber are designed to withstand forces resulting from the LOCA. Steam from a line break inside the drywell would quickly and completely condense in the suppression chamber, and fission products released during LOCA would remain inside the drywell.

Vacuum Relief Capability: Vacuum breakers relieve pressure from suppression chamber to the drywell. Vacuum breakers relieve from the access caisson to the suppression chamber.

Post-Construction Testing: A continuous leak rate test is run on both suppression chamber and drywell. An integrated leak rate test is run at intervals specified in 10 CFR 50 Appendix J.

Penetrations: Penetrations are double and single sealed; they are tested as part of the drywell containment vessel.

D2. EMERGENCY CORE COOLING SYSTEMS — Reactor: Humboldt Bay

Core Spray Cooling System: Designed to cool the core following a LOCA by spraying water pumped from the pressure suppression pool over the core. Automatically initiated at 150 psig reactor pressure and with a scram due to low reactor water level, high drywell pressure, main steam line break or loss of potential to the preferred 115V AC busses. The system has two pumps rated 350 gpm at 140 psig and a heat exchanger rated at 6,000,000 BTU/hr.

Auto-Depressurization System: Two vent valves rated at 196,000 lb/hr at 1250 psig open on simultaneous signals of high drywell pressure, low reactor water level and low reactor feedwater flow for sixty seconds in order to rapidly depressurize the reactor vessel to allow the initiation of core spray or low pressure core flooding.

Residual-Heat-Removal System (RHRS): This system consists of three basic subsystems: (1) core spray system (described above), (2) clean-up system in the post accident cooling mode provides a 70 gpm pump and a 2,625,000 BTU/hr heat exchanger to circulate and cool reactor water, (3) shutdown system provides two 530 gpm pumps and two heat exchangers with a total heat removal capacity of 7,849,900 BTU/hr. At 120 psig reactor pressure this system can be manually initiated to circulate and cool reactor water. The low pressure core flooding system described below is connected to this system.

High-Pressure Coolant-Injection System: Consists of normal feed and condensate systems. Includes 2 electrical driven centrifugal feed-pumps and 2 electric driven centrifugal condensate pumps. One can supply 850 gpm at 1200 psig; sufficient capacity to prevent cladding melting for 12" diameter hole in reactor vessel. Water supply is from main condenser hotwell or from the condensate demineralizer water storage tank.

Low-Pressure Coolant-Injection System: Plant fire protection system and reactor shutdown system are cross-connected. The three fire pumps, each rated 500 gpm at 120 psig, are sequentially started at 150 psig reactor pressure and with a scram due to low reactor water level, high drywell pressure, main steam line break or loss of 115 V AC busses. With the same signals an air operated valve and two motor operated valves open to route fire water to the reactor vessel.

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors:

None

Control-Rod Velocity Limiters:

None

Control-Rod-Drive-Housing Supports: Control rod drive thimble support structure consisting of horizontal beams and brackets installed beneath the control rod drive mechanisms.

Standby Liquid-Control System: Enough sodium pentaborate solution pressurized to 1300 psig by nitrogen can be injected into the reactor vessel in 10 minutes to keep the reactor subcritical with all rods stuck out of the core.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: HUMBOLDT BAY
Standby Coolant System: Emergency condenser - a natural circulation heat exchanger with reactor water on the tube side and fresh water of the shellside. The 8800 gal volume of freshwater is sufficient to dissipate decay heat for approx 8 hours after shutdown. A 25 gpm emergency makeup pump can extend operation beyond 8 hours.
Containment Atmospheric Control System: Both the drywell and the suppression chamber are inerted with dry nitrogen during power operation to prevent the possibility of an hydrogen-oxygen explosion following a LOCA and resultant zirconium-water reaction. The mass of nitrogen in each chamber is monitored by a continuous leak detection system.
Reactor Core Isolation Cooling System (RCICS): This system consists of four subsystems: (1) core spray system, described above; (2) low pressure core flooding, described above; (3) emergency condenser, described above; and (4) four reactor safety valves relieve sequentially on high reactor pressure to discharge reactor steam at 400,000 lb/hr at 1250 psig to the suppression pool.
Reactor Vessel Failure: Not considered credible.
Containment Floodability: The drywell can be filled with water to a level above the top of the reactor core.
Reactor-Coolant Leak-Detection System: Includes instrumentation to detect increases in drywell temperature and humidity or accumulation of water in lower drywell because of a reactor system leak. Also includes instrumentation to detect leakages past the inner and outer "O" ring seals on the reactor vessel head, weepage past the reactor safety valve seats and leakage past various vent and drain valve seats.
Failed-Fuel Detection Systems: Two channels of off-gas monitoring following the air ejector.
Emergency Power: No. 1 and No. 2 50-Mw fossil-fueled power plants and propane-driven engine 60 Kw emergency ac generator. 125-volt battery capable of supplying 240 amp-hours over an 8-hr period. Units No. 1 and 2 are capable of carrying all plant loads. The engine generator is capable of carrying essential plant safety loads. The battery is capable of carrying necessary loads to insure the safe shutdown conditions of the reactor.
Rod-Block Monitor: None
Rod-Worth Minimizer: None

F. GENERAL	Reactor: Humbolt Bay
Windspeed, Direction Recorders, and Seismographs: A wind vane and an anemometer are located on a tower seaward of the plant to give wind direction and speed which are recorded. A strong motion accelerograph takes inputs from three sets of orthogonal accelerometers to record seismic disturbances on a magnetic tape.	
Plant Operation Mode: Base-loaded.	
Site Description: Located on the east shore of Humbolt Bay just off the Pacific Ocean in northern California. The site is relatively flat with some slopes and a small bank rising up toward the bay. The surrounding area has gentle hills that become more pronounced inland. The climate is typical ocean-side weather.	
Turbine Orientation: Turbine centerline is about 12 feet above primary containment vessel. Closest turbine stage is about 73 feet from center line of primary containment vessel. Plant buildings are between turbine and containment.	
Emergency Plans: The site emergency plan organizes plant personnel and makes pre-arrangements to deal effectively with foreseeable emergency situations that might occur on the site. Provisions are made in the emergency plan for notification of company officials and for notification of city, county, and state officials should their assistance be necessary.	
Environmental Monitoring Plans: There are 36 environmental monitoring stations around the site, the fartherest of which is about 10 miles away. Most of the stations have instrumentation to measure stray radiation above background. Two of the stations have equipment to measure airborne activity. The radiation instruments are read at least every 15 days, and the airborne activity instruments read at least every 7 days. In addition, terrestrial and marine samples are collected and analysed on a quarterly basis.	
Radwaste Treatment: Liquid wastes are collected, treated and either stored in holding tanks (long or short term) or discharged to the outfall canal and diluted prior to entering the bay. Solid wastes are collected, packed and stored for ultimate off-site disposal. Gaseous wastes are in general collected, processed, held for decay and discharged through a stack 250 feet high.	
Plant Vent: Single stack 250 feet high with a stack flow of approximately 11,000 cfm.	

Page 6, BWR

G. SITE DATA — Reactor: Humboldt Bay

Nearby Body of Water: Humboldt Bay — Normal Level 0 (MSL); Max Prob Flood Level +20 Ft (MSL)

Size of Site 142.9 Acres — Site Grade Elevation +20 Ft (MSL)

Topography of Site: Relatively flat with some slopes and a small rising bank toward the bay.
of Surrounding Area (5 mi rad): Gentle hills with small stream valleys on a coastal plane.

Total Permanent Population: In 2 mi radius 1700 ; 10 mi 48,700
Date of Data: 1960 — In 5 mi radius 37,900 ; 50 mi ______

Nearest City of 50,000 Population: Santa Rosa, California
Dist. from site Approx. 200 Miles, Direction south, Population 50,006

Land Use in 5 Mile Radius: About 45% of the area is water. The land is used for residential and commercial purposes in the area of Eureka, and for agriculture and lumber outside the city.

Meteorology: Prevailing wind direction ______ Avg. speed ______
SSE 7 MPH, wet season Nov.-Mar.
Stability Data - Not extremely stable. NNW 8 MPH, dry season May-Sept.

Miscellaneous Items Close to the Site: Within 1-1/2 miles there are several small communities with populations of 200 to 650. Eureka, 4 miles north to center of city, has a population of 24,337. King Salmon resort is adjacent to the site. Two fossil fuel plants (50 MW each) are on the site adjacent to the nuclear unit. U. S. Highway 101 runs by within about 1500 feet of the plant.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

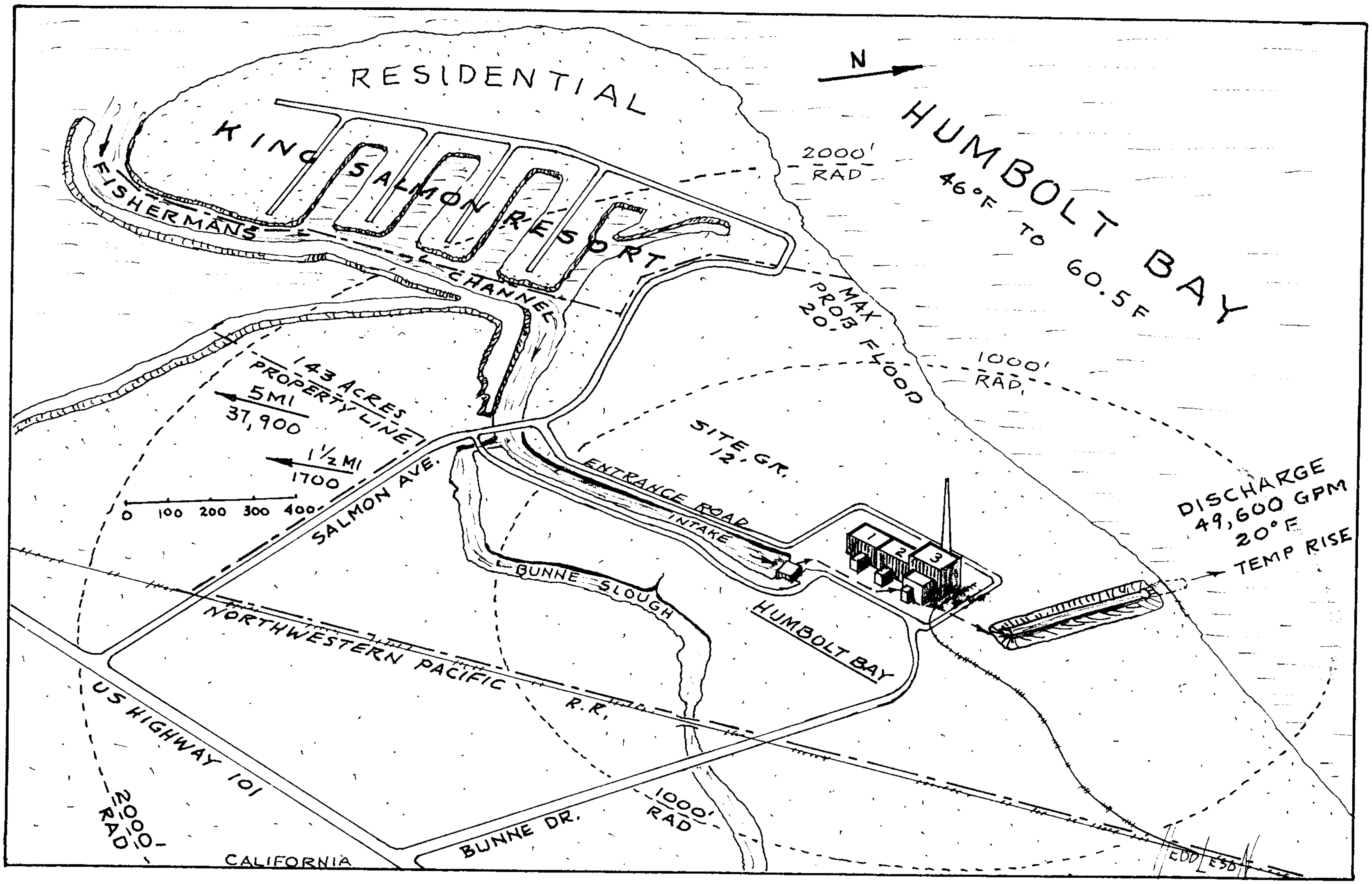
Water Taken From: Humboldt Bay

Intake Structure: Main condenser cooling water is taken from Humboldt Bay, via an intake canal, through trash racks and rotating drum screens to the suction pits of submerged mixed flow centrifugal pumps.

Water Body Temperatures: Winter minimum 46 °F Summer maximum 60.5 °F
River Flow NA (cfs) minimum; NA (cfs) average
Service Water Quantity 1900 gpm/reactor
Flow Thru Condenser 49,600 (gpm)/reactor Temp. Rise 20 °F
Heat Dissipated to Environment 650×10^6 (Btu/hr)/reactor
Heat Removal Capacity of Condenser 376×10^6 (Btu/hr)/reactor

Discharge Structure: Main condenser cooling water is discharged from the condenser to a common 54" header which discharges to an outfall canal which goes to Humboldt Bay.

Cooling Tower(s): Description & Number - None
Blowdown ______ gpm/reactor Evaporative loss ______ gpm/reactor


RESIDENTIAL
KING SALMON RESORT
FISHERMANS CHANNEL
N
HUMBOLT BAY
46°F TO 60.5F
2000' RAD
MAX PROB FLOOD 20.
1000' RAD.
SITE GR. 12
143 ACRES PROPERTY LINE
5 MI 37,900
1 1/2 MI 1700
0 100 200 300 400
SALMON AVE.
ENTRANCE ROAD
INTAKE
1
2
3
DISCHARGE 49,600 GPM 20°F TEMP RISE
BUNNE SLOUGH
HUMBOLT BAY
NORTHWESTERN PACIFIC R.R.
US HIGHWAY 101
2000' RAD
1000' RAD
BUNNE DR.
CALIFORNIA

BIG ROCK POINT, 50-155

Project Name: Big Rock Point Nuclear Plant

Location: Charlevoix, Michigan

Owner: Consumers Powers Company

A-E: Bechtel
Vessel Vendor: Combustion Eng.
NSS Vendor: General Electric
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	240	H_2O/UO_2 Volume Ratio	2.4
Electrical Output, MWe	75	Moderator Temp Coef Cold, Δk/k/°F	-3.0×10^{-5}
Total Heat Output, Safety Design, MWt	293 at Overpower	Moderator Temp Coef Hot, No Voids	-2.0×10^{-4}
Steam Flow Rate, lb/hr	$\sim 1 \times 10^6$	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.1×10^{-3}
Total Core Flow Rate, lb/hr	$\sim 12 \times 10^6$	Moderator Void Coef Operating	-1.35×10^{-3}
Coolant Pressure, psig	1335	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	5607	Doppler Coefficient, Hot, No Voids	-1.06×10^{-5} at 1337° F
Max Power per Fuel Rod Unit Lgth, kw/ft	21.6 at Overpower	Doppler Coefficient, Operating	-1.2×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	$.5 \times 10^6$ at Overpower	Initial Enrichment, %	2.5 - 4.5
Average Heat Flux, Btu/hr-ft^2	$.146 \times 10^6$ at Rated	Average Discharge Exposure, MWD/Ton	11.700
Maximum Fuel Temperature, °F	5203 at Overpower	Core Average Void Within Assembly, %	25.0
Average Fuel Rod Surface Temp, °F	Max ≤ 700°F at Overpower	k_{eff}, All Rods In	~ 0.904
MCHFR	> 1.5 at O.P.	k_{eff}, Max Rod Out	< .997
Total Peaking Factor	2.8 at O.P.	Control Rod Worth, %	≤ 3.0%
Avg Power Density, Kw/ℓ	< 46	Curtain Worth, %	n.a.
Peak Fuel Enthalpy on Rod Drop, Cal/gm	< 450	Burnable Poisons, Type and Form	Gd_2O_3 Blend with UO_2
		Number of Control Rods	32
		Number of Part-Length Rods (PLR)	0

* Reload F design data, Cycle 11
**Cycle 10 data

Compiled by: HEDDLESON - ORNL
HARTMAN - BIG ROCK POINT
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: BIG ROCK PT.

Exclusion Distance, Miles		0.51 mi.	Design Winds in mph:
Low Population Zone Distance, Miles		4.0 mi.	At 0 — 50 ft elev
Metropolis	Distance	Population	50 — 150 ft 100 mph
Saginaw	160	219,743	
Design Basis Earthquake Acceleration, g		0.05 g	150 — 400 ft
Operating Basis Earthquake Acceleration, g		0.05 g	Tornado --- ΔP = -- psi/ -- sec
Earthquake Vertical Shock, % of Horizontal		---	Is Intent of 70 Design Criteria Satisfied? ---

Recirculation Pumping System & MCHFR:

Two mechanical seal pumps operated in fixed flow mode at 17,000 gpm each.

Protective System: Initiates rapid insertion of all control blades on any of eleven signals indicating abnormal operating condition. Initiates containment isolation on three signals.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Drywell Design Pressure, psig	27	Primary Containment Leak Rate, %/day	0.5%/day
Suppression Chamber Design Pressure, psig	---	Second Containment Design Pressure, psig	---
Calculated Max Internal Pressure, psig	23	Second Containment Leak Rate, %/day	---

Type of Construction: Spherical steel vessel built in accordance with ASME Boiler and Pressure Vessel Code, Sections II, VIII and IX, as modified by applicable nuclear codes. The shell is constructed of SA-201 Grade B, firebox quality steel produced to SA-300 specs. Spherical steel vessel 130 ft. in diameter, extending 27 ft. below grade.

Design Basis: Designed to withstand calculated peak pressure of 23 psig and temperature rise of 190° F in the event of nearly instantaneous and complete severance of a recirculating pump discharge line with reactor at hot standby of 1500 psia. Designed also to withstand wind force at design velocity of 100 mph (overrides greatest expected seismic force).

Vacuum Relief Capability Containment is designed for 0.5 psig external pressure (limiting safe external pressure is 1.22 psig). Inlet ventilation valves open auto. at 1 psig.

Post-Construction Testing:

Soap bubble tested at 5 psig and pneumatically tested at 125% design pressure.

Penetrations: Electrical and non-ridgid penetrations are double-sealed; all others are single-sealed.

D2. EMERGENCY CORE COOLING SYSTEMS Reactor: BIG ROCK PT.

Core Spray Cooling System: Cooling water is admitted into a circular sparger above the core which directs water onto the fuel elements. Water is initially supplied from fire protection system followed by recirculation through core spray pumps and heat exchangers. Two 400 gpm pumps take over from fire protection system. Backup provided by spray nozzle in vessel head.

Auto-Depressurization System:

None

Residual-Heat-Removal System (RHRS): Three subsystems make up this system:

1. Reactor Shutdown Cooling System - remove decay heat from reactor core during and following shutdown.
2. Post-Incident Spray System - containment spray initiated in the event of an accident involving loss of coolant from primary system.
3. Core Spray Cooling System - (described above).
4. Emergency Condenser

High-Pressure Coolant-Injection System:

None

Low-Pressure Coolant-Injection System:

(See Core Spray Cooling System)

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors:

None

Control-Rod Velocity Limiters:

Limited only by hydraulic capacity of drive system.

Control-Rod-Drive-Housing Supports:

Spring-loaded mechanical structure mounted below rod drive housings.

Standby Liquid-Control System: Provides means of achieveing and maintaining subcriticality if control rods are unable to do so. The system employes sodium pentaborate - 19% (minimum).

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: BIG ROCK PT.

Standby Coolant System:

Core Spray Cooling System at Low Pressure

Containment Atmospheric Control System: Reactor containment vessel is provided with both forced and induced draft ventilation providing ventilation for all potentially contaminated areas. Heating and cooling units are located on the ventilation inlets to maintain near constant temperature conditions year around.

Reactor Core Isolation Cooling System (RCICS):

None

Reactor Vessel Failure: Based on design analysis, the reactor vessel was adequately designed against probability of brittle-failure for its proposed 40-year lifetime.

Containment Floodability: The containment sphere may be flooded to three feet above grade before overstressing the containment vessel.

Reactor-Coolant Leak-Detection System:

1. Containment sumps volume measurements.
2. Containment air inlet and exhaust dewpoint.
3. Radiation particulate monitor on containment air exhaust.

Failed-Fuel Detection Systems: Fuel element rupture is determined by continously monitoring the gases from the air ejector discharge with a single channel gamma ray spectrometer.

Emergency Power: One diesel-generator automatically starts on a loss of auxiliary power and automatically connects to the electricty-driven fire pump and reactor buidling air locks. Other services can be selected manually as required. One 125V d-c battery system furnishes power for normal switchgear functions, turbine control, annunciators and various emergency functions.

Rod-Block Monitor:

Interlocked for refueling operations with cranes.
Interlocked with accumulators on drive system.
Interlocked at lower power with flux monitors.

Rod-Worth Minimizer:

None

F. GENERAL

Reactor: BIG ROCK PT.

Windspeed, Direction Recorders, and Seismographs:

On site weather station that indicates windspeed and direction.

No. seismographs.

Plant Operation Mode:

Base load.

Site Description:

Six hundred acres of gently sloping, wooded and cleared land on the shore of Lake Michigan in Charlevoix County. Population within a 10-mile radius of the site is 9000 (1960 figures). Forty percent of Charlevoix County is in agricultural use.

Turbine Orientation: Approximately 140 ft. south of containment oriented perpendicular to E-W centerline of containment.

Emergency Plans:

A plant site emergency plan has been prepared and contains detailed written procedures for involved plant personnel in the event of an emergency or accident. Periodic drills and training sessions are held. The plan is coordinated with the State Police, local hospitals and emergency units.

Environmental Monitoring Plans:

Monitoring program started in 1960. The present program includes analysis of weekly air samples, lake and well water samples, fish and plant life specimens and beta-gamma film measurements.

Radwaste Treatment:

Solid Wastes - Collected, processed and packaged for storage. After sufficient decay, the packaged waste is shipped off site.

Gaseous Waste - Off-gas from main condenser are held up for 16 minutes for decay and released through high efficiency filters. Off-gas and building ventilation flows are released from a 240-ft. stack.

Liquid Wastes - Collected and processed on a batch basis for dilution with condenser circulating water in the discharge canal.

Plant Vent:

A 240-ft. high concrete stack.

G. SITE DATA

Reactor: BIG ROCK PT.

Nearby Body of Water: Lake Michigan

Normal Level 580' (MSL)

Max Prob Flood Level 591' (MSL)

Size of Site 600 Acres

Site Grade Elevation 592 (MSL)

Topography of Site: Gently sloping

of Surrounding Area (5 mi rad): Gently sloping

Total Permanent Population: In 2 mi radius 70 ; 10 mi 9,000

Date of Data: 1960 In 5 mi radius 4900 ; 50 mi 132,500

Nearest City of 50,000 Population: Sault Ste Marie, Canada

Dist. from site 93 Miles, Direction NNE , Population 74,000

Land Use in 5 Mile Radius:

Commercial and industrial about four miles south of the site.

Meteorology: Prevailing wind direction SSW Avg. speed 8 mph

Stability Data ----

Miscellaneous Items Close to the Site: U.S. Highway 31 runs SE of the site about 1/2 mile. The C & O RR runs about 1 mile SE. The town of Charlevoix is 4 mi. SSE and Petoskey is 13 mi. E. Lake Charlevoix is 3 mi. S. Only a few residences are scattered within several miles.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Lake Michigan

Intake Structure:

Underwater crib protecting the end of a 60" line.

Water Body Temperatures: Winter minimum 38 °F Summer maximum 68 °F

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

Service Water Quantity 4,200 gpm/reactor

Flow Thru Condenser 49,000 (gpm)/reactor Temp. Rise 20 °F

Heat Dissipated to Environment 400 million (Btu/hr)/reactor

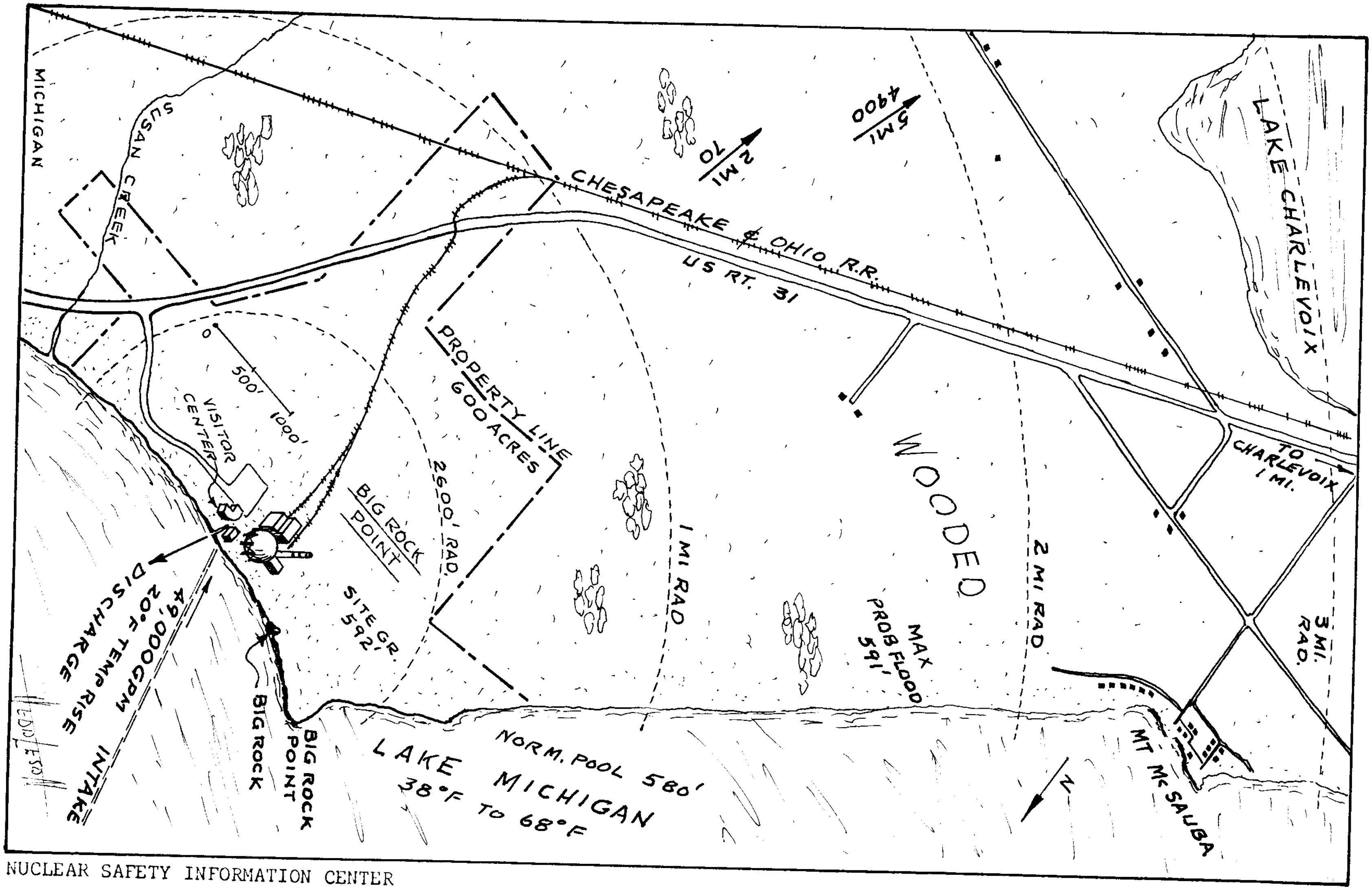
Heat Removal Capacity of Condenser 526×10^6 (Btu/hr)/reactor

Discharge Structure:

Open discharge canal to lake at circulating water pump house.

Cooling Tower(s): Description & Number - None

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



NUCLEAR SAFETY INFORMATION CENTER

Commercial Operation 1-1-68 — Page 1 (PWR)

SAN ONOFRE, 50-206

Project Name: San Onofre Nuclear Generating Station, Unit 1

Location: San Diego Co., Calif.

Owner: Southern Calif. Edison
San Diego Gas and Electric

A-E: Bechtel
Vessel Vendor: Combustion Eng.
NSS Vendor:
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1347	H_2O/U, Cold	3.59
Electrical Output, MWe	450	Avg 1st-Cycle Burnup, MWD/MTU	14,500
Total Heat Output, Safety Design, MWt	1389	First Core Avg Burnup, MWD/MTU	20,000
Total Heat Output, Btu/hr	4595×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2100	Region-1 Enrichment, %	3.15
DNBR, Nominal	2.07	Region-2 Enrichment, %	3.40
Total Flowrate, lb/hr	78×10^6	Region-3 Enrichment, %	3.85
Eff Flowrate for Heat Trans, lb/hr	71×10^6	k_{eff}, Cold, No Power, Clean	1.254
Eff Flow Area for Heat Trans, ft^2	35.1	k_{eff}, Hot, Full Power, Xe and Sm	1.160
Avg Vel Along Fuel Rods, ft/sec	13.3	Total Rod Worth, % BOL	7.1
Avg Mass Velocity, lb/hr-ft^2	---	Shutdown Boron, No Rods-Clean-Cold, ppm	2900
Nominal Core Inlet Temp, °F	553	Shutdown Boron, No Rods-Clean-Hot, ppm	2500
Avg Rise in Core, °F	48.5	Boron Worth, Hot, PCM/PPM	- 7.9
Nom Hot Channel Outlet Temp, °F	637.5	Boron Worth, Cold, PCM/PPM	-10.0
Avg Film Coeff, Btu/hr ft^2-°F	5100	Full Power Moderator Temp Coeff, Δk/k/°F	$(+1 \text{ to } -3.7) \times 10^{-4}$
Avg Film Temp Diff, °F	28.2	Moderator Pressure Coeff, Δk/k/psi	---
Active Heat Trans Surf Area, ft^2	31,222	Moderator Void Coeff, Δk/k/% Void	---
Avg Heat Flux, Btu/hr ft^2	143,350	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -2.5) \times 10^{-5}$
Max Heat Flux, Btu/hr ft^2	463,000	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	---	Burnable Poisons, Type and Form	---
Max Thermal Output, kw/ft	15.0	Number of Control Rods 45 x 16	720
Max Clad Surface Temp, °F	648	Number of Part-Length Rods (PLR)	None
No. Coolant Loops	3	Compiled by: Fred Heddleson 11/72 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: San Onofore #1
Exclusion Distance, Miles		---	Design Winds in mph:
Low Population Zone Distance, Miles		---	At 0 — 50 ft elev 100
Metropolis	Distance	Population	50 — 150 ft 125
San Diego	51	1,357,854	
Design Basis Earthquake Acceleration, g		0.50	150 — 400 ft 155
Operating Basis Earthquake Acceleration, g		0.25	Tornado ---
Earthquake Vertical Shock, % of Horizontal		67	ΔP = -- psi/-- sec
Is Intent of 70 Design Criteria Satisfied?	"Plant meets most of Criteria."…. "design of plant is considered adequate"		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	46.4
Max Leak Rate at Design Pressure, %/day	0.50	Calculated Max Internal Pressure, psig	46.0

Type of Construction: A metal sphere about 1 inch thick with a diameter of 140' and a volume of 1,440,000 cu. ft. About 1/3 of the sphere is underground placed on concrete. The inside of the bottom third of the sphere is concrete lined to support all structures to which equipment is attached. The bottom of the reactor is at minus 10' elevation.

Design Basis: Designed to accommodate, without exceeding design leakage, pressures and temperatures resulting from LOCA. Also designed so it can accommodate the most severe zirconium-water reaction. Also designed to withstand pressures and temperature of LOCA in combination with loads resulting from either maximum seismic or wind forces characteristic of the site.

Vacuum Relief Capability: Designed for 2.0 psig external pressure. No reference found on vacuum relief.

Post-Construction Testing: Will be pressure tested and tested for leak rate.

Periodic leakage tests will be run at 1/2 of design pressure.

Penetrations: Double sealed and individually testable.

Weld Channels: No reference found.

D2. CONTAINMENT SAFETY FEATURES	Reactor: San Onofre #1

Containment Spray System: System sprays borated water from refueling water storage tank or containment sumps into containment atmosphere at rate of 1000 gpm.

Containment Cooling: Recirculating fans cool atmosphere.

Containment Isolation System: Valves close automatically on signal of high sphere pressure or can be closed manually to seal off penetrations.

Containment Air Filtration: Found no reference to types of filters, however a filtering system is available.

Penetration Room: No reference on drawings.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: None mentioned.

High-head Safety Injection: There are two independent systems using feedwater pumps for high pressure injection. Feedwater pumps are supplied with borated water from the safety injection pumps, or feedwater pumps can take suction from the refueling water storage tank at pumping rates of about 7000 gpm. Charging pumps or refueling water pumps can also supply feedwater pumps at 213 gpm and 500 gpm respectively.

Low-head Safety Injection: Apparently, low pressure injection is supplied by the recirculation pumps or by the feedwater pumps. Description in FSAR is not definite.

E. OTHER SAFETY-RELATED FEATURES

Reactor: San Onofre #;

Reactor Vessel Failure: No reference found.

Containment Floodability: No reference found.

Reactor-Coolant Leak-Detection System: Leakage detected in containment by temperature or pressure change, by sump water level and/or pump operation, high humidity, and high radiation alarm. A limit of 10 gpm leakage is cause to shut down the plant.

Failed-Fuel-Detection System: No reference found.

Emergency Power: Two diesel-generators of 600 kw each continuous capacity supplies power to two 480 V buses. Each diesel has its own d-c electrical starting system plus a back up air-starting system. Each diesel has a 50 gallon day tank supplied from one 2000 gal capacity underground tank which has capacity for 36 hrs. of full load operation.

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Part length rods not mentioned. In-core detectors are used for flux distribution mapping. Control system maintains a programmed average temperature.

Boron Dilution Control: The maximum dilution achievable is limited to a rate very small with relation to the ability of the control rods to change reactivity. Excess shutdown reactivity is maintained at all times by limits on control group insertion and two alarms are provided to alert the operator when these limits are reached. Numerous alarms and information are provided to alert the operator. The excess shutdown, and the limit on reactivity insertion by dilution, provide the operator with adequate time to add boron as necessary.

Long-Term Cooling: Recirculation of spilled borated water from the containment sump provides cooling for extended periods following an accident. Water is pumped through the recirculation heat exchanger for cooling. Recirculation pumps can also supply water for containment sphere spray system.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Purging for hydrogen and oxygen control would be started 40 days after a LOCA to prevent hydrogen concentration from exceeding 4 percent of volume.

F. GENERAL

Reactor: San Onofre #1

Windspeed, Direction Recorders, and Seismographs: Temperature and precipitation records have been kept at the plant since Dec 1964. A tower with instruments stand at the top of the cliffs. Two seismographs are installed, one in 1965, and one in 1969.

Plant Operation Mode: Designed for load following.

Site Description: Located along the Pacific Coast 20 ft above sea level about mid-way between Los Angeles and San Diego. The site was excavated from sand-like cliffs that tower 60 to 90 ft above the ocean. The site is completely surrounded by Camp Pendleton Marine Base. The ocean at this point has a narrow beach between the bottom of the cliffs and the water line.

Turbine Orientation: Turbine and reactor are on same centerline.

Emergency Plans: Plans have been developed to safeguard health and safety of station personnel and the public and to minimize property damage after a radiological emergency or other emergency that would develop into a radiological emergency. Plans include training in evacuation, fire fighting, rescue, injuries, and contamination. The Marine Corp, AEC, state agencies, and outside medical facilities will be used.

Environmental Monitoring Plans: Monitoring was started in 1964 to determine the preoperational baseline, and to set up procedures for operational monitoring to see if proper controls of plant wastes were being carried out. The post operating phase are practically the same. Two air sampling stations are used to monitor radioactive particulates. Iodine detection monitors thyroid glands of jackrabbits. Additional sampling includes water supplies, crops, beach samples, kelp, shell fish, and fish.

Radwaste Treatment: Collects, processes, monitors, and disposes of all liquid, solid, and gaseous radioactive waste from the plant. Liquids are collected and processed by filtration, ion exchange, degasification, and dilution prior to discharge to the ocean. Gases are collected, processed, monitored, and then are either stored to permit decay or are discharged along with dilution air through the vent stack. Solids are held in shielded areas for future disposal. During the period 1/71 - 12/71 releases were as follows: - Liquid Beta/gamma 1.54 curies, Liquid tritium 4570 curies; Gaseous Beta/gamma 7667 curies, Gaseous tritium 54 curies.

Plant Vent: A steel stack standing beside the containment sphere. Base is at plant grade (20') and top is same as containment top (120').

Page 6, PWR

G. SITE DATA

Reactor: San Onofre #1

Nearby Body of Water: Pacific Ocean

Normal Level 0 (MSL)

Max Prob Flood Level 13' (MSL)

Size of Site 84 Acres   Site Grade Elevation 20' (MSL)

Topography of Site: Sea cliffs leveled off.

of Surrounding Area (5 mi rad): Hilly.

Total Permanent Population: In 2 mi radius 0 ; 10 mi 39,900

Date of Data: 1969   In 5 mi radius 24,600 ; 50 mi ____

Nearest City of 50,000 Population: Oceanside (1980 pop)

Dist. from site 17 Miles, Direction SE , Population 80,000

Land Use in 5 Mile Radius: Military Base

Meteorology: Prevailing wind direction SW E   Avg. speed 4-15 mph 80% of time

Stability Data - Light wnds and frequent inversions avg 7 mph

Miscellaneous Items Close to the Site: The site is surrounded by Camp Pendleton Marine Base. San Clemente is about 4 mi northwest. Interstate 5 and the Atchison, Tokeka and Santa Fe railroad pass with 1000 ft of the plant on the east side. Camps in the military reservation are 2 to 4 miles away.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

Water Taken From: Pacific Oean

Intake Structure: 3200 ft from shore in water 30 ft deep. 12 ft dia conduct brings water to the intake structure.

Water Body Temperatures: Winter minimum ~55 °F   Summer maximum ~75 °F

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

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 350,000 (gpm)/reactor   Temp. Rise 18 °F

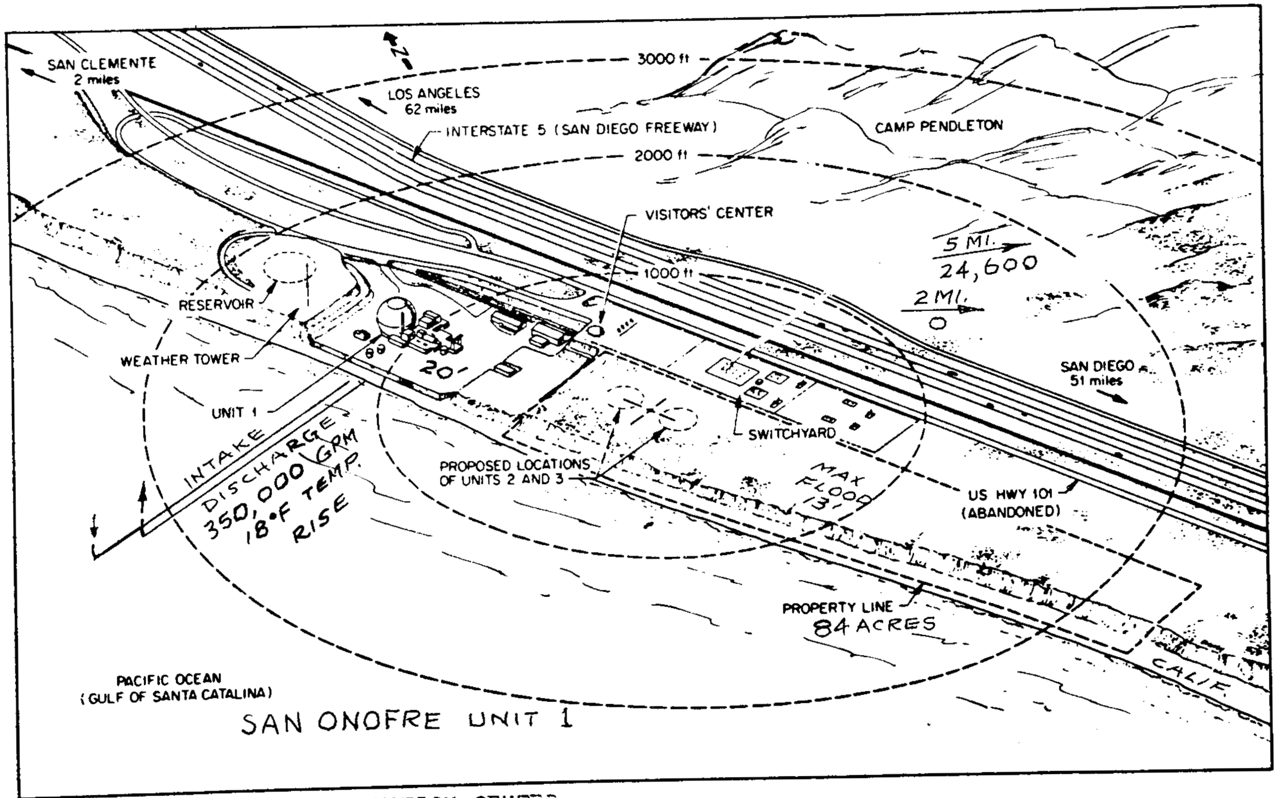
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: 2600 ft from shore in 26 ft of water. Discharged vertically from a 12 ft diameter conduct.

Cooling Tower(s): Description & Number - None

Blowdown ____ gpm/reactor   Evaporative loss ____ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

DATA FROM FACILITY DESCRIPTION
Commercial Operation Since 1-1-68 Page 1 (PWR)

CONNECTICUT YANKEE, 50-213

Project Name: Connecticut Yankee Atomic Power Company
A-E: Stone and Webster
Location: *Town of Haddam
Vessel Vendor: Combustion Eng.
NSS Vendor: Westinghouse
Owner: Eleven Utilities of New Eng.
Containment Constructor: Stone and Webster
*22 mi SSE of Hartford

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1825	H_2O/U, Cold	3.16
Electrical Output, MWe NOMINAL	600	Avg 1st-Cycle Burnup, MWD/MTU	16952
Total Heat Output, Safety Design, MWt	1825	First Core Avg Burnup, MWD/MTU	16952
Total Heat Output, Btu/hr	---	Maximum Burnup, MWD/MTU	34722
System Pressure, psia	2000	Region-1 Enrichment, %	3.02
DNBR, Nominal	2.03	Region-2 Enrichment, %	3.23
Total Flowrate, lb/hr	101.4×10^6	Region-3 Enrichment, %	3.67
Eff Flowrate for Heat Trans, lb/hr	92.3×10^6	k_{eff}, Cold, No Power, Clean	1.28
Eff Flow Area for Heat Trans, ft^2	41.8	k_{eff}, Hot, Full Power, Xe and Sm	1.163
Avg Vel Along Fuel Rods, ft/sec	14.3	Total Rod Worth, %	7.64
Avg Mass Velocity, $lb/hr\text{-}ft^2$	2.15×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	2470
Nominal Core Inlet Temp, °F	554.9	Shutdown Boron, No Rods-Clean-Hot, ppm	2470
Avg Rise in Core, °F	42	Boron Worth, Hot, % Δk/k/ppm	125 PPM/%
Nom Hot Channel Outlet Temp, °F	624.8	Boron Worth, Cold, % Δk/k/ppm	---
Avg Film Coeff, Btu/hr ft^2-°F	5230	Full Power Moderator Temp Coeff, Δk/k/°F	EOL ARO OCB -3.5×10^{-4}
Avg Film Temp Diff, °F	26.1	Moderator Pressure Coeff, Δk/k/psi	-1.0×10^{-6} Neg.
Active Heat Trans Surf Area, ft^2	35900	Moderator Void Coeff, Δk/k/% Void	Negligible
Avg Heat Flux, Btu/hr ft^2	136,400	Doppler Coefficient, Δk/k/°F	1.61
Max Heat Flux, Btu/hr ft^2	443,000	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	5.5	Burnable Poisons, Type and Form	None
Max Thermal Output, kw/ft	14.3	Number of Control Rods	45
Max Clad Surface Temp, °F	651	Number of Part-Length Rods (PLR)	None
No. Coolant Loops	4	Compiled by: Heddleson & Others Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: Connecticut Yankee

Exclusion Distance, Miles	0.32
Low Population Zone Distance, Miles	---

Metropolis	Distance	Population
Meriden, Conn.	16 mi	55,959

Design Basis Earthquake Acceleration, g	0.17
Operating Basis Earthquake Acceleration, g	---
Earthquake Vertical Shock, % of Horizontal	68
Is Intent of 70 Design Criteria Satisfied?	---

Design Winds in mph:

At 0 – 50 ft elev	150
50 – 150 ft	
150 – 400 ft	
Tornado	---
ΔP = psi/ sec	

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Design Pressure, psig	40
Max Leak Rate at Design Pressure, %/day	0.1
Calculated Max Internal Pressure, psig	39.1

Type of Construction: Structure is a right circular cylinder with a hemispherical dome and a flat base. The inside diameter is 135 feet (4 1/2' thick walls) and the straight height is 119.5 feet with 2 1/2' thick dome. The construction is reinforced concrete with an interior steel liner which acts as a leakage barrier. The liner is 1/4 inch thick at the bottom, 3/8 inch thick on the cylindrical walls and 1/2 inch thick on the dome. A 2 ft thick concrete floor was poured over the bottom liner.

Design Basis: Designed to limit the consequences of any release of radioactive material resulting from a loss of reactor coolant.

Vacuum Relief Capability: Designed for 7.5 psi external pressure. Found no reference to relief valves.

Post-Construction Testing: Strength test at 46 psig for one hour. Leakage rate test will be run for 24 hrs at 40 psig and at 15 psig. Periodic leak tests will be run after operation begins.

Penetrations: Electrical penetrations are double sealed and individually testable. Some piping penetrations are double sealed and individually testable.

Weld Channels: Channels are welded over each liner seam weld. Freon gas was introduced into channels and tested with a halogen leak detector.

D2. CONTAINMENT SAFETY FEATURES — Reactor: Connecticut Yankee

Containment Spray System: Installed as backup for recirculation cooling system for use after a LOCA. System uses residual heat removal pumps, heat exchangers, and a spray header ring. System is initiated by LOCA.

Containment Cooling: For normal cooling and after LOCA, an air recirculation system consits of 4 fan-coil units each handling 65,000 cfm. System includes distribution duct work.

Containment Isolation System: An isolation system is available that automatically shuts off valves on penetrations through the containment wall. Most penetrations have valves on both sides.

Containment Air Filtration: The 4 air recirculating units have filter banks attached to inlet plenum, consisting of moisture separator, HEPA filters, and activated charcoal filters with a charcoal spray to control filter temperature.

Penetration Room: There is a room for electrical penetrations.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: None mentioned.

High-head Safety Injection: Two charging pumps deliver 360 gpm each at 2300 psig. Also, two high pressure safety injection pumps can each provide 1750 gpm at 975 psig for small break makeup. Suction is taken from the refueling water storage tank which has a capacity of 250,000 gallons. After 100,000 gal is used, 150,000 gpm is held for later emergencies. System is actuated by low pressurizer pressure, and low pressurizer water level backed up by high containment pressure.

Low-head Safety Injection: Two heat removal system pumps provide a core deluge system to flood the core when system pressure drops to about 300 psig. Each of these two pumps are rated 2200 gpm at 110 psig and take suction from the refueling water storage tank. Actuation signal is the same as the one for high head pumps. These pumps provide recirculation flow from the containment sump after about half of the refueling water storage tank water has been used up.

E. OTHER SAFETY-RELATED FEATURES

Reactor: Connecticut Yankee

Reactor Vessel Failure: No reference found.

Containment Floodability: No reference found.

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

Failed-Fuel-Detection System: No reference found.

