1.0 INTRODUCTION AND SUMMARY

This Updated Final Safety Analysis Report is submitted in accordance with the requirements of 10CFR50.71(e). It is based on the original FSAR, including 84 amendments, which was submitted in support of an application by Indiana & Michigan Electric Company (I&M), whose name is now Indiana Michigan Power Company (the acronym I&M is still used however) for licenses to operate two nuclear power units at its Donald C. Cook Nuclear Plant.

This submittal contains update information for the period up to six months prior to the most recent revision of this document. The update information is of a similar level of detail as that presented in the original FSAR. It includes changes necessary to reflect information and analysis submitted to the NRC or prepared pursuant to Commission requirements, and it includes changes describing physical modifications to the plant.

I&M and Westinghouse Electric Corporation have jointly participated in the design and construction of each unit. In 2000, the Unit 1 Westinghouse Model 51 lower steam generator assembly and upper internals and feedrings were replaced with Babcock and Wilcox (BWI) replacement steam generators Model 51R. Installation was performed by Bechtel. The plant is operated by I&M. Each unit employs a pressurized water reactor nuclear steam supply system furnished by Westinghouse Electric Corporation which is similar in design concept to the majority of the nuclear power plants licensed by the Nuclear Regulatory Commission. Certain components of the auxiliary systems are shared between the two units, but in no case does such sharing result in compromising or impairing the safe and continued operation of either unit. Those systems and components, which are shared, are identified herein and the effects of the sharing analyzed.

The Unit 1 reactor is currently designed for a power output of 3304 MWt and the Unit 2 reactor is designed for a power output of 3468 MWt, which are their licensed ratings. The approximate gross and net electrical outputs of Unit 1 are 1149 MWe gross and 1114 MWe net and of Unit 2 are 1155 MWe and 1117 MWe, respectively.

The remainder of Chapter 1 of this report summarizes the principal design features and safety criteria of the nuclear units, pointing out the similarities and differences with respect to other pressurized water nuclear power plants employing the same technology and basic engineering features as the Cook Nuclear Plant.

The research and development program is discussed in Section 1.6. The quality assurance program is referenced in Sub-Chapter 1.7 and is described in a separate document entitled "Quality Assurance Program Description".

Chapter 2 contains a description and evaluation of the site and environs, supporting the suitability of that site for a nuclear plant of the size and type described. Chapters 3 and 4 describe the reactors and the reactor coolant systems, Chapter 5 the containment and related systems, and Chapters 6 through 11 the emergency and other auxiliary systems.

Chapter 12 describes I&M's program for organization and training of plant personnel. Chapter 13 contains an outline and description of the initial tests and operations associated with plant startup.

Chapter 14 is a safety evaluation summarizing the analyses, which demonstrate the adequacy of the reactor protection system, and the engineered safety features systems. The consequences of various postulated accidents are within the guidelines set forth in the Nuclear Regulatory Commission regulation 10 CFR 100.

The Technical Specifications for the Cook Nuclear Plant are appendices to the Operating License, and are contained in separate volumes. The Technical Specifications designate safety limits, limiting safety system settings, limiting conditions for operation, and surveillance requirements for the safe operation of the plant. Additionally, the Technical Specifications contain certain plant design features and certain administrative controls.

1.0.1 Background Information:

The following was added to the UFSAR during the Revision 17 update. The purpose of the following is to provide a synopsis of the UFSAR. This information is not considered part of the UFSAR and may be revised without initiation of a UFSAR Change Request.

Version vs. Revision

Effective with the 1999 UFSAR update, the UFSAR update submittals to the NRC are given a Revision number (e.g., Revision 16.0). Periodically, interim updates are made to the UFSAR, which are distributed to plant personnel to support day-to-day activities. The interim updates are considered a version update and numbered accordingly (e.g., Version 16.6). Table 1.0-1 provides the relationship between the UFSAR Revision numbers and submittal dates to the NRC.

Approved Changes to the UFSAR

The approved UFSAR Change Requests (UCRs) are considered part of the UFSAR. The approved UCRs that require a change to the facility are considered "Pending" changes and are not considered part of UFSAR until the change to the facility has been implemented.

