AUG 7 1985

Docket No.: 70-2947

Applicant: Illinois Power Company (IPC)

Facility: Clinton Power Station, Unit 1

Subject: SAFETY EVALUATION REPORT - REVIEW OF REVISED LICENSE APPLICATION DATED OCTOBER 9, 1984 AND SUPPLEMENTS DATED FEBRUARY 8, MAY 6, AND JUNE 5, 1985 FOR A MATERIALS LICENSE.

I. INTRODUCTION

A. General

By application received July 1981, and supplements dated January 15, March 31, May 17, June 8 and 28, July 19, and November 17, 1982, and April 25, and July 8, 1983, IPC requested authorization to receive, possess, and use 2,036 kg U-235 in the form of unirradiated fuel assemblies, 30,000 curies of Antimony-124 in the form of sealed neutron sources, and 20 Ci of Pu-238 in neutron calibration sources.

On September 30, 1981, the Nuclear Regulatory Commission issued Materials License No. SNM-1886 to IPC. The license authorized IPC to receive, possess, and use up to one gram of U-235 in any form and 15 microcuries of plutonium. The license was amended August 31, 1983, to authorize the possession and use of up to 20 Ci of Pu-238 in neutron calibration standards and extended the license expiration date to August 31, 1986.

By letters dated October 9, 1984, and its supplements dated February 8, May 6, and June 5, 1985, IPC submitted a revised application incorporating (with modifications) the information from all previous submittals.

The finished fuel assemblies will be supplied by the General Electric Company. Each fuel assembly contains 62 fuel rods and 2 Zircaloy-2 tubes called water rods. The rods are spaced and supported in an 8-by-8 array by seven spacers and a lower and upper tie plate. Table 1 gives general fuel rod parameters that describe the fuel which will eventually be used in Clinton Power Station, Unit 1, a boiling water reactor (BWR). The materials license is being issued to allow early receipt of the fuel for the purpose of inspection and preparation of the fuel for reactor loading and will automatically terminate upon issuance of the Part 50 operating license.

B. Location Description

The Clinton Power Station, Unit 1, is located about 6 miles east of the city of Clinton in DeWitt County, Illinois. The construction permit application was docketed on October 30, 1973, AEC Docket No. 50-461, and Construction Permit No. CPPR-137 was issued in February 1976.

Table 1

Clinton Power Station Fuel Assembly Parameters

Parameter	Initial Core
Rod Array	8 by 8
Number of Fuel Rods per Assembly	62
Fuel Rod Material	UO_2
Pellet Diameter	0.410-inch
Pellet Length	0.410-inch
Pellet Immersion Density (% theoretical)	95.0
Clad Material	Zircaloy-2
Clad I.D.	0.419-inch
Clad O.D.	0.483-inch
Clad Thickness (nominal)	0.032-inch
Pellet Clad Gap	0.0045-inch
Active Fuel Length	150.0-inch
Fuel Rod Pitch	0.636-inch
Number of Water Rods per Assembly	2
Water Rod O.D.	0.591-inch
Water Rod I.D.	0.531-inch

II. AUTHORIZED ACTIVITIES

A. Enriched Uranium Fuel Assemblies

The licensee requests authorization to receive, possess, and store 636 fuel assemblies containing up to 2100 kg of U-235 with a maximum enrichment of 3.00 w/o U-235. The licensee also requests authorization to repackage any assembly, if necessary, for delivery to a carrier. It should be noted that the license does not authorize insertion of a fuel assembly into the reactor vessel.

B. Other Materials

Authorization is also requested to receive, possess, and store antimony-beryllium sources containing a maximum of 30,000 curies, in-core neutron detectors containing 1 g U-235, alpha calibration standards and check sources containing 15μ curies of Pu-239, and neutron calibration standards containing 20 curies of Pu-238.

III. SCOPE OF REVIEW

The safety review of the Illinois Power Company's request for a Materials License included an evaluation of the original application and its supplements and the revised application and its supplements. A detailed review was made of the Illinois Power Company's organization, administration, nuclear criticality safety, radiation protection, and fire protection.

