2.0 SUMMARY DESCRIPTION

2.1 PRINCIPAL ARCHITECTURAL AND ENGINEERING CRITERIA FOR DESIGN

2.1.1 STATION DESIGN

Principal structures and equipment which are necessary for the safe operation of the plant and which may serve either to prevent accidents or to mitigate their consequences will be designed, fabricated and erected in accordance with applicable codes and to withstand the effects of the maximum credible earthquake, flooding conditions, windstorms, ice conditions, temperature and other deleterious natural phenomena reasonably to be anticipated at the Indian Point site during the lifetime of this unit.

2.1.2 CONTAINMENT

The complete containment and engineered safeguards systems (see 2.2.9 will be designed so that without the benefit of outside power off-site doses resulting from any loss-of-coolant accident with fission products in the containment from complete core meltdown will not exceed the limits of 10CFR20 for continuous yearly occupancy in unrestricted areas.

The containment vessel, including the associated access openings and penetrations will be designed, fabricated and erected to accommodate, without failure, the pressures and temperatures subsequent to the hypothetical loss-of-coolant accident (complete sererance of a reactor coolant pipe) within the containment vessel in conjunction with the design earthquake.

Provisions will be made for continuously pressurized, double containment of all liner seams and penetrations including access openings and ventilation ducts.

Provisions will be made to establish and maintain a water seal in all pipes penetrating the containment which could be a potential path for leakage to the environment following a loss of coolant accident.

Provisions will be made to filter and wash the containment atmosphere following a loss-of-coolant accident for rapid removal of particulate and halogen fission products to reduce the potential leakage source. The filters and sprays, each considered independently with only partial operation on emergency power, will be capable of meeting the dose limits of 10CFR100 for fission product

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releases from complete core meltdown and with 0.1 percent per day leakage to the environment at the incident pressure. In this way, these systems provide ample time to correct temporary malfunctions of the leakage preventing containment systems.

Provisions will be made both for the removal of heat from within the containment vessel and for such other measures as may be necessary to maintain indefinitely the integrity of the containment system following any loss-of-coolant accident.

Provisions will be made for initial pre-operational pressure and leak rate testing of the entire containment system and for leak rate testing a suitable pressure at periodic intervals after the facility has commenced operation. In addition, provisions will be included for continuous leak testing of the individual penetrations and containment liner welds. Provisions will also be made to monitor continuously containment system leakage during operation.

2.1.3 REACTOR SYSTEM

A pressurized water reactor and steam generator will be employed to produce steam for use in a steam-driven turbine generator. The license application thermal power rating of the reactor is 2758 thermal megawatts.

The reactor will be fueled with slightly enriched uranium dioxide pellets contained in Zircaloy fuel rods.

Automatic and redundant reactor trips will be provided to prevent anticipated plant transients from producing a Departure from Nucleate Boiling (DNB) ratio of 1.30 or lower under core conditions which might produce fuel or clad damage.

Fuel rod clad will be designed to maintain cladding integrity throughout the anticipated fuel life. Fission gas release within the rods and other factors affecting design life will be considered for the maximum expected exposures.

The reactor will be designed so that there will be no inherent tendency for undamped oscillations in power level or distribution.

The reactor and reactor coolant system will be designed to accommodate safely and without fuel damage, tripping of the turbine-generator, loss of outside electrical power and other operating transients and maneuvers.

Power excursions from any credible reactivity addition accident will not cause damage, either by motion or rupture, to the reactor coolant system or impair operation of required safeguards.

Heat removal systems will be provided which are capable of safely accommodating core residual heat under all credible circumstances, including any loss-of-coolant accident. Each of these heat removal systems will have appropriate and sufficient redundant features so as to provide reliable operation under all credible circumstances.

Reactivity shutdown capability will be provided to make the core 1% subcritical at hot conditions, by rod cluster control insertion, assuming that any one rod cluster control assembly is fully withdrawn and unavailable for use. Boric acid addition will supplement rod control for Xenon decay and plant cooldown.

