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ORNL-NSIC-55
Vol. IV

DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS

Vol. IV

Dockets 50-452 Through 50-503

FRED A. HEDDLESON

NUCLEAR SAFETY INFORMATION CENTER

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Nuclear Safety Information Center

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DESIGN DATA AND SAFETY FEATURES OF COMMERCIAL NUCLEAR POWER PLANTS

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Dockets 50-452 Through 50-503

Fred A. Heddleson
Reactor Division

March 1975

OAK RIDGE NATIONAL LABORATORY
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FOREWORD

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

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ABSTRACT

Design data, safety features, and site characteristics are summarized for 36 nuclear power units in 18 power stations in the United States. Six pages of data are presented for each plant consisting of thermal-hydraulic and nuclear factors, containment features, emergency-core-cooling systems, site features, circulating water system data, and miscellaneous factors. An aerial perspective is also presented for each plant. This volume covers reactors with dockets 50-452 through 50-503.

INTRODUCTION

The data summaries for this report were taken from the Preliminary Safety Analysis Reports (PSARs) and the Environmental Report generated for the U.S. Nuclear Regulatory Commission licensing authorities by applicants wishing to build and operate nuclear power plants. The PSAR and Environmental Report sometimes contain as many as 9000 pages of information presented in 22 volumes to adequately 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. This compilation of summary data is intended to make the more important information readily available.

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

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

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

Volume II, published in January 1972, covered commercial power reactors with docket numbers 50-296 (Browns Ferry No. 3) through 50-395 (Virgil Summer). Volume I (December 1973) covered power reactors up to and including docket 50-295 (Zion Station). Volume III covered reactors with docket numbers 50-397 through 50-449. This volume (IV) covers plants from Greenwood (50-452 and 50-453) to Koshkonong (50-502 and 503).

In the index by sequential docket number, some numbers are missing; these docket numbers are for experimental reactors, for those not producing commercial power, and/or for reactors for which the application was withdrawn.

ORGANIZATION OF INFORMATION

Reactor summaries appear sequentially according to docket number. The first four summaries follow the format used in previous volumes. Starting with the Clinton Power Station, a new format was adopted which provides a better organization of information and incorporates suggestions of report users.

The format for the first four summaries provides general information such as names, size, location, utility, etc., 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, population, design wind speed, seismic design, etc.

D. Engineered Safety Features — Data on containment design values, containment system descriptions, and 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 systems, etc.

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

The new format for the remaining summaries is as follows:

A. General — Plant name, location, utility, designers and builders.

B. Site Data — Site description giving pertinent facts, plus nearby body of water, topography, population, land use, and meteorology facts.

C. Containment and Structures — Design values, type of containment structure, heat removal systems, and safety features.

D. Reactor Coolant — Pressure vessel data, leak detection system, etc.

E. Thermal-Hydraulic and Nuclear — Tabulations of data values.

F. Emergency-Core-Cooling Systems — Descriptions of the different types of injection systems, giving capacities and numbers of pumps, etc.

G. Miscellaneous — Descriptions of residual heat removal system, radwaste system, plant vent, emergency power, emergency plans, and environmental monitoring.

H. Circulating Water System — Descriptions of intake, discharge, cooling towers, water body data, and flow quantities.

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

All parameters are related to rated power output for a single reactor unit unless otherwise noted. For instance, where the reactor report covers two or three reactors of the same rating at one site, all data values given will be for one unit. The aerial perspective sketch presents a graphic description of the reactor and site features. The terms and features used in the sketch are explained in Fig. 1. In most cases, the size of the reactor F 1
building and turbine building on the sketch has been increased over true size to better show their relationship to the site.

ACCURACY OF DATA

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

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

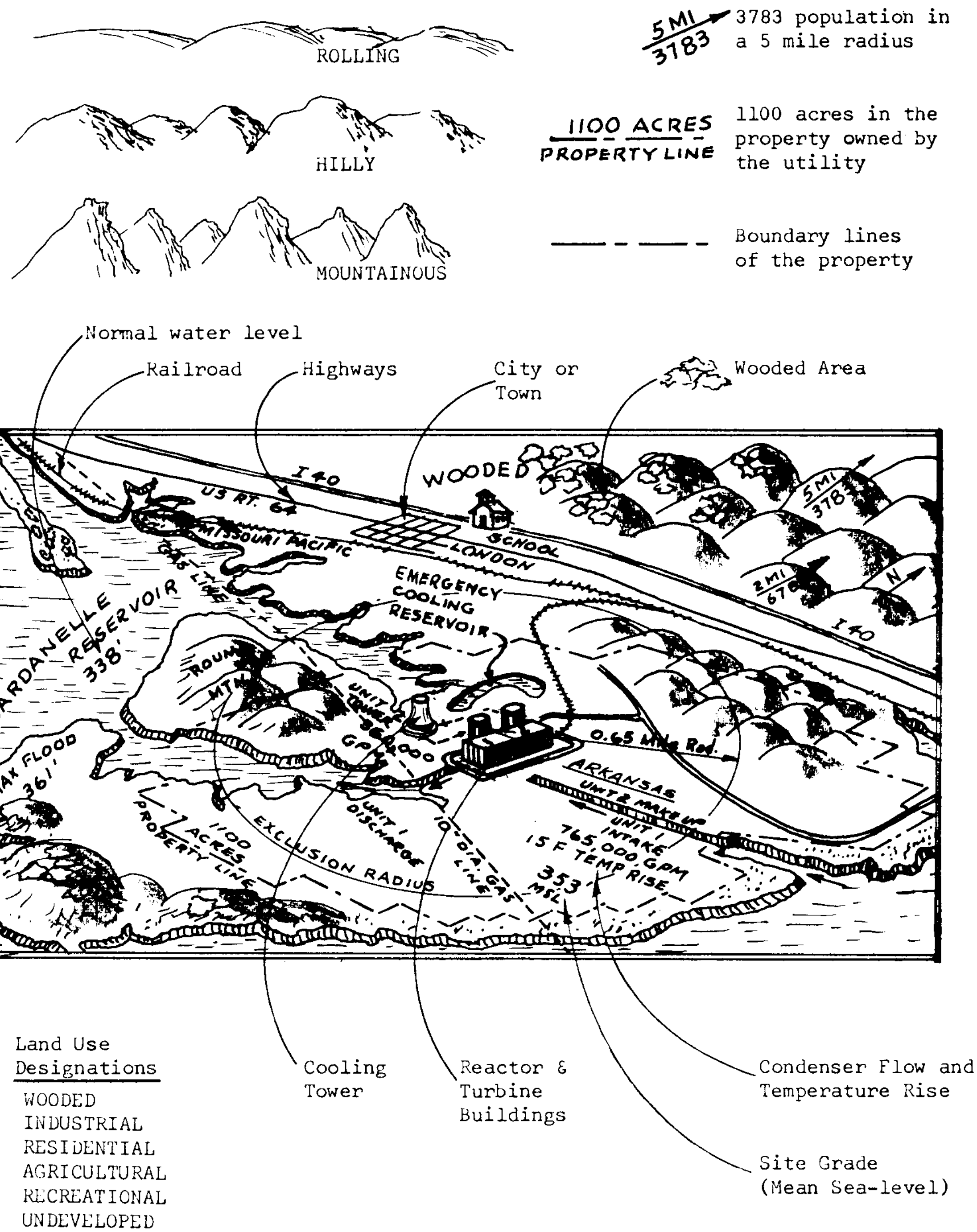

Fig. 1. Explanation of terms for site sketch.

GLOSSARY OF TERMS

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

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

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

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

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

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

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

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

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

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

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

BWR — Boiling water reactor.

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

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

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

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

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

Cold — At ambient temperature.

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

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

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

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

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

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

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

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

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

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

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

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

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

Curtain Worth — The reactivity worth of the poison curtain.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Fuel Element — See Fuel Assembly.

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

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

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

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

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

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

Hot — At temperatures corresponding to full-power operation.

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

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

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

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

LOCA — Loss-of-coolant accident.

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

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

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

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

MCHFR — See Minimum Critical Heat Flux Ratio.

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

MWD — Energy in megawatt-days.

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

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

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

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

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

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

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

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

NSS Vendor — Supplier of the nuclear steam supply system.

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

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

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

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

PWR — Pressurized-water reactor.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Site — Land area location for a power station.

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

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

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

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

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

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

Vessel Vendor — Supplier of the reactor vessel.

DOCKETS 50-452 THROUGH 50-503

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GREENWOOD, 50-452, 50-453

Project Name: Greenwood Energy Center Units 2&3
Location: St. Clair Co., Michigan 55 mi NNE of Detroit
Owner: Detroit Edison Company
A-E: Bechtel
Vessel Vendor: ---
NSS Vendor: Babcock & Wilcox
Containment Constructor: Bechtel

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3413	H_2O/U, Cold	2.92
Electrical Output, MWe	1160	Avg 1st-Cycle Burnup, MWD/MTU	16,790
Total Heat Output, Safety Design, MWt	3760	First Core Avg Burnup, MWD/MTU	---
Total Heat Output, Btu/hr	$11{,}648\times10^6$	Maximum Burnup, MWD/MTU	55,000
System Pressure, psia	2250	Region-1 Enrichment, %	---
DNBR, Nominal	1.73	Region-2 Enrichment, %	Average 2.79
Total Flowrate, lb/hr	139×10^6	Region-3 Enrichment, %	---
Eff Flowrate for Heat Trans, lb/hr	132×10^6	k_{eff}, Cold, No Power, Clean	1.243
Eff Flow Area for Heat Trans, ft^2	56.64	k_{eff}, Hot, Full Power, Xe and Sm	1.121
Avg Vel Along Fuel Rods, ft/sec	15.1	Total Rod Worth, %	9.3
Avg Mass Velocity, $lb/hr\text{-}ft^2$	---	Shutdown Boron, No Rods-Clean-Cold, ppm	1106
Nominal Core Inlet Temp, °F	572.5	Shutdown Boron, No Rods-Clean-Hot, ppm	894
Avg Rise in Core, °F	58.6	Boron Worth, Hot, % Δk/k/ppm	1/105
Nom Hot Channel Outlet Temp, °F	652.7	Boron Worth, Cold, % Δk/k/ppm	1/80
Avg Film Coeff, Btu/hr ft^2-°F	7700	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.9$ to $-3)\times10^{-4}$
Avg Film Temp Diff, °F	26	Moderator Pressure Coeff, Δk/k/psi	-5.0×10^{-7} to $+3.0\times10^{-6}$
Active Heat Trans Surf Area, ft^2	57,602	Moderator Void Coeff, Δk/k/% Void	$(-0.75$ to $-1.7)\times10^{-2}$
Avg Heat Flux, Btu/hr ft^2	197,000	Doppler Coefficient, Δk/k/°F	$(-1.25$ to $-1.45)\times10^{-5}$
Max Heat Flux, Btu/hr ft^2	534,000	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	6.49	Burnable Poisons, Type and Form	Al_2O_3— B_4C
Max Thermal Output, kw/ft	17.6	Number of Control Rods 68 × 16	1088
Max Clad Surface Temp, °F	657	Number of Part-Length Rods (PLR) 8×16	128
No. Coolant Loops	2	Compiled by: Fred Heddleson, Jan. 1974 Nuclear Safety Information Center	

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: GREENWOOD
Exclusion Distance, Miles		0.88 radius	Design Winds in mph:
Low Population Zone Distance, Miles		0.88 radius	At 0 — 50 ft elev 100
Metropolis	Distance	Population	50 — 150 ft 123
Detroit, Mi.	55 mi	4,200,000	
50% Safe Shutdown Earthquake Acceleration, g		0.06	150 — 400 ft 140
Safe Shutdown Earthquake Acceleration, g		0.12	Tornado 300 mph tang.
Earthquake Vertical Shock, % of Horizontal		67	ΔP = ––– psi/–––sec
Is Intent of 70 Design Criteria Satisfied?	Section 3.1 Conformance to AEC General Design 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	50

Type of Construction:

Prestressed reinforced concrete right vertical cylinder with side walls 3'6" thick, a hemispherical dome 2'6" thick, 130' ID set on a reinforced concrete foundation slab 9' thick. Free volume is 2.63×10^6 ft^3. Interior of concrete structure has a steel lining for leak tightness.

Design Basis: Designed to provide sufficient shielding to protect the general public from radiation exposure, and to protect plant personnel during plant operation. The design also incorporates engineered safety features that help the structure withstand the temperature and pressure of the Design Basis Accident so that integrity of containment is not lost, and radioactivity is held sufficiently within the structure. Safe shutdown during an earthquake is also assured.

Vacuum Relief Capability: The low volume purge and filtration system will vent to atmosphere during heatup.

Post-Construction Testing: Integrated leak rate test will be run at calculated peak accident pressure (50 psig) before fuel loading. Tests will be run again about every 3 years. After construction, containment will be tested at 115% of design pressure.

Penetrations: Single-barrier penetrations are used for all piping passing through the walls of containment.

Weld Channels: Found no reference.

D2. CONTAINMENT SAFETY FEATURES	Reactor: GREENWOOD
Containment Spray System: There are 2 independent 100% capacity spray systems each having one pump (1500 gpm that takes suction from the borated water storage tank) and one spray header system. In case of LOCA, the spray system cools the atmosphere and reduces the pressure. A spray system operates in conjunction with the containment cooling system. When borated water storage tank is emptied, water is recirculated from the containment sump.	
Containment Cooling: The second of 2 independent cooling systems, this system consists of 4 air cooling units (fan-coil), the operation of 2 of which has capacity to cool the atmosphere after LOCA. Each fan-coil unit has 84×10^6 Btu/hr capacity under emergency conditions.	
Containment Isolation System: Isolation is initiated upon 4 psig rise in pressure. Valves on penetrations on each side of the containment wall close automatically to prevent leakage of contaminants through open pipes.	
Containment Air Filtration: The low volume purge and filtration systems serves as the cleanup system. There are redundant charcoal filter trains and other filters for cleanup before venting to atmosphere.	
Penetration Room: Drawings show electrical penetration rooms and piping penetration rooms.	
D3. SAFETY INJECTION SYSTEMS	
Accumulator Tanks: Two core flooding tanks each holding 10,875 gal of borated water discharge their contents into the two piping loops, thus flooding the core. Action is automatic with check valves opening when the system pressure drops to about 600 psig.	
High-head Safety Injection: Three high-head pumps, each rated 700 gpm at 1125 psig are provided for the makeup and purification system. Two of these pumps can be used for emergency to inject borated water into the coolant system to makeup for small leaks.	
Low-head Safety Injection: Two low-head pumps, each rated 5000 gpm at 350 psig inject water from the borated water storage tank into the reactor to cover the core to prevent fuel melting. When the borated water storage tank becomes empty, suction of the pumps is switched to the containment sump and the water is recirculated.	

E. OTHER SAFETY-RELATED FEATURES	Reactor: GREENWOOD
Reactor Vessel Failure: No reference found.	
Containment Floodability: No reference found.	
Reactor-Coolant Leak-Detection System: Leakage can be detected by atmospheric monitors, observation of makeup rates to the pressurizer, and by the main sump level and pump operation. Numerous small sumps located in the vicinity of potential leakage can assist in identification of leakage points. These small sumps drain to the main sump. Maximum allowable leakage is 10 gpm (identified) and 1 gpm (unidentified).	
Failed-Fuel-Detection System: Main steam lines have radiation monitors that will detect failed fuel, or they can also detect leakage of steam generator tubes.	
Emergency Power: Four diesel-generator units are provided — 2 for each reactor. Each diesel-generator has 2 load groups to which power is supplied. One of these load groups is redundant equipment. Units are rated 4400 KW continuous and are isolated from each other and independent. Units are started by compressed air. Each unit has a day tank (4 hrs operation) and a storage tank with 7 days supply of fuel.	
Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: In core instruments measure neutron flux for flux mapping during operation. Part length rods are adjusted to maintain an axially balanced power distribution.	
Boron Dilution Control: With the highest rate of dilution, automatic controls will insert rods to maintain power level and reactor coolant temperature. Rod insertion beyond the allowable band will close the feed block valve to terminate addition of water. On manual control with no control rod insertion, reactivity additions cause a high temperature or high pressure trip. Control rod insertion will cause feed block valve to close, terminating addition of borated water.	
Long-Term Cooling: Accomplished by the decay heat removal system which is used during shutdown to reduce and maintain temperature of the system. Pumps circulate the coolant through 2 decay heat coolers which are cooled by the nuclear service water system. A 31-acre emergency cooling reservoir can provide additional water for emergency cooling. Reservoir capacity is 86-million gallons.	
Organic-Iodide Filter: No reference found.	
Hydrogen Recombiner: None mentioned. Hydrogen production is handled by diluting containment air with outside air or by bleed-off containment air to the outside through charcoal and particulate filters.	

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F. GENERAL	Reactor: GREENWOOD
Windspeed, Direction Recorders, and Seismographs: Collection of meteorological data was started in Sept. 1972 using measurements at 35' and 200' levels. Three strong motion accelerographs will be installed. A peak accelerograph will be installed to record peak values and a multielement seismoscope will be installed also.	
Plant Operation Mode: Designed for load following.	
Site Description: The site is a 2 by 3 mile rectangular area well served by country roads and the C&O Railroad. Since the site is about 11 miles from Lake Huron, condenser cooling will require construction of a long spray canal. Also, a 200-acre lake impoundment will be built for emergency cooling. The area close in around the site is sparsely populated and agriculture is the principal activity.	
Turbine Orientation: Ejected turbine blades could strike containment. Center lines are about 190 ft apart.	
Emergency Plans: Plans are being made to cover emergencies ranging from simple local emergencies to very complex emergencies. Plans will be very similar to those developed for the Fermi site. Procedures will be prepared for 5 conditions: (1) Evacuation, (2) fire fighting, (3) rescue, (4) contaminated injury, and (5) civil disorder and bomb threats. Outside agencies will be contacted as required.	
Environmental Monitoring Plans: An offsite radiological monitoring program will be initiated in the environs of Greenwood prior to operation. The purpose will be to document background levels of radioactivity to serve as a basis for an environmental impact assessment of the operation of the plant. Samples will be taken of ground water, soil, milk, vegetation, food crops, wild life, air, fish, sediment, and surface water.	
Radwaste Treatment: Liquid wastes are treated by filtration, degasification, ion exchange, and evaporation. After treatment and monitoring, liquid effluents are either recycled through a subsystem, reused in the plant, or discharged to the environment. Hydrogen in gases is combined to form water. Gases with xenon and krypton are compressed and stored in tanks for later release to the atmosphere. Other gases are monitored, passed through charcoal filters and released to the atmosphere. Solid wastes such as evaporator bottoms and demineralizer bottoms are packed in shipping containers with solidification agents and catalyst. Other solids are packed into shipping containers for shipment offsite for disposal.	
Plant Vent: Vent is on roof of containment at top of dome.	

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G. SITE DATA Reactor: GREENWOOD

Nearby Body of Water: Lake Huron is 10 mi N. Two small streams are 3 mi away.
Normal Level --- (MSL)
Max Prob Flood Level --- (MSL)

Size of Site 3620 Acres Site Grade Elevation 758' (MSL)

Topography of Site: Flat to slightly rolling.

of Surrounding Area (5 mi rad): Flat to rolling.

Total Permanent Population: In 2 mi radius 270 ; 10 mi 15,775

Date of Data: 1970 In 5 mi radius 2532 ; 50 mi 2,055,019

Nearest City of 50,000 Population: Sarnia, Ontario, Canada.

Dist. from site 18 Miles, Direction SE, Population 56,898

Land Use in 5 Mile Radius: Agricultural.

Meteorology: Prevailing wind direction SW Avg. speed 10 mph

Stability Data - Low level inversions (below 500 ft) occur 30% of time.

Miscellaneous Items Close to the Site: An oil-fired power plant (800 MWe) is being built on the N end of the property (Unit 1). Nearest towns: Fargo (147) and Avaco (236), each being 2 mi away. Black River is 4 mi E of the plant. U.S. Hwy 25 is 10 mi E and I-94 terminates in Port Huron ∿15 mi ESE. Nearest school is in Avoca. Nearest hospital is in Yale, 6 mi WNW. Closest dairy farm is 1 mi W with 50 cows.

H. CIRCULATING WATER SYSTEM

Type of System: Spray canal cooling 12,400 ft long, 280 ft wide.

Water Taken From: Makeup from Lake Huron through a 15 mi long pipe line.

Intake Structure: Spray modules are located in the spray canal on 40-ft centers. Depth of canal is 12 ft.

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

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

Service Water Quantity ∿50,000 gpm/reactor

Flow Thru Condenser 520,000 (gpm)/reactor Temp. Rise 30 °F

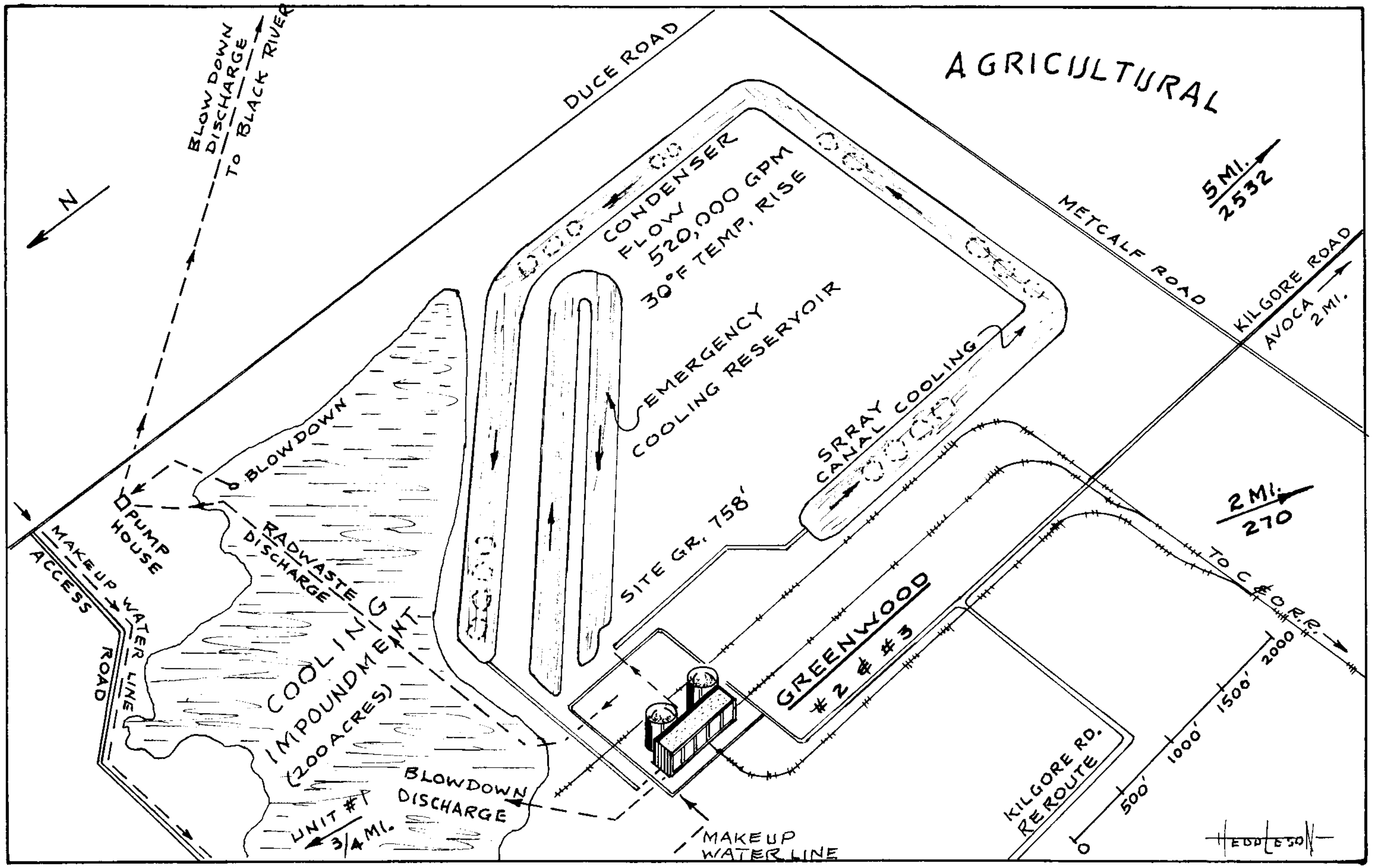
Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 7600×10^6 (Btu/hr)/reactor

Discharge Structure: Blowdown discharge is directed into the onsite cooling impoundment for cooling before discharge to the Black River.

Cooling Tower(s): Description & Number - None

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


AGRICULTURAL
DUCE ROAD
METCALF ROAD
KILGORE ROAD
AVOCA 2 MI.
BLOWDOWN DISCHARGE TO BLACK RIVER
N
CONDENSER FLOW 520,000 GPM 30°F TEMP. RISE
EMERGENCY COOLING RESERVOIR
SPRAY CANAL COOLING
5 MI. 2532
2 MI. 270
TO C & O R.R.
SITE GR. 758'
GREENWOOD #2 & #3
BLOWDOWN
PUMP HOUSE
RADWASTE DISCHARGE
COOLING IMPOUNDMENT (200 ACRES)
MAKEUP WATER LINE
ACCESS ROAD
BLOWDOWN DISCHARGE
UNIT #1 3/4 MI.
MAKEUP WATER LINE
KILGORE RD. REROUTE
0
500'
1000'
1500'
2000'

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BYRON, 50-454, 50-455

Project Name: Byron Station

Location: Ogle Co., near Byron (Northern Ill.)

Owner: Commonwealth Edison

A-E: Sargent & Lundy
Vessel Vendor: ---
NSS Vendor: Westinghouse
Containment Constructor: Sargent & Lundy

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3425	H_2O/U, Cold	4.0
Electrical Output, MWe (net)	1120	Avg 1st-Cycle Burnup, MWD/MTU	14,000
Total Heat Output, Safety Design, MWt	3565	First Core Avg Burnup, MWD/MTU	25,500 to 33,000
Total Heat Output, Btu/hr	$11,642\times10^6$	Maximum Burnup, MWD/MTU	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	2.25
DNBR, Nominal	2.03	Region-2 Enrichment, %	2.80
Total Flowrate, lb/hr	142.2×10^6	Region-3 Enrichment, %	3.30
Eff Flowrate for Heat Trans, lb/hr	135.8×10^6	k_{eff}, Cold, No Power, Clean	1.225 to 1.60
Eff Flow Area for Heat Trans, ft^2	51.4	k_{eff}, Hot, Full Power, Xe and Sm	< 1.25
Avg Vel Along Fuel Rods, ft/sec	16.9	Total Rod Worth, %	∿ 9.74
Avg Mass Velocity, $lb/hr\text{-}ft^2$	2.65×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	< 1500
Nominal Core Inlet Temp, °F	557.3	Shutdown Boron, No Rods-Clean-Hot, ppm	< 1200
Avg Rise in Core, °F	62.3	Boron Worth, Hot, % Δk/k/ppm	1%/120 ppm
Nom Hot Channel Outlet Temp, °F	∿650	Boron Worth, Cold, % Δk/k/ppm	1%/60 ppm
Avg Film Coeff, Btu/hr ft^2-°F	6000	Full Power Moderator Temp Coeff, Δk/k/°F	-4.0×10^{-4}
Avg Film Temp Diff, °F	∿36.2	Moderator Pressure Coeff, Δk/k/psi	$(-0.04$ to $+3.0)\times10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff, Δk/k/% Void	Negative
Avg Heat Flux, Btu/hr ft^2	217,200	Doppler Coefficient, Δk/k/°F	Negative at all power levels
Max Heat Flux, Btu/hr ft^2	521,300	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	7.05	Burnable Poisons, Type and Form	Borosilicate in sst tubes
Max Thermal Output, kw/ft	16.9	Number of Control Rods 53	1060
Max Clad Surface Temp, °F	∿660	Number of Part-Length Rods (PLR) 8	160
No. Coolant Loops	4	Compiled by: Fred Heddleson 2/74 Nuclear Safety Information Center	

W

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: BYRON
Exclusion Distance, Miles	Property boundary from 0.28 to 1.17 mi.		Design Winds in mph:
Low Population Zone Distance, Miles	3 mi radius		At 0 — 50 ft elev 85
Metropolis	Distance	Population	
Rockford, Ill.	17 miles	272,063	50 — 150 ft 100
Safe Shutdown Earthquake Acceleration, g	.12		150 — 400 ft 115
Operating Basis Earthquake Acceleration, g	.06		Tornado 300 mph tang + 60 trans
Earthquake Vertical Shock, % of Horizontal	66		ΔP = 3 psi/ 3sec
Is Intent of 70 Design Criteria Satisfied?	Yes, see Section 3.1.		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	50
Max Leak Rate at Design Pressure, %/day	0.1	Calculated Max Internal Pressure, psig	

Type of Construction:

Reinforced concrete cylindrical walls (post tensioned) 3 1/2-ft thick with shallow dome on a reinforced concrete base foundation slab. A steel liner, 1/4-in. thick, forms a virtually leak-tight containment. Free volume is 2.9×10^6. This is a 3-buttresses system.

Design Basis:

Designed to withstand LOCA with loss of fission products to the atmosphere well within AEC limits. Designed also to withstand all natural loads (snow, wind, seismic) without loss of integrity; with either of above in combination.

Vacuum Relief Capability: When pressure drops 0.1 psig below atmospheric, relief valve opens to let air in to relieve the vacuum condition.

Post-Construction Testing:

Leak-rate tests will be run at 50 psig and 25 psig. Structural acceptance test will be run at 115% of design pressure.

Penetrations:

Has double sealed penetrations, each one individually testable.

Weld Channels: None mentioned; however, a thorough inspection of welds will be made using radiography, magnetic particle liquid penetrant, and vacuum soap box.

D2. CONTAINMENT SAFETY FEATURES	Reactor: BYRON

Containment Spray System:

Two 100% capacity systems will be used, drawing water from the refueling water storage tank spraying it into containment through nozzles high above the operating deck. Rate of flow total will be 2460 gpm of borated water with NaOH to remove iodine.

Containment Cooling:

Four fan-coil coolers operate during normal operation or after LOCA. For normal operation, 2 units run and dissipate 13.5×10^6 Btu/hr. In emergency conditions, 2 units will remove 264×10^6 Btu/hr of heat.

Containment Isolation System:

Two valves on each line that penetrate containment automatically close under accident conditions to isolate the containment atmosphere from the outside environment.

Containment Air Filtration:

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

Penetration Room:

Has penetration areas.

D3. SAFETY INJECTION SYSTEMS

Accumulator Tanks:

Four tanks each holding 6350 gal of borated water under nitrogen gas pressure inject their contents into the reactor vessel when system pressure drops to 585 psig.

High-head Safety Injection:

Four pumps will inject a total of 1200 gpm into the reactor vessel through four lines to flood the core in case of a small break where the high head pumps can maintain the pressure and water level.

Low-head Safety Injection:

There are 2 pumps injecting borated water through 4 lines into the reactor vessel. Total flow is 4500 gpm.

E. OTHER SAFETY-RELATED FEATURES	Reactor: BYRON

Reactor Vessel Failure:

After LOCA, safety injection of water will not effect the integrity of the reactor vessel.

Containment Floodability:

Found no reference.

Reactor-Coolant Leak-Detection System:

Leakage will be detected by makeup water for pressurizer, containment air monitoring which is the most sensitive detection device, containment humidity, pressure, temperature and containment sump water level. Maximum unidentifiable leakage limit is 1 gpm max. Identifiable leakage limit is 10 gpm.

Failed-Fuel-Detection System:

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

Emergency Power:

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

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

Boron Dilution Control:

Long-Term Cooling:

The Essential Service Water System can be used for emergency cooling for long terms. Normally, long-term cooling can be accomplished by recirculation of borated water from the containment sump through heat exchanger coolers.

Organic-Iodide Filter: No reference found.

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

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F. GENERAL	Reactor: BYRON

Windspeed, Direction Recorders, and Seismographs:
Data has not yet been collected for meteorology at the site. A central recording accelerograph will be installed in the control area. Three triaxial sensors will be installed within the containment structure.

Plant Operation Mode:

Designed for load following if required in operation.

Site Description:
The site is roughly rectangular in shape located in North Central Ill. about 1 1/2 miles from the Rock River which is used primarily for recreation. The area is rolling with agriculture predominating. About half of the site is presently used for farming, about 10% of the site being wooded. Elevations vary from 730-ft in the NW corner of the site to 906-ft in the SE portion.

Turbine Orientation: Ejected blades could strike containment.

Emergency Plans:

Emergency and evacuation plans will be developed to implement plans submitted to AEC in May 1972. Plans will assure continued coordination with local, state, and federal agencies. Periodic reviews and practice sessions will be held to maintain familiarity with the plans. A small dispensary will be used at the site for decontamination of personnel. Local hospitals will be used in the plans.

Environmental Monitoring Plans:

Preoperational programs aim to determine present state of surface water, ground water, air quality, meteorological factors, condition of soils, terrestrial diota, aquatic organisms, and radiological factors. After fuel loading, the monitoring program will be similar to the preoperational program except more efforts will be placed on radiological monitoring. Ecological monitoring will be governed somewhat by results of preoperational monitoring.

Radwaste Treatment:

Shared disposal system provides equipment to collect, process, and prepare for disposal all liquid, gaseous, and solid wastes. After collection, liquid wastes are evaporated and may be demineralized. The treated water from demineralizers or evaporator distillate may be recycled in the plant or may be discharged at concentrations within limits of 10CFR20 through the blowdown system to Rock River. Evaporator concentrates and spent demineralizer resins are solidified, drummed, and shipped off-site with other solid wastes for disposal. Gaseous wastes are collected and held up for radioactive decay, then discharged to the atmosphere so controlled that off-site dose is as low as practical.

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

G. SITE DATA

Reactor: BYRON

Nearby Body of Water: Rock River is about 2 miles west

Normal Level 672' (MSL)
Max Prob Flood Level 725' (MSL)

Size of Site 1430 Acres   Site Grade Elevation 868' (MSL)

Topography of Site: Rolling

of Surrounding Area (5 mi rad): Rolling

Total Permanent Population: In 2 mi radius ____ ; 10 mi 19,671

Date of Data: 1970   In 5 mi radius 6059 ; 50 mi 879,712

Nearest City of 50,000 Population: Rockford, Ill.

Dist. from site 17 Miles, Direction NE, Population 147,370

Land Use in 5 Mile Radius: Rural, farming, with 2 small communities, Byron 3.7 mi NNE (pop 1749) and Oregon 5 mi SSW (pop 3539).

Meteorology: Prevailing wind direction * Avg. speed ∿10 mph

Stability Data - Inversions about 1/3 of time.   *NW in winter, S in summer

Miscellaneous Items Close to the Site: Byron is the closest town, about 3 miles NNE. County Highway #2 runs all the east boundary of the site, State Highway #2 is 1 1/2 mi W and State Highway #72 is about 2 mi N. The Chicago Milwaukee RR is about 3 mi N. The Rockford Drag Strip is about 3 mi NNE with a yearly attendance of about 72,500. The nearest school is in Byron. Quad-Cities is the nearest nuclear facility 60 mi SW.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using cooling towers.

Water Taken From: Rock River for makeup.

Intake Structure: Makeup water intake is in the Rock River, WNW of the plant about 2 1/2 mi. The intake structure is reinforced concrete with bar grill, traveling screens and 3 makeup pumps. Also there are 4 diesel-driven fire pumps in the structure.

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

River Flow 400* (cfs) minimum; 4580 (cfs) average

Service Water Quantity 84,000 gpm/reactor   *1 day lowest

Flow Thru Condenser 632,000 (gpm)/reactor   Temp. Rise 24 °F

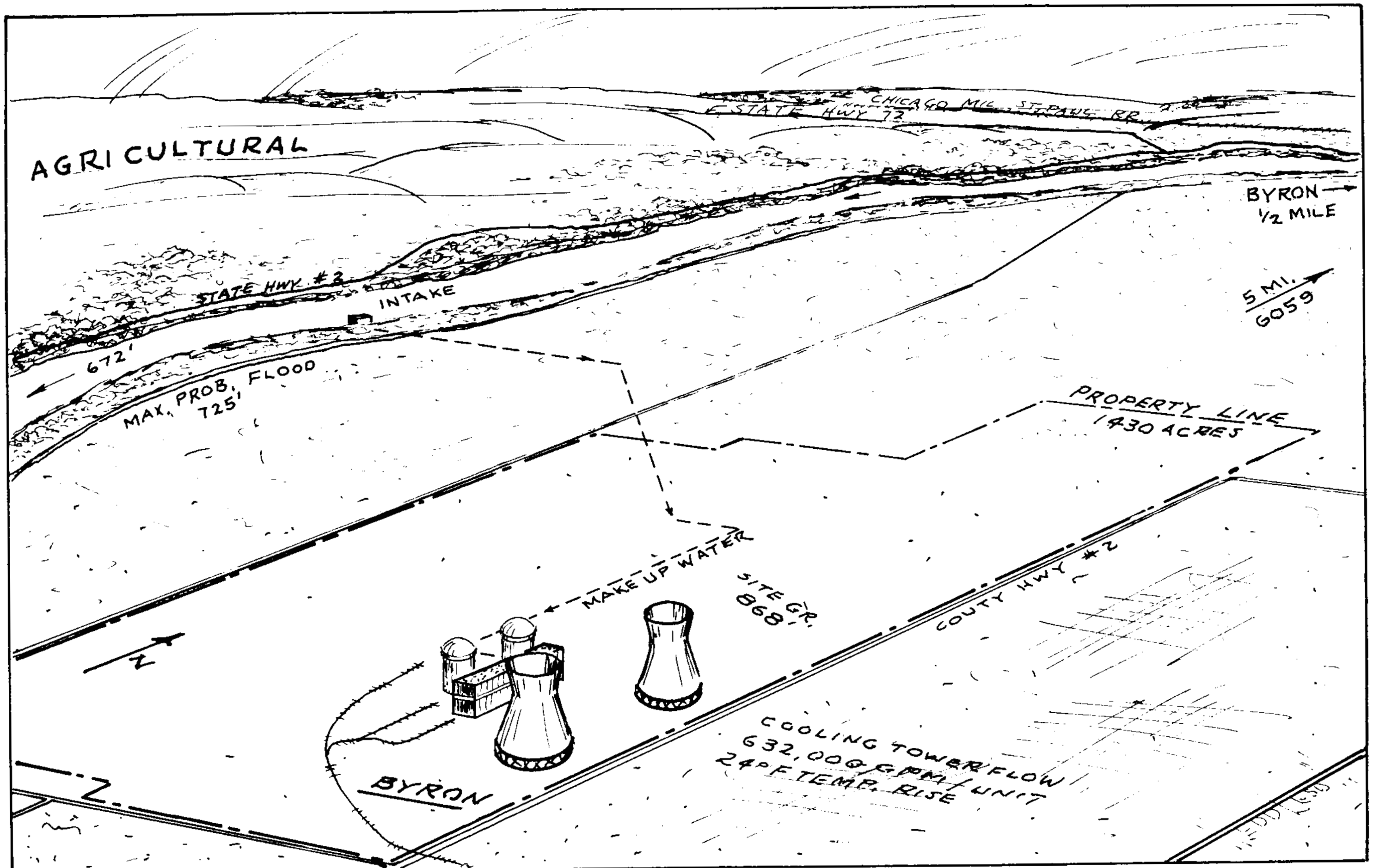
Heat Dissipated to Environment 7400×10^6 (Btu/hr)/reactor

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

Discharge Structure: Blowdown is discharged into the Rock River. The design of the discharge structure is not yet completed.