During the course of the reviews, discussions were held with the NRR project managers, the resident inspectors, the NRC regional office, and with staff members of the licensee. The evaluation of the physical security plan was made by the Physical Security Licensing Branch, Division of Safeguards, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission.

IV. POSSESSION LIMITS

Conditions 6, 7, and 8 of the license will specify the type, form, and quantity of material the licensee may possess under this license and shall be revised to read as follows:

6. Material	7. Form	8. Quantity
A. Uranium enriched in the U-235 isotope	A. In unirradiated reactor fuel assemblies	A. 2,100 kg of U-235 in uranium enriched to no more than 3.00 % in U-235
B. Antimony-124	B. In Sb-Be neutron sources	B. 30,000 Ci of Sb-124 total
C. Uranium enriched in U-235 isotope	C. Contained in-core neutron detectors	C. One (1) gram of U-235 at any enrichment
D. Pu-239	D. Alpha calibration standards and check sources	D. Fifteen (15) microcuries of Pu-239
E. Pu-238	E. Neutron calibration standards	E. 20 Ci of Pu-238

V. ORGANIZATION

A. Nuclear Criticality Safety and Radiation Protection Responsibilities

The Power Plant Manager has overall responsibility for the administrative controls to ensure the safety of all fuel handling and storage operations and is Chairman of the ALARA Committee.

The Radiation Protection Supervisor has direct responsibility to ensure safety during all fuel handling and storage operations. He has functional control of and is responsible for establishing and implementing the Radiological Control Program. He has the responsibility for ensuring that the ALARA policy is implemented, serves as the Radiation Protection Manager, and reports directly to the Power Plant Manager.

The Senior Reactor Operator or Nuclear Engineer, in charge of fuel handling, directly supervises all fuel transfers and verifies the moves are to the proper locations. Fuel handling procedures and changes to them are reviewed and approved by the Station's ALARA Committee. The Plant Manager has the overall responsibility of the ALARA Program.

B. Minimum Qualifications

The qualifications of the aforementioned safety-related personnel have been reviewed and the staff finds they meet the minimum qualifications specified in Regulatory Guide 1.8, "Personnel Selection and Training" and/or ANSI/ ANS-3.1-1978, "American National Standard for Selection and Training of Nuclear Power Plant Personnel." However, the position, Nuclear Engineer, is not specified in the ANSI/ANS Standard. The minimum qualifications for the latter position, as specified by IPC, are adequate for the responsibilities of the position related to the license. Those, as well as the minimum qualifications for the other safety-related positions, are specified in Conditions 11-14 as follows:

Condition 11: The minimum technical qualifications for the Clinton Power Station (CPS) Power Plant Manager shall be in accordance with Section 4.2.1, "Plant Manager," of ANSI/ANS-3.1-1978.

Condition 12: The minimum technical qualifications for the Radiation Protection Supervisor shall be in accordance with that for the "Radiation Protection Manager" specified in Regulatory Guide 1.8, September 1975.

Condition 13: The minimum technical qualifications for the Senior Reactor Operators shall be in accordance with Section 4.3.1, "Supervisors Requiring NRC Licenses," of ANSI/ANS-3.1-1978.

Condition 14: The minimum technical qualifications for the Nuclear Engineer shall be a bachelor of science degree in engineering or a physical science, 1 year nuclear power plant experience, and shall have completed the General Electric Station Nuclear Engineer Training Course.

C. Training

IP has committed to the radiological control training of all individuals prior to entering either a protected or a radiological control area commensurate with the working conditions and the individuals' responsibilities and duties. In addition, "radiological worker" training and annual retraining is given to all personnel working with radioactive materials. Radiation protection technicians and supervisors also receive theoretical and practical training, including periodic drills. Personnel involved in fuel handling activities also receive training prior to fuel receipt.

VI. NUCLEAR CRITICALITY SAFETY

A. General

The fuel assemblies may be stored in the following areas: (1) in the unloading area in their inner and outer shipping containers, (2) in their inner containers in the Fuel Building, (3) New Fuel Storage Vault, (4) Spent Fuel Storage Pool, and (5) Containment Storage Pool. The fuel assemblies will be stored dry in all locations, except location (4) where it will be stored flooded or dry.