FSAR Appendices

The UFSAR is controlled per the requirements of 10 CFR 50.71(e), the FSAR update rule. The original FSAR included Appendices that were not included in the UFSAR when the FSAR was converted to the Updated FSAR (UFSAR) in 1982, as such, the FSAR appendices are not part of UFSAR. During the 2001 UFSAR update, the pertinent information from Appendices M and J was incorporated into the body of the UFSAR.

Historical Information

"Historical Information" contained in the UFSAR is information that was provided in the original FSAR to meet the requirements of 10 CFR 50.34(b) and meets one or more of the following criteria:

a. Information that was accurate at the time the plant was originally licensed, but is not intended or expected to be updated for the life of the plant.

b. Information that is not affected by changes to the plant or its operation.

c. Information that does not change over time. This historical information is not normally updated. However, in some instances, such as a major change in population, the UFSAR would require a change.

"Historical Information" in the DC Cook UFSAR is marked using the word "Historical".

References

General References: General references are not considered part of the UFSAR, but are intended to provide background information or additional detail that the reader may refer to in order to learn more about particular material presented in the UFSAR. References to such information may be located at specific points in the UFSAR, or they may be listed at the end of UFSAR Chapters/Sections or in introductory sections. All UFSAR references are considered "General References" with the exception of those that are incorporated by reference as identified below.

Incorporation by Reference: "Incorporation by reference" refers to a method by which all or part of a separate source document can be made part of the UFSAR without duplicating the desired information in the UFSAR. Information that is appropriate to include in the UFSAR that is also part of a separate licensee-controlled document or technical report may be incorporated in the UFSAR by appropriate reference to that information.

The following documents are incorporated into the UFSAR by reference:

1. NFPS 805 Fire Protection Program Manual (NFPPM)
2. Fire Safety Analysis (FSA)
3. Safe Shutdown Capability Assessment (R1900-0024-001)
4. Technical Requirements Manual (TRM)

The following documents are considered incorporated by reference, but are controlled and are updated by regulation:

1. Updated Quality Assurance Program Description (QAPD)
2. Emergency Plan
3. Security Plan
4. Environmental Protection Plan
5. Offsite Dose Calculation Manual

1.1 PLANT SITE SUMMARY

1.1.1 Site Description

The approximately 650 acre site is located along the eastern shore of Lake Michigan in Lake Township, Berrien County, Michigan about 11 miles south-southwest of Benton Harbor. The population density of the area surrounding the site is relatively low. The minimum distance from the reactor containment structures to the exclusion area is about 2000 feet, with the nearest continuously occupied resident located about 2160 feet north of the reactors. The population center distance is about eight miles. The area is primarily devoted to agricultural pursuits with some manufacturing in the Benton Harbor-St. Joseph and Niles areas.

1.1.2 Meteorology

In order to obtain meteorological data for the determination of diffusion and dispersion at the site, a meteorological recording station was established on the site during the fall of 1966, and the analysis of three years data from this station is included in this report. The original meteorological system has been replaced, and the analysis of five years data from 2001 to 2005 is included in this report to supplement the original analysis.

The site is extremely well ventilated with an extremely high percentage of strong winds and a very low occurrence of thermal inversions. There is no strong preference for any particular wind direction.

1.1.3 Geology and Hydrology

An investigation of site geology and hydrology was completed in 1966. The geology of the region is regular with no faults within about 50 miles of the site. The subsurface soils are adequate to support the structures, and drainage of surface and ground waters is toward the lake over almost the entire site area.

1.1.4 Seismology

The area is relatively inactive seismically with no major earthquake epicenters located within about 400 miles of the site. There has been some minor activity closer to the site but no shocks within 50 miles have been large enough to cause significant structural damage.

For design purposes, a horizontal ground acceleration of 0.10g is used. All equipment and structures necessary for plant safety have been designed to withstand the effects of a horizontal ground acceleration of 0.20g.