2.1.4 CONTROL AND INSTRUMENTATION

The Station will be provided with a centralized control room having adequate shielding to permit occupancy during all accident situations. Sufficient interlocks are provided to prevent the operator from creating situations which are beyond the capability of the automatic protection systems or which would require rapid operator action to correct the situation. Automatic protection is provided to bring the plant to a safe condition without the need for rapid operator action.

A reliable reactor protection system will be provided which will automatically initiate corrective action before Station conditions reach unsafe limits. Periodic testing capability will be provided. Sufficient redundance will be provided so that failure or removal from service of any one component or portion of the system will not preclude trip or actuation of other protective devices when required.

2.1.5 ELECTRICAL POWER

Sufficient normal and emergency auxiliary sources of electrical power will be provided to assure a capability for a safe and orderly shutdown of the plant and continued maintenance of the Station in a safe condition under all credible circumstances.

2.1.6 RADIOACTIVE WASTE DISPOSAL

Gaseous, liquid and solid waste disposal facilities will be designed so that discharge of effluents and off-site shipments shall be in accordance with applicable governmental regulations.

Process and discharge streams are appropriately monitored and automatic features are incorporated, as may be necessary to preclude releases above the permissible limits of 10CFR20.

2.1.7 SHIELDING AND ACCESS CONTROL

The radiation shielding in the facility and the station access control patterns will be such that the radiation levels shall not cause exposures of operating personnel during normal operation and maintenance to exceed the applicable limits of 10CFR20. Following any loss-of-coolant accident, applicable limits of 10CFR20 will not be exceeded off-site and continued operation of Unit No. 1 as well as operation necessary to maintain Unit No. 2 in a safe condition will be possible without exceeding 10CFR20 permissible doses for restricted areas.

2.1.8 FUEL HANDLING AND STORAGE

Appropriate fuel handling and storage facilities will be provided to preclude accidental criticality and to provide for the safe handling, storage and shipment of spent fuel.

2.2 SUMMARY PLANT DESCRIPTION

2.2.1 INTRODUCTION

The nuclear power plant described in this exhibit incorporates a closed-cycle pressurized water nuclear steam supply system and a turbine-generator system utilizing dry and saturated steam. Equipment includes a radioactive waste disposal system, fuel handling system, main transformer, circulating water system, and all auxiliaries, structures, and other on-site facilities required to provide a complete and operable nuclear power plant. An isometric artists conception of the completed plant is given as the frontispiece.

2.2.2 STRUCTURES

The major structures are a reactor containment, auxiliary building, control room, turbine building. A general layout of the building arrangements is shown on Figure 2-1.

The containment system provided will mitigate the consequences of any loss-of-coolant accident without reliance on outside power so that people off-site will not be exposed beyond the levels allowed by 10CFR20 for continuous yearly occupancy in unrestricted areas.

The containment structure consists of reinforced concrete, which also serves as shielding, and an all welded steel liner. Continuously pressurized double containment is provided at all liner seams and penetrations including access openings and ventilation ducts. The pressure supply will be redundant with separate air compressor systems and nitrogen bottle systems. Pipes penetrating the containment which could become a potential path for leakage to the environment following a loss-of-coolant accident are designed with a vertical leg which provides a water seal. In most of these pipes, the water seal is always present. For those where the water seal may not always be present, a redundant, automatic system which does not rely on outside power is provided to inject seal water quickly. The operation of the system can be monitored after the accident and provisions are included for manually replenishing the seal water if required.

The containment vessel, including the associated access openings and penetrations, will be designed, fabricated and erected to accommodate, without failure, the pressures and temperatures subsequent to the hypothetical loss-of-coolant accident (complete severance of a reactor coolant pipe) within the containment vessel in conjunction with the design earthquake.

Air recirculation cooling and containment sprays, designed to operate after a loss-of-coolant accident and without outside power, will be included for removal of heat from within the containment vessel to maintain indefinitely the integrity of the containment system.

The entire reactor coolant system is surrounded by the massive concrete internal structures of the containment including shields over the reactor vessel, pressurizer and steam generators. These shields will intercept any missiles generated in a loss-of-coolant accident and prevent damage to the steel containment liner.