B. Shipping Container Storage

Fuel assemblies may be temporarily stored in their inner and outer shipping containers or only in their inner containers. The shipping containers will not be stacked more than 3 layers high with no more than 24 containers in a single array. The licensee has committed to maintain a minimum of 25-feet spacing between groups of 24 shipping containers. Nuclear criticality safety is assured since the safety of fuel stored in their inner shipping containers in an infinite array stacked four high has been established (Amendment No. 5 to Materials License No. SNM-1097, dated June 6, 1978, Docket No. 70-1113). The 25 feet of separation between arrays is adequate for isolation between arrays.

C. Fuel Handling

The licensee has stated he plans to have no more than three fuel assemblies outside their shipping containers or storage racks at one time. However, the licensee did not specify the minimum distance between this grouping of assemblies and all other fuel. The NRC staff has shown that three isolated fuel assemblies cannot be made critical independent of the spacing between them and of the degree of water moderation and/or reflection. The staff has also determined that a separation of at least 12 inches between the grouping of three fuel assemblies, and all other fuel assemblies in their shipping containers or storage rack locations, is required to assure the nuclear criticality safety of the arrays, under all degrees of water moderation and/or reflection. The staff recommends Condition Nos. 15 and 16 be added to identify these requirements.

Condition 15: No more than three fuel assemblies shall be outside their shipping containers and storage racks at any one time.

Condition 16: The minimum edge-to-edge distance between the group of three fuel assemblies and all other fuel assemblies shall be 12 inches.

D. New Fuel Storage Vault

The new fuel racks in the New Fuel Storage Vault are designed to store up to 240 fuel assemblies. There are 24 rows and 10 fuel assemblies per row. The center-to-center spacing between assemblies is 7 inches within a row and 12.25 inches between rows. The licensee's and the NRC staff's criticality calculations were for infinite arrays at all moderator densities. Calculations of k_{eff} for the array were independently performed by the NRC staff. The staff calculated the array to be supercritical when enveloped in mist with a density between 0.01 g/cm^3 and 0.15 g/cm^3 (approximate densities). If the entire array were flooded with full density water, k_{eff} of the array would be approximately 0.82.

IP has provided four aluminum plate covers over the vault to prevent the entry of mist. Further, no more than two of the covers would ever be off the vault and expose no more than 12 rows (120 assemblies) of fuel assemblies. The licensee has stated in the FSAR that covers will normally be in place over the vault except when new fuel is to be inserted or removed from the rack. Since it has been estimated by the staff that an array of as few as five rows of assemblies fully flooded with water mist at optimum density for maximum k_{eff} may become critical, IP has installed firehose protection stations equipped with solid stream nozzles to fight fires that may, but are unlikely to, occur in the vault. The licensee has committed to establish station administrative procedures specifying actions to be taken for control of combustibles, control of ignition sources, and to control action to be taken in the event of a fire. It is recommended Conditions 17 and 18 be added to emphasize the water mist control in fighting fires.

Condition 17: Fuel assemblies, when stored in the New Fuel Storage Vault, shall be stored under the following conditions:

a. No more than 12 rows of fuel assemblies shall remain uncovered during the loading or unloading of fuel assemblies.

b. Metal covers shall cover all other rows containing fuel assemblies during loading and unloading of fuel assemblies.

c. When loading or unloading of fuel assemblies is not in progress, metal covers shall cover all rows of fuel assemblies.

Condition 18: All firehoses servicing the New Fuel Storage Vault area shall be equipped with solid stream nozzles.

Conditions 17 and 18 preclude the possibility of moderating an entire open section of the fuel array and from generating mist over the entire exposed array to assure nuclear criticality safety. The NRC staff concludes that, with the above controls, the licensee's actions are adequate to ensure nuclear criticality safety during fuel handling operations in the New Fuel Storage Vault.