Emergency Power: Two diesel-generator sets each rated 2850 kw supply power to emergency electrical busses at 4160v. Both units are housed in the same Class I building in separate rooms separated by a 12" thick concrete wall. Each diesel-generator set has its own starting system, controls, etc. Each unit has a day tank with capacity for 2 hrs. operation and each has a 5000 gal storage tank nearby.

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Part length rods not mentioned. Axial power controlled by control rods and boron solution in coolant. No reference found to in-core instrumentation.

Boron Dilution Control: Because of the procedures involved in the dilution process, an erroneous dilution is considered incredible. 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: Accomplished by residual heat removal pumps taking suction from containment sump and recirculating borated water.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: No reference found.

F. GENERAL

Reactor: Connecticut Yankee

Windspeed, Direction Recorders, and Seismographs: A 100 ft tower with meteorological instruments has recorded data since 1962 at 25' and 129' mean sea level elevations. No reference found to seismographs.

Plant Operation Mode: Base loaded.

Site Description: Located in the Connecticut River Valley on the Northwest side of the river on a flat-like flood plain on a sort of peninsula formed by the Salmon River because of its angle of approach to the Conn. River. The western river bank rises up steeply and the banks north of the plant rise up steeply. River water here is fresh although a salt water wedge just about reaches the site.

Turbine Orientation: Ejected turbine blades could strike containment. Turbine-generator was supplied by Westinghouse.

Emergency Plans: Emergency procedures have been prepared, delineating operator action to assist in, and back up, the safety securement of the plant. Copies of all emergency procedures are on file at the plant. Copies are maintained by the operators and are kept in the main control room. Certain parts of the emergency procedures must be known and memorized by the licensed personnel, so as to result in immediate recognition and appropriate action following an emergency. The emergency procedures were evolved by the joint effort of Westinghouse and Conneciticut Yankee engineers and senior operating personnel.

Environmental Monitoring Plans: Monitoring started in 1962 to obtain background data. Air samples determined gross beta activity, river water samples were taken for gross alpha and beta. In 1964 collecting of river sediments, soils, vegetation and biological life was started. After operation, the same general program continued with changes made for improvements as needed.

Radwaste Treatment: Processes followed are 1) holdup in storage tanks for decay, 2) demineralization to remove radioisotopes, 3) filtration to remove insoluable inpurities, 4) evaporation to concentrate radioactivity to small volumes, and 5) dilution by mixing radioactive releases with large volumes of air or water. Liquid wastes are mixed with the circulating water and discharged to the river. Gaseous waste, after suitable decay are released through the primary vent stack to the atmosphere, after dilution and monitoring. Solid wastes are packed into 55 gal drums (cement added for shielding if required) and shipped off-site for disposal.

Plant Vent: 175 ft high stack-probably reinforced concrete.

G. SITE DATA

Reactor: Connecticut Yankee

Nearby Body of Water: Connecticut River

Normal Level ~1' (MSL)
Max Prob Flood Level 23.7' (MSL)

Size of Site 525 Acres **Site Grade Elevation** 21' (MSL)

Topography of Site: Level along the river with steep slopes rising up from river.
of Surrounding Area (5 mi rad): Mostly hilly.

Total Permanent Population: In 2 mi radius 1937 ; 10 mi ______
Date of Data: 1970 In 5 mi radius 8568 ; 50 mi ______

Nearest City of 50,000 Population: Meriden, Conn.
Dist. from site 16 **Miles, Direction** WNW , **Population** 55,959

Land Use in 5 Mile Radius: 80% wooded.

Meteorology: Prevailing wind direction NNW Avg. speed 8 mph
Stability Data - Stable conditions about 1/2 time.

Miscellaneous Items Close to the Site: Several small communities are close to the site, Haddam (pop ~400) being about 1 mi away just across the river. Haddam Meadows State Park is less than one mile from the reactor. The N.Y. New Haven and Hartford RR runs along the SW river bank adjacent to state route 9. Access to the plant is from state route 151.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

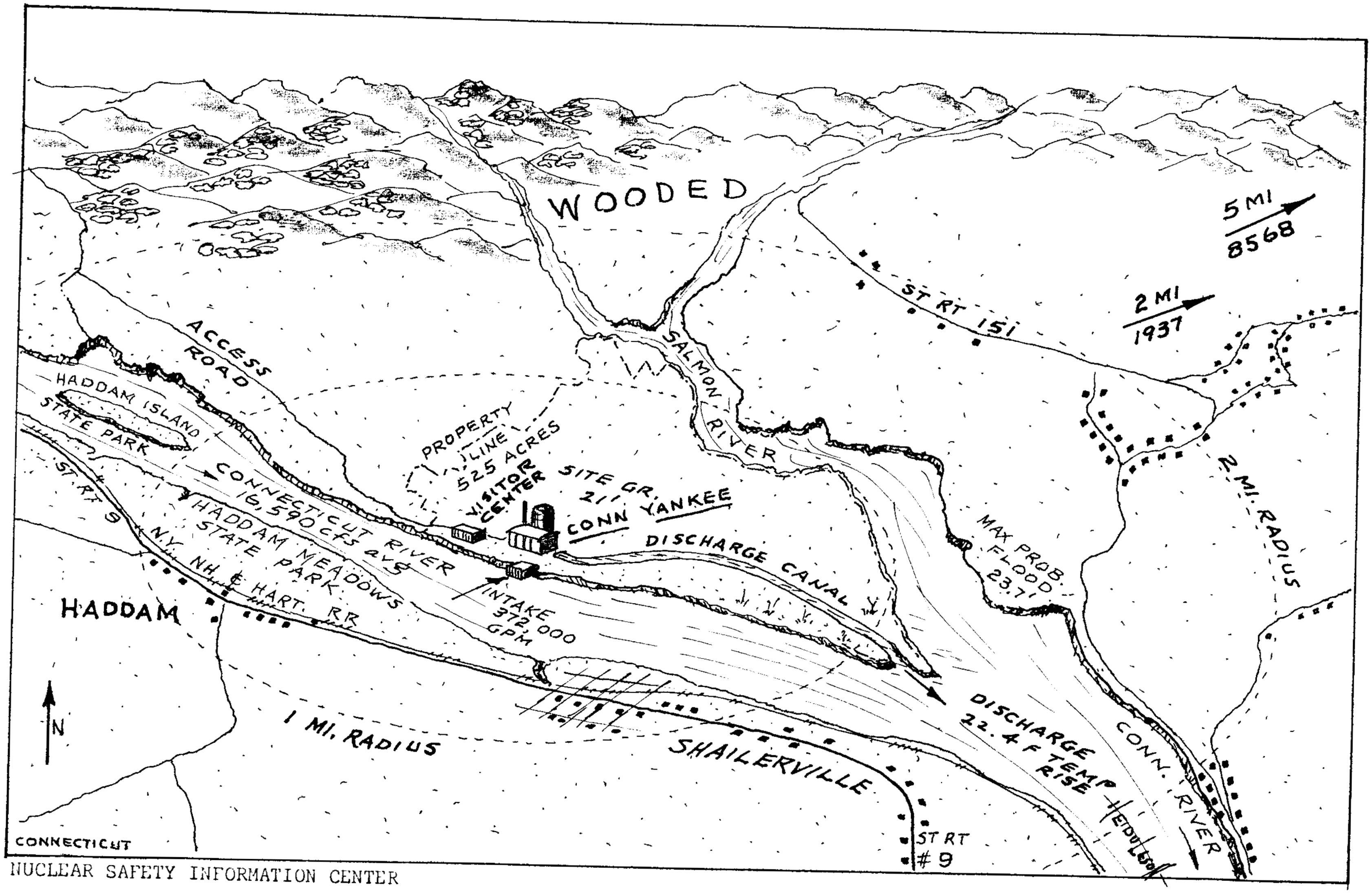
Water Taken From: Connecticut River

Intake Structure: Built at shore line with river bottom dredged to facilitate water entry. Velocity through trash rack about 1 fps. Trash racks and pumps are also housed in the structure.

Water Body Temperatures: Winter minimum 34 °F Summer maximum 85 °F
River Flow 1,060 (cfs) minimum; 16,590 (cfs) average
Service Water Quantity 24,000 gpm/reactor
Flow Thru Condenser 372,000 (gpm)/reactor Temp. Rise 22.4 °F
Heat Dissipated to Environment --- (Btu/hr)/reactor
Heat Removal Capacity of Condenser 4100×10^6 (Btu/hr)/reactor

Discharge Structure: Water from condenser flows over a weir and enters the discharge canal which flows into the river about 1 mile below the plant. Velocity of flow entering the river is 0.2 fps.

Cooling Tower(s): Description & Number - None
Blowdown ______ gpm/reactor Evaporative loss ______ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

OYSTER CREEK, 50-219

Project Name: Oyster Creek Nuclear Generating Station

Location: Lacey Township, N. J.

Owner: Jersey Central Power & Light Company

A-E: Burns & Roe

Vessel Vendor: Combustion Eng.

NSS Vendor: General Electric

Containment Constructor: Chicago Bridge & Iron

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1930	H_2O/UO_2 Volume Ratio	2.38
Electrical Output, MWe	640 (Net)	Moderator Temp Coef Cold, Δk/k/°F	-6.0×10^{-5}
Total Heat Output, Safety Design, MWt	1930	Moderator Temp Coef Hot, No Voids	-19.0×10^{-5}
Steam Flow Rate, lb/hr	7.259×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	61.0×10^6	Moderator Void Coef Operating	-1.3×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	49,137	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	17.2	Doppler Coefficient, Operating	-1.2×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	392,700	Initial Enrichment, %	2.1
Average Heat Flux, Btu/hr-ft^2	129,632	Average Discharge Exposure, MWD/Ton	15,000
Maximum Fuel Temperature, °F	4175	Core Average Void Within Assembly, %	29.2
Average Fuel Rod Surface Temp, °F	558	k_{eff}, All Rods In	.96
MCHFR	1.901	k_{eff}, Max Rod Out	.99
Total Peaking Factor	3.03	Control Rod Worth,	∿.01 Δk
Avg Power Density, Kw/ℓ	40.6	Curtain Worth,	–.10 Δk (Total)
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	Gadolinium Oxide in Fuel Rods.
		Number of Control Rods	137
		Number of Part-Length Rods (PLR)	None

Compiled by: Oyster Creek Personnel 8/73
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: Oyster Creek

Exclusion Distance, Miles	25	
Low Population Zone Distance, Miles	2	
Metropolis	Distance	Population
Atlantic City	35 Miles	175,043
Design Basis Earthquake Acceleration, g	.22	
Operating Basis Earthquake Acceleration, g	.11	
Earthquake Vertical Shock, % of Horizontal	65 to 70	

Design Winds in mph:	
At 0 — 50 ft elev	100
50 — 150 ft	130
150 — 400 ft	150
Tornado	360
ΔP = 3 psi/ 3 sec	
Is Intent of 70 Design Criteria Satisfied?	---

Recirculation Pumping System & MCHFR:
Decrease in flow rate through recirculation pumping system causes power decrease. Flow maintained to prevent MCHFR from reaching fuel-damage limits.

Protective System:
Receives inputs from sensors monitoring selected parameters in plants and initiates operation of protective devices. Over-rides all other plant operating and control systems.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Drywell Design Pressure, psig	62	Primary Containment Leak Rate, %/day	.5
Suppression Chamber Design Pressure, psig	35	Second Containment Design Pressure, psig	.25
Calculated Max Internal Pressure, psig	33	Second Containment Leak Rate, %/day	100

Type of Construction:
Primary construction is a vertical cylindrical insulated pressure vessel of high strength alloy carbon steel. Drywell is a steel pressure vessel with spherical lower portion and a cylindrical upper portion. The suppression chamber is a steel pressure vessel in the shape of a torus below and encircling the drywell.

Design Basis:
To provide the capability, in the event of a postulated LOCA, to limit the release of fission products to plant environment so that off-site doses are in compliance with those specified in 10CFR100.

Vacuum Relief Capability
Used to prevent the primary containment from exceeding the external design pressure.

Post-Construction Testing:
Drywell and suppression chamber are leak tested and pressure tested at 1.15 times their design pressure. Periodic leakage tests are done during plant life.

Penetrations:
Pipe penetrations use bellows expansion seal. Electrical penetrations require bonding resin in the seal.

D2. EMERGENCY CORE COOLING SYSTEMS Reactor: Oyster Creek

Core Spray Cooling System:
Two independent core spray system loops are provided with two full capacity pumps and booster pumps in each loop. Draws suction from absorption pool and sprays into reactor vessel. Each pump has flow capacity of 3400 gpm. Each loop delivers this rated flow of 3400 gpm at 285 psig.

Auto-Depressurization System:
Utilizes pressure relief valves to reduce reactor system pressure. Valves open automatically on simultaneous occurrence of low-low-low reactor water level, high drywell pressure and activation of core spray pumps.

Residual-Heat-Removal System (RHRS):
System utilizes pumps, heat exchangers and piping to perform three main functions: The removal of decay heat during and after shutdown; low-pressure coolant injection following loss-of-coolant accident; and the removal of heat from containment following a loss-of-coolant accident by pumping water from suppression pool to prevent excessive temperature rise in the suppression pool.

High-Pressure Coolant-Injection System:
Requires condensate and feedwater pump in normal feedwater train. Powered by two diesel generators. Prevents fuel temperatures from exceeding 2000°F and fuel failures for break of .02 sq ft. Triggered by high drywell pressure and low reactor water level.

Low-Pressure Coolant-Injection System:
The low-pressure coolant injection system consists of a core spray system which is initiated by a loss of coolant from break sizes larger than about .075 sq ft.

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors:
Provided in each main steam line between the vessel and the first isolation valve to limit steam flow in the event of a steam line break.

Control-Rod Velocity Limiters:
The maximum free-fall velocity which the rod itself can achieve is limited by the hydraulic characteristics of velocity limiter to <5 ft/sec.

Control-Rod-Drive-Housing Supports:
Prevents rod ejection accident by limiting motion of rod to less than 3 inches in event of housing failure. May be removed and inspected on shutdown.

Standby Liquid-Control System:
Used for reactivity control when control rods can't shut down reactor. Contains at least 3310 gallons of 13% sodium pentaborate solution.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: Oyster Creek
Standby Coolant System: Includes core spray system, automatic depressurization system, containment cooling system, emergency water system, high drywell pressure system, low feed water flow system and main steam line high flow system.
Containment Atmospheric Control System: Designed to maintain an inert atmosphere with the primary containment to preclude energy releases from a possible hydrogen-oxygen reaction following a postulated loss-of-coolant accident.
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 systems. Can be manually started. Removes decay heat and provides makeup water if feedwater pumps are inoperative.
Reactor Vessel Failure: Vessel designed and fabricated to very high standard of quality to assure low probability of failure.
Containment Floodability: Neither required nor practical based on an evaluation of the as-built system.
Reactor-Coolant Leak-Detection System: Includes five indicators: equipment drain pump flow, floor drain pump flow, closed cooling water temperature rise, drywell temperature rise, and drywell pressure rise. Has sensitivity spectrum from <5 gpm to leakage from which automatic action will result.
Failed-Fuel Detection Systems: Consists of gamma radiation monitors external to main steam lines located just outside of primary containment. Designed to detect large release of fission products from fuel. Trip signals generated by monitor initiate scram and isolate radioactive material released.
Emergency Power: Two 2500 Kw diesel generators are provided in the event of an emergency. A 15,000 gallon fuel oil storage tank provides fuel that would last three days for one of the 2500 Kw diesel generators operating continuously at full load.
Rod-Block Monitor: Uses LPRM signals to block control rod withdrawal which may result in fuel damage.
Rod-Worth Minimizer: Designed as a backup to the reactor operator that will block rod motion if rod withdrawal sequence procedures are violated.

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F. GENERAL

Reactor: Oyster Creek

Windspeed, Direction Recorders, and Seismographs:

Wind speed and temperature have been continuously recorded at the 75 and 400 ft levels above grade since 1966.

Plant Operation Mode:

Load following. Power correspondingly decreases with flow through recirculation pumps.

Site Description:

Located on the Atlantic Coast of New Jersey. The 1416-acre site is partially in Lacey and partially in Ocean Townships of Ocean County. It is approximately two miles inland from the shore of Barnegat Bay. Surrounding area is mostly undeveloped. Many severe storms have hit the area, with a hurricane or tornado striking about once each year.

Turbine Orientation: Ejected turbine blades could strike containment. Centerlines approximately 138 feet apart.

Emergency Plans:

Practice drills and training will be required of personnel in order that they may cope with any emergency, such as fire, radiation exposure, contamination, etc., in the most effective manner. Outside organizations, fire department, state police, AEC and hospitals will be called upon as needed.

Environmental Monitoring Plans:

The site environs monitoring subsystem provides continuous monitoring of radiological conditions at three selected site-boundary locations. A pre-operational program sampling clams, water and sediment will be continued every 4 weeks during the first year of operation. Other items to be monitored include rain, wells, milk, and crops.

Radwaste Treatment:

Wastes will be collected, stored, processed and diluted for release or shipment off site. After processing, liquid wastes will be either shipped off site or diluted and released in the condenser cooling water. Gases will be collected and compressed in tanks to allow for decay and/or release through 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.

Plant Vent:

Includes one baffled inlet, two tees with flow out the branch, one elbow and one sudden expansion outlet.

G. SITE DATA

Reactor: Oyster Creek

Nearby Body of Water: Atlantic Ocean

Normal Level 0 (MSL)

Max Prob Flood Level 21.5 ft (MSL)

Size of Site 1416 Acres

Site Grade Elevation 23 ft (MSL)

Topography of Site: Flat

of Surrounding Area (5 mi rad): Rolling plains to flat lowlands.

Total Permanent Population: In 2 mi radius 2514 ; 10 mi 45,586

Date of Data: 1970 In 5 mi radius 9835 ; 50 mi 3,483,895

Nearest City of 50,000 Population: Atlantic City, New Jersey

Dist. from site 35 Miles, Direction SSW, Population 53,000 (1970)

Land Use in 5 Mile Radius:
Mostly undeveloped except for limited recreational, farming, and residential areas.

Meteorology: Prevailing wind direction WNW Avg. speed 7 mph

Stability Data - Steady breeze from coast blows inland.

Miscellaneous Items Close to the Site:
Located between the N.J. Garden State Parkway and State Highway No. 9. Nearest town is Forked River (∿2 mi.) with nearest area of sizable population being Dover Township with 30,340. A large influx of summer recreation people occurs in the summer.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Barnegat Bay & Forked River

Intake Structure:
Structure has two sections, each containing a three-section trash rack and traveling water screen, two emergency pumps, one service water pump and one screen wash system.

Water Body Temperatures: Winter minimum 35 °F Summer maximum 83 °F

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

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 460,000 (gpm)/reactor Temp. Rise 14 °F

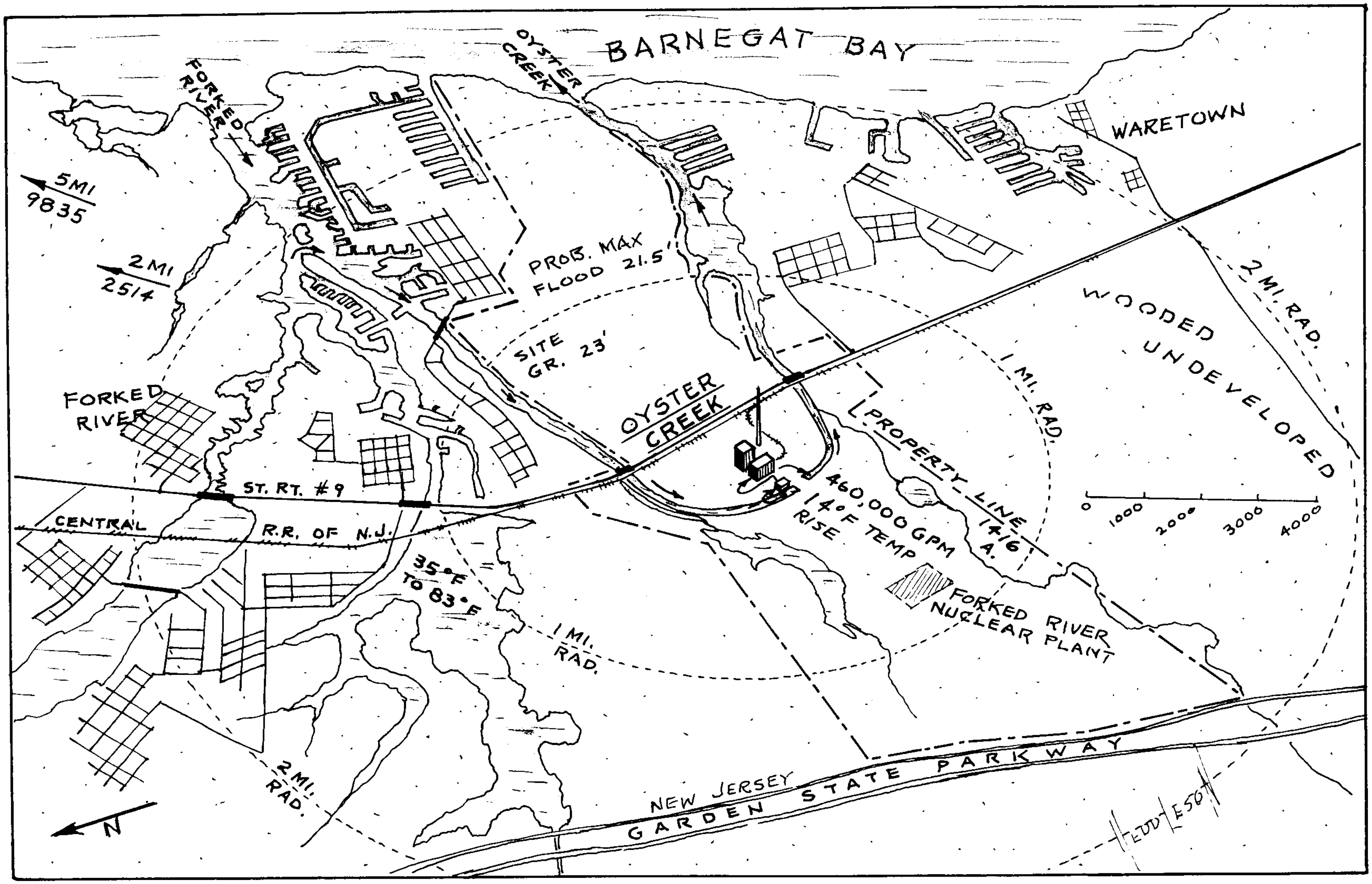
Heat Dissipated to Environment 12.8×10^6 (Oyster Creek & ~~Forked River)~~ (Btu/hr)/reactor

Heat Removal Capacity of Condenser 4500×10^6 (Btu/hr)/reactor

Discharge Structure:
Water enters a ten-foot, six-inch square discharge tunnel leading to discharge canal.

Cooling Tower(s): Description & Number - None

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



NUCLEAR SAFETY INFROMATION CENTER

Page 1 (BWR)

NINE MILE POINT, 50-220

Project Name: Nine Mile Point Nuclear Station Unit 1

Location: Scriba, New York

Owner: Niagara Mohawk Power Corp.

A-E: Niagara Mohawk
Vessel Vendor: C.E.
NSS Vendor: General Electric Co.
Containment Constructor: C.B. & I.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1850	H_2O/UO_2 Volume Ratio	2.38
Electrical Output, MWe	650	Moderator Temp Coef Cold, Δk/k/°F (BO2)	-9.0×10^{-5}
Total Heat Output, Safety Design, MWt	1850	Moderator Temp Coef Hot, No Voids	-18×10^{-5}
Steam Flow Rate, lb/hr	7.29×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-5}
Total Core Flow Rate, lb/hr	67.5×10^6	Moderator Void Coef Operating	-1.3×10^{-5}
Coolant Pressure, psig	1030	Doppler Coefficient, Cold	-1.2×10^{-5}
Heat Transfer Area, ft^2	46,680	Doppler Coefficient, Hot, No Voids	-1.0×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	17.5	Doppler Coefficient, Operating	$\leq 1.2 \times 10^{-5}$
Maximum Heat Flux, Btu/hr-ft^2	402,500	Initial Enrichment, %	2.10% Avg.
Average Heat Flux, Btu/hr-ft^2	130,500	Average Discharge Exposure, MWD/Ton	15,000 MWD/ST
Maximum Fuel Temperature, °F	4250	Core Average Void Within Assembly, %	30.5
Average Fuel Rod Surface Temp, °F	560	k_{eff}, All Rods In	.96
MCHFR	1.90	k_{eff}, Max Rod Out	<.99
Total Peaking Factor	3.06	Control Rod Worth, % (In Sequence)	<1%
Avg Power Density, Kw/ℓ	41	Curtain Worth, %	--
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	Gd_2O_3
		Number of Control Rods	129
		Number of Part-Length Rods (PLR)	0

Compiled by: Nine Mile Point Personnel 8/73
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA	Reactor: NINE MILE POINT #1
Exclusion Distance, 4000 Ft. to the west Over a mile to E., 1½ Mile to South	Design Winds in mph:
Low Population Zone Distance, 6500 Meters	At 0 — 50 ft elev
Metropolis / Distance / Population: Syracuse / 36 / 635,946	50 — 150 ft 125 mph at 30 Feet
Design Basis Earthquake Acceleration, g 0.11 g	150 — 400 ft Tornado ---
Operating Basis Earthquake Acceleration, g ---	ΔP = --- psi/--- sec
Earthquake Vertical Shock, % of Horizontal ---	Is Intent of 70 Design Criteria Satisfied? ---

Recirculation Pumping System & MCHFR:

Five external pumps driven by variable speed electric motors. MCHFR = 1.9 @ 100% flow.

Protective System: A dual-logic channel protective system (one-out-of-two system used twice) is provided to automatically initiate appropriate action whenever specific station conditions reach pre-established limits.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Drywell Design Pressure, psig 62	Primary Containment Leak Rate, 0.5 w/o per day
Suppression Chamber Design Pressure, psig 35	Second Containment Design Pressure, psig N/A
Calculated Max Internal Pressure, psig DW=50 T=25	Second Containment Leak Rate, %/day 100

Type of Construction: The drywell is a steel pressure vessel with a 70 ft. diameter spherical lower portion and a 33 ft. dia. cylindrical upper portion. The pressure suppression chamber is a steel pressure vessel in the shape of a torus below and encircling the drywell. The primary containment is surrounded by the reactor building for secondary containment.

Design Basis: To provide capability in event of postulated LOCA to limit fission-product release so that off-site doses would be held below 10 CFR 100 limits. Design basis accident is a double ended break of a reactor coolant recirculation line.

Vacuum Relief Capability To prevent containment pressure from dropping below the vacuum rating of 2 psi for the drywell and 1 psi for the suppression chamber, relief valves are provided.

Post-Construction Testing: Two integrated leak rate tests at pressures of 35 psig and 22 psig and subsequent testing as per technical specifications.

Penetrations: Penetrations have a double-seal arrangement which can be pressurized to allow verification of tightness.

D2. EMERGENCY CORE COOLING SYSTEMS Reactor: Nine Mile Point #1

Core Spray Cooling System: Two independent loops, each with two sets of pumps and one reactor vessel spray sparger ring. Each set of pumps is sized to deliver 3400 gpm to the spray nozzles at 113 psid. Water is supplied from the suppression pool. Each core spray system operating with only one set of pumps can remove all decay heat from the core.

Auto-Depressurization System: Six solenoid-actuated relief valves are provided to depressurize the primary system to approx. 50 psi. The signals for initiation are simultaneous low-low reactor water level, high-high drywell pressure, and lo-lo-lo reactor water level.

Residual-Heat-Removal System (RHRS):

N/A

High-Pressure Coolant-Injection System: The HPCI system consists of existing feedwater and condensate pumps. The sources of water are the condenser hotwell and condensate storage tanks. The system is initiated by either a turbine trip signal or a reactor low water level signal, and will supply 3800 gpm at a reactor pressure of 1000 psig.

Low-Pressure Coolant-Injection System:

N/A

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors: Venturi tube in each main steam line between the reactor vessel and first isolation valve to limit the loss of coolant in event of main steam line break. The ratio of diameters is approx. 0.57 which limits flow to 200% of rated.

Control-Rod Velocity Limiters: An integral part of the bottom of each control rod limits the free fall drop velocity to 5 ft/sec or less, thus limiting the rate of reactivity addition.

Control-Rod-Drive-Housing Supports: Limits accidental reactivity addition in the event of a CRD housing failure. The housing support permits less than 3 inches of total control rod motion.

Standby Liquid-Control System: Provides redundant capability to bring the reactor to the cold shutdown condition at any time in core life independent of the control rod system capabilities. A 13.5% solution of sodium pentaborate is used.

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E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: Nine Mile Point #1
Standby Coolant System: Consists of 3 systems; HPCI, Core Spray, Automatic Depressurization System.
Containment Atmospheric Control System: Six water-cooled heat exchanger fan units maintain temp. below 150°F during normal operation, A purge system provides ventilation for maintenance operations and purges containment if radioactivity is above limits. A liquid nitrogen system is available to inert the entire primary containment for reactor operation.
Reactor Core Isolation Cooling System (RCICS): N/A
Reactor Vessel Failure: N/A
Containment Floodability: A system is provided to manually flood the containment after an accident. Fire pumps supply water to the reactor through the feedwater header. This water spills thru the broken line to drywell.
Reactor-Coolant Leak-Detection System: A double "O" ring type seal is provided on the reactor vessel head closure. The area between the seals is monitored for leakage. Other leakage from valves,pumps, etc, is detected by high water level in the drywell sump tank.
Failed-Fuel Detection Systems: Main steam line monitoring system will indicate failed fuel by high radiation readings in either main steam line. There are 4 monitoring channels and the system is capable of initiating automatic reactor shutdown.
Emergency Power: Two completely independent emergency diesel generator systems are provided, each having a capacity adequate to provide power to all of the loads deemed essential on an emergency basis. Each diesel generator is housed in a separate room and is capable of supply 2950 kw. Each diesel has its own 4160 v switch gear and 600 v unit sub-station. Diesel fuel is available for 4 days of continuous operation. The estimated total load is 4050 hp.
Rod-Block Monitor: N/A
Rod-Worth Minimizer: Computer programmed sequences that assist the operator in manual control so rod movements are sequenced to achieve minimum rod-worth changes.

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F. GENERAL	Reactor: Nine Mile Point #1

Windspeed, Direction Recorders, and Seismographs:

1-Bendix wind speed, Direction recorder
1-Seismic recording system consisting of detectors located in various locations in the building, 4 of which will record fault characteristics when triggered by sufficient vibration-acceleration.

Plant Operation Mode:

Base loaded power production.

Site Description: The Nine Mile Point-JAF Site comprises approx. 1500 acres on the southeast shore of Lake Ontario. Station Buildings are situated in the western quadrant of a 200 acre cleared area centrally located along the lake shore. Site grade is 261' MSL which is well above normal lake level of 240'. For many miles around the site the country is characterized by rolling terrain rising gently up from the lake.

Turbine Orientation:

The turbine center line is east-west

Emergency Plans: On-Site emergency plans include procedures for handling contaminated injuries, fires, radiation exposure incidents, restricted area evacuations. Arrangements have been made with two hospitals in the area to handle contaminated injuries. Emergencies which may affect off-site areas are coordinated through the New York State-Bureau of Radiological Health with such agencies as the State Police, Civil Defense, Coast Guard and Sheriffs Office

Environmental Monitoring Plans: Eleven on and off site monitoring stations have been operated since 1969. These stations consist of an air sample, a rainwater collector and a TLD dosimeter. Six of the stations are equipped with a recording gamma dose rate meter. Lake studies are performed in Lake Ontario consisting of fish studies, benthic organism studies, lake water chemistry and radiochemistry, and lake thermal studies.

Radwaste Treatment: Liquid waste are segregated into Hi and Lo conductivity wastes and Hi and Lo radioactivity wastes. Lo conductivity wastes are recovered and returned to the condensate storage system. Hi conductivity-Hi activity wastes are concentrated, Lo activity waste are discharged to environment within 10 CFR 20 limits. Solid waste are removed from the site in either 55 gal. drums or concrete shipping casks for disposal by contractors. At present turbine air ejector off gases are processed through a 30 min hold up pipe and to a 350' stack. The off gas system is being modified to include a recombiner charcoal hold up system to be operating by 1975.

Plant Vent: All building ventilation is routed to the 350' stack. This includes reactor building, turbine building, administration building and rad-waste building.

G. SITE DATA

Reactor: Nine Mile Point #1

Nearby Body of Water: Lake Ontario Normal Level 246' (MSL)
Max Prob Flood Level --- (MSL)

Size of Site 1500 Acres Site Grade Elevation 261' (MSL)

Topography of Site: Flat to rolling
of Surrounding Area (5 mi rad): Rolling terrain rising gently up from lake.

Total Permanent Population: In 2 mi radius 300 ; 10 mi 29,900
Date of Data: 1960 Census In 5 mi radius 1200 ; 50 mi

Nearest City of 50,000 Population: Syracuse, N.Y.
Dist. from site 36 Miles, Direction South, Population 216,038

Land Use in 5 Mile Radius:

Residential, agricultural, recreational

Meteorology: Prevailing wind direction SW Avg. speed ---
Stability Data - ---

Miscellaneous Items Close to the Site:

Nine Mile Point Progress Center - On site
J.A. FitzPatrick Nuclear Power Plant - On Site

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Lake Ontario

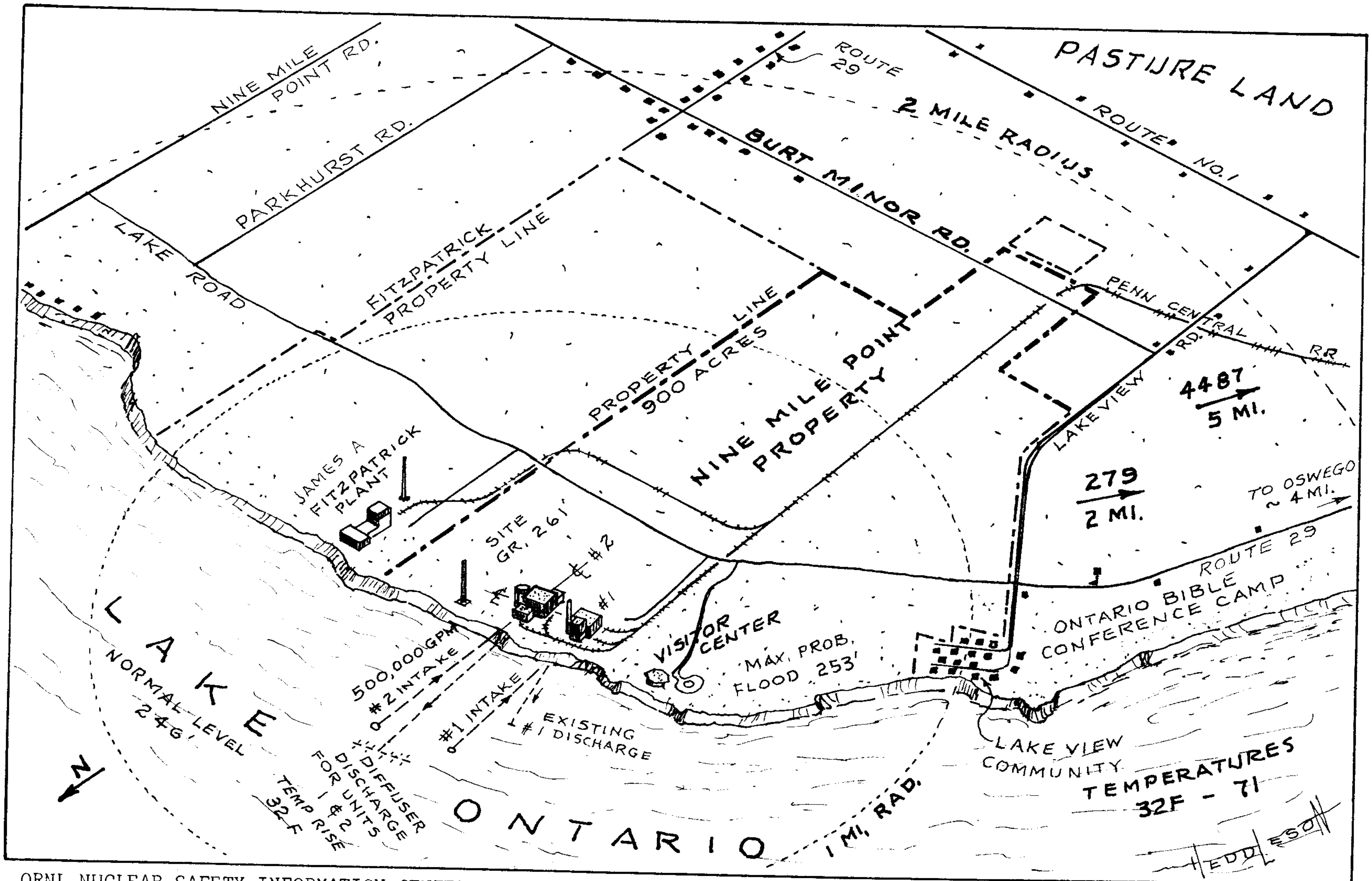
Intake Structure:

Inlet tunnel under lake bottom, concrete lined extending, approximately two tenths of a mile off-shore.

Water Body Temperatures: Winter minimum 34 °F Summer maximum 78 °F
River Flow N/A (cfs) minimum; N/A (cfs) average
Service Water Quantity 19,200 gpm/reactor
Flow Thru Condenser 250,000 (gpm)/reactor Temp. Rise 32 °F
Heat Dissipated to Environment 4100 MBTU/hr (Btu/hr)/reactor
Heat Removal Capacity of Condenser (Btu/hr)/reactor

Discharge Structure: Concrete-lined tunnel under the lake bottom extending approximately on tenth of a mile off-shore.

Cooling Tower(s): Description & Number - N/A
Blowdown gpm/reactor Evaporative loss gpm/reactor



ORNL NUCLEAR SAFETY INFORMATION CENTER

DRESDEN 50-237, 50-249

Project Name: Dresden Nuclear Power Station Units 2 & 3
Location: Grundy County, Morris, Illinois
Owner: Commonwealth Edison Co.

A-E: ---
Vessel Vendor: Babcock & Wilcox
NSS Vendor: General Electric Co.
Containment Constructor: ---

A. THERMAL-HYDRAULIC

Thermal Output, MWt	2527
Electrical Output, MWe	809 net
Total Heat Output, Safety Design, MWt	3032
Steam Flow Rate, lb/hr	9.945×10^{6}
Total Core Flow Rate, lb/hr	98×10^{6}
Coolant Pressure, psig	1015
Heat Transfer Area, ft^2	62,640
Max Power per Fuel Rod Unit Lgth, kw/ft	17.5
Maximum Heat Flux, Btu/hr-ft^2	405,000
Average Heat Flux, Btu/hr-ft^2	131,860
Maximum Fuel Temperature, °F	3470
Average Fuel Rod Surface Temp, °F	1050
MCHFR	3.18
Total Peaking Factor	3.1
Avg Power Density, Kw/ℓ	41.08
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280

B. NUCLEAR

H_2O/UO_2 Volume Ratio	2.41
Moderator Temp Coef Cold, Δk/k/°F	-8.0×10^{-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	-1.4×10^{-3}
Doppler Coefficient, Cold	-1.2×0^{-5}
Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Doppler Coefficient, Operating	-1.2×10^{-5}
Initial Enrichment, %	2.12
Average Discharge Exposure, MWD/Ton	19,000
Core Average Void Within Assembly, %	38.0
k_{eff}, All Rods In	.96
k_{eff}, Max Rod Out	.99
Control Rod Worth, %	17
Curtain Worth, %	---
Burnable Poisons, Type and Form	Gadolina Rods
Number of Control Rods	177
Number of Part-Length Rods (PLR)	---

Compiled by: Dresden Plant Personnel 8/73
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Dresden Units 2 & 3	
Exclusion Distance, Miles	.5 mi radius		Design Winds in mph:	
Low Population Zone Distance, Miles	---		At 0 — 50 ft elev	170 mph
Metropolis	Distance	Population	50 — 150 ft	170 mph
Chicago, Illinois	47	6,978,947	150 — 400 ft	
Design Basis Earthquake Acceleration, g	.2		Tornado	500 mph
Operating Basis Earthquake Acceleration, g	.1		ΔP = 2.52 psi/ 1/2 sec	
Earthquake Vertical Shock, % of Horizontal	67		Is Intent of 70 Design Criteria Satisfied?	---

Recirculation Pumping System & MCHFR: Analysis indicates that the MCHFR at 2527 MWt and rated flow will be $\geq$1.50 for the higher design peaking factors of 1.30 local, 1.57 axial, and 1.47 relative assembly power.

Protective System: Provides protection against consequences of conditions that threaten integrity of nuclear system process barrier by scramming the reactor following abnormal operational transients.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT			
Drywell Design Pressure, psig	62	Primary Containment Leak Rate, %/day	.5
Suppression Chamber Design Pressure, psig	62	Second Containment Design Pressure, psig	.25
Calculated Max Internal Pressure, psig	---	Second Containment Leak Rate, %/day: In-leakage 100% @ —.25 in. water neg pressure.	

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 158,236 ft^3 and suppression chamber free volume is 117,245 ft^3.

Design Basis:

To provide a barrier which, in the event of a loss of coolant accident, will control the release of fission products and to rapidly reduce the pressure in the containment resulting from loss-of-coolant accident.

Vacuum Relief Capability

Designed for 0.5 differential pressure.

Post-Construction Testing:

Testing includes integrated leakage rate tests of penetrations and valves and operability tests of isolation valves.

Penetrations:

Testing of penetrations include pressure testing of the penetrations, access openings and flanged openings.

D2. EMERGENCY CORE COOLING SYSTEMS	Reactor: Dresden Units 2 & 3

Core Spray Cooling System:

Provided to prevent any fuel clad melting as a result of the various postulated LOCA's through the use of two sub-systems each independent and full capacity systems. Each system consists of a 4500 gpm pump, valves and piping, and an independent circular sparger ring inside the inner shroud just over the core.

Auto-Depressurization System:

Provides protection against overpressure of the reactor under both operational and accidental conditions by venting steam from the reactor into the suppression pool. Accomplished by electromatic relief valves.

Residual-Heat-Removal System (RHRS):

The shutdown cooling system is used to cool the reactor down below 350°F. It will cool the reactor down to 125°F and maintain this temperature. This is accomplished by circulating water from the reactor through the shutdown heat exchangers and back to the reactor. The cooldown rate is controlled by regulating the shutdown pump discharge flow through the shutdown heat exchanger. Cooling water for the heat exchangers is supplied by the reactor building closed cooling-water system.

High-Pressure Coolant-Injection System:

Used to pump water from the condensate storage tank or suppression chamber pool into the reactor in the event of a LOCA. The system consists of an HPCI steam turbine which drives a two-stage pump.

Low-Pressure Coolant-Injection System:

Used to pump water from the suppression chamber into the reactor vessel in the event of a LOCA, to rapidly decrease vessel pressure and to prevent fuel clad melting. Consists of two separate parallel loops, each containing a heat exchanger and two pumps. A ring spray header in the reactor vessel is provided for each loop.

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors: Venturi welded into each steam line between reactor and first isolation valve. This limits steam flow, in case of line break, to permit closure of the steam-line isolation valves before coolant falls below top of core.

Control-Rod Velocity Limiters: Reduces consequences if a high-worth rod dropped out of the reactor core. Accomplished by a single type-304 stainless steel casting in the shape of two nearly mated conical elements.

Control-Rod-Drive-Housing Supports: Prevents ejection of a control rod from the reactor in the event a control rod drive housing should fail. The housing support design was based upon permitting less than three inches of total control rod travel.

Standby Liquid-Control System: To shutdown reactor at any time during core life independent of the control rod system capabilities; sodium pentaborate is pumped into the coolant system.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: Dresden Units 2 & 3

Standby Coolant System:
Used to provide inexhaustible supply of water to condenser hotwell so that feedwater can be maintained to the reactor in the event it is needed for core flooding. The system supplies about 15,000 gpm.

Containment Atmospheric Control System:

Provides drywell and suppression chamber nitrogen inerting capability. Also includes coolers for reducing drywell temperature.

Reactor Core Isolation Cooling System (RCICS):

None

Reactor Vessel Failure:

None

Containment Floodability: Containment is floodable to ensure reactor core remains covered. This is accomplished through the use of the standby coolant system.

Reactor-Coolant Leak-Detection System:

Reactor coolant leak detection is in the form of a continual drywell air sampler and a manifold arrangement where various points can be monitored individually.

Failed-Fuel Detection Systems:

Failed fuel would be detected through the use of the main steam line high radiation monitors and the off gas system continual monitoring system.

Emergency Power:

Should a total loss of auxiliary power from off-site occur, backup power will be supplied from three 2500 Kva diesel generators. Fuel oil supply will provide 100 hours of running at full power.

Rod-Block Monitor: Designed to initiate a rod block under the worst permitted bypass and chamber failure conditions to prevent local fuel damage during the worst single rod withdrawal error starting from any permitted power flow and conditions.

Rod-Worth Minimizer: Continuously monitors control rod positions, compares the operator-selected rod movements and positions against a predetermined rod pattern, and prevents rod movements that are not in accordance with this pattern.

F. GENERAL

Reactor: Dresden Units 2 & 3

Windspeed, Direction Recorders, and Seismographs:

A tower erected at the site continuously records windspeed, direction, temperature, dew point and rain fall. A seismograph is located in the reactor building to measure ground vibration.

Plant Operation Mode:

Load Following

Site Description:

Site is about 47 miles SW of Chicago where the Des Plaines and Kankakee Rivers come together; adjacent to the Dresden lock on the Illinois River. The site is comparatively level with maximum vaira-tion of 25-ft elevation. The area around the site is mostly agri-cultural and industrial.

Turbine Orientation: It is improbable that ejected turbine blades could strike containment.

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:

Environmental monitoring is contracted to outside organizations. Included in the routine sampling are: (1) 17 sample stations for air-borne particulate and iodine samples. Filters are changed weekly at each station. These stations also have ion chambers which are read weekly and TLD's read quarterly. (2) Weekly samples include surface water and milk. (3) Fallout-airborne solids and liquids - monthly; soil - annually; feedcrops - annually; foodstuffs - 3 times per year. (4) Well water - quarterly; bottom sediments - semiannually; slime - quarterly; aquatic animal - quarterly.

Radwaste Treatment: System collects, processes, controls and disposes of potentially radioactive waste from Units 2 & 3. Liquids from the reactor process systems or liquids which have become contaminated are processed according to their purity before being released either for return to the plant as condensate, sent to the discharge canal, or immobilized in drums for eventual disposal offsite. Solid wastes are processed for disposal offsite.

Plant Vent:

Stack height is 310 feet.

G. SITE DATA

Reactor: Dresden Units 2 & 3

Nearby Body of Water: Illinois River and Kankakee River

Normal Level 505' (MSL)
Max Prob Flood Level 508' (MSL)

Size of Site 953 Acres

Site Grade Elevation 516' (MSL)

Topography of Site: Flat

of Surrounding Area (5 mi rad): Rolling prairie

Total Permanent Population: In 2 mi radius 50 ; 10 mi 25,000

Date of Data: 1968 In 5 mi radius 2600 ; 50 mi ____

Nearest City of 50,000 Population: Joliet, Illinois

Dist. from site 14 Miles, Direction NE , Population 75,000

Land Use in 5 Mile Radius:

Agriculture

Meteorology: Prevailing wind direction W Avg. speed 10 mph

Stability Data - Gases would be rapidly diluted and dispersed.