The design will include provisions for continuous leak rate monitoring of the entire containment system and for continuous leak testing of the individual penetrations and liner seams. In addition, provisions will be included for initial preoperational pressure and leak rate testing of the entire containment system and for periodic retesting at a suitable pressure after the facility has been in operation.

2.2.3 NUCLEAR STEAM SUPPLY SYSTEM

The nuclear steam supply system will consist of a pressurized water reactor, reactor coolant system, and associated auxiliary fluid systems. The reactor coolant system will be arranged as four closed reactor coolant loops connected in parallel to the reactor vessel, each containing a reactor coolant pump and a steam generator. An electrically heated pressurizer will be connected to one of the loops.

The reactor core will be composed of uranium dioxide pellets enclosed in Zircaloy tubes with selded end plugs. The tubes will be supported in assemblies by a spring clip grid structure. The mechanical control rods will consist of clusters of stainless steel clad absorber rods and guide tubes located within the fuel assembly. The core will be loaded in three concentric regions with new fuel being introduced into the outer region, moved inward at successive refuelings and discharged from the inner region to spent fuel storage.

The steam generators will be vertical U-tube units containing Inconel tubes. Integral separating equipment will reduce the moisture content of the steam at the steam generator outlet to 1/4 per cent or less.

The reactor coolant pumps will be vertical, single stage, centrifugal pumps equipped with controlled leakage shaft seals.

Auxiliary systems will be provided to fill the reactor coolant system and to add makeup water, purify reactor coolant water, provide chemicals for corrosion inhibition and reactor control, cool system components, remove residual heat when the reactor is shutdown, cool the spent fuel storage pool, sample reactor coolant water and provide for emergency safety injection.

2.2.4 REACTOR AND PLANT CONTROL

The reactor will be controlled by a coordinated combination of chemical shim and mechanical control rods. The control system will allow the plant to accept step load increases of 10% and ramp load increases of 5% per minute over the load range of 15 to 100% power. Similar step and ramp load reductions will be possible over the range of 100% to 15% power.

Complete supervision of both the nuclear and turbine generator plants will be accomplished from the central control room.

2.2.5 WASTE DISPOSAL SYSTEM

The waste disposal system will provide all equipment necessary to collect, process, and prepare for disposal of all radioactive liquid, gaseous and solid wastes produces as a result of reactor operation and to collect reactor coolant vent and drain effluent.

Liquid wastes will be collected and evaporated, and after appropriate cleaning and filtering, the evaporator condensate may be reused as reactor plant makeup water or discharged to the river via the condenser discharge at concentration below 10CFR20 limits. The evaporator residues will be reused or drummed and shipped from the site for ultimate disposal in an authorized location.

Gaseous wastes will be collected and stored until their radioactivity level is low enough so that discharge to the environment will not cause radioactivity concentrations above 10CFR20 limits.

2.2.6 FUEL HANDLING SYSTEM

The reactor will be refueled with equipment designed to handle spent fuel under water from the time it leaves the reactor vessel until it is placed in a cask for shipment from the site. Underwater transfer of spent fuel provides an optically transparent radiation shield, as well as a reliable source of coolant for removal of residual heat.

2.2.7 TURBINE AND AUXILIARIES

The turbine is a four element, tandem compound, six flow, 1800 RPM unit with 44 inch last row blades. The turbine consists of one double-flow high pressure element and three low pressure double flow elements each exhausting into its own condenser. The exhaust steam from the high pressure turbine element exhausts into six horizontal moisture separators where moisture is removed and the steam reheated by live steam prior to entering low pressure turbine elements.

Three surface type, single pass, radial flow condensers are provided with bolted divided water boxes at both ends. The hotwell is designed for two minute storage while operating at maximum turbine throttle flow with free volume for condensate surge protection. Provision is made for condensing the main feedpump drive turbine exhaust. The condensers have steam turbine by-pass condensing arrangements to condense turbine bypass steam for controlled startups and to condense residual and decay heat steam.