Cooling Tower(s): Description & Number - 2 natural draft towers 450-ft high × 520-ft diam at base.

Blowdown 13,050 gpm/reactor   Evaporative loss 9000 gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

BRAIDWOOD, 50-456, 50-457

Project Name: Braidwood Station

Location: Will Co., Ill.
50 Miles SW of Chicago

Owner: Commonwealth Edison

A-E: Sargent & Lundy
Vessel Vendor: ---
NSS Vendor: Westinghouse
Containment
Constructor: Sargent & Lundy

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	3425	H_2O/U, Cold	4.0
Electrical Output, MWe (net)	1120	Avg 1st-Cycle Burnup, MWD/MTU	14,000
Total Heat Output, Safety Design, MWt	3565	First Core Avg Burnup, MWD/MTU	25,500 to 33,000
Total Heat Output, Btu/hr	$11{,}642\times10^6$	Maximum Burnup, MWD/MTU	50,000
System Pressure, psia	2250	Region-1 Enrichment, %	2.25
DNBR, Nominal	2.03	Region-2 Enrichment, %	2.80
Total Flowrate, lb/hr	142.2×10^6	Region-3 Enrichment, %	3.30
Eff Flowrate for Heat Trans, lb/hr	135.8×10^6	k_{eff}, Cold, No Power, Clean	1.225 to 1.60
Eff Flow Area for Heat Trans, ft^2	51.4	k_{eff}, Hot, Full Power, Xe and Sm	< 1.25
Avg Vel Along Fuel Rods, ft/sec	16.9	Total Rod Worth, %	∿ 9.74
Avg Mass Velocity, lb/hr-ft^2	2.65×10^6	Shutdown Boron, No Rods-Clean-Cold, ppm	< 1500
Nominal Core Inlet Temp, °F	557.3	Shutdown Boron, No Rods-Clean-Hot, ppm	< 1200
Avg Rise in Core, °F	62.3	Boron Worth, Hot, % Δk/k/ppm	1%/120 ppm
Nom Hot Channel Outlet Temp, °F	∿650	Boron Worth, Cold, % Δk/k/ppm	1%/60 ppm
Avg Film Coeff, Btu/hr ft^2-°F	6000	Full Power Moderator Temp Coeff, Δk/k/°F	-4.0×10^{-4}
Avg Film Temp Diff, °F	∿36.2	Moderator Pressure Coeff, Δk/k/psi	$(-0.04$ to $+3.0)\times10^{-6}$
Active Heat Trans Surf Area, ft^2	52,200	Moderator Void Coeff, Δk/k/% Void	Negative
Avg Heat Flux, Btu/hr ft^2	217,200	Doppler Coefficient, Δk/k/°F	Negative at all power levels
Max Heat Flux, Btu/hr ft^2	521,300	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Thermal Output, kw/ft	7.05	Burnable Poisons, Type and Form	Borosilicate in sst tubes
Max Thermal Output, kw/ft	16.9	Number of Control Rods 53	1060
Max Clad Surface Temp, °F	∿660	Number of Part-Length Rods (PLR) 8	160
No. Coolant Loops	4	Compiled by: Fred Heddleson 2/74 Nuclear Safety Information Center	

W

Page 2, PWR

C. SAFETY-RELATED DESIGN CRITERIA			Reactor: BRAIDWOOD
Exclusion Distance, Miles	0.3		Design Winds in mph:
Low Population Zone Distance, Miles	1.125 radius		At 0 — 50 ft elev 85
Metropolis	Distance	Population	50 — 150 ft 100
Chicago, Ill.	45 mi.	6,978,947	150 — 400 ft 115
Safe Shutdown Earthquake Acceleration, g	0.12		Tornado 300 mph tang + 60 trans
Operating Basis Earthquake Acceleration, g	0.06		ΔP = 3 psi/ 3sec
Earthquake Vertical Shock, % of Horizontal	66		
Is Intent of 70 Design Criteria Satisfied?	Yes, see Section 3.1		

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT		Design Pressure, psig	50
Max Leak Rate at Design Pressure, %/day	0.1	Calculated Max Internal Pressure, psig	

Type of Construction:

Reinforced concrete cylindrical walls (post tensioned) 3 1/2-ft thick with shallow dome on a reinforced concrete base foundation slab. A steel liner, 1/4-in. thick, forms a virtually leak-tight containment. Free volume is 2.9×10^6. This is a 3-buttresses system.

Design Basis:

Designed to withstand LOCA with loss of fission products to the atmosphere well within AEC limits. Designed also to withstand all natural loads (snow, wind, seismic) without loss of integrity; with either of above in combination.

Vacuum Relief Capability: When pressure drops 0.1 psig below atmospheric, relief valve opens to let air in to relieve the vacuum condition.

Post-Construction Testing:

Leak-rate tests will be run at 50 psig and 25 psig. Structural acceptance test will be run at 115% of design pressure.

Penetrations:

Has double sealed penetrations, each one individually testable.

Weld Channels: None mentioned; however, a thorough inspection of welds will be made using radiography, magnetic particle liquid penetrant, and vacuum soap box.

D2. CONTAINMENT SAFETY FEATURES	Reactor: BRAIDWOOD
Containment Spray System: Two 100% capacity systems will be used, drawing water from the refueling water storage tank spraying it into containment through nozzles high above the operating deck. Rate of flow total will be 2460 gpm of borated water with NaOH to remove iodine.	
Containment Cooling: Four fan-coil coolers operate during normal operation or after LOCA. For normal operation, 2 units run and dissipate 13.5×10^6 Btu/hr. In emergency conditions, 2 units will remove 264×10^6 Btu/hr of heat.	
Containment Isolation System: Two valves on each line that penetrate containment automatically close under accident conditions to isolate the containment atmosphere from the outside environment.	
Containment Air Filtration: A recirculation system uses pre-filters, HEPA filters, and charcoal filters to clean up the air. Purge air enters through a similar filter system.	
Penetration Room: Has penetration areas.	
D3. SAFETY INJECTION SYSTEMS	
Accumulator Tanks: Four tanks each holding 6350 gal of borated water under nitrogen gas pressure inject their contents into the reactor vessel when system pressure drops to 585 psig.	
High-head Safety Injection: Four pumps will inject a total of 1200 gpm into the reactor vessel through four lines to flood the core in case of a small break where the high head pumps can maintain the pressure and water level.	
Low-head Safety Injection: There are 2 pumps injecting borated water through 4 lines into the reactor vessel. Total flow is 4500 gpm.	

E. OTHER SAFETY-RELATED FEATURES	Reactor: BRAIDWOOD
Reactor Vessel Failure: After LOCA, safety injection of water will not effect the integrity of the reactor vessel.	
Containment Floodability: Found no reference.	
Reactor-Coolant Leak-Detection System: Leakage will be detected by makeup water for pressurizer, containment air monitoring which is the most sensitive detection device, containment humidity, pressure, temperature and containment sump water level. Maximum unidentifiable leakage limit is 1 gpm max. Identifiable leakage limit is 10 gpm.	
Failed-Fuel-Detection System: Similar to Zion plant where reactor coolant water is analyzed periodically for radioactivity. Instruments for prompt detection of delayed neutrons in the coolant are being tested at the Ginna plant.	
Emergency Power: Two diesel generators are provided for each unit, each rated 4000 KW for continuous service, ready to accept load in 10 seconds. Units have independent compressed air starting. Each unit has a day tank (90 min capacity at full load), 2 transfer pumps, and a storage tank with 7 days supply for full load continuous operation.	
Control of Axial Xenon Oscillations By Burnable Shims, Part-Length Control Rods, In-Core Instrumentation: ---	
Boron Dilution Control: ---	
Long-Term Cooling: Normally borated water would be recirculated as long as required, taking suction from the containment sump. If more water were required, it could be taken from the tremendous capacity of the cooling lake, or makeup from the Kankakee River could be used.	
Organic-Iodide Filter: No reference found.	
Hydrogen Recombiner: Two 50 cfm thermal recombiners are available to heat incoming air stream to 1200°F and recombine hydrogen.	

F. GENERAL	Reactor: BRAIDWOOD

Windspeed, Direction Recorders, and Seismographs:
Data has not yet been collected for meteorology at the site. A central recording accelerograph will be installed in the control area. Three triaxial sensors will be installed within the containment structure.

Plant Operation Mode:
Designed for load following if required in operation.

Site Description:

Located on the Kankakee plain where farm lands have been replaced by strip coal mining. The site has been mined already. The former strip mine area will be used for a cooling lake with about 2640 surface acres.

Turbine Orientation: Ejected blades could strike containment.

Emergency Plans:
Emergency and evacuation plans will be developed to implement plans submitted to AEC in May 1972. Plans will assure continued coordination with local, state, and federal agencies. Periodic reviews and practice sessions will be held to maintain familiarity with the plans. A small dispensary will be used at the site for decontamination of personnel. Local hospitals will be used in the plans.

Environmental Monitoring Plans:
Preoperational programs aim to determine present state of surface water, ground water, air quality, meteorological factors, condition of soils, terrestrial diota, aquatic organisms, and radiological factors. After fuel loading, the monitoring program will be similar to the preoperational program except more efforts will be placed on radiological monitoring. Ecological monitoring will be governed somewhat by results of preoperational monitoring.

Radwaste Treatment:
Shared disposal system provides equipment to collect,process, and prepare for disposal all liquid, gaseous, and solid wastes. After collection, liquid wastes are evaporated and may be demineralized. The treated water from demineralizers or evaporator distillate may be recycled in the plant or may be discharged at concentrations within limits of 10CFR20 through the blowdown system to Rock River. Evaporator concentrates and spent demineralizer resins are solidified, drummed, and shipped off-site with other solid wastes for disposal. Gaseous wastes are collected and held up for radioactive decay, then discharged to the atmosphere so controlled that off-site dose is as low as practical.

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

G. SITE DATA

Reactor: BRAIDWOOD

Nearby Body of Water: Kankakee River - 3 mi E, cooling lake on the site

Cool. Lake — Normal Level 595' (MSL)
Max Prob Flood Level 555' (MSL)

Size of Site 4320 Acres   Site Grade Elevation 590' (MSL)

Topography of Site: Flat to rolling

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

Total Permanent Population: In 2 mi radius 1879 ; 10 mi 22,116

Date of Data: 1970   In 5 mi radius 8892 ; 50 mi 3,878,784

Nearest City of 50,000 Population: Joliet, Ill.

Dist. from site 20 Miles, Direction NNE , Population 80,378

Land Use in 5 Mile Radius: Agricultural

Meteorology: Prevailing wind direction SW   Avg. speed 9.7 mph

Stability Data - Diffusion is fairly good

Miscellaneous Items Close to the Site: State Highway 129 and 53 run adjacent to the site on the NW corner. The GM&O RR runs between the 2 highways. Joliet is 20 mi NNE. The community of Godley (242 pop) is near the NW corner. Joliet arsenal is about 8 mi NNE. There are 4 state parks within a 10-mi radius. Nearest hospital is 13 mi NW in Morris. Nearest school is 1 1/2 mi SW with 325 students. Dresden Nuclear Station is 12 mi NNW and LaSalle is 25 mi W.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using cooling lake.

Water Taken From: Kankakee River for make up.

Intake Structure: A reinforced concrete structure with grill bar, traveling screens and pumps. Design velocity at the intake structure will be 0.5 fps.

Water Body Temperatures: Winter minimum 32 °F   Summer maximum 87 °F

River Flow --- (cfs) minimum; 134 (cfs) average

Service Water Quantity 45,450 gpm/reactor

Flow Thru Condenser 731,200 (gpm)/reactor   Temp. Rise 20 °F

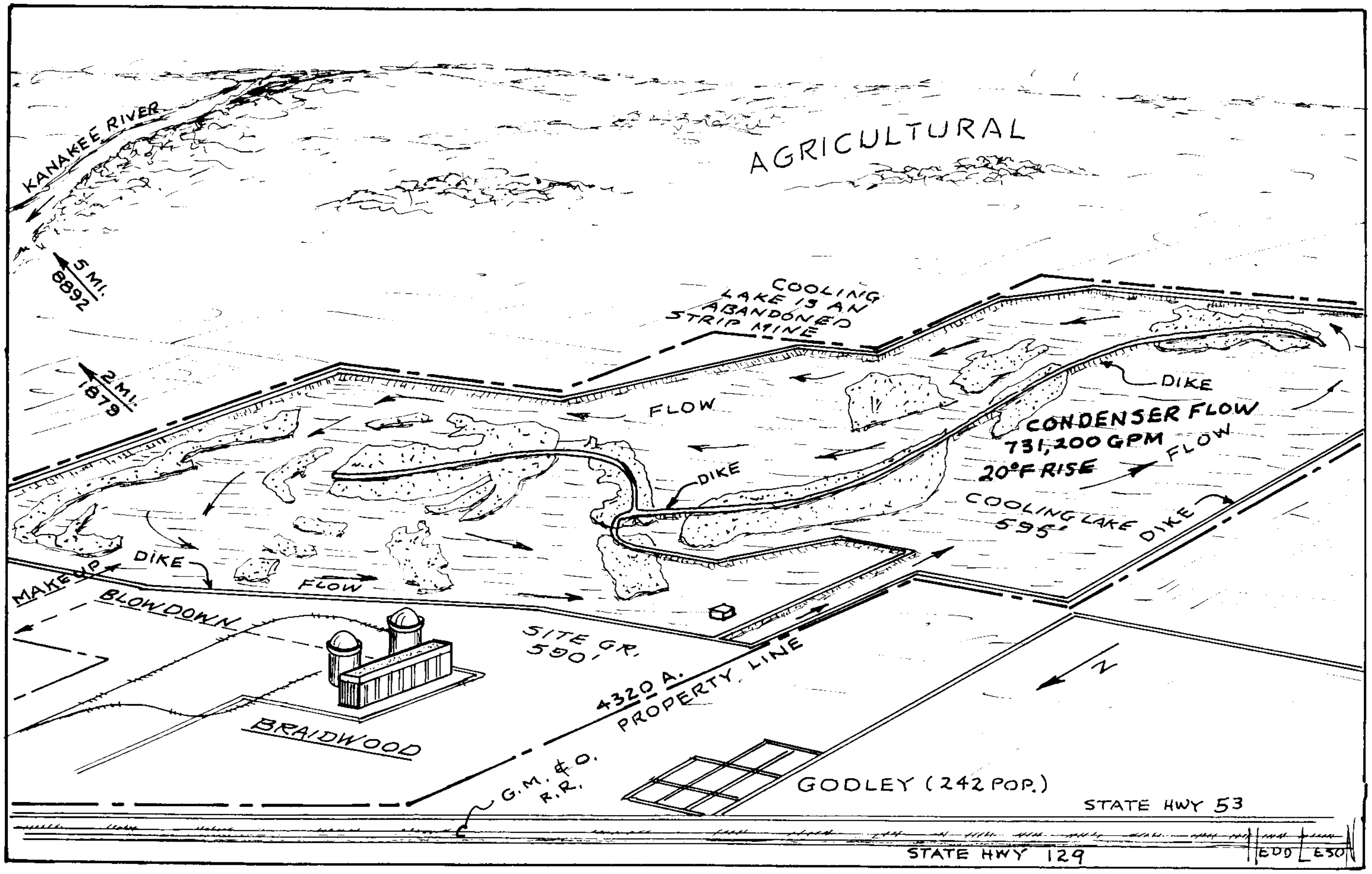
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: Blowdown from cooling lake discharged to Kankakee River through a surface discharge flume.

Cooling Tower(s): Description & Number - None

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



NUCLEAR SAFETY INFORMATION CENTER

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RIVER BEND — 50-458, 50-459

Project Name: River Bend Station, Units 1 and 2
A-E: Stone and Webster

Location: W. Feliciana Parish, La. 24 mi NNW of Baton Rouge
Vessel Vendor: Chicago Bridge & Iron
NSS Vendor: General Electric

Owner: Gulf States Utilities Co.
Containment Constructor: Stone and Webster

A. THERMAL-HYDRAULIC		B. NUCLEAR	
Thermal Output, MWt	2894	H_2O/UO_2 Volume Ratio	---
Electrical Output, MWe (net)	934	Moderator Temp Coef Cold, Δk/k/°F	$+4\times10^{-5}$
Total Heat Output, Safety Design, MWt	3039	Moderator Temp Coef Hot, No Voids	-14×10^{-5}
Steam Flow Rate, lb/hr	12.45×10^6	Moderator Void Coef Hot, No Voids, Δk/k/%	---
Total Core Flow Rate, lb/hr	84.5×10^6	Moderator Void Coef Operating	---
Coolant Pressure, psig	1040	Doppler Coefficient, Cold	-1.8×10^{-5}
Heat Transfer Area, ft^2	59,369	Doppler Coefficient, Hot, No Voids	-0.95×10^{-5}
Max Power per Fuel Rod Unit Lgth, kw/ft	13.4	Doppler Coefficient, Operating	-1.05×10^{-5}
Maximum Heat Flux, Btu/hr-ft^2	354,100	Initial Enrichment, %	1.70
Average Heat Flux, Btu/hr-ft^2	159,550	Average Discharge Exposure, MWD/Ton	12,000 to 19,000
Maximum Fuel Temperature, °F	3325	Core (max exit) Void Within Assembly, %	76
Average Fuel Rod Surface Temp, °F	560	k_{eff}, All Rods In	---
MCHFR	≥1.9	k_{eff}, Max Rod Out	---
Total Peaking Factor	2.219	Control Rod Worth	0.01 Δk
Avg Power Density, Kw/ℓ	56.0	Curtain Worth, %	---
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	Burnable Poisons, Type and Form	Gadolinia mixed into UO_2
		Number of Control Rods	145
		Number of Part-Length Rods (PLR)	None

Compiled by: Fred Heddleson, March 1974
ORNL, Nuclear Safety Information Center

C. SAFETY-RELATED DESIGN CRITERIA

Reactor: River Bend

Exclusion Distance, Miles	0.38 mi radius	
Low Population Zone Distance, Miles	2 mi radius	
Metropolis	Distance	Population
Baton Rouge, La.	24 mi.	285,167
Safe Shutdown Earthquake Acceleration, g		0.10
Operating Basis Earthquake Acceleration, g		0.05
Earthquake Vertical Shock, % of Horizontal		---

Design Winds in mph:

At 0 — 50 ft elev	100
50 — 150 ft	120
150 — 400 ft	140
Tornado	300 mph tang. + 60 trans.
ΔP =	3 psi/ 3sec
Is Intent of 55 Design Criteria Satisfied?	Yes

Recirculation Pumping System & MCHFR: The recirculation flow control system controls a variable-position flow control valve. The system automatically adjusts the reactor power output to the load demand.

Protective System: Designed to monitor reactor parameters, sense abnormalities, and to scram the reactor to prevent fuel damage when trip points are exceeded. There is no case where scram trip set points allow the core to exceed thermal hydraulic safety limits.

D. ENGINEERED SAFETY FEATURES

D1. CONTAINMENT

Drywell Design Pressure, psig	25	Primary Containment Leak Rate, %/day	0.1
Suppression Chamber Design Pressure, psig	15	Second Containment Design Pressure, psig (internal)	−10.0-in water
Calculated Max Internal Pressure, psig	23.5	Second Containment Leak Rate, %/day	1800

Type of Construction: A free-standing steel structure 1/4-in. thick forms a right circular cylinder with an ellipsoidal dome and flat bottom. Surrounding this is a reinforced concrete shield building which is a right circular cylinder with a constant radius dome. A separation provides annular space between the two structures. The containment internal structures include a reinforced concrete drywell and horizontal suppression pool. Suppression chamber free volume is 1.2×10^6 ft^3; annulus free volume is 465,000 ft^3; and drywell free volume is 251,000 ft^3.

Design Basis: Primary containment is designed to accommodate, without failure, the pressures and temperatures resulting from LOCA. The shield building provides secondary containment so that both primary and secondary will limit off-site doses from postulated accidents below AEC 10CFR100.

Vacuum Relief Capability: Found no reference.

Post-Construction Testing: Leakage rate tests will be conducted to determine leakage rate total, and from various sources per App. J of 10CFR50.

Penetrations: Single sealed with no taps for pressurizing as shown in PSAR figures.

D2. EMERGENCY CORE COOLING SYSTEMS	Reactor: River Bend

Core Spray Cooling System: Two core spray lines enter the reactor vessel and divide to form 2 half circles of pipes on the reactor wall. There is a high pressure core spray system and a low pressure system. High pressure is described below. Low pressure system consists of centrifugal pump, sparger and piping. Suction is taken from the suppression pool. There is one pump rated 5000 gpm at 120 psid. Low pressure system protects the core for large sized pipe breaks.

Auto-Depressurization System: If the high pressure core spray system cannot maintain reactor water level, the ADS vents steam through 7 pressure relief valves to lower the pressure so that flow from the low pressure core spray and low pressure coolant injection systems can flood the core in time to prevent fuel damage.

Residual-Heat-Removal System (RHRS): Combines 4 subsystems: 1) shutdown cooling and reactor vessel head spray, 2) steam condensing mode in RCIC system, 3) low pressure coolant injection, and 4) containment cooling. Equipment consists of 3 closed loops, 2 heat exchangers, and 3 main system pumps with associated valves, piping, and controls. Main system pumps (3) are sized for LPCI operation; 5050 gpm/pump at 20 psid. The 2 heat exchangers have total capacity of 129×10^6 Btu/hr. In the shut down cooling mode, the system must cool reactor to 125°F in 20 hrs. The RCIC system is described on page 4 of this report.

High-Pressure Core Spray System: This system has one pump rated 5010 gpm at 1100 psid with necessary piping, valves and controls. This system operates to provide core flooding for large or small leaks or breaks. It continues to operate after other low pressure injection system begins operation. Pump suction is from the condensate storage tank or the suppression pool. Two semicircular sparger rings with nozzles spray water radially over core and into fuel assemblies.

Low-Pressure Coolant-Injection System: This system is part of the Residual Heat Removal System and has 3 pumps each rated 5010 gpm at 20 psid which start automatically at same time LPCS system starts. The purpose is to flood the core when reactor pressure drops to a low value along with low water level in the reactor. Pump suction is the suppression pool, providing the means for long-term recirculation. Injection into the reactor is through 3 separate nozzles.

E. OTHER SAFETY-RELATED FEATURES

Main-Steam-Line Flow Restrictors: In the case of a line break, this venturi device limits flow from the reactor vessel to a value of 200% rated line flow.

Control-Rod Velocity Limiters: Limits velocity at which a rod can fall out. Designed so that velocity is limited in one direction only. Scram velocity not effected.

Control-Rod-Drive-Housing Supports: Beams installed under the housings prevent the housing and rod from dropping more than about 2-in. in case of housing failure. Thus, rod travel would be limited to a safe value.

Standby Liquid-Control System: A manual system for injecting a boron neutron absorber solution into the reactor to either shut it down or keep it shut down in case the control rods will not do it.

E. OTHER SAFETY-RELATED FEATURES (cont'd) Reactor: River Bend
Standby Coolant System: Each reactor has one standby cooling tower that has capacity for cooling after a LOCA. Fans for these towers have electrical power supplied by the diesel generator emergency power system if necessary.
Containment Atmospheric Control System: A ventilation system purges containment and drywell volumes, the annulus leak collection system maintains a subatmospheric pressure in the annulus and collects air that leaks out of containment; the standby gas treatment system processes air in the annulus passing it through prefilter and HEPA filters, and then charcoal beds and another set of HEPA filters.
Reactor Core Isolation Cooling System (RCICS): Provides makeup water to reactor vessel when vessel is isolated. The RCIC system uses a steam-driven turbine-pump unit and operates automatically in time and with sufficient coolant flow to maintain adequate water level in the reactor vessel. Turbine pump flow rate is 600 gpm at 1140 psid. This is a subsystem of Residual Heat Removal System.
Reactor Vessel Failure: Found no reference.
Containment Floodability: Can be flooded — 28,880 cu ft of liquid will flood to top of weir wall.
Reactor-Coolant Leak-Detection System: Consists of temperature, pressure, flow, and fission-product sensors with associated instrumentation and alarms. Abnormal leakage is annunciated in the following systems: main steam lines, reactor water cleanup system, residual heat removal, reactor core isolation cooling and feed water system. Allowable leakage for unidentified leakage is 5 gpm.
Failed-Fuel Detection Systems: Main steam line radiation monitoring system has 4 gamma radiation monitors located on the steam lines just outside containment. Monitors are designed to detect a gross release of fission products from the fuel. High radiation causes reactor to scram and main-steam line isolation valves to close.
Emergency Power: Three diesel-generator sets are provided for each reactor unit. Two sets are devoted to safety related equipment and one set is exclusively for the HPCS system. The two units for safety equipment are rated 3500 KW continuous operation and either one can carry all the emergency load. The unit for HPCS is 2200 KW continuous rating. All units are housed separately and completely independent. Each has a day tank with 1 hr of fuel and 2 full capacity fuel pumps to transfer fuel from each independent storage tank which has fuel supply for 1 diesel for 7 days full load operation.
Rod-Block Monitor: Prevents fuel damage due to a single rod withdrawal error. This system receives input from LPRM channels and initiates a signal to stop control rod withdrawal.
Rod-Worth Minimizer: A part of the computer system that enforces control-rod procedures for startup, shutdown, and low power level operation. It prevents operator from setting up control rod patterns not consistent with prestored sequences.

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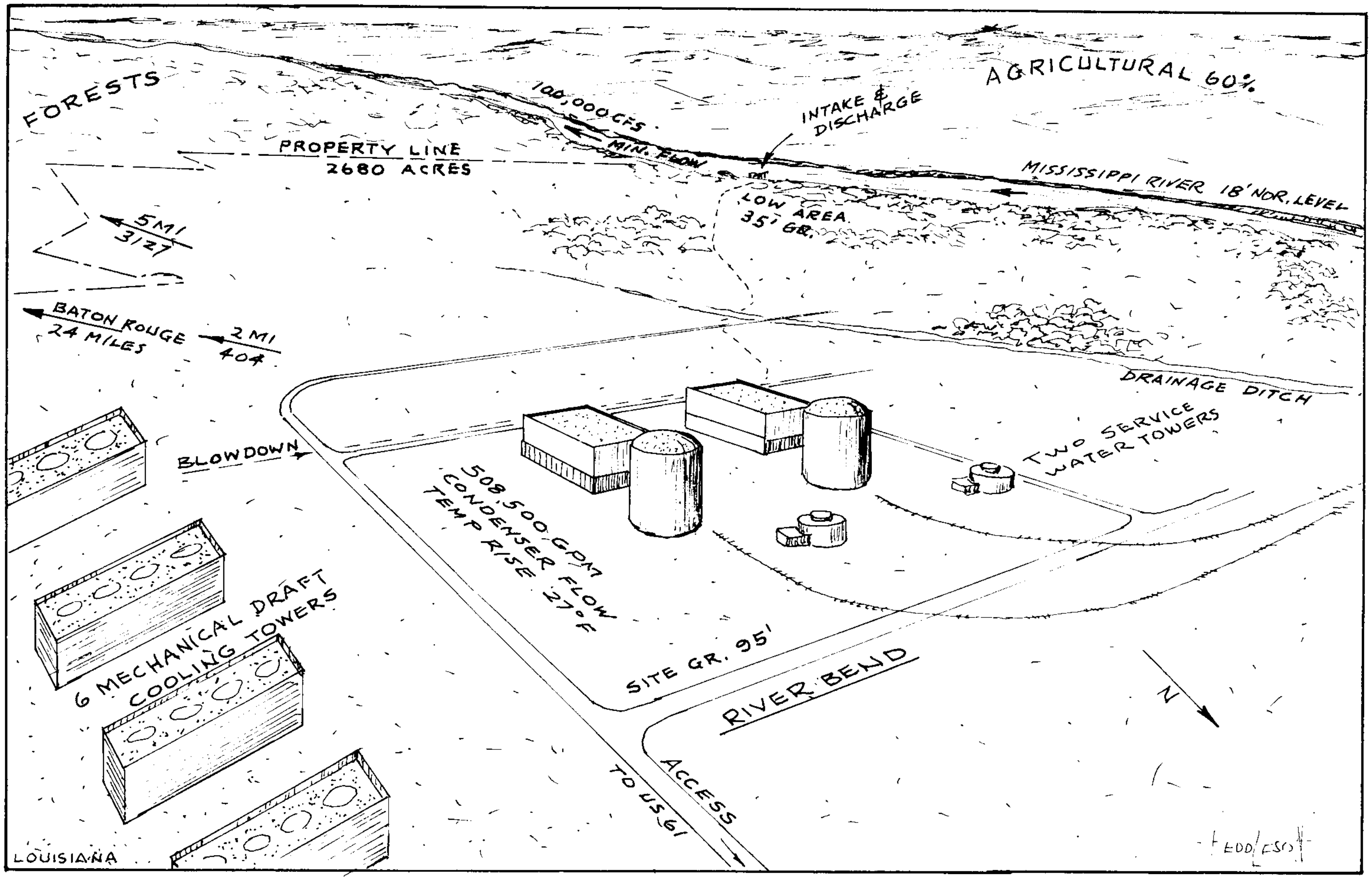
F. GENERAL	Reactor: River Bend
Windspeed, Direction Recorders, and Seismographs: Monitoring of weather data started in Dec. 1971 on the site, a 150-ft tower measured temperature, dewpoint, wind speed and direction, and precipitation. Strong motion triaxial accelerographs are installed in 4 locations. Three are in the reactor building, the fourth is field located.	
Plant Operation Mode: Found no reference.	
Site Description: Heavily wooded with several small streams crossing and draining to either Grants Bayou or to Alligator Bayou. Located on the east bank of the Mississippi River. Site is on 2 levels, 1 an alluvial flood plain 35-ft msl and an upper terrace with an average elevation of 100 ft. Site is near Mississippi River mile 262. Six pipe lines run within 4 miles of the site. Most of the distribution is natural gas.	
Turbine Orientation: Reactor & turbine are on same center line. Ejected turbine blades could not strike containment. GE will supply turbine.	
Emergency Plans: Section 13.3 describes emergency plans in much detail. Plans cover accidents from minor situations to a major accident requiring outside assistance and area evacuation. State and local agencies have been contacted and briefed on plans. All personnel will be trained in emergency procedures and will be appraised of their responsibilities. The Louisiana Division of Radiation Control as well as AEC, Red Cross, police and fire organizations can be called in if needed.	
Environmental Monitoring Plans: Preoperational programs are studying the Mississippi River and other small streams in the area to establish a base for later study after plant operation begins. Included are water quality surveys, physical, chemical, and biological characteristics of aquatic ecosystems looking at plankton, benthos, and fish. Other studies involve groundwater, air, vegetation, birds, mammals, reptile, and radiological measurements.	
Radwaste Treatment: Gaseous radwaste from main condenser is processed continuously through an ambient temperature charcoal system which holds up radioactive components and particulate matter before release. Activity is lowered to below 740 μCi/sec at a failed fuel basis of 100,000 μCi/sec after 30 min delay. Liquid and solid radwaste is processed by batches allowing activity checks at each stage. Liquid waste is released to the environment from only one point after being checked in sample tanks. Discharges are diluted with cooling tower blowdown and monitored. Packaged radioactive solid waste is stored indoors for periods of time to allow for further decay prior to shipment for off-site disposal.	
Plant Vent: Containment roof-top release point — 165 ft above grade.	

G. SITE DATA	Reactor: River Bend
Nearby Body of Water: Mississippi River	Normal Level 18' (MSL) Max Prob Flood Level 95' (MSL)
Size of Site 2680 Acres	Site Grade Elevation 95' (MSL)
Topography of Site: Two levels 35' and 100' of Surrounding Area (5 mi rad): Flat to rolling	
Total Permanent Population: In 2 mi radius 404 ; 10 mi 19,146 Date of Data: 1970 In 5 mi radius 3127 ; 50 mi	
Nearest City of 50,000 Population: Baton Rouge, La. Dist. from site 24 Miles, Direction SSE, Population 165,963	
Land Use in 5 Mile Radius: About 60% agricultural, and 35% forest lands.	
Meteorology: Prevailing wind direction SE Avg. speed 6 mph Stability Data - Site has infrequent episodes of high air pollution.	
Miscellaneous Items Close to the Site: There are a few residences near the northern border. Nearest settlement is St. Francisville 2 1/2 mi N. Crown Zellerbach Paper Mill is 2 mi S. US Hwy 61 (N-S route) runs within ∿1 mi of one reactor. State Hwy 965 runs through the site property. Illinois Central Railroad runs through the site ∿2000 ft S of #2 reactor. Audubon State Park is 3.2 mi NNE. There is a church 0.6 miles W.SW.	

H. CIRCULATING WATER SYSTEM
Type of System: Closed system using cooling towers.
Water Taken From: Mississippi for makeup — 13,400 gpm.
Intake Structure: Built on E side of Mississippi River in a recession along the bank. Pumps are supported on a platform at elevation 60'. Two 30" pipe lines run 18,500 ft to the plant clarifier.
Water Body Temperatures: Winter minimum --- °F Summer maximum --- °F River Flow 100,000 (cfs) minimum; --- (cfs) average Service Water Quantity 42,000 gpm/reactor max Flow Thru Condenser 508,500 (gpm)/reactor Temp. Rise 27 °F Heat Dissipated to Environment --- (Btu/hr)/reactor Heat Removal Capacity of Condenser 6860×10^6 (Btu/hr)/reactor
Discharge Structure: Blowdown is discharged into the Mississippi River from a 30" diam pipe supported on a platform extending the pipe out into the river. The pipe discharges at 46 ft elevation. Normal river level is 18 ft.
Cooling Tower(s): Description & Number - 3 mech. draft for each reactor - 360' lg × 72' wide Blowdown 3200 winter ~~1450 summer~~ gpm/reactor Evaporative loss 10,700 gpm/reactor 165 gpm drift



NUCLEAR SAFETY INFORMATION CENTER

A. GENERAL

PROJECT NAME: Clinton Power Station, Units 1 and 2

LOCATION: DeWitt Co., Ill., 6 miles E. of Clinton (E. Central Ill.)

OWNER: Illinois Power Company

OWNER'S ADDRESS & CONTACT: L. J. Koch, Mgr. Nuclear Projects
500 S. 27th Street
Decatur, Illinois 62525

ARCHITECT/ENGINEER: Sargent & Lundy

REACTOR MANUFACTURER: G.E.

CONTAINMENT CONSTRUCTOR: Not given.

TURBINE MANUFACTURER: Not given.

ESTIMATED STARTUP DATE: June 1980

DATE: May 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: On a peninsula in the proposed reservoir formed by a dam at the confluence of Salt Creek and North Fork Salt Creek (dam will be 3/4 mile from site). The surrounding area is flat and sparsely populated. The land use is predominantly agricultural. This site is very near the geographical center of the U.S.A. Clinton is 6 miles west, Farmer City 11 miles ENE, and DeWitt (population 200) is 3 miles ENE, U.S. Highway 54 and State Highways 10 and 48 pass through the site. The Illinois Central Railroad crosses the site. The nearest hospital is in Clinton. Weldon Springs State Park is 6 miles SW. The nearest school is in Weldon, 5.3 miles ESE.

Nearby Body of Water: Reservoir on Salt Creek and North Fork of Salt Creek	Normal Level 690' (MSL) Max Prob Flood Level 707' (MSL)
Size of Site 15,000 Acres	Site Grade Elevation 736' (MSL)

Topography of Site: Flat

of Surrounding Area (5 mi rad): Flat except along the creeks.

Total Permanent Population: In 2 mi radius 141 ; 10 mi 13,143

Date of Data: 1972 In 5 mi radius 1199 ; 50 mi 720,998

Nearest City of 50,000 Population: Decatur, Ill.