1. The Seismic Instrumentation System (SIS) consists of a computer, HMI, an uninterruptible power supply, six digital recorders, six triaxial accelerometers and associated electronic equipment. The computer and electronics are located in the Unit 1 main control room and is connected to annunciators in the Unit 1 and Unit 2 main control rooms, which illuminate when the system detects seismic motion. The SIS is a shared-unit system. The accelerometers are oriented such that both axes are pointed in the same direction and aligned along one axis. The locations of which are as follows:
   a. The 34.5kV Loop Feed Block House
   b. The top of the primary shield wall
   c. The bottom of the reactor pit
   d. The top of the crane wall
   e. The Auxiliary Building Foundation, EL. 587’
   f. The Auxiliary Building, EL 633’
2. The 34.5kV Loop Feed block House was chosen as a site free from influences of the other structures such that in the event of seismic excitation the accelerometer will effectively measure actual ground acceleration.
3. The top of primary shield wall and the bottom of the reactor pit were chosen, as they represent a rigid part of the containment and will, by considerations of geometry, be used to determine the rigid body rotation of the containment foundation.
4. The Auxiliary Building was chosen as an independent Seismic Category I structure whose seismic response is different than that of containment.

5. Recording is activated automatically at 0.02g acceleration and annunciators in the control rooms are illuminated. Actions taken subsequent to a seismic event are in accordance with the surveillance requirements of the Technical Requirements Manual.

6. In addition to the above instrumentation, a number of peak acceleration or peak displacement recorders (approximately l0) are placed on selected Class I structures and the 34.5kV Loop Feed Block House to aid in the verification of the seismic analyses following a seismic event. These instruments are similar to scratch gages.

7. The rocking motion of the containment structure can be determined by the use of two (2) sets of accelerometers, one each placed at the top of the primary shield wall and on the containment foundation and oriented along the north-south axis of the plant. These accelerometers are connected to transmit signals simultaneously to a central recording device.

1.1.5 Limnology

Limnology studies of Lake Michigan show that the lake provides adequate dilution and dispersion of plant effluents. The plant is designed to withstand the effects of the maximum seiche or the maximum wind whipped wave for the site.

1.1.6 Environmental Radiation Monitoring

An environmental radiation-monitoring program formulated for the site and the surrounding area has been initiated and data collection started prior to plant operation.

1.2 DESIGN HIGHLIGHTS

The design of each unit was based upon proven concepts, which had been developed and successfully applied in the construction of pressurized water reactor systems. In subsequent paragraphs, a few of the design features are listed which represent slight variations or extrapolations from other units.

1.2.1 Power Level

The Donald C. Cook licensed power level or rated thermal power (RTP) is 3304 MWt for Unit 1 and 3468 MWt for Unit 2. These power levels are comparable with power levels of pressurized water reactors, which are now operating and are justified by the engineering and safety analyses reported in this document.

1.2.2 Reactor Coolant Loops

The reactor coolant system for each unit consists of four loops.

1.2.3 Peak Specific Power

Based on the maximum permitted hot channel factors, operation at a thermal heat output of 3304 MWt corresponds to a peak specific power of 15.85 kW/ft (F_Q = 2.32) for Unit 1 and at a thermal heat output of 3468 MWt for Unit 2 corresponds to a peak specific power of 12.9 kW/ft (F_Q = 2.335).

1.2.4 Fuel Assembly Design

The fuel assembly design incorporates the rod cluster control assembly concept in a canless assembly utilizing spring clip grids to provide support for the 15 x 15 (Unit 1) and 17 x 17 (Unit 2) arrays of fuel rods.

Another aspect of the fuel design is internally pressurized fuel rods. This does not result in any change in fuel rod design criteria. Internal pressurization represents no significant change in plant safety margins during accident transients. Further discussion of fuel rod design is contained in Chapter 3 and Reference 2.

1.2.5 Ice Condenser Containment Structure

The ice condenser reactor containment involves the very rapid absorption of the energy released in the improbable event of a loss-of-coolant accident by condensing the steam in a low temperature heat sink. This heat sink, located inside the containment, consists of a suitable quantity of borated ice in a cold storage compartment. The containment is a reinforced concrete structure with a steel liner capable of withstanding a design pressure of 12 psig. The overall integrated leak rate limit is 0.25% by weight of the containment air volume per day. The structure is designed to resist wind and seismic loads and is fully protected from electrical storms and fire. Access to the containment structure is provided by means of personnel air locks and an equipment hatch. Such access is limited during periods of operation.