Three motor driven, multi-stage, vertical, pit type, centrifugal condensate pumps are provided, each taking suction from the condenser hotwells. The condensate pumps discharge into three separate parallel trains of feedwater heaters and provide the suction supply to the feedwater pumps.

One four element, two stage air ejector with common inter-and after-condensers is provided for each condenser. For normal air removal, one air ejector unit is required per condenser. The ejectors function by using main steam.

2.2.8 ELECTRICAL SYSTEM

The main generator has sufficient capability to handle the gross kilowatt output of the steam turbine with its control valves wide open at rated steam conditions. The generator will feed electrical power at 22 KV through isolated phase bus to two half-sized main power transformers.

The auxiliary power distribution system for Indian Point Unit No. 2 is essentially the same as that used in present day conventional plants. Two large auxiliary transformers supply power at 6.9 KV. One transformer, designated the unit auxiliary, is fed directly from the generator output.

The other transformer, designated the station auxiliary, is supplied from the 138 KV Buchanan Substation. The two main step-up transformers will be conventional 2-winding forced oil-air cooled units. The station service system will consist of auxiliary transformers, 6900 V. switchgear, 480 V. motor control centers, and 125 V dc equipment. Emergency power supplied by two of three diesel engine driven generators will be capable of operating post-accident containment cooling and air cleaning equipment as well as partial capacity of both high head and low head safety injection pumps to ensure an acceptable post-loss-of-coolant containment pressure transient.

2.2.9 ENGINEERED SAFEGUARDS SYSTEMS

The engineered safeguards systems to be provided for this plant will have sufficient redundancy of components and power sources such that under the conditions of a hypothetical loss-of-coolant, the systems, even when operating with partial effectiveness and only on-site emergency power, maintain the integrity of the containment and keep the exposure of the public within the limits allowed by 10CFR20 for continuous yearly occupancy in unrestricted areas.

The systems provided are:

a) The steel lined reinforced concrete containment vessel which provides a highly reliable barrier against the escape of fission products. All liner seams and vessel penetrations including access openings and ventilation ducts are provided with continuously pressurized double containment. The pressure supply will be redundant with separate air compressor systems and a back-up system with nitrogen bottles. Pipes penetrating the containment which could become a potential path for leakage to the environment following a loss of coolant accident are designed with a vertical leg which provides a water seal. In most of these pipes, the water seal always is present. For those where the water seal is not always present, a redundant automatic system which does not rely on outside power is provided to inject seal water quickly. The operation of the system can be monitored after the accident and provisions are included for manually replenishing the seal water if required. These provisions assure virtually no leakage to the environment.

b) The Safety Injection System which provides borated water to cool the core by filling the reactor vessel through the cold legs of the reactor coolant loops and by injection over the top of the core through the hot legs of the reactor coolant loops.

c) The Containment Ventilation System which provides a dynamic heat sink to cool the containment atmosphere under the conditions of a loss-of-coolant accident. The system utilizes the normal containment ventilation and cooling equipment which is also capable of removing the accident condition heat load.

d) Air recirculation filters and containment sprays, designed to operate after a loss-of-coolant accident and without outside power, and included for rapid removal of particulate and halogen fission products following any loss-of-coolant accident. These systems reduce the potential consequences of this accident and each system by itself, with partial operation on emergency power, will be capable of meeting the dose limits of 10CFR100 for fission product releases from complete core meltdown and 0.1 per cent per day leakage to the environment at the incident pressure. In this way, these systems reduce the fission product inventory available for leakage in the event of a temporary malfunction of the leak preventing systems. The containment spray system will also provide a dynamic heat sink operable on emergency power to cool the containment atmosphere following a loss-of-coolant accident.

2.2.10 PLANT DESIGN AND OPERATING PARAMETERS

Table 2-1 presents a summary of the preliminary design and operating parameters of the Indian Point Unit #2. The Table gives a comparison of these data with the data for the proposed Brookwood Plant and the data for the Connecticut-Yankee Plant which has been reviewed and approved by an Atomic Safety and Licensing Board and for which the Atomic Energy Commission has granted a construction permit.