Dist. from Site 22 Miles, Direction SSW, Population 90,397

Land Use in 5-Mile Radius: Agricultural

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

Stability Data — Relatively favorable dispersion regime.

Meteorological Measurements — On-site data is available from 4/72–1/73. Meteorological data sources used for site studies came from 57 miles NW and Springfield 50 miles SW.

B. SITE DATA (Continued) REACTOR: Clinton

Exclusion Distance, Miles	0.6 radius	
Low Population Zone Distance, Miles	2.5 radius	
Metropolis	Distance	Population
Decatur, Ill.	20 mi.	125,010
Safe Shutdown Earthquake Acceleration, g	0.15	
Operating Basis Earthquake Acceleration, g	0.07	
Earthquake Vertical Shock, % of Horizontal	67	

Design Winds in mph:

At 0 – 50 ft elev	94.5
50 – 150 ft	106
150 – 400 ft	114.6

Tornado 300 mph rotational + 60 trans.

ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES

Drywell Design Pressure, psig	25	Primary Containment Leak Rate, %/day	0.5
Suppression Chamber Design Pressure, psig	---	Secondary Containment Design Pressure, psig	15
Calculated Max Internal Pressure, psig	21.5	Secondary Containment Leak Rate, %/day	---

Type of Construction: Mark III concept, cylindrical reinforced concrete, steel lined with a hemispherical dome, all founded on a soil-supported flat concrete slab. The suppression pool surrounds the drywell and is within the cylindrical concrete containment wall. Free air volume is 1.75×10^6 cu ft. The drywell has 0.25×10^6 cu ft of free air volume. Walls are 3' thick and dome is 2'-6".

Design Basis: To limit release of radioactive materials in case of LOCA so offsite doses will be below 'reference values' stated in 10 CFR 100.

Vacuum Relief Capability: Designed for 3 psig external pressure. Vacuum breaker system is provided between the drywell and containment volumes.

Post-Construction Testing: Leak rate tests will be run in accordance with App. U of 10 CFR 50 when construction ends and periodically thereafter. Structural acceptance test will be run in accordance with AEC Guide 1.18 except pressure will be run up to 115% of design.

Penetrations: Sketches of penetrations indicate that all penetrations are doubled sealed.

Weld Channels: Found no reference.

C. CONTAINMENT & STRUCTURES (Contd) REACTOR: Clinton

Containment Heat Removal System: Heat is removed from containment using the suppression pool cooling mode of residual heat removal system; steam is condensed in the suppression pool. Long-term bulk temperature of the suppression pool will not exceed 185°F. RHR heat exchangers will remove heat from suppression pool water. All systems will be testable.

Standby Gas Treatment System: Has two independent systems each of 100% capacity, consisting of a fan, demister, prefilter, electric heater, two high-efficiency particulate filter banks, two charcoal iodine adsorbers, and a flow control device. All gaseous discharge can be processed before discharging to the environment.

Combustible Gas Control: Designed to sample, mix hydrogen with containment atmosphere and purge. A recombiner will be installed in containment.

Containment Floodability: Drywell will flood after LOCA to the top of the weir wall, then run back into the suppression pool.

Strong Motion Accelerometer: Provided for unit 1 only - monitors continuously, but records only when triggered. There are 3 locations — in free field, basement of containment, and high against containment structure wall.

Turbine Orientation: Reactor containment and turbine on same centerline. Ejected blades could not strike containment. Mfg - G.E.

D. REACTOR COOLANT

Reactor Vessel Failure: Designed for 40 year life. Quality control methods assure that design specifications are met - thus making failure very unlikely.

Reactor Vessel Design: Material — Low alloy steel with SST cladding

Shell ID, in. 216 Shell thickness, in. 5.375" (min.)

Overall height, ft/in. ~70 ft Cladding thickness, in. 1/8" (min.)

Leak-Detection System: Consists of temp., press., flow, and fission product sensors which detect and annunciate leaks from main steam lines, reactor water cleanup system, RHRS, RCIC system, pool cooling and cleanup system and instrument lines. Reactor water level indicates large leaks.

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

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

E. REACTOR CHARACTERISTICS		REACTOR: Clinton	
E1. THERMAL-HYDRAULIC		**E2. NUCLEAR**	
Thermal Output, MWt	2894	Moderator Temp Coef Cold, Δk/k/°F	$+4\times10^{-5}$
Electrical Output, MWe (net)	955	Moderator Temp Coef Hot, No Voids	-14×10^{-5}
Total Heat Output, Safety Design, MWt	3039	Moderator Void Coef Hot, No Voids, Δk/k/%	$\sim-5\times10^{-4}$
Steam Flow Rate, lb/hr	12.45×10^6	Moderator Void Coef Operating	$\sim-16\times10^{-4}$
Total Core Flow Rate, lb/hr	84.5×10^6	Doppler Coefficient, Cold	-1.8×10^{-5}
Feedwater Flow Rate, million lb/hr	12.42×10^6	Doppler Coefficient, Hot, No Voids	-0.95×10^{-5}
Feedwater Temperature, °F	420	Doppler Coefficient, Operating	-1.05×10^{-5}
Coolant Pressure, psig	1040	Initial Enrichment, %	1.70
Heat Transfer Area, ft^2	59369	Average Discharge Exposure, MWD/Ton	12,000 to 19,000
Max Power per Fuel Rod Unit Lgth, kw/ft	13.4	Control Rod Worth, %	0.01 Δk
Maximum Heat Flux, Btu/hr-ft^2	354,000	Burnable Poisons, Type and Form	Gd_2O_3 mixed into UO_2
Average Heat Flux, Btu/hr-ft^2	159,550	Number of Moveable Control Rods	145
Maximum Fuel Temperature, °F	3325	No. of In-Core Neutron Detectors (Fixed)	132
Average Fuel Rod Surface Temp., °F	560	No. of In-Core Detector Assemblies	33
MCHFR	≥ 1.9	Number of Fuel Assemblies	592
Coolant Enthalpy at Core Inlet, Btu/lb	527.8	Fuel Rod Array	8×8
Total Peaking Factor	2.22	No. Fuel Rods Per Fuel Assembly	63
Avg Power Density, Kw/ℓ	56.0	MISCELLANEOUS:	
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280	BWR/6 Nuclear Steam Supply	
Core Max. Exit Voids Within Assembly, %	76		
Number of Recirculation Loops	2		
Pipe Diameter, in.	20		
Recirculation Pump Flow, gpm	32,500		
Number of Jet Pumps in Reactor	20		
Number of Main Steam Lines	4		
Pipe Diameter, in.	24		

F. EMERGENCY CORE COOLING SYSTEMS REACTOR: Clinton

High-Pressure Core Spray: Consists of one motor-driven pump, 1400 gpm at 1147 psid, piping, valves, etc., the pump and motor located outside containment. Suction is from the RCIC condensate storage tank, or the suppression pool. Piping inside the reactor vessel has spray nozzles which spray the fuel. Low water level or high drywell pressure starts the pump.

Auto-Depressurization System: This system releases pressure from the reactor vessel through pressure relief valves so low pressure emergency core cooling systems can operate to flood the core. ADS will not activate unless either LPCS or LPCI pumps are operating.

Low-Pressure Core Spray: Consists of one pump, valves, piping and spray sparger over the core. Actuated by indication of breach in coolant system, but water is not delivered to the core unless vessel pressure is reduced. This system operating in conjunction with ADS and HPCS can maintain cladding below fragmentation temp. One pump delivers 5010 gpm at 119 psid.

Low-Pressure Coolant-Injection System: A part of Residual Heat Removal System. This system is actuated in the same manner as LPCS system. There are 3 pumps each rated 5050 gpm at 20 psid which flood the core after LOCA to maintain the fuel below fragmentation temperature.

G. MISCELLANEOUS

Residual-Heat-Removal System (RHRS): Consists of pumps, heat exchangers, piping, and controls, to do the following:

1. Remove decay heat during and after station shutdown.
2. Inject water into the reactor vessel to flood the core following LOCA. See Low-Pressure Coolant Injection above.
3. Remove heat from the suppression pool water following a LOCA. This is done by circulating suppression pool water through the heat exchanger.

Radwaste System: The 2 units have common treatment facilities housed in 2 buildings - one for liquid and solid waste treatment and one for gaseous waste treatment. Gaseous radwaste system uses a low-temperature condenser off-gas system. Hydrogen and oxygen are catalytically recombined, dried, cooled to 45°F, and passed through HEPA and charcoal filter held at 0°F. Liquid wastes are collected, processed on a batch basis and mostly returned for re-use. A small portion is discharged to the environment. Solid wastes will be packed in 55-gal drums, some solidified in concrete and shipped off-site for disposal.

Plant Vent: A common HVAC vent adjacent to unit 1 containment will vent 200' above grade (9' above top of containment).

G. MISCELLANEOUS (Continued) REACTOR: Clinton

Emergency Power: Description of system is not clear. Apparently there are six diesel-generator sets supplying power to three distribution divisions. Units are rated 3520 kW for divisions 1 and 2 and 2600 kW for division 3. Each division has two diesel-generator sets, which are completely independent in all respects.

Emergency Plans: Plans will be developed to satisfy requirements of 10 CFR 50, App. E, to cope with emergency situations such as fire, explosion, radiation, equipment failures, natural disasters, sickness or injury, and civil disturbance. Outside agencies such as law enforcement, fire departments, health departments, civil defense, AEC, and medical support will be called upon. All station personnel will be trained to assume their assigned responsibility and how to function in case of accidents.

Environmental Monitoring: Preoperational aquatic and terrestrial monitoring has three phases — preconstruction, construction, and lake filling. Program goals will be to determine if adverse impacts on the environment have occurred, are occurring, or will occur. Monitoring will evaluate water, air, geology, soil, vegetation, small land animals, aquatic organisms, fish, birds, etc. Radiological monitoring will be carried out also to set baselines for review of the effect of plant operation.

H. CIRCULATING WATER SYSTEM

Type of System: Once through.

Water Taken From: New reservoir.

Intake Structure: Reinforced concrete structure housing the circulating water pumps, traveling screens, and plant service water pumps. The structure is 230' × 144' × 58' high. Pipes to and from condenser are 14' diameter.

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

River Flow 29 (cfs) minimum; 202 (cfs) average

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 565,800 (gpm)/reactor Temp. Rise 23 °F

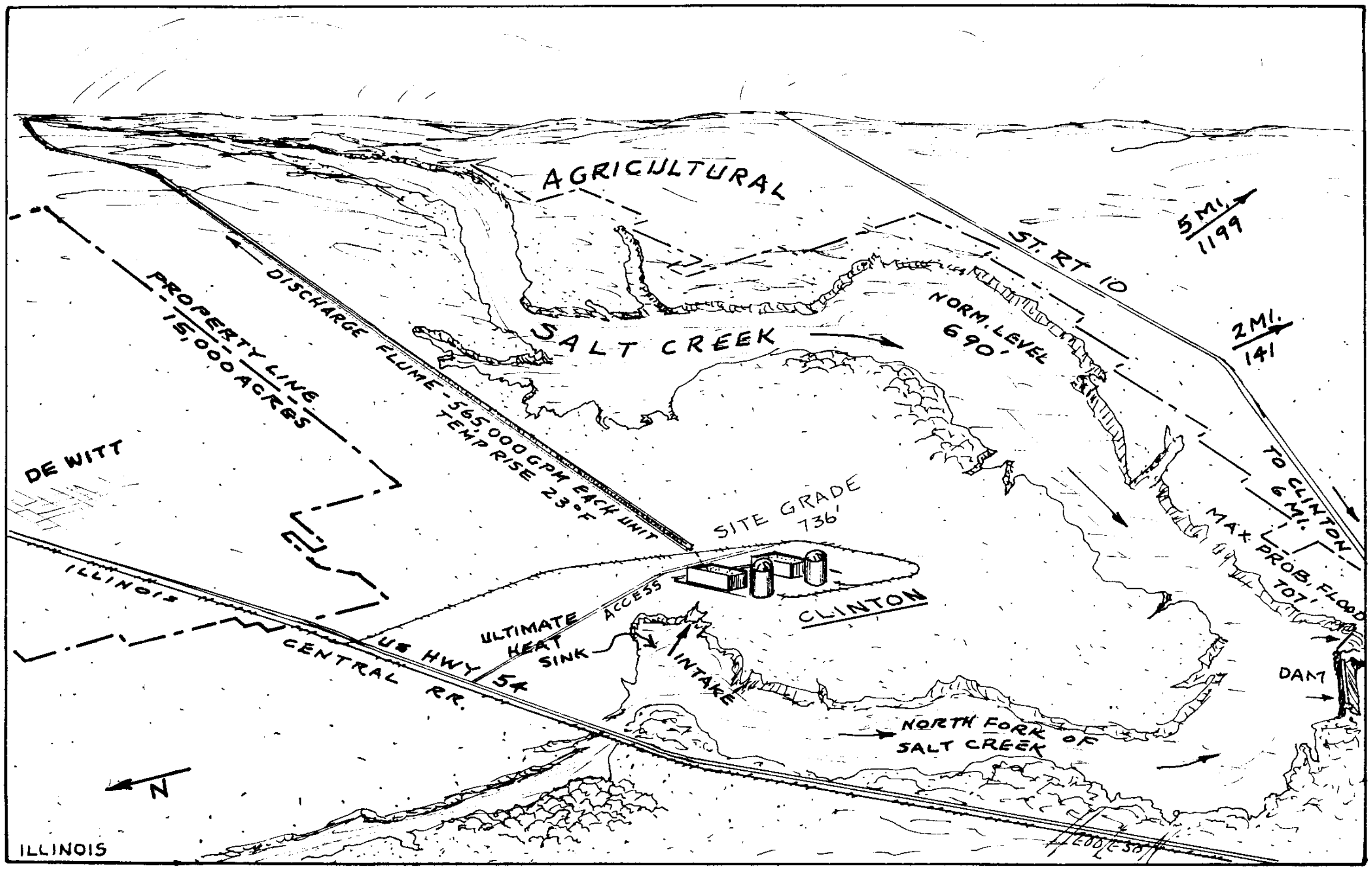
Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 6453×10^6 (Btu/hr)/reactor

Discharge Structure: Water is discharged from the plant into an open discharge flume which runs about 3 miles to where the flume discharges into the lake.

Cooling Tower(s): Description & Number — None

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



NUCLEAR SAFETY INFORMATION CENTER

ALLENS CREEK, 50-466, 50-467 — Page 1, BWR

A. GENERAL

PROJECT NAME: Allens Creek Nuclear Generating Station, Units 1 & 2

LOCATION: Austin County, Texas - 45 miles W of Houston

OWNER: Houston Lighting & Power Company

OWNER'S ADDRESS & CONTACT: G. W. Oprea, Jr. - Group Vice President, P.O. Box 1700, Houston, Texas 77001

ARCHITECT/ENGINEER: Ebasco Services

REACTOR MANUFACTURER: General Electric

CONTAINMENT CONSTRUCTOR: Ebasco

TURBINE MANUFACTURER: G.E.

ESTIMATED STARTUP DATE: 1979-1981

DATE: June 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description:
Located on the Brazos River flood plain about 4 miles NE of Wallis (pop 1028), and 7 miles SSE of Sealy (pop 2685). State route #36 runs general SE-NW about 1 mile west of the plant. A cooling lake will be formed through which Allens Creek will flow with the cooling lake discharging into the Brazos River. The nearest school is in Wallis, and the nearest medical center is in Sealy. Numerous small farm roads run through the area immediately surrounding the cooling lake. The bottom land area where the cooling lake will be located is 98' to 105' elevation. The plant will be located on a bluff west of the flood plain on land of 98' to 146' elevation. The Sante Fe and Southern Pacific Railroads cross at the south end of the cooling lake. A spur will be run into the site from the Sante Fe.

Nearby Body of Water: Brazos River & 7600 A. cooling lake — Normal Level --- (MSL); Max Prob Flood Level 141.4' (MSL)

Size of Site 11,000 Acres — Site Grade Elevation 142' (MSL)

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

Total Permanent Population: In 2 mi radius 72; 10 mi 8,000
Date of Data: 1970 — In 5 mi radius 1850; 50 mi 1,470,000

Nearest City of 50,000 Population: Houston
Dist. from Site 45 Miles, Direction E, Population 1,240,000

Land Use in 5-Mile Radius: Agricultural 80%, other forests and rangeland.

Meteorology: Prevailing wind direction SSE — Avg. speed 11.6 mph

Stability Data — Stable periods with light winds are of short duration

Meteorological Measurements — Data has been taken for about 1 yr at the site using a 198' high tower.

B. SITE DATA (Continued) REACTOR: Allens Creek

Exclusion Distance, Miles	0.9	
Low Population Zone Distance, Miles	3 1/2 radius	
Metropolis	Distance	Population
Houston, Texas	45 mi	1,985,000
Safe Shutdown Earthquake Acceleration, g		0.10
Operating Basis Earthquake Acceleration, g		0.05
Earthquake Vertical Shock, % of Horizontal		67

Design Winds in mph:

At 0 – 50 ft elev	165
50 – 150 ft	196
150 – 400 ft	229

Tornado 300 mph tang. + 60 trans

ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES

Drywell Design Pressure, psig	25	Primary Containment Leak Rate, %/day	0.5
Suppression Chamber Design Pressure, psig	15	Secondary Containment Design Pressure, psig	0.2
Calculated Max Internal Pressure, psig	26	Secondary Containment Leak Rate, %/day	---

Type of Construction:

Mark III type using drywell/pressure suppression concept in a dry containment structure. The cylindrical suppression pool surrounds the drywell but is inside the free standing steel containment vessel which is cylindrical with a domed roof. A reinforced concrete shield building surrounds the steel containment vessel leaving an annulus space between the two structures. Free volume of containment is 1.16×10^6 cu ft. Drywell free volume is 276,000 cu ft.

Design Basis:

Designed to control release of radioactivity to the environment using the leak-tight steel shell, the shield building, standby gas treatment system, and auxiliaries after LOCA. Design based on double-ended break of the largest reactor coolant pipe. Containment temperature and pressure are limited following LOCA by the Engineered Safety Features, Suppression Pool, and Residual Heat Removal System.

Vacuum Relief Capability:

There will be 2 vacuum relief lines with a check valve and an automatic air-operated butterfly valve.

Post-Construction Testing:

Structural acceptance test will be run at 115% of design pressure and held for 1 hr. After the structural test, a leak-rate text will be run at design pressure. Three leak-rate tests will be performed during each 10-yr period after startup.

Penetrations: Sketches of penetrations show them to be single sealed; however, the test states that electrical penetrations can be pressurized and checked for leakage.

Weld Channels: Found no reference.

C. CONTAINMENT & STRUCTURES (Contd) **REACTOR:** Allens Creek

Containment Heat Removal System: Steam dumped into containment in case of LOCA will vent to the suppression pool. As the steam condenses there, the suppression pool water will be heated. It will be pumped back to the reactor vessel, through the Residual Heat Removal heat exchangers for cooling. System is designed to limit suppression pool to a maximum of 185 F. A containment spray system is proposed but no details are given in the PSAR.

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

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

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

Strong Motion Accelerometer: Accelerometers will be installed with readout in control room, but locations are not yet established.

Turbine Orientation: G.E. will furnish turbine. Reactor and turbine centerlines are 195' apart. Ejected turbine blades could strike containment.

D. REACTOR COOLANT

Reactor Vessel Failure: Designed by ASME Boiler & Pressure Vessel Code, Sect. III, etc. Both elastic and inelastic stress analysis techniques were used. Failure not mentioned. Designed for 40-year life.

Reactor Vessel Design: Material — Low alloy steel partially clad

Shell ID, in.	238	Shell thickness, in.	5.769
Overall height, ft/in.	∿73'	Cladding thickness, in.	1/8

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

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

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

E. REACTOR CHARACTERISTICS		REACTOR: Allens Creek	
E1. THERMAL-HYDRAULIC		**E2. NUCLEAR**	
Thermal Output, MWt	3579	Moderator Temp Coef Cold, Δk/k/°F	$+4 \times 10^{-5}$
Electrical Output, MWe (net)	~1200	Moderator Temp Coef Hot, No Voids	-14×10^{-5}
Total Heat Output, Safety Design, MWt	3758	Moderator Void Coef Hot, No Voids, Δk/k/%	---
Steam Flow Rate, lb/hr	15.4×10^6	Moderator Void Coef Operating	---
Total Core Flow Rate, lb/hr	105×10^6	Doppler Coefficient, Cold	-1.7×10^{-5}
Feedwater Flow Rate, million lb/hr	15.4×10^6	Doppler Coefficient, Hot, No Voids	-1.05×10^{-5}
Feedwater Temperature, °F	420	Doppler Coefficient, Operating	-1.1×10^{-5}
Coolant Pressure, psig	1040	Initial Enrichment, %	2.07
Heat Transfer Area, ft^2 Total	73,409	Average Discharge Exposure, MWD/Ton	12,000 to 19,000
Max Power per Fuel Rod Unit Lgth, kw/ft	13.4	Control Rod Worth, %	0.01 Δk
Maximum Heat Flux, Btu/hr-ft^2	354,000	Burnable Poisons, Type and Form	Gd_2O_3 mixed with UO_2
Average Heat Flux, Btu/hr-ft^2	159,580	Number of Moveable Control Rods	177
Maximum Fuel Temperature, °F	3325	No. of In-Core Neutron Detectors (Fixed)	164
Average Fuel Rod Surface Temp., °F	---	No. of In-Core Detector Assemblies	41
MCHFR	≥1.9	Number of Fuel Assemblies	732
Coolant Enthalpy at Core Inlet, Btu/lb	527.9	Fuel Rod Array	8 × 8
Total Peaking Factor	2.22	No. Fuel Rods Per Fuel Assembly	63
Avg Power Density, Kw/ℓ	56.0	MISCELLANEOUS:	
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280		
Core Max. Exit Voids Within Assembly, %	76		
Number of Recirculation Loops	2		
Pipe Diameter, in.	22/24		
Recirculation Pump Flow, gpm	35,400		
Number of Jet Pumps in Reactor	20		
Number of Main Steam Lines	4		
Pipe Diameter, in.	26		

F. EMERGENCY CORE COOLING SYSTEMS REACTOR: Allens Creek

High-Pressure Core Spray: Consists of one motor-driven pump, 1650 gpm at 1100 psid or 6000 gpm at 200 psid, piping, valves, etc., the pump and motor located outside containment. Suction is from the RCIC condensate storage tank, or the suppression pool. Piping inside the reactor vessel has spray nozzles which spray water over the core. Low water level or high drywell pressure starts the pump. System is designed to cool the core sufficiently to limit cladding temperatures to less than 2300F.

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

Low-Pressure Core Spray: Consists of one pump (6000 gpm at 122 psid), spray sparger in the reactor vessel above the core, piping, etc. Suction is taken from the suppression pool. Pump is actuated by low water in the reactor vessel or high pressure in the drywell. System can spray enough water on the core to hold cladding temperatures below 2300F.

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

G. MISCELLANEOUS

Residual-Heat-Removal System (RHRS): The system has 3 pumps rated 7100 gpm each at 20 psid, 2 heat exchangers rated 45×10^6 Btu/hr each, piping, etc. There are 4 modes of operation:

1. Shutdown cooling to 125F in 20 hours after reactor shutdown.
2. Use heat exchangers to condense steam from the reactor vessel.
3. Low-Pressure Coolant-Injection System — described above.
4. Containment Heat Removal System — discussed at top of page 3.

The heat exchangers are cooled by RHR service water.

Radwaste System: Gaseous system recombines hydrogen and oxygen catalytically. Gases are then passed through HEPA and charcoal filters. All gases after filtering are vented through the plant stack. All liquid radwaste is totally recycled during normal operation, and none will be released to the environment except in highly improbable off-standard conditions. Solid wastes will be packaged and shipped off-site for disposal.

Plant Vent: Stack top is 328 ft above ground level.

G. MISCELLANEOUS (Continued) REACTOR: Allens Creek

Emergency Power: There are 3 diesel-generator sets for each reactor, each one serving safety-related loads for one of 3 divisions. Each diesel generator with its auxiliaries will be independent and separately housed. Two of the 3 are rated at 4586 kW and the third at 2600 kW continuously. Each unit will have a day tank with capacity for 4 hrs of operation. There will be 2 storage tanks for all diesels.

Emergency Plans: Plans will be developed to satisfy requirements of 10 CFR 50, App. E, to cope with emergency situations such as fire, explosion, radiation, equipment failures, natural disasters, sickness or injury, and civil disturbance. Outside agencies such as law enforcement, fire departments, health departments, civil defense, AEC, and medical support will be called upon. All station personnel will be trained to assume their assigned responsiblity and how to function in case of accidents.

Environmental Monitoring: A preoperational program will start at least one year before construction begins. This program will set base line data and will follow thru construction. This program will guide the operational program. Sampling will include aquatic, terrestrial, and air particulates such as water sampling of creeks and rivers, aquatic organisms, fish, vegetation, mammals, birds, invertebrates, ground water and air particulates including meteorological measurements. Program in detail is being planned.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using man-made 7600 acre cooling lake.

Water Taken From: Brazos River for make up.

Intake Structure: Reinforced intake structure will be located at the edge of the cooling lake. It will house circulating water pumps, trash racks, and traveling screens. Water will flow from intake to condenser in 2 conduits.

Water Body Temperatures: Winter minimum 73 °F; Summer maximum 89 °F

River Flow Brazos (cfs) minimum; 7314 (cfs) average

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 810,000 (gpm)/reactor Temp. Rise 19.5 °F

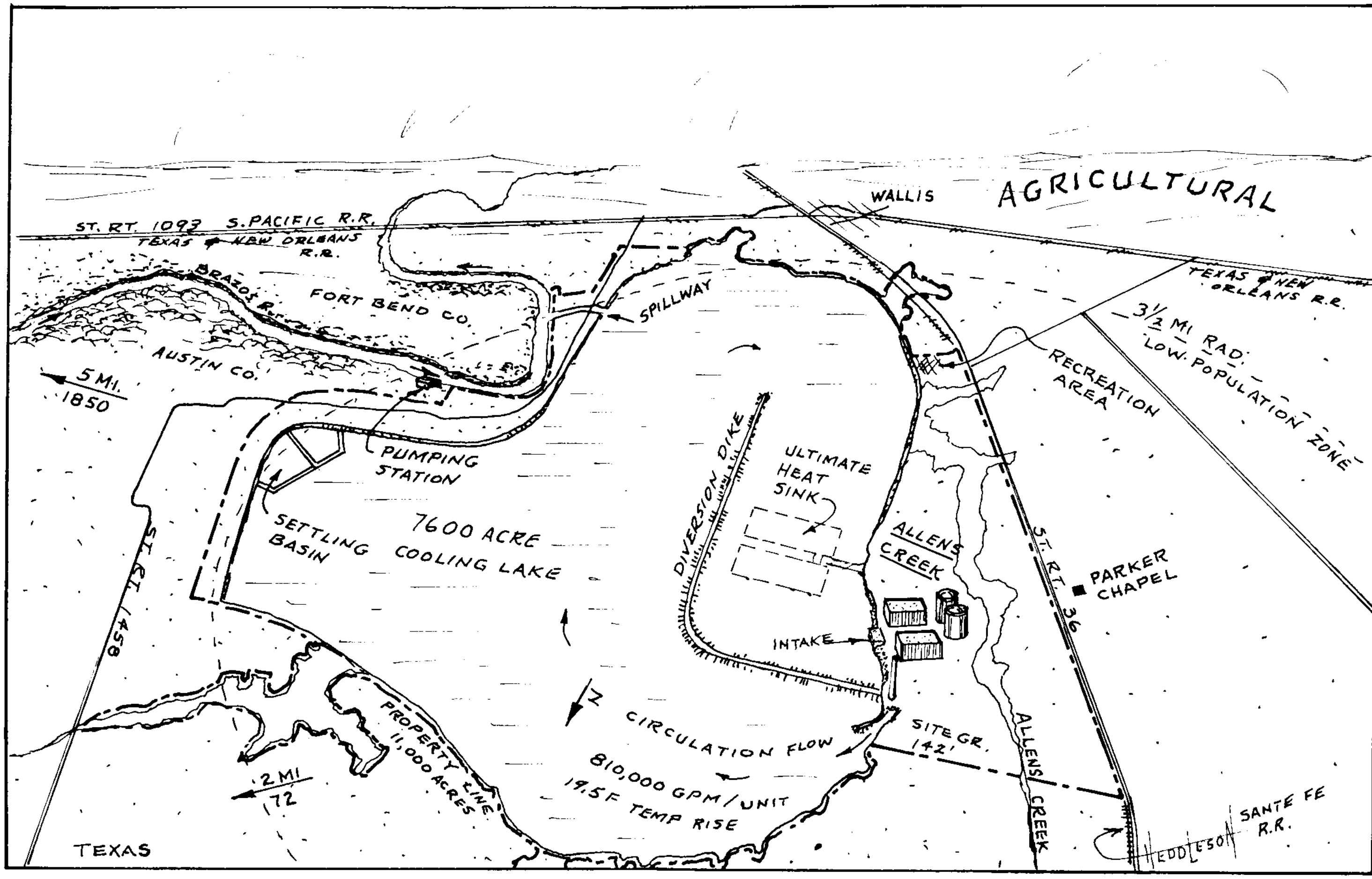
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: Water will be discharged from the condenser thru 2 conduits to a seal well which discharges into a canal. The canal runs into the cooling lake which has diversion dike for maximum circulation.

Cooling Tower(s): Description & Number — None

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


AGRICULTURAL
WALLIS
ST. RT. 1093
S. PACIFIC R.R.
TEXAS & NEW ORLEANS R.R.
BRAZOS R.
FORT BEND CO.
AUSTIN CO.
5 MI.
1850
SPILLWAY
PUMPING STATION
SETTLING BASIN
7600 ACRE COOLING LAKE
DIVERSION DIKE
ULTIMATE HEAT SINK
ALLENS CREEK
INTAKE
PARKER CHAPEL
ST. RT. 36
RECREATION AREA
TEXAS & NEW ORLEANS R.R.
3 1/2 MI RAD. LOW POPULATION ZONE
ST. RT. 1458
PROPERTY LINE 11,000 ACRES
2 MI
172
N
CIRCULATION FLOW
810,000 GPM/UNIT
19.5F TEMP RISE
SITE GR. 142'
ALLENS CREEK
SANTE FE R.R.
EDDLESON
TEXAS

PILGRIM 50-471, 50-472 **Page 1,** PWR

A. GENERAL

PROJECT NAME: Pilgrim Station, Units 2 & 3

LOCATION: Plymouth County, Mass.

OWNER: Boston Edison Company & Others

OWNER'S ADDRESS & CONTACT: Thomas J. Galligan, Jr. - President
Boston Edison Co.
800 Boylston St.
Boston, Mass.
02199

ARCHITECT/ENGINEER: Bechtel

REACTOR MANUFACTURER: Combustion Engineering

CONTAINMENT CONSTRUCTOR: Bechtel

TURBINE MANUFACTURER: G. E.

ESTIMATED STARTUP DATE: 1980-82

DATE: June 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description:
Plant is located on a bluff 22 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 within 1/2 mile. About 7000 seasonal summer residents live along the beach within 5 miles of the plant. The nearest residence is about 1/2 mile away. The nearest school is 2 mi. SE in Manomet. State highway 3A runs along the south border of the property with an access road from 3A running into the plant. Rocky Ridge Road runs E-W about 1/2 mile south of the reactors. Two beach parks are within 2 1/2 miles of the plant having about 75,000 visitors a year. Plymouth Plantation 2 1/2 miles W. has 250,000 visitors each year.

Nearby Body of Water: Cape Cod Bay
Normal Level 0 (MSL)
Max Prob Flood Level 14.7' (MSL)

Size of Site 517 **Acres** **Site Grade Elevation** 22.0' (MSL)

Topography of Site: Varies from 0 to 200' - Flat to rolling in reactor area.
of Surrounding Area (5 mi rad): Rolling to hilly - hills up to 400'

Total Permanent Population: **In 2 mi radius** 1524 ; **10 mi** 35,724
Date of Data: 1972 **In 5 mi radius** 9003 ; **50 mi** 3,873,725

Nearest City of 50,000 Population: Brockton, Mass.
Dist. from Site 23 **Miles, Direction** W NW, **Population** 88,000

Land Use in 5-Mile Radius: Open space and vacant 85%

Meteorology: **Prevailing wind direction** SW **Avg. speed** 16 mph

Stability Data — In an area of low pollution potential - good air mixing

Meteorological Measurements — Data has been recorded since 1968 with a 300' high tower.

B. SITE DATA (Continued) REACTOR: Pilgrim 2 & 3

Exclusion Distance, Miles 0.27 min.	Design Winds in mph:
Low Population Zone Distance, Miles 4 mile radius	At 0 — 50 ft elev 100
Metropolis / Distance / Population	50 — 150 ft 125
Boston, Mass. / 33 mi. / 2,753,700	150 — 400 ft 155
Safe Shutdown Earthquake Acceleration, g 0.15	Tornado 300 mph
Operating Basis Earthquake Acceleration, g 0.075	ΔP = --- psi/ --- sec
Earthquake Vertical Shock, % of Horizontal ---	Bechtel report BC-TOP-3 is referenced.

C. CONTAINMENT AND STRUCTURES

Design Pressure, psig 60	Free Volume, cu ft 2.38×10^6
Calculated Max Internal Pressure, psig 53.9	Max Leak Rate at Design Pressure, %/day 0.1

Type of Construction:

A steel-lined, prestressed concrete structure, cylindrical, with a hemispherical roof. Concrete side walls are 3 1/2 ft thick with a 2 1/2 ft thick dome. The steel liner is 1/4" thick.

Design Basis:

Designed to establish a leak tight container so no significant amount of radioactive materials will be released to the environment. Designed so that containment structure, isolation system, containment spray system, air filtration system, and containment cooling all work together to hold down containment pressures and temperatures thus reducing leakage.

Vacuum Relief Capability:

Found no reference to vacuum relief.

Post-Construction Testing:

Design provides for integrated leak-rate testing in accordance with App. J of 10CFR50. Structural integrity test will be run at 115 percent of design pressure.

Penetrations:

Found no reference to penetration types or design.

Weld Channels:

Found no reference to the use of weld channels for weld inspection and monitoring.

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: Pilgrim 2 & 3

Containment Spray System: Consists of 2 independent loops, each having one pump (3000 gpm) which take suction from the refueling water tank in the injection mode and from the containment sump for recirculation mode, heat exchanger, and spray additive system for sodium hydroxide. Borated water is also pumped into the spray spargers.

Containment Cooling: There are 2 independent loops each consisting of 2 fan cooler units. Fan cooler coils are cooled by component cooling water system. The containment spray system can also perform the containment cooling function after LOCA. Each fan cooler circulates 32,400 cfm having 66×10^6 BTU/hr. heat removal capacity.

Containment Air Filtration: Works in conjunction with containment spray system to reduce fission product releases after LOCA by filtering air exhausted from the complex.

Combustible Gas Control: Has 2 independent loops each with an air compressor and 2 fans for dilution of containment air with outside air to prevent accumulation of combustible gases in the dome.

Containment Floodability: 380,000 gallons of water from the refueling water tank will flood containment to 2 feet above the containment floor elevation.

Strong Motion Accelerometer: Units will be installed and will be described in the FSAR.

Turbine Orientation: Turbine & reactor center lines are about 170' apart. Ejected turbine blades could strike containment. General Electric will supply the turbine.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference. Designed, fabricated, and inspected in accordance with all applicable codes and practices - failure unlikely.

Reactor Vessel Design: **Material** AS-533 Grade B, Class I Steel

Shell ID, in. 172 **Shell Thickness** 8 1/2

Overall Height, ft/in. 43' -6" **Cladding Thickness, in.** 1/8

Reactor-Coolant Leak-Detection System: Liquid leakage from unidentified sources can be detected in less than one hour if leakage rate is 1 gpm. Detection will be made by sump level and rate of flow from the sump plus airborne particulate radioactivity monitoring and airborne gaseous radioactivity monitoring. Leaks can be detected also from temp. and pressure sensors and from fan-cooler condensate flow.

Failed-Fuel-Detection System:

Found no reference.