Miscellaneous Items Close to the Site: South of the site is the GE Nuclear Power Plant Training Center. Also located in the same area is GE's Midwest Fuel Recovery Plant. Other activities are the Illinois Clay Products Company (Refractories and Brick Products) and some agricultural operations. A large abandoned strip mine is located in the area also.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Illinois River

Intake Structure:

Canal from the Illinois River to the crib house which contains a screen for removing debris from the water prior to being pumped through plant.

Water Body Temperatures: Winter minimum 40 °F Summer maximum 85 °F

River Flow 3000 (cfs) minimum; 4200 (cfs) average

Service Water Quantity 30,000 gpm/reactor

Flow Thru Condenser 471,000 (gpm)/reactor Temp. Rise --- °F

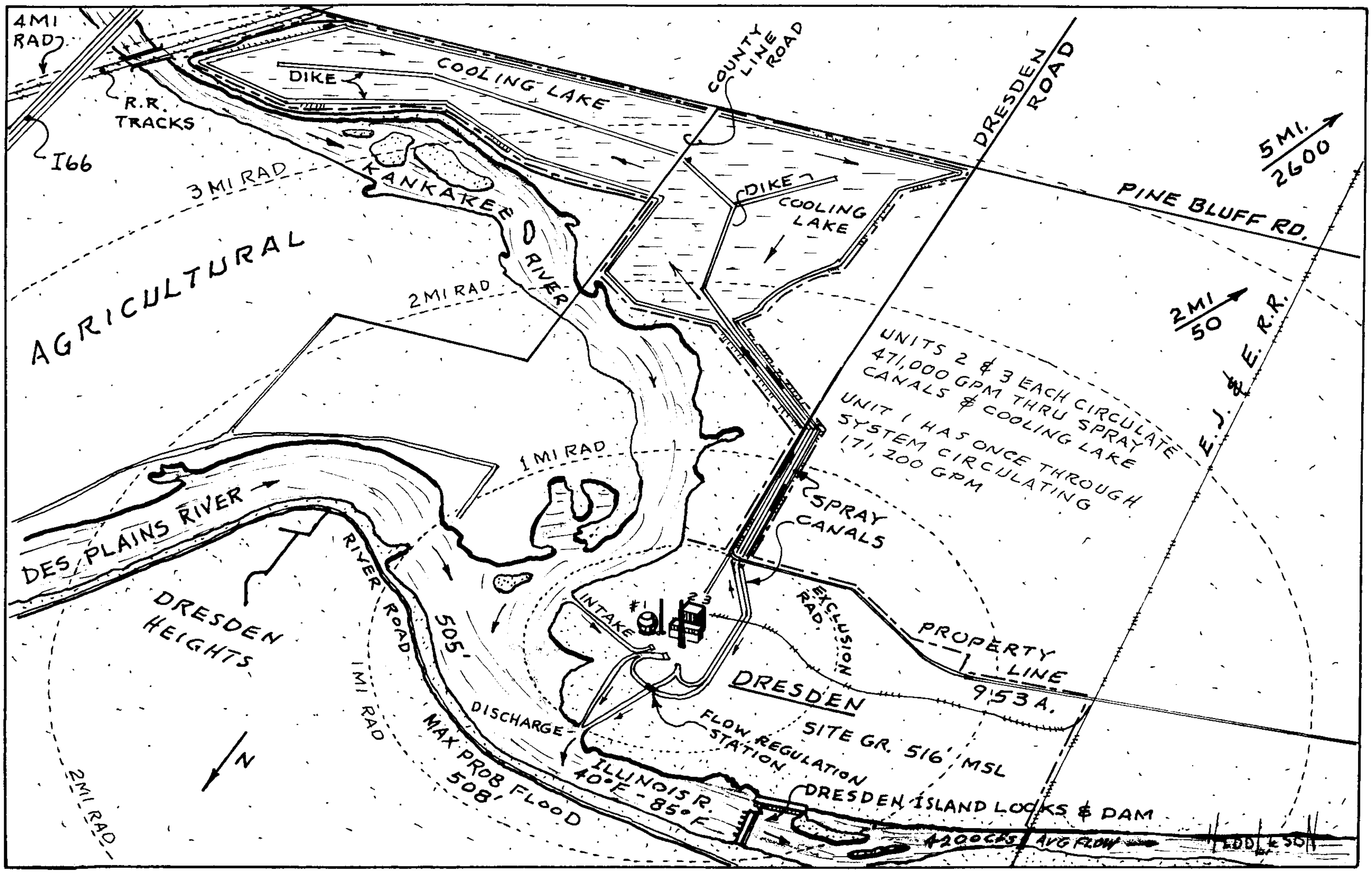
Heat Dissipated to Environment 5.6×10^9 (full power) (Btu/hr)/reactor

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

Discharge Structure: A canal carries water to a cooling lake of approx 1275 acres with a hold-up time of about 3 days. The water then divides, some going back into the Illinois River and some returns to the plant intakes. Spray modules are floated in the canals.

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

Blowdown ____ gpm/reactor Evaporative loss ____ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

GINNA, 50-244

Project Name: Ginna Station

Location: Ontario, N. Y.

Owner: Rochester Gas & Electric

A-E: Gilbert Assoc.
Vessel Vendor: Babco
NSS Vendor: Westinghouse
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1520	H_2O/U, Cold	3.35
Electrical Output, MWe	496	Avg 1st-Cycle Burnup, MWD/MTU	7800
Total Heat Output, Safety Design, MWt	1520	First Core Avg Burnup, MWD/MTU	19227
Total Heat Output, Btu/hr	5180×10^6	Maximum Burnup, MWD/MTU	50000
System Pressure, psia	2250	Region-1 Enrichment, %	2.44
DNBR, Nominal	2.06	Region-2 Enrichment, %	2.78
Total Flowrate, lb/hr	68×10^6	Region-3 Enrichment, %	3.48
Eff Flowrate for Heat Trans, lb/hr	64×10^6	k_{eff}, Cold, No Power, Clean	1.105
Eff Flow Area for Heat Trans, ft^2	27	k_{eff}, Hot, Full Power, Xe and Sm	1.14
Avg Vel Along Fuel Rods, ft/sec	14.8	Total Rod Worth, %	7.18
Avg Mass Velocity, lb/hr-ft^2	2.41×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	2000
Nominal Core Inlet Temp, °F	537.3	Shutdown Boron, No Rods-Clean-Hot, ppm	1602
Avg Rise in Core, °F	60	Boron Worth, Hot, % $\Delta k/k$/ppm	.0086
Nom Hot Channel Outlet Temp, °F	637.8	Boron Worth, Cold, % $\Delta k/k$/ppm	NA
Avg Film Coeff, Btu/hr ft^2-°F	5600	Full Power Moderator Temp Coeff, $\Delta k/k$/°F	.0064
Avg Film Temp Diff, °F	26.9	Moderator Pressure Coeff, $\Delta k/k$/psi	$(-0.3 \text{ to } 3.5)\times10^{-6}$
Active Heat Trans Surf Area, ft^2	28,715	Moderator Void Coeff, $\Delta k/k$/% Void	NA
Avg Heat Flux, Btu/hr ft^2	150,500	Doppler Coefficient, $\Delta k/k$/°F	$(-1 \text{ to } -1.6)\times10^{-5}$
Max Heat Flux, Btu/hr ft^2	508,700	Shutdown Margin, Hot 1 rod stuck, %$\Delta k/k$	2.99
Avg Thermal Output, kw/ft	4.88	Burnable Poisons, Type and Form	44 BPRA
Max Thermal Output, kw/ft	16.5	Number of Control Rods	29
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	4
No. Coolant Loops	2	Compiled by: J. LAY (GINNA) and Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: GINNA

Exclusion Distance, Miles	.29-.85 miles	Design Winds in mph:
Low Population Zone Distance, Miles	3 miles	At 0 — 50 ft elev
Metropolis / Distance / Population		50 — 150 ft
Rochester	20 miles / 882,667	NA
Design Basis Earthquake Acceleration, g	.20	150 — 400 ft
Operating Basis Earthquake Acceleration, g	.08g	Tornado ---
Earthquake Vertical Shock, % of Horizontal	---	ΔP = --- psi/-- sec NA
Is Intent of 70 Design Criteria Satisfied?	Yes, each section of the FSAR discusses manner in which design meets intent of criteria	

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT	Design Pressure, psig 60
Max Leak Rate at Design Pressure, %/day 0.1%	Calculated Max Internal Pressure, psig 52.7

Type of Construction: A 3.5' thk right cylinder with a flat base of 2. The dome is hemispherical 2.5' thk and has a .375" thk steel liner as do the walls. The liner on the base is .250" thk and is covered by 2' of concrete. The dome & wall are of mild steel reinforced prestressed concrete. Rock anchors are also prestressed, and eliminate the need for an approximately 9' thk. base. All principle mild steel reinforcement is done using 2.25 DIA. deformed steel bars.

Design Basis: The design is based upon limiting load factors which are used as the ratio by which dead accident, earthquake, and wind loads are multiplied for design purposes to ensure the load deformation behavior of the structure is one of an elastic low strain reponse.

Vacuum Relief Capability: Design for 2.5 PSI diffierential. There is a remote manually operated depressurization system.

Post-Construction Testing: The containment structure was subjected to an internal pressure of 115% design pressure for 1 hour. All welds bolts, fastenings, liner, seams, etc. were inspected by either Halogen leak detectors, liquid penetrant, spot radiograph, and/or pressure testing.

Penetrations: Double barrier type. The penetrations are designed so that the temperature of the concrete around the penetration does not exceed 150 F. For high temperature piping, a forced air cooling system integrated into the pentrating sleeve, was required.

Weld Channels: Seams in floor liner under concrete fill and all wall and dome seams are pressurized using leak detection channels. The channels are divided into areas so locations of leaks can be determined

D2. CONTAINMENT SAFETY FEATURES Reactor: GINNA
Containment Spray System: 2 spray pumps, 1370 GPM @ 190 PSIG each. 2 spray headers located in the containment structure and one chemical treatment tank with a 5100 gal. capacity Sodium Hydroxide concentration = 30 wt.%
Containment Cooling: The heat released to containment is removed by four 38,000 CFM air recirculation coolers. During normal operation, 3 of 4 air cooling units are required. Each air handling unit transfers 1.575×10^6BTU/hr. to the service heater system during normal operation and 50.0×10^6BTU/hr. for MCA conditions.
Containment Isolation System: Isolation valves are provided as necessary for all fluid system lines penetrating containment to assure 2 barriers for redundance against leakage of radioactive fluids to the environment in event of LOCA. These barriers are in form of isolation valves. Nornal operation & maintenance is facilitated into design.
Containment Air Filtration: 2 fan and filter units @ 5000 CFM each. Air passes through an absolute filter, then through a charcoal bed filter. Continous or part-time operation is possible.
Penetration Room: No such labeled room.
D3. SAFETY INJECTION SYSTEMS
Accumulator Tanks: 2 accumulater tanks with a total volume of 3500 cu ft. and a normal operating pressure of 760 PSIG. Each accumulater contains 500 Cu. ft. of borated water. (3750 gal.)
High-head Safety Injection: 3 high head pumps with a design rate of 300 GPM @ 1750 PSIG draw borated water from the 340,000 gallon refueling water storage tank and deliver it to both reactor coolant loops and to the reactor vessel. Design flow is provided by any two of the three pumps, and can supply water lost by a break up to 4" size.
Low-head Safety Injection: This system & the residual heat removal syst. are the same. 2 pumps are provided, each = 1560 GPM @ 120 PSIG. These pumps operate when coolant press. has dropped to 600 PSIG after accumulaters have functioned. The pumps take suction from refueling water store tank, & if supply is exhausted, recirculation phase starts with water pumped from the containment sump. 2 heat exchangers are provided rating at 24.15×10^6 BTU / HR.

E. OTHER SAFETY-RELATED FEATURES

Reactor: GINNA

Reactor Vessel Failure: No reference found.

Containment Floodability: Plant level & containment lining along with design codes & integrity make flooding possibility almost non-existent

Reactor-Coolant Leak-Detection System: 1) Containment air particulate monitor, 2) Containment radiogas monitor, 3) Containment humidity detector, 4) A method by which moisture from the containment atmosphere is condensed collected and measured to give a total leakage reading. Leakage is monitored continuously and is recorded three times a day for different components of the reactor coolant system.

Failed-Fuel-Detection System: Failed fuel detection is achieved by Primary sample chemistry. In addition, a GM tube is installed on the primary system let-down line. This detects the increase in primary coolant activity caused by failed fuel.

Emergency Power: 2 diesel - generator sets automatically started and placed on line upon under-voltage on one of the 480 volt buses associated with the set. Each is rated at 1950 kW @ 900RPM. The fuel reserves are almost unlimited, with an on-site supply for 40 hours continous run. Rochester Gas & Electric has readily availible sources in the nearby Rochester area with equipment available to deliver in almost every type of weather. The service is of non-union RG&E employees.

Control of Axial Xenon Oscillations

1) Burnable Poison Shins
2) Boron in the Coolant
3) Part-Length Control Rods
4) In-Core movable Instrumentation

Boron Dilution Control: Because of the procedures involved in the dilution process, an erroneous dilution is considered unlikely. But if an unintentional dilution of boron in the coolant does occur, alarms and detectors are able to alert the operator to the condition. The maximum reactivity addition would be slow enough to allow the operator to determine the cause of the dilution and to take corrective action before excessive shutdown margin is lost.

Long-Term Cooling: 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 exchanges in the system can cool the recirculated and borated water.

Organic-Iodide Filter: Impregnated charcoal filters located in the containment vessel, purge vent, & plant vent.

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

F. GENERAL	Reactor: GINNA
Windspeed, Direction Recorders, and Seismographs: 3 windspeed & direction indicators with recorders at levels of 50', 150', 250'. Recorders are located in the basement of the turbine bldg. and the Control Room.	
Plant Operation Mode: Load following	
Site Description: The site is either flat or rolling (gentle), gradually sloping upwards to the south. The plant is at a MSL of about 270'. General use of the land is agricultural. The plant site is on the south side of Lake Ontario.	
Turbine Orientation: Turbine centerline runs east-west and is located 147' from the containment centerline.	
Emergency Plans: Plans will be written to cover all emergencies affecting personnel or public health & safety. These plans will vary in scope with the seriousness of the accident and the extend to contamination or radioactivity release. Overall responsibility for safe operation of the plant & public safety and health lies with the Plant Superintendent; and all communications with, or release of information to, the general public will be made by him or his alternate.	
Environmental Monitoring Plans: Monitoring variable include air, water, lake bottom, fish, soil, vegetation, milk, algae, and direct radiation (samples). The program tests equipment, sampling and analytical procedures, investigates 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 samples of milk are taken from nearby dairies and processed in the plant's Chemical Lab. Samples are also sent to the New York State Dept. of Environmental Conservation.	
Radwaste Treatment: Provides equipment to collect, process, and prepare for disposal within limits of 10CFR20 all radioactive liquid, gaseous and solid wates. Liquid wastes are evaporated and/or demineralized. Treated water from demineralizers of the evaporaters will be monitored and discharged via condenser discharge. Evaporator concentrates and demineralizers 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.	
Plant Vent: 2 vents; one from the auxiliary bldg. and one from the containment vessel. Charcoal and HEPA filters are employed.	

G. SITE DATA — Reactor: GINNA

Nearby Body of Water: Lake Ontario — Normal Level 246' (MSL); Max Prob Flood Level 250.78' (MSL)

Size of Site 338 Acres — Site Grade Elevation 270' (MSL)

Topography of Site: Gently rolling or flat with a gradual upward sloping to the south to 440' @ 3.5 miles south

of Surrounding Area (5 mi rad):

Total Permanent Population: In 2 mi radius 860; 10 mi 33,450

Date of Data: 1970 — In 5 mi radius 7710; 50 mi ---

Nearest City of 50,000 Population: Rochester

Dist. from site 20 Miles, Direction WSW, Population 296,233

Land Use in 5 Mile Radius:

Agricultural, fruitland

Meteorology: Prevailing wind direction WSW Avg. speed 9.5 mph

Stability Data - ---

Miscellaneous Items Close to the Site: 1) 4 schools 3.5 miles from site with 2280 pupils and 180 staff. 2) 1 house 2200' SE of plant. 3) 1 house 1500' S of plant. 4) Horsebarns 1400' S of plant. 5) 1 building 800' S of plant not permanently occupied. Rochester is 20 miles WSW. Lake Road (Hwy 18 runs E-W ~1/2 mi south of the plant, and US104 runs E-W 3 1/2 mi south. The N.Y. Centrall RR runs along side of US104.

H. CIRCULATING WATER SYSTEM

Type of System: Once through system

Water Taken From: Lake Ontario

Intake Structure: Structure is on lake bottom 3100' from shore, and water flows to pumps in a screenhouse via a 10' diam concrete-lined tunnel in bedrock. Electric heaters are installed in the intake structure, therefore clogging by ice is nearly impossible.

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

River Flow N.A. (cfs) minimum; N.A. (cfs) average

Service Water Quantity 19,000 gpm/reactor

Flow Thru Condenser 356,000 (gpm)/reactor Temp. Rise 19.6max °F

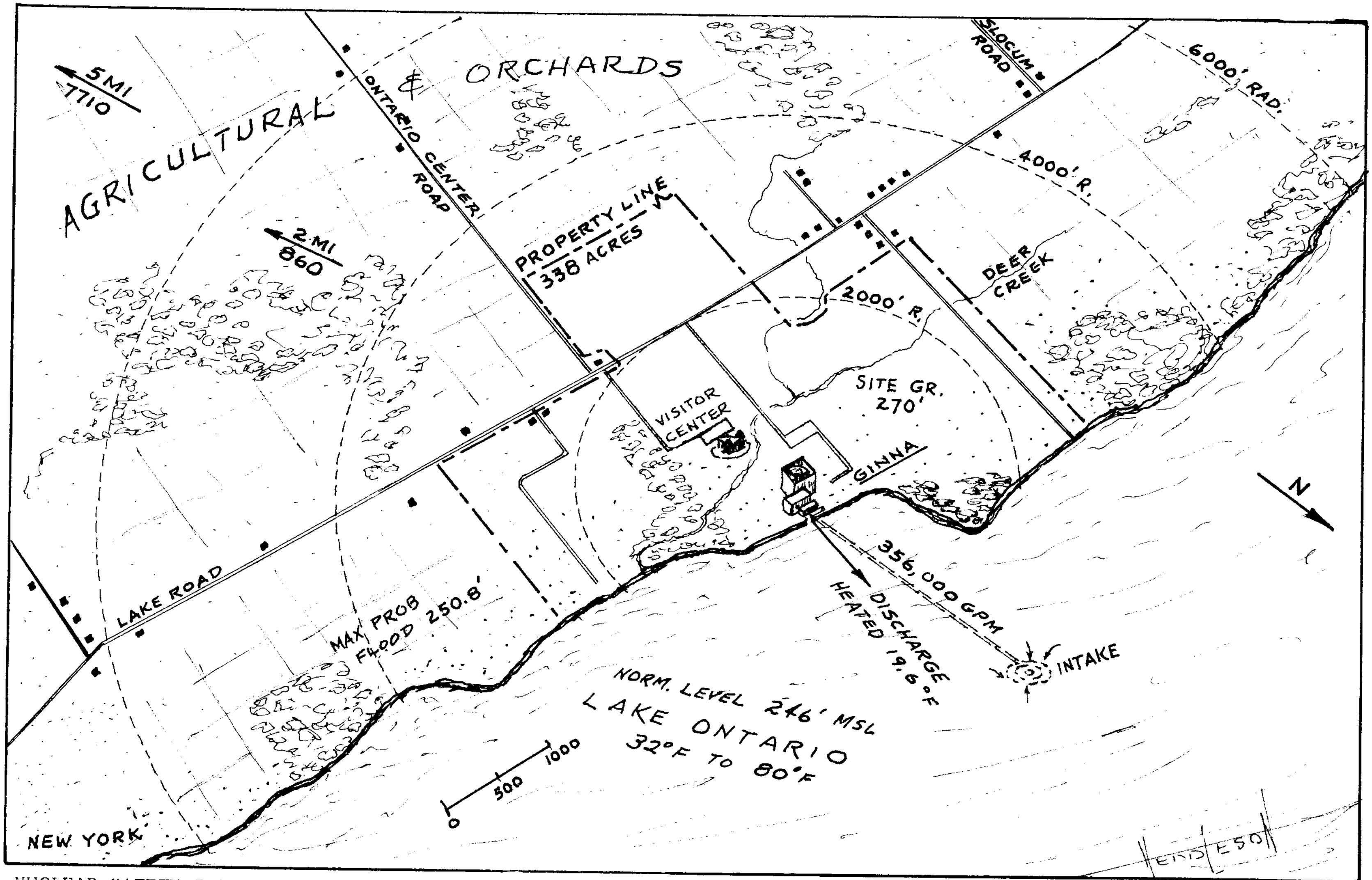
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: Open canal discharge system. Water flows from plant straight to an open canal, via underground tunnels, emptying into Lake Ontario.

Cooling Tower(s): Description & Number - None

Blowdown N.S. gpm/reactor Evaporative loss N.A. gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

MILLSTONE #1, 50-245

Project Name: Millstone Nuclear Power Station, Unit 1

Location: Waterford, Ct.

Owner: Connecticut Light & Power
Hartford Electric Light,
Western Mass.

A-E: EBASCo
Vessel Vendor: Combustion Eng.
NSS Vendor: General Electric
Containment
Constructor: EBASCo

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2011	H_2O/UO_2 Volume Ratio	2.41
Electrical Output, MWe	655	Moderator Temp Coef Cold, Δk/k/°F	-8.0×10^{-5}
Total Heat Output, Safety Design, MWt	2011	Moderator Temp Coef Hot, No Voids	-17.0×10^{-5}
Steam Flow Rate, lb/hr	7.938×10^{6}	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	69×10^{6}	Moderator Void Coef Operating	-1.4×10^{-3}
Coolant Pressure, psig	1035	Doppler Coefficient, Cold	-1.2×10^{-5}
Heat Transfer Area, ft^2	57,796	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	17.5	Doppler Coefficient, Operating	-1.2×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	400,000	Initial Enrichment, %	2.07
Average Heat Flux, Btu/hr-ft^2	130,000	Average Discharge Exposure, MWD/Ton	15,000
Maximum Fuel Temperature, °F	3720	Core Average Void Within Assembly, %	38.9
Average Fuel Rod Surface Temp, °F	1050	k_{eff}, All Rods In	0.96
MCHFR	1.90	k_{eff}, Max Rod Out	1.24
Total Peaking Factor	3.08	Control Rod Worth, %	16% ΔK
Avg Power Density, Kw/ℓ	40.8	Curtain Worth, %	12% K
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	Poison Curtains
		Number of Control Rods	145
		Number of Part-Length Rods (PLR)	None

Data from FSAR.

Compiled by: F. Heddleson (ORNL)
Ferland (Millstone Pt. Co.)
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: MILLSTONE #1

Exclusion Distance, Miles	0.4	
Low Population Zone Distance, Miles	3	
Metropolis	Distance	Population
Hartford, Conn.	38	663,891
Design Basis Earthquake Acceleration, g	0.17	
Operating Basis Earthquake Acceleration, g	0.07	
Earthquake Vertical Shock, % of Horizontal	---	

Design Winds in mph:

At 0 — 50 ft elev	
50 — 150 ft	115 mph gusts
150 — 400 ft	140 mph
Tornado	300 mph
ΔP = __ psi/__ sec	
Is Intent of 70 Design Criteria Satisfied?	---

Recirculation Pumping System & MCHFR:

Designed such that MCHFR will always exceed 1.0 during the transient resulting from a loss of power to both draining loops.

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

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Drywell Design Pressure, psig	62	Primary Containment Leak Rate, %/day	0.5
Suppression Chamber Design Pressure, psig	62	Second Containment Design Pressure, psig	0.253
Calculated Max Internal Pressure, psig	62	Second Containment 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: The performance objectives of drywell are:

a. To provide a barrier which, in the event of a loss-of-coolant accident, will control the release of fission products to the secondary containment, and

b. To rapidly reduce the pressure in the containment resulting from the loss-of-coolant accident.

Vacuum Relief Capability Two groups of vacuum breakers prevent primary containment from exceeding 2 psi of vacuum. One is suppression chamber-to-drywell group, the other, the reactor building-to-torus group.

Post-Construction Testing: Pneumatic test at 1.15 times design pressure equals 71.3 psig. Following the strength test, the vessels were tested for leakage rate at designed pressure.

Penetrations: Personnel hatches and equipment hatches are double sealed and testable. Pipe penetrations are not testable.

D2. EMERGENCY CORE COOLING SYSTEMS Reactor: MILLSTONE #1

Core Spray Cooling System:

Two independent loops, each with a full capacity pump and reactor-vessel spray sparger ring. Pump capacity 3850 gpm @ 90 psid. Water supply is the suppression pool. Reactor low water level or high drywell pressure initiates system.

Auto-Depressurization System: Reduces reactor pressure by use of pressure relief valves so the LPCI and core spray systems will begin operation. System automatically initiated on coincident of low low reactor water level, high drywell pressure with 120 sec. time delay.

Residual-Heat-Removal System (RHRS):

Not applicable.

Feedwater Coolant-Injection System (FWCI): The FWCI system utilizes normal plant equipment, pumping from the main condenser hotwell through feedwater system into reactor vessel. Make-up water to the condenser hotwell is supplied from the condensate storage tank. FWCI components have emergency on-site power supplies.

Low-Pressure Coolant-Injection System:

Two independent loops, two 1/3 capacity pumps per loop. Each pump rated at 5000 GPM at 90 psid. System supplies large quantities of water to the reactor core at low pressures.

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors:

Installed in each main steam line close to reactor to limit loss of water from the reactor in case of a steam line rupture.

Control-Rod Velocity Limiters:

Integral part of the bottom of each control rod, limits reactivity addition rate on drop rod accident.

Control-Rod-Drive-Housing Supports: Located under reactor vessel near rod housing. Prevents significant nuclear transient if a drive housing separates from the bottom of the reactor vessel.

Standby Liquid-Control System: Provides redundant, independent system other than control rods to achieve and maintain subcriticality - 13.4% sodium pentaborate B-1 weight.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: MILLSTONE #1

Standby Coolant System:

Containment Atmospheric Control System:

Five cooling fans circulate and cool drywell atmosphere. A purge system allows drywell to be purged with nitrogen. If the drywell air exceeds radioactive limits, drywell can be purged through SGT.

Reactor Core Isolation Cooling System (RCICS):

The isolation condenser system is designed to provide emergency reactor core cooling without loss of water when the reactor becomes isolated from the turbine and the main condenser by closure of the MSIV.

Reactor Vessel Failure:

No reference found.

Containment Floodability:

Drywell can be flooded to a level above the reactor core.

Reactor-Coolant Leak-Detection System:

Leakage is either identified or unidentified leakage. Identified is pump seal leakage, etc. Unidentified is steam leaks or pipe ruptures. Unidentified leakage limit is 2.5 GPM.

Failed-Fuel Detection Systems: The main steam line radiation monitoring system consists of four gamma radiation monitors, located external to the main steam lines outside of primary containment. Upon detection of high radiation, trip signals generated by detectors will initiate a reactor scram.

Emergency Power: One diesel generator rated at 2650 KW and a gas turbine rated at 11.5 megawatts. The gas turbine has the capability to start on D.C. auxiliaries and be at full load within 48 seconds after start signal. Each alone is capable of supplying power to shutdown and maintain the plant in a safe condition.

Rod-Block Monitor: Reactor manual control system includes controls that prevent rod movement under certain conditions and prevents fuel damage.

Rod-Worth Minimizer: Design to serve as a backup to procedural control to limit control rod worth during startup and low power operation.

F. GENERAL

Reactor: MILLSTONE #1

Windspeed, Direction Recorders, and Seismographs: Aerovane wind instrument mounted on 140-foot tower. Bristol temperature differential instrument senses temperature at 140-foot level and 60-foot level. A teledryne geotech strong-motion accelerograph is mounted on a cement pedestal on the ground floor of the Turbine Building.

Plant Operation Mode:

Base loaded.

Site Description: Located along the southern coast of Connecticut on a peninsula where the Niantic River flows into Niantic Bay, Long Island Sound is just south of the site. The site is characterized by flat land, an ocean shore climate, and a quarry on the site into which heated water from the condensers are piped. The quarry is about 350' x 1200'.

Turbine Orientation:

Ejected blades could strike containment structure.

Emergency Plans:

Prescribes immediate actions to be taken 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. Plan prescribes action to be taken in order of priority and responsibilities of plant personnel.

Environmental Monitoring Plans:

A study of environmental radiation levels was started April 1967 and will continue through plant operation. The purpose of such is to provide a baseline from which any increase in radiation, due to plant operation can be detected and evaluated. The survey program will include air samples, soil and vegetation, gamma background radiation and samples of aquatic life.

Radwaste Treatment:

Liquid wastes are collected, stored and/or treated for disposal or returned to the condensate system. Solid wastes are collected, processed and packed into 55-gallon drums for disposal at burial grounds.

Plant Vent: Gaseous wastes are collected, held for decay, then released through 375-foot-high stack.

G. SITE DATA

Reactor: MILLSTONE #1

Nearby Body of Water: Niantic Bay (Long Island Sound)

Normal Level 0 (MSL)

Max Prob Flood Level 18 (MSL)

Size of Site 500 Acres   Site Grade Elevation 14 (MSL)

Topography of Site: flat

of Surrounding Area (5 mi rad): flat to rolling

Total Permanent Population: In 2 mi radius 4776; 10 mi 98,784

Date of Data: 1970   In 5 mi radius 46,550; 50 mi 2,481,518

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

Dist. from site 35 Miles, Direction W, Population 137,707

Land Use in 5 Mile Radius:

73% underdeveloped/11% recreational/9% agricultural

Meteorology: Prevailing wind direction WNW   Avg. speed 9.5 mph

Stability Data - ---

Miscellaneous Items Close to the Site:
The village of Niantic is 1.5 mi. NW and New London (31,630 pop.) is 3.2 mi. ENE. There is a residential area 1/2 mi. NE of the site. The Penn Central RR runs E-W across the northern boundary. Harkness Memorial Park is 3 mi. E. The Connecticut Yankee Power reactor is 20 mi. NW.

H. CIRCULATING WATER SYSTEM

Type of System: Once through using a quarry.

Water Taken From: Niantic Bay

Intake Structure: Four 105,000 gpm, vertical, mixed flow, wet pit removal element circulating water pumps located in the intake structure, delivering salt water from Long Island Sound to the condenser water box.

Water Body Temperatures: Winter minimum 36 °F   Summer maximum 72 °F

River Flow N/A (cfs) minimum; N/A (cfs) average

Service Water Quantity 40,000 gpm/reactor

Flow Thru Condenser 420,000 (gpm) ~~/reactor~~   Temp. Rise 21 °F

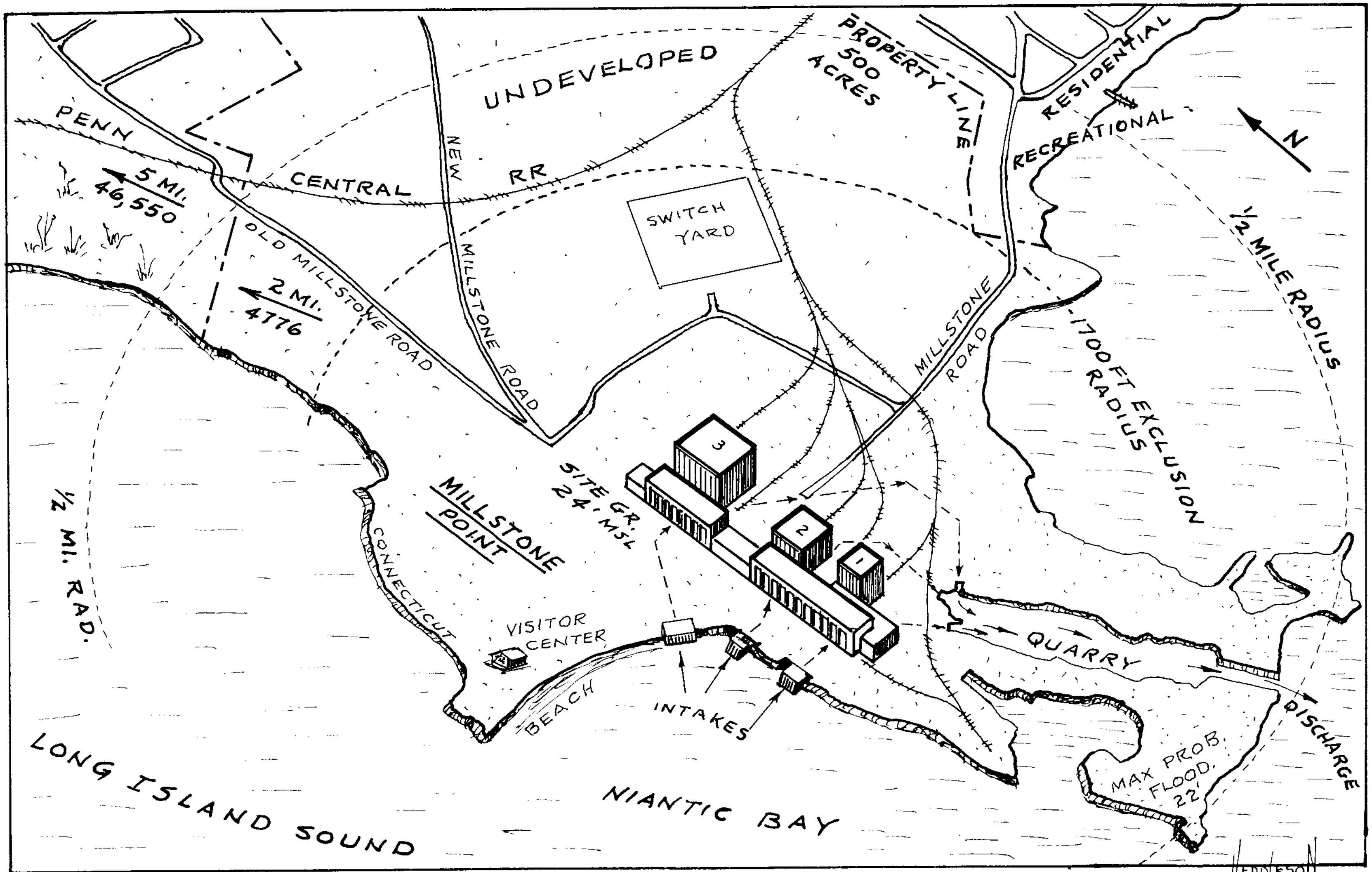
Heat Dissipated to Environment 438×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser 8904×10^6 (Btu/hr)/reactor

Discharge Structure: Quarry 1200' long which empties into Twotree Channel in Long Island Sound.

Cooling Tower(s): Description & Number - None

Blowdown _____ gpm/reactor   Evaporative loss _____ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

INDIAN POINT, 50-247

Project Name: INDIAN POINT NUCLEAR GENERATING UNIT 2

Location: Buchanan, N.Y.*

Owner: Consolidated Edison of NY

*24 mi N. of N.Y. City limits

A-E: United Engrs. & Constructors
Vessel Vendor: Combustion Engr.
NSS Vendor: Westinghouse
Containment Constructor: Not specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2758	H_2O/U, Cold	4.01
Electrical Output, MWe	---	Avg 1st-Cycle Burnup, MWD/MTU	14,200
Total Heat Output, Safety Design, MWt	3216	First Core Avg Burnup, MWD/MTU	24,700
Total Heat Output, Btu/hr	9413×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	2.2
DNBR, Nominal	2.00	Region-2 Enrichment, %	2.7
Total Flowrate, lb/hr	136.3×10^6	Region-3 Enrichment, %	3.2
Eff Flowrate for Heat Trans, lb/hr	130.0×10^6	k_{eff}, Cold, No Power, Clean	1.257
Eff Flow Area for Heat Trans, ft^2	---	k_{eff}, Hot, Full Power, Xe and Sm	1.152
Avg Vel Along Fuel Rods, ft/sec	15.4	Total Rod Worth, %	8.5
Avg Mass Velocity, $lb/hr\text{-}ft^2$	2.53	Shutdown Boron, No Rods-Clean-Cold, ppm	1405
Nominal Core Inlet Temp, °F	543	Shutdown Boron, No Rods-Clean-Hot, ppm	1370
Avg Rise in Core, °F	55.5	Boron Worth, Hot, % Δk/k/ppm	1/89
Nom Hot Channel Outlet Temp, °F	633.5	Boron Worth, Cold, % Δk/k/ppm	1/72
Avg Film Coeff, $Btu/hr\ ft^2\text{-}°F$	5790	Full Power Moderator Temp Coeff, Δk/k/°F	-2.5×10^{-5} to -3.0×10^{-4}
Avg Film Temp Diff, °F	30.3	Moderator Pressure Coeff, Δk/k/psi	$(.2 \text{ to } 3) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff, $\Delta k/gm/cm^3$	−0.1 to 0.3
Avg Heat Flux, $Btu/hr\ ft^2$	175,600	Doppler Coefficient, Δk/k/°F	$(-1.1 \text{ to } -1.8) \times 10^{-5}$
Max Heat Flux, $Btu/hr\ ft^2$	567,300	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1%
Avg Thermal Output, kw/ft	5.7	Burnable Poisons, Type and Form	---
Max Thermal Output, kw/ft	18.4	Number of Control Rods	1060
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	160
No. Coolant Loops	4	Compiled by: Fred Heddleson Feb. 1972 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: INDIAN POINT 2	
Exclusion Distance, Miles		0.2 radius	Design Winds in mph:	
Low Population Zone Distance, Miles		0.65 radius	At 0 — 50 ft elev	30
Metropolis	Distance	Population		
New York City	24 mi	11,528,649	50 — 150 ft	30
Design Basis Earthquake Acceleration, g		0.15	150 — 400 ft	30
Operating Basis Earthquake Acceleration, g		0.10	Tornado	300 mph tang + 60
Earthquake Vertical Shock, % of Horizontal	67 DBE	50 OBE	ΔP =	3 psi/ 3 sec
Is Intent of 70 Design Criteria Satisfied?	Section 1.3 discusses how design criteria is met.			

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	47
Max Leak Rate at Design Pressure, %/day	0.1	Calculated Max Internal Pressure, psig	44

Type of Construction:

A reinforced-concrete vertical right cylinder with flat base and hemispherical dome. Vertical walls are 4'-6" thick and dome is 3'-6" thick. A weld-steel liner (min. thick. 1/4") is attached to inside of concrete for leak tightness. Concrete base is 9'-0" thick with bottom liner plate on this mat. Liner is then covered with 3'-0" of concrete. Free volume is 2.61×10^6 cu ft.

Design Basis:

Designed to withstand the following major loading conditions imposed by

a. complete failure of reactor coolant system

b. coincident failure of the reactor coolant system with an earthquake or wind

with essentially no leakage of radioactive materials.

Vacuum Relief Capability:

A pressure-relief line with 3 butterfly valve vents to plant vent.

Post-Construction Testing:

A strength test will be run at 54 psig for 1 hr. Leakage rate tests will be run at 47 psig for 24 hr and at half of this for 24 hr. Leakage-rate tests will be run periodically after startup.

Penetrations:

All piping and electrical penetrations are double barrier and individually testable.

Weld Channels:

All welded joints in the liner have steel channels welded over them on the inside. Welds are checked with Freon during construction.

D2. CONTAINMENT SAFETY FEATURES Reactor: INDIAN POINT 2

Containment Spray System:

Two sets of 2 out of 3 (Hi Hi) containment pressure signals initiate 2 pumps, taking suction from the refueling-water storage tank, so that 5000 gpm of borated water is sprayed into containment. Contents of a tank containing sodium hydroxide is sprayed in to assist in iodine removal. Water from the sump can be recirculated.

Containment Cooling:

Designed to maintain temp during operation at 120F or lower. System uses recirculation and fan-coil coolers. Five cooling units each have capacity of 2.2×10^6 Btu/hr for normal operation and 76.32×10^6 Btu/hr capacity for accident conditions. Valves throttle water for temp control for normal operation, but open wide on high containment pressure.

Containment Isolation System:

Two valves are installed on each line which penetrates containment - one on the inside and one on the outside. Valves close automatically to prevent leakage from containment in case of line rupture or other accident. Valves close on containment isolation signal.

Containment Air Filtration:

Recirculated air passes thru HEPA filters. In case of an accident, charcoal filters are used. Flow capacity thru charcoal filters is 8000 cfm.

Penetration Room:

No reference found.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks:

Four tanks, each holding ∿5500 gallons of borated water, discharge their contents into the 4 cold legs of the reactor when system pressure drops to 650 psig. Pressure in accumulators is maintained by nitrogen gas. Check valves in discharge lines open at 650 psig.

High-head Safety Injection:

Flow from two pumps is directed into two headers (one pump for each). One header supplies the two cold legs and the other the two hot legs of the vessel. There is a third standby pump. These pumps are rated 400 gpm each at 1700 psig. Pumps take suction from the refueling-water storage tank which contains borated water. One injection header contains a boron injection tank which discharges its contents into the reactor when injection is initiated.

Low-head Safety Injection:

In a line break accident, when system pressure drops to about 250 psig, two pumps of the Residual Heat Removal System start up and deliver large quantities of water (3000 gpm @ 250 psig each) to flood the core and prevent fuel damage. These pumps take suction from the refueling-water storage tank until it is emptied. Water can then be recirculated from the sump.

E. OTHER SAFETY-RELATED FEATURES

Reactor: INDIAN POINT 2

Reactor Vessel Failure:

Found no reference.

Containment Floodability:

Found no reference.

Reactor-Coolant Leak-Detection System:

Indication of leakage is provided in the control room by detection of deviation from normal conditions including air particulate activity, radiogas activity, humidity, condensate run off and monitoring of sump level and sump pump operation.

Failed-Fuel-Detection System:

Found no reference.

Emergency Power:

Available from the Buchanan substation and a gas turbine at the Indian Point site. In addition, there are 3 diesel-generator sets each rated at 1750 Kw continuously. Any 2 units can supply the minimum requirements for 1 set of safeguards equipment. Each unit has a 2-hr fuel supply in the day tank with storage tank supply to run 2 units for 80 hours.

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation:

Part-length rods and borosilicate glass in SST rods are provided to suppress oscillations. Out-of-core instrumentation monitors power distribution. In-core instrumentation is used to calibrate out-of-core

Boron Dilution Control: Because of procedures involved in the dilution process, an erroneous dilution is considered incredible. 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 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:

Can be accomplished by recirculating borated water that collects in the containment sump. Two recirculation pumps, heat exchangers, and the two low-head Residual Heat Removal System pumps accomplish the task. There are 2 heat exchangers, each having 56.4×10^6 Btu/hr capacity.

Organic-Iodide Filter:

No reference found.

Hydrogen Recombiner:

There are two recombiners shown on the reactor building top floor.

F. GENERAL Reactor: INDIAN POINT 2

Windspeed, Direction Recorders, and Seismographs:
A 100-ft tower on the site has collected data for several years. No reference found to seismographs.

Plant Operation Mode:

Load following.

Site Description: Site is on the east bank of the Hudson River about 45 miles north of where the river joins the Atlantic Ocean. Steep banks rise up from the river and the turns in the river near the site cause it to be in a sort of bowl. The site area slopes from the edge of the river bank so that turbine building and reactor building are built on different site grades.

Turbine Orientation: Turbine & reactor are ∿190' apart. Turbine located so it is unlikely that ejected blades would strike containment.

Emergency Plans:
Procedures will be prepared and periodic training sessions held so all personnel are familiar with procedures and their responsibilities. If radioactivity is released, there will be off-site surveys cooperatively with AEC, New York state agencies, and Coast Guard. Contingency plans have been prepared for fire, earthquakes, tornado, and radioactivity releases.

Environmental Monitoring Plans:

Program started in 1958 to determine background data before unit #1 startup. In addition, New York state carries out a program of monitoring. Measurements are made of radioactivity in fresh water, river water, bottom sediments, fish, aquatic vegetation, soil, vegetation, and air. Cooling water from unit #1 has been monitored for activity.

Radwaste Treatment:

Liquid wastes are collected in sumps and tanks where they are held for processing as required. The bulk of liquid wastes collected are processed and retained inside the plant. Processed water from which most of the radioactivity has been removed is released into the circulating water discharge. Gaseous wastes are collected and held in tanks under nitrogen pressure until some radioactive decay occurs. Release is through the monitored plant vent intermittently in accordance with technical specs. Solid wastes are packed into 55-gal drums and shipped offsite for disposal. Total activity released in liquid form is 26.2 mc/yr excluding tritium.

Plant Vent:

There is one stack for units 1, 2, and 3. It is 400 ft high.

G. SITE DATA

Reactor: INDIAN POINT 2

Nearby Body of Water: Hudson River

Normal Level 0' (MSL)
Max Prob Flood Level 15' (MSL)

Size of Site 239 Acres   Site Grade Elevation 15' to 54' (MSL)

Topography of Site: Hilly
of Surrounding Area (5 mi rad): Hilly to mountainous.

Total Permanent Population: In 2 mi radius 39,200 ; 10 mi 440,000
Date of Data: 2000   In 5 mi radius 150,200 ; 50 mi 21,300,000

Nearest City of 50,000 Population: White Plains.
Dist. from site 14 Miles, Direction SSE , Population 50,220 (70)

Land Use in 5 Mile Radius:
Most residential with some large parks and military reservations.

Meteorology: Prevailing wind direction NNE SSW Avg. speed 7 mph
Stability Data - Slightly unstable to neutral.

Miscellaneous Items Close to the Site:

The site is in a densely populated area with Peekskill 2 mi NE (pop 18,881 in 1970) and Buchanan 1 mi SE (pop ∿2500). Camp Smith, military reservation, is 1 mi N and West Point is about 8 mi N. Indian Point nuclear units 1 and 2 are adjacent.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

Water Taken From: Hudson River.

Intake Structure:
Reinforced concrete at river's edge with 7 separate channels, one for each of 6 circulating pumps and one for service water pumps. Each channel has skimmer wall, trash rack, traveling screen, etc.