The licensee plans to wrap the fuel assemblies in polyethylene sheeting to protect them from the environment while in storage. The fuel assemblies may become internally moderated with water while the spaces between assemblies would be occupied only with air. This could occur if the storage area flooded, the area then drained, and the water was retained in the plastic bags. Under these conditions, the array may become critical. The licensee plans to have the polyethylene sheets open at both ends to enable water to drain freely from the fuel assemblies. Under these conditions, there is no nuclear criticality hazard from full density flooding (water) and subsequent draining. The NRC staff emphasizes the licensee's action to prevent such a situation in License Condition 19.

Condition 19: Fuel assemblies shall be stored in such a manner that water would drain freely from the assemblies in the event of flooding and subsequent draining of the fuel storage area.

It is the staff's opinion that with this condition, the licensee has established reasonable and satisfactory precautions to avoid accidental criticality in the New Fuel Storage Vault.

E. Upper Containment Fuel Storage Pool

The Upper Containment Fuel Storage Pool has the same design as the New Fuel Storage Vault. Therefore, k_{eff} of fresh fuel stored in this pool is the same at all water mist densities as it is in the New Fuel Storage Vault (assuming infinite arrays). Since the k_{eff} of the array is only 0.82 when flooded with full density water, IP presently plans to store fresh fuel assemblies in this pool only under water. This requirement will be emphasized as Condition 20.

Condition 20: Fresh fuel assemblies shall be stored in the Containment Fuel Storage Pool only under water.

F. Fuel Building Spent Fuel Storage Pool

The racks in the Spent Fuel Storage Pool form a square array of storage cells spaced on 6.4375-inch centers. The walls that separate storage locations are composed of two steel sheets with a nominal thickness of 0.060 inches, welded to each other to form a pocket 0.150-inches wide in which a 4.25-inch wide by 0.11 inch thick Boral poison sheet is placed for criticality control. The Boral plates contain boron with an areal density of 0.030 g B-10/cm^2. The inner diameters of the storage cells are 6.1675 inches. The layers of steel and Boral provide a margin of safety to prevent an inadvertent criticality.

The staff determined the maximum k_{eff} for an infinite array of fuel assemblies in the Spent Fuel Storage Pool to be 0.840 ± 0.004 at the optimum degree of water moderation (full density water) within and between assemblies. Therefore, any size array of fuel assemblies in the Spent Fuel Storage Pool is safe from inadvertent criticality under all degrees of water moderation. The licensee has a quality assurance program starting with the certification of the analysis of the Boral plates, continuing with the manufacturing of the plates, their installation in the spent fuel racks, and the surveillance program to assure their continued presence in the racks. The Resident Inspectors, T. P. Gwynn and P. L. Hiland, have confirmed the Boral meets the above specifications and has been fabricated into plates which were installed in the storage racks in their design positions.

IP has stated it has no intention "at this time" to store fuel assemblies in the control rod racks. Since the staff was not supplied with sufficient information to evaluate the nuclear criticality safety of these racks if loaded with fuel assemblies, it recommends Condition 21 be added to the license.

Condition 21: No fuel assemblies shall be stored in the control rod racks.

VII. RADIATION SAFETY

The Radiological Control Program at CPS has been established and managed to protect the public, workers, and the environment and to monitor and control radiation exposure and radioactive materials. The objectives of the program are to control radiation exposures and releases of radioactive materials in effluents to unrestricted areas, not only within regulatory limits, but as low as reasonably achievable (ALARA). Each incoming and outgoing shipment of radioactive material is handled in compliance with radiological control procedures and limit surface contamination to either 1000 dpm beta/gamma per 100 cm^2 of surface area or 100 dpm as measured by a pancake GM detector. Alpha emitting loose surface contamination is limited to 100 dpm alpha per 100 cm^2.

The antimony-124 neutron startup sources, separated from their beryllium sleeves, are stored in their shipping containers prior to installation in the reactor core vessel. The shipping containers are lead-filled drums, meeting DOT package specifications, and are General Electric Model 1500 Shielded Containers licensed under S.P. No. 5939. The containers are stored under lock and key security with access controlled by Radiation Protection Personnel. Radiation surveys are made upon receipt of the radioactive materials and at subsequent specified intervals.