E. REACTOR CHARACTERISTICS		REACTOR: Pilgrim 2 & 3	
E1. THERMAL-HYDRAULIC		**E2. NUCLEAR**	
Thermal Output, MWt	3456	H_2O/U, Cold	Hot 2.08
Electrical Output, MWe (net)	1180	Avg 1st-Cycle Burnup, MWD/MTU	12,600
Total Heat Output, Safety Design, MWt	3629	Maximum Burnup, MWD/MTU	31,600
Total Heat Output, Btu/hr	$11{,}800 \times 10^6$	Region-1 Enrichment, %	1.9
System Pressure, psia	2250	Region-2 Enrichment, %	2.4
DNBR, Nominal	2.26	Region-3 Enrichment, %	3.0
Total Flowrate, lb/hr	148×10^6	k_{eff}, Cold, No Power, Clean	1.169
Eff Flowrate for Heat Trans, lb/hr	142.8×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.071
Eff Flow Area for Heat Trans, ft^2	54.8	Total Rod Worth, %	>8
Avg Vel Along Fuel Rods, ft/sec	16.5	Shutdown Boron, No Rods-Clean-Cold, ppm	980
Heat Generated in Fuel, %	96.5	Shutdown Boron, No Rods-Clean-Hot, ppm	970
Hot Channel Factors, Fq	2.35	Boron Worth, Hot, % Δk/k/ppm	1/82
Nominal Core Inlet Temp, °F	557.5	Boron Worth, Cold % Δk/k/ppm	1/62
Avg Rise in Core, °F	60.3	Full Power Moderator Temp Coeff, Δk/k/°F	$(-.5 \text{ to } -2.2) \times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	651.4	Moderator Pressure Coeff, Δk/k/psi	$(+.6 \text{ to } 2.9) \times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	6200	Moderator Void Coeff, Δk/k/% Void	$(-.26 \text{ to } -1.28) \times 10^{-3}$
Avg Film Temp Diff, °F	30	Doppler Coefficient, Δk/k/°F	$(-1.1 \text{ to } -1.9) \times 10^{-5}$
Active Heat Trans Surf Area, ft^2	62,000	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Heat Flux, Btu/hr ft^2	184,000	Burnable Poisons, Type and Form	Allumina with boron carbide
Max Heat Flux, Btu/hr ft^2	429,900	Number of Control Rods	411
Avg Thermal Output, kw/ft	5.39	Number of Part-Length Rods (PLR)	32
Max Thermal Output, kw/ft	12.6	Number of Fuel Assemblies	217
Max Clad Surface Temp, °F	656.5	Overall Dimensions, inches	16 × 16
No. Coolant Loops	2	Number of Fuel Rods	49,476
		Fuel Rod Cladding Material	Ni Cr Fe alloy
		Weight of Uranium, lbs.	223,900

F. SAFETY INJECTION SYSTEMS REACTOR: Pilgrim 2 & 3

Core Flooding System: Four tanks each contain 11,200 gallons of borated water under pressure of 600 psig. Tanks dump their contents into the reactor vessel when system pressure drops to 600 psig.

High-Pressure Injection System: Two pumps operate to replace water lost by small breaks in the coolant system. These pumps are rated 380 gpm at 1400 psig with maximum flow of 800 gpm at 700 psig. Pumps take suction from the refueling water storage tank, and are started automatically by 2 of 4 signals of low pressurizer pressure, or 2 of 4 high containment pressure.

Low-Pressure Injection System: There are 2 pumps, each rated 5500 gpm at 110 psig. These pumps are used also for shutdown cooling and sized for one pump to be able to perform that function. Pumps take suction from the refueling water tank with action initiated by 2 of 4 low pressurizer pressure signals, or 2 of 4 high containment pressure signals. About 380,000 gallons of borated water is available for core cooling.

G. MISCELLANEOUS

Decay Heat Removal System: Long term cooling, or shutdown cooling is provided by running the low-pressure injection pumps. For shutdown cooling, the flow rate can vary from 0 to 800 gpm. After LOCA, recirculation flow is initiated from low level signals from the refueling water tank. These RAS signals stop the low-pressure pumps, but continue recirculation using the high-pressure injection pumps.

Radwaste System: Liquid wastes are collected, stored, processed, and recycled, discharged, or shipped off-site. Two different processing systems are used, one for reactor coolant wastes and one for all other wastes. Recycling is the goal, but some liquid, after processing is released to the environment. Gaseous wastes are collected, compressed, cooled, dryed, and stored at 75 psig for decay. A decay time of 80 days is provided with an additional release time of 40 days. Discharges vented will be small percentages of limits set by 10CFR20. Solid wastes will be collected, stored for decay, then packed in 55 gallon drums and shipped off-site for disposal.

Plant Vent: The vent release point is located near the containment dome at an elevation of 255 feet above grade.

G. MISCELLANEOUS (Continued) REACTOR: Pilgrim 2 & 3

Emergency Power: Two independent diesel-generator sets rated at 3800 kW (continuous) supply emergency power for shutdown, or other services when off-site power fails. Generators are independently housed and have independent auxiliary systems. Day tank has 4 hour fuel supply, and on site storage will run diesels for 7 days.

Emergency Plans: The current plan being used for Pilgrim Unit 1 will be modified slightly to accomodate units 2 and 3. Construction workers will be covered in the modified plan until construction is completed. The Pilgrim Division Head will direct all emergency activities. Plans cover accidents from minor radioactive spills to a postulated major emergency. Outside agencies will be used as required. Employees are trained in procedures.

Environmental Monitoring: Preoperational data for unit #1 and data secured since operation started establishes base data needed to access the effects of units 2 and 3 operation. Samples are collected and measurements are made to follow temperature, circulation, thermal plumes, and aquatic biology of Cape Cod Bay. Ground water studies show that sub-surface drainage is toward the bay. Terrestrial flora and fauna surveys have been made along with air sampling for radioactivity measurements.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Cape Cod Bay

Intake Structure: Intake channel for unit 1 will be used for units 2 & 3. An 8 bay reinforced concrete intake structure will house pumps, traveling screens, and bar racks. Designed so fish can pass laterally in front of traveling screens and escape back to the bay. Approach velocities are about 1 fps.

Water Body Temperatures: Winter minimum 31 °F; Summer maximum 65 °F

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

Service Water Quantity 35,000 gpm/reactor

Flow Thru Condenser 765,000 (gpm)/reactor Temp. Rise 20 °F

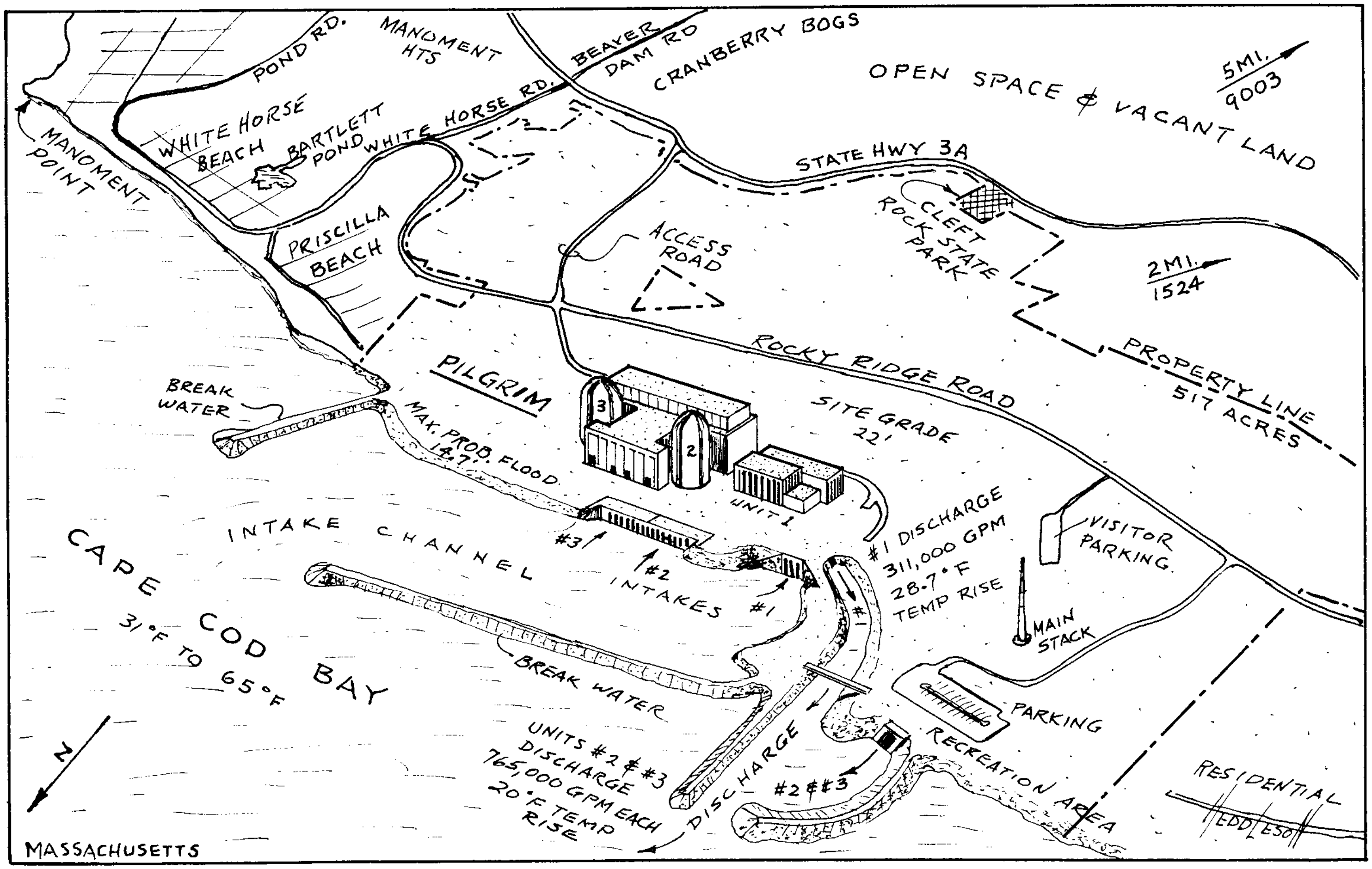
Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 7700×10^6 (Btu/hr)/reactor

Discharge Structure: Cooling water is piped from the condenser in concrete conduct to the surface jet discharge channel used by unit 1. From there, discharge passes through a short canal to the bay, discharging into the bay about 250' from the shore line.

Cooling Tower(s): Description & Number — None

Blowdown ______ gpm/reactor Evaporative loss ______ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

QUANICASSEE 50-475, 50-476 Page 1, PWR

A. GENERAL

PROJECT NAME: Quanicassee Plant, Units 1 & 2

LOCATION: Bay County, Mich. - 6 miles E. of Bay City

OWNER: Consumer Power Company

OWNER'S ADDRESS & CONTACT: Mr. Stephen H. Howell, Vice President
Consumer Power Co.
1945 W. Parnell Rd.
Jackson, Mich. 49201

ARCHITECT/ENGINEER: Bechtel

REACTOR MANUFACTURER: Westinghouse

CONTAINMENT CONSTRUCTOR: Bechtel

TURBINE MANUFACTURER: Westinghouse

ESTIMATED STARTUP DATE: 1980-81

DATE: July 1974
COMPILED BY: F. A. Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Located on the southern shore of Saginaw Bay about 1 mile east of the town of Quanicassee (pop 116). The site is currently used for agriculture with the northern portion along the Bay being Marsh land. State hwy 25 forms the southern border of the property and Nebobish Road cuts across the northern edge of the site. The Penn Central freight line is the nearest railroad, about 6 miles SW. A railroad spur will be run in from here. The closest school is 4 1/2 mi W, nearest hospital is 4 1/2 mi W. NW. (Bay City Medical Care Facility) Bay City is the nearest large city (about 50,000 pop) 7 mi W. A wild life refuge of 217 acres borders the site on the E. This area is one of the most agriculturally productive in Mich. specializing in cash crops. There is only one dairy herd within 5 miles being about 5 miles S. Recreational areas are concentrated along the Bay.

Nearby Body of Water: Saginaw Bay
Normal Level 580' (MSL)
Max Prob Flood Level 603.5' (MSL)

Size of Site 1065 Acres Site Grade Elevation 605' (MSL)

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

Total Permanent Population: In 2 mi radius 504 ; 10 mi 72,364
Date of Data: 1970 In 5 mi radius 3,217 ; 50 mi 1,052,000

Nearest City of 50,000 Population: Bay City, Michigan
Dist. from Site 7 Miles, Direction W , Population 50,000

Land Use in 5-Mile Radius: Agricultural

Meteorology: Prevailing wind direction WSW Avg. speed 9 mph

Stability Data — Pasquill F and G occurs 16% of the time

Meteorological Measurements — Taken at site on 10 meter towers for one year June 72 thru May 73.

B. SITE DATA (Continued) REACTOR: QUANICASSEE 1 & 2

Exclusion Distance, Miles	0.5 radius	
Low Population Zone Distance, Miles	1.83	
Metropolis	Distance	Population
Saginaw, Mich.	17.5 mi.	226,200
Safe Shutdown Earthquake Acceleration, g	0.12	
Operating Basis Earthquake Acceleration, g	0.06	
Earthquake Vertical Shock, % of Horizontal	66	

Design Winds in mph:

At 0 — 50 ft elev	100
50 — 150 ft	120
150 — 400 ft	140

Tornado 300 mph tang. +60 trans.
ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES

Design Pressure, psig: 60	Free Volume, cu ft: 2,400,000
Calculated Max Internal Pressure, psig: 51.2	Max Leak Rate at Design Pressure, %/day: 0.10

Type of Construction: Prestressed concrete structure with a cylindrical wall, a hemispherical roof and a flat foundation slab. Wall and dome are prestressed by a post-tensioning system.

The foundation slab is reinforced with carbon steel. The inside surface of the structure is lined with a 1/4" thick carbon steel liner to ensure a high degree of leak-tightness.

Design Basis: The design assures that containment is protected against postulated missiles from both equipment failures and external sources. The containment design provides means for integrated leak rate testing, and for local leak rate testing of individual piping, electrical and access penetrations.

Vacuum Relief Capability:

Found no reference

Post-Construction Testing: Tested in accordance with Bechtel report BC-TOP-5

Penetrations:

Found no design data

Weld Channels:

Found no reference.

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: QUANICASSEE 1 & 2

Containment Spray System: Operates in conjunction with fan coolers; 3 of coolers and 1 of 2 spray pumps can cool containment after LOCA. Pumps take suction from borated water refueling storage tank-or from containment sump. Pump capacity is 2460 gpm. Sodium hydroxide is added to remove iodine.

Containment Cooling: There are 8 fan coolers, 3 of which operate in conjunction with containment spray to remove heat after LOCA. Six units are required during normal operation. Heat removal capacity is 100×10^6 Btu/hr. at 300°F.

Containment Air Filtration: A recirculation and cleanup air system has complete filtration. Also, the purge system filters all air discharged to the environment. The filtering system has prefilters, HEPA filters and 50,000 CFM capacity fans. The recirculation and cleanup system has charcoal filters.

Combustible Gas Control: Two 100% capacity hydrogen recombiners are provided to hold hydrogen concentration below 4.1 vol.%. Also, a hydrogen vent system is provided

Containment Floodability:

Found no reference

Strong Motion Accelerometer:

Found no reference

Turbine Orientation: Reactors and turbine are on the same center line.

D. REACTOR COOLANT

Reactor Vessel Failure:

No reference found

Reactor Vessel Design: Material ---

Shell ID, in. 173 Shell Thickness ---

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

Reactor-Coolant Leak-Detection System: Leakage will be monitored by air particulate, radioactive gas, condensate measuring, humidity, charging pump operation, sump level and pump operation, and make-up water required. Allowable leakage is 10 gpm for identified and 1 gpm for unidentified.

Failed-Fuel-Detection System: Could not find description.

Page 4, PWR

E. REACTOR CHARACTERISTICS		REACTOR: QUANICASSEE 1 & 2	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3425	H_2O/U, Cold	3.48
Electrical Output, MWe (net)	1200	Avg 1st-Cycle Burnup, MWD/MTU	14,000
Total Heat Output, Safety Design, MWt	3582	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	$11,640 \times 10^6$	Region-1 Enrichment, %	2.03
System Pressure, psia	2250	Region-2 Enrichment, %	2.63
DNBR, Nominal	1.88	Region-3 Enrichment, %	3.23
Total Flowrate, lb/hr	138.4×10^6	k_{eff}, Cold, No Power, Clean	1.225
Eff Flowrate for Heat Trans, lb/hr	132.2×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.148
Eff Flow Area for Heat Trans, ft^2	51.4	Total Rod Worth, %	9 3/4 BOL
Avg Vel Along Fuel Rods, ft/sec	16.3	Shutdown Boron, No Rods-Clean-Cold, ppm	$<$1500
Heat Generated in Fuel, %	---	Shutdown Boron, No Rods-Clean-Hot, ppm	$<$1100
Hot Channel Factors, Fq	---	Boron Worth, Hot, % $\Delta k/k$/ppm	1/100
Nominal Core Inlet Temp, °F	557.5	Boron Worth, Cold % $\Delta k/k$/ppm	1/85
Avg Rise in Core, °F	63.7	Full Power Moderator Temp Coeff, $\Delta k/k$/°F	(+0.04 to −3.0) $\times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	648	Moderator Pressure Coeff, $\Delta k/k$/psi	(−0.4 to +3.0) $\times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	6000	Moderator Void Coeff, $\Delta k/k$/% Void	(+0.5 to −2.5) $\times 10^{-3}$
Avg Film Temp Diff, °F	36.2	Doppler Coefficient, $\Delta k/k$/°F	(−1 to −2) $\times 10^{-5}$
Active Heat Trans Surf Area, ft^2	52,200	Shutdown Margin, Hot 1 rod stuck, %$\Delta k/k$	1
Avg Heat Flux, Btu/hr ft^2	217,200	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Heat Flux, Btu/hr ft^2	579,600	Number of Control Rods	1060
Avg Thermal Output, kw/ft	7	Number of Part-Length Rods (PLR)	160
Max Thermal Output, kw/ft	18.8	Number of Fuel Assemblies	---
Max Clad Surface Temp, °F	657	Overall Dimensions, inches	---
No. Coolant Loops	4	Number of Fuel Rods	---
		Fuel Rod Cladding Material	Zircaloy
		Weight of Uranium, lbs.	---

F. SAFETY INJECTION SYSTEMS REACTOR: QUANICASSEE 1 & 2

Core Flooding System: Four accumulators each holding 6350 gallons of borated water dump their contents into the reactor when system pressure drops below 600 psig. Tanks are pressurized to 600 - 650 psig with nitrogen gas.

High-Pressure Injection System: There are 4 lines for injection, and 2 pumps, each rated 150 gpm. There are 2 intermediate pressure pumps each rated at 400 gpm. Suction is taken from the refueling water storage tank. Concentrated boric acid is injected into the reactor when pumps first start.

Low-Pressure Injection System: Four lines, and 2 pumps with piping, instrumentation, etc. make up this system. Pumps are rated 3000 gpm at 600 psig. Pumps take suction from the refueling water storage tank and when this supply is exhausted, recirculation of water from the containment sump is possible.

G. MISCELLANEOUS

Decay Heat Removal System: System is used to reduce the temperature of reactor coolant at a controlled rate from 350°F to 140°F, within 20 hrs. after shutdown, and to maintain the proper reactor coolant temperature during refueling. Two pumps are available rated 3500 gpm at 140 psig. Residual heat removal pumps circulate reactor coolant through two heat exchangers, returning it to the reactor coolant system through the low pressure injection header. Heat exchanger capacity is 44×10^6 Btu/hr. each.

Radwaste System: Liquid waste system collects, processes, and recycles reactor grade water, removes or concentrates radioactive constituents and processes them until suitable for release or shipment offsite. The gaseous waste processing system removes fission product gases from reactor coolant and contains these gases during normal plant operation. The system also collects gases generated from the boron recycle evaporator. The solid waste processing system receives, packages, stores, and disposes of all solid radioactive wastes and liquid concentrates from liquid waste system.

Plant Vent: Vent is at the top of the containment structure.

G. MISCELLANEOUS (Continued) REACTOR: QUANICASSEE 1 & 2

Emergency Power: Two diesel generator sets are provided for each reactor. Each generator is connected to a load group, each reactor having 2 load groups. Diesels are rated 4400 kW each continuously. Each diesel-generator set is independent from the other and has its own auxiliaries. Each diesel has a day tank with 4 hr supply of fuel, one storage tank with 7 days supply of fuel and 2 transfer pumps.

Emergency Plans: Plan provides for protection of plant personnel and the general public and for the prevention or mitigation of property damage resulting from an incident. An emergency organization will be formed and trained and local agencies and state and federal agencies will be used to cover the spectrum of possible emergencies.

Environmental Monitoring: Will be initiated at least two years prior to operation. Purpose will be to document background levels of radioactivity in various local media, particularly environmental pathways that could lead to highest exposures. Further, the program will serve as a basis of assessment of the impact of plant releases.

An operational program will also be conducted to measure this impact.

Media to be sampled will be air, water, aquatic biota, crops and milk both in the preoperational and operational programs.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using cooling towers, 1 for each unit.

Water Taken From: Weadock discharge canal makeup for towers 31,000 gpm total (2 units)

Intake Structure: Installed along side the Weadock discharge canal. The structure houses 5 pumps. The intake opening to the canal has trash rack and fish screen. Traveling screens might be installed in the future. 8' dia. pipe runs to intake pumps suction.

Water Body Temperatures: Winter minimum 52 °F; Summer maximum 95 °F*

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

Service Water Quantity 41,300 gpm/reactor *Weadock Canal

Flow Thru Condenser 458,000 (gpm)/reactor Temp. Rise 33 °F

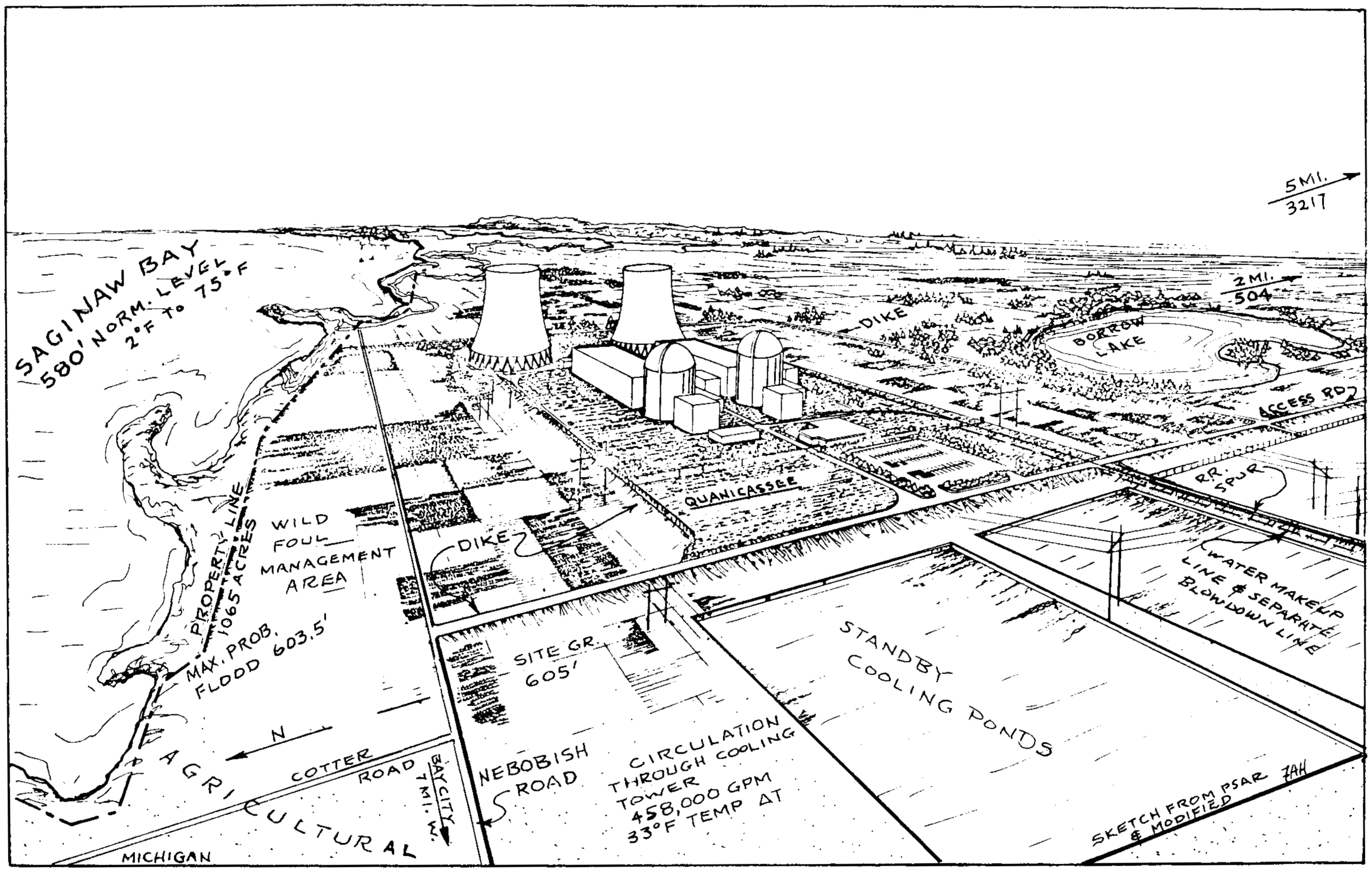
Heat Dissipated to Environment 7800×10^6 (Btu/hr)/reactor

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

Discharge Structure: Blow-down is pumped from the plant site about 7 miles and discharged into the Karn-Weadock Canal at the bottom through a pipe.

Cooling Tower(s): Description & Number — 1 Hyperbolic, each 460'ϕ × 500 high

Blowdown 4,250 gpm/reactor Evaporative loss 11,125 gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

A. GENERAL *Site A/E - Sargent & Lundy

PROJECT NAME: Wolf Creek Generating Station Unit No. 1

LOCATION: Coffey Co., Kansas (28 mi. ESE of Emporia, Kan.)

OWNER: Kansas Gas & Electric Co.

OWNER'S ADDRESS & CONTACT: E.S. Hall, Vice Pres. - Operations
Kansas Gas & Electric Co.
201 N. Market Street
Wichita, Kansas 76201

*ARCHITECT/ENGINEER: Bechtel

REACTOR MANUFACTURER: Westinghouse

CONTAINMENT CONSTRUCTOR: Sargent & Lundy

TURBINE MANUFACTURER: G.E.

ESTIMATED STARTUP DATE: 1981

DATE: July 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Located in the dissected uplands 3.6 mi. E. of the Neosho River Valley in an area where the land is gently rolling with elevations from 1020' to 1120'. The site is on the E. side of a proposed man-made cooling lake formed by empounding Wolf Creek which drains into the Neosho River. Makeup water to help fill the cooling lake will be pumped from the John Redmond Reservoir which is 3.6 mi W. of the site. The John Redmond Reservoir has recreational use and a wild life refuge area is there. The site is 53 mi. S. of Topeka and 3.5 mi NE of Burlington (pop. 2099). There are 3 schools 4.3 miles from the site with 700 pupils. There is a hospital in Burlington, a dairy herd 1.8 mi, a National Guard Armory 4 mi SW. U.S. Hwy is 2.8 mi. W and the nearest railroad is 9.5 mi. SE.

Nearby Body of Water: Cooling Lake on the Neosho River — Normal Level 1090' (MSL); Max Prob Flood Level 1098.5' (MSL)

Size of Site 1100 Acres — Site Grade Elevation 1099.5' (MSL)

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

Total Permanent Population: In 2 mi radius 38; 10 mi 4059
Date of Data: 1970 — In 5 mi radius 2537; 50 mi 163,912

Nearest City of 50,000 Population: Topeka
Dist. from Site 55 Miles, Direction N, Population 127,500

Land Use in 5-Mile Radius: Rangeland - 46%, Agriculture - 36%

Meteorology: Prevailing wind direction summer SSE, winter NNW — Avg. speed 11 mph

Stability Data — Pasquill D about 64% of time.

Meteorological Measurements — Began collection of weather data in May 1973

B. SITE DATA (Continued) **REACTOR:** WOLF CREEK

Exclusion Distance, Miles	0.7 radius	
Low Population Zone Distance, Miles	2.5 radius	
Metropolis	Distance	Population
Topeka, Kan.	55 mi	155,322
Safe Shutdown Earthquake Acceleration, g	0.20	
Operating Basis Earthquake Acceleration, g	0.10	
Earthquake Vertical Shock, % of Horizontal	60	

Design Winds in mph:

At 0 — 50 ft elev	100
50 — 150 ft	120
150 — 400 ft	140

Tornado 300 mph tang + 60 trans.
ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES S* - Information from SNUPPS, Std. Nuclear Unit Power Plant System

Design Pressure, psig	60	Free Volume, cu ft	2.50 $\times 10^6$
Calculated Max Internal Pressure, psig	51	Max Leak Rate at Design Pressure, %/day	0.10

S* **Type of Construction:** Prestressed post-tensioned concrete structure with a cylindrical wall, a hemispherical dome and a flat foundation slab. Inside of the structure is lined with 1/4" thick steel plate to ensure leak tightness. Inside diameter is 140' and height is 135'.

S* **Design Basis:** Designed to control the release of radioactivity from a LOCA so that radiation doses do not exceed the limits of 10CFR100. To accomplish this function, design specifies - max. leak rate, performance of engineered safety features so that design temperature and pressures are not exceeded.

Vacuum Relief Capability: Found no reference

S* **Post-Construction Testing:** Tested in accordance with Bechtel report "Test Criteria for Integrated Leak Rate..." BN-TOP-1, Rev. 1. Structure will be pressure tested at 1.15 design pressure of 60, or at 69 psig.

Penetrations: Found no reference

S* **Weld Channels:** Seam welds in the liner plate are tested by the vacuum box method for leak tightness.

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: **WOLF CREEK**

S* **Containment Spray System**: Operates in conjunction with fan coolers; 2 of 4 coolers and 1 of 2 spray pumps can cool containment after LOCA. Pumps take suction from borated water refueling storage tank or from containment sump in the recirculation mode. Pump capacity is 2460 gpm. Sodium hydroxide is added to remove iodine.

S* **Containment Cooling**: There are 4 fan coolers, 2 of which operate in conjunction with containment spray to remove heat after LOCA. Three units are required during normal operation. Heat removal capacity is 104 $\times 10^6$ Btu/hr each at 300°F.

S* **Containment Air Filtration**: A recirculation and cleanup air system has complete filtration including charcoal filters. Also, a purge system filters all air discharged to the environment. The purge system has prefilters, HEPA filters and 50,000 CFM capacity fans.

S* **Combustible Gas Control**: Two 100% capacity hydrogen recombiners are provided to hold hydrogen concentration below 4.1 vol.%. Also, a hydrogen purge subsystem is provided.

Containment Floodability: Found no reference

S* **Strong Motion Accelerometer**: Triaxial accelerometers will be installed, one on the containment base, and one in the containment building on the operating floor. A peak recording accelerometer will be installed in auxiliary bldg.

S* **Turbine Orientation**: Reactors and turbine are on the same center line. General Electric will supply the turbine.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference.

W **Reactor Vessel Design**: **Material** SA 533, Gr A or B, Class 1

Shell ID, in. 173 **Shell Thickness** 8 1/4 in.

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

S* **Reactor-Coolant Leak-Detection System**: Leakage will be monitored by air particulate, radioactive gas, condensate measuring, humidity, charging pump operation, sump level and pump operation, and make-up water required. Allowable leakage is 10 gpm for identified and 1 gpm for unidentified.

Failed-Fuel-Detection System: Could not find description.

E. REACTOR CHARACTERISTICS		REACTOR: WOLF CREEK	
E1. THERMAL-HYDRAULIC		**E2. NUCLEAR**	
Thermal Output, MWt	3425	H_2O/U, Cold	3.48
Electrical Output, MWe (net)	1150	Avg 1st-Cycle Burnup, MWD/MTU	14,000
Total Heat Output, Safety Design, MWt	3650	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	$11{,}640 \times 10^6$	Region-1 Enrichment, %	2.03
System Pressure, psia	2250	Region-2 Enrichment, %	2.63
DNBR, Nominal	1.88	Region-3 Enrichment, %	3.23
Total Flowrate, lb/hr	138.4×10^6	k_{eff}, Cold, No Power, Clean	1.225
Eff Flowrate for Heat Trans, lb/hr	132.2×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.148
Eff Flow Area for Heat Trans, ft^2	51.4	Total Rod Worth, %	9 3/4 BOL
Avg Vel Along Fuel Rods, ft/sec	16.3	Shutdown Boron, No Rods-Clean-Cold, ppm	<1500
Heat Generated in Fuel, %	---	Shutdown Boron, No Rods-Clean-Hot, ppm	<1100
Hot Channel Factors, Fq	---	Boron Worth, Hot, % Δk/k/ppm	1/100
Nominal Core Inlet Temp, °F	557.5	Boron Worth, Cold % Δk/k/ppm	1/85
Avg Rise in Core, °F	63.7	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.04 \text{ to } -3.0) \times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	648	Moderator Pressure Coeff, Δk/k/psi	$(-0.4 \text{ to } +3.0) \times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	6000	Moderator Void Coeff, Δk/k/% Void	$(+0.5 \text{ to } -2.5) \times 10^{-3}$
Avg Film Temp Diff, °F	36.2	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -2) \times 10^{-5}$
Active Heat Trans Surf Area, ft^2	52,200	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Heat Flux, Btu/hr ft^2	217,200	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Heat Flux, Btu/hr ft^2	579,600	Number of Control Rods	1060
Avg Thermal Output, kw/ft	7	Number of Part-Length Rods (PLR)	160
Max Thermal Output, kw/ft	18.8	Number of Fuel Assemblies	193
Max Clad Surface Temp, °F	657	Overall Dimensions, inches	8.426 × 8.426
W No. Coolant Loops	4	Number of Fuel Rods	50,952
W indicates information taken from Westinghouse RESAR.		Fuel Rod Cladding Material	Zircaloy
		Weight of Uranium, lbs.	253,675

F. SAFETY INJECTION SYSTEMS REACTOR: WOLF CREEK
Core Flooding System: Four accumulators each holding 6350 gallons of borated water dump their contents into the reactor when system pressure drops below 600 to 650 psig. Tanks are pressurized to 700 psig with nitrogen gas. Mechanical operation of swing-disc check valves is an automatic operation that opens the line between accumulators and the coolant system. S*
High-Pressure Injection System: There are 4 lines for injection, and 2 pumps, each rated 550 gpm. There are 2 intermediate pressure pumps each rated at 425 gpm. Suction is taken from the refueling water storage tank. Concentrated boric acid is injected into the reactor when pumps first start. S*
Low-Pressure Injection System: Four lines, and 2 pumps with piping, instrumentation, etc. make up this system. Pumps are rated 3000 gpm at 600 psig. Pumps take suction from the refueling water storage tank and when this supply is exhausted, recirculation of water from the containment sump is possible. S*
G. MISCELLANEOUS
Decay Heat Removal System: System is used to reduce the temperature of reactor coolant at a controlled rate from 350°F to 140°F, within 20 hrs after shutdown, and to maintain the proper reactor coolant temperature during refueling. Two pumps are available rated 3500 gpm at 140 psig. Residual heat removal pumps circulate reactor coolant through two heat exchangers, returning it to the reactor coolant system through the low pressure injection header. Heat exchanger capacity is 44×10^6 Btu/hr each. S*
Radwaste System: Liquid waste system collects, processes, and recycles reactor grade water, removes or concentrates radioactive constituents and processes them until suitable for reuse or for processing in the solid radwaste system. The gaseous waste processing system removes fission product gases from reactor coolant and contains these gases during normal plant operation. The system also collects gases generated from the boron recycle evaporator. The solid waste processing system receives, packages, stores all solid radioactive wastes generated until shipment offsite. S*
Plant Vent: Vent is at the top of the containment structure.

G. MISCELLANEOUS (Continued) REACTOR: WOLF CREEK NO. 1

Emergency Power: Two diesel generator sets are provided for each reactor. Each generator is connnected to a load group, each reactor having 2 load groups. Diesels are rated 4500 kW each continuously. Each diesel-generator set is independent from the other and has its own auxiliaries. Each diesel has a day tank with 8 hr supply of fuel, one storage tank with 7 days supply of fuel and 2 transfer pumps.

S*

Emergency Plans: Plan provides for protection of plant personnel and the general public and for the prevention or mitigation of property damage resulting from an incident. An emergency organization will be formed and trained and local agencies and state and federal agencies will be used to cover the spectrum of possible emergencies.

Environmental Monitoring: Preoperational program will establish base-line data from which effect of operation can be evaluated. Sampling will include surface waters, biological sampling in the rivers and creeks, fish sampling, ground water, air soils, vegetation, terrestrial mammals, insects, and other factors. Radiological sampling will begin 1 year before start up. Sampling periods are pre-construction, construction, lake filling and operation.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system withdrawing water from cooling lake and returning it to the lake.

Water Taken From: Cooling lake on the Wolf Creek - 6000 acres.

Intake Structure: Reinforced structure about 93' × 100' with 4 bays and 4 circulating pumps, and 2 service water pumps. There are trash racks and traveling screens. Intake velocity will vary from 0.5 to 1 fps.