1.2.6 Other Engineered Safety Features

In addition to the ice condenser system and the containment structure, other engineered safety features provided are similar to those provided in other PWR plants. There is an emergency core cooling system that can be powered from emergency on-site diesel generators.

The system design is such that it can be tested while the plant is at power. A containment spray system provides cool water spray into the containment atmosphere for heat removal. The spray system reduces the concentration of airborne halogen fission products in the containment atmosphere, and contains sodium hydroxide for keeping the halogens in solution.

1.2.7 Emergency Power

In addition to the multiple ties to outside sources for emergency power, emergency diesel generator (EDG) units are provided as backup power supplies for the case of loss of all outside power. The EDGs are capable of operating sufficient core cooling and containment cooling equipment to ensure an acceptable post-accident pressure transient in the affected unit, and safe shutdown of the other unit, even if one EDG fails to operate in each unit.

1.2.8 Use of Solid-State Logic Protection System

By applying solid state techniques to the design of the Reactor Protection System and the Engineered Safety Features Actuation System, significant improvements have been made over the previous designs, which utilized relays in the logic. The solid state system has improved system reliability, reduced test time, reduced the number of field wires, reduced equipment size, and increased system flexibility.

Designated the "Solid State Logic Protection System", the design includes both reactor protection and engineered safety features actuation. The design uses integrated circuit NAND gates as the basic logic element. These elements are assembled on printed circuit cards to form the building blocks for the system. The IEEE criteria for nuclear power plant protection systems

(IEEE-279) (Reference 3) has been used as a guide in the design of the system. Further information on the system is contained in Chapter 7.

1.2.9 References for Section 1.2

1. WCAP-7407-L, R. F. Barry, et. al., "Power Maldistributions". (WNES Proprietary Class 2).
2. WCAP-9002, "Use of Internally Pressurized Fuel Rods in Westinghouse Pressurized Water Reactors," H. M. Ferrari, et al., February 1969 (WNES Proprietary Class 2).
3. IEEE No. 279, "Proposed IEEE Criteria for Nuclear Power Plant Protection Systems, (Effective August 30, 1968)."

1.3 SUMMARY PLANT DESCRIPTION

The inherent design of the pressurized water, closed-cycle reactor minimizes the quantities of fission products released to the atmosphere. Four barriers exist between the fission product accumulation and the environment. These are the uranium dioxide fuel matrix, the fuel cladding, the reactor vessel and coolant loops, and the reactor containment. The consequences of a breach of the fuel cladding are greatly reduced by the ability of the uranium dioxide lattice to retain fission products. Escape of fission products through a fuel-cladding defect would be contained within the pressure vessel, loops and auxiliary systems. Breach of these systems or equipment would release the fission products to the reactor containment where they would be retained. The reactor containment is designed to retain adequately these fission products under the most severe accident conditions, as analyzed in Chapter 14.

Several engineered safety features have been incorporated into the plant design to reduce the consequences of a loss-of-coolant accident. These safety features include an Emergency Core Cooling System (ECCS). This system automatically delivers borated water to the reactor vessel for cooling the core under high and low reactor coolant pressure conditions. The ECCS also serves to insert negative reactivity into the core in the form of borated water during plant cooldown, following a steam line break or an accidental steam release. Other safety features, which have been included in the reactor containment design, are an Ice Condenser System containing sodium tetraborate impregnated ice and which acts to effect a depressurization of the containment following a loss-of-coolant or steam line break accident, and a Containment Spray System which acts to depressurize the containment and to remove iodine from the atmosphere by washing action.

1.3.1 Structures and Equipment

The major structures are the two ice condenser reactor containments, auxiliary building, turbine building, service building, and fuel handling facility, which makes up a portion of the auxiliary building. General layouts of the containment, auxiliary building, turbine building and interior component arrangements are shown on Figures 1.3-1, 1.3-1A, and 1.3-2 through 1.3-10.

The ice condenser reactor containment is a domed, steel lined, reinforced concrete cylinder anchored to a reinforced concrete foundation slab. The containment is designed to withstand the internal pressure accompanying a loss-of-coolant accident. It is virtually leaktight and provides adequate radiation shielding for both normal operation and accident conditions.