Water Body Temperatures: Winter minimum 32 °F Summer maximum 78 °F

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

Service Water Quantity 30,000 gpm/reactor

Flow Thru Condenser 840,000 (gpm)/reactor Temp. Rise 16.6 °F

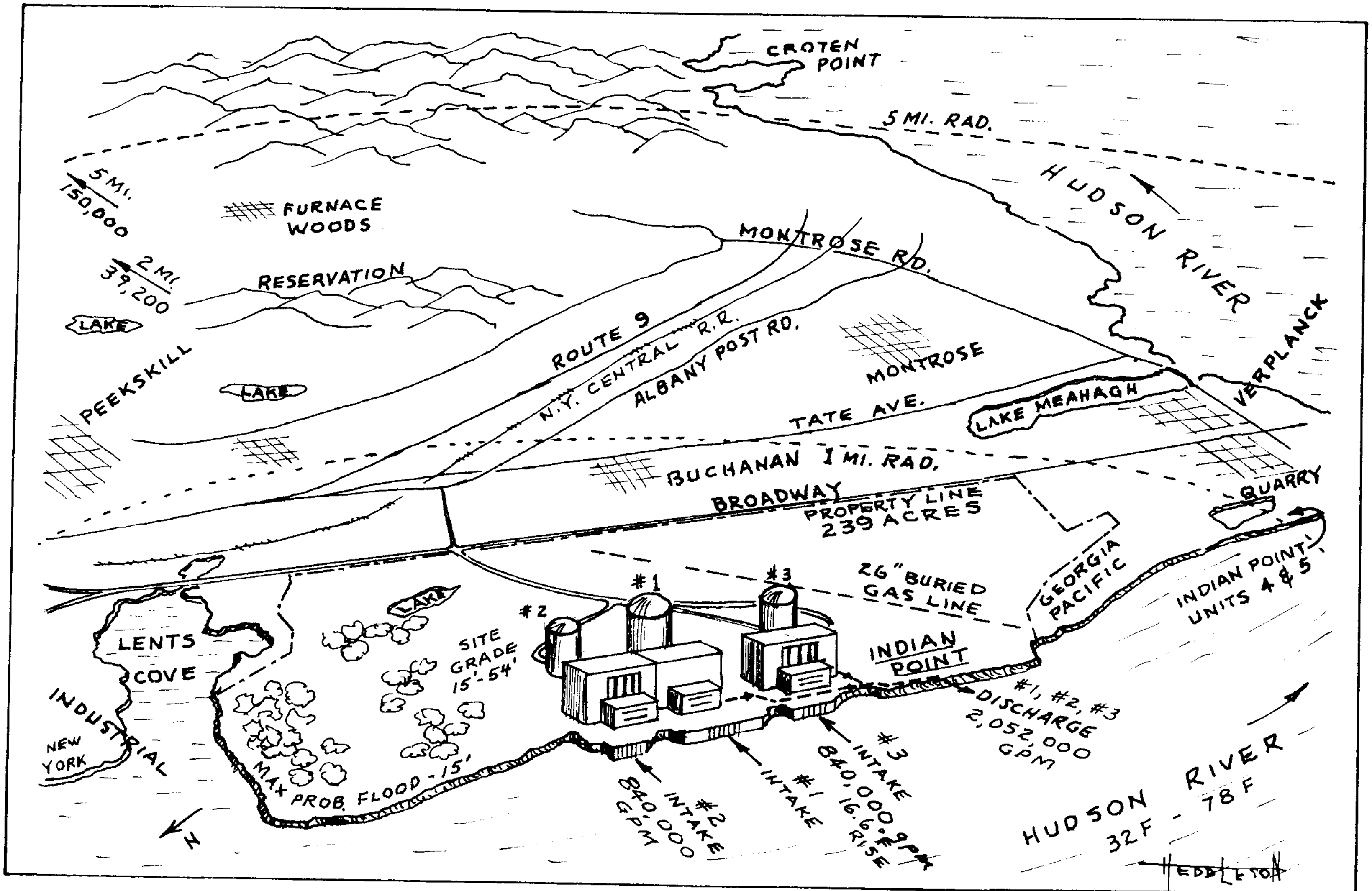
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure:
Common discharge channel for unit 3 and #1 and #2. Discharged to river thru 12 ports 4' × 15' spaced 20 ft apart at depth of 18 feet.

Cooling Tower(s): Description & Number - None

Blowdown ______ gpm/reactor Evaporative loss ______ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

DATA FROM FSAR Page 1 (PWR)

TURKEY POINT, 50-250, 50-251

Project Name: Turkey Point Plant Units No. 3 and 4

Location: W. Shore of Biscayne Bay, Florida

Owner: Florida Power and Light

A-E: Bechtel

Vessel Vendor: Babcock and Wilcox

NSS Vendor: Westinghouse

Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2200	H_2O/U, Cold	4.18
Electrical Output, MWe	728	Avg 1st-Cycle Burnup, MWD/MTU	13,000
Total Heat Output, Safety Design, MWt	2300	First Core Avg Burnup, MWD/MTU	24,500 Equilibrium
Total Heat Output, Btu/hr	7479×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	1.85
DNBR, Nominal	1.81	Region-2 Enrichment, %	2.55
Total Flowrate, lb/hr	101.5×10^6	Region-3 Enrichment, %	3.10
Eff Flowrate for Heat Trans, lb/hr	---	k_{eff}, Cold, No Power, Clean	1.180
Eff Flow Area for Heat Trans, ft^2	---	k_{eff}, Hot, Full Power, Xe and Sm	1.077
Avg Vel Along Fuel Rods, ft/sec	14.3	Total Rod Worth, % (EOL all in)	8.68
Avg Mass Velocity, lb/hr-ft^2	2.32×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	1250
Nominal Core Inlet Temp, °F	546.2	Shutdown Boron, No Rods-Clean-Hot, ppm	1210
Avg Rise in Core, °F	58.3	Boron Worth, Hot, % Δk/k/ppm	7.3
Nom Hot Channel Outlet Temp, °F	642	Boron Worth, Cold, % Δk/k/ppm	5.6
Avg Film Coeff, Btu/hr ft^2-°F	---	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.3 \text{ to } -3.5) \times 10^{-4}$
Avg Film Temp Diff, °F	---	Moderator Pressure Coeff, Δk/k/psi	$(-0.3 \text{ to } 3.5) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	42,460	Moderator Void Coeff, Δk/k/ gm/cm^3	-0.1 to 0.3
Avg Heat Flux, Btu/hr ft^2	171,600	Doppler Coefficient, Δk/k/°F	$(-1.0 \text{ to } -1.6) \times 10^{-5}$
Max Heat Flux, Btu/hr ft^2	554,200	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	---	Burnable Poisons, Type and Form	Borated Pyrex glass
Max Thermal Output, kw/ft	17.9	Number of Control Rods 45	45 assy.
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 8	8 assy.
No. Coolant Loops	3	Compiled by: Fred Heddleson 10/72 Nuclear Safety Information Center	

Page 2, PWR

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Turkey Point
Exclusion Distance, Miles		0.79	Design Winds in mph:
Low Population Zone Distance, Miles		5 radius	At 0 – 50 ft elev 145
Metropolis	Distance	Population	
Miami	25 mile	1,267,792	50 – 150 ft ---
Design Basis Earthquake Acceleration, g		0.05	150 – 400 ft ---
Operating Basis Earthquake Acceleration, g		0.15	Tornado 337 mph
Earthquake Vertical Shock, % of Horizontal		---	ΔP = 2.25 psi/ --sec
Is Intent of 70 Design Criteria Satisfied?	Yes – Sect. 1.3 reviews. Section 1.8 says it can be operated without undue risk to public.		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	59.0
Max Leak Rate at Design Pressure, %/day	0.25	Calculated Max Internal Pressure, psig	49.9

Type of Construction: A continuous post-tensioned vertical concrete cylinder with 3 3/4 ft thick walls and a hemispherical dome roof 3 1/4 ft thick. The foundation slab is reinforced concrete 10 1/2 ft thick. The interior is lined with 1/4" thick welded steel plate. Interior free volume is 1,500,000 cu ft.

Design Basis: The containment is designed to withstand environmental effects and the internal pressure and temperature accompanying a loss-of-coolant accident. It also provides adequate radiation shielding for both normal operation and accident conditions.

Vacuum Relief Capability: Designed for 2.5 psig external pressure, and vacuum breakers are not provided.

Post-Construction Testing: Leakage rate tests will be performed at max calculated accident pressure, maintained for 24 hrs. Tests will be run at one other pressure. Structure will be pressure tested at 10, 20, 30, 40, 50, 55 and 63.25 psig.

Penetrations: Penetrations are single sealed and not individually testable, except for the electrical penetrations.

Weld Channels: Found no reference.

E. OTHER SAFETY-RELATED FEATURES — **Reactor:** Turkey Point

Reactor Vessel Failure: No reference found.

Containment Floodability: No reference found.

Reactor-Coolant Leak-Detection System: Provided by continuous monitoring of containment air activity. Any increase in normal parameters indicates a change in containment. The basic design criterion is the detection of deviations from normal conditions including air particulate activity, radiogas activity, and in addition, in the case of gross leakage, the liquid inventory in the process systems and containment sump.

Failed-Fuel-Detection System: No reference found.

Emergency Power: First source of emergency power is from either or both of the adjacent coal fired 432 MW units 1 and 2. Also, there are 2 GM diesel-generator sets each rated 2500 KW continuously. Generator sets are located in separate rooms and each diesel has independent starting and auxiliaries. Each engine has a 4000 gal day tank. The 2 day tanks are supplied by one common storage tank of 64,000 gal capacity.

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Part length rods suppress the axial xerox oscillations. Out-of-core instruments monitor power distribution, and in-core instruments are used to calibrate out of core.

Boron Dilution Control: Established procedures for the dilution process make erroneous dilution incredible. If an unintentional boron dilution should occur, operator will be alerted to the situation. Max. reactivity addition due to dilution is slow enough to allow the operator to determine the cause and take corrective action before excessive shutdown margin is lost.

Long-Term Cooling: Accomplished by recirculation of borated water from the containment sump, and the use of component cooling water pumps to supply the fan-coil units with cold water. The containment spray system can also be used for long term cooling.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Hydrogen concentration will be monitored and bleed-off from containment will hold concentration below a hazardous level.

F. GENERAL	Reactor: Turkey Point

Windspeed, Direction Recorders, and Seismographs: Meteorological data has been collected since 1967 measuring wind velocity and direction, temperatures, and other factors. Found no reference to seismographs.

Plant Operation Mode: Designed for load following, but plants will operate base loaded.

Site Description: Located on western shore or Biscayne Bay about 25 mi S of Miami, Fla. The site is in the center of a large swamp area not suitable for farming. About 5 to 8 miles E. across Biscayne Bay a chain of offshore islands separates the bay from the ocean. The land surrounding the site to the west is swamp for 3 or 4 miles where fields begin. No inhabitants live in a 5 mile area.

Turbine Orientation: Ejected turbine blades could strike containment. Centerlines are about 150' apart. Westinghouse supplied.

Emergency Plans: Detailed emergency procedures have been developed so that each individual has full knowledge of his responsibilities and duties. Period drills will be held for practice. Arrangements have been made with Miami Medical School to handle injuries. Dade County firemen have received training in radiation monitoring. If evacuation is required it will be handled by local and/or state authorities.

Environmental Monitoring Plans: Studies started in 1966 to access Biscayne Bay for biological and ecological factors that might be influenced by construction of the two nuclear plants. These studies included the biotic system, plankton, fish, benthic flora and fauna, trees, circulation and salinity. This work was carried out by scientists of the University of Miami. Over 75 reports have been issued, most of which say, "in summary no irretrievable and litte, if any short-range damage is expected as a result of the power plant operation."

Radwaste Treatment: Liquid wastes will be collected in tanks for evaporation and demineralizing to reduce activity to the lowest practicable value. Activity will be reduced near to or equal to natural background, except that the tritium is expected to be about 1% of MPC. Gaseous wastes will be stored in decay tanks and later released through the monitored plant vent. At the site boundary annual dose will not exceed natural background radiation from secondary effects of cosmic rays. Nitrogen cover gases will be reused to minimize waste releases. Solid wastes will be drummed at the highest concentrations practical to minimize the number of containers shipped.

Plant Vent: Vent runs up the side of one containment structure to 200' elevation.

G. SITE DATA

Reactor: Turkey Point

Nearby Body of Water: Biscayne Bay

Normal Level 0' (MSL)

Max Prob Flood Level 13.2' (MSL)

Size of Site 3300 Acres

Site Grade Elevation 18' (MSL) compacted limestone fill

Topography of Site: Flat

of Surrounding Area (5 mi rad): Flat

Total Permanent Population: In 2 mi radius 0 ; 10 mi 87,735

Date of Data: 1976 In 5 mi radius 5 ; 50 mi ____

Nearest City of 50,000 Population: Miami, Fla.

Dist. from site 25 Miles, Direction N , Population 320,000(70)

Land Use in 5 Mile Radius: Undeveloped, mostly swampy with some agriculture in NW portion.

Meteorology: Prevailing wind direction ESE Avg. speed ---

Stability Data - Has strong winds and a high percent of unstability.

Miscellaneous Items Close to the Site: The nearest farming area and residence is about 4 mi. NW. Hawk Missile Base is 1 1/2 mi. NW. There is a recreational park on the ocean front (Homestead) about 2 mi. NNW. U.S. Hyw. #1 runs NE-SW about 9 mi. from the site, and the Florida East Coast R.R. runs near by U.S. #1. Florida city (pop 5133) and Homestead (pop 13,674) are E and NE about 9 or 10 miles.

H. CIRCULATING WATER SYSTEM Units 1 and 2 (coal fired) are adjacent.

Type of System: Once through.

Water Taken From: Biscayne Bay

Intake Structure: Water drawn in through an intake canal and barge canal to the intake structure which has trash racks and traveling screens. Later, make up water total of 540,000 gpm will be withdrawn from Card Sound for both nuclear and coal fired units.

Water Body Temperatures: Winter minimum 54°F (70 avg.) Summer maximum 90°F (85 avg.)

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

Service Water Quantity 32,000 gpm/reactor

Flow Thru Condenser 624,000 (gpm)/reactor Temp. Rise 16 °F

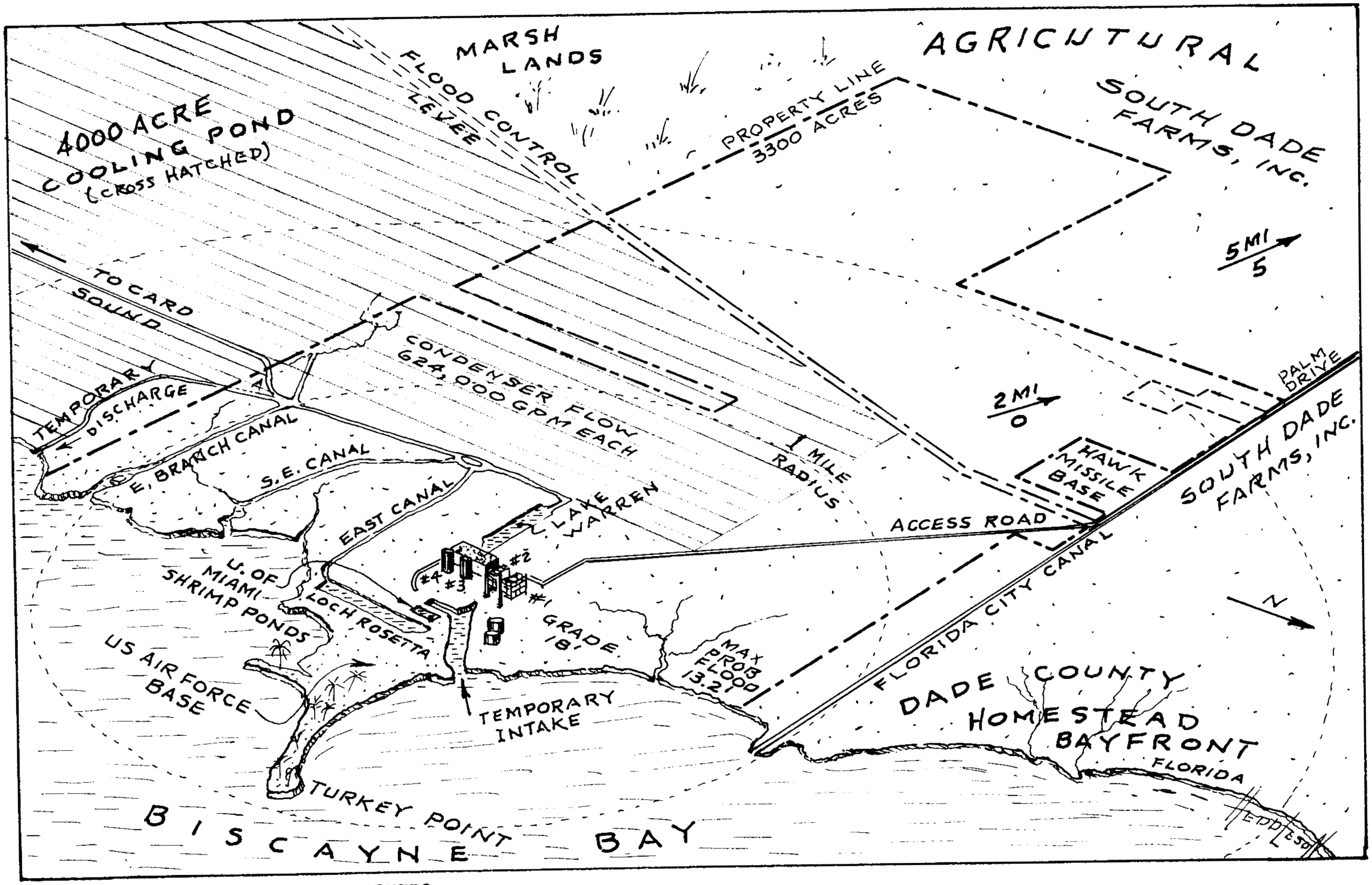
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: Discharged to Lake Warren, then split 2,750 cfs to Card Sound and 1,500 cfs to Grand Canal and Biscayne Bay. This may not be the final arrangement. A cooling reservior is being planned which will cover 4000 acres. Limited blowdown will be returned to Card Sound.

Cooling Tower(s): Description & Number - None

Blowdown ____ gpm/reactor Evaporative loss ____ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

QUAD-CITIES, 50-254, 50-265

Project Name: Quad-Cities Nuclear Power Station, Units 1&2
Location: Cordova, Illinois
Owner: Commonwealth Edison Co. Iowa-Ill. Gas & Elec. Co.

A-E: Sargent & Lundy
Vessel Vendor: Babcock & Wilcox
NSS Vendor: General Electric
Containment Constructor: Chicago Bridge & Iron

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2511	H_2O/UO_2 Volume Ratio	2.41
Electrical Output, MWe	850	Moderator Temp Coef Cold, Δk/k/°F	-8×10^{-5}
Total Heat Output, Safety Design, MWt	2684	Moderator Temp Coef Hot, No Voids	-17×10^{-5}
Steam Flow Rate, lb/hr	9.765×10^{6}	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	98×10^{6}	Moderator Void Coef Operating	-1.4×10^{-3}
Coolant Pressure, psig	1000	Doppler Coefficient, Cold	-1.2×10^{-5}
Heat Transfer Area, ft^2	62,640	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	17.5	Doppler Coefficient, Operating	-1.2×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	405,300	Initial Enrichment, %	2.12
Average Heat Flux, Btu/hr-ft^2	131,200	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	30 to 38
Average Fuel Rod Surface Temp, °F	558	k_{eff}, All Rods In	.96
MCHFR	≥1.9	k_{eff}, Max Rod Out	≤.99
Total Peaking Factor	∿3.0	Control Rod Worth, %	1% in sequence
Avg Power Density, Kw/ℓ	40.8	Curtain Worth, %	N.A.
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	Gd_2O_3
		Number of Control Rods	177 cruciform
		Number of Part-Length Rods (PLR)	N.A.

Compiled by: Commonwealth Edison & ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: Quad-Cities 1&2

Exclusion Distance, Miles	0.5	
Low Population Zone Distance, Miles	3.0	
Metropolis	Distance	Population
Davenport-Moline	18 mi.	362,638
Design Basis Earthquake Acceleration, g	.12	
Operating Basis Earthquake Acceleration, g	.24	
Earthquake Vertical Shock, % of Horizontal	---	

Design Winds in mph:

At 0 — 50 ft elev 110

50 — 150 ft

150 — 400 ft

Tornado 860 mph

ΔP = -- psi/ --sec

Is Intent of 70 Design Criteria Satisfied? ---

Recirculation Pumping System & MCHFR:

Reactor power level is controlled by a combination of control rod positioning and reactor coolant recirculation flow to maintain MCHFR $\geq$1.9.

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

Drywell Design Pressure, psig	56	Primary Containment Leak Rate, %/day	0.5 w/o penetrations
Suppression Chamber Design Pressure, psig	56	Second Containment Design Pressure, psig	7" water
Calculated Max Internal Pressure, psig	48	Second Containment Leak Rate, %/day	4000 cfm

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 at a lower elevation. The torus is constructed of steel supported on a concrete foundation.

Design Basis:

To provide capability in event of postulated LOCA to limit fission-product release so that off-site doses would be held below 10CFR 100 limits. Design-basis accident is a double-ended pipe rupture.

Vacuum Relief Capability

Primary containment designed for external pressure differential of 2 psid; vacuum breakers provided.

Post-Construction Testing:

Drywell and suppression chamber tested pneumatically for leakage at 48 psig. Reactor building was leak-checked with building at negative 0.25 in H_2O.

Penetrations:

D2. EMERGENCY CORE COOLING SYSTEMS — Reactor: Quad-Cities 1&2

Core Spray Cooling System: System has 2 independent loops, each with one 100% capacity pump, a spray sparger above the core, piping and controls. System is actuated by low water level in reactor or high pressure in drywell. Water is taken from suppression pool. One loop can operate for any size of pipe rupture to limit fuel-clad temperature after LOCA. Each pump delivers 4500 gpm at 90 psid.

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 system can operate.

Residual-Heat-Removal System (RHRS):
There are three modes of operation: (1) shutdown cooling, (2) low-pressure coolant injection following LOCA, and (3) containment cooling system that limits temperature of suppression pool after LOCA by circulating water through RHRS heat exchangers, and a spray system in the drywell that removes energy after LOCA.

High-Pressure Coolant-Injection System:
There is one loop with 5600 gpm capacity at 150 psig. Water comes from the 350,000-gal. condensate storage tank or the suppression pool. A steam turbine using reactor steam drives a booster pump and a pump which injects water through the feedwater piping.

Low-Pressure Coolant-Injection System:
Provides reactor core cooling for a large spectrum of loss of coolant accidents completely independent of the core spray subsystem. The system provides adequate cooling for intermediate and large line break sizes up to and including the DBA without assistance from any other ECCS. The maximum flow capacity is 14,500 gpm at 20 psig above suppression pool pressure with 3 pumps running.

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors: Venturi-type restrictor in each of 4 lines limits loss flow from reactor vessel in case of line rupture, steam flow in severed line restricted to $\sim$200% of rated flow.

Control-Rod Velocity Limiters: Protects against hi-reactivity insertion rate in case of control-rod-drop accident by limiting rod velocity. Velocity limited in 1 direction but does not effect scram rate. Accomplished w/large clearance piston & baffles inside control rod guide tube.

Control-Rod-Drive-Housing Supports:
A gridwork located immediately below the control rod housing. It prevents control rod ejection should the control rod housing fail.

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 bottom of the reactor.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: Quad-Cities 1&2
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.
Containment Atmospheric Control System: A cooling and vent system will hold normal operating temperature at ∿150°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): Operate 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 mention.
Containment Floodability: Can flood drywell to a level above reactor core.
Reactor-Coolant Leak-Detection System: There is a seal-ring leak detection system for the reactor vessel-vessel head interface. Maximum unidentified leakage permitted into the drywell is 5 gpm and the total leakage permitted is 25 gpm as detected by discharge of equipment drain and floor drain sump pumps.
Failed-Fuel Detection Systems: Main steamline monitoring system will indicate failed fuel by high radiation readings in any main steam line. This system can initiate a reactor scram. Four channels do the monitoring.
Emergency Power: Three diesel generators, each rated at 2500 Kw; each alone is capable of supplying power to shut down and maintain plant in a safe condition. Fuel oil supply available for 2 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: This subsystem hinders control rod withdrawal errors to prevent fuel damage. Two RBM monitoring channels are provided.
Rod-Worth Minimizer: Computer-programmed sequences that assist the operator in manual control so rod movements are sequenced to achieve minimum rod-worth changes

F. GENERAL — Reactor: Quad-Cities 1&2

Windspeed, Direction Recorders, and Seismographs:
400' meteorological tower has continuous windspeed and direction at 35'; 125'; 300' and 400'. One seismograph located in basement of unit 1 Turbine Building.

Plant Operation Mode:
Load following by adjusting recirculating pump speeds.

Site Description:
Located on the east side of the Mississippi River about 3 miles north of Cardova, Illinois. Site grade is 595' which is about 23 feet above normal river level, but about 9 feet below maximum probable flood. Site is flat with agriculture to the east and small industrial park to the north. On the western bank of the Mississippi is a wildlife refuge and the confluence of the Wapsipinican River with the Mississippi River.

Turbine Orientation: Centerline distance between turbine and containment is 125 ft. Ejected turbine blades could strike containment.

Emergency Plans:

Generating Stations Emergency Plan and Quad-Cities Station Emergency Procedure sets forth individual responsibilities and action levels in accordance with guidelines set forth by the AEC and other regulatory agencies.

Environmental Monitoring Plans:

Three on site, 13 offsite environs monitoring stations; particulate, charcoal continuous air samplers, two 10 MR ion chambers, quarterly and annual TLD; contained in each. Also grass, soil, milk, water samples, cattlefeed, and fish sampled at various times throughout the year. Thermal monitoring of Mississippi River downstream and upstream of plant. Continuous river studies of water quality, fish population and history, entrainment studies, artificial substrate of periphyton, chlorination studies, and macroinvertebrate community.

Radwaste Treatment:

Liquid wastes are collected, stored and/or treated for disposal through the circulating water effluent or returned to the condensate system. Solid wastes are collected, processed, and packed into 55-gal. drums for disposal offsite. Gaseous wastes are collected, processed, held for decay and discharged through the elevated release point.

Plant Vent:

310 feet tall.

G. SITE DATA Reactor: Quad-Cities 1&2

Nearby Body of Water: Mississippi River
Normal Level 572 (MSL)
Max Prob Flood Level 589 (MSL)

Size of Site 404 Acres Site Grade Elevation 595 ft (MSL)

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

Total Permanent Population: In 2 mi radius 280 ; 10 mi 26,619
Date of Data: 1970 In 5 mi radius 11,690 ; 50 mi 600,113

Nearest City of 50,000 Population: Davenport, Iowa
Dist. from site 20 Miles, Direction SW , Population 97,500

Land Use in 5 Mile Radius:
Plant part of a small industrial park surrounded by agricultural areas.

Meteorology: Prevailing wind direction Uniform, westerly predominating
Stability Data: Has strong winds and a high percent of unstability.

Miscellaneous Items Close to the Site:

Industrial Park nearby comprising a 3-M Chemical Plant, FS Fuel Storage facility, and a closed anhydrous ammonia plant.

H. CIRCULATING WATER SYSTEM

Type of System: Two diffuser pipes 2000 ft and 1600 ft long across the river. It is a once-through system now.

Water Taken From: Mississippi River

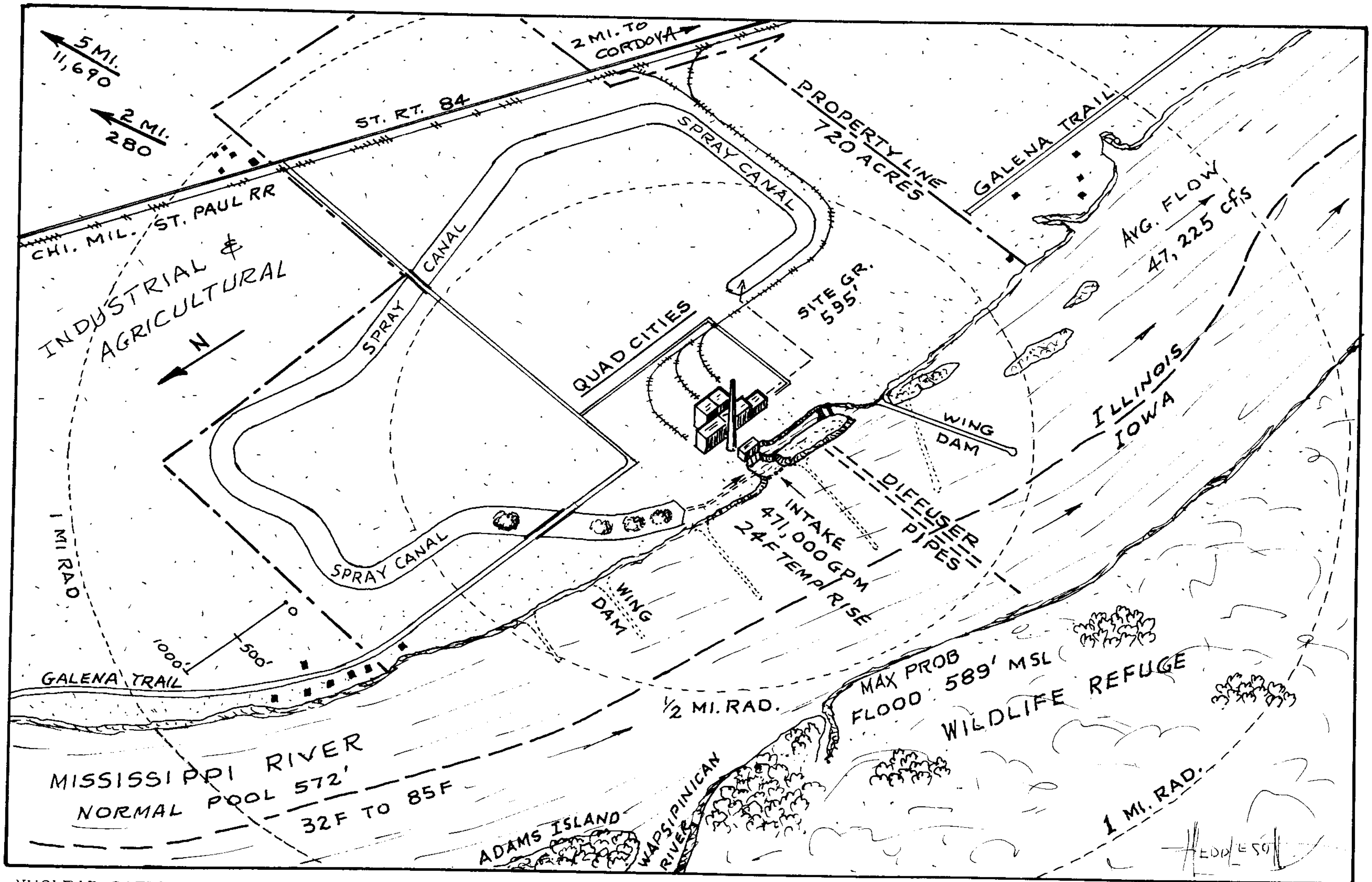
Intake Structure:
Concrete and cinder-block crib house with circulating water pumps. Bar racks, traveling screens and booms are provided.

Water Body Temperatures: Winter minimum 32 °F Summer maximum 85 °F
River Flow 6570 (cfs) minimum; 47,225 (cfs) average
Service Water Quantity 30,000 gpm/reactor
Flow Thru Condenser 471,000 (gpm)/reactor Temp. Rise 24 °F
Heat Dissipated to Environment --- (Btu/hr)/reactor
Heat Removal Capacity of Condenser --- (Btu/hr)/reactor

Discharge Structure: Spray Canal to be completed in 1975. Until then, two 16' diffuser pipes 1600' & 2000' long cross the Miss. River to mix heated water with the river. Pipes located on bottom 18' below the surface.

Cooling Tower(s): Description & Number -

Blowdown NA gpm/reactor Evaporative loss NA gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

DATA FROM FSAR

Page 1 (PWR)

PALISADES, 50-255

Project Name: Palisades Plant

Location: Van Buren Co., Mich.

Owner: Consumers Power Co.

A-E: Bechtel
Vessel Vendor: Combustion Engineering
NSS Vendor: Combustion Engineering
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2200	H_2O/U, Cold	1.64
Electrical Output, MWe	700	Avg 1st-Cycle Burnup, MWD/MTU	10,180
Total Heat Output, Safety Design, MWt	2650	First Core Avg Burnup, MWD/MTU	26,100
Total Heat Output, Btu/hr	7510×10^6	Maximum Burnup, MWD/MTU	50,000
System Pressure, psia	2100	Region-1 Enrichment, %	1.65
DNBR, Nominal	2.0	Region-2 Enrichment, %	2.08 & 2.54
Total Flowrate, lb/hr	125×10^6	Region-3 Enrichment, %	2.54 & 3.20
Eff Flowrate for Heat Trans, lb/hr	---	k_{eff}, Cold, No Power, Clean	1.212
Eff Flow Area for Heat Trans, ft^2	58.69	k_{eff}, Hot, Full Power, Xe and Sm	1.111
Avg Vel Along Fuel Rods, ft/sec	12.7	Total Rod Worth, % BOL	8.6
Avg Mass Velocity, lb/hr-ft^2	2.07×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	1180
Nominal Core Inlet Temp, °F	545	Shutdown Boron, No Rods-Clean-Hot, ppm	1210
Avg Rise in Core, °F	46	Boron Worth, Hot, % $\Delta k/k$/ppm	1070
Nom Hot Channel Outlet Temp, °F	642.8	Boron Worth, Cold, % ppm/1% $\Delta\rho$	67
Avg Film Coeff, Btu/hr ft^2-°F	4860	Full Power Moderator Temp Coeff, $\Delta k/k$/°F	$(-0.08 \text{ to } -2.25) \times 10^{-4}$
Avg Film Temp Diff, °F	30	Moderator Pressure Coeff, $\Delta k/k$/psi	$(+0.1 \text{ to } +1.7) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	51,400	Moderator Void Coeff, $\Delta k/k$/% Void	$(-0.06 \text{ to } -1.0) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	142,400	Doppler Coefficient, $\Delta k/k$/°F	---
Max Heat Flux, Btu/hr ft^2	541,200	Shutdown Margin, Hot 1 rod stuck, %$\Delta k/k$	2
Avg Thermal Output, kw/ft	4.63	Burnable Poisons, Type and Form	B_4C in alumina (in rods)
Max Thermal Output, kw/ft	17.6	Number of Control Rods - Full length	41
Max Clad Surface Temp, °F	648	Number of Part-Length Rods (PLR)	4
No. Coolant Loops	2	Compiled by: Fred Heddleson Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: PALISADES
Exclusion Distance, Miles	0.44 rad		Design Winds in mph:
Low Population Zone Distance, Miles			At 0 — 50 ft elev 100
Metropolis	Distance	Population	
Kalamozoo	34 mi	201,550	50 — 150 ft 120
Design Basis Earthquake Acceleration, g	0.2		150 — 400 ft 140
Operating Basis Earthquake Acceleration, g	0.1		Tornado 300 mph + 60 trans.
Earthquake Vertical Shock, % of Horizontal			ΔP = 3 psi/ -- sec
Is Intent of 70 Design Criteria Satisfied?	Yes, Appendix I discusses conformance.		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	55
Max Leak Rate at Design Pressure, %/day	0.2	Calculated Max Internal Pressure, psig	51

Type of Construction: A prestressed posttensioned concrete structure in the shape of a vertical right cylinder with dome-type roof and flat base. Vertical walls are 3 1/2 ft thick and the dome is 3 ft. A steel liner is 1/4" thick. Free volume is 1.64×10^6 cu ft.

Design Basis: Designed to contain pressures and temperatures resulting from DBA in which energy is released by a double-ended pipe rupture when there is a simultaneous loss of power, and engineered safety features operate to mitigate the accident.

Vacuum Relief Capability: No reference found.

Post-Construction Testing: Leakage rate tests will be performed at 100% design pressure and at lower pressures. Pressure tests will be run at 5 levels, the highest being 1.15 times design pressure.

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

Weld Channels: No reference found.

D2. CONTAINMENT SAFETY FEATURES	Reactor: PALISADES

Containment Spray System: Three half-capacity pumps take suction initially from the Safety Injection and Refueling Water storage tank. When this supply is low, suction is transferred to the containment sump. Pumps rated 1340 gpm @ 200 psia start automatically on high pressure in containment, or manually from the control room. During recirculation, heat exchangers cool the water.

Containment Cooling: Three of four fan-coil units can hold temp. to design limits following a DBA. Normally, all 4 units run to hold temp. below 104°F with 5.5×10^6 Btu/hr total capacity. Safety injection signal switch coolers to emergency mode opening cooling water valve so each unit has 76.6×10^6 Btu/hr capacity.

Containment Isolation System: Containment isolation signal initiates closure of certain valves. In a LOCA valves associated with engineered safety features will be open.

Containment Air Filtration: Main exhaust fan can vent 1000 cfm from containment thru a charcoal filter system.

Penetration Room: There are 2 electrical penetration areas. Pipes come thru containment purge exhaust area.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks are provided, each containing 7500 gal of borated water at 200 psia nitrogen pressure. Each tank discharges into one of the 4 inlet nozzles. Operation is automatic and passive simply by operation of check valves when system pressure drops to 200 psia.

High-head Safety Injection: Three pumps supply water thru the inlet nozzles from the safety injection and refueling water storage tank, each rated 300 gpm @ 1100 psia. One high-pressure pump and one low-pressure pump combined can furnish sufficient cooling water for any LOCA. Upon depletion of storage tank water, low-pressure pumps automatically stop and suction for high-pressure pumps switch to the containment sump.

Low-head Safety Injection: Two pumps supply water from the safety injection and refueling water storage tank, each rated 3000 gpm @ 150 psia. One high-pressure and one low-pressure pump can supply sufficient cooling water for any LOCA. Both high-pressure and low-pressure pumps are located outside containment.

E. OTHER SAFETY-RELATED FEATURES Reactor: PALISADES
Reactor Vessel Failure: No reference found.
Containment Floodability: Designed for flooding of compartments housing engineered safety features.
Reactor-Coolant Leak-Detection System: No reference found.
Failed-Fuel-Detection System: No reference found.
Emergency Power: Two diesel-generator sets are provided, each rated 3500 brake horsepower. Engines are designed for air starting, and both units have 2 independent air starting systems. Units reach rated speed and are ready for loading with 10 seconds after receipt of the start signal. Full load can be carried after 30 seconds. Each engine has a 600 gal. fuel oil day tank plus a shared 30,000 gal. underground storage tank. Under full load, a diesel will consume about 200 gal/hr.
Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Oscillations will be manually controlled by part-length rods using information provided by the out-of-core detectors. There are in-core detectors that provide information on the core.
Boron Dilution Control: Because of administrative procedures and safeguards provided for boron dilution, probability of an erroneous dilution is very small. Nevertheless, if an unintentional dilution does occur, numerous alarms and indications alert the operator to the condition. The maximum reactivity addition due to dilution is slow enough to allow the operator to determine the cause and take corrective action before shutdown margin is lost.
Long-Term Cooling: Accomplish by recirculation of sump water thru heat exchangers, or by letting natural steam formation bleed off to steam generators. Steam generated is vented to the atmosphere. Shutdown cooling heat exchangers have heat transfer capacity of 27.5×10^6 Btu/hr for each of 2.
Organic-Iodide Filter: No reference found.
Hydrogen Recombiner: Hydrogen venting from containment will be used to hold concentration below 3.58 v/o.

F. GENERAL	Reactor: PALISADES

Windspeed, Direction Recorders, and Seismographs: Meteorological data has been collected at 2 site locations - one near the shore line at 200 ft above grade and the other behind a sand dune about 55 feet above the ground. A strong motion accelerograph will be installed.

Plant Operation Mode: Designed for load following

Site Description: Located on the eastern shore of Lake Michigan. Site area consists of rolling sand dunes which extend inland for about 1 mile. Beach level is about 600 ft sea level with dunes rising to about 740' elevation and then dropping off abruptly to 610 ft about 2400 feet inland. Area is sparsely settled and wooded.

Turbine Orientation: Ejected turbine blades could strike containment. Centerlines are $\sim$140 ft apart.

Emergency Plans: The site emergency plan describes action levels to be taken by plant personnel, in the event of uncontrolled releases of radioactivity, that will minimize radiation exposure to persons, both on site and off site. The plan prescribes the action to be taken in order of priority and the responsibilities of personnel for taking such action, and also summarizes personnel and material resources available for assistance in minimizing radiation exposure.

Environmental Monitoring Plans: A preoperational survey was started to determine naturally existing radioisotopes. Food chains, air, and water are sampled. Farm crops, berries, orchard products, milk, well water, and organic samples are collected. The operational program will be an extension of the preoperational program with more frequent sampling as required.

Radwaste Treatment: Designed for 1% failed fuel rods. Liquid wastes are classified as clean or dirty. They will be collected, monitored and processed by holdup for decay, filtration, ion-exchange and dilution as required. The cleaned up liquid will be released thru the circulating water system. Gases are collected and discharged thru HEPA filters or processed by holdup in compressed gas tanks. After sufficient decay, gas will be released thru the plant vent. Solid wastes will be stored and packed into 55 gal drums and shipped off-site for disposal.

Plant Vent: Vent runs up the side of containment structure venting at an elevation near the top of containment.

G. SITE DATA — Reactor: PALISADES

Nearby Body of Water: Lake Michigan — Normal Level ~580' (MSL); Max Prob Flood Level --- (MSL)

Size of Site 487 Acres — Site Grade Elevation 590' (MSL)

Topography of Site: Flat to Rolling

of Surrounding Area (5 mi rad): Rolling

Total Permanent Population: In 2 mi radius 313 ; 10 mi ____

Date of Data: 1970 In 5 mi radius 5420 ; 50 mi ____

Nearest City of 50,000 Population: Kalamazoo, Mich.

Dist. from site 35 Miles, Direction E , Population 208,300

Land Use in 5 Mile Radius: Agricultural, Wooded, Berry farms, and Orchards

Meteorology: Prevailing wind direction Westerly Avg. speed 12 mph

Stability Data - Neutral to unstable about 70% of time.

Miscellaneous Items Close to the Site: South Haven, the nearest city is 4 1/2 miles N having 6471 population. Van Buren State Park joins the utility property on the north. East of the sand dunes the land is rolling with many open fields, berry farms, and orchards. During the summer many tourist come to the beaches. The C&O RR runs N-S about 2 mil. E of plant. Interstate I-196 is about 3/4 mi. east.

H. CIRCULATING WATER SYSTEM

Type of System: Once thru now, but cooling towers will be built later.

Water Taken From: Lake Michigan

Intake Structure: Water taken 3300 ft from shore thru an intake crib and pipe tunnel to the intake structure housing traveling screens and pumps. Service water intake will be used for cooling tower makeup.

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

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

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 390,000 (gpm)/reactor Temp. Rise 25 °F

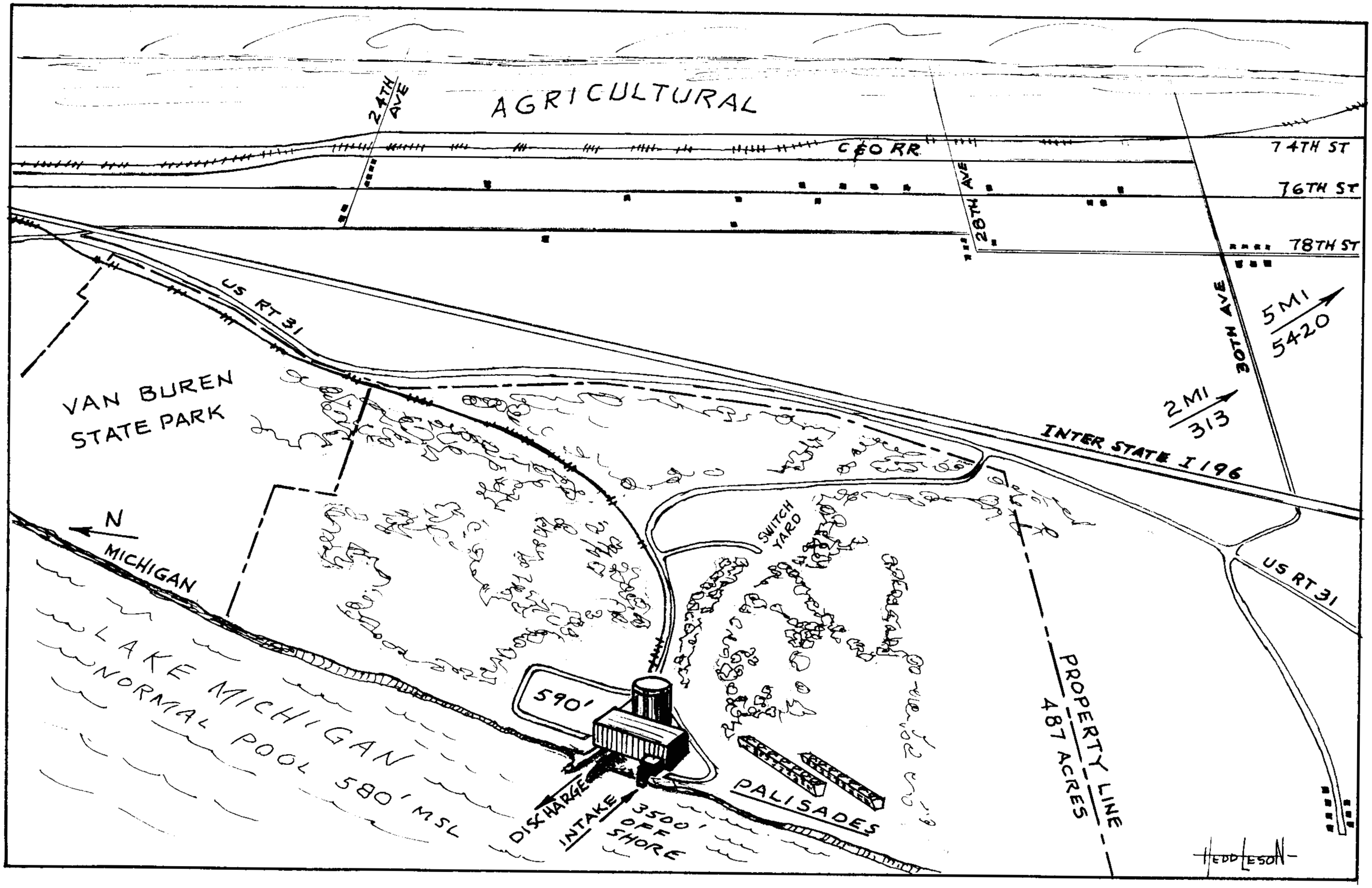
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: A discharge canal at the shore projects into the lake about 108 ft. Width at open end is 100 ft.

Cooling Tower(s): Description & Number - Two mechanical draft each 650' lg × 65' wide.

Blowdown 1320 gpm/reactor Evaporative loss 12,320 gpm/reactor


AGRICULTURAL
24TH AVE
C&O RR
74TH ST
76TH ST
28TH AVE
78TH ST
US RT 31
VAN BUREN STATE PARK
5 MI 5420
30TH AVE
2 MI 313
INTER STATE I 196
N
MICHIGAN
SWITCH YARD
US RT 31
LAKE MICHIGAN
NORMAL POOL 580' MSL
590'
PROPERTY LINE
487 ACRES
PALISADES
DISCHARGE
INTAKE
3500' OFF SHORE
HEDDLESON

BROWNS FERRY, 50-259, -260, -296

Project Name: Browns Ferry Nuclear Plant, Units 1, 2, & 3
Location: Limestone Co., Ala.
Owner: Tenn. Valley Authority

A-E: TVA
Vessel Vendor: Babcock & Wilcox
NSS Vendor: General Electric
Containment Constructor: TVA

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3293	H_2O/UO_2 Volume Ratio	2.43
Electrical Output, MWe	1098	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output, Safety Design, MWt	3440	Moderator Temp Coef Hot, No Voids	-17.0×10^{-5}
Steam Flow Rate, lb/hr	13.38×10^{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	66,098	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	424,400	Initial Enrichment, %	2.19
Average Heat Flux, Btu/hr-ft^2	163,234	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4430	Core Maximum 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, One Rod, Normal Sequence	0.01 Δk
Avg Power Density, Kw/ℓ	50.732	Curtain Worth, %	---
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280 cal/gm	Burnable Poisons, Type and Form	372 Flat Boron - SST
Data from FSAR.		Number of Control Rods	185 Cruciform
		Number of Part-Length Rods (PLR)	None

Compiled by: Fred Heddleson, Aug. 1971
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: Browns Ferry

Exclusion Distance, Miles	~0.75	Design Winds in mph:	
Low Population Zone Distance, Miles	7	At 0 – 50 ft elev	100
Metropolis / Distance / Population: Huntsville, Ala. / 30 / 228,239		50 – 150 ft	120
Design Basis Earthquake Acceleration, g	0.20	150 – 400 ft	140
Operating Basis Earthquake Acceleration, g	0.10	Tornado 300 mph tang ΔP = --- psi/--- sec	
Earthquake Vertical Shock, % of Horizontal	---	Is Intent of 70 Design Criteria Satisfied?	Yes

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 sytem overrides all operator actions and process controls.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Drywell Design Pressure, psig	56	Primary Containment Leak Rate, %/day	0.5
Suppression Chamber Design Pressure, psig	56	Second Containment Design Pressure, Inches of Water	2
Calculated Max Internal Pressure, psig	46.6	Second Containment 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 110,000 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 aren't

D2. EMERGENCY CORE COOLING SYSTEMS — Reactor: Browns Ferry
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 four 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 through 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 pressures 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
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 & 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. Limits fallout velocity to 5 ft/sec.
Control-Rod-Drive-Housing Supports: Housing supports are located underneath reactor vessel near the control rod housing. Supports limit travel of a control rod to $\sim$2" 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 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.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: Browns Ferry
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.
Containment Atmospheric Control System: Atmosphere inerting not mentioned. Primary containment is held at about 135F 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: 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."
Containment Floodability: Can flood primary containment to a level above reactor core.
Reactor-Coolant Leak-Detection System: 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-generating sets, each rated at 2850 kw for 2000 hrs 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.