Water Body Temperatures: Winter minimum 32°F; Summer maximum 87°F

River Flow 0 (cfs) minimum; 1020 (cfs) average

Service Water Quantity 35,000 gpm/reactor

Flow Thru Condenser 551,250 (gpm)/reactor Temp. Rise 30.4°F

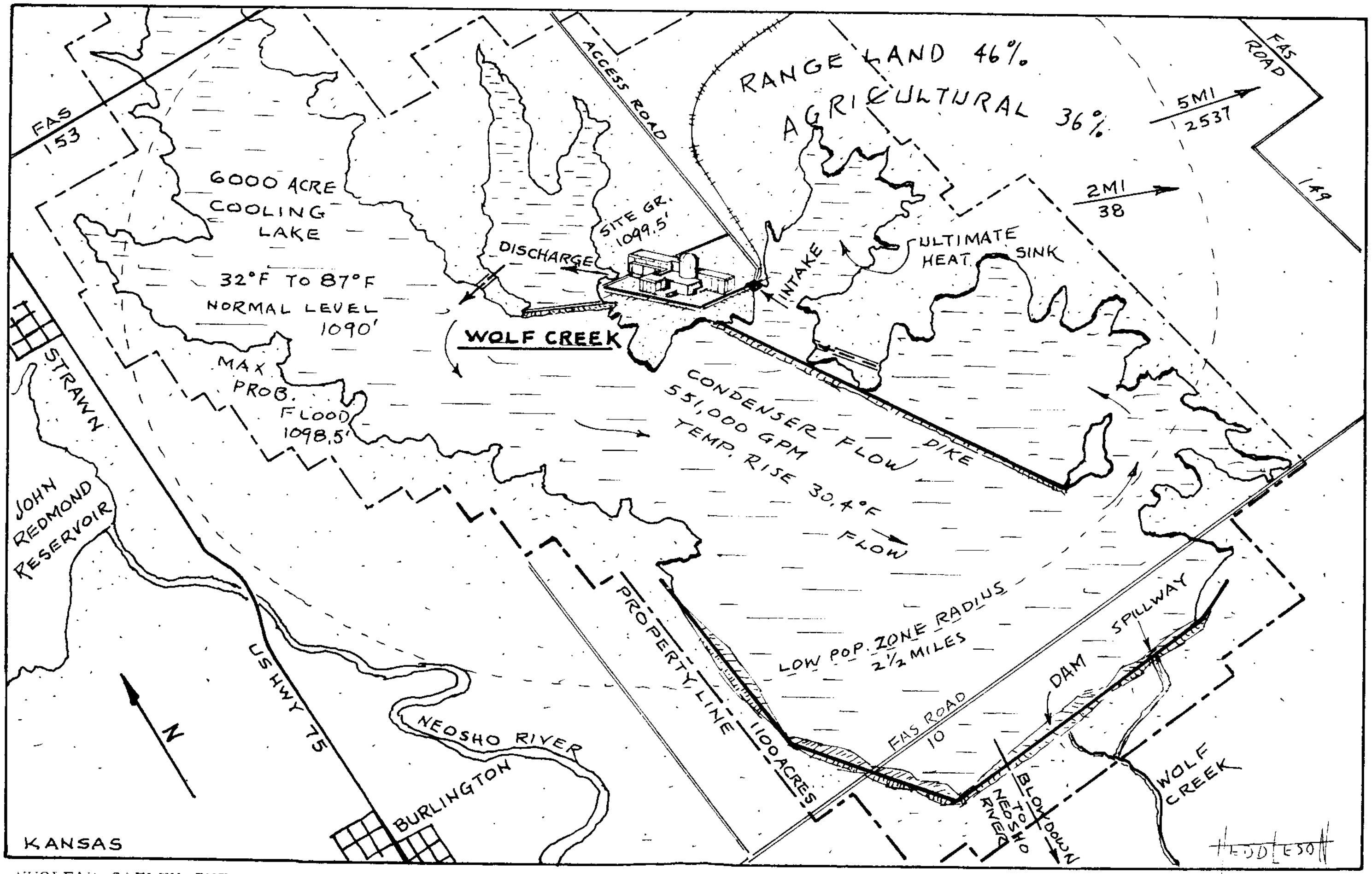
Heat Dissipated to Environment 8500×10^6 (Btu/hr)/reactor

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

Discharge Structure: Reinforced concrete structure about 50' wide by 170' long which discharges water at lake surface in the 50' wide stream. Unit has a slope of 4 to 1 into the lake.

Cooling Tower(s): Description & Number — No cooling towers.

Blowdown ________ gpm/reactor Evaporative loss ________ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

CALLAWAY, 50- 483, 50- 486 Page 1, PWR

A. GENERAL *Site A/E - Sverdrup & Parcel

PROJECT NAME: Callaway Plant, Units 1 & 2

LOCATION: Callaway Co., Missouri (80 mi. W. of St. Louis)

OWNER: Union Electric Co.

OWNER'S ADDRESS & CONTACT: John K. Bryan, Vice Pres., Engg & Const.
P.O. Box 149
Union Electric
St. Louis, Mo. 63166

*ARCHITECT/ENGINEER: Bechtel

REACTOR MANUFACTURER: Westinghouse

CONTAINMENT CONSTRUCTOR: Not decided

TURBINE MANUFACTURER: G.E.

ESTIMATED STARTUP DATE: 1981

DATE:
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Located on an 8 sq mi plateau about 300' higher than the Missouri River flood plain, and about 5 miles N. of the river. Plateau elevations range from 800' to 858'. The utility owns an additional 1760 acres which forms a corridor from the site south to the river and will be used for access road, railroad spur and water pipe line. Access road will connect with Mo. hwy #94 which runs along the river. Jefferson City (pop 32,407) is WSW 25 mi, and Fulton (pop 12,248) is 10 mi N. The closest dairy herd is 1.5 miles away, the closest railroad is 3.5 miles, and I-70 is 12 miles N.

Nearby Body of Water: Missouri River 5 miles south — Normal Level 509' (MSL); Max Prob Flood Level 559' (MSL)

Size of Site 3177 Acres — Site Grade Elevation 840' (MSL)

Topography of Site: Flat - on a small plateau
of Surrounding Area (5 mi rad): Rolling to Hilly

Total Permanent Population: In 2 mi radius 87; 10 mi 9,154
Date of Data: 1970 — In 5 mi radius 893; 50 mi 305,347

Nearest City of 50,000 Population: Columbia, Mo.
Dist. from Site 40 Miles, Direction WNW, Population 58,804

Land Use in 5-Mile Radius: 60% forests, 20% farming, and 20% pasture land

Meteorology: Prevailing wind direction SSE — Avg. speed 10 mph

Stability Data — Site is characterized by rapid transport and dispersion of polutants.

Meteorological Measurements —
Data has been collected since March 1972 with a 300 ft tower.

B. SITE DATA (Continued) REACTOR: CALLAWAY

Exclusion Distance, Miles		0.75	**Design Winds in mph:**
Low Population Zone Distance, Miles		2.5	At 0 — 50 ft elev 100
Metropolis	Distance	Population	50 — 150 ft 120
Columbia, Mo.	40	80,900	150 — 400 ft 140
St. Louis, Mo.	80	675,000	
Safe Shutdown Earthquake Acceleration, g		0.20	Tornado 300 mph tang + 60 trans.
Operating Basis Earthquake Acceleration, g		0.12	ΔP = 3 psi/ 3 sec
Earthquake Vertical Shock, % of Horizontal		60	

S*

C. CONTAINMENT AND STRUCTURES S* - Information from SNUPPS, Std. Nuclear Unit Power Plant System

Design Pressure, psig	60	Free Volume, cu ft	2.50×10^6
Calculated Max Internal Pressure, psig	51	Max Leak Rate at Design Pressure, %/day	0.10

S*

Type of Construction: Prestressed post-tensioned concrete structure with a cylindrical wall, a hermispherical dome and a flat foundation slab. Inside of the structure is lined with 1/4" thick steel plate to ensure leak tightness. Inside diameter is 140' and heighth is 135'. S*

Design Basis: Designed to control the release of radioactivity from a LOCA so that radiation doses do not exceed the limits of 10CFR100. To accomplish this function, design specifies - max. leak rate, performance of engineered safety features so that design temperature and pressures are not exceeded. S*

Vacuum Relief Capability: Found no reference

Post-Construction Testing: Tested in accordance with Bechtel report "Test Criteria for Integrated Leak Rate..." BN-TOP-1, Rev. 1. Structure will be pressure tested at 1.15 design pressure of 60, or at 69 psig. S*

Penetrations: Found no reference

Weld Channels: Seam welds in the liner plate are tested by the vacuum box method for leak tightness. S*

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

Containment Spray System: Operates in conjunction with fan coolers; 2 of 4 coolers and 1 of 2 spray pumps can cool containment after LOCA. Pumps take suction from borated water refueling storage tank or from containment sump in the recirculation mode. Pump capacity is 2460 gpm.
S* Sodium hydroxide is added to remove iodine.

Containment Cooling: There are 4 fan coolers, 2 of which operate in conjunction with containment spray to remove heat after LOCA. Three units are required during normal operation. Heat removal capacity is
S* 104×10^6 Btu/hr. each at 300°F.

Containment Air Filtration: A recirculation and cleanup air system has complete filtration including charcoal filters. Also, a purge system filters all air discharged to the environment. The purge system has
S* prefilters, HEPA filters and 50,000 CFM capacity fans.

Combustible Gas Control: Two 100% capacity hydrogen recombiners are provided to hold hydrogen concentration below 4.1 vol.%. Also, a
S* hydrogen purge subsystem is provided

Containment Floodability: Found no reference

Strong Motion Accelerometer: Triaxial accelerometers will be installed one on the containment base, and one in the containment building on
S* the operating floor. A peak recording accelerometer will be installed in auxiliary bldg.

Turbine Orientation: Reactors and turbine are on the same center line.
S* General Electric will supply the turbine.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference.

Reactor Vessel Design: **Material** SA 533, Gr A or B, Class 1

Shell ID, in. 173 **Shell Thickness** 8 1/4 in.

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

Reactor-Coolant Leak-Detection System: Leakage will be monitored by air particulate, radioactive gas, condensate measuring, humidity, charging pump operation, sump level and pump operation, and make-up water required. Allowable leakage is 10 gpm for identified and 1 gpm
S* for unidentified.

Failed-Fuel-Detection System: Could not find description.

E. REACTOR CHARACTERISTICS		REACTOR: CALLAWAY	
E1. THERMAL-HYDRAULIC		**E2. NUCLEAR**	
Thermal Output, MWt	3425	H_2O/U, Cold	3.48
Electrical Output, MWe (net)	1150	Avg 1st-Cycle Burnup, MWD/MTU	14,000
Total Heat Output, Safety Design, MWt	3650	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	$11,640 \times 10^6$	Region-1 Enrichment, %	2.03
System Pressure, psia	2250	Region-2 Enrichment, %	2.63
DNBR, Nominal	1.88	Region-3 Enrichment, %	3.23
Total Flowrate, lb/hr	138.4×10^6	k_{eff}, Cold, No Power, Clean	1.225
Eff Flowrate for Heat Trans, lb/hr	132.2×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.148
Eff Flow Area for Heat Trans, ft^2	51.4	Total Rod Worth, %	9 3/4 BOL
Avg Vel Along Fuel Rods, ft/sec	16.3	Shutdown Boron, No Rods-Clean-Cold, ppm	<1500
Heat Generated in Fuel, %	--	Shutdown Boron, No Rods-Clean-Hot, ppm	<1100
Hot Channel Factors, Fq	---	Boron Worth, Hot, % Δk/k/ppm	1/100
Nominal Core Inlet Temp, °F	557.5	Boron Worth, Cold % Δk/k/ppm	1/85
Avg Rise in Core, °F	63.7	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.04 \text{ to } -3.0) \times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	648	Moderator Pressure Coeff, Δk/k/psi	$(-0.4 \text{ to } +3.0) \times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	6000	Moderator Void Coeff, Δk/k/% Void	$(+0.5 \text{ to } -2.5) \times 10^{-3}$
Avg Film Temp Diff, °F	36.2	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -2) \times 10^{-5}$
Active Heat Trans Surf Area, ft^2	52,200	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Heat Flux, Btu/hr ft^2	217,200	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Heat Flux, Btu/hr ft^2	579,600	Number of Control Rods	1060
Avg Thermal Output, kw/ft	7	Number of Part-Length Rods (PLR)	160
Max Thermal Output, kw/ft	18.8	Number of Fuel Assemblies	193
Max Clad Surface Temp, °F	657	Overall Dimensions, inches	8.426 × 8.426
No. Coolant Loops	4	Number of Fuel Rods	50,952
W indicates information taken from Westinghouse RESAR		Fuel Rod Cladding Material	Zircaloy
		Weight of Uranium, lbs.	253,675

W

F. SAFETY INJECTION SYSTEMS REACTOR: CALLAWAY

Core Flooding System: Four accumulators each holding 6350 gallons of borated water dump their contents into the reactor when system pressure drops below 600 to 650 psig. Tanks are pressurized to 700 psig with nitrogen gas. Mechanical operation of swing-disc check valves is an automatic operation that opens the line between accumulators and the coolant system. S*

High-Pressure Injection System: There are 4 lines for injection, and 2 pumps, each rated 550 gpm. There are 2 intermediate pressure pumps each rated at 425 gpm. Suction is taken from the refueling water storage tank. Concentrated boric acid is injected into the reactor when pumps first start. S*

Low-Pressure Injection System: Four lines, and 2 pumps with piping, instrumentation, etc. make up this system. Pumps are rated 3000 gpm at 600 psig. Pumps take suction from the refueling water storage tank and when this supply is exhausted, recirculation of water from the containment sump is possible. S*

G. MISCELLANEOUS

Decay Heat Removal System: System is used to reduce the temperature of reactor coolant at a controlled rate from 350°F to 140°F, within 20 hrs after shutdown, and to maintain the proper reactor coolant temperature during refueling. Two pumps are available rated 3500 gpm at 140 psig. Residual heat removal pumps circulate reactor coolant through two heat exchangers, returning it to the reactor coolant system through the low pressure injection header. Heat exchanger capacity is 44×10^6 Btu/hr each. S*

Radwaste System: Liquid waste system collects, processes, and recycles reactor grade water, removes or concentrates radioactive constituents and processes them until suitable for reuse or for processing in the solid radwaste system. The gaseous waste processing system removes fission product gases from reactor coolant and contains these gases during normal plant operation. The system also collects gases generated from the boron recycle evaporator. The solid waste processing system receives, packages, stores all solid radioactive wastes generated until shipment offsite. S*

Plant Vent: Vent is at the top of the containment structure 232 ft above grade.

G. MISCELLANEOUS (Continued) REACTOR: CALLAWAY

Emergency Power: Two diesel generator sets are provided for each reactor. Each generator is connected to a load group, each reactor having 2 load groups. Diesels are rated 4500 kW each continuously. Each diesel-generator set is independent from the other and has its own auxiliaries. Each diesel has a day tank with 8 hr supply of fuel, one storage tank with 7 days supply of fuel and 2 transfer pumps.

Emergency Plans: Detailed Plans will be in the FSAR and will delineate actions taken by plant personnel to minimize exposure, and dose of persons both onsite and offsite. Radiological emergencies at the facility fall into three categories: local, site, and general emergencies. Plan will specify actions to be taken, responsibilities of personnel, and personnel and material resources available for assistance in minimizing radiation exposure. Offsite public and private support agencies will be incorporated into the Emergency Plan and written agreements will be made between these agencies and Union Electric.

Environmental Monitoring: Environmental Report not available and PSAR did not cover this type of monitoring.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using one hyperbolic cooling tower per reactor.

Water Taken From: Missouri River - 40,000 Gpm total makeup for 2 units.

Intake Structure: Makeup for cooling towers pumped from an intake structure along the Missouri River.

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

River Flow 5500 (cfs) minimum; 78,400 (cfs) average

Service Water Quantity 35,000 gpm/reactor

Flow Thru Condenser 550,000 (gpm)/reactor Temp. Rise 30 °F

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

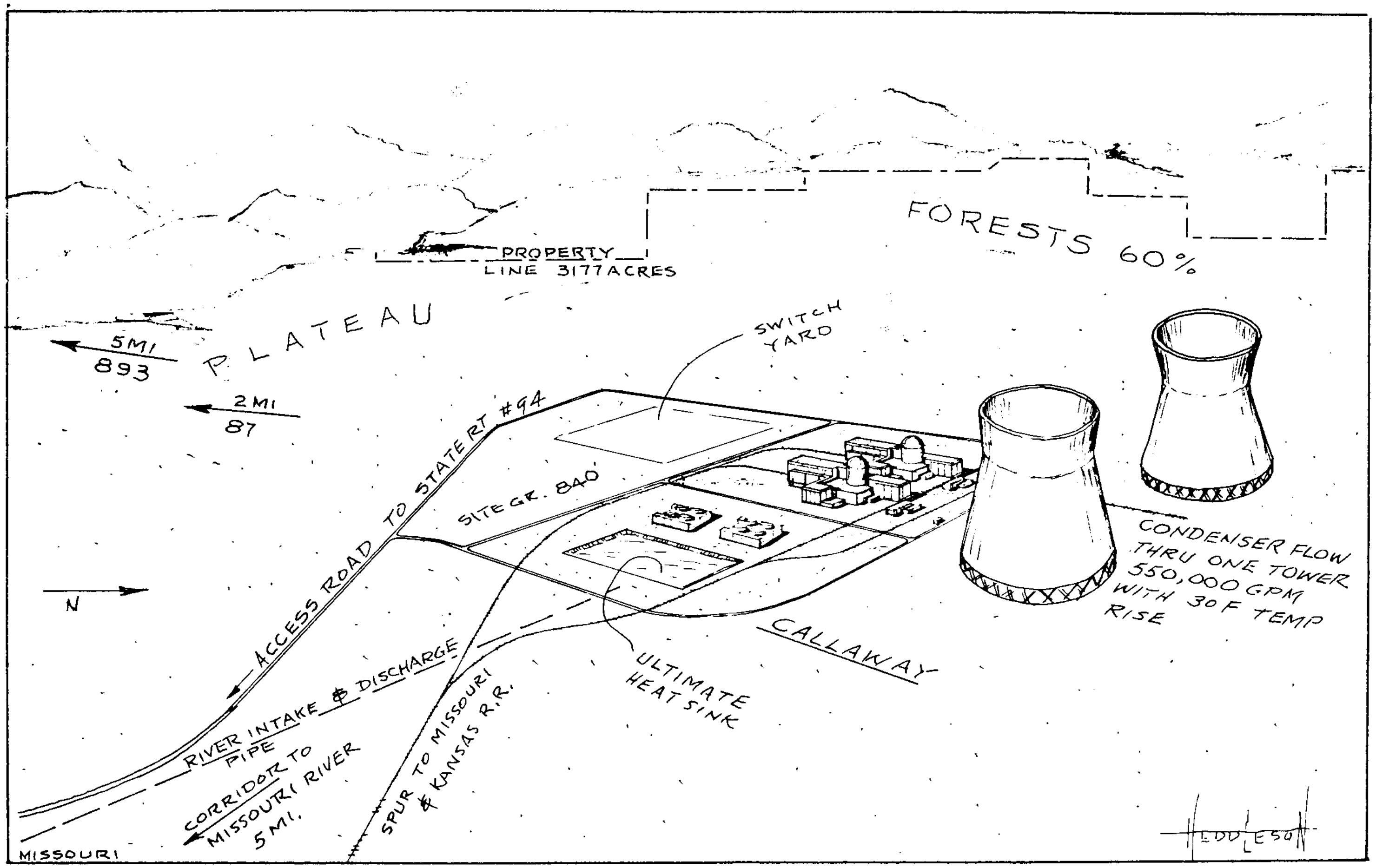
Heat Removal Capacity of Condenser --- (Btu/hr)/reactor

Discharge Structure:

Blowdown from cooling towers is discharged into the Missouri River

Cooling Tower(s): Description & Number - 1 hyperbolic tower for each unit 500' dia. x 500' high.

Blowdown 4868 gpm/reactor Evaporative loss 15,000 gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

TYRONE, 50-484, 50-487 **Page 1,** PWR

A. GENERAL *Site A/E - Commonwealth Associates

PROJECT NAME: Tyrone Energy Park, Units 1 & 2

LOCATION: Dunn Co., Wisconsin (west-central)

OWNER: Northern States Power Company

OWNER'S ADDRESS & CONTACT: A.V. Dienhart, Vice Pres. - Engineering
Northern States Power Co.
414 Nicollet Mall
Minneapolis, MN 55401

***ARCHITECT/ENGINEER:** Bechtel

REACTOR MANUFACTURER: Westinghouse

CONTAINMENT CONSTRUCTOR: ---

TURBINE MANUFACTURER: G.E.

ESTIMATED STARTUP DATE: 1982

DATE: July 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Located on the E. bank of the Chippewa River about 100 feet above the river valley with elevations from 820' to 845'. The site is 1.2 mi SE of the river. Dunnville public hunting and fishing ground is 2 miles from the site. A dairy herd is 1.5 mile E. from the site with 2242 herds in a 5 mile radius- The nearest commercial airport is in Eau Clair (pop. 38,600) 20 mi NE. State route 85, 1 mi S., is the nearest road with I 94 about 14 mi. The Chicago-Milwaukee-St. Paul RR passes through the site perimeters. Durand, (pop. 2,103) is 8 miles SW. Nearest school 4 1/2 mi E. NE. Meridean is nearest village 3 mi NE. Durand has a hospital.

Nearby Body of Water: Chippewa River — **Normal Level** 720' (MSL); **Max Prob Flood Level** 788.5' (MSL)

Size of Site 4700 **Acres** — **Site Grade Elevation** 839.5' (MSL)

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

Total Permanent Population: In 2 mi radius 99 ; 10 mi 8630
Date of Data: 1970 — In 5 mi radius 1126 ; 50 mi ______

Nearest City of 50,000 Population: Minneapolis - St. Paul, Minn.
Dist. from Site 65 **Miles, Direction** WNW , **Population** 750,000

Land Use in 5-Mile Radius: Agricultural and dairy farms

Meteorology: Prevailing wind direction ~~winter NNE~~ summer SSE **Avg. speed** ~~11 mph~~ 9 mph

Stability Data — Neutral conditions (Pasquill D) and slightly stable (Pasquill E) frequently.

Meteorological Measurements —
Measurements started in May 1973 with a 200' tower.

Page 2, PWR

B. SITE DATA (Continued)			REACTOR: TYRONE	
Exclusion Distance, Miles		0.86 radius	**Design Winds in mph:**	
Low Population Zone Distance, Miles		---	At 0 — 50 ft elev	100
Metropolis	Distance	Population	50 — 150 ft	120
Minneapolis St. Paul	65 mi	1,813,647	150 — 400 ft	140
Safe Shutdown Earthquake Acceleration, g		0.20	Tornado 300 mph tang + 60 trans.	
Operating Basis Earthquake Acceleration, g		0.10	ΔP = 3 psi/ 3 sec	
Earthquake Vertical Shock, % of Horizontal		60		

C. CONTAINMENT AND STRUCTURES S* - Information from SNUPPS, Std. Nuclear Unit Power Plant System

Design Pressure, psig	60	Free Volume, cu ft	2.50×10^6
Calculated Max Internal Pressure, psig	51	Max Leak Rate at Design Pressure, %/day	0.10

S* **Type of Construction:** Prestressed post-tensioned concrete structure with a cylindrical wall, a hemispherical dome and a flat foundation slab. Inside of the structure is lined with 1/4" thick steel plate to ensure leak tightness. Inside diameter is 140' and heighth is 135'.

S* **Design Basis:** Designed to control the release of radioactivity from a LOCA so that radiation doses do not exceed the limits of 10CFR100. To accomplish this function, design specifies - max. leak rate, performance of engineered safety features so that design temperature and pressures are not exceeded.

Vacuum Relief Capability: Found no reference

S* **Post-Construction Testing:** Tested in accordance with Bechtel report "Test Criteria for Integrated Leak Rate..." BN-TOP-1, Rev. 1. Structure will be pressure tested at 1.15 design pressure of 60, or at 69 psig.

Penetrations: Found no reference

S* **Weld Channels:** Seam welds in the liner plate are tested by the vacuum box method for leak tightness.

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

Containment Spray System: Operates in conjunction with fan coolers; 2 of 4 coolers and 1 of 2 spray pumps can cool containment after LOCA. Pumps take suction from borated water refueling storage tank or from containment sump in the recirculation mode. Pump capacity is 2460 gpm.
S* Sodium hydroxide is added to remove iodine.

Containment Cooling: There are 4 fan coolers, 2 of which operate in conjunction with containment spray to remove heat after LOCA. Three units are required during normal operation. Heat removal capacity is
S* 104×10^6 Btu/hr. each at 300°F.

Containment Air Filtration: A recirculation and cleanup air system has complete filtration including charcoal filters. Also, a purge system filters all air discharged to the environment. The purge system has
S* prefilters, HEPA filters and 50,000 CFM capacity fans.

Combustible Gas Control: Two 100% capacity hydrogen recombiners are provided to hold hydrogen concentration below 4.1 vol.%. Also, a
S* hydrogen purge subsystem is provided

Containment Floodability: Found no reference

Strong Motion Accelerometer: Triaxial accelerometers will be installed one on the containment base, and one in the containment building on
S* the operating floor. A peak recording accelerometer will be installed in auxiliary bldg.

S* **Turbine Orientation**: Reactors and turbine are on the same center line. General Electric will supply the turbine.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference.

Reactor Vessel Design: **Material** SA 533, Gr A or B, Class 1

Shell ID, in. 173 **Shell Thickness** 8 1/4 in.

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

Reactor-Coolant Leak-Detection System: Leakage will be monitored by air particulate, radioactive gas, condensate measuring, humidity, charging pump operation, sump level and pump operation, and make-up water required. Allowable leakage is 10 gpm for identified and 1 gpm
S* for unidentified.

Failed-Fuel-Detection System: Could not find description.

E. REACTOR CHARACTERISTICS		REACTOR: TYRONE	
E1. THERMAL-HYDRAULIC		**E2. NUCLEAR**	
Thermal Output, MWt	3425	H_2O/U, Cold	3.48
Electrical Output, MWe (net)	1150	Avg 1st-Cycle Burnup, MWD/MTU	14,000
Total Heat Output, Safety Design, MWt	3650	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	$11{,}640 \times 10^6$	Region-1 Enrichment, %	2.03
System Pressure, psia	2250	Region-2 Enrichment, %	2.63
DNBR, Nominal	1.88	Region-3 Enrichment, %	3.23
Total Flowrate, lb/hr	138.4×10^6	k_{eff}, Cold, No Power, Clean	1.225
Eff Flowrate for Heat Trans, lb/hr	132.2×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.148
Eff Flow Area for Heat Trans, ft^2	51.4	Total Rod Worth, %	9 3/4 BOL
Avg Vel Along Fuel Rods, ft/sec	16.3	Shutdown Boron, No Rods-Clean-Cold, ppm	<1500
Heat Generated in Fuel, %	---	Shutdown Boron, No Rods-Clean-Hot, ppm	<1100
Hot Channel Factors, Fq	---	Boron Worth, Hot, % Δk/k/ppm	1/100
Nominal Core Inlet Temp, °F	557.5	Boron Worth, Cold % Δk/k/ppm	1/85
Avg Rise in Core, °F	63.7	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.04 \text{ to } -3.0) \times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	648	Moderator Pressure Coeff, Δk/k/psi	$(-0.4 \text{ to } +3.0) \times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	6000	Moderator Void Coeff, Δk/k/% Void	$(+0.5 \text{ to } -2.5) \times 10^{-3}$
Avg Film Temp Diff, °F	36.2	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -2) \times 10^{-5}$
Active Heat Trans Surf Area, ft^2	52,200	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Heat Flux, Btu/hr ft^2	217,200	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Heat Flux, Btu/hr ft^2	579,600	Number of Control Rods	1060
Avg Thermal Output, kw/ft	7	Number of Part-Length Rods (PLR)	160
Max Thermal Output, kw/ft	18.8	Number of Fuel Assemblies	193
Max Clad Surface Temp, °F	657	Overall Dimensions, inches	8.426 × 8.426
No. Coolant Loops	4	Number of Fuel Rods	50,952
W indicates information taken from Westinghouse RESAR		Fuel Rod Cladding Material	Zircaloy
		Weight of Uranium, lbs.	253,675

W

F. SAFETY INJECTION SYSTEMS   REACTOR: TYRONE

Core Flooding System: Four accumulators each holding 6350 gallons of borated water dump their contents into the reactor when system pressure drops below 600 to 650 psig. Tanks are pressurized to 700 psig with nitrogen gas. Mechanical operation of swing-disc check valves is an automatic operation that opens the line between accumulators and the coolant system.

S*

High-Pressure Injection System: There are 4 lines for injection, and 2 pumps, each rated 550 gpm. There are 2 intermediate pressure pumps each rated at 425 gpm. Suction is taken from the refueling water storage tank. Concentrated boric acid is injected into the reactor when pumps first start.

S*

Low-Pressure Injection System: Four lines, and 2 pumps with piping, instrumentation, etc. make up this system. Pumps are rated 3000 gpm at 600 psig. Pumps take suction from the refueling water storage tank and when this supply is exhausted, recirculation of water from the containment sump is possible.

S*

G. MISCELLANEOUS

Decay Heat Removal System: System is used to reduce the temperature of reactor coolant at a controlled rate from 350°F to 140°F, within 20 hrs after shutdown, and to maintain the proper reactor coolant temperature during refueling. Two pumps are available rated 3500 gpm at 140 psig. Residual heat removal pumps circulate reactor coolant through two heat exchangers, returning it to the reactor coolant system through the low pressure injection header. Heat exchanger capacity is 44×10^6 Btu/hr each.

S*

Radwaste System: Liquid waste system collects, processes, and recycles reactor grade water, removes or concentrates radioactive constituents and processes them until suitable for reuse or for processing in the solid radwaste system. The gaseous waste processing system removes fission product gases from reactor coolant and contains these gases during normal plant operation. The system also collects gases generated from the boron recycle evaporator. The solid waste processing system receives, packages, stores all solid radioactive wastes generated until shipment offsite.

S*

Plant Vent: Vent is at the top of the containment structure 232 ft above grade.

G. MISCELLANEOUS (Continued) REACTOR: TYRONE

Emergency Power: Two diesel generator sets are provided for each reactor. Each generator is connected to a load group, each reactor having 2 load groups. Diesels are rated 4500 kW each continuously. Each diesel-generator set is independent from the other and has its own auxiliaries. Each diesel has a day tank with 8 hr supply of fuel, one storage tank with 7 days supply of fuel and 2 transfer pumps.

S*

Emergency Plans: Plan provides for protection of plant personnel and the general public and for the prevention or mitigation of property damage resulting from an incident. An emergency organization will be formed and trained and local agencies and state and federal agencies will be used to cover the spectrum of possible emergencies.

Environmental Monitoring: A preoperational program will establish baseline data from which the effect of plant operation can be evaluated. Sampling of surface waters will include water studies, biological aspects, aquatic organisms, fish and benthos. Terrestrial studies will be sampling vegetation, soils, mammals, insects and birds. Air and ground water samples will also be taken. The radiological program will begin before construction starts.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using cooling towers.

Water Taken From: Chippewa River for cooling tower makeup, 15,300 gpm for each unit.

Intake Structure: Reinforced concrete about 70' × 70' set at edge of river bank. Has trash racks, traveling screens, and 5 pumps for make-up water - four req'd. with 1 spare. Approach velocity is 0.3 fps.

Water Body Temperatures: Winter average 34 °F; Summer average 76 °F

River Flow 500 (cfs) minimum; 5,600 (cfs) average

Service Water Quantity 35,000 gpm/reactor

Flow Thru Condenser 550,000 (gpm)/reactor Temp. Rise 30.4°F

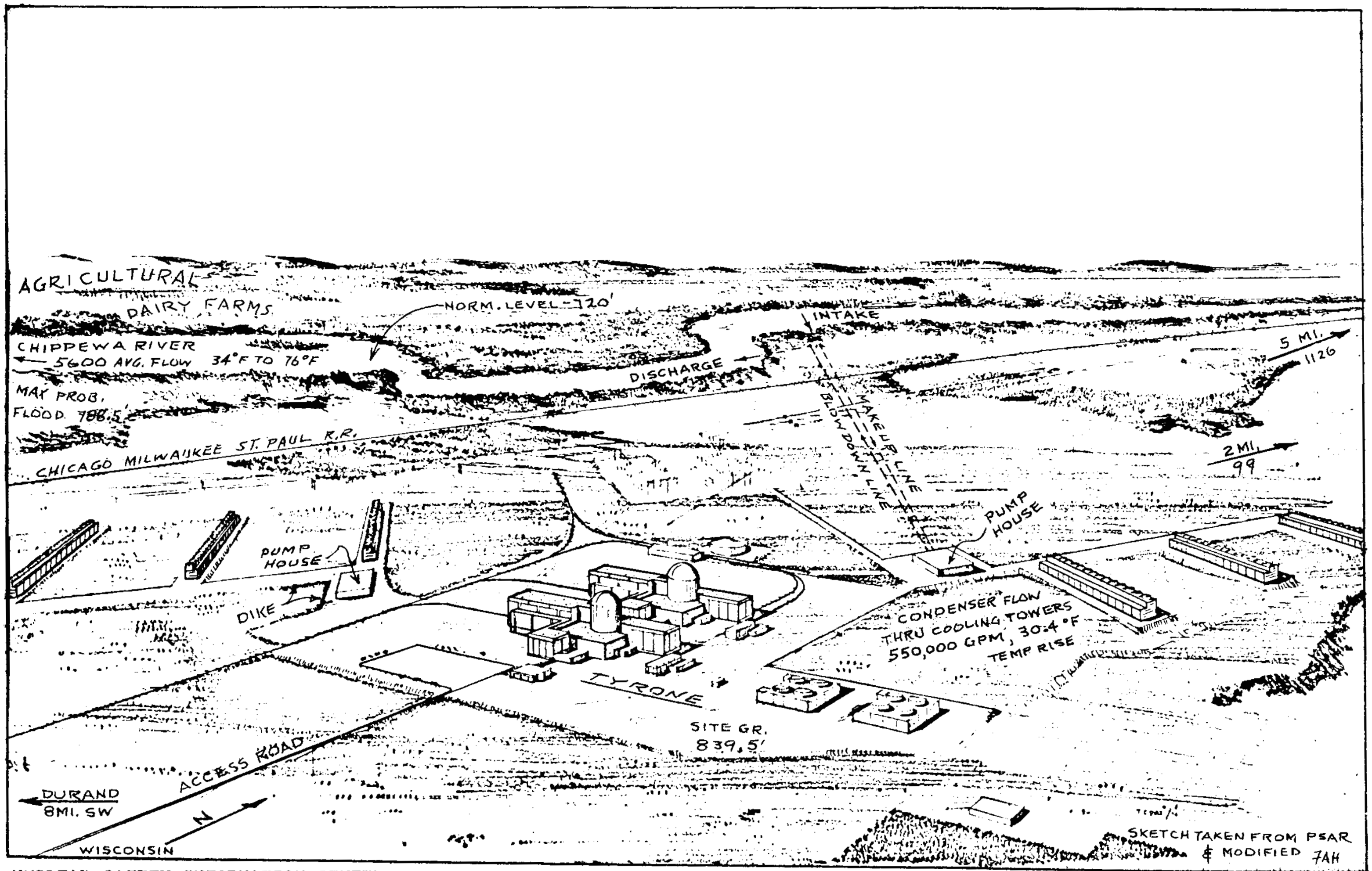
Heat Dissipated to Environment 8500×10^6 (Btu/hr)/reactor

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

Discharge Structure: All wastes and blowdown will be piped to river and discharged thru a diffuser consisting of a 2' dia. pipe with 16 six-inch pipes coming off vertically and then bending 90 deg. to discharge parallel to the flow.

Cooling Tower(s): Description & Number — 3 mech. draft for each reactor.

Blowdown 2505 gpm/reactor Evaporative loss 12,800 gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

STERLING, 50- 485 Page 1, PWR

A. GENERAL *Site A/E - Bechtel

PROJECT NAME: Sterling Power Project Nuclear Unit No. 1

LOCATION: Cayuga Co., N.Y. (50 mi E. of Rochester)

OWNER: Rochester Gas and Electric Co.

OWNER'S ADDRESS & CONTACT: Robert R. Koprowski, Vice Pres.-Chief Engr.
Rochester Gas & Electric
89 E. Avenue
Rochester, N.Y. 14649

*ARCHITECT/ENGINEER: Bechtel

REACTOR MANUFACTURER: Westinghouse

CONTAINMENT CONSTRUCTOR: Bechtel

TURBINE MANUFACTURER: G.E.

ESTIMATED STARTUP DATE: 1982

DATE: August 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Located on the south shore of Lake Ontario with State Hwy 104A along the SE border. Topography is characterized by low-rounded hills with site elevations from 246' to 420'. Site is 34 miles NW of Syracuse, N.Y. and 6.8 miles SW of Oswego. Fairhaven State Park is 2.4 miles SW from the site. A dairy herd is 1.6 mi. US hwy #104 is 4 mi SE. Penn Central RR is 4 miles S. An existing fossil fuel plant is about 4000 ft SSW. The closest school is 5.4 mi SW. Oswego Hospital is 8.4 mi E.

Nearby Body of Water: Lake Ontario
Normal Level 246' (MSL)
Max Prob Flood Level 259' (MSL)

Size of Site 2800 Acres Site Grade Elevation 263' (MSL)

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

Total Permanent Population: In 2 mi radius 197 ; 10 mi 36,180
Date of Data: 1970 In 5 mi radius 2778 ; 50 mi 1,153,753

Nearest City of 50,000 Population: Syracuse
Dist. from Site 34.5 Miles, Direction SE , Population 197,208

Land Use in 5-Mile Radius: Predominantly agricultural and forests - agricultural 1/3.

Meteorology: Prevailing wind direction W to S Avg. speed about 6 mph

Stability Data — Well ventilated with atmospheric diffusion of pollutants good, with high air pollution potential 2 days a year.

Meteorological Measurements —
Measurements at the site started in Dec. 1972 from a 340' tower.

B. SITE DATA (Continued) REACTOR: STERLING

Exclusion Distance, Miles	0.7 min.	
Low Population Zone Distance, Miles	2.5 radius	
Metropolis	Distance	Population
Syracuse, n.Y.	34,5 mi.	636,507
Safe Shutdown Earthquake Acceleration, g		0.20
Operating Basis Earthquake Acceleration, g		0.10
Earthquake Vertical Shock, % of Horizontal		60

Design Winds in mph:

At 0 — 50 ft elev	100
50 — 150 ft	120
150 — 400 ft	140

Tornado 300 mph tang + 60 trans. S*

ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES S* - Information from SNUPPS, Std, Nuclear Unit Power Plant System

S* Design Pressure, psig	60	Free Volume, cu ft	2.50×10^6
Calculated Max Internal Pressure, psig	51	Max Leak Rate at Design Pressure, %/day	0.10

S* Type of Construction: Prestressed post-tensioned concrete structure with a cylindrical wall, a hemispherical dome and a flat foundation slab. Inside of the structure is lined with 1/4" thick steel plate to ensure leak tightness. Inside diameter is 140' and heighth is 135'.