The seismic criteria used to design the structures and equipment in the plant are described in Sub-Chapter 2.9. The maximum horizontal ground acceleration for the Operating Basis Earthquake (OBE) is 0.10g acting coincidentally with a maximum vertical ground acceleration of 0.067g. However, the design ensures that no undue risk to public health and safety results from a horizontal ground acceleration of 0.20g acting coincidentally with a vertical ground acceleration of 0.134g (Design Basis Earthquake - DBE).

1.3.2 Nuclear Steam Supply System

For each unit, the Nuclear Steam Supply System consists of a pressurized water reactor, Reactor Coolant System, and associated auxiliary fluid systems. The Reactor Coolant System is arranged as four closed reactor coolant loops connected in parallel to the reactor vessel, each loop containing a reactor coolant pump and steam generator. An electrically heated pressurizer is connected to the hot leg of one reactor coolant loop.

The reactor core is composed of uranium dioxide pellets enclosed in Zircaloy tubes with welded end plugs. The tubes are supported in assemblies by a spring clip grid structure. The mechanical control rods consist of clusters of stainless steel clad silver-indium-cadmium absorber rods and Zircaloy guide tubes located within the fuel assemblies.

The reactor vessel and reactor internals contain and support the fuel and control rods. The reactor vessel is cylindrical with hemispherical heads and is clad internally with stainless steel.

The pressurizer is a vertical cylindrical pressure vessel with hemispherical heads and is equipped with electrical heaters and spray nozzles for system pressure control.

The steam generators are vertical U-tube type heat exchangers utilizing Inconel tubes. Integral separating equipment reduces the moisture content of the steam at the turbine throttle to 1/4 percent or less.

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

Auxiliary systems are provided to charge 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, provide for emergency safety injection, and vent and drain the Reactor Coolant System.

1.3.3 Reactor and Plant Control

The reactor is controlled by a coordinated combination of soluble neutron absorbers and mechanical control rods. The control system allows the plant to accept step load changes of 10%, and ramp load changes of 5% per minute, over the load range of 15 to 95% power, under normal operating conditions. Supervision of both the reactor and turbine-generator is accomplished from the control room in each unit.

1.3.4 Waste Disposal System

The shared waste disposal system provides all equipment necessary to collect, process, and prepare for disposal, the radioactive liquid, and gaseous and solid wastes produced as a result of reactor operation.

All liquid wastes are collected and held for monitoring. Equipment is provided for evaporating or demineralizing the liquid. The treated water from the demineralizers or the evaporator distillate may be recycled for use in the plant or may be discharged via the condenser discharge at concentrations well within the limits of 10 CFR 20. The evaporator concentrates are solidified and shipped from the site for ultimate disposal in an authorized location. Spent demineralizer resins are de-watered and shipped in a high integrity container from the site for ultimate disposal in an authorized location. A steam generator blowdown treatment system is provided to permit continued plant operation with limited fuel clad defects concurrent with steam generator tube leaks.

Gaseous wastes are collected and held for radioactive decay. Discharge to the environment is controlled to keep the off-site dose well within the limits of 10 CFR 20.

1.3.5 Fuel Handling System

Each reactor is 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 onsite storage or shipment off the site. Underwater transfer of spent fuel provides an optically transparent radiation shield as well as a reliable source of coolant for removal of decay heat.

The fuel handling system also provides capability for receiving, handling and storage of new fuel. Both the new fuel storage facility and the spent fuel storage facility are shared by the two units.

1.3.6 Turbine and Auxiliaries

Each turbine is a tandem compound, four element, 1,800 rpm unit, having one high pressure and three functionally identical low pressure elements. Combination moisture separator-reheaters are employed to dry and superheat the steam between the high and low-pressure turbines. The auxiliaries include deaerating surface condensers, steam jet air ejectors, turbine driven main feed pumps, motor driven condensate pumps, and six stages of feedwater heating.

1.3.7 Electrical System

The main generators are 1800 rpm, 3 phase, 60 cycle, hydrogen and water cooled units. The main transformers deliver generator power to the 345 kV and 765 kV switchyards. The station auxiliary power system consists of auxiliary transformers, 4160 v and 600 v switchgear, 600 v motor control centers, 120 v a-c vital instrument buses and 250 v d-c buses.