F. GENERAL

Reactor: Browns Ferry

Windspeed, Direction Recorders, and Seismographs: Weather data collection started Feb. 1967 using a 300 ft high tower. Data are digitally recorded and placed on paper punch tape. Three triaxial accelerographs will be installed, 2 in unit 1 building and 1 on the base slab of the diesel-generator building.

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

Site Description: 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-mi radius and 3128 in a 5-mi 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 O-19 to decay, after which gas passes through high efficiency off-gas filters before stack release. Solid wastes are collected, dewatered, and shipped offsite.

Plant Vent: 600 ft reinforced concrete.

G. SITE DATA

Reactor: Browns Ferry

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 radius 208 ; 10 mi ____
Date of Data: 1970   In 5 mi radius 3128 ; 50 mi ____

Nearest City of 50,000 Population: Huntsville, Alabama
Dist. from site 30 Miles, Direction E , Population 146,000 ('70)

Land Use in 5 Mile Radius: Agricultural — 70%

Meteorology: Prevailing wind direction SSW Avg. speed 6 mph
Stability Data - Neutral 47% of time.

Miscellaneous Items Close to the Site:

Athens, Alabama (population 14,000), is 10 mi NE and Decatur (population 38,000) is 10 mi SE. Redstone Arsenal is 25 mi E. The closest railroad is 6 mi E of site.

H. CIRCULATING WATER SYSTEM

Type of System: Once through, closed, or helper cycles.

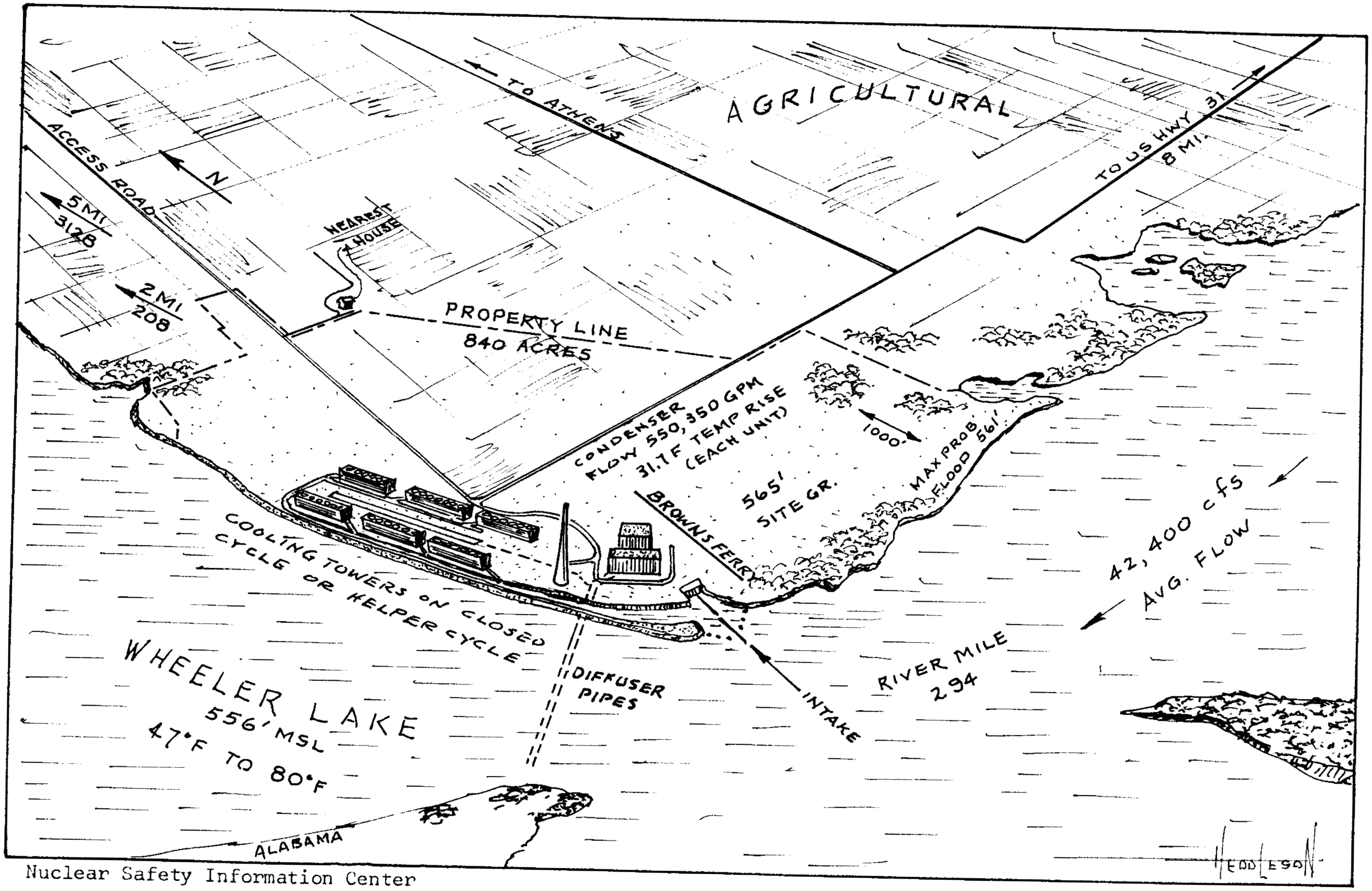
Water Taken From: Wheeler Lake

Intake Structure: Concrete structure in a small inlet.

Water Body Temperatures: Winter minimum 40 °F Summer maximum 88 °F
River Flow 45,000 (cfs) minimum; --- (cfs) average
Service Water Quantity 30,000 gpm/reactor
Flow Thru Condenser 550,350 (gpm)/reactor Temp. Rise 31.7 °F
Heat Dissipated to Environment --- (Btu/hr)/reactor
Heat Removal Capacity of Condenser 7770×10^6 (Btu/hr)/reactor

Discharge Structure: Diffuser pipes extending across channel.

Cooling Tower(s): Description & Number - 6 mech. draft, 2 for each reactor.
Blowdown 49,500 gpm/reactor Evaporative loss --- gpm/reactor



Nuclear Safety Information Center

Data From FSAR Page 1 (PWR)

ROBINSON, 50-261

Project Name: H. B. Robinson Steam Electric Plant Unit 2

Location: Darlington Co., S.C.

Owner: Carolina Power & Light

Commercial Operation - 3/7/71

A-E: Ebasco Services

Vessel Vendor: Combustion Engineering

NSS Vendor: Westinghouse

Containment Constructor: Not Specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2200	H_2O/U, Cold	4.18
Electrical Output, MWe	769	Avg 1st-Cycle Burnup, MWD/MTU	14,500
Total Heat Output, Safety Design, MWt	2300	First Core Avg Burnup, MWD/MTU	---
Total Heat Output, Btu/hr	7479×10^6	Maximum Burnup, MWD/MTU	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	1.85
DNBR, Nominal	1.81	Region-2 Enrichment, %	2.55
Total Flowrate, lb/hr	101.5×10^6	Region-3 Enrichment, %	3.10
Eff Flowrate for Heat Trans, lb/hr	97×10^6	k_{eff}, Cold, No Power, Clean	1.180
Eff Flow Area for Heat Trans, ft^2	41.8	k_{eff}, Hot, Full Power, Xe and Sm	1.077
Avg Vel Along Fuel Rods, ft/sec	14.3	Total Rod Worth, % BOL	8.14
Avg Mass Velocity, lb/hr-ft^2	2.32×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	1250
Nominal Core Inlet Temp, °F	546.2	Shutdown Boron, No Rods-Clean-Hot, ppm	1210
Avg Rise in Core, °F	58.3	Boron Worth, Hot, % Δk/k	7.3
Nom Hot Channel Outlet Temp, °F	642	Boron Worth, Cold, % Δk/k	5.6
Avg Film Coeff, Btu/hr ft^2-°F	5400	Full Power Moderator Temp Coeff, Δk/k/°F	$(+.3 \text{ to } -3.5) \times 10^{-4}$
Avg Film Temp Diff, °F	31.8	Moderator Pressure Coeff, Δk/k/psi	$(-.3 \text{ to } +3.5) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	42,460	Moderator Void Coeff, Δk/k/% Void	$(+.5 \text{ to } -2.5) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	171,600	Doppler Coefficient, Δk/k/°F	$(-1.0 \text{ to } -1.6) \times 10^{-5}$
Max Heat Flux, Btu/hr ft^2	554,200	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	5.5	Burnable Poisons, Type and Form	Borated Pyrex Glass in SST Tubes
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: Fred Heddleson April 1972 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: ROBINSON
Exclusion Distance, Miles		0.27 radius	Design Winds in mph:
Low Population Zone Distance, Miles		4.5	At 0 — 50 ft elev 108
Metropolis	Distance	Population	
Columbia, S.C.	56	322,880	50 — 150 ft 133
Design Basis Earthquake Acceleration, g		0.2	150 — 400 ft 162
Operating Basis Earthquake Acceleration, g		0.1	Tornado 300 mph
Earthquake Vertical Shock, % of Horizontal		67	ΔP = --- psi/---sec
Is Intent of 70 Design Criteria Satisfied?	Section 1.3 information describes conformance to criteria.		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	42
Max Leak Rate at Design Pressure, %/day	0.1	Calculated Max Internal Pressure, psig	37.8

Type of Construction: Structure is a reinforced concrete vertical cylinder with prestressed steel tendons in the vertical wall, a reinforced concrete hemispherical dome, all supported on soil supported steel pipe friction piles. Side walls are 3'-6" thick and dome is 2'-6" thick with 1/2" steel liner for walls and 3/8" steel liner for dome. Free volume is 2,100,000 ft^3.

Design Basis: Designed so that discharge of coolant through a double-ended rupture of the main loop piping, followed by operation of only the engineered safety features which can run simultaneously with power from one on-site diesel generator (one high head safety injection pump, one residual heat removal pump, two fan cooler units, one spray pump), will result in low radioactive materials leakage from the containment structure with no risk to public health and safety.

Vacuum Relief Capability: Negative pressure of 2 psig was considered. When negative pressure reaches 1 psig, operator is alerted in control room. Relief valves are opened manually.

Post-Construction Testing: Proof tested at 115% of design pressure. Leakage rate tests will be conducted in accordance with ANS 7.60. Periodic leak tests will be run.

Penetrations: All are double sealed with pressure taps for pressurizing and testing. A pressurizing system pressurizes penetrations in case of LOCA.

Weld Channels: Weld channels were used on all bottom seam welds and around welds where penetrations were joined to the liner.

D2. CONTAINMENT SAFETY FEATURES Reactor: ROBINSON
Containment Spray System: Designed to spray water into containment after LOCA for cooling and to remove elemental iodine. Two pumps can each supply 1161 gpm of borated water. Suction is taken from the refueling water storage tank with sodium hydroxide added for iodine removal. Also, water can be recirculated from the containment sump and cooled.
Containment Cooling: In normal operation, containment temp will be held to 120F or less with 3 of 4 fan-coil units operating. Each unit then has 1.75×10^6 Btu/hr capacity. Under accident conditions, cooling capacity of each unit is 40×10^6 Btu/hr. Fans handle 85,000 cfm each normally, or 65,000 cfm in accident mode.
Containment Isolation System: Isolation valves on lines penetrating containment provide 2 barriers between the containment atmosphere and the outside environment. Automatic isolation is initiated by a containment isolation signal. Valves are designed to the same seismic criteria as the containment vessel.
Containment Air Filtration: Two 5000 cfm fan-filter units are provided to remove iodine and other particulate activities using charcoal filters. Twelve units are installed which also have HEPA filters.
Penetration Room: Nothing shown as such on drawings.
D3. SAFETY INJECTION SYSTEMS
Accumulator Tanks: There are 3 tanks, each holding 5800 gallons of borated water under nitrogen pressure. Each tank is connected to a cold leg of the reactor and isolated by 2 check valves. When system pressure drops below 600 psig, check valves open and the borated water is forced into the coolant system.
High-head Safety Injection: Three pumps taking suction from the refueling water storage tank operate on the safety injection signal to pump 375 gal each, of borated water at 1750 psig. Water is pumped into 2 headers one of which supplies the vessel cold legs and the other the hot legs. At first, the water is pumped thru one header which causes contents of the boric injection tank with 12% boric acid (900 gal) to be flushed into the coolant system.
Low-head Safety Injection: Two Residual Heat Removal System pumps each supply 3000 gallons of borated water to the three cold legs at 600 psig. Suction is taken from the refueling water storage tank until that supply is about exhausted. The operator will then switch pumps to the recirculation phase pumping from the containment sump. Water from the sump passes thru the residual heat removal heat exchangers (total capacity - 59×10^6 Btu/hr) for cooling.

E. OTHER SAFETY-RELATED FEATURES

Reactor: ROBINSON

Reactor Vessel Failure: No reference found.

Containment Floodability: No reference found.

Reactor-Coolant Leak-Detection System: Leakage can be measured by an air particulate monitor, radiogas monitor, humidity detector, measurement of moisture condensed on cooling coils, amount of coolant system makeup in pressurizer, and by sump pump operation.

Failed-Fuel-Detection System: Failed fuel detection is performed by analysis of coolant samples taken from the letdown sampler which give precise indication of any increase in coolant fission product concentration. (Amendment 5, page 1 of 8).

Emergency Power: First source is a 110-4.16 Kv startup transformer. This transformer has multiple sources of supply. Also, there are 2 diesel-generator sets (Fairbanks-Morse 3125 Kva) rated 2500 Kw. Each unit is separately housed and independent in all ways. Air starting has supply for 8 cranks. Each unit has a 200 gallon fuel tank with access to fuel from a 25,000 gallon storage tank.

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Burnable poison rods assure a zero or negative moderator temp coef. Part-length control rods are provided to control axial oscillations. In-core instrumentation will be used to periodically calibrate out-of-core instruments.

Boron Dilution Control: Because of the procedures involved in the dilution process, an erroneous dilution is considered incredible. 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: Residual heat removal loop can maintain a circulation of borated water from the containment sump thru heat exchangers to the reactor vessel for long term cooling. The containment spray system can operate in a similar manner to cool the containment atmosphere.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Containment will be vented for 1 hr daily at a flow rate that will maintain hydrogen below 3% by volume concentration.

F. GENERAL	Reactor: ROBINSON

Windspeed, Direction Recorders, and Seismographs: Collection of meteorological data started in April 1967 using instruments on a 120' high tower. Two strong motion recorders are installed - one in the containment building and the other on the north side of the refueling water tank.

Plant Operation Mode: Designed for load following.

Site Description: Located in northeastern South Carolina on the southern edge of The Sand Hills region adjacent to Lake Robinson. The area is sparsely populated and topography is rolling hills. The man-made lake is about 4000 ft wide and 7 1/2 miles long. Farming is the predominant activity. The nearest residence is 1400 ft south of the plant and there is a small community about 1/2 mile SE.

Turbine Orientation: Ejected blades from the Westinghouse turbine could strike containment. Centerlines are 170' apart.

Emergency Plans: Plans are available (Sect. 5, Vol. IV of FSAR) that details procedures to follow so that an emergency will be handled in an efficient, timely manner with minimum exposure of plant personnel and the public. Periodic drills will be held for training and continued familiarity. Emergencies are classified as LOCAL, SITE, or GENERAL EMERGENCY. The latter covers accidents effecting distances beyond the exclusion boundary. Local and state authorities as well as medical personnel have been familarized.

Environmental Monitoring Plans: Preoperational program started late in 1968 to test equipment, sampling, analysis, and to obtain preoperational measurements. Samples were collected from 25 points within a 5 mile radius such as air, ground water, surface water, bottom sediments, soil, and fish. After operation started, sampling continued to determine if operation was effecting the environment in a measurable way.

Radwaste Treatment: Radioactive fluids entering the Waste Processing System are collected in sumps and tanks until determination of subsequent treatment can be made. They are sampled and analyzed to determine the quantity of radioactivity, with a periodic isotopic identification, and then processed. Most liquids are processed and retained inside the plant by the Chemical & Volume Control System recycle train. Processed water from waste disposal is discharged through a monitored line into the circulating water discharge. Gases are held up in decay tanks to allow sufficient decay and then vented under strict control or returned to the Volume Control System. Solid wastes are packaged into 55-gallon drums by a hydraulically operated baler. The system is controlled from a central panel in the auxiliary building, and appropriate alarms and indicators are located in the control room.

Plant Vent: A 54" metal stack runs up the side of containment to 375' elevation (about 45' below top of containment).

G. SITE DATA

Reactor: ROBINSON

Nearby Body of Water: Lake Robinson, 2250 acres

Normal Level 220' (MSL)

Max Prob Flood Level 222' (MSL)

Size of Site 5000 Acres

Site Grade Elevation 225' (MSL)

Topography of Site: Rolling

of Surrounding Area (5 mi rad): Rolling

Total Permanent Population: In 2 mi radius 1375 ; 10 mi ______

Date of Data: 1976 In 5 mi radius 12,552 ; 50 mi 694,605

Nearest City of 50,000 Population: Columbia, S.C.

Dist. from site 56 Miles, Direction SW , Population 113,542

Land Use in 5 Mile Radius: Agricultural and wooded. Lake Robinson provides Recreation area.

Meteorology: Prevailing wind direction NE Avg. speed 5.8 mph

Stability Data - About 1/3 each of stable, neutral, and unstable.

Miscellaneous Items Close to the Site: The nuclear plant is adjacent to unit #1 a coal-fired plant of 185 MWe capacity. The nearest town is Hartsville, 4.5 miles ESE. Florence is 25 miles SE and Columbia is 56 miles away. The Atlantic Ocean is about 88 miles SE. Sand Hills State Forest is 4 miles N where 3000 acres of watermelons are grown. Nearest dairy farm is 7 miles E.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

Water Taken From: Lake Robinson

Intake Structure: Reinforced concrete on edge of lake, using 3 circulating pumps. Trash racks and traveling screens are provided. At max flow, velocity through screens is about 2 fps.

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

River Flow 21 (cfs) minimum; 169 (cfs) average

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 482,100 (gpm)/reactor Temp. Rise 18 °F

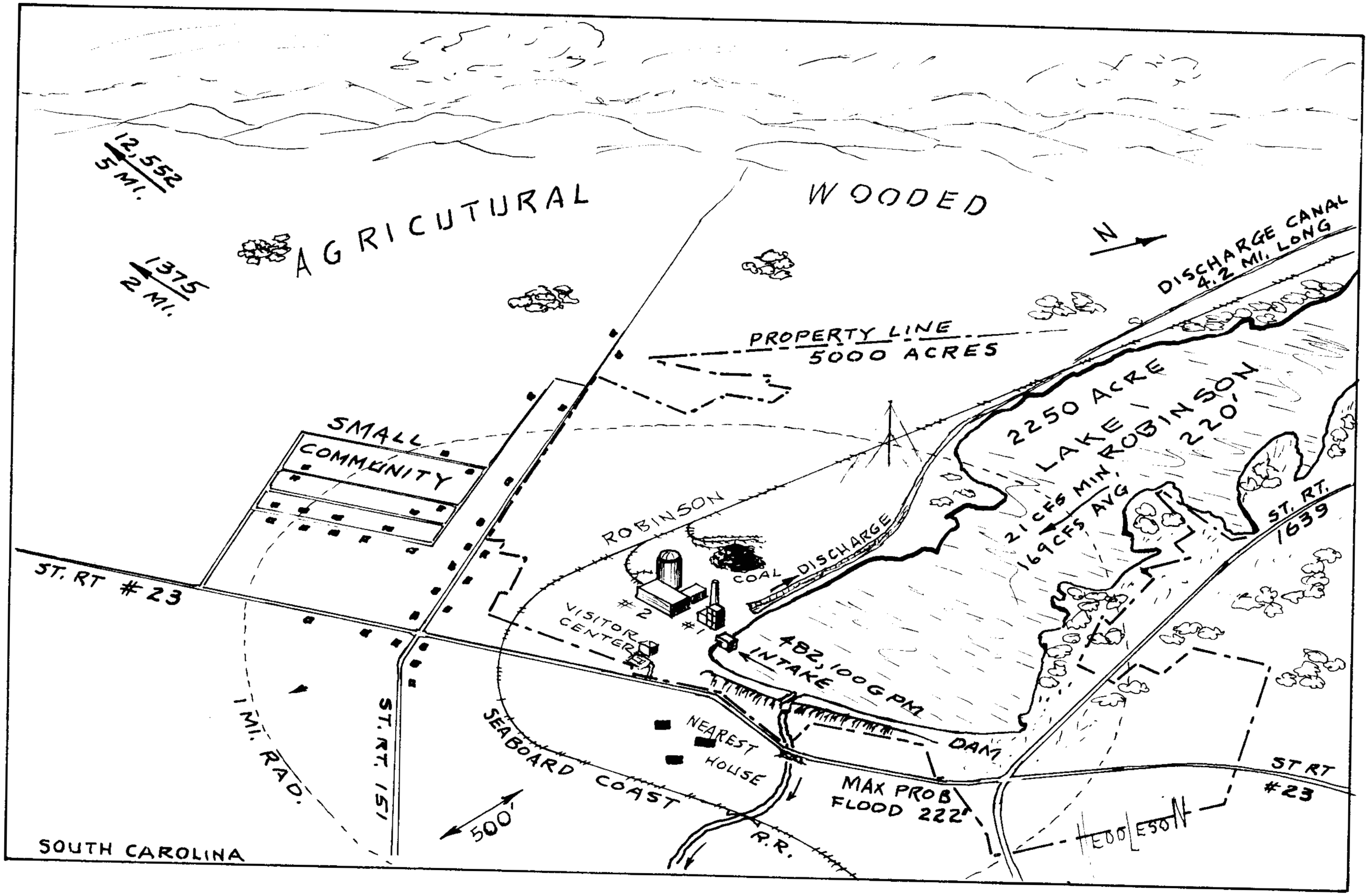
Heat Dissipated to Environment 4300×10^6 (Btu/hr)/reactor

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

Discharge Structure: Discharged back to the lake through a 4.2 mile long discharge canal that returns water to the lake about 4 miles upstream.

Cooling Tower(s): Description & Number - None

Blowdown ______ gpm/reactor Evaporative loss ______ gpm/reactor


12,552
5 MI.
1375
2 MI.
AGRICUTURAL
WOODED
N
DISCHARGE CANAL
4.2 MI. LONG
PROPERTY LINE
5000 ACRES
SMALL
COMMUNITY
2250 ACRE
LAKE ROBINSON
220'
21 CFS MIN
169 CFS AVG
ROBINSON
COAL
DISCHARGE
ST. RT #23
#2
#1
VISITOR
CENTER
482,100 GPM
INTAKE
ST. RT.
1639
NEAREST
HOUSE
DAM
ST RT
#23
1 MI. RAD.
ST. RT. 151
SEABOARD COAST
R.R.
MAX PROB
FLOOD 222'
500'
SOUTH CAROLINA
HEDDLESON

MONTICELLO, 50-263

Project Name: Monticello Nuclear Generating Plant
Location: 3 miles northwest of village of Monticello, Minnesota
Owner: Northern States Power Co

A-E: Bechtel Corporation
Vessel Vendor: Chicago Bridge & Iron
NSS Vendor: General Electric Co
Containment Constructor: Chicago Bridge & Iron

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1670	H_2O/UO_2 Volume Ratio	2.45
Electrical Output, MWe	545 (net)	Moderator Temp Coef Cold, $\Delta k/k/°F$	-8.0×10^{-5}
Total Heat Output, Safety Design, MWt	1670	Moderator Temp Coef Hot, No Voids	-11.0×10^{-5}
Steam Flow Rate, lb/hr	6.77×10^6	Moderator Void Coef Hot, No Voids, $\Delta k/k/\%$	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	57.6×10^6	Moderator Void Coef Operating	-1.4×10^{-3}
Coolant Pressure, psig	1025	Doppler Coefficient, Cold	-1.2×10^{-5}
Heat Transfer Area, ft^2	41,876	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	17.5	Doppler Coefficient, Operating	-1.2×10^{-5}
Maximum Heat Flux, $Btu/hr\text{-}ft^2$	405,000	Initial Enrichment, %	2.25 (avg)
Average Heat Flux, $Btu/hr\text{-}ft^2$	131,350	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	4450	Core Average Void Within Assembly, %	38.6
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	3.08	Control Rod Worth, %	$21\% \Delta k$
Avg Power Density, Kw/ℓ	40.6	Curtain Worth, %	$12\% \Delta k$
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	Flat Boron - SS
		Number of Control Rods	121
		Number of Part-Length Rods (PLR)	None

Compiled by: F.A. Heddleson & L.L. Taylor (NSP)
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: MONTICELLO

Exclusion Distance, Miles	0.4	
Low Population Zone Distance, Miles	1	
Metropolis	Distance	Population
Minneapolis-St. Paul	33 mi.	1,813,647
Design Basis Earthquake Acceleration, g	0.12	
Operating Basis Earthquake Acceleration, g	0.06	
Earthquake Vertical Shock, % of Horizontal	67	

Design Winds in mph:

At 0 — 50 ft elev	100
50 — 150 ft	not available
150 — 400 ft	not available
Tornado	300 mph
ΔP =	3 psi/ 3 sec

Is Intent of 70 Design Criteria Satisfied? yes

Recirculation Pumping System & MCHFR:

The recirculation system consists of two recirculation pump loops and twenty jet pumps. 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

Drywell Design Pressure, psig	56	Primary Containment Leak Rate, %/day	0.5
Suppression Chamber Design Pressure, psig	56	Second Containment Design Pressure, psig	0.25
Calculated Max Internal Pressure, psig	41	Second Containment 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 134,200 ft^3 and suppression chamber free volume is 108,250 ft^3.

Design Basis:

Designed to provide a barrier which, in the event of a loss-of-coolant accident, will control the release of fission products to the secondary containment, and to rapidly reduce the pressure in the containment resulting from the loss-of-coolant accident.

Vacuum Relief Capability: Designed for external pressure 2 psi greater than the internal pressure. Relief devices let air flow from reactor building to suppression chamber, to the drywell.

Post-Construction Testing: Leakage rate tests will be performed at 41 psig as follows: (a) during the first refueling outage, (b) within 24 months from the date of the test in (a), (c) within 48 months of the test in (b) and every 48 months thereafter.

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

D2. EMERGENCY CORE COOLING SYSTEMS	Reactor: MONTICELLO

Core Spray Cooling System: Consists of two independent loops each having one 100% capacity pump, valves and piping to an independent circular sparger ring inside the reactor vessel inner shroud above the core. Each pump delivers 3020 gpm at 145 psig. Initiated by low water level coincident with low pressure in the reactor or high drywell pressure.

Auto-Depressurization System: Uses three pressure relief valves to vent steam to the suppression pool to reduce coolant pressure in sufficient time to allow either core spray or LPCIS to cool core to prevent clad melting.

Residual-Heat-Removal System (RHRS): Consists of four main pumps, two heat exchangers and four service water pumps arranged in two loops. There are three modes of operation which are: (1) shutdown cooling; (2) suppression pool cooling which pumps suppression pool water through 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 system. Pumps are rated at 4,000 gpm each @ 20 psid and heat exchangers 57.5×10^6 Btu/hr each.

High-Pressure Coolant-Injection System: Designed to pump water into the reactor vessel under loss-of-coolant conditions which do not result in rapid depressurization of the pressure vessel. One turbine-driven pump provides 3,000 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 drywell.

Low-Pressure Coolant-Injection System: Is an integral part of RHRS. It operates to restore and, if necessary, maintain the coolant inventory in the reactor vessel after a loss-of-coolant accident so that the core is sufficiently cooled to preclude fuel clad melting.

E. OTHER SAFETY-RELATED FEATURES

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

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. Does not 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 the control rod housing is ruptured. Supports prevent a nuclear excursion as a result of a housing failure.

Standby Liquid-Control System: Will bring the reactor to a shutdown condition at any time during core life independent of the control rod drive system capabilities. A sodium pentaborate solution is delivered to the reactor by one of two 28 gpm, 1500 psi positive displacement pumps.

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

Standby Coolant System: Two independent core spray cooling systems and four LPCI pumps.

Containment Atmospheric Control System: Performs two functions: (1) initial purge of the primary containment with nitrogen to reduce oxygen concentration to less than 4% by volume; and (2) automatically controls the supply of nitrogen to maintain oxygen concentration at less than 4.9% by volume. Permits purging of atmosphere prior to maintenance operations.

Reactor Core Isolation Cooling System (RCICS): Consists of a turbine-driven pump capable of delivering makeup water to the reactor vessel if it is isolated. The turbine is powered by residual steam from the reactor and is automatically initiated by a low water level in the reactor. System can deliver 400 gpm.

Reactor Vessel Failure: The reactor vessel is designed and fabricated for a 40 year life based upon the specified design and operating conditions.

Containment Floodability: Can flood primary containment to a level above the reactor core.

Reactor-Coolant Leak-Detection System: Leaks are detected by: (a) a timer which actuates an alarm when the interval between drywell sump pump operation decreases below an adjustable minimum, and (b) monitoring drywell pressure, temperature, and iodine and particulate airborne activity. Total leakage rate limit is set at 25 gpm with a limit of 5 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. Gamma sensitive detectors monitor the main steam lines.

Emergency Power: Two independent diesel generators, each capable of providing sufficient power to safely shut down the reactor upon the loss of all outside power simultaneous with the design basis accident. Output is rated at 2500 kw, 4160 V, three phase, 60 Hz AC. Rated for 10% overload for 2,000 hours or 22% overload for 30 minutes out of each 24 hours. Each diesel generator is designed to start automatically and within 10 seconds begin to accept load. Two reserve station transformers can supply emergency power if off-site power is not lost.

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.

F. GENERAL

Reactor: MONTICELLO

Windspeed, Direction Recorders, and Seismographs: Wind speed, direction and temperature measured at three levels on a 100 meter tower (at 10, 40 and 100 meters). Data recorded on tape at tower, relayed to plant control room and Minneapolis General Office on teletype. Seismograph recorder with three detectors is installed.

Plant Operation Mode: Reactor power is controlled by movement of control rods and by regulation of the reactor coolant recirculation system flow rate.

Site Description: Located about 3 miles northwest of the village of Monticello, Minnesota. Size of the site is approximately 1,325 acres with a site elevation of 930 ft. Bluffs located about 1 mile north and south of the site rise to 950 ft MSL. Beyond 1 mile north, the terrain is relatively level with numerous lakes and wooded areas. To the south, west and east the terrain is hilly and dotted with numerous small lakes.

Turbine Orientation: The plane of rotation of the turbine wheels intersects the containment structure. The reactor & turbine centerlines are 130 ft apart.

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

Environmental Monitoring Plans: Pre-operational surveys were conducted for three years to establish background radiation levels. Sampling is performed as follows: (a) air particulate activity, (b) gamma background radiation, (c) soil samples, (d) vegetation, (e) water, and (f) milk. State Department of Health performs analyses of all samples collected. Occasional samples will be shipped to a private analytical laboratory for the purpose of supporting the result of the analyses by the State Department of Health.

Radwaste Treatment: Liquid wastes are recycled to the condensate system to the maximum extent practicable, making for a near-zero release condition. Gaseous releases from air ejectors are passed through recombiners, charcoal filters and are compressed and stored for at least 50 hours prior to releasing to the atmosphere. Solid wastes are collected, stored for decay, and shipped off-site.

Plant Vent: Continuous monitoring on plant vents. Air ejector off-gas stack releases gases at height of 320 ft.

G. SITE DATA

Reactor: MONTICELLO

Nearby Body of Water: Mississippi River
Normal Level 905 ft. (MSL)
Max Prob Flood Level 916 ft. (MSL)

Size of Site 1,325 Acres   Site Grade Elevation 930 ft. (MSL)

Topography of Site:
of Surrounding Area (5 mi rad): Flat alluvial terraces. Slope away from river at grades of 2 or 3%.

Total Permanent Population: In 2 mi radius 150 ; 10 mi 12,300
Date of Data: 1970   In 5 mi radius 5,000 ; 50 mi 1,956,000

Nearest City of 50,000 Population: Minneapolis - St. Paul
Dist. from site 33 Miles, Direction SE , Population 745,000

Land Use in 5 Mile Radius:
Agricultural - dairy farming and vegetable crops

Meteorology: Prevailing wind direction NW Avg. speed 7 mph
Stability Data - Wide variations in temperature. Scanty winter precipitation. Ample summer rainfall. Tendency to extremes.

Miscellaneous Items Close to the Site:
Sherburne National Wildlife Refuge is about 9 miles NE to 12 miles N of the site. Lake Maria State Park is located about 6 miles WSW of the site and the Sand Dunes State Forest and campground are located about 9 miles NE of the site.

H. CIRCULATING WATER SYSTEM

Type of System: Open cycle, once-through cooling towers. Closed cycle with cooling towers, and variations of these modes.

Water Taken From: Mississippi River

Intake Structure: Canal bottom is 62 ft wide and 898 ft MSL. Design low flow stage is 904 ft MSL. Maximum ice thickness is 40 inches, leaving 2.5 ft of open water. Chlorination equipment at intake.

Water Body Temperatures: Winter minimum 32 °F   Summer maximum 85 °F

River Flow 240 (cfs) minimum; 4,600 (cfs) average

Service Water Quantity 28,000 gpm/reactor

Flow Thru Condenser 280,000 (gpm)/reactor   Temp. Rise 27 °F

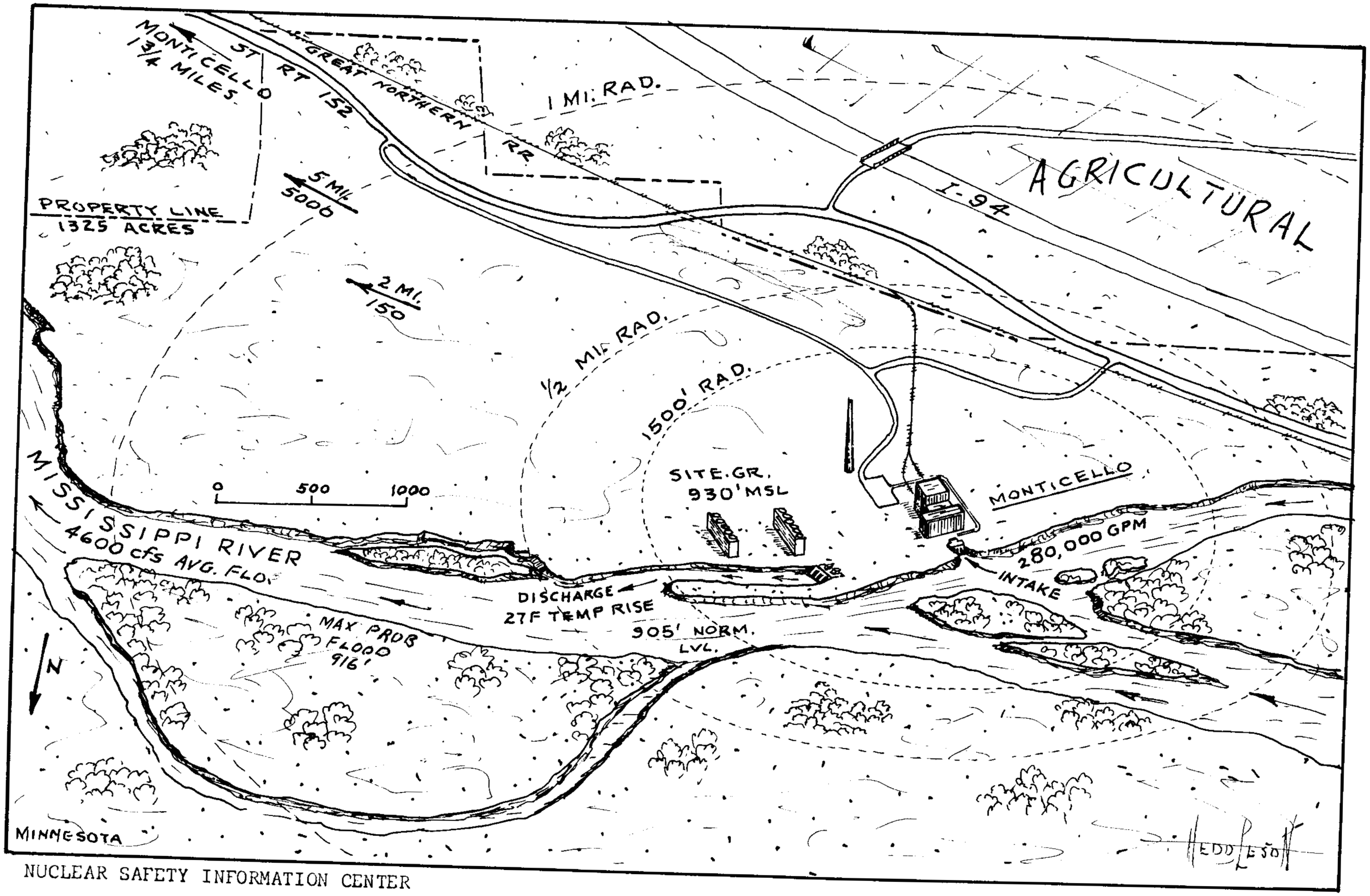
Heat Dissipated to Environment 3.76×10^9 (Btu/hr)/reactor

Heat Removal Capacity of Condenser 3.76×10^9 (Btu/hr)/reactor

Discharge Structure: Outlet lines drop below turbine building and are wye-connected to a 108" pipe. Line runs 600' to discharge structure where flow diverges into parallel paths. Water goes through two sluice gates where it is pumped to cooling towers or discharged to river.

Cooling Tower(s): Description & Number - Crossflow - two

Blowdown 15,000 gpm/reactor   Evaporative loss 8,400 gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

POINT BEACH, 50-301 & 50-266

Project Name: Point Beach Nuclear Plant Units 1 & 2
Location: W. shore of Lake Mich. 30 mi SE of Green Bay
Owner: Wisc. Elec. Pwr. & Wisc.-Mich. Power
A-E: Bechtel
Vessel Vendor: Babcock & Wilcox
NSS Vendor: Westinghouse
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, Safety Design, MWt	1518	First Core Avg Burnup, MWD/MTU	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 Flowrate, 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, %	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 Pressure 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 1 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	Compiled by: F. A. Heddleson 7/71 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Point Beach	
Exclusion Distance, Miles		0.74 Radius	Design Winds in mph:	
Low Population Zone Distance, Miles		5.6	At 0 — 50 ft elev	108
Metropolis	Distance	Population	50 — 150 ft	130
Green Bay, Wis.	27	158,244	150 — 400 ft	150
Design Basis Earthquake Acceleration, g		0.12	Tornado 300 mph tang. + 60 trans.	
Operating Basis Earthquake Acceleration, g		0.06	ΔP = 3 psi/ - sec	
Earthquake Vertical Shock, % of Horizontal		67		
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 Pressure, psig	60
Max Leak Rate at Design Pressure, %/day	0.4	Calculated Max Internal Pressure, psig	53

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. thk 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.

D2. CONTAINMENT SAFETY FEATURES Reactor: Point Beach

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. The barriers are in the form of isolation valves.

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

Penetration Room: No rooms labeled as such on drawings.

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.

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.

E. OTHER SAFETY-RELATED FEATURES Reactor: Point Beach
Reactor Vessel Failure: No reference found.
Containment Floodability: No reference found.
Reactor-Coolant Leak-Detection System: Provided by equipment which continuously monitors containment air activity and humidity, and run-off 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 System: 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 By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Boron shim in the coolant and part-length rods help control oscillations. The in-core instrumentation are used for calibration of out-of-core instruments which indicate power distribution.
Boron Dilution Control: Because of procedures involved in dilution process, an erroneous dilution is considered unlikely. Nevertheless, if an unintentional dilution of boron in the coolant does occur, numerous alarms and indications alert the operator to the condition. The maximum reactivity addition due to dilution is slow enough to allow operator to determine the cause of the addition and to take corrective action if necessary before shutdown margin is lost.
Long-Term Cooling: 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.
Organic-Iodide Filter: No reference found.
Hydrogen Recombiner: Post-accident purging provides a safe and reliable method for controlling potential hydrogen accumulation.

F. GENERAL	Reactor: Point Beach

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 Operation Mode: Load following.

Site Description: 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 Wisconsin 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 demineralized. Treated water from demineralizers or the evaporators 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.

Plant Vent: Runs up through roof of secondary containment - ∿175' high.

G. SITE DATA

Reactor: Point Beach

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 radius 270 ; 10 mi ______

Date of Data: 1975 In 5 mi radius 1439 ; 50 mi ______

Nearest City of 50,000 Population: Green Bay, Wisconsin

Dist. from site 27 Miles, Direction NW , Population 85,000 ('69)

Land Use in 5 Mile Radius: Agricultural-dairy farming and vegetable canning

Meteorology: Prevailing wind direction SW Avg. speed 10 mph

Stability Data - Neutral to stable

Miscellaneous Items Close to the Site: Town of Two Creeks adjacent to site. Point Beach State Forest is just south of site. State route 42 runs north-south about 1 1/4 miles west of plant. Kiwaunee Nuclear Plant is about 5 miles north.

H. CIRCULATING WATER SYSTEM

Type of Syetem: Once through

Water Taken From: Lake Michigan

Intake Structure: Intake is located 1750 ft from shore in 22 ft deep water having an OD of 110 ft and an ID of 60 ft. Top elevation is 8 ft above normal lake level. Water enters through 38 pipes 30" in dia located 5 ft above lake bed.

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

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

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 350,000* (gpm)/reactor Temp. Rise 19.3* °F

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

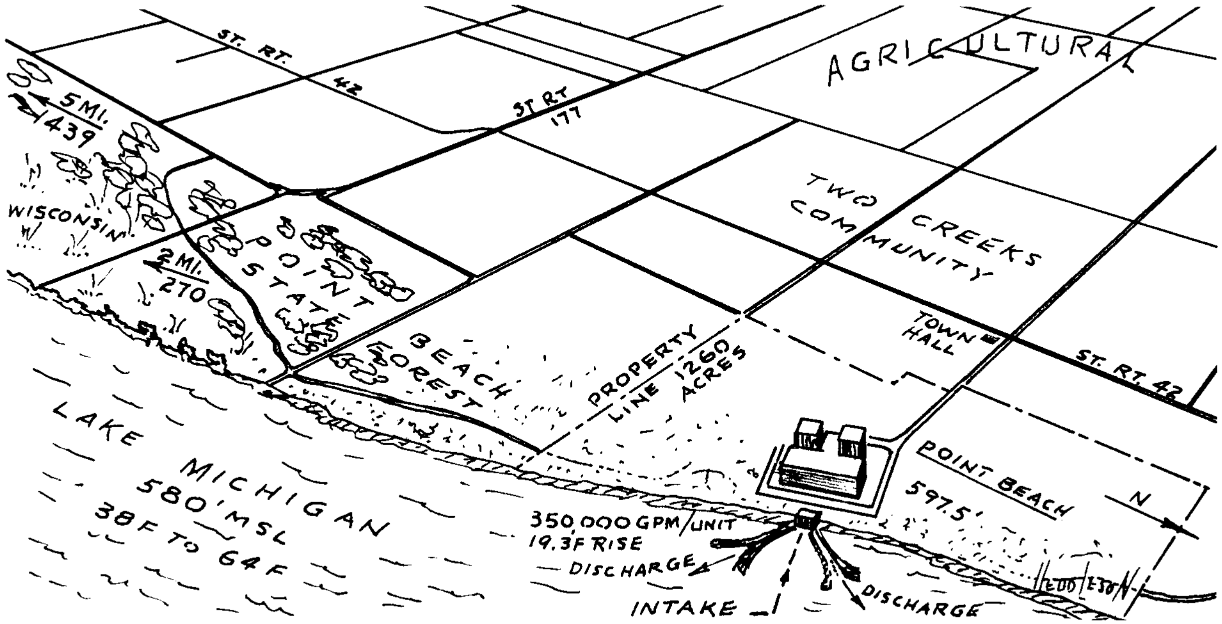
Heat Removal Capacity of Condenser ______ (Btu/hr)/reactor

Discharge Structure: Water discharged through 2 flumes which project from shoreline about 150 ft.

*For lake above 40F. When below 40F, values are 214,000 gpm & 31.5F.

Cooling Tower(s): Description & Number - None

Blowdown ______ gpm/reactor Evaporative loss ______ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

DATA FROM FSAR

Page 1 (PWR)

OCONEE, 50-269, 50-270, 50-287

Project Name: Oconee Nuclear Station, Units 1, 2, and 3

Location: Oconee Co., S.C.

Owner: Duke Power Co.

A-E: Bechtel
Vessel Vendor: Babcock & Wilcox
NSS Vendor: Babcock & Wilcox
Containment Constructor: Duke

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	*2452 2584	H_2O/U, Cold	---
Electrical Output, MWe	847	Avg 1st-Cycle Burnup, MWD/MTU	9600 **14,250
Total Heat Output, Safety Design, MWt	2568	First Core Avg Burnup, MWD/MTU	28,800
Total Heat Output, Btu/hr	8765×10^6	Maximum Burnup, MWD/MTU	55,000
System Pressure, psia	2200	Region-1 Enrichment, %	---
DNBR, Nominal	2.0	Region-2 Enrichment, %	*2.0 **2.65 †2.25
Total Flowrate, 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	*1.248 **1.244 †1.188
Eff Flow Area for Heat Trans, ft^2	49.19	k_{eff}, Hot, Full Power, Xe and Sm	*1.134 **1.109 †1.082
Avg Vel Along Fuel Rods, ft/sec	15.73	Total Rod Worth, %	10.6 7.4†
Avg Mass Velocity, $lb/hr\text{-}ft^2$	---	Shutdown Boron, No Rods-Clean-Cold, ppm	*1338 **1547 †1381
Nominal Core Inlet Temp, °F	554	Shutdown Boron, No Rods-Clean-Hot, ppm	*1488 **1553 †1479
Avg Rise in Core, °F	51.5	Boron Worth, Hot, % Δk/k/ppm	*1/85 **1/100 †1/110
Nom Hot Channel Outlet Temp, °F	642.8	Boron Worth, Cold, % Δk/k/ppm	*1/64 ** 1/75 †1/82
Avg Film Coeff, Btu/hr ft^2-°F	5000	Full Power Moderator Temp Coeff, Δk/k/°F	$(+.5 \text{ to } -3.0) \times 10^{-4}$
Avg Film Temp Diff, °F	31	Moderator Pressure Coeff, Δk/k/psi	-5×10^{-7} to $+3 \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	49,734	Moderator Void Coeff, Δk/k/% Void	$+4.0 \times 10^{-4}$ to -1.6×10^{-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 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	5.656	Burnable Poisons, Type and Form	Boron in Zircaloy-4 Tubes
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	Compiled by: Fred Heddleson Aug. 1971 Nuclear Safety Information Center	

*Unit 1 only ** Unit 2 only †Unit 3 only

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Oconee
Exclusion Distance, Miles	1 radius		Design Winds in mph:
Low Population Zone Distance, Miles	6		At 0 — 50 ft elev 95
Metropolis	Distance	Population	
Greenville, S.C.	26	299,502	50 — 150 ft 110
Design Basis Earthquake Acceleration, g	0.05 to 0.15		150 — 400 ft 130
Operating Basis Earthquake Acceleration, g	---		Tornado 300 mph
Earthquake Vertical Shock, % of Horizontal	---		ΔP = 3 psi/ 5 sec
Is Intent of 70 Design Criteria Satisfied?	Yes, see Section 1.3 and Appendix 1A		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	59
Max Leak Rate at Design Pressure, %/dav	0.5	Calculated Max Internal Pressure, psig	53.9

Type of Construction: The structure consists of a post-tensioned reinforced concrete cylinder (3'-9" thk) and dome connected to and supported by a massive reinforced concrete foundation slab. The entire interior surface of the structure is lined with a 1/4-in. thick welded steel plate to assure a high degree of leak tightness. Free containment volume is 1,900,000 cu ft.