S* Design Basis: Designed to control the release of radioactivity from a LOCA so that radiation doses do not exceed the limits of 10CFR100. To accomplish this function, design specifies max. leak rate, performance of engineered safety features so that design temperature and pressures are not exceeded.

Vacuum Relief Capability: Found no reference

S* Post-Construction Testing: Tested in accordance with Bechtel report "Test Criteria for Integrated Leak Rate..." BN-TOP-1, Rev. 1. Structure will be pressure tested at 1.15 design pressure of 60, or at 69 psig.

Penetrations: Found no reference

S* Weld Channels: Seam welds in the liner plate are tested by the vacuum box method for leak tightness.

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: STERLING	
Containment Spray System: Operates in conjunction with fan coolers; 2 of 4 coolers and 1 of 2 spray pumps can cool containment after LOCA. Pumps take suction from borated water refueling storage tank or from containment sump in the recirculation mode. Pump capacity is 2460 gpm. Sodium hydroxide is added to remove iodine.	S*
Containment Cooling: There are 4 fan coolers, 2 of which operate in conjunction with containment spray to remove heat after LOCA. Three units are required during normal operation. Heat removal capacity is 104×10^6 Btu/hr. each at 300°F.	S*
Containment Air Filtration: A recirculation and cleanup air system has complete filtration including charcoal filters. Also, a purge system filters all air discharged to the environment. The purge system has prefilters, HEPA filters and 50,000 CFM capacity fans.	S*
Combustible Gas Control: Two 100% capacity hydrogen recombiners are provided to hold hydrogen concentration below 4.1 vol.%. Also, a hydrogen purge subsystem is provided	S*
Containment Floodability: Found no reference	
Strong Motion Accelerometer: Triaxial accelerometers will be installed, one on the containment base, and one in the containment building on the operating floor. A peak recording accelerometer will be installed in auxiliary bldg.	S*
Turbine Orientation: Reactors and turbine are on the same center line. General Electric will supply the turbine.	S*
D. REACTOR COOLANT	
Reactor Vessel Failure: Found no reference.	
Reactor Vessel Design: Material SA 533, Gr A or B, Class 1 Shell ID, in. 173 Shell Thickness 8 1/4 in. Overall Height, ft/in. 43'-10" Cladding Thickness, in. 1/8	W
Reactor-Coolant Leak-Detection System: Leakage will be monitored by air particulate, radioactive gas, condensate measuring, humidity, charging pump operation, sump level and pump operation, and make-up water required. Allowable leakage is 10 gpm for identified and 1 gpm for unidentified.	S*
Failed-Fuel-Detection System: Could not find description.	

E. REACTOR CHARACTERISTICS		REACTOR: STERLING	
E1. THERMAL-HYDRAULIC		**E2. NUCLEAR**	
Thermal Output, MWt	3425	H_2O/U, Cold	3.48
Electrical Output, MWe (net)	1150	Avg 1st-Cycle Burnup, MWD/MTU	14,000
Total Heat Output, Safety Design, MWt	3650	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	$11,640 \times 10^6$	Region-1 Enrichment, %	2.03
System Pressure, psia	2250	Region-2 Enrichment, %	2.63
DNBR, Nominal	1.88	Region-3 Enrichment, %	3.23
Total Flowrate, lb/hr	138.4×10^6	k_{eff}, Cold, No Power, Clean	1.225
Eff Flowrate for Heat Trans, lb/hr	132.2×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.148
Eff Flow Area for Heat Trans, ft^2	51.4	Total Rod Worth, %	9 3/4 BOL
Avg Vel Along Fuel Rods, ft/sec	16.3	Shutdown Boron, No Rods-Clean-Cold, ppm	<1500
Heat Generated in Fuel, %	---	Shutdown Boron, No Rods-Clean-Hot, ppm	<1100
Hot Channel Factors, Fq	---	Boron Worth, Hot, % Δk/k/ppm	1/100
Nominal Core Inlet Temp, °F	557.5	Boron Worth, Cold % Δk/k/ppm	1/85
Avg Rise in Core, °F	63.7	Full Power Moderator Temp Coeff, Δk/k/°F	$(+0.04 \text{ to } -3.0) \times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	648	Moderator Pressure Coeff, Δk/k/psi	$(-0.4 \text{ to } +3.0) \times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	6000	Moderator Void Coeff, Δk/k/% Void	$(+0.5 \text{ to } -2.5) \times 10^{-3}$
Avg Film Temp Diff, °F	36.2	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -2) \times 10^{-5}$
Active Heat Trans Surf Area, ft^2	52,200	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1
Avg Heat Flux, Btu/hr ft^2	217,200	Burnable Poisons, Type and Form	Borosilicate glass in SST tubes
Max Heat Flux, Btu/hr ft^2	579,600	Number of Control Rods	1060
Avg Thermal Output, kw/ft	7	Number of Part-Length Rods (PLR)	160
Max Thermal Output, kw/ft	18.8	Number of Fuel Assemblies	193
Max Clad Surface Temp, °F	657	Overall Dimensions, inches	8.426 × 8.426
No. Coolant Loops	4	Number of Fuel Rods	50,952
W indicates information taken from Westinghouse RESAR		Fuel Rod Cladding Material	Zircaloy
		Weight of Uranium, lbs.	253,675

W

F. SAFETY INJECTION SYSTEMS REACTOR: STERLING

Core Flooding System: Four accumulators each holding 6350 gallons of borated water dump their contents into the reactor when system pressure drops below 600 to 650 psig. Tanks are pressurized to 700 psig with nitrogen gas. Mechanical operation of swing-disc check valves is an automatic operation that opens the line between accumulators and the
S* coolant system.

High-Pressure Injection System: There are 4 lines for injection, and 2 pumps, each rated 550 gpm. There are 2 intermediate pressure pumps each rated at 425 gpm. Suction is taken from the refueling water storage tank. Concentrated boric acid is injected into the reactor when
S* pumps first start.

Low-Pressure Injection System: Four lines, and 2 pumps with piping, instrumentation, etc. make up this system. Pumps are rated 3000 gpm at 600 psig. Pumps take suction from the refueling water storage tank and when this supply is exhausted, recirculation of water from the
S* containment sump is possible.

G. MISCELLANEOUS

Decay Heat Removal System: System is used to reduce the temperature of reactor coolant at a controlled rate from 350°F to 140°F, within 20 hrs after shutdown, and to maintain the proper reactor coolant temperature during refueling. Two pumps are available rated 3500 gpm at 140 psig. Residual heat removal pumps circulate reactor coolant through two heat exchangers, returning it to the reactor coolant system through the low pressure injection header. Heat exchanger capacity
S* is 44×10^6 Btu/hr each.

Radwaste System: Liquid waste system collects, processes, and recycles reactor grade water, removes or concentrates radioactive constituents and processes them until suitable for reuse or for processing in the solid radwaste system. The gaseous waste processing system removes fission product gases from reactor coolant and contains these gases during normal plant operation. The system also collects gases generated from the boron recycle evaporator. The solid waste processing system receives, packages, stores all solid radioactive wastes gener-
S* ated until shipment offsite.

Plant Vent: Vent is at the top of the containment structure 232 ft above grade.

G. MISCELLANEOUS (Continued) REACTOR: STERLING

Emergency Power: Two diesel generator sets are provided for each reactor. Each generator is connected to a load group, each reactor having 2 load groups. Diesels are rated 4500 kW each continuously. Each diesel-generator set is independent from the other and has its own auxiliaries. Each diesel has a day tank with 8 hr supply of fuel, one storage tank with 7 days supply of fuel and 2 transfer pumps.

Emergency Plans: Emergency operating and site contingency plans are developed so emergencies of all kinds will be handled in a prompt and competent manner. Arrangements involving local, state and federal agencies is made to ensure readiness of people beyond the plant exclusion area. Minor emergencies will be handled by the normal plant organization. Lines of authority, responsibilities and functions are fully described. Major emergency situations warranting formation of a special force will be developed.

Environmental Monitoring: Environmental Report not available and PSAR did not cover this monitoring.

H. CIRCULATING WATER SYSTEM

Type of System: Once through

Water Taken From: Lake Ontario

Intake Structure: A reinforced concrete structure 4000' off shore in water about 27' deep. Structure is 120' in diameter with 5' × 15' openings all around the periphery. Water flows through a 20' dia conduit to the pump structure. Inlet velocity through intake is 1.5 fps.

Water Body Temperatures: Winter minimum 36°F; Summer maximum 75°F

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

Service Water Quantity 35,000 gpm/reactor

Flow Thru Condenser 834,000 (gpm)/reactor Temp. Rise 20 °F

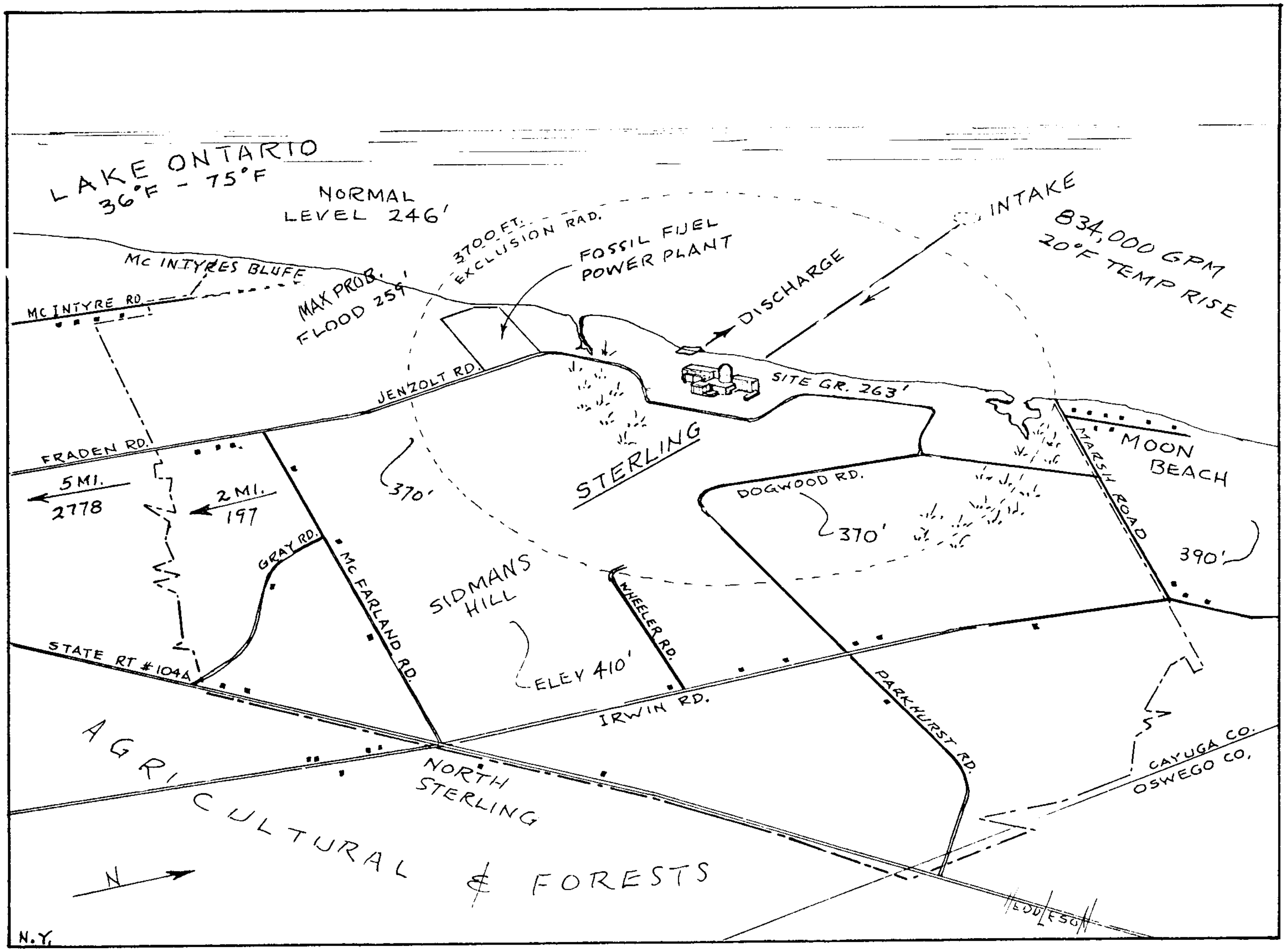
Heat Dissipated to Environment --- (Btu/hr)/reactor

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

Discharge Structure: Reinforced concrete on edge of lake shore, consisting of a seal well which overflows to a sloping canal chute which discharges into a canal which projects out into the lake about 200 ft for surface discharge.

Cooling Tower(s): Description & Number — None

Blowdown ________ gpm/reactor Evaporative loss ________ gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

PERKINS, 50-488, 50-489, 50-490 — Page 1, PWR

A. GENERAL

PROJECT NAME: Perkins Nuclear Station Units 1, 2, and 3

LOCATION: Davie County, N.C., 20 mi SSW of Winston-Salem

OWNER: Duke Power Co.

OWNER'S ADDRESS & CONTACT: W. H. Owen, Vice Pres., Design Engg.
Duke Power
P.O. Box 2178
Charlotte, N.C. 28242

ARCHITECT/ENGINEER: Duke

REACTOR MANUFACTURER: Comb. Engg

CONTAINMENT CONSTRUCTOR: Duke

TURBINE MANUFACTURER: G.E.

ESTIMATED STARTUP DATE: 1981

DATE: Sept. 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Site is bordered on the E. and W. by private property, on the S. by Yadkin River, and on the N. by state highway 801. Nearest towns are Mocksbille (pop 2400) 7 mi NW., Lexington (16,000) 11 mi E., and Salisbury (22,000) 12 mi S. Nearest railroad is the Southern 5 mi N. Nearest major highways are US 64 2.4 mi NE and US 601 5 mi W. Williams Mfg. Co. 2.2 mi NNE. is the only industrial facility in 5 miles. Nearest airport is Twin Lakes 7.5 mi N. River intake structure is a river mile 289. Nearest hospital is 7.8 mi WNW. The nearest school is Churchland Elementary 4.5 mi SSE. McGuire Nuclear Power Plant is 40 mi SW.

Nearby Body of Water: Yadkin River — Normal Level 640' (MSL); Max Prob Flood Level 693.2' (MSL)

Size of Site --- Acres — Site Grade Elevation 710' (MSL)

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

Total Permanent Population: In 2 mi radius 544 ; 10 mi 33,590
Date of Data: 1970 In 5 mi radius 3738 ; 50 mi 1,506,152

Nearest City of 50,000 Population: Winston-Salem
Dist. from Site 20 Miles, Direction NNE , Population 143,000

Land Use in 5-Mile Radius: Agricultural

Meteorology: Prevailing wind direction NE Avg. speed 8.6 mph
Stability Data — Calm G conditions occur about 5% of time
Meteorological Measurements —
Data collection started Oct. -73 with a 130' high tower.

B. SITE DATA (Continued) REACTOR: PERKINS

Exclusion Distance, Miles		0.47 radius
Low Population Zone Distance, Miles	5	
Metropolis	Distance	Population
Greensboro-Winston-Salem	20	603,895
Safe Shutdown Earthquake Acceleration, g		0.15
Operating Basis Earthquake Acceleration, g		0.08
Earthquake Vertical Shock, % of Horizontal		---

Design Winds in mph:

At 0 — 50 ft elev	95
50 — 150 ft	110
150 — 400 ft	130

Tornado 300 mph rot. + 60 trans.

ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES

Design Pressure, psig	49.5	Free Volume, cu ft	3.3×10^6
Calculated Max Internal Pressure, psig	45	Max Leak Rate at Design Pressure, %/day	0.2

Type of Construction: Steel spherical containment 195 ft in diameter and 1 1/2 inches thick surrounded by an annulus and then 3 ft thick shielding concrete. The annulus is maintained at a negative pressure.

Design Basis: Designed to protect the public from consequences of LOCA, based on pipe break in reactor coolant system; such that leakage of radioactive materials will not exceed AEC limits. The containment shell is supplemented by engineering safety features which minimize the consequences.

Vacuum Relief Capability: Found no reference

Post-Construction Testing: Designed for periodic leakage rate testing, as are penetrations.

Penetrations: Designed so they can be tested for leakage, but the sketch of penetrations show them to be single barrier type.

Weld Channels: Found no reference.

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

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

Containment Cooling: Four fan-coil units are available for cooling and circulating the air. Three units run during normal operation and cool the air and blow it downward where other fans distribute the cool air to major heat generation areas. These units not used for emergency cooling after LOCA.

Containment Air Filtration: Leakage from containment is picked up by the annulus ventilation system and filtered through charcoal filters and exhausted so as to maintain 0.5 in. of water vacuum in the annulus.

Combustible Gas Control: The containment hydrogen recombiner system prevents concentration of hydrogen from reaching the lower flammable limit of 4%.

Containment Floodability: Found no reference

Strong Motion Accelerometer: Two strong motion triaxial accelerographs will be installed on the containment structure along with peak accelerometer.

Turbine Orientation: Turbine and reactor are on the same center line.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference

Reactor Vessel Design: Material SA-533 GR. B, Class 1

Shell ID, in. 182 1/4   Shell Thickness ---

Overall Height, ft/in. 50'-2"   Cladding Thickness, in. 1/8

Reactor-Coolant Leak-Detection System: Measurement of leakage into containment is mainly determined by sump level detector with air particulate monitor as backup. Leakage limit for unidentified leakage is 2 gpm. A 1 gpm leak can be detected in 40 minutes.

Failed-Fuel-Detection System: Found no reference

Page 4, PWR

E. REACTOR CHARACTERISTICS		REACTOR: PERKINS	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3817	H_2O/U, Cold	3.57
Electrical Output, MWe (net)	1280	Avg 1st-Cycle Burnup, MWD/MTU	13,740
Total Heat Output, Safety Design, MWt	4018	Maximum Burnup, MWD/MTU	---
Total Heat Output, Btu/hr	$13,000 \times 10^6$	Region-1 Enrichment, %	1.9
System Pressure, psia	2250	Region-2 Enrichment, %	2.4
DNBR, Nominal	2.22	Region-3 Enrichment, %	2.9
Total Flowrate, lb/hr	164×10^6	k_{eff}, Cold, No Power, Clean	1.169
Eff Flowrate for Heat Trans, lb/hr	157.4×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.071
Eff Flow Area for Heat Trans, ft^2	60.8	Total Rod Worth, % Δp (hot)	>10
Avg Vel Along Fuel Rods, ft/sec	16.6	Shutdown Boron, No Rods-Clean-Cold, ppm	960
Heat Generated in Fuel, %	96.5	Shutdown Boron, No Rods-Clean-Hot, ppm	980
Hot Channel Factors, Fq	---	Boron Worth, Hot, % Δk/k/ppm	---
Nominal Core Inlet Temp, °F	565	Boron Worth, Cold % Δk/k/ppm	---
Avg Rise in Core, °F	58	Full Power Moderator Temp Coeff, Δk/k/°F	-2.1×10^{-4}
Nom Hot Channel Outlet Temp, °F	653	Moderator Pressure Coeff, Δk/k/psi	$(+.49 \text{ to } 2.55) \times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	---	Moderator Void Coeff, Δk/k/% Void	$(-.26 \text{ to } -1.35) \times 10^{-3}$
Avg Film Temp Diff, °F	---	Doppler Coefficient, Δk/k/°F	$(-1 \text{ to } -1.8) \times 10^{-5}$
Active Heat Trans Surf Area, ft^2	69,000	Shutdown Margin, Hot 1 rod stuck, %Δk/k	---
Avg Heat Flux, Btu/hr ft^2	182,200	Burnable Poisons, Type and Form	---
Max Heat Flux, Btu/hr ft^2	425,700	Number of Control Rods	81 assem.
Avg Thermal Output, kw/ft	5.34	Number of Part-Length Rods (PLR)	8 assem.
Max Thermal Output, kw/ft	12.5	Number of Fuel Assemblies	241
Max Clad Surface Temp, °F	---	Overall Dimensions, inches	16 × 16
No. Coolant Loops	2	Number of Fuel Rods 236 × 241	56,876
C-80 Combustion Engineering "System 80" design. Data from there indicated by C-80		Fuel Rod Cladding Material	Zircaloy -4
		Weight of Uranium, lbs.	317,131

F. SAFETY INJECTION SYSTEMS REACTOR: PERKINS
C-80 Core Flooding System: Four tanks are provided to flood the core with borated water in case of LOCA and a drop in system pressure to 600 psig. Tanks are pressurized to 600 psig with nitrogen gas. Check valves open automatically to dump contents into the reactor vessel. Each tank holds about 14,000 gallons of liquid.
C-80 High-Pressure Injection System: There are 2 pumps each rated 600 gpm at 1300 psig. They are used to inject borated water into the system if small breaks should occur. Pumps take suction from the refueling water storage tank. These pumps are used also for long term cooling.
C-80 Low-Pressure Injection System: There are 2 pumps in this system each rated 4000 gpm at 150 psig. These pumps inject large quantities of borated water into the core after LOCA. Pumps take suction from the refueling water storage tank. These pumps also function to provide shutdown cooling, by pumping through the heat exchangers.
G. MISCELLANEOUS
C-80 Decay Heat Removal System: Long term decay heat removal uses one of the 2 high-pressure safety injection pumps and recirculates borated water from the containment sump, passing the water through heat exchangers for cooling. Each pump is rated about 1200 gpm at 500 psig. Both pumps could be used if necessary, but one pump has the required capacity.
Radwaste System: System collects and provides controlled treatment for liquid wastes so that releases of radionuclides are below concentrations specified in 10CFR20 and as low as practical. Gaseous wastes are collected, stored, and monitored so that any release will be well below concentrations specified by 10CFR20 and as low as practical. System is designed to protect plant personnel, the general public, and the environment. Solid wastes are collected, processed, and prepared for shipment to offsite disposal stations.
Plant Vent: One for each building at 920.5', running up side of containment. This is 210.5 feet above grade.

G. MISCELLANEOUS (Continued) REACTOR: PERKINS

Emergency Power: Two independent diesel-electric generating units are each rated 6250 kW for continuous operation. Each unit is housed separately and is completely independent. Each unit has a day tank with a 1 hour supply of fuel, and each unit has an underground storage tank with 7 days supply.

Emergency Plans: A coordinated effort involving station personnel, facilities and equipment; emergency resources, and capabilities of Duke Power; outside emergency service; and various local, state and federal agencies concerned for public health and safety. Each Emergency Plan is compatible with facility design features, site layout and site location with respect to access routes, surrounding population, and river and land use. Further description of each Emergency Plan will be presented in the FSAR.

Environmental Monitoring: A pre-operational study program was started in Sept. -73 on the plant site and the Yadkin River. Sampling included water, air-born particulates, radiation dose, bottom and shoreline sediment, aquatic vegetation, plankton, terrestrical vegetation, fish, and other misc. sampling. A second phase of monitoring will begin in the fall of 1974 based on phase I findings. A preoperational Radiological program intends to establish baseline measurements that can be used to access effects of plant operation.

H. CIRCULATING WATER SYSTEM

Type of System: Closed cycle with cooling towers.

Water Taken From: Yadkin River for makeup of 18,000 gpm per cooling tower

Intake Structure: Reinforced concrete structure at river shore line has trash racks, traveling screens, and pumps. The 3 pumps pump water (0.5 fps max. approach velocity) to the Nuclear Service Water Pond where another set of pumps deliver makeup to the cooling towers.

Water Body Temperatures: Winter minimum 37 °F; Summer maximum 78 °F

River Flow 330 (cfs) minimum; 2853 (cfs) average

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 758,000 (gpm)/reactor Temp. Rise 24 °F

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

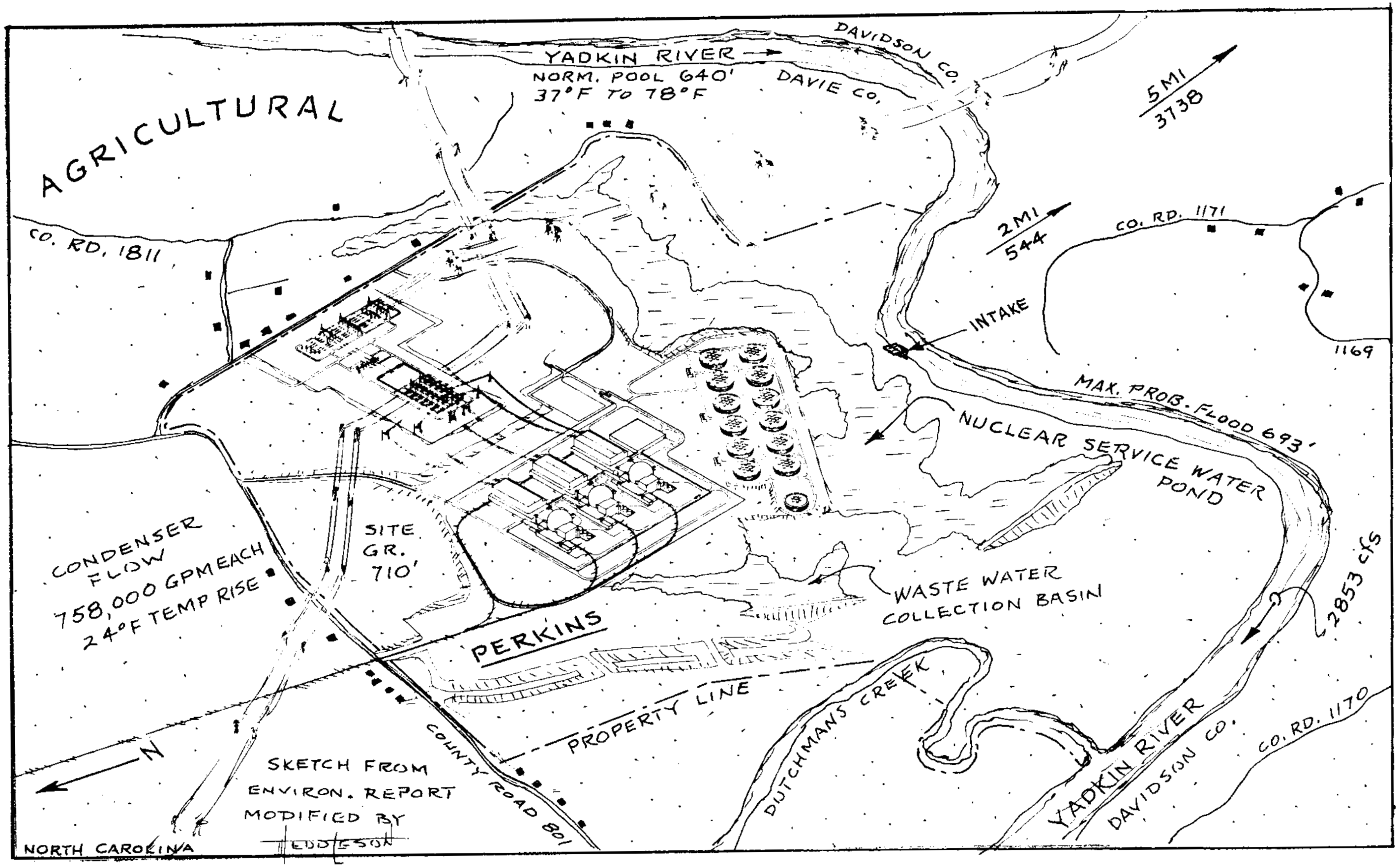
Heat Removal Capacity of Condenser 8404×10^6 (Btu/hr)/reactor

NOTE: These values given in PSAR are erratic

Discharge Structure: Found no information on the method of discharging waste water back to the river.

Cooling Tower(s): Description & Number — Circular mechanical draft - 12 towers, 4 for each plant.

Blowdown 1750 gpm/reactor Evaporative loss 16,158 gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

CHEROKEE, 50-491, 50-492, 50-493 Page 1, PWR

A. GENERAL

PROJECT NAME: Cherokee Nuclear Station Units 1, 2, and 3

LOCATION: Cherokee County, S.C., 21 mi. E NE of Spartanburg

OWNER: Duke Power Co.

OWNER'S ADDRESS & CONTACT: W. H. Owen, Vice President, Design Engg.
Duke Power
P.O. Box 2178
Charlotte, N.C. 28242

ARCHITECT/ENGINEER: Duke

REACTOR MANUFACTURER: Comb. Engg.

CONTAINMENT CONSTRUCTOR: Duke

TURBINE MANUFACTURER: G.E.

ESTIMATED STARTUP DATE: 1981

DATE: Sept. 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Located in an area with sparse population and rolling topography. Ninety-nine Islands Reservoir provides make up water for the cooling towers. I-85 is about 7 miles NW, State hwy 105 is 4 mi SW, US 29 is 5 mi NW, State hwy 5 is 5 mi NE, and the Southern Railroad is 5 miles NE. Although in Cherokee County, the plant is only 1 1/2 miles from York Co. The nearest school is 4 1/2 mi WSW. Nearest residence is 1 mi S. Several milk cows are within 2 miles of the site. Blacksburg, about 6 miles N. is the nearest town (pop 2174). Other Duke Power Co. nuclear plants are Catawba (25 miles), McGuire (43 miles) and Oconee (82 miles).

Nearby Body of Water: Broad River and the Ninety-nine Island Reservoir — Normal Level 509' (MSL); Max Prob Flood Level 541.7' (MSL)

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

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

Total Permanent Population: In 2 mi radius 566 ; 10 mi 31,877
Date of Data: 1970 — In 5 mi radius 3490 ; 50 mi 1,308,327

Nearest City of 50,000 Population: Charlotte, N.C.
Dist. from Site 38 Miles, Direction ENE , Population 241,178

Land Use in 5-Mile Radius: Mostly cattle raising. About 6% of the land is suitable for pasture or farming.

Meteorology: Prevailing wind direction SW Avg. speed 7 mph

Stability Data — Calm periods estimated to be 5% of time.

Meteorological Measurements — Data collection started in Sept. 1973 with measurements taken at 30' and 130' levels.

B. SITE DATA (Continued) REACTOR: CHEROKEE

Exclusion Distance, Miles	0.47 radius		**Design Winds in mph:**
Low Population Zone Distance, Miles	5		At 0 — 50 ft elev: 95
Metropolis	Distance	Population	50 — 150 ft: 110
Charlotte, N.C.	38 mi	409,370	150 — 400 ft: 130
Safe Shutdown Earthquake Acceleration, g	0.15		Tornado 300 mph rot. + 60 trans.
Operating Basis Earthquake Acceleration, g	0.08		ΔP = 3 psi/ 3 sec
Earthquake Vertical Shock, % of Horizontal	---		

C. CONTAINMENT AND STRUCTURES

Design Pressure, psig	49.5	Free Volume, cu ft	3.3×10^6
Calculated Max Internal Pressure, psig	45	Max Leak Rate at Design Pressure, %/day	0.2

Type of Construction: Steel spherical containment 195 ft in diameter and 1 1/2 inches thick surrounded by an annulus and then 3 ft thick shielding concrete. The annulus is maintained at a negative pressure.

Design Basis: Designed to protect the public from consequences of LOCA, based on pipe break in reactor coolant system; such that leakage of radioactive materials will not exceed AEC limits. The containment shell is supplemented by engineering safety features which minimize the consequences.

Vacuum Relief Capability: Found no reference

Post-Construction Testing: Designed for periodic leakage rate testing, as are penetrations.

Penetrations: Designed so they can be tested for leakage, but the sketch of penetrations show them to be single barrier type.

Weld Channels: Found no reference.

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

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

Containment Cooling: Four fan-coil units are available for cooling and circulating the air. Three units run during normal operation and cool the air and blow it downward where other fans distribute the cool air to major heat generation areas. These units not used for emergency cooling after LOCA.

Containment Air Filtration: Leakage from containment is picked up by the annulus ventilation system and filtered through charcoal filters and exhausted so as to maintain 0.5 in. of water vacuum in the annulus.

Combustible Gas Control: The containment hydrogen recombiner system prevents concentration of hydrogen from reaching the lower flammable limits of 4%.

Containment Floodability: Found no reference

Strong Motion Accelerometer: Two strong motion triaxial accelerographs will be installed on the containment structure along with peak accelerometer.

Turbine Orientation: Turbine and reactor are on the same center line.

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference

Reactor Vessel Design: Material SA-533 GR. B, Class 1

Shell ID, in. 182 1/4 Shell Thickness ---

Overall Height, ft/in. 50' - 2" Cladding Thickness, in. 1/8

Reactor-Coolant Leak-Detection System: Measurement of leakage into containment is mainly determined by sump level detector with air particulate monitor as backup. Leakage limit for unidentified leakage is 2 gpm. A 1 gpm leak can be detected in 40 minutes.

Failed-Fuel-Detection System: Found no reference

E. REACTOR CHARACTERISTICS		REACTOR: CHEROKEE	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3817	H_2O/U, Cold	3.57
Electrical Output, MWe (net)	1280	Avg 1st-Cycle Burnup, MWD/MTU	13,740
Total Heat Output, Safety Design, MWt	4018	Maximum Burnup, MWD/MTU	---
Total Heat Output, Btu/hr	$13{,}000 \times 10^6$	Region-1 Enrichment, %	1.9
System Pressure, psia	2250	Region-2 Enrichment, %	2.4
DNBR, Nominal	2.22	Region-3 Enrichment, %	2.9
Total Flowrate, lb/hr	164×10^6	k_{eff}, Cold, No Power, Clean	1.169
Eff Flowrate for Heat Trans, lb/hr	157.4×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.071
Eff Flow Area for Heat Trans, ft^2	60.8	Total Rod Worth, % Δp (hot)	>10
Avg Vel Along Fuel Rods, ft/sec	16.6	Shutdown Boron, No Rods-Clean-Cold, ppm	960
Heat Generated in Fuel, %	96.5	Shutdown Boron, No Rods-Clean-Hot, ppm	980
Hot Channel Factors, Fq	---	Boron Worth, Hot, % $\Delta k/k$/ppm	---
Nominal Core Inlet Temp, °F	565	Boron Worth, Cold % $\Delta k/k$/ppm	---
Avg Rise in Core, °F	58	Full Power Moderator Temp Coeff, $\Delta k/k/°F$	-2.1×10^{-4}
Nom Hot Channel Outlet Temp, °F	653	Moderator Pressure Coeff, $\Delta k/k$/psi	$(+.49 \text{ to } 2.55) \times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	---	Moderator Void Coeff, $\Delta k/k$/% Void	$(-.26 \text{ to } -1.35) \times 10^{-3}$
Avg Film Temp Diff, °F	---	Doppler Coefficient, $\Delta k/k/°F$	$(-1 \text{ to } -1.8) \times 10^{-5}$
Active Heat Trans Surf Area, ft^2	69,000	Shutdown Margin, Hot 1 rod stuck, %$\Delta k/k$	---
Avg Heat Flux, Btu/hr ft^2	182,200	Burnable Poisons, Type and Form	---
Max Heat Flux, Btu/hr ft^2	425,700	Number of Control Rods	81 assem.
Avg Thermal Output, kw/ft	5.34	Number of Part-Length Rods (PLR)	8 assem.
Max Thermal Output, kw/ft	12.5	Number of Fuel Assemblies	241
Max Clad Surface Temp, °F	---	Overall Dimensions, inches	16 × 16
No. Coolant Loops	2	Number of Fuel Rods 236 × 241	56,876
C-80 Combustion Engineering "System 80" design. Data from there indicated by C-80		Fuel Rod Cladding Material	Zircaloy -4
		Weight of Uranium, lbs.	317,131

F. SAFETY INJECTION SYSTEMS REACTOR: CHEROKEE	
C-80	Core Flooding System: Four tanks are provided to flood the core with borated water in case of LOCA and a drop in system pressure to 600 psig. Tanks are pressurized to 600 psig with nitrogen gas. Check valves open automatically to dump contents into the reactor vessel. Each tank holds about 14,000 gallons of liquid.
C-80	High-Pressure Injection System: There are 2 pumps each rated 600 gpm at 1300 psig. They are used to inject borated water into the system if small breaks should occur. Pumps take suction from the refueling water storage tank. These pumps are used also for long term cooling.
C-80	Low-Pressure Injection System: There are 2 pumps in this system each rated 4000 gpm at 150 psig. These pumps inject large quantities of borated water into the core after LOCA. Pumps take suction from the refueling water storage tank. These pumps also function to provide shutdown cooling, by pumping through the heat exchangers.
	G. MISCELLANEOUS
C-80	Decay Heat Removal System: Long term decay heat removal uses one of the 2 high-pressure safety injection pumps and recirculates borated water from the containment sump, passing the water through heat exchangers for cooling. Each pump is rated about 1200 gpm at 500 psig. Both pumps could be used if necessary, but one pump has the required capacity.
	Radwaste System: System collects and provides controlled treatment for liquid wastes so that releases of radionuclides are below concentrations specified in 10CFR20 and as low as practical. Gaseous wastes are collected, stored, and monitored so that any release will be well below concentrations specified by 10CFR20 and as low as practical. System is designed to protect plant personnel, the general public, and the environment. Solid wastes are collected, processed, and prepared for shipment to offsite disposal stations.
	Plant Vent: One for each building at 800.5', running up side of containment. This is 210.5 feet above grade.

G. MISCELLANEOUS (Continued) REACTOR: CHEROKEE

Emergency Power: Two independent diesel-electric generating units are each rated 6250 kW for continuous operation. Each unit is housed separately and is completely independent. Each unit has a day tank with a 1 hour supply of fuel, and each unit has an underground storage tank with 7 days supply.