Two diesel generators are provided for each unit as on-site sources of power in the event of a complete loss of normal and reserve a-c power. In addition, two storage batteries are provided for each unit as on-site sources of power in the event of a complete loss of normal d-c power. Each diesel generator and battery has sufficient capacity to operate the equipment necessary for one unit to prevent undue risk to public health and safety should a loss-of-coolant accident occur.

1.3.8 Safety Features

The engineered safety features provided for this plant have sufficient redundancy of components and power sources such that under the conditions of a loss-of-coolant accident they can maintain the integrity of the containment and keep the exposure of the public below the limits of 10 CFR 100, even when operating with partial effectiveness. The safety features incorporated in the design of this plant and the functions they serve are summarized below.

a. The Emergency Core Cooling System (ECCS) injects borated water into the Reactor Coolant System. The ECCS limits damage to the core and limits the energy and fission products released into the containment following a loss-of-coolant accident.

b. A steel-lined, domed, reinforced concrete containment vessel is anchored to a reinforced concrete foundation slab. The containment is designed to remain virtually leaktight during the pressure transient following a loss-of-coolant accident.

c. An Ice Condenser System reduces containment pressure and removes iodine radioactivity following a loss-of-coolant accident.

d. A Containment Spray System is used to reduce containment pressure and to remove iodine from the containment atmosphere following a loss-of-coolant accident.

e. The Containment Isolation System incorporates valves and controls on piping systems penetrating the containment structure. The valves are arranged to provide two barriers between the Reactor Coolant System or containment atmosphere and the environment. System design is such that failure of one valve to close will not prevent isolation, and no manual operation is required for immediate isolation. Automatic Phase "A" isolation is initiated by a containment isolation signal derived from the safety injection automatic activation logic and Phase "B" isolation from a containment pressure high-high signal.

f. Reliable on-site diesel-generator power is provided for the engineered safeguards loads in the event of failure of station auxiliary power. In addition, even if external auxiliary power to the station is lost concurrent with an accident, power is available for the engineered safeguards from on-site diesel-generator power to assure protection of the public health and safety for any loss-of-coolant accident.

g. The active components necessary for the proper operation of the engineered safety features are operable from the control room.

The Engineered Safety Features in this plant are the ECCS, the containment structure, the Ice Condenser System, and the Containment Spray System (items a, b, c, d above).

1.3.9 Shared Facilities and Equipment

Separate and similar systems and equipment are provided for each unit except as noted below. In those instances where components of a system are shared by both units, those components, which are shared, are either shown in the following listing or discussed in the applicable Sub-Chapter.

1.3.9.a Chemical and Volume Control System

Item	Number Shared
Boric Acid Tanks	3
Batching Tank	1
Hold-up Tanks	3
Boric Acid Reserve Tank	1
Recirculation Pump	1
Boric Acid Evaporator Feed Pumps	3
Evaporator Feed Ion Exchangers	4
Boric Acid Evaporator (Converted to a radioactive waste evaporator) (See Section 11.1)	2
Monitor Tanks	4
Monitor Tank Pumps	2
Evaporator Condensate Demineralizers	2

1.3.9.b Spent Fuel Pit Cooling System

Item	Number Shared
Spent Fuel Pool Pumps	2
Spent Fuel Pool Demineralizer	1
Spent Fuel Pool Filter	1
Spent Fuel Pool Heat Exchangers	2
Refueling Water Purification Pump	1

1.3.9.c Fuel Handling System

Item	Number Shared
Spent Fuel Storage Pool	1
New Fuel Storage Area	1
Decontamination Area	1
Spent Fuel Pool Bridge Crane	1

1.3.9.d Service Water Systems

Item	Number Shared
Essential Service Water Pumps	4
Non-Essential Service Water Pumps	4

1.3.9.e Auxiliary Steam System

1.3.9.f Waste Disposal System

1.3.9.g Radiation Monitoring System

1.3.9.h Structures, Buildings And Miscellaneous

Item
Auxiliary Building
Fuel Handling Area
Service Building
Lake Intake Structures
Compressed Air Services
Plant Heating Steam System
Make-up Water Supply and Treatment System
Non-Essential Service Water System
Seismic Monitoring System
Post-Accident Sampling System

1.3.9.i Component Cooling Water System

Item	Number Shared
Component Cooling Water Pumps	1