Design Basis: Designed to withstand internal pressure due to a LOCA with no loss of integrity, and with radioactivity release from containment reasonably low such that dose rates do not exceed limits set by AEC.

Vacuum Relief Capability: External design pressure is 3 psig. No reference found to vacuum breakers.

Post-Construction Testing: Pressure tested at 115 percent of design pressure. Leakage rate tests will be conducted at 53.9 psig and again at half of this.

Penetrations: Figure 5.2 indicates all penetrations as single barrier.

Weld Channels: No reference found.

D2. CONTAINMENT SAFETY FEATURES Reactor: Oconee
Containment Spray System: Provides atmosphere cooling to limit post-accident pressure by spraying borated water into atmosphere. System consists of 2 pumps, 2 spray headers, valves, piping, etc. System sized for 100% capacity (240×10^6 Btu/hr) with both spray paths operating. Pumps take suction initially from borated water storage tank, but transferred to containment sump later. Pump rating 1600 gpm @ 200 psig.
Containment Cooling: Uses 3 fan coil units in addition to 4 fan circulators to cool and hold containment below 104F in normal operation. In case of accident these same units cool the atmosphere each having capacity of 80×10^6 Btu/hr. Low pressure service water cools the coils. This system is initiated for emergency service by containment pressure of 4 psig.
Containment Isolation System: Building isolation occurs on 4 psig pressure in the reactor building at which time isolation valves, one on each side of containment wall for all penetrations, close to prevent leakage of radioactive materials.
Containment Air Filtration: Any air leaving containment passes through particulate filters, HEPA filters, and charcoal filters before venting through the stack.
Penetration Room: Yes, with special ventilation system.
D3. SAFETY INJECTION SYSTEMS
Accumulator Tanks: Two tanks, each containing 7000 gallons of borated water dump their contents into the reactor vessel when system pressure drops below 600 psig. Two check valves in series open up the connecting line between the accumulators and the reactor vessel. Nitrogen cover gas pressurizes the accumulators. Contents of the 2 tanks are sufficient to flood the core and cover it to prevent fuel melting.
High-head Safety Injection: System is actuated by low coolant system pressure of 1500 psig, or reactor building pressure of 4 psig. Three pumps taking suction from the borated-water storage tank can each supply 480 gpm at 1500 psig. This system can replace water lost by small breaks. During normal operation, these are the reactor charging pumps.
Low-head Safety Injection: System designed to maintain core cooling for larger break sizes. System operates independently of and in addition to the high pressure system. Automatic actuation is initiated at 500 psig, or a reactor building pressure of 4 psig. There are 2 separate flow paths, each including 1 pump and 1 heat exchanger, terminating in the reactor vessel through core flooding nozzles. Pump takes suction from borated water storage tank. When storage tank is about empty, operator initiates recirculation of spilled coolant from containment sump.

E. OTHER SAFETY-RELATED FEATURES Reactor: Oconee
Reactor Vessel Failure: Concluded that even if there were a crack and it was in the worst location, it could not propagate through the vessel wall.
Containment Floodability: No reference found.
Reactor-Coolant Leak-Detection System: Leakage is indicated in the control room by changes in containment temperature, and/or humidity, by level in the pressurizer and let-down storage tank, by sump-pump operation and by the gaseous monitoring system which would show changes in radioactivity levels. A 60 gpm leak would be noticed in 5 minutes because of the sump high-level alarm in the control room.
Failed-Fuel-Detection System: No reference found.
Emergency Power: Has multiple redundant buses and tie buses supplying power, instruments, and controls. Engineered safety features for each unit are arranged on a 3-component basis and supplied from 3 separate auxiliary power buses, each of which can be supplied from any of the 7 sources of power; 2 of which are on-site Keowee Hydroelectric 87,500 KVA Generating Units.
Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Boron in Zircaloy-4 tubes helps control oscillations. Part-length rods with silver-indium-cadmium used to shape axial power. In-core instrumentation provides neutron flux detectors to monitor core performance.
Boron Dilution Control: The highest rate of boron dilution can be handled by the Control System, which would insert rods to maintain power level and thus limit coolant system temperature rise. If an interlock failure occurred while reactor was under manual control, reactivity additions would cause a high coolant temperature trip or a high-pressure trip. So, thermal power will not exceed 114% rated power and system pressure will not exceed code limits.
Long-Term Cooling: Accomplished by recirculation of injected borated water which has collected in the containment sump. The 2 low pressure injection system pumps can each deliver 3000 gpm @ 100 psig through LPCI heat exchangers to the reactor vessel. Long term cooling uses the LPCI system.
Organic-Iodide Filter: No reference found
Hydrogen Recombiner: Unacceptable hydrogen concentration does not result until 780 hrs after LOCA. Purging will control hydrogen at that time.

F. GENERAL — Reactor: Oconee

Windspeed, Direction Recorders, and Seismographs: Data collection started in 1966 with instruments on a 44-ft high pole located near mid site. In 1967 a 150-ft high tower was adopted for measurements. Found no reference to site seismographs.

Plant Operation Mode: Designed for load following.

Site Description: Oconee is part of the Keowee-Toxaway project in NW South Carolina consisting of a series of man-made lakes for nuclear, hydro, and pump storage generation. Lake Keowee, on which Oconee is located covers 18,372 acres. The land surrounding the site is hilly and wooded. Population in this area is sparse.

Turbine Orientation: Ejected turbine blades could strike containment structure. Centerlines are 242 ft apart.

Emergency Plans: Established for protection of life and property, it applies to radiation and contamination where health and safety of station personnel and the general public may be involved. The plan involves station personnel, facilities, and equipment of Duke Power Company; outside emergency services; and various local, state and federal agencies. Detailed procedures will be prepared prior to the operation of Unit 1.

Environmental Monitoring Plans: Purpose of the program is to measure and evaluate radioactivity levels from plant operations. Program is divided into pre-operational and operational phases, such that pre-operational levels may provide a base line to which operational levels can be compared. Activity is most likely to be found in air and water beyond the plant where these materials are dispersed and diluted by stream flow and wind. Air and water are primary samples. They serve as one of the earliest indicators of change in levels. Other samples include river bottom and lake sediment, vegetation, fish and animals, and milk.

Radwaste Treatment: System is designed for disposal within the limits of 10CFR20 if clad defects occur in 1% of the fuel. Liquid waste can be discharged to the tailrace of Keowee hydroelectric plant either before or after treatment. Gaseous wastes can be released immediately or held for decay and released later. If required, all gases will be filtered. Solid wastes are drummed and shipped off-site for disposal.

Plant Vent: Could not be determined.

G. SITE DATA

Reactor: Oconee

Nearby Body of Water: Lake Keowee
Normal Level 800' (MSL)
Max Prob Flood Level 808' (MSL)

Size of Site ∿500 Acres
Duke Power owns 150,000 acres
Site Grade Elevation *796' (MSL)
*Dikes prevent flooding

Topography of Site: Flat to Rolling

of Surrounding Area (5 mi rad): Hilly

Total Permanent Population: In 2 mi radius 886 ; 10 mi ----

Date of Data: 2010 In 5 mi radius 6205 ; 50 mi ----

Nearest City of 50,000 Population: Greenville, S.C.

Dist. from site 26 Miles, Direction E , Population 61,436

Land Use in 5 Mile Radius: Wooded

Meteorology: Prevailing wind direction N Avg. speed 6.5 mph

Stability Data - Pasquill F - 35%, Pasquill D - 60%

Miscellaneous Items Close to the Site: Keowee dam is close to the nuclear plant. A small church is about 3/4 miles from the plant. The nearest residence is 1.2 miles N. The nearest school is 3.8 miles S. The Southern RR runs generally N-S about 6 miles to the east.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

Water Taken From: Lake Keowee - 18,372 acres

Intake Structure: A skimmer wall causes water to be drawn from depths of 710' to 733' and then passes thru trash racks and traveling screens before entering the pumps. There are 4 circulating pumps per reactor. Velocity thru skimmer-wall ports will be 0.6 fps.

Water Body Temperatures: Winter minimum 44 °F Summer maximum 77 °F

River Flow --- (cfs) minimum; 1100 (cfs) average

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 680,000 (gpm)/reactor Temp. Rise 17.2 °F

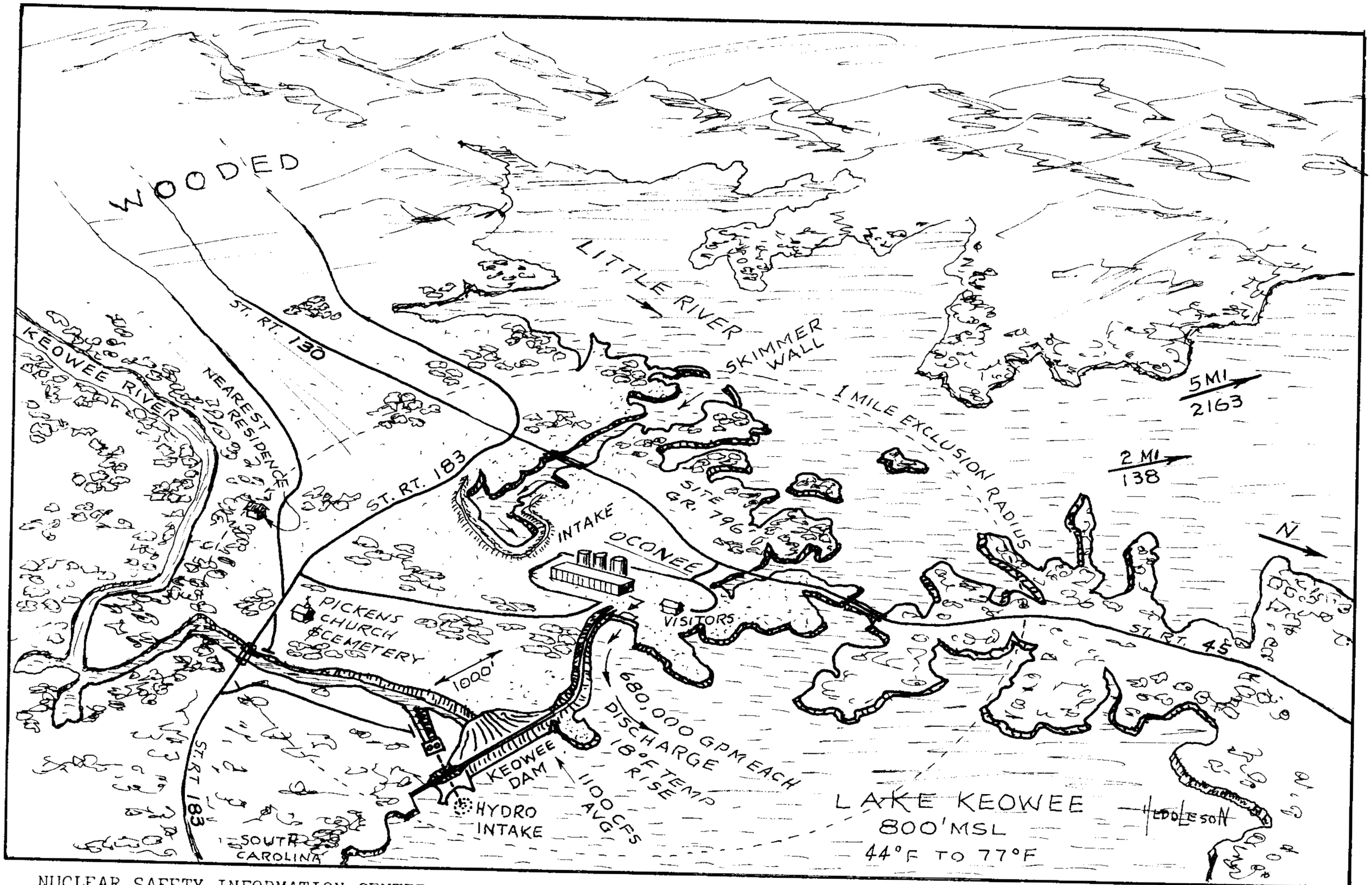
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: All three units discharge thru one structure into the lake near Keowee dam. Two 11'dia. pipes carry water from each unit to the discharge structure. Discharge is underwater at the 765' level.

Cooling Tower(s): Description & Number - None

Blowdown ______ gpm/reactor Evaporative loss ______ gpm/reactor



WOODED
LITTLE RIVER
SKIMMER WALL
ST. RT. 130
KEOWEE RIVER
NEAREST RESIDENCE
1 MILE EXCLUSION RADIUS
5 MI
2163
2 MI
138
ST. RT. 183
SITE GR. 796
INTAKE
OCONEE
N
PICKENS CHURCH & CEMETERY
VISITORS
ST. RT. 45
1000'
680,000 GPM EACH
DISCHARGE
18°F TEMP RISE
KEOWEE DAM
1100 CFS AVG
HYDRO INTAKE
LAKE KEOWEE
800'MSL
44°F TO 77°F
ST. RT 183
SOUTH CAROLINA

VERMONT YANKEE, 50-271

Project Name: Vermont Yankee Power Station

Location: Vernon, Windham Co., Vt.

Owner: Vermont Yankee Power Corp*

A-E: Ebasco Services
Vessel Vendor: Not specified
NSS Vendor: General Electric
Containment Constructor: Ebasco

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1593	H_2O/UO_2 Volume Ratio	2.47
Electrical Output, MWe	514	Moderator Temp Coef Cold, Δk/k/°F	-5.0×10^{-5}
Total Heat Output, Safety Design, MWt	1665	Moderator Temp Coef Hot, No Voids	39.0×10^{-5}
Steam Flow Rate, lb/hr	6.43×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	48.0×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	31,838	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	18.37	Doppler Coefficient, Operating	-1.3×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	425,500	Initial Enrichment, %	2.40
Average Heat Flux, Btu/hr-ft^2	163,296	Average Discharge Exposure, MWD/Ton	19,085
Maximum Fuel Temperature, °F	4380	Core Average Void Within Assembly, %	74.5
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	2.60	Control Rod Worth, %	0.01 Δk
Avg Power Density, Kw/ℓ	50.94	Curtain Worth, %	---
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	156 Flat, Boron-SST
		Number of Control Rods	89 Cruciform
		Number of Part-Length Rods (PLR)	None

Data From FSAR.

*Ten New England Utilities.

Compiled by: Fred Heddleson Aug. 1971
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA — Reactor: VERMONT YANKEE

Exclusion Distance, Miles		0.17	Design Winds in mph:
Low Population Zone Distance, Miles		5	At 0 — 50 ft elev 80
Metropolis	Distance	Population	50 — 150 ft
Manchester, N. H.	55 mi.	108,461	
Design Basis Earthquake Acceleration, g		0.14	150 — 400 ft
Operating Basis Earthquake Acceleration, g		0.07	Tornado ΔP = --psi/-- sec
Earthquake Vertical Shock, % of Horizontal		67	Is Intent of 70 Design Criteria Satisfied? Yes

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

Drywell Design Pressure, psig	56	Primary Containment Leak Rate, %/day	0.5
Suppression Chamber Design Pressure, psig	56	Second Containment Design Pressure, psig	0.25
Calculated Max Internal Pressure, psig	35	Second Containment 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 134,200 ft^3 and suppression chamber free volume is 108,250 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 for off-site-dose guide lines. System also designed for loads imposed by tornadoes, pipe whiplash, earthquakes, and other credible accidents without loss of integrity.

Vacuum Relief Capability: Designed for two 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 56 psig. The system will be pressure tested at 1.25 times the design pressure (1.25 × 56 = 70 psig). Instrumentation is permanently installed to provide data for calculating leakage at all pressures.

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

D2. EMERGENCY CORE COOLING SYSTEMS	Reactor: VERMONT YANKEE
Core Spray Cooling System: Consists of two independent loops each having one 100% capacity pump, 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 3000 at 120 psig, taking suction from the suppression pool.	
Auto-Depressurization System: If HPCIS flow does not restore and maintain water level in the pressure vessel, pressure relief valves open and vent steam; thus reducing nuclear system pressure so the LPCIS will operate to inject water into the vessel. Core is covered preventing fuel damage.	
Residual-Heat-Removal System (RHRS): Consists of four main pumps and two heat exchangers arranged in two loops plus four service water pumps. There are four 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 through the heat exchangers to hold pool water below 170F, 3) cools containment by diverting part of the flow through spray headers in the drywell or suppression pool, and 4) Low Pressure Coolant Injection which is discussed below. Pumps are rated 7200 gpm each at 20 psid and heat exchangers 57.5×10^6 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 4250 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 in conjunction with HPCIS and auto-depressurization. Four pumps, each rated 7200 gpm @ 20 psid supply sufficient water to flood the core and prevent melting.	

E. OTHER SAFETY-RELATED FEATURES
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: On each control rod to limit velocity at which a control rod can fall out of the core. The limiters contain no moving parts, nor does it effect scram. Limits fallout velocity to 5 ft/sec.
Control-Rod-Drive-Housing Supports: Located underneath reactor vessel near the control rod housings. Supports limit travel to about 2-in. if that control rod housing ruptures. Supports prevent a nuclear excursion as a result of a housing failure.
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.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: VERMONT YANKEE
Standby Coolant System: A piping cross-tie is provided between the Residual Heat Removal System and the service water system so an additional source of water is available for containment flooding or other post-accident needs.
Containment Atmospheric Control System: Atmosphere will not be inerted with nitrogen. See Section I.2.3 for discussion of the disadvantages and dangers of nitrogen inerting.
Reactor Core Isolation Cooling System (RCICS): Provides makeup water to the reactor vessel whenever the vessel is isolated or during shutdown. The RCICS uses one 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 416 gpm @ 1135 psid. Pump takes suction from either demineralized water storage tank or from suppression pool
Reactor Vessel Failure: No reference found.
Containment Floodability: Can be flooded.
Reactor-Coolant Leak-Detection System: Leaks are detected by 1) sensing excess flow in piping systems, 2) pressure and temperature changes in containment, 3) monitoring for high flow and temperature through selected drains, and 4) drywell sump leak rate alarm system. Total leakage rate limit is set at 50 gpm with 15 gpm of this classified as unidentifiable.
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 main steam lines. Detectors are located near main steam lines in the space between primary containment and secondary containment walls.
Emergency Power: Two standby diesel generators are provided as independent, redundant power sources for the reactor core cooling load following a loss-of-coolant accident. Each diesel generator can power the loads required during design basis postaccident conditions and to maintain the station in a safe shutdown condition. Capacity of the units is 3000 kW each for an indefinite period. Both units have a day tank with fuel for 4 hrs operation. Day tanks are supplied from a storage tank with fuel for one diesel operating fully loaded for 7 days.
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: A function of the computer which prevents rod withdrawal under low power conditions if rod to be withdrawn is not in a preplanned pattern. The effect is to limit reactivity worth of the control rod.

F. GENERAL

Reactor: VERMONT YANKEE

Windspeed, Direction Recorders, and Seismographs: Data was collected for one year (Aug. 1967–July 1968) using instruments installed on a 140-ft high tower. Wind direction reads out in control room. A strong-motion accelerometer was installed.

Plant Operation Mode: Environmental Report says plant will be base-loaded.

Site Description: Located on the west side of the Connecticut River on Vernon Pond just above Vernon Dam and hydrostation. Hills rise up on both sides of the river so a valley condition exists which effects winds and other meteorological condition. Site is small in size.

Turbine Orientation: Ejected turbine blades could strike containment. Centerlines are 160 ft apart.

Emergency Plans: An organized emergency plan outlining the actions and responsibilities of station personnel and off-site support group is in final stage of development. Liaison is now being established with federal, state, and local agencies responsible for public safety. The final detailed emergency plan shall reflect the combined efforts of all responsible organizations. The emergency plan will be an integral part of the Vermont Yankee Operations Manual. Date 4-15-70.

Environmental Monitoring Plans: Preoperation program will establish background radiation levels and concentrations in air, water, and tissue at selected locations; determine variability between sample locations; and observe any cyclic or seasonal trends in samples. Operational program will sample radiation levels and concentrations of radionuclides in air and water, resulting from station operation, make possible the prompt recognition of any increase in levels of radioactivity, and differentiate station releases from other abnormal trends in environmental radiation due to natural or man-made sources.

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 gland seal condenser and gas treatment system. A 30-min. holdup time allows N-16 and O-19 to decay and then pass through high efficiency off-gas filters before stack release. Solid wastes are collected, dewatered, and shipped off-site.

Plant Vent: 318-ft high tapered reinforced concrete.

G. SITE DATA

Reactor: VERMONT YANKEE

Nearby Body of Water: Connecticut River, Vernon Pond

Normal Level 220' (MSL)

Max Prob Flood Level 235' (MSL)

Size of Site 125 Acres   Site Grade Elevation 250' (MSL)

Topography of Site: Flat

of Surrounding Area (5 mi rad): Rolling to Hilly

Total Permanent Population: In 2 mi radius 2060 ; 10 mi ____

Date of Data: 1970   In 5 mi radius 6590 ; 50 mi ____

Nearest City of 50,000 Population: Holyoke, Mass.

Dist. from site 39 Miles, Direction S, Population 52,500

Land Use in 5 Mile Radius: Wooded ~75%, balance agricultural and industrial.

Meteorology: Prevailing wind direction NNW Avg. speed 8 mph

Stability Data - Average

Miscellaneous Items Close to the Site: Houses are ∿1500 ft from reactor. An elementary school is ∿2000 ft away. Vernon Dam is 1/2 mile below the site. Center of the river is the Vermont-N.H. state line, Mass. is 3 miles south. Community of Vernon is ∿2000 ft W. and Hillsdale, N.H., about 1 1/2 mile east.

H. CIRCULATING WATER SYSTEM

Type of System: Once through, closed cycle, or a combination.

Water Taken From: Connecticut River.

Intake Structure: Reinforced concrete at edge of river. A trash rack and traveling screen are located in front of pumps. About 1 fps is velocity thru trash racks.

Water Body Temperatures: Winter minimum 32 °F   Summer maximum 84 °F

River Flow 1200 (cfs) minimum; 10,170 (cfs) average

Service Water Quantity 12,000 gpm/reactor

Flow Thru Condenser 366,000 (gpm)/reactor   Temp. Rise 20 °F

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

Heat Removal Capacity of Condenser 3605×10^6 (Btu/hr)/reactor

Discharge Structure: An aerating structure about 100 ft wide discharges at edge of river. This structure diverts water to cooling towers, the intake structure, or to the river.

Cooling Tower(s): Description & Number - Two mechanical draft.

Blowdown 5000 gpm/reactor   Evaporative loss 5000 gpm/reactor

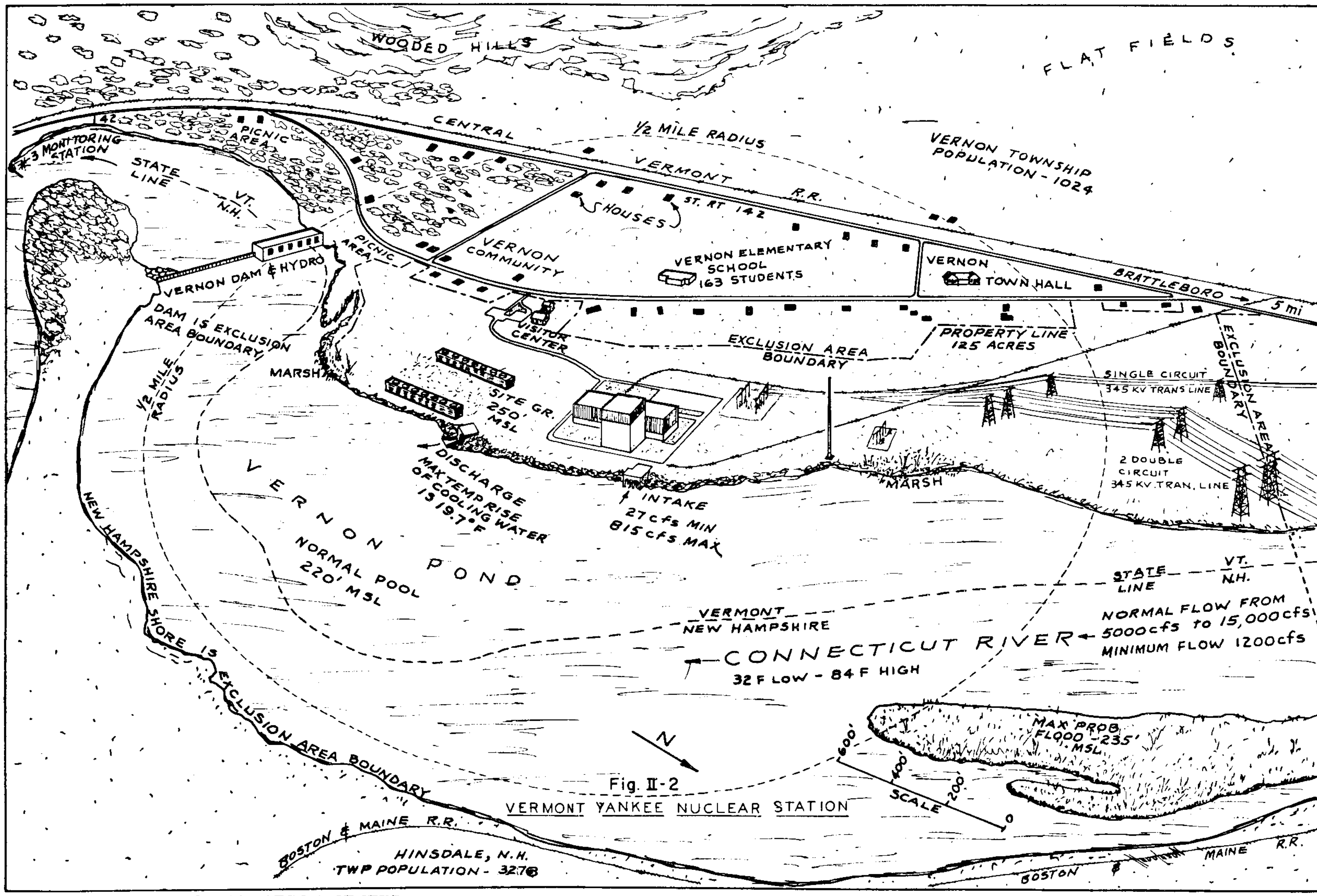


Fig. II-2

VERMONT YANKEE NUCLEAR STATION

NUCLEAR SATETY INFORMATION CENTER

SALEM, 50-272 & 50-311

Project Name: Salem Nuclear Generating Station, Units 1 & 2
Location: Salem Co., N. J.
Owner: Public Service Elec. & Gas
A-E: Public Service Electric
Vessel Vendor: Not specified
NSS Vendor: Westinghouse
Containment Constructor: Public Serv. Elec.

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3250	H_2O/U, Cold	3.48
Electrical Output, MWe	1050	Avg 1st-Cycle Burnup, MWD/MTU	12,000
Total Heat Output, Safety Design, MWt	3391	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	Region-2 Enrichment, %	2.70
Total Flowrate, 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
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 Pressure 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	$(-0.2 \text{ to } -3) \times 10^{-3}$
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 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	6.7	Burnable Poisons, Type and Form	Pyrex glass in SST tubes
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	Compiled by: Fred Heddleson, July 1971 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Salem
Exclusion Distance, Miles		0.8 radius	Design Winds in mph:
Low Population Zone Distance, Miles		5	At 0 — 50 ft elev 108
Metropolis	Distance	Population	
Wilmington, Del.	20 mi.	499,497	50 — 150 ft 131
Design Basis Earthquake Acceleration, g		0.15	150 — 400 ft 160
Operating Basis Earthquake Acceleration, g		0.08	Tornado 300 mph
Earthquake Vertical Shock, % of Horizontal		67	ΔP = 3 psi/ -sec
Is Intent of 70 Design Criteria Satisfied?	Yes, Sect. 1.4 states "... general design criteria are followed in design of this plant."		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	47
Max Leak Rate at Design Pressure, %/day	0.1	Calculated Max Internal Pressure, psig	43

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 thick). 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 penetrations 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.

D2. CONTAINMENT SAFETY FEATURES	Reactor: Salem
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'.	

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.

E. OTHER SAFETY-RELATED FEATURES Reactor: Salem
Reactor Vessel Failure: No reference found.
Containment Floodability: No reference found.
Reactor-Coolant Leak-Detection System: 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 System: 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 By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Boric acid solution in the coolant and part-length rods will help control oscillations. The in-core instrumentation will yield information on neutron flux.
Boron Dilution 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: 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 through the residual heat removal loop heat exchangers for cooling.
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.

F. GENERAL	Reactor: Salem
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 Operation Mode: Load following	
Site Description: Located on the east bank of the Delaware River estuary on Artificial Island. The island is connected to the mainland by a strip of tideland formed by hydraulic fill. The site and surrounding area is flat, mostly tidal marshes and grasslands. The river is 2 miles wide at the site.	
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.	
Plant Vent: No reference found to stack.	

G. SITE DATA

Reactor: Salem

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 radius 0 ; 10 mi ____

Date of Data: 1967 In 5 mi radius 1184 ; 50 mi ____

Nearest City of 50,000 Population: Wilmington, Delaware

Dist. from site 20 Miles, Direction N , Population 92,500 ('69)

Land Use in 5 Mile Radius: Tidal marshes and grasslands

Meteorology: Prevailing wind direction NW Avg. speed 11 mph

Stability Data - ---

Miscellaneous Items Close to the Site: The site is quite remote being 7 1/2 miles south of Salem, N.J. Port Penn is about 4 1/4 miles NW in Delaware, and Hancock Bridge is NE about 4 miles. The nearest railroad is 8 miles NE. The nearest road is 2 1/2 miles from the site.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Delaware River

Intake Structure: A 12 bay structure with trash racks, traveling screens, pumps, etc. Fish escape passages are provided. Inlet velocity is 1 fps.

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

River Flow --- (cfs) minimum; 15,000 (cfs) average
400,000 cfs avg tidal flow

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 1,100,000 (gpm)/reactor Temp. Rise 13.6 °F

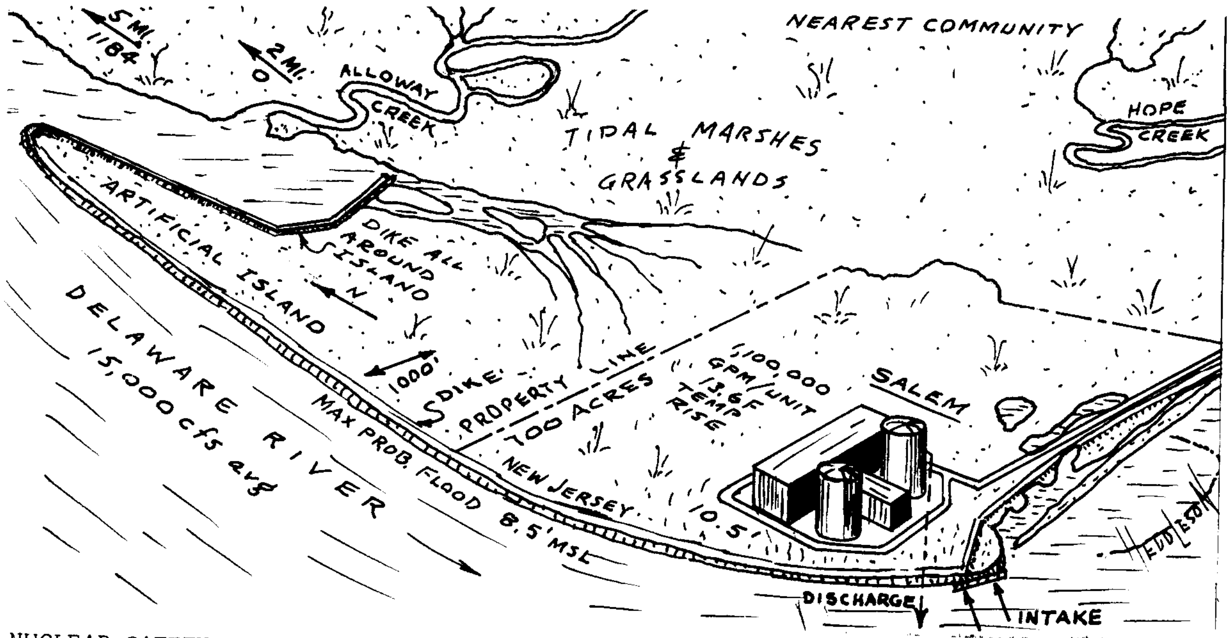
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: Submerged pipes extend 500 ft into the river.

Cooling Tower(s): Description & Number - None

Blowdown ____ gpm/reactor Evaporative loss ____ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

DIABLO CANYON, 50-323, 50-275

Project Name: Diablo Canyon Nuclear Units 1 & 2

Location: San Luis Obispo Co.*

Owner: Pacific Gas & Electric

*150 miles NW of Los Angeles

A-E: PG&E

Vessel Vendor: Combustion Engineering

NSS Vendor: Westinghouse

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, 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 Flowrate, 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, $lb/hr\text{-}ft^2$	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 to -3.0) $\times 10^{-4}$
Avg Film Temp Diff, °F	34.7	Moderator Pressure Coeff, Δk/k/psi	(+0.2 to +3.0) $\times 10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff, Δk/k/% Void	(-0.2 to -3.0) $\times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	207,000	Doppler Coefficient, Δk/k/°F	(-1 to -2) $\times 10^{-5}$
Max Heat Flux, Btu/hr ft^2	583,000	Shutdown Margin, Hot 1 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	Compiled by: Fred Heddleson Feb. 1971 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA — Reactor: Diablo Canyon

Exclusion Distance, Miles		0.50	Design Winds in mph:		psf
Low Population Zone Distance, Miles		6	At 0 — 50 ft elev	70.7	20
Metropolis	Distance	Population	50 — 150 ft	86.5	30
Santa Barbara	100 mi	264,324	150 — 400 ft	100.0	40
Design Basis Earthquake Acceleration, g		0.20*	Tornado - Not given		
Operating Basis Earthquake Acceleration, g		0.15	ΔP = --psi/ --sec		
Earthquake Vertical Shock, % of Horizontal		66			

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

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.

D2. CONTAINMENT SAFETY FEATURES	Reactor: Diablo Canyon
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 atmosphere 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: Isolation valves provide two barriers against leakage of radioactivity from 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.	
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 water 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.	

E. OTHER SAFETY-RELATED FEATURES Reactor: Diablo Canyon
Reactor Vessel Failure: No reference found.
Containment Floodability: No reference found.
Reactor-Coolant Leak-Detection System: 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 System: 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 By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: There are 160 part-length rods in the core which are not moving. They are provided for power control but do contribute to shutdown margin.
Boron Dilution 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 change is well within the reactivity control range provided by control rod cluster motion. Therefore Protective System provides adequate protection.
Long-Term Cooling: 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.
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."

F. GENERAL

Reactor: Diablo Canyon

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 Operation Mode: Load following.

Site Description: Located on a bluff overlooking the Pacific Ocean about 85 ft above the normal water level. The land slopes from the ocean up to 1000 ft within 1 mile of the shore line. The coast line is rugged with 2 small coves which provide some shelter for intake and discharge structures. The mouth of Diablo Canyon opens on the property.

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 occuring 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.

Plant Vent: No reference found.

G. SITE DATA Reactor: Diablo Canyon

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 radius 4 ; 10 mi 4443
Date of Data: 1970   In 5 mi radius 14 ; 50 mi ____

Nearest City of 50,000 Population: Santa Barbara, Calif.
Dist. from site 100 Miles, Direction SE , Population 70,215

Land Use in 5 Mile Radius: Undeveloped and Wooded

Meteorology: Prevailing wind direction NW / SE   Avg. speed 12 mph
Stability Data - ---

Miscellaneous Items Close to the Site: Site is remote, the nearest town being San Luis Obispo which is 12 miles ENE. Beaches 7 to 15 miles ESE have an influx of summer visitors. Pismo Beach State Park is 15 miles away. Morro Bay State Park is about 10 mi N of site. U.S. Hyw 101 runs N-S about 9 mi. E of the plant. Vandenberg Air Force Base is 35 mi. SSE.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

Water Taken From: Pacific Ocean.

Intake Structure: Reinforced concrete structure located at shore line in a cove with artificial breakwater wall. A curtain wall will stop floating debris and trash racks will stop other large objects. Traveling screens and pumps are inside the structure which is Class I.

Water Body Temperatures: Winter minimum 50 °F   Summer maximum 63 °F

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

Service Water Quantity 4,000 gpm/reactor

Flow Thru Condenser 863,000 (gpm)/reactor   Temp. Rise 18 °F

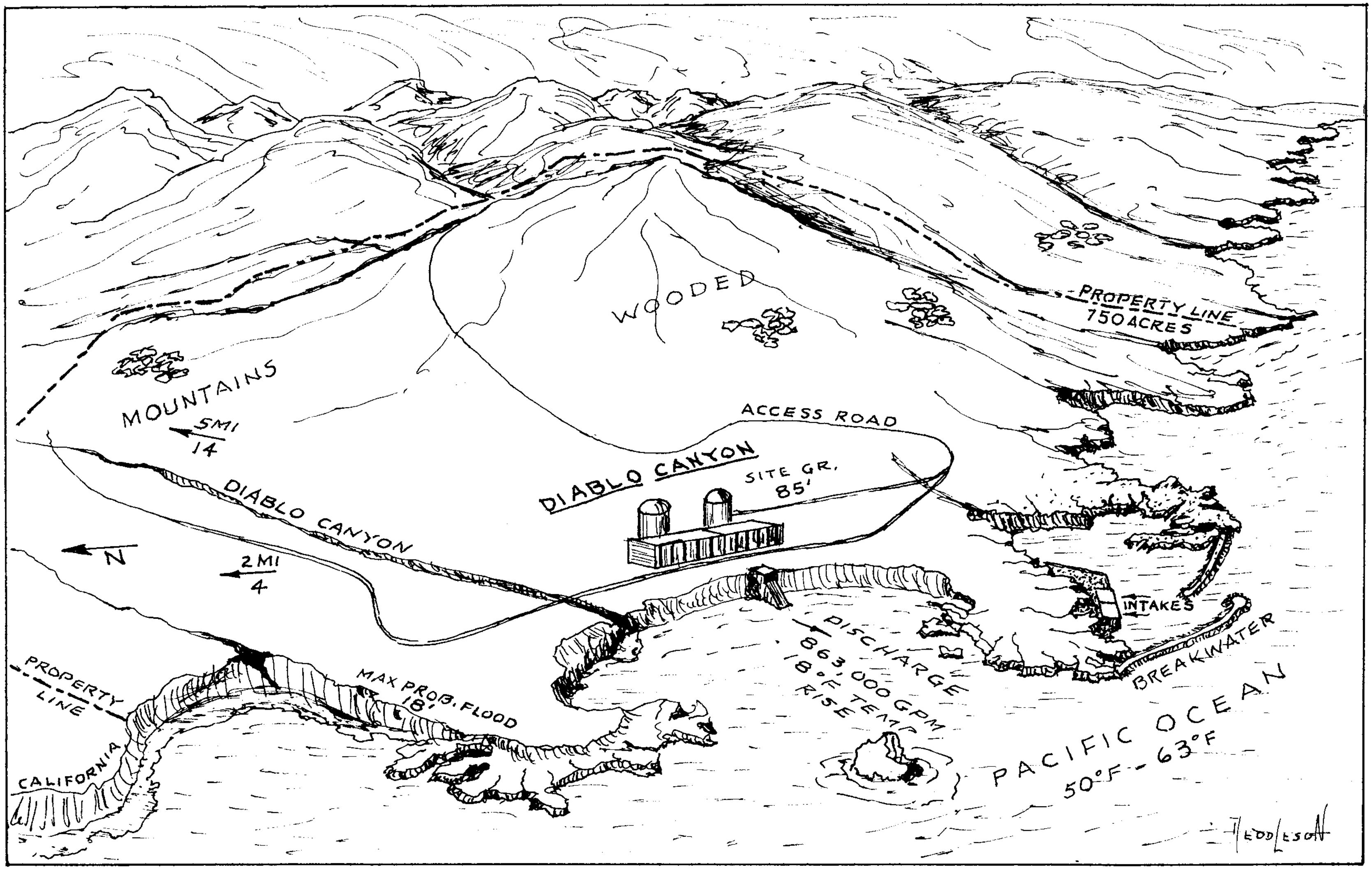
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: Reinforced concrete structure drops water in stairstep-type weir overflow from elev 70' to the ocean and discharges on the surface at the shore line.

Cooling Tower(s): Description & Number - None

Blowdown ____ gpm/reactor   Evaporative loss ____ gpm/reactor



PROPERTY LINE
750 ACRES
WOODED
MOUNTAINS
5 MI
14
ACCESS ROAD
DIABLO CANYON
SITE GR.
85'
DIABLO CANYON
N
2 MI
4
INTAKES
DISCHARGE
863,000 GPM
18°F TEMP
RISE
BREAKWATER
PROPERTY
LINE
MAX PROB. FLOOD
18'
CALIFORNIA
PACIFIC OCEAN
50°F - 63°F

PEACH BOTTOM, 50-277, 50-278

Project Name: Peach Bottom Atomic Power Station 2 & 3
Location: York Co., Pa.
Owner: Philadelphia Electric
A-E: Bechtel
Vessel Vendor: Babcock & Wilcox
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	1098	Moderator Temp Coef Cold, Δk/k/°F	---
Total Heat Output, Safety Design, MWt	3440	Moderator Temp Coef Hot, No Voids	-1.0×10^{-3}
Steam Flow Rate, lb/hr	13.38×10^{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	-1.7×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.18×10^{-5}
Heat Transfer Area, ft^2	66,098	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 Maximum Void Within Assembly, %	79 - Tbl 1.7.1 74.7- " 3.7.1
Average Fuel Rod Surface Temp, °F	560	k_{eff}, All Rods In	---
MCHFR	$\geq$ 1.9	k_{eff}, Max Rod Out	< 0.99
Total Peaking Factor	2.6	Control Rod Worth, one rod, normal sequence	0.01 Δk
Avg Power Density, Kw/ℓ	50.8	Curtain Worth, %	---
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	372 flat, boron sst
THIS DATA IS FROM FSAR		Number of Control Rods	185 cruciform assemblies
		Number of Part-Length Rods (PLR)	None

Compiled by: Fred Heddleson, Aug. 1971
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: Peach Bottom

Exclusion Distance, Miles	0.51 radius	
Low Population Zone Distance, Miles	---	
Metropolis	Distance	Population
Lancaster, Pa.	19	319,693
Design Basis Earthquake Acceleration, g	0.12	
Operating Basis Earthquake Acceleration, g	0.05	
Earthquake Vertical Shock, % of Horizontal	67	

Design Winds in psf:

At 0 — 50 ft elev	25
50 — 150 ft	35
150 — 400 ft	45
Tornado 300 mph tang + trans. ΔP = 3 psi/ 3 sec	
Is Intent of 70 Design Criteria Satisfied?	Yes

Recirculation Pumping System & MCHFR: Recirculation rate effects type of boiling and thus MCHFR. Core heat-transfer surface area and coolant flow rate are set so 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

Drywell Design Pressure, psig	56	Primary Containment Leak Rate, %/day	0.50
Suppression Chamber Design Pressure, psig	56	Second Containment Design Pressure, psig	0.25
Calculated Max Internal Pressure, psig	41.5	Second Containment 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 contain the released steam in case of a double-ended pipe rupture so that leakage of radioactivity to the environment will not exceed the limits of 10CFR100. Also designed to withstand earthquake forces.

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: Pressure tested at 1.25 times the design pressure of 56 psig. Leakage rate tests run at 41.5 psig and again at a reduced pressure to establish leakage rate/pressure relationships.

Penetrations: Some penetratons are double sealed and some are not. The electrical penetrations and those with expansion bellows are individually testable for leakage.

D2. EMERGENCY CORE COOLING SYSTEMS

Reactor: Peach Bottom

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: If the HPCIS flow does not restore level in the pressure vessel, pressure-relief valves open to reduce nuclear system pressure so that LPCI operates to inject water into the pressure vessel.

Residual-Heat-Removal System (RHRS): Consists of four main pumps and four heat exchangers arranged in two loops plus four high-pressure 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 through the heat exchangers for cooling so pool temperature will not exceed 170F. This part of the system also cools containment by diverting part of the flow through spray headers in the drywell, and 3) Low Pressure Injection which is discussed below. Main pumps are rated 10,000 gpm @ 20 psid and heat exchangers 70×10^6 Btu/hr.

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

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

Control-Rod Velocity Limiters: Attachment on each control rod to limit velocity at which a rod can fall out of core. Reactivity insertion rate resulting from a rod drop accident is limited. The limiters contain no moving parts, nor does it effect scram.

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

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 accomplishes the function.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: Peach Bottom
Standby Coolant System: A piping cross-tie is provided between the RHRS and the High Pressure Service Water System which furnishes an additional source of water for post-accident needs. Service water pumps (4) are each rated for 4500 gpm.
Containment Atmospheric Control System: Can be purged with nitrogen to reduce and maintain the atmosphere to less than 5% oxygen. Temperature during operation is held to 135F or lower.
Reactor Core Isolation Cooling System (RCICS): Provides makeup water to reactor vessel during shutdown or when isolated from main condenser, especially if feedwater pumps cannot supply required water. Initiated by reactor low water level. A steam driven turbine-pump unit operates automatically in time and with sufficient flow to maintain adequate reactor vessel water level. System can deliver 616 gpm @ 1120 psid. Pump can take suction from the condensate storage tank or supprn. pool.
Reactor Vessel Failure: Section 4.2.5 states, "Use of the ASME Boiler and Pressure Vessel code...provides assurance...extremely low probability of failure due."
Containment Floodability: Can be flooded.
Reactor-Coolant Leak-Detection System: 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 3100 kW. Three diesels can supply power for one unit under DBA conditions plus necessary loads for safe shutdown of other unit. The diesel generators start up and reach rated speed within ten seconds. Each engine has a fuel day tank with fuel for 2 1/2 hrs operation. Also available is a storage tank with fuel for operating the diesel at full load for 7 days.
Rod-Block Monitor: Designed to prevent fuel damage as a refult 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: Computer prevents rod withdrawal under low power conditions if the rod to be withdrawn is not in accordance with a preplanned pattern to limit the reactivity worth.