Emergency Plans: A coordinated effort involving station personnel, facilities and equipment; emergency resources, and capabilities of Duke Power; outside emergency service; and various local, state and federal agencies concerned for public health and safety. Each Emergency Plan is compatible with facility design features, site layout and site location with respect to access routes, surrounding population, and river and land use. Further description of each Emergency Plan will be presented in the FSAR.

Environmental Monitoring: A pre-operational study program was started in Sept. -73 on the plant site and the Broad River. Sampling included water, air-born particulates, radiation dose, bottom and shoreline sediment, aquatic vegetation, plankton, terrestrical vegetation, fish, and other misc. sampling. A second phase of monitoring will begin in the fall of 1974 based on phase I findings. A preoperational Radiological program intends to establish baseline measurements that can be used to access effects of plant operation.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system with cooling towers.

Water Taken From: Broad River for cooling tower makeup

Intake Structure: Reinforced concrete structure at river shore line has trash racks, traveling screens, and pumps. The 3 pumps pump water (0.5 fps max. approach velocity) to the Nuclear Service Water Pond where another set of pumps deliver makeup to the cooling towers.

Water Body Temperatures: Winter minimum 41 °F; Summer maximum 82 °F

River Flow 224 (cfs) minimum; 2472 (cfs) average

Service Water Quantity --- gpm/reactor

Flow Thru Condenser 758,000 (gpm)/reactor Temp. Rise 24 °F

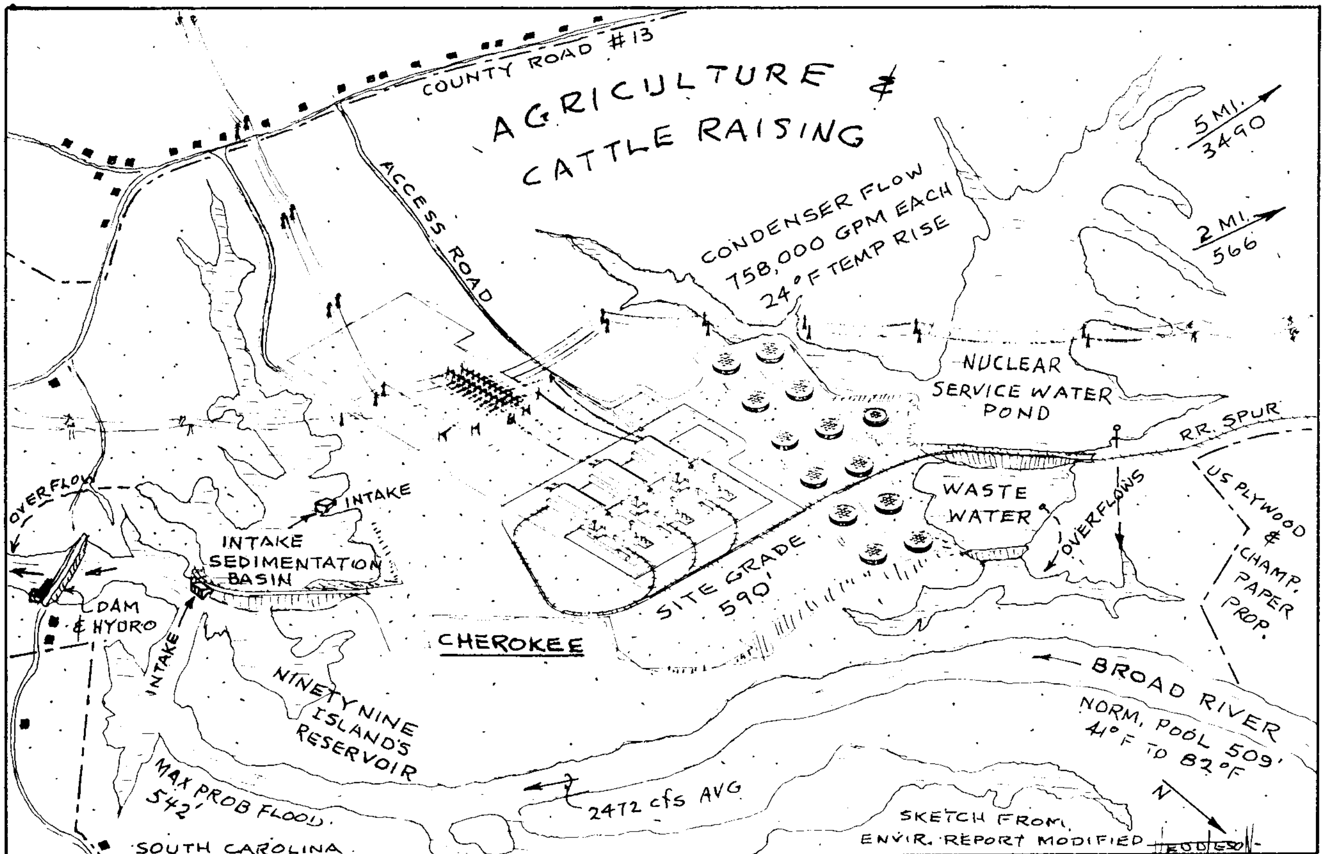
Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 8404×10^6 (Btu/hr)/reactor

Discharge Structure: Found no information

Cooling Tower(s): Description & Number — 12 circular mech. draft towers

Blowdown 1750 gpm/reactor Evaporative loss 16,158 gpm/reactor



NUCLEAR SAFETY INFORMATION CENTER

MONTAGUE, 50-496, 50-497 Page 1, BWR

A. GENERAL

PROJECT NAME: Montague Nuclear Power Station 1 & 2

LOCATION: Franklin Co., NW Mass., 3.5 miles ESE of Greenfield

OWNER: Four N.E. Utilities will own 88% - 30 others own 12%

OWNER'S ADDRESS & CONTACT: Mr. Donald C. Switzer, President
Northeast Nuclear Energy Co.
P. O. Box 270
Hartford, Conn. 06101

ARCHITECT/ENGINEER: Stone & Webster

REACTOR MANUFACTURER: G.E.

CONTAINMENT CONSTRUCTOR: NUS Co.

TURBINE MANUFACTURER: G.E.

ESTIMATED STARTUP DATE: 1981

DATE: October 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Site is located on the Montague Plain, a flat area about 1.5 miles E. of the Connecticut River and about 230 ft above the river. A hill just NW of the plant rises up about 300 ft above the site. Then east of the site about 1.5 mi, hills begin that rise up to 900 ft elev. Most of the area is covered with scrub oak. Two bodies of water, about 1 mi SE are used for municipal water supplies. Several small towns are within 2 miles of the site and Greenfield (pop 15,000) is 3.5 mi WNW. The nearest residence is 0.8 mi from the reactors. I91 is 5 mi W. Two railroad lines pass within 1.5 mi of the reactors. Four dairy herds are within 2.5 mi of the site, about 150 cows total, about 130 in the SW. The nearest hospital is 2.7 mi WNW in Montague City. Numerous recreational sites are within 5 mi of the site.

Nearby Body of Water: Connecticut River — Normal Level 106' (MSL); Max Prob Flood Level 190' (MSL)

Size of Site 1900 Acres — Site Grade Elevation 340' (MSL)

Topography of Site: Flat
of Surrounding Area (5 mi rad): Hills NW (close) and East (1 1/2 mi)

Total Permanent Population: In 2 mi radius 2590; 10 mi 37819
Date of Data: 1970 — In 5 mi radius 23692; 50 mi ---

Nearest City of 50,000 Population: Holyoke
Dist. from Site 15.5 Miles, Direction SSW, Population 50,112

Land Use in 5-Mile Radius: Mostly wooded (about 75%) with small amount of farming and pasturing.

Meteorology: Prevailing wind direction S — Avg. speed 8 mph
Stability Data — High potential for air pollution about 2 each year.
Meteorological Measurements — Taken at the site since Sept. -73 at 33', 150', 325', and 494' levels.

B. SITE DATA (Continued) REACTOR: Montague

Exclusion Distance, Miles	0.48 radius	
Low Population Zone Distance, Miles	2.5	
Metropolis	Distance	Population
Springfield-Holyoke	30 mi	592,922
Safe Shutdown Earthquake Acceleration, g		0.20
Operating Basis Earthquake Acceleration, g		0.10
Earthquake Vertical Shock, % of Horizontal		---

Design Winds in mph:

At 0 — 50 ft elev	90
50 — 150 ft	105
150 — 400 ft	125

Tornado 300 mph rot. + 60 trans.

ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES

Drywell Design Pressure, psig	25	Primary Containment Leak Rate, %/day	0.3
Suppression Chamber Design Pressure, psig	15	Secondary Containment Design Pressure, psig	0.6
Calculated Max Internal Pressure, psig	20.3	Secondary Containment Leak Rate, %/day	---

Type of Construction: A free-standing steel structure a right circular cylinder with a torospherical dome and flat bottom. Surrounding containment is a reinforced concrete shield building. Shield building is a right circular cylinder with a constant radius dome and is separated from containment. Separation provides an annular space between the two structures. Internal structures include a reinforced concrete drywell and a suppression pool. Drywell free vol. is 273,000 cu. ft. and suppression chamber - 1.37×10^6.

Design Basis: Designed to withstand with sufficient margin the peak accident pressure and temperature that could occur during LOCA; and also to limit the release of fission products so the public and employees will be protected from radiation exposure. The outside shield building provides shielding and provides secondary containment.

Vacuum Relief Capability: Found no reference

Post-Construction Testing: Periodic integrated leak tests will be run in accordance with app. J of 10CFR50. After construction, leakage tests will be run to find leaks and establish leak rates. An acceptance structure test will be run pressurizing the structure to determine its meeting acceptance codes.

Penetrations: Some are double barrier and some of single barrier.

Weld Channels: All floor welded seams will be covered with continuously welded test channels.

C. CONTAINMENT & STRUCTURES (Contd)   REACTOR: Montague

Containment Heat Removal System: Four fan-coil unit coolers, each with 50% capacity, operate automatically to remove containment heat after LOCA. Also, the containment heat removal system of RHS operates to cool containment suppression pool water.

Standby Gas Treatment System: Process exhaust air from various systems to limit release of radioactivity. System goes into operation during a LOCA to collect and filter exhaust air from the annulus. There are 2 parallel systems. Filter banks have demister, electric heating coil, prefilters, HEPA filters, and charcoal absorber banks.

Combustible Gas Control: There is a hydrogen mixing system in the dry-well with effluent lines running to the annulus. Also, there are hydrogen recombiners.

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

Strong Motion Accelerometer: Units will be installed in 4 locations. Three will be in unit 1 containment, and the 4th in the auxillary building. Also, peak recording accelerometers will be installed.

Turbine Orientation: Turbine and reactor are on the same centerline - the 2 turbines are parallel to each other.

D. REACTOR COOLANT

Reactor Vessel Failure: No reference to vessel failure was found.

Reactor Vessel Design: Material — Low alloy steel/cladded

Shell ID, in. 238   Shell thickness, in. 5.77

Overall height, ft/in. 70' - 10"   Cladding thickness, in. 1/8

Leak-Detection System: Consists of temperature, pressure, flow, and fission product sensors which detects and annunciates leakage. Small leaks are detected by temperature and pressure changes, fill up rate of sumps, and fission product concentration. Large leaks are detected by changes in water levels and changes in flow rates in process lines.

Failed-Fuel-Detection System: Four gamma radiation monitors external to the main steam lines just outside containment monitors gross release of fission products released into the steam. When radiation is detected, trip signals are generated that scram the reactor and close the isolation valves.

Long-Term Cooling: Suppression pool water is circulated through the reactor and cooled by heat exchangers.

E. REACTOR CHARACTERISTICS REACTOR: Montague

E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3579	Moderator Temp Coef Cold, $\Delta k/k/°F$	$+4 \times 10^{-5}$
Electrical Output, MWe (net)	1150	Moderator Temp Coef Hot, No Voids	-14×10^{-5}
Total Heat Output, Safety Design, MWt	3758	Moderator Void Coef Hot, No Voids, $\Delta k/k/\%$	$\sim -5 \times 10^{-4}$
Steam Flow Rate, lb/hr	15.4×10^{6}	Moderator Void Coef Operating	$\sim -20 \times 10^{-4}$
Total Core Flow Rate, lb/hr	105×10^{6}	Doppler Coefficient, Cold	-1.7×10^{-5}
Feedwater Flow Rate, million lb/hr	15.36×10^{6}	Doppler Coefficient, Hot, No Voids	-1.05×10^{-5}
Feedwater Temperature, °F	420	Doppler Coefficient, Operating	-1.1×10^{-5}
Coolant Pressure, psig	1040	Initial Enrichment, %	2.07
Heat Transfer Area, ft^2	73,409	Average Discharge Exposure, MWD/Ton	12,000 to 19,000
Max Power per Fuel Rod Unit Lgth, kw/ft	13.4	Control Rod Worth, %	0.01 Δk
Maximum Heat Flux, $Btu/hr\text{-}ft^2$	354,000	Burnable Poisons, Type and Form	Gd_2O_3 mixed with UO_2
Average Heat Flux, $Btu/hr\text{-}ft^2$	159,550	Number of Moveable Control Rods	177
Maximum Fuel Temperature, °F	3325	No. of In-Core Neutron Detectors (Fixed)	164
Average Fuel Rod Surface Temp., °F	565	No. of In-Core Detector Assemblies	41
MCHFR	≥ 1.9	Number of Fuel Assemblies	732
Coolant Enthalpy at Core Inlet, Btu/lb	527.9	Fuel Rod Array	8 × 8
Total Peaking Factor	2.22	No. Fuel Rods Per Fuel Assembly	63
Avg Power Density, Kw/ℓ	56.0	MISCELLANEOUS:	
Peak Fuel Enthalpy on Rod Drop, Cal/gm	280		
Core Max. Exit Voids Within Assembly, %	76		
Number of Recirculation Loops	2		
Pipe Diameter, in.	22/24		
Recirculation Pump Flow, gpm	35,400		
Number of Jet Pumps in Reactor	20		
Number of Main Steam Lines	4		
Pipe Diameter, in.	26		

F. EMERGENCY CORE COOLING SYSTEMS   REACTOR: Montague

__High-Pressure Core Spray__: Provides and maintains coolant inside reactor vessel to keep cladding below fragmentation temperature in the case of small coolant system breaks or leaks. System has one pump rated 1465 gpm at 1130 psid or 6000 gpm at 200 psid. Pump takes suction initially from condensate storage tank, but can switch to containment sump if necessary.

__Auto-Depressurization System__: Rapidly reduces reactor vessel pressure in a LOCA situation when high press. core spray fails to maintain adequate water level on the core - so the low pressure injection systems can start operating. The ADS vents thru safety relief valves that are part of the pressure relief system.

__Low-Pressure Core Spray__: Consists of one independent pump, valves, and piping to deliver cooling water to the spray sparger over the core. The pump is rated 6000 gpm at 122 psid. This system in conjunction with the ADS or HPCS can maintain fuel cladding below fragmentation temperature. Water is pumped from the suppression pool. Low water in reactor or high drywell pressure, with low pressure in the reactor vessel, automatically starts this system.

__Low-Pressure Coolant-Injection System__: An operating mode of Residual Heat Removal System to inject large quantities of water into the pressure vessel when pressure has dropped after LOCA. There are 3 pumps, each rated 7100 at 20 psid. Pumps start automatically on low water level in the reactor vessel or high drywell pressure and take suction from the suppression pool.

G. MISCELLANEOUS

__Residual-Heat-Removal System (RHRS)__: A system of pumps, heat exchangers, and piping that has the following operating modes: (1) removes decay heat during and after plant shutdown, (2) injects water into the reactor vessel after LOCA to flood the core and prevent melting of the fuel cladding, and (3) remove heat from containment following LOCA to hold down pressure. Two pumps (LPCI) are rated 7100 gpm at 20 psid.

__Radwaste System__: Gaseous radwaste from the main condenser is processed through continuously operating refrigerated charcoal which holds up radioactive components and removes particulate matter. This decreases noble gas release to a value below 70 Ci/sec. Liquid and solid radwaste is processed by batch operation allowing activity checks at each stage. Liquid waste is released to the environment from only one point after being checked in waste discharge sample tanks. All radioactive discharges are diluted with cooling tower blowdown and monitored. Packaged radioactive solid waste is stored for further decay prior to shipment for offsite disposal.

__Plant Vent__: Roof top exhaust about 165 ft above grade.

G. MISCELLANEOUS (Continued) REACTOR: Montague

Emergency Power: There are 3 emergency diesel-generators for each reactor, all electrically and physically independent of each other. These units can supply A-C power within 10 seconds after receipt of starting signal. One unit is exclusive for core spray systems. The day tank has 1 hr supply of fuel and a buried tank for each unit has 7 days supply for full power operation.

Emergency Plans: To delineate an organization to cope with emergencies, to classify them as to severity, to define and assign responsibilities and authorities, and to outline effective courses of action and protective measures required to mitigate the consequences and to safeguard the public and station personnel. Detailed emergency procedures are developed and available which take into account radiation hazards, weather conditions, and availability of technical and operating personnel.

Environmental Monitoring: Preoperational studies are being carried out to establish base line data so construction effects and effects of operation can be determined. Numerous studies will be conducted on the Conn. River to determine water quality, biological organisms, and fish life. Vegetation will be collected and studied including aerial infrared photography. Sound measurements will be made to establish a working baseline. Soils, birds, mammals, and reptiles will be studied. Also, a radiological monitoring program will be started.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using hyperbolic cooling tower.

Water Taken From: Connecticut River for makeup

Intake Structure: Reinforced concrete structure on the river bank with 3 - 50% capacity pumps. Trash racks and traveling screens are provided. Traveling screens are protected from freezing by a curtain wall. Lateral fish passageways are provided.

Water Body Temperatures: Winter minimum 32 °F; Summer maximum 87 °F

River Flow 1300 (cfs) minimum; 13,460 (cfs) average

Service Water Quantity 25,000 gpm/reactor

Flow Thru Condenser 600,000 (gpm)/reactor Temp. Rise 28 °F

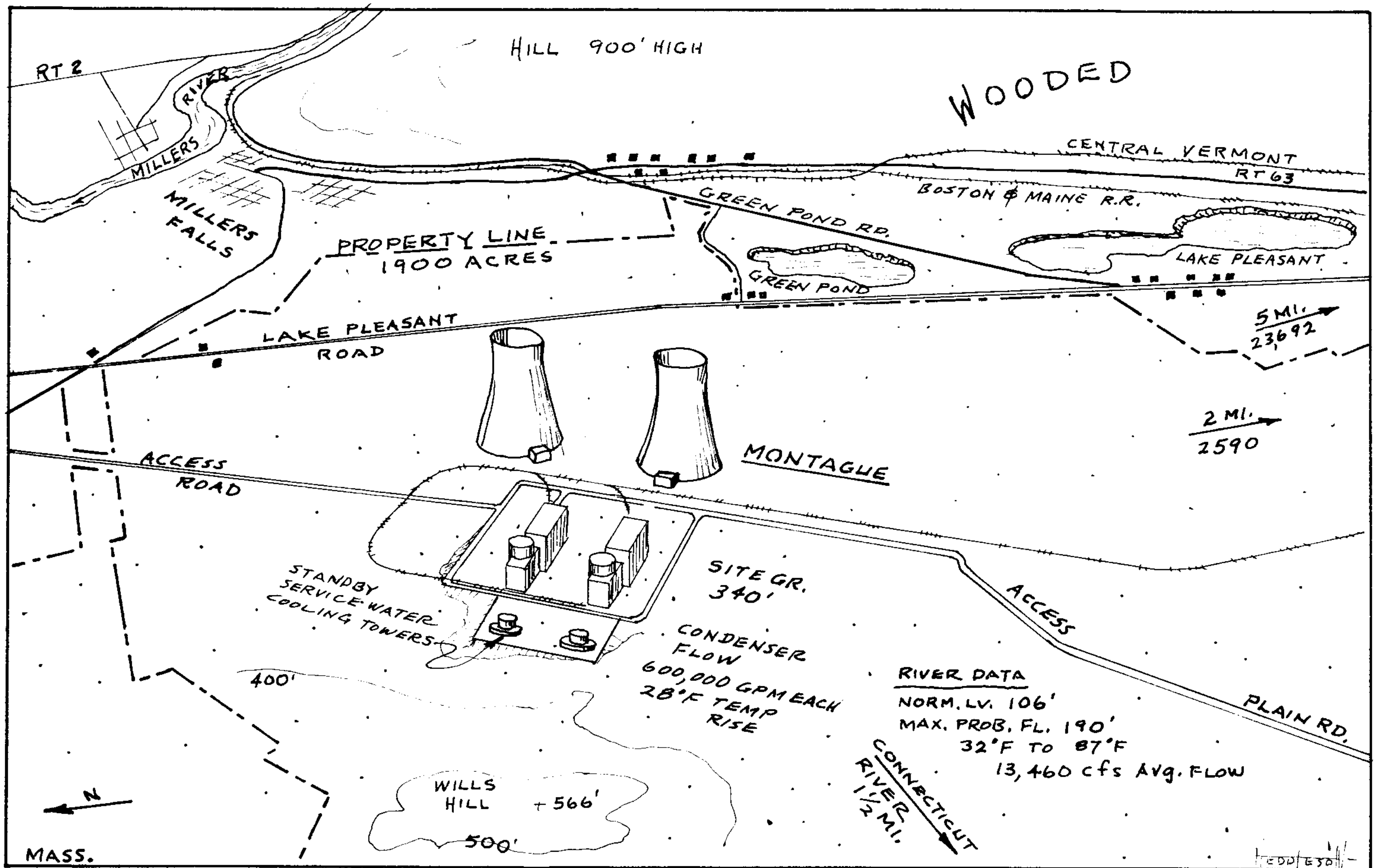
Heat Dissipated to Environment 8300×10^6 (Btu/hr)/reactor

Heat Removal Capacity of Condenser 8540×10^6 (Btu/hr)/reactor

Discharge Structure: A 15" diameter pipe projecting out into the river about 25 ft discharges blowdown to the river.

Cooling Tower(s): Description & Number — One each hyperbolic tower

Blowdown 5000 gpm/reactor Evaporative loss 24,000 gpm/reactor


HILL 900' HIGH
WOODED
RT 2
RIVER
MILLERS
MILLERS FALLS
CENTRAL VERMONT
RT 63
BOSTON & MAINE R.R.
GREEN POND RD.
PROPERTY LINE
1900 ACRES
GREEN POND
LAKE PLEASANT
LAKE PLEASANT ROAD
5 MI.
23,692
2 MI.
2590
MONTAGUE
ACCESS ROAD
STANDBY SERVICE WATER COOLING TOWERS
SITE GR. 340'
CONDENSER FLOW
600,000 GPM EACH
28°F TEMP RISE
RIVER DATA
NORM. LV. 106'
MAX. PROB. FL. 190'
32°F TO 87°F
13,460 cfs Avg. FLOW
ACCESS
PLAIN RD.
CONNECTICUT RIVER 1 1/2 MI.
400'
WILLS HILL +566'
500'
N
MASS.

SOUTH TEXAS 50-498, 50-499 Page 1, PWR

A. GENERAL

PROJECT NAME: South Texas Project, Units 1 & 2

LOCATION: South Central Matagora Co. - 90 miles S.W. of Houston

OWNER: Houston Lighting & Power and others

OWNER'S ADDRESS & CONTACT: G. W. Oprea, Jr. Group Vice-Pres.
Electric Tower
P.O. Box 1700
Houston, Texas 77001

ARCHITECT/ENGINEER: Brown & Root

REACTOR MANUFACTURER: Westinghouse

CONTAINMENT CONSTRUCTOR: Brown & Root

TURBINE MANUFACTURER: Westinghouse

ESTIMATED STARTUP DATE: 1980

DATE: November 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Located in a rural area 3 miles W. of the Colorado River, about 14 miles from the Gulf of Mexico and about 10 miles N. of the Bay of Matagora which opens into the Gulf. The town of Matagora (pop 1219) is 8 mi. SE, Bay City (pop 11,733) is 15 mi. NNE. The nearest school is in Matagora. Nearest state highways are Rt 60 7 1/2 mi. E. and Rt 35 9 mi. NW. The nearest railroad is the Missouri Pacific, from which a spur will be run in, about 5 miles NNE. The nearest residence is 2 1/2 mi. WSW. There are 6 ranches within 10 miles of the site with a total of 3600 head of cattle. A 16" dia. natural gas line crosses the site, 2.1 mi. NW of the plant.

Nearby Body of Water: Colorado River — Normal Level 0 (MSL); Max Prob Flood Level 60' (MSL)

Size of Site 12,350 Acres — Site Grade Elevation 28' (MSL)

Topography of Site: Flat 15' to 30' MSL
of Surrounding Area (5 mi rad): Flat

Total Permanent Population: In 2 mi radius 9; 10 mi 3207
Date of Data: 1970 — In 5 mi radius 229; 50 mi 176,239

Nearest City of 50,000 Population: Galveston
Dist. from Site 80 Miles, Direction ENE, Population 65,000

Land Use in 5-Mile Radius: Agricultural - growing of rice is the major crop.

Meteorology: Prevailing wind direction SE — Avg. speed 9 1/2 mph 195' level

Stability Data — Tendency for stable conditions.

Meteorological Measurements — Site measurements of meterological data started in July 1973 with 33' and 195' elevations on the tower.

B. SITE DATA (Continued) REACTOR: SOUTH TEXAS

Exclusion Distance, Miles	about 1 mi Rad.
Low Population Zone Distance, Miles	3
Metropolis: Houston, Texas — Distance: 90 mi. — Population: 1,985,031	
Safe Shutdown Earthquake Acceleration, g	0.10
Operating Basis Earthquake Acceleration, g	0.05
Earthquake Vertical Shock, % of Horizontal	67

Design Winds in mph:

At 0 – 50 ft elev	120
50 – 150 ft	145
150 – 400 ft	175

Tornado 300 mph tang. + 60 trans.

ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES

Design Pressure, psig	56.5	Free Volume, cu ft	3.3×10^6
Calculated Max Internal Pressure, psig	49.4	Max Leak Rate at Design Pressure, %/day	0.3

Type of Construction: A post-tensioned concrete cylinder with a steel liner plate, hemispherical top and flat bottom. The cylinder portion and the hemispherical dome of the Containment are prestressed by a post-tensioning system consisting of horizontal and vertical tendons. Walls are 4 ft thick, roof 3 ft thick and the steel liner varies from 3/16 to 3/8 in. Diameter is 150 ft (ID) and heighth is 165 ft.

Design Basis: Designed to accommodate, without exceeding the design leak rate, the transient peak pressure and temperature associated with a design basis accident. The containment heat removal system is designed to cool the atmosphere after a LOCA to prevent over pressurization.

Vacuum Relief Capability: A vacuum relief system is provided to handle normal variations in pressure which could result in a vacuum inside containment. Liner is designed for 2.5 psi vacuum.

Post-Construction Testing: The structural acceptance test is run at 1.15 times containment design pressure, being applied in 4 equal pressure increments. Preoperational and post-operational leakage rate tests will be run per 10CFR Appendix J.

Penetrations: Sketches of penetrations show them to be single barrier without pressure taps for testing.

Weld Channels: Found no reference.

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: SOUTH TEXAS

Containment Spray System: Cool, borated water is sprayed into the containment atmosphere to limit the temperature rise after LOCA. Suction is taken from the Refueling Water Storage Tank. When supply is exhausted, water is recirculated from the containment sump. Three pumps, each rated 1800 gpm at 300 psig, are the major components of 3 separate spray systems, each independent of the other. Sodium hydroxide is added

Containment Cooling: Six 25% fan coolers limit the air temperature during normal operation and after LOCA. Units are arranged in 3 redundant trains. During normal operation, the Chilled Water System cools the coils. After LOCA, the Component Cooling Water System cools the coils. Cooler capacity is 2.25×10^6 or 47.4×10^6 Btu/hr each

Containment Air Filtration: The containment Penetration Space Exhaust Subsystem provides air cleanup. It maintains negative pressure in the penetration space. There are 2 100% capacity units consisting of prefilters, HEPA, carbon filters, HEPA for carbon fines, and exhaust fan.

Combustible Gas Control: There are 2 independent systems - hydrogen recombiner and a purge system which maintains hydrogen concentration below combustible limits.

Containment Floodability: Found no reference

Strong Motion Accelerometer: Two units will be installed in containment, one in the basement and one just above it high up in the structure.

Turbine Orientation: The turbine and the reactor are on parallel center lines. Ejected turbine blades probably could not strike containment. The basement unit will read out in the control room.

D. REACTOR COOLANT

W Reactor Vessel Failure: Designed by ASME Boiler & Pressure Vessel Code, Sect. III, etc. Both elastic and inelastic stress analysis techniques were used. Failure not mentioned.

W Reactor Vessel Design: **Material** SA533 Gr A or B, Class 1

Shell ID, in. 173 — **Shell Thickness** about 6"

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

Reactor-Coolant Leak-Detection System: Consists of temperature, pressure, humidity, flow, and radioactivity sensors with associated instrumentation and alarms. Small leaks are detected by temperature and pressure changes, increasing sump levels and radioactivity concentration changes inside Containment. Large leaks are detected by changes in reactor coolant inventory and changes in process line flows.

Failed-Fuel-Detection System: Found no reference.

E. REACTOR CHARACTERISTICS		REACTOR: SOUTH TEXAS	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	3800	H_2O/U, Cold	3.43
Electrical Output, MWe (net)	1250	Avg 1st-Cycle Burnup, MWD/MTU	---
Total Heat Output, Safety Design, MWt	---	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	$12,966 \times 10^6$	Region-1 Enrichment, %	2.10
System Pressure, psia	2250	Region-2 Enrichment, %	2.60
DNBR, Nominal	2.02	Region-3 Enrichment, %	3.10
Total Flowrate, lb/hr	144.7×10^6	k_{eff}, Cold, No Power, Clean	1.222
Eff Flowrate for Heat Trans, lb/hr	138.2×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.138
Eff Flow Area for Heat Trans, ft^2	51.1	Total Rod Worth, % $\Delta k/k$	9.2
Avg Vel Along Fuel Rods, ft/sec	17.2	Shutdown Boron, No Rods-Clean-Cold, ppm	1447
Heat Generated in Fuel, %	97.4	Shutdown Boron, No Rods-Clean-Hot, ppm	1420
Hot Channel Factors, Fq	2.50	Boron Worth, Hot, % $\Delta k/k$	7.63
Nominal Core Inlet Temp, °F	559.8	Boron Worth, Cold % $\Delta k/k$	5.5
Avg Rise in Core, °F	66.8	Full Power Moderator Temp Coeff, pcm/°F	0 to −40
Nom Hot Channel Outlet Temp, °F	---	Moderator Pressure Coeff, $\Delta k/k$/psi	$(-0.04 \text{ to } 3.0) \times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	---	Moderator Void Coeff, $\Delta k/k$/% Void	$(50 \text{ to } 250) \times 10^{-5}$
Avg Film Temp Diff, °F	---	Doppler Coefficient, $\Delta k/k$/°F	-2.4×10^{-5}
Active Heat Trans Surf Area, ft^2	68,000	Shutdown Margin, Hot 1 rod stuck, %$\Delta k/k$	2.49-4.87
Avg Heat Flux, Btu/hr ft^2	185,200	Burnable Poisons, Type and Form	Borosilicate glass
Max Heat Flux, Btu/hr ft^2	463,100	Number of Control Rods	1464
Avg Thermal Output, kw/ft	5.33	Number of Part-Length Rods (PLR)	192
Max Thermal Output, kw/ft	13.3	Number of Fuel Assemblies	193
Max Clad Surface Temp, °F	660	Overall Dimensions, inches	8.426 × 8.426
No. Coolant Loops	4	Number of Fuel Rods	50,952
		Fuel Rod Cladding Material	Zircaloy-4
		Weight of Uranium, lbs.	253,675

W — W indicates that information came from Westinghouse RESAR-41 3817 MWt NSSS.

F. SAFETY INJECTION SYSTEMS REACTOR: SOUTH TEXAS

Core Flooding System: There are 3 accumulators, each holding 13,500 gallons of borated water. Units are pressurized to 650 psig with nitrogen gas. When system pressure drops to 650 psig, 2 check valves in each line open so that accumulators inject their contents into 3 of 4 cold legs of the reactor vessel. W

High-Pressure Injection System: Three pumps each rated 800 gpm at 1250 psig inject borated water from the refueling water storage tank into a reactor cold leg. These pumps are used also to fill and provide makeup to the accumulators. Pumps start automatically on safety injection signal which is generated by any one of the following: low pressurizer pressure, high containment pressure, low steam line pressure, low T cold coincident with reactor trip, or a power level below 10%, or by manual actuation. W

Low-Pressure Injection System: Three pumps each rated 1400 gpm at 600 psig deliver borated water from the refueling water storage tank when the coolant system pressure drops below 700 psig. These pumps recirculate water from the containment sump when the refueling water storage tank supply is exhausted. In this operating mode, the Residual Heat Removal heat exchangers cool the flow. W

G. MISCELLANEOUS

Decay Heat Removal System: System transfers heat from the Reactor Coolant System to the Component Cooling System for plant shutdown and maintains this temperature during shutdown. Also, the system serves as part of the emergency core cooling system with dual use of the residual heat exchanger. This system also transfers refueling water. There are 3 pumps each rated 3400 gpm at 600 psig and 3 heat exchangers with 39.4×10^6 Btu/hr capacity. Suction of pumps is the refueling water storage tank. W

Radwaste System: Liquid waste system has 2 subsystems, one to recycle all water that can be reused, and the other system for processing wastes that will be discharged to the environment. The bulk of liquids is processed and recycled by the Boron Recycle System. There are 2 waste gas treatment systems. One is the bldg. ventilation filtering system and the other is Gaseous Waste Processing System which removes and processes fission gas products. This GWPS provides long term hold up for decay of Kryton and Xenon. These gases consist mostly of hydrogen and is passed through four charcoal delay beds before being released. The Solid Waste Processing System packs solid wastes into 55 gal. drums for shipment to offsite disposal sites.

Plant Vent: Vented 212 ft above grade adjacent to the containment structure at a point about level with where the vertical cylinder joins with the dome.

G. MISCELLANEOUS (Continued) REACTOR: SOUTH TEXAS

Emergency Power: Supplied to each reactor unit by 3 50% capcity diesel generator sets, each rated 4500 kW. Each engine has a day tank, 2 transfer pumps and storage tank. Day tank has 90 minute fuel supply and storage tank has 7 days. Units are completely independent, separately housed, etc.

Emergency Plans: Plans will be developed prior to operation to provide organization of personnel to deal with foreseeable emergencies. It will be compatible with the Texas Emergency Operations Plan, and will cover fire or explosion, injury and illness, radiation and contamination accidents, and other emergencies resulting from operational malfunctions, natural disasters and civil disturbances. The detailed Emergency Plan will be presented in the FSAR.

Environmental Monitoring: A program was started in June 1973 to collect data and evaluate it to establish preoperational baseline from which later effects of plant construction and operation can be accessed. This program covers sampling of surface waters, ground water, air and meteorological data, geological and soil aspects of the site, and radiological monitoring. The program is planned to be flexible so changes can be made for improvement as determined in practice.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system using 7000 acre cooling pond.

Water Taken From: Colorado River for makeup.

Intake Structure: Reinforced concrete 280' lg × 100' wide located at N. end of cooling reservoir. There will be 8 bays with circulating pumps, traveling screens and trash racks. Max. approch velocity to screens is 0.63 fps.