F. GENERAL	Reactor: Peach Bottom

Windspeed, Direction Recorders, and Seismographs: Data collection started in 1959 for unit 1 and was expanded in 1967 for units 2 and 3. Some data collected on a microwave tower about 320 ft above grade. Found no reference to plant installed seismographs.

Plant Operation Mode: Designed for load following using recirculation control.

Site Description: Located in a valley formed by steep hills along the Susquahanna River. The site is rather removed with two access roads. Slatesville, a small community, is about three miles SW.

Turbine Orientation: Ejected turbine blades could strike containment. Centerlines are 174 ft apart.

Emergency Plans: Plans are formulated with public agencies so that Plant personnel receive instructions in emergency procedures and use of emergency equipment. Periodic training drills are held. Emergencies involving personnel, on or off-site, can be handled in an orderly, effective manner. Procedures include services of the State Police, the local fire department, a local hospital, and other public agencies.

Environmental Monitoring Plans: Survey started in 1960 for unit 1. Objective was to get quantitative data on radioactivity in the vicinity of the plant prior to operation. The program of sampling is still going on. Twelve sampling stations are used to monitor materials in the food chain of both animals and humans. Samples are taken for background gamma, airborne particulate, water, milk, vegetation, aquatic biota, fish, shellfish, small game, soil, and silt.

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 O-19 to decay to daughter products that can be collected on high efficiency off-gas filters before stack release. Solid wastes are collected, dewatered, and shipped offsite.

Plant Vent: 500 feet high reinforced concrete.

G. SITE DATA	Reactor: Peach Bottom
Nearby Body of Water: Conowingo reservoir of Susquahanna River	Normal Level 109' (MSL); Max Prob Flood Level *134' (MSL)
Size of Site 620 Acres	Site Grade Elevation 116' (MSL) *Plant protected to 135'.

Topography of Site: Rolling to hilly

of Surrounding Area (5 mi rad): Rolling to hilly

Total Permanent Population: In 2 mi radius 685 ; 10 mi ____

Date of Data: 1970 In 5 mi radius 14,492 ; 50 mi ____

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

Dist. from site 19 Miles, Direction N , Population 57,690 ('70)

Land Use in 5 Mile Radius: Agricultural and wooded

Meteorology: Prevailing wind direction Westerly Avg. speed 4 mph

Stability Data - Stable dispersion conditions ∿30% of time.

Miscellaneous Items Close to the Site: Unit No. 1 is about 850' from center line between reactors. A visitor's center is about 1350' away. Within 5 miles there are 2 hospitals, Bainbridge Naval Training Station, Aberdeen Proving Ground, and Army Chemical Center. All land along Conowingo Pond is owned by Philadelphia Electric or their subsideraries. There is a pumped-storage facility about 4 miles above the site.

H. CIRCULATING WATER SYSTEM

Type of System: Once through with helper cooling towers to cool effluent.

Water Taken From: Conowingo Pond of Susquehanna River

Intake Structure: Water first passes through a screen structure, which has trash racks and traveling screens, and into the intake pond which is divided in 2 parts. The intake structure houses the circulating pumps.

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

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

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 750,000 (gpm)/reactor Temp. Rise 20.8 °F

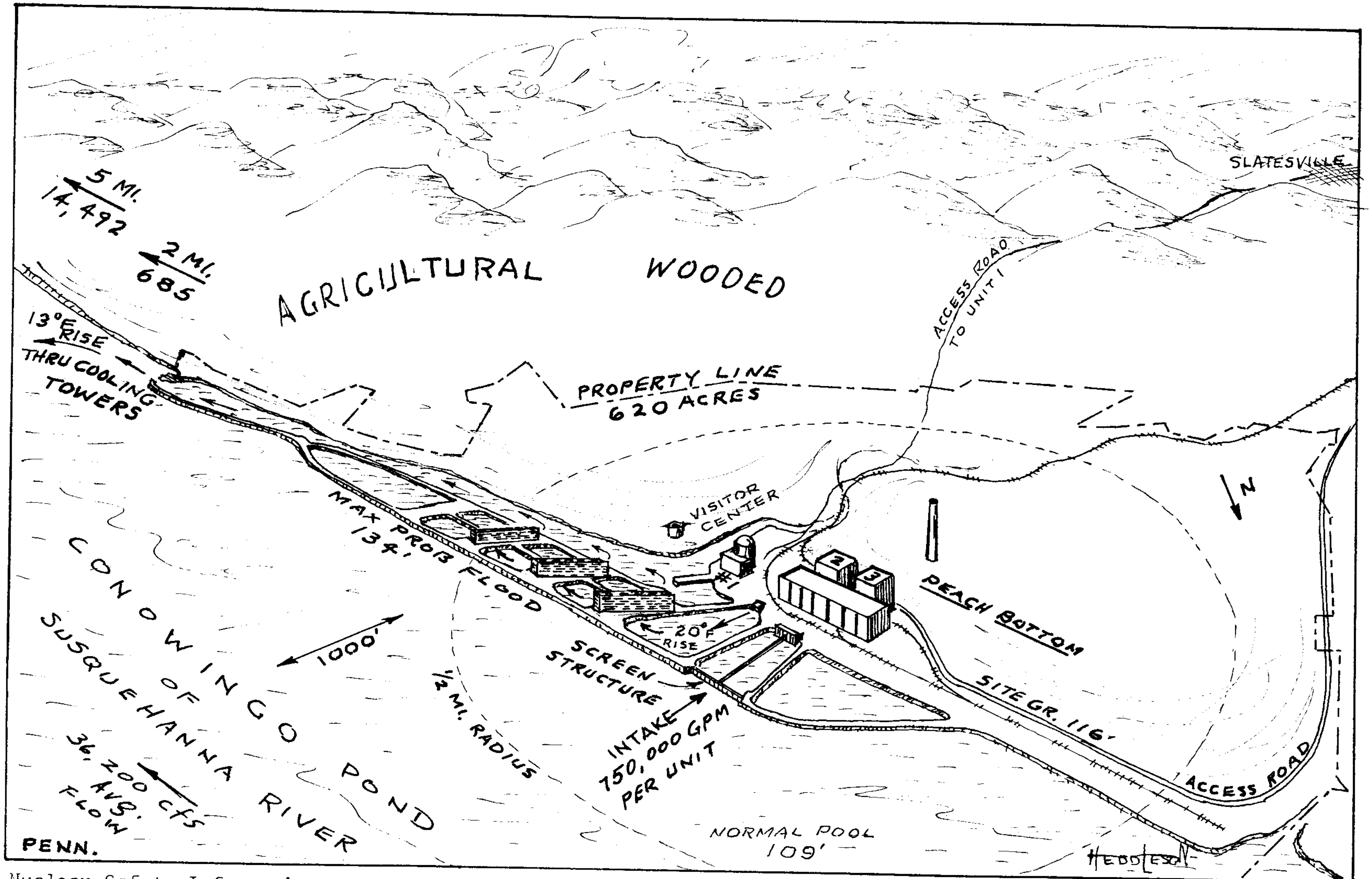
Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 7500×10^6 (Btu/hr)/reactor

Discharge Structure: Water from condenser discharged to a cooling tower supply pool. Cooling towers discharge to a 5000 ft long canal which flows into the river. Temperature at end of canal is ∿13F above ambient when cooling towers are used.

Cooling Tower(s): Description & Number - Three mechanical draft

Blowdown None gpm/reactor Evaporative loss 5,550 gpm/reactor



Nuclear Safety Information Center

Data From FSAR

Page 1 (PWR)

SURRY, 50-280, 50-281

Project Name: Surry Power Station Unit 1 & 2

Location: Surry Co., Virginia

Owner: Virginia Elect. & Power

A-E: Stone & Webster

Vessel Vendor: Babcock & Wilcox

NSS Vendor: Westinghouse

Containment Constructor: Not Specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2441	H_2O/U, Cold	4.18
Electrical Output, MWe	823	Avg 1st-Cycle Burnup, MWD/MTU	12,600
Total Heat Output, Safety Design, MWt	2546	First Core Avg Burnup, MWD/MTU	22,300
Total Heat Output, Btu/hr	8331×10^6	Maximum Burnup, MWD/MTU	---
System Pressure, psia	2250	Region-1 Enrichment, %	1.85
DNBR, Nominal	1.97	Region-2 Enrichment, %	2.55
Total Flowrate, lb/hr	100.7×10^6	Region-3 Enrichment, %	3.10
Eff Flowrate for Heat Trans, lb/hr	96.2×10^6	k_{eff}, Cold, No Power, Clean	1.176
Eff Flow Area for Heat Trans, ft^2	41.8	k_{eff}, Hot, Full Power, Xe and Sm	1.090
Avg Vel Along Fuel Rods, ft/sec	14.2	Total Rod Worth, % BOL,HFP	10.05
Avg Mass Velocity, $lb/hr\text{-}ft^2$	2.31×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	1250
Nominal Core Inlet Temp, °F	543	Shutdown Boron, No Rods-Clean-Hot, ppm	1240
Avg Rise in Core, °F	65.5	Boron Worth, Hot, % $\Delta k/k$	6.9
Nom Hot Channel Outlet Temp, °F	642	Boron Worth, Cold, % $\Delta k/k$	5.3
Avg Film Coeff, Btu/hr ft^2-°F	5400	Full Power Moderator Temp Coeff, $\Delta k/k/°F$	$(.3 \text{ to } -3.5) \times 10^{-4}$
Avg Film Temp Diff, °F	35.0	Moderator Pressure Coeff, $\Delta k/k/psi$	$(-.3 \text{ to } 3.5) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	42,460	Moderator Void Coeff, $\Delta k/k/gr/cm^3$	-0.1 to $+0.3$
Avg Heat Flux, Btu/hr ft^2	191,100	Doppler Coefficient, $\Delta k/k/°F$	$(-1 \text{ to } -1.6) \times 10^{-5}$
Max Heat Flux, Btu/hr ft^2	534,100	Shutdown Margin, Hot 1 rod stuck, %$\Delta k/k$	1
Avg Thermal Output, kw/ft	6.2	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Thermal Output, kw/ft	17.3	Number of Control Rods	960
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR)	100
No. Coolant Loops	3	Compiled by: Fred Heddleson March 1972, Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Surry
Exclusion Distance, Miles		0.31 radius	Design Winds in psf:
Low Population Zone Distance, Miles		3 radius	At 0 — 50 ft elev 30
Metropolis	Distance	Population	
Newport News	17 mi.	292,159	50 — 150 ft 45
Design Basis Earthquake Acceleration, g		0.15	150 — 400 ft 55
Operating Basis Earthquake Acceleration, g		0.07	Tornado 300 mph tang + 60 trans.
Earthquake Vertical Shock, % of Horizontal		67	ΔP = 1.5psi/ 5 sec
Is Intent of 70 Design Criteria Satisfied?	Yes, Section 1.4 states that "design... meets the intent of criteria..."		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	45.0
Max Leak Rate at Design Pressure, %/day	0.1	Calculated Max Internal Pressure, psig	39.2

Type of Construction: A heavily reinforced concrete structure, with vertical cylindrical walls (4'-6" thk) and a hemispherical dome supported on a flat base mat. Interior has a 3/8" thk steel liner on the vertical walls and 1/2" steel liner for dome.

Design Basis: Designed for operation at subatmospheric pressure of 9 to 11 psig and to maintain full containment integrity when subjected to DBA, and earthquake, and tornado design conditions with radiation leakage limited to less than 10CFR100 criteria.

Vacuum Relief Capability: Vacuum pumps operate continuously, to hold containment at 9 to 11 psig vacuum.

Post-Construction Testing: Leak-rate tests will be run at 45, 25, and 9 psig using leakage monitoring system for measurements. Periodic tests will be run thereafter. Strength test will be run when structure is completed.

Penetrations: Double barrier sealed and individually testable.

Weld Channels: Used on some liner joints with pressure taps for testing

D2. CONTAINMENT SAFETY FEATURES	Reactor: Surry
Containment Spray System: Operates after LOCA to spray chilled borated water from the Refueling Water Storage Tank into containment. A recirculation spray system pumps water from the containment sump through heat exchangers to spray nozzles. NaOH is added to the water to help remove radioactive iodine.	
Containment Cooling: Containment atmosphere is limited to a temperature of 105F during operation by 3 fan-coil cooling units which each recirculate 75,000 cfm with a cooling capacity of 1200 MBh and 3 control rod drive cooling units each rated 726 MBh.	
Containment Isolation System: Two barriers to leakage exist on each penetration through the containment wall; an isolation valve on each side. These valves close automatically on the safety injection signal, but can also be closed manually from the control room.	
Containment Air Filtration: There are roughing, particulate, and charcoal filters. Normally, only roughing filters are used. Bypass-damper operation diverts air through particulate and charcoal filters.	
Penetration Room: Electrical penetration room shown on plans. Pipes enter a tunnel at containment wall.	
D3. SAFETY INJECTION SYSTEMS	
Accumulator Tanks: Three tanks each holding about 7000 gpm of borated water under 650 psig nitrogen pressure, can release and deliver their contents to the 3 hot legs and 3 cold legs of the reactor vessel in ∿10 seconds. Injection occurs when reactor system pressure drops below 650 psig.	
High-head Safety Injection: Three safety injection pumps inject borated water from the refueling water storage tank into the 3 hot legs and 3 cold legs of the reactor vessel when small breaks occur. The 3 pumps feed 2 headers, one of which contains the boron injection tank. Concentrated boric acid is flushed from the tank into the reactor for addition of negative reactivity. Each pump capacity is 150 gpm @ 2750 psig.	
Low-head Safety Injection: Two low-head pumps each delivers 3000 gpm @ 300 psig from the refueling water storage tank to 2 hot legs of the reactor vessel. When supply in the refueling water storage tank is about gone, alarms in the control room signal to operator to switch over the 2 pumps to the containment sump initiating the recirculation phase which can be used for long term cooling.	

E. OTHER SAFETY-RELATED FEATURES — Reactor: Surry

Reactor Vessel Failure: No reference found.

Containment Floodability: No reference found.

Reactor-Coolant Leak-Detection System: The following methods of detection are used: 1) Air particulate monitoring, 2) Gas monitoring, 3) Pressurizer makeup water, 4) Containment sump water level, 5) Pressure, temeprature, humidity, 6) Reactor vessel head flange.

Failed-Fuel-Detection System: No reference found.

Emergency Power: There are 3 diesel generators for the 2 units. Each unit has an exclusive generator and the third diesel generator is backup for either of the other two. Each diesel-generator set is independent, starting automatically when normal power fails, accepting load in 10 seconds, and carrying full load in 25 seconds. Each unit has 3-hr. fuel supply in its day tank. Backup fuel is stored in a buried storage tank.

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Part length rods suppress xenon induced oscillations in the axial direction. Burnable shims help to make moderator temperature coefficient more negative. In-core instrumentation is used to calibrate out-of-core instruments.

Boron Dilution Control: Boron dilution is a manual operation. A boric acid blend system helps the operator match the boron concentration of makeup water during normal charging to that in the Reactor Coolant System. The Chemical and Volume Control System limits, even under various failure modes, the potential rate of dilution to a value which, after indication by alarms, provides the operator sufficient time to correct the situation in a safe and orderly manner.

Long-Term Cooling: Can be accomplished by the low-head safety injection pumps recirculating borated water from the containment collection sump.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: FSAR dated 5/1/71 said recombiner was being studied and that a suitable system would be employed.

F. GENERAL Reactor: Surry
Windspeed, Direction Recorders, and Seismographs: Data collected for 25 months starting Nov. 1967 from 2 towers (150' high tower on site and 20' tower at tip of Hog Island).
Plant Operation Mode: Load Following.
Site Description: Plant is located on a peninsula-like piece of land surrounded on 3 sides by the James River which is about 3 miles wide all around the site and has a 25-ft deep channel. This point in the river is just about the limit of salt intrusion from the ocean. Area surrounding the site is low and flat much of which is heavily wooded and marshy. Population density is low.
Turbine Orientation: Reactor and turbine centerline are 265' apart. Ejected blades could strike containment.
Emergency Plans: Plans have been prepared and training given to employees to establish working procedures for handling emergencies. Off-site agencies have been consulted such as AEC, police, State Health Dept., civil defense, fire depts., rescue squads, Medical College of Virginia, State Forestry Dept., and Dept. of Game and Fisheries.
Environmental Monitoring Plans: A program will be carried out to verify the adequacy of radiation control and to provide field data for estimating dose to the environment. A preoperational surveillance has been underway for some time with cooperation from Virginia Institute of Marine Science to establish base-line conditions for evaluation of operating data. Milk, shellfish, and silt have been selected as indicator samples.
Radwaste Treatment: Liquid wastes are collected and evaporated as required. After degassifying and filtering, the evaporator condensate is analyzed before discharge to the river. With 1% defective fuel, 1.97 curie/yr will be discharged, tritium excluded. If there is steam generator leakage, this figure will be 57.46 curie/yr. Evaporator residues and noncombustible solid wastes are drummed, and combustible solid wastes can be baled or drummed. They are shipped from the site for disposal. Gaseous wastes are held for decay, stripped of most hydrogen and moisture, diluted and discharged through the plant vent.
Plant Vent: About 10 feet higher than top of containment structure.

G. SITE DATA
Reactor: Surry

Nearby Body of Water: James River
Normal Level 0' (MSL)
Max Prob Flood Level 25.4' (MSL)

Size of Site 840 Acres
Site Grade Elevation 26.5' (MSL)

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

Total Permanent Population: In 2 mi radius 36 ; 10 mi ____
Date of Data: 1966 In 5 mi radius 724 ; 50 mi ____

Nearest City of 50,000 Population: Newport News, Virginia
Dist. from site 17 Miles, Direction SE , Population 138,177

Land Use in 5 Mile Radius: Agricultural west and south. Water and military reservations north and east. Recreation (hunting, fishing, parks) is popular in area.

Meteorology: Prevailing wind direction None Easterly Avg. speed 7.5 mph
Stability Data - Slightly unstable to neutral 2/3 of time.

Miscellaneous Items Close to the Site: Jamestown Island, a Federal park, is 4-mi NW; Chippokes Plantation, a State park, is 3-mi WSW. Jamestown National Historical Park is 5-mi WNW and Colonial Williamsburg is 7 1/2-mi NNW. Adjacent to the site on the north is Hog Island, a waterfowl refuge. These numerous attractions bring thousands of visitors to the area.

H. CIRCULATING WATER SYSTEM

Type of System: Once Through.

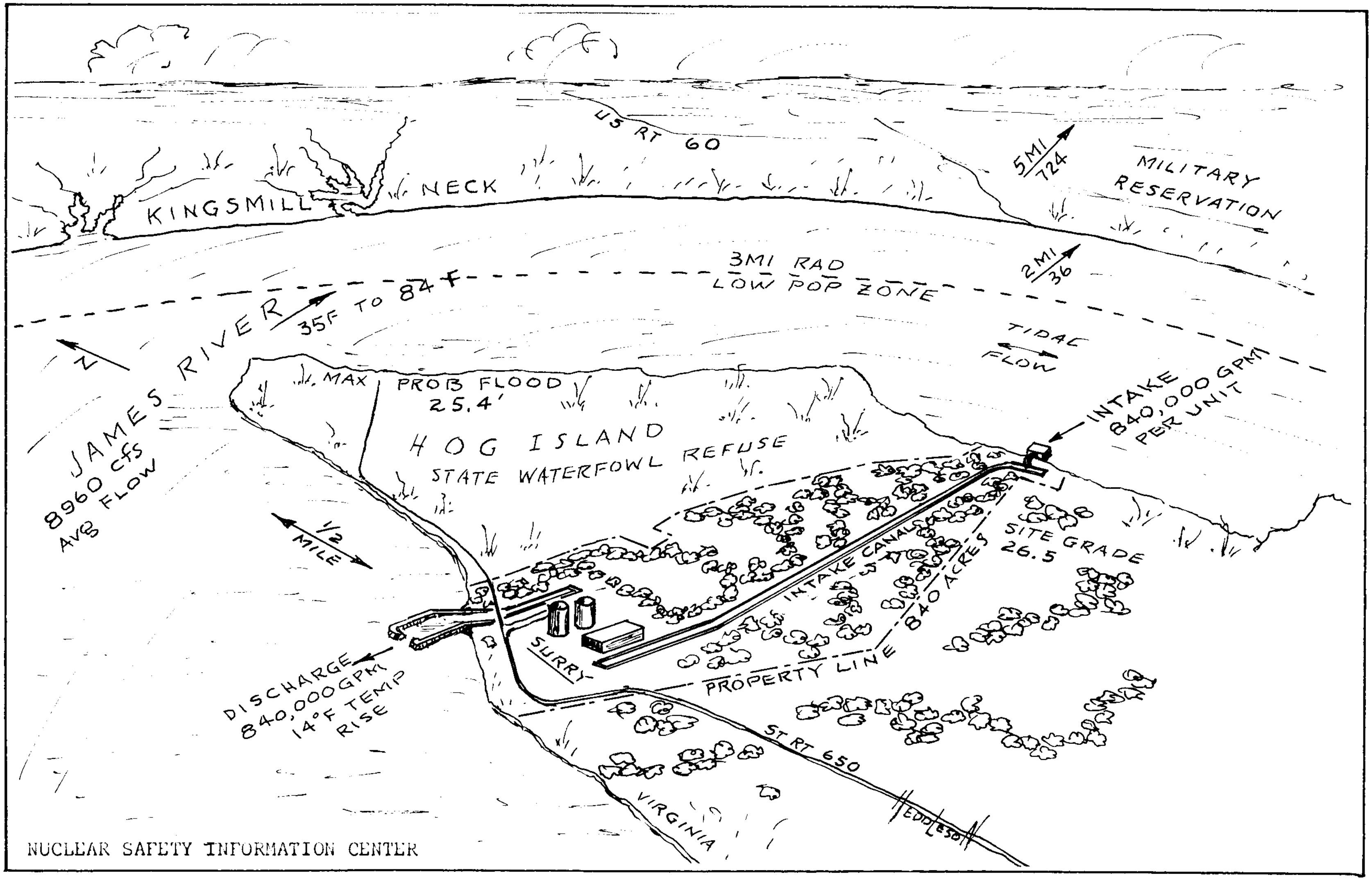
Water Taken From: James River.

Intake Structure: A reinforced concrete structure pumps water from the river and lifts it over the bank to a concrete lined canal that conveys the water about 1.7 miles to the condenser intake. The canal holds 45,000,000 gallons of water.

Water Body Temperatures: Winter minimum 35 °F Summer maximum 84 °F
River Flow Tidal flow (cfs) minimum; 8960 (cfs) average
Service Water Quantity --- gpm/reactor
Flow Thru Condenser 840,000 (gpm)/reactor Temp. Rise 14 °F
Heat Dissipated to Environment --- (Btu/hr)/reactor
Heat Removal Capacity of Condenser --- (Btu/hr)/reactor

Discharge Structure: A discharge canal about 2900 ft long conveys water to the discharge structure made of timbers with five 50-ft wide bays having timber control gates so discharge velocities can be held near 6 fps.

Cooling Tower(s): Description & Number - None
Blowdown ____ gpm/reactor Evaporative loss ____ gpm/reactor


US RT 60
KINGSMILL NECK
5MI 724
MILITARY RESERVATION
3MI RAD LOW POP ZONE
2MI 36
35F TO 84F
JAMES RIVER
N
TIDAL FLOW
MAX PROB FLOOD 25.4'
HOG ISLAND
STATE WATERFOWL REFUSE
INTAKE 840,000 GPM PER UNIT
JAMES 8960 cfs AVG FLOW
1/2 MILE
INTAKE CANAL
840 ACRES
SITE GRADE 26.5
SURRY
PROPERTY LINE
DISCHARGE 840,000 GPM 14°F TEMP RISE
ST RT 650
VIRGINIA
EDDLESON
NUCLEAR SAFETY INFORMATION CENTER

PRAIRIE ISLAND, 50-282, 50-306

Project Name: Prairie Island Nuclear Generating Plant, Units 1 & 2
Location: Goodhue Co., Minn.*
Owner: Northern States Power
*30 miles SE of St. Paul, Minn.

A-E: Pioneer Service & Engineering Co.
Vessel Vendor: Babcock & Wilcox
NSS Vendor: Westinghouse
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, Safety Design, MWt	1721	First Core Avg Burnup, MWD/MTU	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 Flowrate, 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 Pressure 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 1 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	Compiled by: Fred Heddleson, June 1971 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Prairie Island
Exclusion Distance, Miles		0.43 Radius	Design Winds in mph:
Low Population Zone Distance, Miles		1 1/2	At 0 — 50 ft elev 100
Metropolis	Distance	Population	
Minneapolis - St. Paul	30	1,813,647	50 — 150 ft 120
Design Basis Earthquake Acceleration, g		0.12	150 — 400 ft 140
Operating Basis Earthquake Acceleration, g		0.06	Tornado 300 mph tang + 60 trans
Earthquake Vertical Shock, % of Horizontal		67	ΔP = 3 psi/ 3sec
Is Intent of 70 Design Criteria Satisfied?	Yes, plant will be designed, constructed, and operated to comply with intent of criteria (Sect. 1.8).		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	41.4
Max Leak Rate at Design Pressure, %/day	0.5; actual 0.02	Calculated Max Internal Pressure, psig	42.6

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' 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.

D2. CONTAINMENT SAFETY FEATURES Reactor: Prairie Island

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.

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.

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.

E. OTHER SAFETY-RELATED FEATURES

Reactor: Prairie Island

Reactor Vessel Failure: No reference found.

Containment Floodability: No reference found.

Reactor-Coolant Leak-Detection System: 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 System: 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 By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Burnable poison rods compensate for slow changes in reactivity, part-length rods are used to control neutron flux distribution oscillations, and out-of-core detectors will be used with no in-core detectors.

Boron Dilution 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: 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.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Containment venting are regarded satisfactory.

F. GENERAL	Reactor: Prairie Island

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 Operation Mode: Designed for load following.

Site Description: Located on the west bank of the Mississippi River on a level flood plain about 1 1/2 miles wide. Steep bluffs rise up from the flood plain. A dam about 1 1/2 miles below the plant forms a stable pool of water from which plant cooling water is taken.

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.

Plant Vent: Vent is apparently from top of containment. Actual location could not be determined.

G. SITE DATA Reactor: Prairie Island

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
of Surrounding Area (5 mi rad): Rolling

Total Permanent Population: In 2 mi radius 374 ; 10 mi ____
Date of Data: 1970 In 5 mi radius 3267 ; 50 mi ____

Nearest City of 50,000 Population: Minneapolis-St. Paul
Dist. from site 30 Miles, Direction NW , Population 1,865,000

Land Use in 5 Mile Radius: Agricultural - dairy farming and vegetable canning.

Meteorology: Prevailing wind direction NW-SE Avg. speed 9.4 mph
Stability Data - Neutral to stable ∿80% of time.

Miscellaneous Items Close to the Site: Red Wing (Pop. 10,191) is 6 mi. SE. The nearest residence is 3000' away. The Wisconsin line is 2300 ft NE in the center of the river. The railroad line is 2300' SW of the reactor building. U.S. Highway 61 runs within 3 miles of the plant. The nearest airport is 7 mi. ESE for Red Bank.

H. CIRCULATING WATER SYSTEM

Type of System: Once through with variable cycle cooling towers.

Water Taken From: Mississippi River

Intake Structure: Water flows from river thru a canal which has a scimmer wall at the entrance. A mixing structure about the center of the canal mixes new water and recirculated water. The screen house has traveling screens and circulating pumps.

Water Body Temperatures: Winter minimum 32 °F Summer maximum 82 °F

River Flow 4600 (cfs) minimum; 15,020 (cfs) average

Service Water Quantity 26,000 gpm/reactor

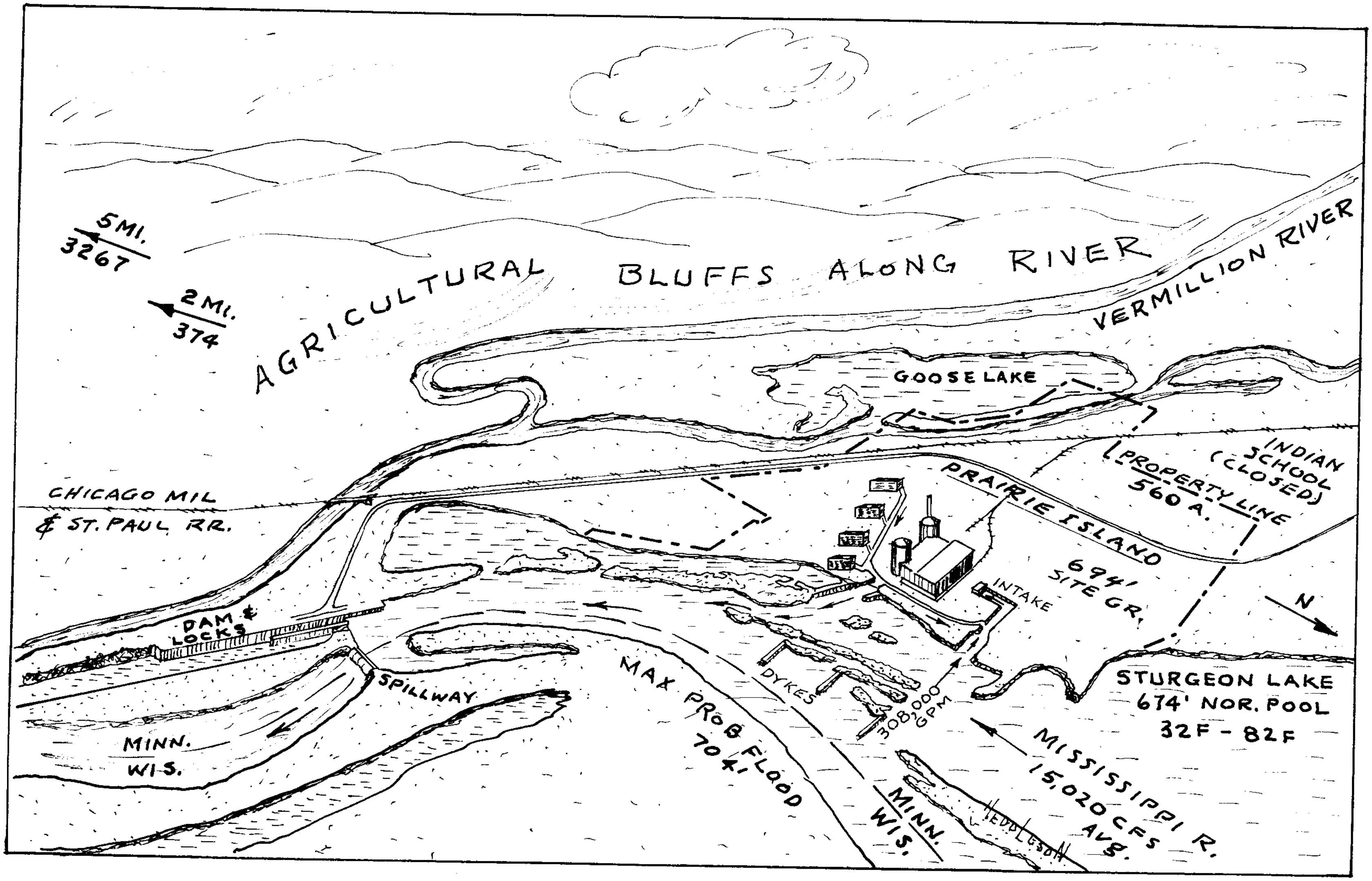
Flow Thru Condenser 308,000 (gpm)/reactor Temp. Rise 27 °F

Heat Dissipated to Environment 8370×10^6 (Btu/hr)/ total

Heat Removal Capacity of Condenser 3880×10^6 (Btu/hr)/reactor

Discharge Structure: Condenser cooling water first goes to a discharge basin from which it can be discharged to the river or pumped to the cooling towers, or divided between the two. Water from towers can be discharged to the river or recirculated.

Cooling Tower(s): Description & Number - 4 mechanical draft towers for both units to cool water before discharge back to river.
Blowdown --- gpm/reactor Evaporative loss 22,500 gpm/ total


5 MI.
3267
2 MI.
374
AGRICULTURAL BLUFFS ALONG RIVER
VERMILLION RIVER
GOOSE LAKE
INDIAN SCHOOL (CLOSED)
PROPERTY LINE
560 A.
PRAIRIE ISLAND
CHICAGO MIL & ST. PAUL RR.
694' SITE GR.
INTAKE
N
DAM & LOCKS
SPILLWAY
DYKES
308,000 GPM
STURGEON LAKE
674' NOR. POOL
32F - 82F
MINN.
WIS.
MAX PROB FLOOD 704'
MINN.
WIS.
MISSISSIPPI R.
15,020 CFS AVG.

FORT CALHOUN, 50-285

Project Name: Fort Calhoun Station, Unit No. 1
Location: Washington Co., Nebraska
Owner: Omaha Public Power Dist.
A-E: Gibbs and Hill
Vessel Vendor: Combustion Engineering
NSS Vendor: Combustion Engineering
Containment Constructor: Peter Kiewit & Sons

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1420	H_2O/U, Cold	1.59
Electrical Output, MWe	481	Avg 1st-Cycle Burnup, MWD/MTU	9300
Total Heat Output, Safety Design, MWt	1500	First Core Avg Burnup, MWD/MTU	18,549
Total Heat Output, Btu/hr	4846×10^6	Maximum Burnup, MWD/MTU	50,000
System Pressure, psia	2100	Region-1 Enrichment, %	1.39
DNBR, Nominal	2.21	Region-2 Enrichment, %	2.38
Total Flowrate, lb/hr	71.7×10^6	Region-3 Enrichment, %	3.17
Eff Flowrate for Heat Trans, lb/hr	68.5×10^6	k_{eff}, Cold, No Power, Clean	1.180
Eff Flow Area for Heat Trans, ft^2	32.6	k_{eff}, Hot, Full Power, Xe and Sm	1.080
Avg Vel Along Fuel Rods, ft/sec	12.7	Total Rod Worth, %	9.7 (BOL)
Avg Mass Velocity, lb/hr-ft^2	2.1×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	820
Nominal Core Inlet Temp, °F	534.6	Shutdown Boron, No Rods-Clean-Hot, ppm	860
Avg Rise in Core, °F	55.7	Boron Worth, Hot, % Δk/k/ppm	1/73
Nom Hot Channel Outlet Temp, °F	630	Boron Worth, Cold, % Δk/k/ppm	1/55
Avg Film Coeff, Btu/hr ft^2-°F	4970	Full Power Moderator Temp Coeff, Δk/k/°F	$(-0.4 \text{ to } -2.0) \times 10^{-4}$
Avg Film Temp Diff, °F	35	Moderator Pressure Coeff, Δk/k/psi	$(0.4 \text{ to } 2.1) \times 10^{-6}$
Active Heat Trans Surf Area, ft^2	28,200	Moderator Void Coeff, Δk/k/% Void	$(-0.36 \text{ to } -1.8) \times 10^{-3}$
Avg Heat Flux, Btu/hr ft^2	167,400	Doppler Coefficient, Δk/k/°F	$(-1.35 \text{ to } -0.97) \times 10^{-5}$
Max Heat Flux, Btu/hr ft^2	508,800	Shutdown Margin, Hot 1 rod stuck, %Δk/k	2
Avg Thermal Output, kw/ft	5.8	Burnable Poisons, Type and Form	Boron Carbide + Al Pellets in Rods
Max Thermal Output, kw/ft	17.6	Number of Control Rods 45 × 5	225
Max Clad Surface Temp, °F	648	Number of Part-Length Rods (PLR) 4×5	20
No. Coolant Loops	2	Compiled by: Fred Heddleson, March '72 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Fort Calhoun
Exclusion Distance, Miles		0.23	Design Winds in mph:
Low Population Zone Distance, Miles		5	At 0 — 50 ft elev 90
Metropolis	Distance	Population	50 — 150 ft 115
Omaha, Neb.	19	541,453	150 — 400 ft 145
Design Basis Earthquake Acceleration, g		0.17	Tornado 500 mph total for tang. & trans. forces
Operating Basis Earthquake Acceleration, g		0.08	ΔP = 3 psi/ 3 sec
Earthquake Vertical Shock, % of Horizontal		67	
Is Intent of 70 Design Criteria Satisfied?	No reference found.		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	60.0
Max Leak Rate at Design Pressure, %/day	0.2	Calculated Max Internal Pressure, psig	59.3

Type of Construction: A reinforced concrete, partially prestressed cylinder with vertical walls and domed roof. The cylinder has a 1/4" thick steel liner for leak tightness. The structure is supported on steel piles driven 70-ft to bedrock. Cylindrical walls are 3'-10 1/2" thick and domed roof is 3'-0" thick. Free volume is 1.05×10^6 cu ft. The domed roof is also lined with 1/4" steel plate.

Design Basis: Designed to withstand a LOCA in conjunction with earthquake, or for design tornado with no loss of integrity that would allow leakage of radioactive materials in excess of design leakage limits.

Vacuum Relief Capability: No reference found.

Post-Construction Testing: Will be tested at 1.15 times design pressure and monitored for response. After this strength test, leakage rate tests will be done at 2 different pressures. After startup, leakage rate tests will be run periodically at 30 psig.

Penetrations: All penetrations are double sealed and individually testable.

Weld Channels: Test channels are welded over all seams which are not accessible for inspection after placement of interior concrete.

D2. CONTAINMENT SAFETY FEATURES	Reactor: Fort Calhoun
Containment Spray System: System consists of 3 pumps, 2 heat exchangers, piping instrumentation, etc., to spray borated water into containment. Water is recirculated from the containment sump, passing it through heat exchangers for cooling. There are 3 pumps, each rated 2000 gpm at 190 psig, and 2 heat exchangers rated 87.5×10^6 Btu/hr.	
Containment Cooling: System provides both the normal cooling function and heat removal during LOCA using 4 fan-coil units, 2 rated 70×10^6 Btu/hr and 2 rated at 140×10^6 Btu/hr. Two units have filters (consisting of HEPA and charcoal filters), and 2 do not. Filters are bypassed in normal operation. During an accident, air is circulated through the charcoal filters for removal of iodine.	
Containment Isolation System: Designed to prevent release of radioactivity through penetrations by having a valve on each end of the penetrations. All valves are normally closed except those for engineered safety features. Valves close automatically, except those that should remain open.	
Containment Air Filtration: Designed for filtration of the 0.2% leakage from containment. Air is passed through HEPA and charcoal filters.	
Penetration Room: Yes, separate ones for mechanical and electrical.	
D3. SAFETY INJECTION SYSTEMS	
Accumulator Tanks: Four tanks, each holding 5500 gallons of borated water, will dump their contents into the reactor when system pressure drops below 200 psig. Each tank is connected by piping to one of the 4 reactor cold legs. A check valve operates to release the flow.	
High-head Safety Injection: Three pumps, each rated 150 gpm at 1735 psig, take suction from the Safety Injection and Refueling Water Tank to supply borated water to reactor as makeup for small breaks. One pump has 100% of required capacity; however, all 3 pumps start on Safety Injection Signal (pressurizer low pressure or containment high pressure).	
Low-head Safety Injection: Two pumps, each rated 1500 gpm at 500 psig, flood the core when system pressure drops to the range of pump operation. Pumps take suction from the Safety Injection & Refueling Water Tank which contains borated water (1700 ppm). The tank capacity is 314,000 gpm which is 24 minutes supply with everything running. When tank is nearly empty, pump suction is switched to the containment sump for recirculation. One pump can supply 100% of required water.	

E. OTHER SAFETY-RELATED FEATURES — Reactor: Fort Calhoun

Reactor Vessel Failure: No reference found.

Containment Floodability: No reference found.

Reactor-Coolant Leak-Detection System: Running of sump pumps can detect a 1 gpm leak, change in dewpoint can detect a 3 gpm leak, and a rising radiation background would indicate leaks. Both gas monitors and air-particulate monitors can measure increased activity.

Failed-Fuel-Detection System: No reference found.

Emergency Power: Two diesel-generator sets furnish emergency on-site power. Each unit is completely independent with all its auxiliaries, etc. and separately housed. Generators are rated 4.16 kv, for 2950 kW for 30 minutes, or 2500 kW for one year base load. Diesels are started by air systems, each having capacity for 5 starts. Each unit has a day tank, and fuel is stored on site for 100 hrs operation of both units fully loaded.

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Boric acid is used for reactivity changes associated with water temp, xenon effects and fuel burnup. In-core monitors provide info on neutron flux distribution and temperatures in the core. There are part-length rods also.

Boron Dilution Control: Because of the equipment and controls and the administrative procedures provided, the probability of erroneous dilution is considered very small. Nevertheless, if an unintentional dilution of boron 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 lost.

Long-Term Cooling: A continuous source of borated water is provided by recirculating water which collects in the containment sump. The high-pressure safety injection pumps operate when high pressure dictates, but low-pressure pumps can be used when reactor pressure is reduced to their working level.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: Hydrogen purging is practical and satisfactory for limiting post LOCA hydrogen accumulation.

F. GENERAL

Reactor: Fort Calhoun

Windspeed, Direction Recorders, and Seismographs: There is a meteorological tower on the site. Seismograph type instruments will be located on top of the auxiliary foundation mat and on site grade away from buildings.

Plant Operation Mode: Load following.

Site Description: Located on the west bank of the Missouri River about 19 miles north of Omaha. Site is relatively flat, about 10 feet higher than the normal river pool. River level is rather constant because of a system of dams. A strip along the river has been partially filled in by Corp of Engineers. Land surrounding the site is relatively flat.

Turbine Orientation: Ejected turbine blades could strike containment. Center lines of turbine and reactor are 172 ft apart.

Emergency Plans: Will summarize personnel and material resources available for control of emergencies. Periodic drills will be held and detailed procedures will be prepared. Local authorities will be familiarized on their need for cooperation and assistance. State Highway Patrols of Nebraska and Iowa will control highway traffic. Evacuation will be handled by Nebraska State disaster agencies. Blair Hospital has agreed to serve accepting contaminated patients.

Environmental Monitoring Plans: Designed to provide data on types and amount of radioactivity present in the environment. The preoperational program is designed to assess environmental conditions before the arrival of fuel. Subsequent analyses during the operational program will be documented to demonstrate that plant operations do not have a significant effect on the environment. Specific radionuclide and/or gross radioactivity analyses are performed on the following samples: surface water, well water, mud, aquatic biota, milk, vegetation, air particulates, and wildlife.

Radwaste Treatment: Liquid wastes will be collected, monitored and processed on a batch basis. Total annual collection will be 84,746 gallons. After processing it will be released in the circulating water discharge. Average concentration expected is 5×10^{-10} μCi/cc plus 3×10^{-7} μCi/cc of tritium. Gases will be collected, compressed, stored, analyzed, and released when satisfactory through the plant vent. Hold up time will be about 30 days, at which time release represents about 481 curies. Solid wastes will be collected and packaged into 55 gallon drums and shipped offsite for disposal.

Plant Vent: Stack runs up side of containment.

G. SITE DATA

Reactor: Fort Calhoun

Nearby Body of Water: Missouri River

Normal Level 992' (MSL)

Max Prob Flood Level 1004' (MSL)

Size of Site 380 Acres

Site Grade Elevation 1004' (MSL)

Topography of Site: Flat to rolling

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

Total Permanent Population: In 2 mi radius 820 ; 10 mi 24,270

Date of Data: 1980 In 5 mi radius 12,720 ; 50 mi ______

Nearest City of 50,000 Population: Omaha, Nebraska

Dist. from site 19 Miles, Direction S-SE , Population 352,000 ('69)

Land Use in 5 Mile Radius: Agricultural

Meteorology: Prevailing wind direction NW-SE (Dec.–May) S-SE (June–Nov.) Avg. speed 11 mph

Stability Data – Neutral

Miscellaneous Items Close to the Site: North Omaha Airport is 16 miles S-SE. Northern city limits of Omaha is about 12 miles south. Highway #73 runs NE-SW about 3000 ft from the plant. There are about 6 houses along this road 3000–4000' from the reactor bldg. DeSoto National Wild Life Refuge is east of the plant about 1 1/2 miles consisting of 8100 acres. Blair, the closest community, is 3 mi NW with ~5000 inhabitants.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

Water Taken From: Missouri River

Intake Structure: Reinforced concrete structure at river shore line having trash racks, traveling screens and pumps. There are 6 bays and 3 pumps. Velocity thru screens will vary from 1.4 to 2.3 ft/sec.

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

River Flow 6500 (cfs) minimum; 26,750 (cfs) average

Service Water Quantity 5000 gpm/reactor

Flow Thru Condenser 365,000 max. (gpm)/reactor Temp. Rise 17.9 °F

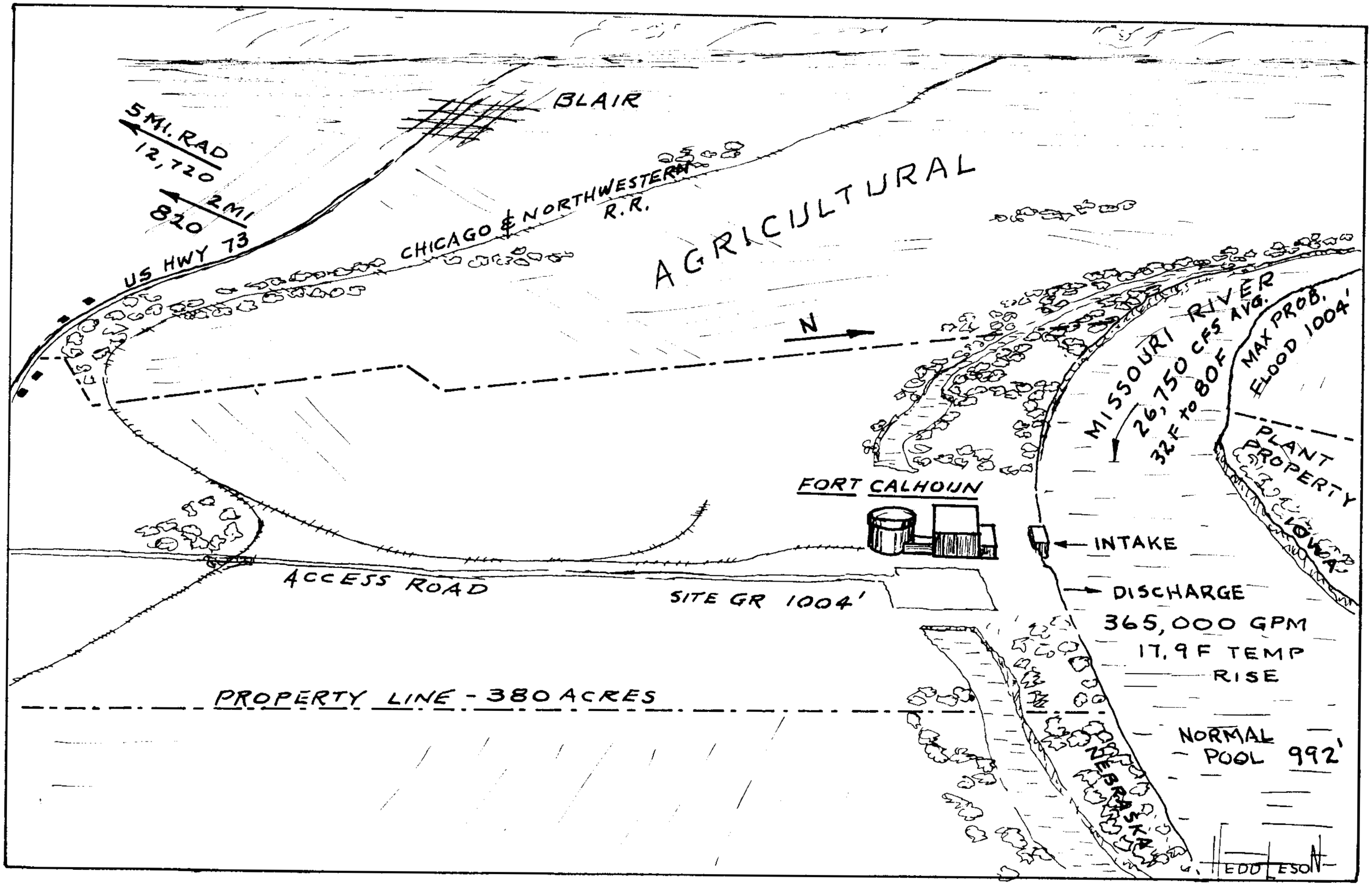
Heat Dissipated to Environment 3300×10^6 (River) (Btu/hr)/reactor

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

Discharge Structure: Discharged at river shore line with discharge velocity from 1.9 to 3.8 ft/sec.