Water Body Temperatures: Winter minimum 42 °F; Summer maximum -- °F

River Flow 0 (cfs) minimum; 2200 (cfs) average

Service Water Quantity 30,000 gpm/reactor

Flow Thru Condenser 907,400 (gpm)/reactor Temp. Rise 19 °F

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

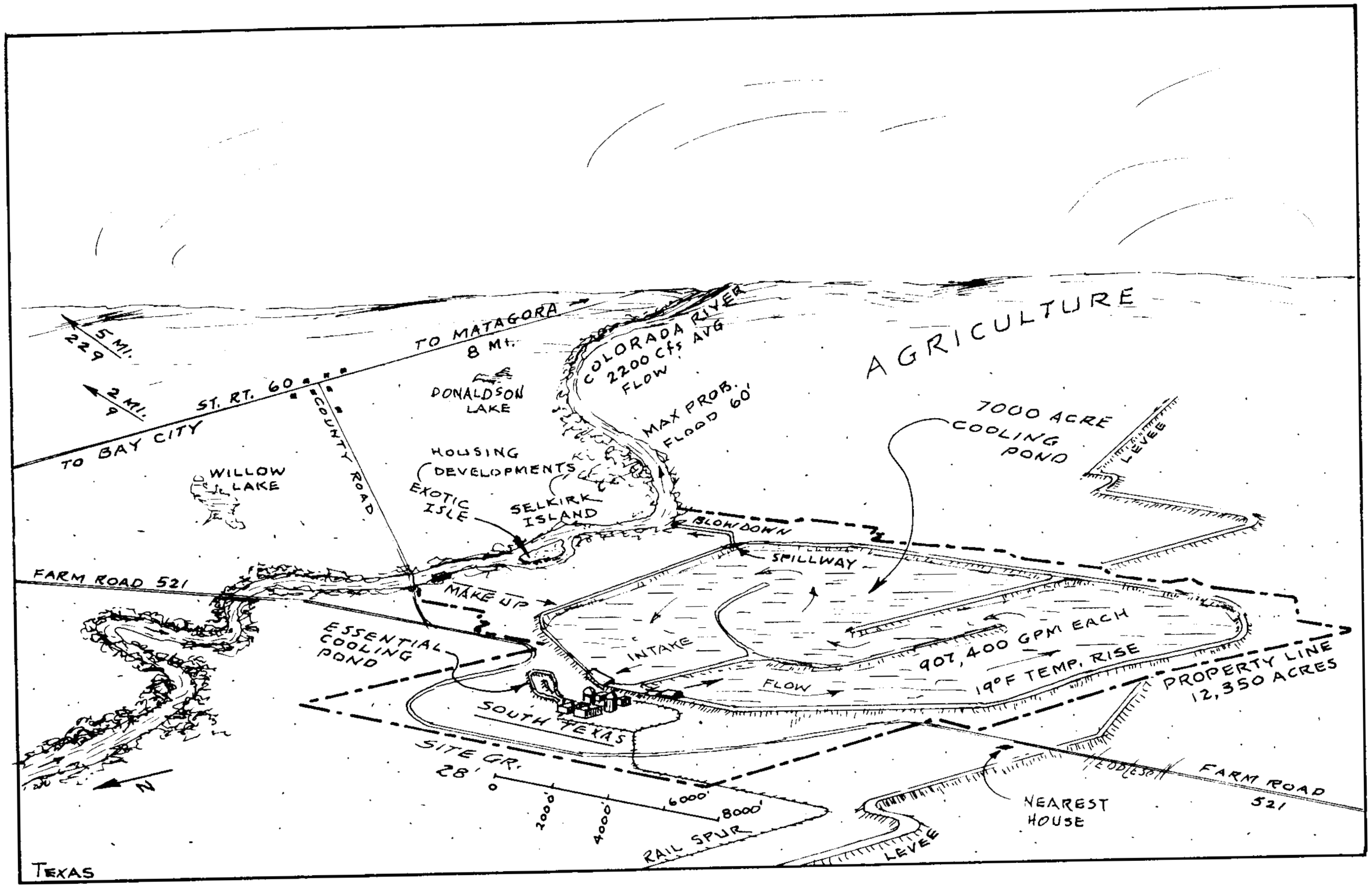
Heat Removal Capacity of Condenser --- (Btu/hr)/reactor

Discharge Structure: Pipe 11.5' dia. carries water from the turbine condenser to the cooling reservoir (one for each unit). Pipe will discharge into the reservoir under the water level at an invert of 8' MSL.

Cooling Tower(s): Description & Number — No towers

Blowdown 8340 gpm/reactor Evaporative loss --- gpm/reactor

Cooling pond to Colo. River



NUCLEAR SAFETY INFORMATION CENTER

DAVIS-BESSE 50-500, 50-501 Page 1, PWR

A. GENERAL

PROJECT NAME: Davis-Besse Nuclear Power Station Units 2 & 3
LOCATION: Ottawa Co., Ohio (21 miles E. SE. of Toledo)
OWNER: Ohio Edison 35% + 4 other utilities*
OWNER'S ADDRESS & CONTACT: Lowell E. Roe, Vice Pres. - Power
Toledo Edison Company
300 Madison Avenue
Toledo, Ohio 43652
ARCHITECT/ENGINEER: Bechtel
REACTOR MANUFACTURER: Babcock-Wilcox
CONTAINMENT CONSTRUCTOR: Chicago B & I
TURBINE MANUFACTURER: G.E.
ESTIMATED STARTUP DATE: 1981

DATE: December 1974
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

*Toledo Edison, Duquesne Light, Penn. Power Co., Cleveland Elec. Illum. Co.

Site Description: Situated on Lake Erie with about 2/3 of the area covered by marsh land. Two wildlife refuges border the site plus Crane Creek State Park. The Toussaint River flows into the lake on the south border of the site. There is a KOA Kamp ground about 1 1/2 miles S. Erie Industrial Park 4 miles SE employs about 1100. Camp Perry, on the east side of the industrial park is a National Guard training camp with flexible population. State highway #2 forms the western site boundary. Nearest railroad is the Penn Central 5 mi S. of the site. The nuclear plant is served by a spur from the Norfolk & Western 6 mi. SW of the site. On the SW corner there is a small cluster of summer cottages known as Locust Point or Toussaint, Ohio. Another community of summer cottages is Sand Beach 1 mi North.

Nearby Body of Water: Normal Level 571' (MSL)
Max Prob Flood Level 584' (MSL)

Size of Site 954 Acres Site Grade Elevation 584' (MSL)

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

Total Permanent Population: In 2 mi radius 460 ; 10 mi 17,740
Date of Data: 1980 In 5 mi radius 1571 ; 50 mi 2,224,772

Nearest City of 50,000 Population: Toledo
Dist. from Site 21 Miles, Direction WNW, Population 383,818

Land Use in 5-Mile Radius: Agricultural and marsh land

Meteorology: Prevailing wind direction SW to W Avg. speed 9.6 mph
Stability Data — Calm about 3% of time, with generally neutral conditions.
Meteorological Measurements — Data recorded from a 300 ft high tower since December 1969. A 340 ft new tower is being installed.

B. SITE DATA (Continued) REACTOR: DAVIS-BESSE 2 & 3

Exclusion Distance, Miles		0.4
Low Population Zone Distance, Miles		2 mi radius
Metropolis	Distance	Population
Toledo, Ohio	21 mi	692,571
Safe Shutdown Earthquake Acceleration, g		0.15
Operating Basis Earthquake Acceleration, g		0.08
Earthquake Vertical Shock, % of Horizontal		66

Design Winds in mph:

At 0 — 50 ft elev	90
50 — 150 ft	105
150 — 400 ft	125

Tornado 300 mph tang. + 60 trans.

ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES

Design Pressure, psig	40	Free Volume, cu ft	2,834,000
Calculated Max Internal Pressure, psig	34	Max Leak Rate at Design Pressure, %/day	0.5

Type of Construction: A cylindrical steel pressure vessel 1 1/2" thick with hemispherical dome and ellipsoidal bottom which houses the reactor vessel, and other components. It is completely enclosed by a reinforced concrete shield building having cylindrical walls 2.5 ft thick with a 2 ft thick shallow dome roof. An annular space is provided between the containment vessel and the shield building. With the exception of the concrete under the containment vessel, there are no structural ties between the containment vessel and the shield building above the foundation slab.

Design Basis: Designed to provide protection to the public from consequences of any break in the largest size coolant pipe so the public will not be exposed to radioactivity leaked from containment. The concrete shield building is designed to provide biological shielding in case of accident conditions.

Vacuum Relief Capability: Ten swing-disc relief valves located around periphery of containment open when a vacuum starts to develop. Max design vacuum is 0.5 psig.

Post-Construction Testing: Will be tested for structural performance at 45 psig. Leakage rate tests will be run when construction ends and periodically thereafter.

Penetrations: Nearly all penetrations are the double barrier type and can be individually pressurized and tested.

Weld Channels: Welds will be radiographed or where radiographs could be questioned magnetic particle, liquid penetrant, or ultrasonics will be used. Found no mention of weld channels.

C. CONTAINMENT & STRUCTURES (Contd.) REACTOR: DAVIS-BESSE 2 & 3

Containment Spray System: Two half-capacity pumps, two half-capacity spray headers, valves, piping, and instrumentation comprise the system. High containment pressure and emergency injection-actuation signal start the pumps, which take suction first from the borated-water storage tank and then the containment sump. Pumps deliver 1300 gpm each. Sodium hydroxide is added to the spray water to remove iodine.

Containment Cooling: Consists of three fan-cooler units. Each unit is a finned-tube cooling coil and a direct driven fan. Containment air maintained at max of 120 F during operation and a min of 40 F during shutdown. In case of LOCA, any two units are capable of cooling containment. LOCA heat removal capacity is 75 x 10^6 Btu/hr each.

Containment Air Filtration: Space between containment shell and shield building and penetration rooms maintained at slight vacuum during accident conditions. Exhaust from these areas through HEPA and charcoal filters. Two independent systems (fans & filters) are available.

Combustible Gas Control: Hydrogen will be held to 3% vol or less by adding air to containment, purging air from containment, and by circulating the air for mixing.

Containment Floodability: Found no reference

Strong Motion Accelerometer: There will be 4 triaxial strong motion accelerometers, one triggering unit, a play back unit, and 3 peak acceleration recorders.

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

D. REACTOR COOLANT

Reactor Vessel Failure: Found no reference to failure.

Reactor Vessel Design: Material Plate SA-533 gr. B CL-1

Shell ID, in. 171 Shell Thickness ---

Overall Height, ft/in. 40'-9" Cladding Thickness, in. 1/8

Reactor-Coolant Leak-Detection System: Many systems can monitor for leakage such make-up tank level, containment sump level and pump operation, pressure, temperature and humidity measurements. The most sensative monitor could be the radioactive gas monitor. Unidentified leakage limit is set for about 1 gpm.

Failed-Fuel-Detection System: Found no reference

E. REACTOR CHARACTERISTICS		REACTOR: DAVIS-BESSE 2 & 3	
E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	2772	H_2O/U, Cold	---
Electrical Output, MWe (net)	906	Avg 1st-Cycle Burnup, MWD/MTU	14,866
Total Heat Output, Safety Design, MWt	2789	Maximum Burnup, MWD/MTU	---
Total Heat Output, Btu/hr	9461×10^6	Region-1 Enrichment, %	---
System Pressure, psia	2200	Region-2 Enrichment, %	2.54 avg first cycle
DNBR, Nominal	3.05	Region-3 Enrichment, %	---
Total Flowrate, lb/hr	131.3×10^6	k_{eff}, Cold, No Power, Clean	1.228
Eff Flowrate for Heat Trans, lb/hr	124.2×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.105
Eff Flow Area for Heat Trans, ft^2	48.5	Total Rod Worth, %	---
Avg Vel Along Fuel Rods, ft/sec	16.0	Shutdown Boron, with Rods-Clean-Cold, ppm	895
Heat Generated in Fuel, %	97.3	Shutdown Boron, with Rods-Clean-Hot, ppm	541
Hot Channel Factors, Fq	2.65	Boron Worth, Hot, % $\Delta k/k$/ppm	1/102
Nominal Core Inlet Temp, °F	555.4	Boron Worth, Cold % $\Delta k/k$/ppm	1/75
Avg Rise in Core, °F	56.2	Full Power Moderator Temp Coeff, $\Delta k/k$/°F	$(0.1 \text{ to } -2.6) \times 10^{-4}$
Nom Hot Channel Outlet Temp, °F	648.8	Moderator Pressure Coeff, $\Delta k/k$/psi	-1×10^{-7} to $+2.7 \times 10^{-6}$
Avg Film Coeff, Btu/hr ft^2-°F	---	Moderator Void Coeff, $\Delta k/k$/% Void	---
Avg Film Temp Diff, °F	---	Doppler Coefficient, $\Delta k/k$/°F	$(-1.45 \text{ to } -2.01) \times 10^{-5}$
Active Heat Trans Surf Area, ft^2	55,250	Shutdown Margin, Hot 1 rod stuck, %$\Delta k/k$	
Avg Heat Flux, Btu/hr ft^2	166,613	Burnable Poisons, Type and Form	Al_2O_3-B_4C in Zircaloy-4
Max Heat Flux, Btu/hr ft^2	442,060	Number of Control Rods 53 × 24	1272
Avg Thermal Output, kw/ft	4.84	Number of Part-Length Rods (PLR)	192
Max Thermal Output, kw/ft	12.85	Number of Fuel Assemblies	177
Max Clad Surface Temp, °F	654	Overall Dimensions, inches	8.536 × 8.536
No. Coolant Loops	2	Number of Fuel Rods	46,628
		Fuel Rod Cladding Material	Zircaloy-4
		Weight of Uranium, metric tons	91.6

F. SAFETY INJECTION SYSTEMS REACTOR: DAVIS-BESSE 2 & 3
Core Flooding System: Two accumulator tanks, each holding 10,575 gal of borated water are pressurized to 600 psig with nitrogen. Except during normal cooldown, when pressure in the reactor system drops to 600 psig, check valves open and the contents are discharged into the reactor vessel to cover the core to prevent fuel melting.
High-Pressure Injection System: Provided by makeup and purification system to prevent uncovering core for small- and intermediate-sized pipe breaks. System designed to hold clad temperatures below 2300F. Source of water is borated-water storage tank. Emergency injection will occur when system pressure reaches 1500 psig or a containment pressure of 4 psi during operation. Pumps will deliver about 500 gpm at 1150 psi.
Low-Pressure Injection System: This system starts when reactor pressure is about 135 psi or containment pressure of 4 psi. Two pumps are available, one of which can deliver 3000 gpm of borated water at 150 psig. This system doubles as the decay-heat-removal system. This system uses a passive crossover arrangement of cavitating venturis to restrict blowdown and allow adequate core flooding without operator action should a break in a core flooding line occur along with a single active failure in the redundant train.
G. MISCELLANEOUS
Decay Heat Removal System: This system is used for heat removal during shutdown and/or emergency conditions plus long term cooling. Two pumps rated 3000 gpm at 150 psig, shared with Low Pressure Safety Injection, circulate the water thru decay heat remover heat exchangers with capacity of 105×10^6 Btu/hr. These exchangers cool the recirculated water from the containment sump.
Radwaste System: Separate radwaste systems are provided for each unit. With the exception of certain gaseous wastes, wastes are processed on a batch basis. The liquid waste system collects, stores, processes, monitors, recycles, or discharges using degasification, filtration, demineralization, and evaporation. The end product is demineralized water and boric acid. Primary source of gases is from the degasifier. Gases are collected until sufficient guantities are available, then they are compressed into the gas decay tanks. When enough decay has occurred, the gases are slowly released thru filters. Solid wastes are packed into 55 gal drums and shipped offsite for disposal.
Plant Vent: Stack runs up side of containment structure, venting at about 840' elev, 250' above grade.

G. MISCELLANEOUS (Continued) REACTOR: DAVIS-BESSE 2 & 3

Emergency Power: Each unit has 2 diesel-generator sets rated 2600 kW continuous. Each set is completely independent and separated from the others. Each diesel generator will handle one load group-one essential and one redundant. Each diesel day tank and storage tank with 7 days supply for full power operation is independent.

Emergency Plans: Purpose is to delineate an organization for coping with emergencies, to classify emergencies according to severity, define and assign responsibilities and authorities, and to outline the most effective action and protective measures to mitigate consequences of an accident and to safeguard the public and station personnel. Detailed procedures have been developed and are available.

Environmental Monitoring: Monitoring was started in October 1968 before unit 1 was begun. The lake is an important aspect of the environment so it has been studied in detail with sampling of waters, fish, and aquatic life. Other studies involve geology of the site, air particulate monitoring, soil samples, vegetation, birds, mammals, and the marsh environment. At present, a preoperational radiological monitoring program is underway for Davis-Besse #1 which will be modified as required.

H. CIRCULATING WATER SYSTEM

Type of System: Closed system with hyperbolic cooling towers.

Water Taken From: Lake Erie for makeup - 70,000 gpm average flow.

Intake Structure: A crib 3000 ft out in the lake is 11 ft below the low water level. It is constructed of timbers octagon shaped with approach velocity of 0.34 fps for 70,000 gpm flow. A semicircular rock fill protects the crib from ice. A pipe 8' in dia takes water to the plant.

Water Body Temperatures: Winter minimum 32 °F; Summer maximum 82 °F

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

Service Water Quantity 30,750 gpm/reactor

Flow Thru Condenser 480,000 (gpm)/reactor Temp. Rise 26 °F

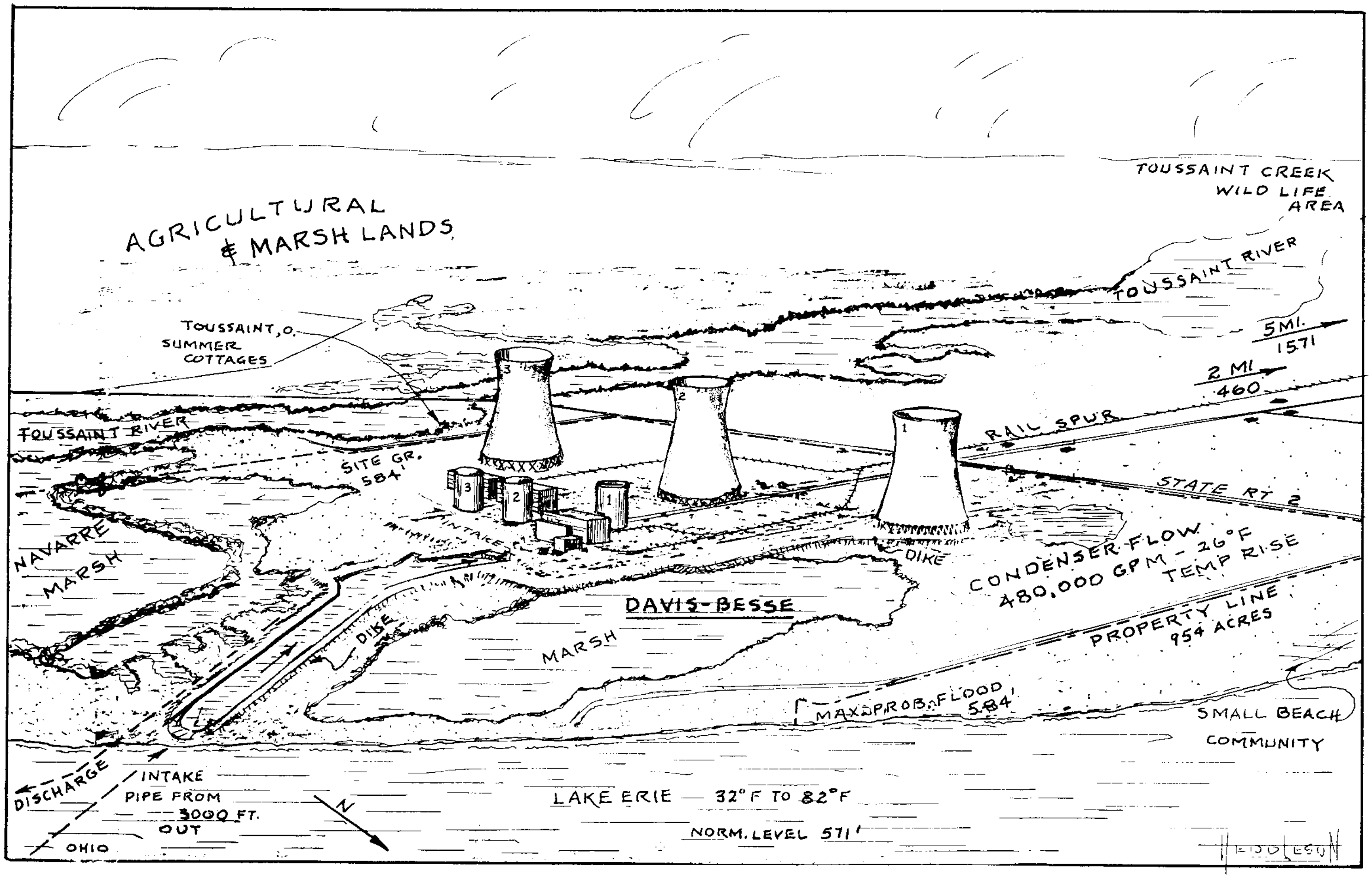
Heat Dissipated to Environment 6200×10^6 (Btu/hr)/reactor

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

Discharge Structure: All effluents are collected in a collection and mixing box. Most effluents are from the cooling towers. From there water goes thru a 6' dia. pipe 1300 ft out into the lake where it is discharged thru a slot type jet discharge.

Cooling Tower(s): Description & Number — 1 hyperbolic for each unit 500' high.

Blowdown 9200 gpm/reactor Evaporative loss 10,400 max gpm/reactor


AGRICULTURAL
& MARSH LANDS
TOUSSAINT CREEK
WILD LIFE
AREA
TOUSSAINT RIVER
5 MI.
1571
2 MI.
460
TOUSSAINT, O.
SUMMER
COTTAGES
TOUSSAINT RIVER
RAIL SPUR
SITE GR.
584'
STATE RT 2
INTAKE
DIKE
NAVARRE
MARSH
CONDENSER FLOW
480,000 GPM - 26°F
TEMP RISE
DAVIS-BESSE
DIKE
MARSH
PROPERTY LINE
954 ACRES
MAX. PROB. FLOOD
584'
SMALL BEACH
COMMUNITY
DISCHARGE
INTAKE
PIPE FROM
3000 FT.
OUT
N
LAKE ERIE — 32°F TO 82°F
NORM. LEVEL 571'
OHIO

KOSHKONONG, 50-502, 50-503 Page 1, PWR

A. GENERAL WISCONSIN UTILITIES PROJECT

PROJECT NAME: Koshkonong Nuclear Plant Units 1 & 2

LOCATION: S.W. Jefferson Co., 52 miles S.W. of Milwaukee

OWNER: *Wisconsin Electric Power, Wis. Power & Light, Wis. Pub. Service, *Madison Gas & Electric

OWNER'S ADDRESS & CONTACT: Sol Burstein, Exec. Vice-President, Wisconsin Electric Power, 231 W. Michigan Street, Milwaukee, Wisconsin 53201

ARCHITECT/ENGINEER: Stone & Webster

REACTOR MANUFACTURER: Westinghouse

CONTAINMENT CONSTRUCTOR: Stone & Webster

TURBINE MANUFACTURER: Allis-Chalmers

ESTIMATED STARTUP DATE: ---

DATE: January 1975
COMPILED BY: Fred Heddleson
NUCLEAR SAFETY INFORMATION CENTER

B. SITE DATA

Site Description: Plant site is 1.3 miles S. of Lake Noshkonong which averages about 5 ft of depth covering 10,500 acres. Several towns are within 10 miles of the plant, namely; Fort Atkinson NNE 5 mi (pop 9,164), Whitewater 7 mi ESE (pop 12,038), Milton 6 mi SSW (pop 3,699), Edgerton 10 mi WSW (pop 4,118). State hwy 26 borders the site and crosses I90 12 miles S of the site. The Chicago & NW RR runs parallel along hwy 26. An elementary school with 25 pupils is 0.6 miles WNW. There are no other schools in a 5 mile radius. Nearest hospital is in Fort Atkinson. Numerous dairy herds are found in the 5 mile radius. Two roads that now cross the site will be closed. They are Grogan Road and Vickerman Road.

Nearby Body of Water: Lake Koshkonong
Normal Level 776' (MSL)
Max Prob Flood Level 830' (MSL)

Size of Site 1410 Acres   Site Grade Elevation 850' (MSL)

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

Total Permanent Population: In 2 mi radius 757 ; 10 mi 45,400
Date of Data: 1970   In 5 mi radius 4774 ; 50 mi 2,173,500

Nearest City of 50,000 Population: Madison, Wisconsin
Dist. from Site 31 Miles, Direction NNW, Population 173,258

Land Use in 5-Mile Radius: About 75% agricultural

Meteorology: Prevailing wind direction S, NW winter   Avg. speed 11 mph

Stability Data — Very low air pollution potential

Meteorological Measurements — Began collection of data in July -73, with tower about 200' high.

B. SITE DATA (Continued) REACTOR: KOSHKONONG

Exclusion Distance, Miles		0.6 radius
Low Population Zone Distance, Miles		3 radius
Metropolis	Distance	Population
Madison, Wis.	31 mi	290,272
Safe Shutdown Earthquake Acceleration, g		0.12
Operating Basis Earthquake Acceleration, g		0.06
Earthquake Vertical Shock, % of Horizontal		66

Design Winds in mph:

At 0 — 50 ft elev	90
50 — 150 ft	105
150 — 400 ft	125

Tornado 300 mph rot. + 60 trans.

ΔP = 3 psi/ 3 sec

C. CONTAINMENT AND STRUCTURES

Design Pressure, psig	45	Free Volume, cu ft	2.36×10^6
Calculated Max Internal Pressure, psig	39.3	Max Leak Rate at Design Pressure, %/day	0.2

Type of Construction: Steel-lined, reinforced concrete structure with vertical cylindrical wall and a hemispherical dome all supported on a concrete base mat. Cylindrical walls are 4'-6" thick with 2'-6" thick dome. Base mat is 10' thick. The steel liner is 3/8" thick on the side walls and 1/2" thick on dome. Inside diameter is 135 ft. Containment structure was designed to maintain a slight positive pressure during operation providing a means for periodic monitoring of leakage.

Design Basis: Designed to contain the release of radioactive fluids and fission products resulting from postulated accidents in containment. The containment structure is designed in conjunction with other engineered safeguards to mitigate accidents.

Vacuum Relief Capability: No reference found to vacuum relief valves.

Post-Construction Testing: Structural acceptance test is run in accordance with AEC Regulatory Guide 1.18. Pressure is raised in 4 steps to 1.15 times design pressure and measurements made of deformation, cracks, etc. Leakage rate test will be conducted to verify leakage rates. Periodic leakage rate tests will be run after startup.

Penetrations: Sketches in the PSAR indicate the penetrations to be single barrier type without leakage test-connections.

Weld Channels: All liner plate seams are covered with channels that are welded to the liner plate. The channels are sectionalized so seams can be tested for leakage.

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

Containment Spray System: Consists of 2 independent spray trains, each consisting of one spray pump, 2 spray headers, spray nozzles, etc. Pumps take suction from the refueling water storage tank. Sodium hydroxide is added to the borated water to remove iodine. When water in the storage tank is exhausted, suction is taken thru the containment sump. Pump capacity is 4000 gpm each. RHR heat exchangers cool sump water.

Containment Cooling: There are 4 fan-coil units with adjustable fan blades, each with 50% cooling capacity. Units cool for normal operation or switch over to emergency operation on injection signal. Normal capacity is 5.4×10^6 Btu/hr and 208×10^6 for emergency conditions.

Containment Air Filtration: There are two 50% capacity systems consisting of fans and filter banks containing prefilters, a carbon absorber, and 2 HEPA filters. Each system is rated for 10,000 cu ft min circulation.

Combustible Gas Control: Used to maintain hydrogen concentration below 4 volume percent by use of hydrogen recombiner and also by a purge system. Startup would be several days after a LOCA.

Containment Floodability: Found no reference.

Strong Motion Accelerometer: Two units will be installed - one on base mat and one on operating floor. A third unit will be placed in the auxiliary building. Peak recording units will be installed also.

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

D. REACTOR COOLANT

Reactor Vessel Failure: All possible steps will be taken in design, fabrication, inspection, and operation to prevent failure.

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

Shell ID, in. 157 Shell Thickness 7 7/8 in.

Overall Height, ft/in. 42'-7" Cladding Thickness, in. 1/8

Reactor-Coolant Leak-Detection System: Detection methods are by Gas and Particulate Radiation monitors, amounts of make-up water to coolant system, containment sump level, fan-cooler heat loads, and containment press., temp., and humidity. Max allowable leakage (total) will be 10 gpm.

Failed-Fuel-Detection System: Fission products will be detected by the gross radioactivity monitor on the letdown line.

E. REACTOR CHARACTERISTICS REACTOR: KOSHKONONG

E1. THERMAL-HYDRAULIC		E2. NUCLEAR	
Thermal Output, MWt	2775	H_2O/U, Cold	2.42
Electrical Output, MWe (net)	960	Avg 1st-Cycle Burnup, MWD/MTU	11,000
Total Heat Output, Safety Design, MWt	2958	Maximum Burnup, MWD/MTU	50,000
Total Heat Output, Btu/hr	$9,471 \times 10^6$	Region-1 Enrichment, %	2.10
System Pressure, psia	2250	Region-2 Enrichment, %	2.60
DNBR, Nominal	201	Region-3 Enrichment, %	3.10
Total Flowrate, lb/hr	107.5×10^6	k_{eff}, Cold, No Power, Clean	1.185
Eff Flowrate for Heat Trans, lb/hr	102.7×10^6	k_{eff}, Hot, Full Power, Xe and Sm	1.109
Eff Flow Area for Heat Trans, ft^2	41.5	Total Rod Worth, % $\Delta\rho$	10.68
Avg Vel Along Fuel Rods, ft/sec	15.6	Shutdown Boron, No Rods-Clean-Cold, ppm	1455
Heat Generated in Fuel, %	97.4	Shutdown Boron, No Rods-Clean-Hot, ppm	1430
Hot Channel Factors, Fq	2.50	Boron Worth, Hot, % pcm/ppm	−8
Nominal Core Inlet Temp, °F	554.8	Boron Worth, Cold % pcm/ppm	−16
Avg Rise in Core, °F	66.7	Full Power Moderator Temp Coeff, pcm/°F	0 to −40
Nom Hot Channel Outlet Temp, °F	---	Moderator Pressure Coeff, pcm/psi	−0.004 to + 0.3
Avg Film Coeff, Btu/hr ft^2-°F	---	Moderator Void Coeff, pcm/% Void	−250
Avg Film Temp Diff, °F	---	Doppler Coefficient, pcm/°F	−1.8
Active Heat Trans Surf Area, ft^2	48,600	Shutdown Margin, Hot 1 rod stuck, %Δk/k	1.77 min.
Avg Heat Flux, Btu/hr ft^2	189,800	Burnable Poisons, Type and Form	Borosilicate glass
Max Heat Flux, Btu/hr ft^2	474,500	Number of Control Rods 56	1344
Avg Thermal Output, kw/ft	5.44	Number of Part-Length Rods (PLR) 5	120
Max Thermal Output, kw/ft	13.9	Number of Fuel Assemblies	157
Max Clad Surface Temp, °F	1250	Overall Dimensions, inches	8.426 × 8.426
No. Coolant Loops	3	Number of Fuel Rods	41,448
		Fuel Rod Cladding Material	Zircaloy - 4
		Weight of Uranium, lbs.	181,205

F. SAFETY INJECTION SYSTEMS REACTOR: KOSHKONONG
Core Flooding System: There are 3 accumulator tanks, one each connected to each cold leg of the reactor. Each tank contains 7000 gal of borated water held at 600 psig by pressurized nitrogen gas. Contents are forced into the reactor vessel when reactor system pressure drops below 600 psig.
High-Pressure Injection System: Injection after a line break, at high pressure is handled by one or more of the 3 charging pumps which take suction from the refueling water storage tank. Injection is made thru the boron injection tank and then into the 3 cold legs. Pumps are rated 450 gpm total. Pumps start automatically on the injection signal with capacity to handle small line breaks or leaks.
Low-Pressure Injection System: There are 2 low pressure pumps which are part of the Decay Heat Removal System. They are rated about 3500 gpm each and take suction from the refueling water storage tank until it is depleted, then from the containment sump in the recirculation phase using the RHRS heat exchangers to cool the water. Both high pressure and low pressure pumps run at the same time.
G. MISCELLANEOUS
Decay Heat Removal System: This system operates to cool the reactor water and core during the second phase of plant shutdown and to maintain reactor in shutdown condition. Also, the system transfers refueling water between the refueling water storage tank and the refueling cavity. The system pumps function as the low pressure injection pumps described above. An important part of the system is heat exchangers which transfer heat to the component cooling water system.
Radwaste System: Liquid waste system collects, classifies, and processes liquids either for recycle or discharge offsite using filtration, evaporation and demineralization. Gaseous wastes, consisting of streams containing various levels of radioactivity, are collected and treated before release using continuous degasification and purification of the reactor coolant letdown. Degasification and purification produces a hydrogen gas stream, which is passed through charcoal decay beds to provide holdup time for decay of noble gases. Solid wastes are collected, stored, packaged and shipped offsite for disposal.
Plant Vent: PSAR does not properly describe.

G. MISCELLANEOUS (Continued) REACTOR: KOSHKONONG

Emergency Power: Two diesel-generator sets furnish emergency power for each reactor unit. Units are completely independent from each other and are rated 4100 kW each. One diesel unit has 100% of required capacity for one reactor unit. Each has a 550 gal day tank and an underground storage tank with 7 days supply.

Emergency Plans: Will be developed for incidents which could affect health and safety of the public and plant personnel. These incidents ranging in severity from minor spills within plant confines to incidents requiring assistance of offsite agencies. Provisions will be made for evacuation of persons in portions of low population zone. Plans will be in accordance with State of Wisconsin Radiological Response Plan. Planning will be based on that developed for the Point Beach Nuclear Plant.

Environmental Monitoring: Baseline studies were started in May 1973 designed to identify the existing ecosystem so effects of construction and operation could be known. The study covers adult and juvenile fishes, fish eggs, benthos, zooplanton, phytoplankton, periphyton and aquatic macrophytes plus floral and faunal communities near the plant. Soils, ground water and meteorological studies are also underway. A radiological program is underway to determine existing backgrounds so later measurements will indicate effects of plant operation.

H. CIRCULATING WATER SYSTEM

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

Water Taken From: Lake Koshkonong and Rock River. 29,000 gpm make up.

Intake Structure: Located on the lake shore, a reinforced structure with traveling screen, trash racks, etc. There are 3 pump bays. Water is pumped 9000 ft to the plant where it is treated. Velocities thru trash racks and traveling screens is less than 0.5 fps.

Water Body Temperatures: Winter minimum 32°F; Summer maximum 89 °F

River Flow 1.3 (cfs) minimum; 850 (cfs) average Rock River

Service Water Quantity 20,000 gpm/reactor

Flow Thru Condenser 450,000 (gpm)/reactor Temp. Rise 30 °F

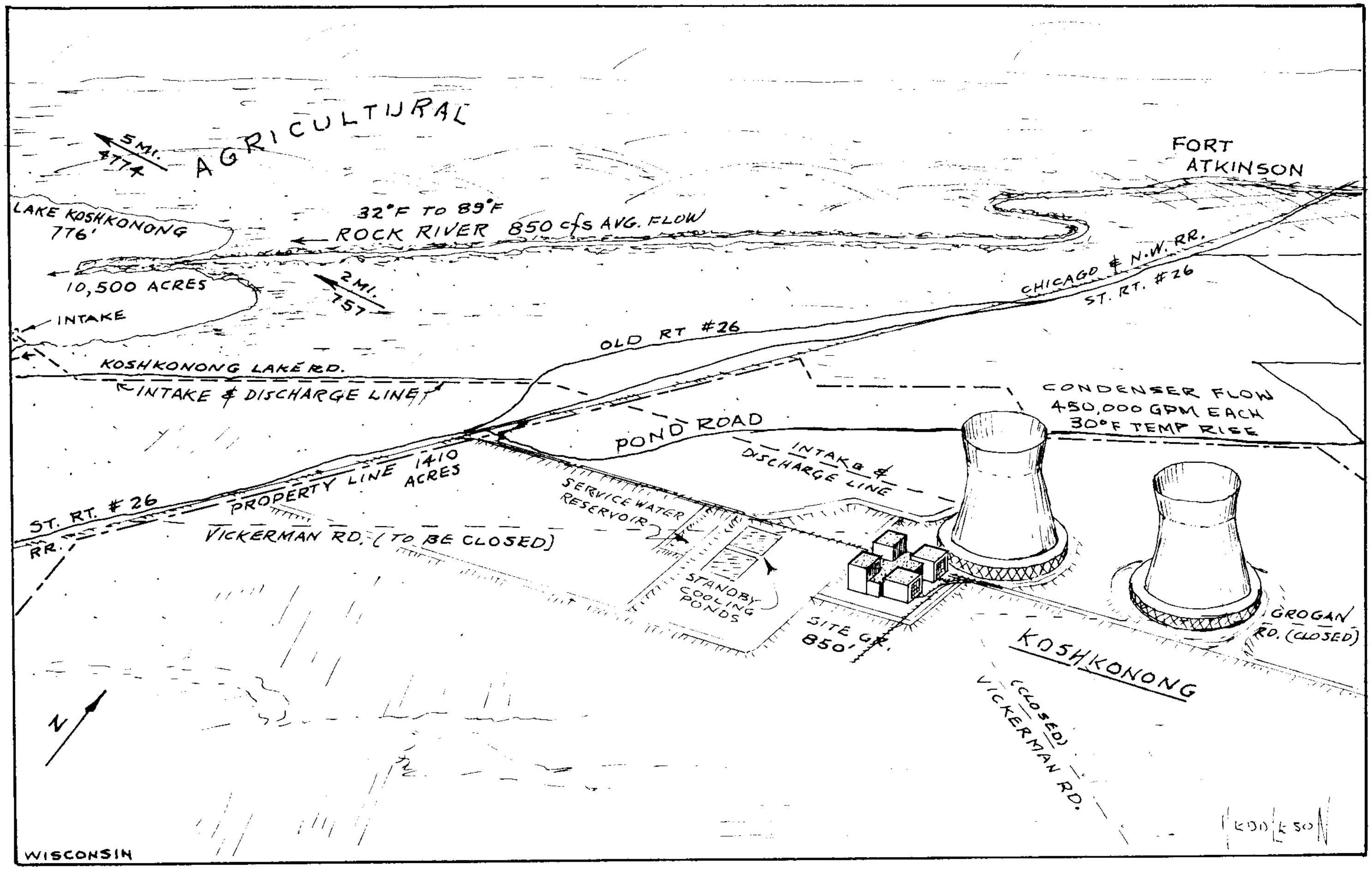
Heat Dissipated to Environment --- (Btu/hr)/reactor

Heat Removal Capacity of Condenser 6685×10^6 (Btu/hr)/reactor

Discharge Structure: Blowdown is discharged into the S end of the lake near the outlet. Distance from plant to discharge is 23,000 ft. An underwater round diffuser is used, 4 ft in diameter × 2 ft high. Blowdown pipe is 27 in.

Cooling Tower(s): Description & Number — One natural draft tower for each reactor.

Blowdown 9000 to 17,750 gpm/reactor Evaporative loss 17,400 gpm/reactor



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