Cooling Tower(s): Description & Number – None

Blowdown ______ gpm/reactor Evaporative loss ______ gpm/reactor


BLAIR
5 MI. RAD
12,720
2 MI
820
US HWY 73
CHICAGO & NORTHWESTERN R.R.
AGRICULTURAL
N
MISSOURI RIVER
26,750 CFS AVG.
32F to 80F
MAX PROB. FLOOD 1004'
PLANT PROPERTY
IOWA
FORT CALHOUN
INTAKE
DISCHARGE
365,000 GPM
17.9F TEMP
RISE
ACCESS ROAD
SITE GR 1004'
PROPERTY LINE - 380 ACRES
NORMAL POOL 992'
NEBRASKA

INDIAN POINT, 50-286

Project Name: INDIAN POINT NUCLEAR GENERATION UNIT 3

Location: Buchanan, N.Y.*

Owner: Consolidated Edison of NY

*24 mi N. of N.Y. City limits

A-E: United Engrs. & Constructors
Vessel Vendor: ---
NSS Vendor: Westinghouse
Containment Westinghouse
Constructor: Responsibility

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3025	H_2O/U, Cold	3.99
Electrical Output, MWe	965	Avg 1st-Cycle Burnup, MWD/MTU	14,700
Total Heat Output, Safety Design, MWt	3216	First Core Avg Burnup, MWD/MTU	26,800
Total Heat Output, Btu/hr	10324×10^6	Maximum Burnup, MWD/MTU Equilibrium	33,000
System Pressure, psia	2250	Region-1 Enrichment, %	2.25
DNBR, Nominal	2.12	Region-2 Enrichment, %	2.80
Total Flowrate, lb/hr	136.3×10^6	Region-3 Enrichment, %	3.30
Eff Flowrate for Heat Trans, lb/hr	130.1×10^6	k_{eff}, Cold, No Power, Clean	1.293
Eff Flow Area for Heat Trans, ft^2	---	k_{eff}, Hot, Full Power, Xe and Sm	1.181
Avg Vel Along Fuel Rods, ft/sec	15.6	Total Rod Worth, %	9.34
Avg Mass Velocity, lb/hr-ft^2	2.54×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	1423
Nominal Core Inlet Temp, °F	542.6	Shutdown Boron, No Rods-Clean-Hot, ppm	1432
Avg Rise in Core, °F	60.3	Boron Worth, Hot, % Δk/k/ppm	1/85
Nom Hot Channel Outlet Temp, °F	633.5	Boron Worth, Cold, % Δk/k/ppm	1/70
Avg Film Coeff, Btu/hr ft^2-°F	5880	Full Power Moderator Temp Coeff, Δk/k/°F	$(-.3 \text{ to } 3.0)\times 10^6$
Avg Film Temp Diff, °F	32.8	Moderator Pressure Coeff, Δk/k/psi	0.3×10^6 to 4.0×10^{-6}
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff, Δk/gm/cm^3	−0.1 to 0.9
Avg Heat Flux, Btu/hr ft^2	193,000	Doppler Coefficient, Δk/k/°F	$(-1.0 \text{ to } -2.0)\times 10^{-5}$
Max Heat Flux, Btu/hr ft^2	539,000	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1%
Avg Thermal Output, kw/ft	6.2	Burnable Poisons, Type and Form	Borosilicate glass in SST
Max Thermal Output, kw/ft	17.5	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 Feb. 1972 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA		Reactor: INDIAN POINT 3
Exclusion Distance, Miles	0.2 radius	Design Winds in psf:
Low Population Zone Distance, Miles	0.65 radius	At 0 – 50 ft elev; 50 – 150 ft; 150 – 400 ft: 30
Metropolis: New York City	Distance: 24 mi; Population: 11,528,649	
Design Basis Earthquake Acceleration, g	0.15	
Operating Basis Earthquake Acceleration, g	0.10	Tornado 300 mph tang + 60 trans.
Earthquake Vertical Shock, % of Horizontal	67DBE 50 OBE	ΔP = 3 psi/ 3 sec
Is Intent of 70 Design Criteria Satisfied?	Section 1.3 discusses how design criteria is met.	

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	47
Max Leak Rate at Design Pressure, %/day	0.1	Calculated Max Internal Pressure, psig	44

Type of Construction: A reinforced-concrete vertical right cylinder with flat base and hemispherical dome. Vertical walls are 4'–6" thick and dome is 3'–6" thick. A weld-steel liner (min. thick. 1/4") is attached to inside of concrete for leak tightness. Concrete base is 9'–0" thick with bottom liner plate on this mat. Liner is then covered with 3'–0" of concrete. Free volume is 2.61×10^6 cu ft.

Design Basis: Designed to withstand the following major loading conditions emposed by

a. complete failure of reactor coolant system
b. coincident failure of the reactor coolant system with an earthquake or wind

with essentially no leakage of radioactive materials.

Vacuum Relief Capability: A pressure-relief line with 3 butter-fly valves vents to plant vent.

Post-Construction Testing: A strength test will be run at 54 psig for 1 hr. Leakage rate tests will be run at 47 psig for 24 hr. and at half of this for 24 hr. Leakage-rate tests will be run periodically after startup.

Penetrations: All piping and electrical penetrations are double barrier and individually testable.

Weld Channels: All welded joints in the liner have steel channels welded over them on the inside. Welds are checked with Freon during construction.

D2. CONTAINMENT SAFETY FEATURES	Reactor: INDIAN POINT 3

Containment Spray System: Two sets of 2 out of 3 (Hi Hi) containment pressure signals initiate 2 pumps, taking suction from the refueling-water storage tank, so that 5000 gpm of borated water is sprayed into containment. Contents of a tank containing sodium hydroxide is sprayed in to assist in iodine removal. Water from the sump can be recirculated.

Containment Cooling: Designed to maintain temp during operation at 120F or lower. System uses recirculation and fan-coil coolers. Five cooling units each have capacity of 2.2×10^6 BTU/hr for normal operation and 76.32×10^6 BTU/hr capacity for accident conditions. Valves throttle water for temp control for normal operation, but open wide on high containment pressure.

Containment Isolation System: Two valves are installed on each line which penetrates containment - one on the inside and one on the outside. Valves close automatically to prevent leakage from containment in case of line rupture or other accident. Valves close on containment isolation signal.

Containment Air Filtration: Recirculated air passes thru HEPA filters. In case of an accident, charcoal filters are used. Flow capacity thru charcoal filters is 8000 cfm.

Penetration Room: No reference found.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks: Four tanks, each holding ~5500 gallons of borated water, discharge their contents into the 4 cold legs of the reactor when system pressure drops to 650 psig. Pressure in accumulators is maintained by nitrogen gas. Check valves in discharge lines open at 650 psig.

High-head Safety Injection: Flow from two pumps is directed into two headers (one pump for each). One header supplies the two cold legs and the other the two hot legs of the vessel. There is a third standby pump. These pumps are rated 400 gpm each at 1700 psig. Pumps take suction from the refueling-water storage tank which contains borated water. One injection header contains a boron injection tank which discharges its contents into the reactor when injection is initiated.

Low-head Safety Injection: In a line break accident, when system pressure drops to about 250 psig, two pumps of the Residual Heat Removal System starts up and deliver large quantities of water (3000 gpm @ 250 psig, each) to flood the core and prevent fuel damage. These pumps take suction from the refueling-water storage tank until it is emptied. Water can then be recirculated from the sump.

E. OTHER SAFETY-RELATED FEATURES Reactor: INDIAN POINT 3

Reactor Vessel Failure: Found no reference.

Containment Floodability: Found no reference.

Reactor-Coolant Leak-Detection System: Indication of leakage is provided in the control room by detection of deviation from normal conditions including air particulate activity, radiogas activity, humidity, condensate run off and monitoring of sump level and sump pump operation.

Failed-Fuel-Detection System: Found no reference.

Emergency Power: Available from the Buchanan substation and a gas turbine at the Indian Point site. In addition, there are 3 diesel-generator sets each rated at 1750 kW continuously. Any 2 units can supply the minimum requirements for 1 set of safeguards equipment. Each unit has a 2 hr. fuel supply in the day tank with storage tank supply to run 2 units for 80 hours.

Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Part-length rods and borosilicate glass in SST rods are provided to suppress oscillations. Out-of-core instrumentation monitors power distribution. In-core instrumentation is used to calibrate out-of-core.

Boron Dilution Control: Because of procedures involved in the dilution process, an erroneous dilution is considered incredible. 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 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: Can be accomplished by recirculating borated water that collects in the containment sump. Two recirculation pumps, heat exchangers, and the two low-head Residual Heat Removal System pumps accomplish the task. There are 2 heat exchangers, each having 56.4×10^6 BTU/hr capacity.

Organic-Iodide Filter: No reference found.

Hydrogen Recombiner: There are two recombiners shown on the reactor building top floor.

F. GENERAL	Reactor: INDIAN POINT 3

<u>Windspeed, Direction Recorders, and Seismographs</u>: A 100 ft tower on the site has collected data for several years. No reference found to seismographs.

<u>Plant Operation Mode</u>: Load following.

<u>Site Description</u>: Site is on the east bank of the Hudson river about 45 miles north of where the river joins the Atlantic Ocean. Steep banks rise up from the river and the turns in the river near the site cause it to be in a sort of bowl. The site area slopes from the edge of the river bank so that turbine building and reactor building are built on different site grades.

<u>Turbine Orientation</u>: Turbine and reactor are about 190' apart. Turbine located so it is unlikely that ejected blades would strike containment.

<u>Emergency Plans</u>: Procedures will be prepared and periodic training sessions held so all personnel are familiar with procedures and their responsibilities. If radioactivity is released, there will be off-site surveys cooperatively with AEC, New York State agencies and Coast Guard. Contingency plans have been prepared for fire, earthquakes, tornado, and radioactivity releases.

<u>Environmental Monitoring Plans</u>: Program started in 1958 to determine background data before unit #1 startup. In addition, New York State carries out a program of monitoring. Measurements are made of radioactivity in fresh water, river water, bottom sediments, fish, aquatic vegetation, soil, vegetation, and air. Cooling water from unit #1 has been monitored for activity.

<u>Radwaste Treatment</u>: Liquid wastes are collected in sumps and tanks where they are held for processing as required. The bulk of liquid wastes collected are processed and retained inside the plant. Processed water from which most of the radioactivity has been removed is released into the circulating water discharge. Gaseous wastes are collected and held in tanks under nitrogen pressure until some radioactive decay occurs. Release is through the monitored plant vent intermittently in accordance with technical specs. Solid wastes are packed into 55 gal drums and shipped offsite for disposal. Total activity released in liquid form is 26.2 mc/yr excluding tritium.

<u>Plant Vent</u>: There is one stack for units 1, 2, and 3. It is 400 feet high.

G. SITE DATA

Reactor: INDIAN POINT 3

Nearby Body of Water: Hudson River

Normal Level 0' (MSL)

Max Prob Flood Level 15' (MSL)

Size of Site 239 Acres — Site Grade Elevation 15' to 54' (MSL)

Topography of Site: Hilly

of Surrounding Area (5 mi rad): Hilly to mountainous

Total Permanent Population: In 2 mi radius 39,200 ; 10 mi 440,000

Date of Data: 2000 — In 5 mi radius 150,200 ; 50 mi 21,300,000

Nearest City of 50,000 Population: White Plains

Dist. from site 14 Miles, Direction SSE, Population 50,220 (70)

Land Use in 5 Mile Radius: Most residential with some large parks and military reservations.

Meteorology: Prevailing wind direction NNE/SSW — Avg. speed 7 mph

Stability Data - Slightly unstable to neutral.

Miscellaneous Items Close to the Site: The site is in a densely populated area with Peekskill 2 mi NE (pop 18,881 in 1970) and Buchanan 1 mi SE (pop ∿2500). Camp Smith, military reservation, is 1 mi N and West Point is about 8 mi North. Indian Point nuclear units 1 and 2 are adjacent.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Hudson River

Intake Structure: Reinforced concrete at river's edge with 7 separate channels, one for each of 6 circulating pumps and one for service water pumps. Each channel has skimmer wall, trash rack, traveling screen, etc.

Water Body Temperatures: Winter minimum 32 °F — Summer maximum 78 °F

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

Service Water Quantity 30,000 gpm/reactor

Flow Thru Condenser 840,000 (gpm)/reactor — Temp. Rise 16.6 °F

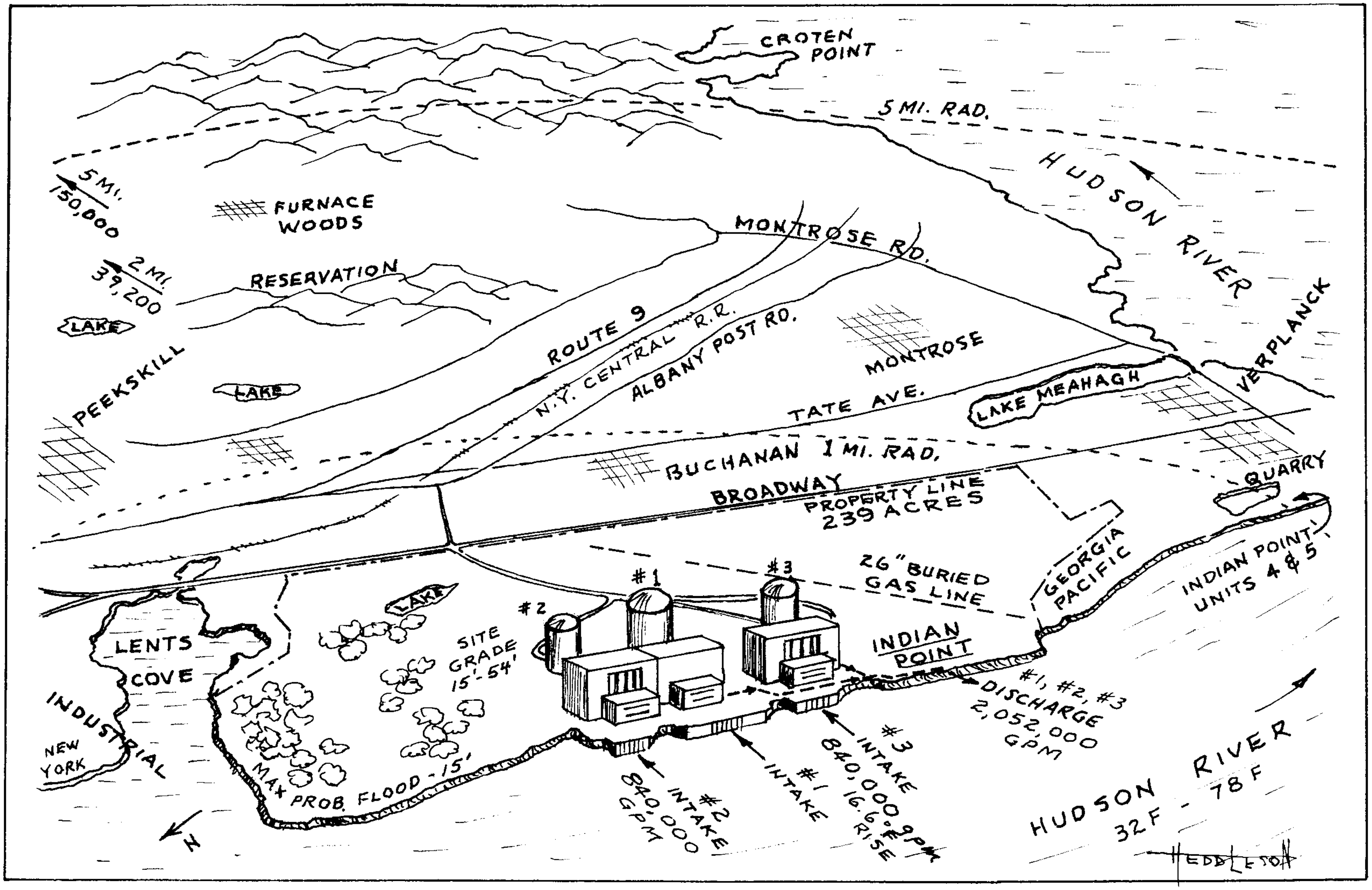
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: Common discharge channel for unit 3 and #1 and #2. Discharged to river thru 12 ports 4' × 15' spaced 20 ft apart at depth of 18 feet.

Cooling Tower(s): Description & Number - None

Blowdown ______ gpm/reactor — Evaporative loss ______ gpm/reactor


CROTEN POINT
5 MI. RAD.
HUDSON RIVER
5 MI. 150,000
2 MI. 39,200
FURNACE WOODS
RESERVATION
LAKE
LAKE
PEEKSKILL
MONTROSE RD.
ROUTE 9
N.Y. CENTRAL R.R.
ALBANY POST RD.
MONTROSE
VERPLANCK
LAKE MEAHAGH
TATE AVE.
BUCHANAN 1 MI. RAD.
BROADWAY
PROPERTY LINE 239 ACRES
QUARRY
26" BURIED GAS LINE
GEORGIA PACIFIC
INDIAN POINT UNITS 4 & 5
#1
#2
#3
LAKE
SITE GRADE 15'-54'
INDIAN POINT
LENTS COVE
INDUSTRIAL
NEW YORK
MAX PROB. FLOOD - 15'
#1, #2, #3 DISCHARGE 2,052,000 GPM
#2 INTAKE 840,000 GPM
#1 INTAKE
#3 INTAKE 840,000 gpm 16.6°F RISE
HUDSON RIVER 32F - 78F
N
HEDDLESON

DATA FROM FSAR FOR UNIT 1.

Page 1 (PWR)

THREE MILE ISLAND, 50-289, 50-320

Project Name: Three Mile Island Nuclear Station, Units 1 & 2

Location: Goldsboro, Penn.

Owner: Metropolitan Edison - Unit 1
Jersey Central - Unit 2

A-E: Gilbert Associates - Unit 1
Vessel Vendor: Babcock & Wilcox
NSS Vendor: Babcock & Wilcox
Containment Constructor: United Engineers

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, 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, %	---
DNBR, Nominal	2.0	Region-2 Enrichment, %	---
Total Flowrate, 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	1.244
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, $lb/hr\text{-}ft^2$	---	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, $Btu/hr\ ft^2\text{-}°F$	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 Pressure 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 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	5.656	Burnable Poisons, Type and Form	$Al_2O_3 - B_4C$ Zircaloy-4
Max Thermal Output, kw/ft	17.63	Number of Control Rods	976
Max Clad Surface Temp, °F	654	Number of Part-Length Rods (PLR)	---
No. Coolant Loops	2	Compiled by: Fred Heddleson Feb. 1971 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: Three Mile Island
Exclusion Distance, Miles		0.38 rad.	Design Winds in mph:
Low Population Zone Distance, Miles		2	At 0 — 50 ft elev 80
Metropolis	Distance	Population	50 — 150 ft 105
Harrisburg, Pa.	10 mi.	410,626	
Design Basis Earthquake Acceleration, g		0.12	150 — 400 ft 135
Operating Basis Earthquake Acceleration, 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 Pressure, psig	55 - Unit 1 60 - Unit 2
Max Leak Rate at Design Pressure, %/day	0.2	Calculated Max Internal Pressure, psig	53.6

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.

D2. CONTAINMENT SAFETY FEATURES	Reactor: Three Mile Island
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 in spray removes iodine from containment atmosphere. Suction from borated water storage tank until supply is exhaused, 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.	
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.	

E. OTHER SAFETY-RELATED FEATURES	Reactor: Three Mile Island

Reactor Vessel Failure: No reference found.

Containment Floodability: No reference found.

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

Failed-Fuel-Detection System: 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 By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Poison rods help control oscillations. No mention found of part length rods. 36 detectors monitor core flux and readout in the control room.

Boron Dilution 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: 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.

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.

F. GENERAL	Reactor: Three Mile Island
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 Operation Mode: Load following - matching megawatt generation to unit load demand.	
Site Description: Plant is located on Three Mile Island along the east side of the Susquehanna River, on Conowago Reservoir. At this point, the river is about 10,000 ft wide having numerous islands scattered in the area. Hills rise up from the west side of the river and the east side is relatively flat for about 1 mile.	
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 coordination of off-site activites with state officials. Agencies will be familiarized 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 evaporator 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, stored and packaged in DOT approved containers.	
Plant Vent: Vent on top of reactor bldg - 200 ft above grade.	

G. SITE DATA

Reactor: Three Mile Island

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 radius 2700 ; 10 mi ____

Date of Data: 1969 — In 5 mi radius 28,659 ; 50 mi ____

Nearest City of 50,000 Population: Harrisburg

Dist. from site 10 Miles, Direction NW , Population 73,500

Land Use in 5 Mile Radius: Agricultural

Meteorology: Prevailing wind direction WNW Avg. speed ∿5

Stability Data - Pasquill D to E

Miscellaneous Items Close to the Site: York Haven hydrostation is about 2 1/2 miles downstream. Middletown (pop 9000) is 4 miles north. State Route 441 runs along the east bank of the river paralleling Penn Central railroad. Olmsted State airport is 2 1/2 miles NW and the Harrisburg airport is 8 miles WNW. Peach Bottom plant is 35 mi. downstream on Conowago Pond. Nearest houses are about 2000 ft away.

H. CIRCULATING WATER SYSTEM

Type of System: Close Loop.

Water Taken From: Susquehanna for makeup.

Intake Structure: A reinforced concrete structure is provided for each reactor, consisting of a skimmer wall, traveling bar screens, traveling screens, and pumps. Intake velocity is 0.2 fps.

Water Body Temperatures: Winter minimum 33 °F — Summer maximum 85 °F

River Flow 1700 (cfs) minimum; 34,000 (cfs) average

Service Water Quantity 54,500 gpm/ total, including makeup

Flow Thru Condenser 430,000 (gpm)/reactor — Temp. Rise -- °F

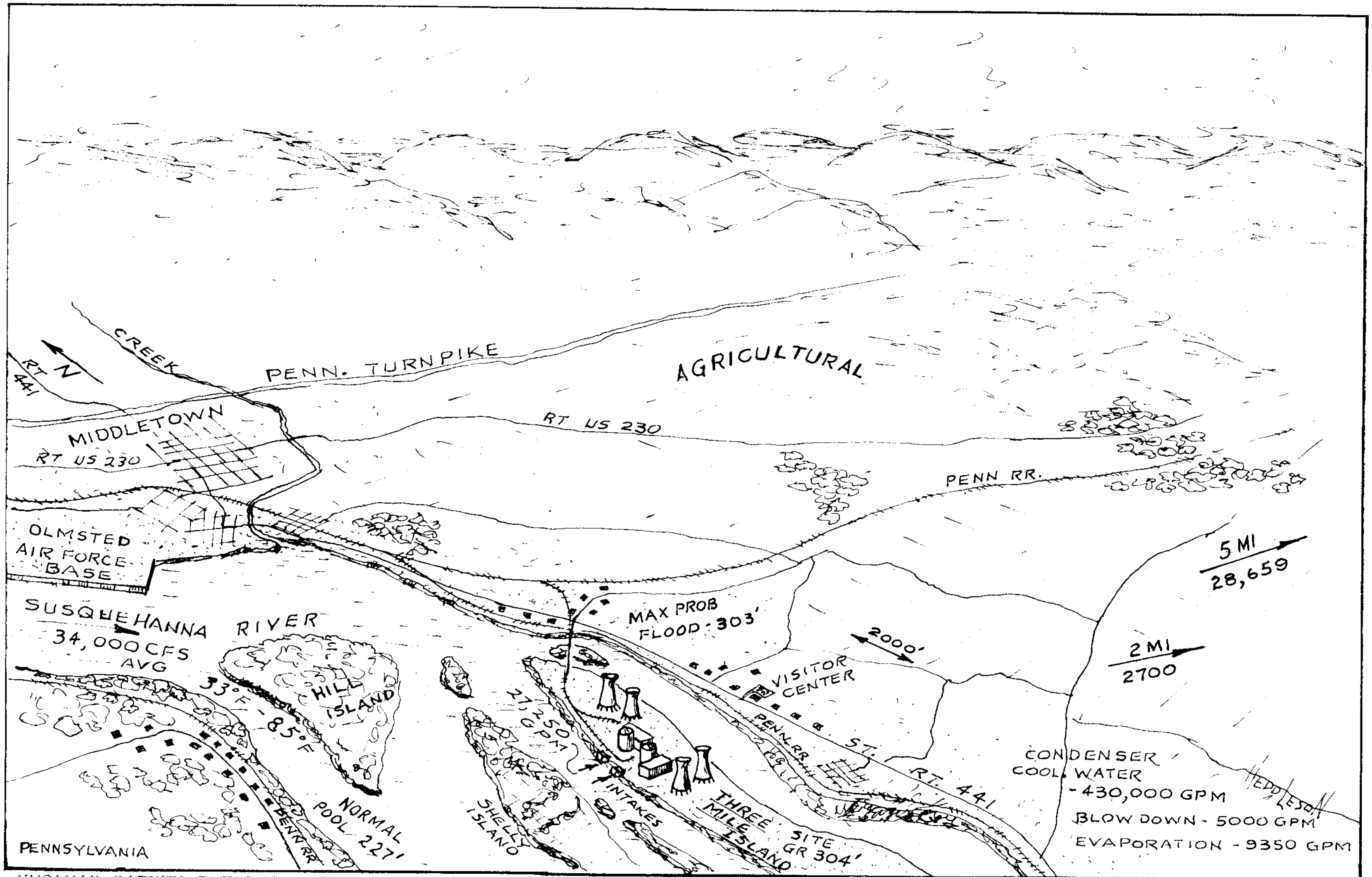
Heat Dissipated to Environment 11.5×10^9 (Btu/hr)/ total

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

Discharge Structure: Discharged water is about ambient river temp. and is discharged at the shoreline from 3 discharge pipes. Total discharge quantity is about 36,000 gpm.

Cooling Tower(s): Description & Number - Each unit has 2 hyperbolic towers and 2 mech. draft tower to cool blowdown & service water.

Blowdown 5000 gpm/reactor — Evaporative loss 9350 gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

PILGRIM, 50-293

Project Name: Pilgrim Nuclear Station, #1

Location: Plymouth TWP, Mass.*

Owner: Boston Edison Co.

*5 mi. E. of Plymouth, Mass.

A-E: Bechtel

Vessel Vendor: Combustion Engr.

NSS Vendor: General Electric

Containment Constructor: Not Specified

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	1998	H_2O/UO_2 Volume Ratio	2.41
Electrical Output, MWe	687	Moderator Temp Coef Cold, Δk/k/°F	-8.0×10^{-5}
Total Heat Output, Safety Design, MWt	1998	Moderator Temp Coef Hot, No Voids	-20.0×10^{-5}
Steam Flow Rate, lb/hr	7.983×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	-1.0×10^{-3}
Total Core Flow Rate, lb/hr	69×10^6	Moderator Void Coef Operating	-1.6×10^{-3}
Coolant Pressure, psig	1020	Doppler Coefficient, Cold	-1.3×10^{-5}
Heat Transfer Area, ft^2	50,182	Doppler Coefficient, Hot, No Voids	-1.2×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	17.5	Doppler Coefficient, Operating	$< -1.3 \times 10^{-5}$
Maximum Heat Flux, Btu/hr-ft^2	326,300	Initial Enrichment, %	2.19
Average Heat Flux, Btu/hr-ft^2	145,490	Average Discharge Exposure, MWD/Ton	19,000
Maximum Fuel Temperature, °F	3530	Core Average Void Within Assembly, %	71.8
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	40.5	Curtain Worth, %	---
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	264 Flat Boron - SST
DATA FROM FSAR		Number of Control Rods	145 Cruciform
		Number of Part-Length Rods (PLR)	None

Compiled by: Fred Heddleson, Aug. 1971
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: PILGRIM	
Exclusion Distance, Miles		0.33	Design Winds in psf:	
Low Population Zone Distance, Miles		1 1/2	At 0 — 50 ft elev	28
Metropolis	Distance	Population	50 — 150 ft	44
Brockton, Mass.	22	189,820		
Design Basis Earthquake Acceleration, g		0.15	150 — 400 ft	66
Operating Basis Earthquake Acceleration, g		0.08	Tornado 300 mph tang + 60 trans ΔP = 3 psi/ 3 sec	
Earthquake Vertical Shock, % of Horizontal		---	Is Intent of 70 Design Criteria Satisfied?	Yes

Recirculation Pumping System & MCHFR: Recirculation rate effects the type of boiling and thus the MCHFR. Limits on MCHFR are set for not less than 1.9 at 1998 MWt operation.

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

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Drywell Design Pressure, psig	56	Primary Containment Leak Rate, %/day	0.5
Suppression Chamber Design Pressure, psig	56	Second Containment Design Pressure, psig	0.25
Calculated Max Internal Pressure, psig	45	Second Containment 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 147,000 ft^3 and suppression chamber free volume is 120,000 ft^3.

Design Basis: Designed to withstand a double-ended rupture of the largest sized pipe and to contain any radioactivity released by the fuel.

Vacuum Relief Capability: Designed for 2 psig external pressure. Air vents to suppression chamber and then to drywell.

Post-Construction Testing: A pneumatic pressure test run at 1.25 times design pressure. Leakage rate tests will be run at 45 psig and at a lower pressure to establish leakage rate/pressure relationships.

Penetrations: Designs shown in Fig. 5.2-1 through 5.2-4 indicate single barrier penetrations. Electrical penetrations are double sealed and individually testable.

D2. EMERGENCY CORE COOLING SYSTEMS Reactor: PILGRIM

Core Spray Cooling System: Consists of 2 independent pump loops that deliver cooling water to spray spargers over the core, actuated by a breach in the nuclear system process barrier. This system cools the fuel by spraying water onto the core. Either core spray loop is capable of preventing fuel clad melting following a LOCA. There are 2 pumps each rated 3600 @ 104 psid.

Auto-Depressurization System: If HPCIS fails to maintain reactor vessel water level, this system acts to rapidly reduce reactor vessel pressure so the low pressure injection systems can operate. Steam is vented through the relief valves.

Residual-Heat-Removal System (RHRS): A system of pumps, heat exchangers and piping that does the following: (1) Removal of decay heat during and after station shutdown. (2) Injects cooling water into reactor - LPCI system. See below. (3) Suppression pool water is pumped through RHRS heat exchangers for cooling. (4) Containment spray is 4th mode using pumps to spray water into containment atmosphere to lower temperature and remove energy. There are 4 pumps each rated 4800 gpm @ 20 psid and 2 heat exchangers rated 64×10^6 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 4250 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 4800 gpm @ 20 psid supply sufficient water to flood the core and prevent melting.

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors: A venturi type flow restrictor in each steam line close to reactor vessel to limit loss of coolant from reactor vessel in case of steam line break.

Control-Rod Velocity Limiters: Attachment on each control rod to limit velocity at which a control rod can fall out of the core. The limiters contain no moving parts, nor does it effect scram.

Control-Rod-Drive-Housing Supports: Housing supports are located underneath reactor vessel near control rod housings. Supports limit travel if control rod housing is ruptured. Supports prevent a nuclear excursion.

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.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: PILGRIM
Standby Coolant System: The Residual Heat Removal System and the station salt water service piping are connected by permanent piping sized for 5000 gpm flow @ 0 psig. Two locked-closed valves prevent inadvertant mixture.
Containment Atmospheric Control System: Although applicant plans to operate with an air atmosphere, design and construction has provided a system for nitrogen purging if needed.
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 400 gpm @ 1120 psid.
Reactor Vessel Failure: No reference found
Containment Floodability: Primary containment can be flooded if a breach in the primary barrier cannot be sealed.
Reactor-Coolant Leak-Detection System: Integrated flow through sump pumps is best indication of leakage. Other indicators are containment temperature, pressure, and humidity. Identifiable leakage max limit is 48 gpm, and unidentified limit is 15 gpm for a max total limit of 63 gpm.
Failed-Fuel Detection Systems: The main steam line radiation monitoring system consists of gamma radiation monitors located external to the lines just outside of primary containment. Monitors detect gross release of fission products from the fuel. Upon detection of high radiation, trip signals generated by the monitors initiate a reactor scram and isolation.
Emergency Power: Two 2600 kW diesel-generators furnish on-site emergency ac power to the 4160 volt emergency bus. These units start in 10 seconds and start accepting load. Each unit with auxiliaries is independent of the other. Fuel is available, stored on the site, for 7 days operation of one engine at full power.
Rod-Block Monitor: One of the systems of the on-line computer which monitors rod position and blocks rod movement which could cause reactivity excursion.
Rod-Worth Minimizer: Prevents rod withdrawal under low power conditions if rod to be withdrawn is not in accordance with 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.

F. GENERAL	Reactor: PILGRIM

Windspeed, Direction Recorders, and Seismographs: A meteorological tower 220 ft high has been used since May 1968. Top of tower is 300' MSL. Reference to seismographs not found.

Plant Operation Mode: Load following is accomplished by varing the recirculation flow to the reactor.

Site Description: Plant is located on a bluff 20 ft above Cape Cod Bay about 5 miles SE of Plymouth, Mass. The site is typical of an ocean site with persistant winds, periodic serious hurricanes, and other ocean side effects. The plant is in a sparsely settled area except for beach properties near the site which are 1/2 mile to 2 1/2 miles away.

Turbine Orientation: Ejected turbine blades could strike containment structure. Centerlines are 159 ft apart.

Emergency Plans: Emergencies classified as nonradiological and radiological. In nonradiological emergencies, the plan to limit the effect, and prevent them from causing a radiological emergency. For radiological emergencies, the plan is to hold the emergency to a minimum, protect personnel and the general public, and recover from the emergency. Semi-annual drills will be conducted to ensure proper training of personnel.

Environmental Monitoring Plans: A study of pre-operational radiation levels was initiated in August, 1969, which includes sampling and laboratory radioactivity analyses of airborne particulates, airborne iodine, fresh water, sea water, marine life, marine sediments, milk, and crops. Background radiation levels are also being established. Sampling activities are concentrated within a few miles of the station; however, sampling is also conducted at locations over 20 miles from the station. These studies will be continued after station startup. Comparison of the operational and pre-operational data will permit detection of any increase in radiation levels.

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 minute holdup time allows the noble gases with short half-lives to decay to solid daughters which are removed by the high efficiency off-gas filters. Solid wastes are collected, dewatered, and shipped offsite.

Plant Vent: A steel stack 320 feet high.

G. SITE DATA

Reactor: PILGRIM

Nearby Body of Water: Cape Cod Bay

Normal Level 0' (MSL)

Max Prob Flood Level 13.5' (MSL)

Size of Site 517 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 radius 2167 ; 10 mi ____

Date of Data: 2015 In 5 mi radius 15063 ; 50 mi ____

Nearest City of 50,000 Population: Brockton, Mass.

Dist. from site 22 Miles, Direction NW, Population 88,000

Land Use in 5 Mile Radius: Undeveloped - 75%, Agricultural - 7%, Residential - 5%

Meteorology: Prevailing wind direction SSW WNW Avg. speed 9.4

Stability Data - Moderately stable.

Miscellaneous Items Close to the Site: Plymouth, Mass. is about 5 mi from the site (NW). The site is surrounded by mostly undeveloped land and water except for the beach properties of Priscilla and White House Beach. The nearest residences are ∿2000 ft away. Boston is 35 miles NW of site.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

Water Taken From: Cape Code Bay of Atlantic Ocean.

Intake Structure: Reinforced concrete structure at edge of Bay, having trash racks, traveling screens, and pumps for the circulating system and the service water system. The intake is protected by a breakwater. Inlet velocity is 1 fps.

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

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

Service Water Quantity 10,000 gpm/reactor

Flow Thru Condenser 311,000 (gpm)/reactor Temp. Rise 29 °F

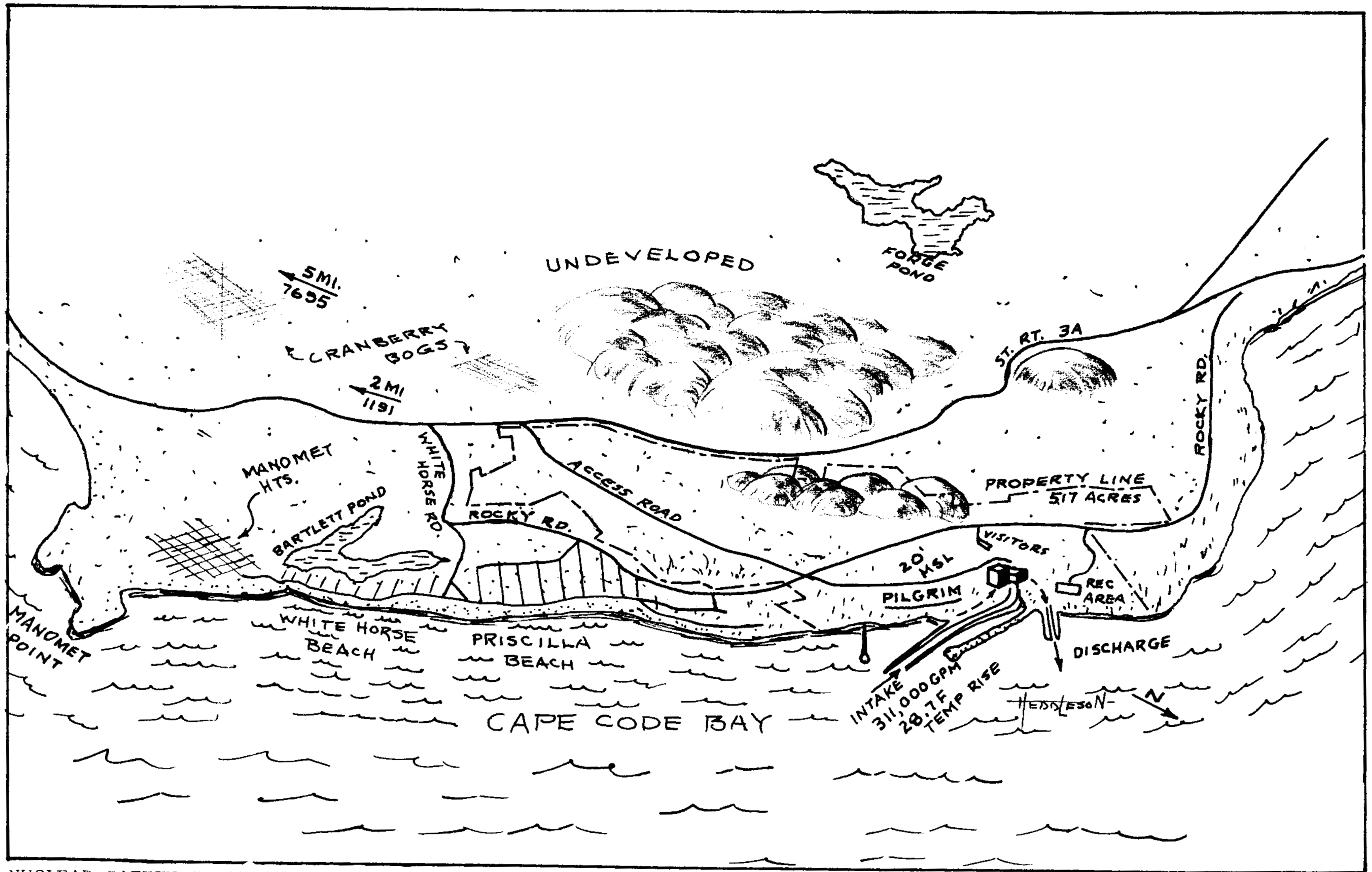
Heat Dissipated to Environment 4500×10^6 (Btu/hr)/reactor

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

Discharge Structure: Surface jet discharge at shore line using a canal to convey the water about 850 ft to the Bay. Canal is shaped to produce a jet action for better mixing with Bay water.

Cooling Tower(s): Description & Number - None

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



NUCLEAR SAFETY INFORMATION CENTER

DATA FROM FSAR Page 1 (PWR)

ZION STATION, 50-295, 50-304

Project Name: Zion Station, Units 1 & 2

Location: NE Illinois*

Owner: Commonwealth Edison

*40 mi N of Chicago

A-E: Sargent & Lundy

Vessel Vendor: Babcock & Wilcox

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, Safety Design, MWt	3391	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, %	2.25
DNBR, Nominal	2.02	Region-2 Enrichment, %	2.80
Total Flowrate, 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, % $\Delta k/k$/ppm	1/85
Nom Hot Channel Outlet Temp, °F	631.7	Boron Worth, Cold, % $\Delta k/k$/ppm	1/70
Avg Film Coeff, Btu/hr ft^2-°F	5800	Full Power Moderator Temp Coeff, $\Delta k/k$/°F	$(-0.3 \text{ to } -3.2) \times 10^{-4}$
Avg Film Temp Diff, °F	35.6	Moderator Pressure Coeff, $\Delta k/k$/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, $\Delta k/k$/°F	-1.7×10^{-5}
Max Heat Flux, Btu/hr ft^2	579,600	Shutdown Margin, Hot 1 rod stuck, %$\Delta k/k$	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	Compiled by: Fred Heddleson May 1972 Nuclear Safety Information Center	

Page 2, PWR

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: ZION
Exclusion Distance, Miles		0.25 radius	Design Winds in mph:
Low Population Zone Distance, Miles		---	At 0 — 50 ft elev 100
Metropolis	Distance	Population	
Kenosha, Wis.	8 mi	117,917	50 — 150 ft 120
Design Basis Earthquake Acceleration, g		0.17	150 — 400 ft 140
Operating Basis Earthquake Acceleration, g		0.08	Tornado 300 mph tang + 60 trans.
Earthquake Vertical Shock, % of Horizontal		67	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.		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	47
Max Leak Rate at Design Pressure, %/day	0.1	Calculated Max Internal Pressure, psig	42

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.

D2. CONTAINMENT SAFETY FEATURES	Reactor: ZION
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. Isolation is automatic.	
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.	

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.

E. OTHER SAFETY-RELATED FEATURES

Reactor: ZION

Reactor Vessel Failure: Containment Floodability: 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. Almost 1,000,000 gallons of water, total, is available for core cooling.

Reactor-Coolant Leak-Detection System: Provided by equipment which monitors containment air activity and humidity. The basic design criterion is detection of deviations from normal containment enviromental 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 System: 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 By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: Eight assemblies of part-length rods help control axial power. Out-of-core detectors (long ion chambers) will monitor both axial and radial power distribution. In-core detectors will not be used.

Boron Dilution 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 to 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 alarms.

Long-Term Cooling: 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.

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%.

F. GENERAL

Reactor: ZION

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

Seismographs not mentioned.

Plant Operation Mode: Designed for load following.

Site Description: The site lies along Lake Michigan consisting of a series of sand ridges or dunes intersparced with marshes. Dunes are covered with low vegetation. The lake is shallow in this area being about 22 ft deep, 2500 ft from shore. The site has good ventilation due to prevailing breezes. Since the site is adjacent to the city of Zion, population density near the plant is high.

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.

Plant Vent: Eight feet diameter stack runs up the side of containment to Elev. 772'-6", 180' above grade.

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G. SITE DATA

Reactor: ZION

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 radius 25,665 ; 10 mi ______

Date of Data: 1985   In 5 mi radius 106,615 ; 50 mi ______

Nearest City of 50,000 Population: Waukegan, Ill.

Dist. from site 6 Miles, Direction S , Population 64,665 ('70)

Land Use in 5 Mile Radius: Residential, Industrial, Agricultural, and Recreational

Meteorology: Prevailing wind direction Variable SW Avg. speed ---

Stability Data - Well ventilated

Miscellaneous Items Close to the Site: Site is bounded by the Illinois Beach State Park on the south, a city park on the north, the city of Zion on the west and the lake on the east. A Westinghouse reactor simulator-trainer is located along the west boundary. The Wisconsin state line is 3 1/2 miles north. Chi-NW railroad runs along the western boundary. Interstate I-94 is 6 miles west.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

Water Taken From: Lake Michigan

Intake Structure: Located 2600 ft offshore in 22 ft deep water. Cap over intake is 10 ft below the lake surface at normal level.

Water Body Temperatures: Winter minimum 32 °F   Summer maximum ∿66 °F

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

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 735,000 (gpm)/reactor   Temp. Rise 20 °F

Heat Dissipated to Environment 7500×10^6 (Btu/hr)/reactor

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

Discharge Structure: Each unit has separate discharge 760 ft from shoreline. Structure is 75' × 30' with discharge ports along each side. Discharge openings are 3' high and continuous.

Cooling Tower(s): Description & Number - None

Blowdown ______ gpm/reactor   Evaporative loss ______ gpm/reactor

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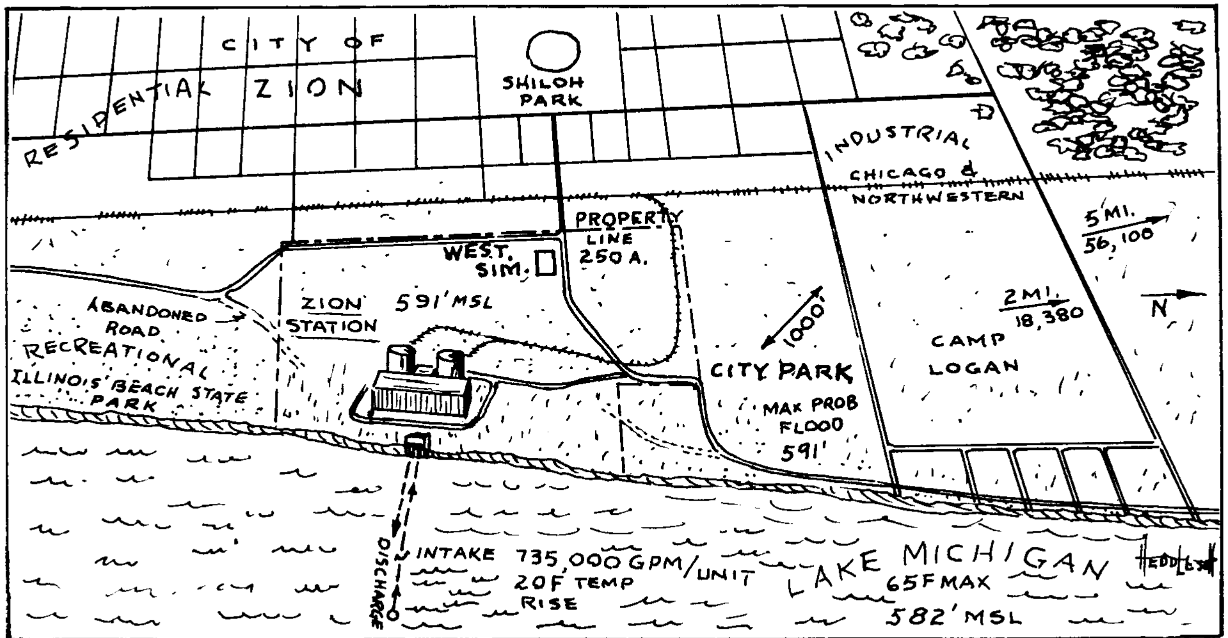

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