The neutron startup sources may be loaded into the source holders and installed in the core vessel prior to receipt of the operating license. Removal of the source pins from the cask, loading them into the holders, and transfer to the reactor vessel are all done under water and at no time, will any radioactive source component outside a shipping container (cask) be allowed to come within 5 feet of the surface. The procedures are covered by a Radiation Work Permit, and a Radiation Protection representative shall be present during manipulations of the loaded cask and all source handling operations to monitor the operations. Although the licensee has committed to leak testing the sources within 31 days prior to installation in the core and following repair or maintenance, it is recommended Condition 22 be added to clarify that the test will be performed prior to installation in the core vessel.

> Condition 22: The antimony-124 startup sources shall be leak tested within 31 days prior to installation in the reactor core vessel and following repair or maintenance.

The licensee also requested the receipt, possession, and installation of incore fission detectors containing small quantities of U-235. An acceptable leak test was specified by the licensee for the fission detectors. The detectors are stored in a permanent warehouse in their shipping containers. The warehouse is locked and access controlled.

Alpha-calibration standards and check sources were also requested by the licensee. They will be stored in a locked cabinet in the Radiation Protection Instrument Calibration Facility. The storage cabinet is locked and access controlled.

When not in use, the neutron calibration standards are locked in the shielded storage position of a neutron irradiator. The irradiator is also within the Instrument Calibration Facility. The storage area is locked and access controlled.

The staff has concluded that the CPS Radiation Protection Program, together with the proposed license conditions, is adequate for the protection of the public, CPS personnel, and the environment.

VIII. ENVIRONMENTAL PROTECTION

The Final Environmental Statement related to the operation of the Clinton Power Station, Unit 1, dated May 31, 1982, has been prepared and issued by the NRC as NUREG-0854. An Environmental Assessment has also been prepared for the 10 CFR Part 70 fuel storage license in accordance with 10 CFR 51.21. This Assessment supports a Finding of No Significant Impact which was published in the Federal Register on June 3, 1985.

IX. FIRE SAFETY

The areas in the Fuel Building and in the Containment Building, where fuel storage and handling are conducted, have very little combustible material. Administrative controls are implemented to control the quantity of combustible materials, ignition sources, and action to be taken in the event of a fire. Fire protection is provided by charged firehose stations having solid stream nozzles and by portable halon extinguishers in the vicinity of each storage and handling area. The staff feels the fire protection system for the facility is adequate.

X. PHYSICAL PROTECTION

The Clinton Power Station physical security plan was reviewed and it was the staff's opinion that the program described was adequate and met the requirements of 10 CFR 73.67. The licensee was notified by NRC letter dated May 31, 1983, that his "Fuel Storage Physical Security Plan" was approved. By letter dated May 14, 1985, IP requested authorization to modify the CPS security plan. The NRC, by letter dated June 11, 1985, notified the licensee the modification was approved. The staff recommends Condition 23 be added approving the modified plan.

Condition 23: The approved "Clinton Power Station, Unit 1, Physical Protection Plan for Special Nuclear Material (SNM)," submitted by letter dated May 18, 1982, and as revised by letters dated November 17, 1982, and May 14, 1985, for the fixed site and in-transit protection of special nuclear material of low strategic significance shall be fully implemented by the date of fuel receipt and shall be in effect whenever fresh fuel is stored onsite.

XI. CONCLUSIONS

1. After reviewing the application and its supplements, the NRC staff finds that:

   a. The application meets the requirements of the Atomic Energy Act, as amended, and the regulations of the Commission.

b. Issuance of the license would not be inimical to the common defense and security.

c. Issuance of the license would not constitute an unreasonable risk to the health and safety of the public.

2. With the recommended license conditions, the NRC staff finds that:

a. The applicant is qualified by reason of training and experience to use the material for the purpose requested in accordance with the regulations in 10 CFR 70.23.

b. The applicant's proposed equipment and facilities are adequate to protect health and minimize danger to life or property.

c. The applicant's proposed procedures to protect health and to minimize danger to life or property are adequate.

XII. RECOMMENDATIONS

The staff recommends approval of the application and its supplements subject to the following conditions which the staff finds are appropriate to protect health or to minimize danger to life or property:

11. The minimum technical qualifications for the Clinton Power Station (CPS) Power Plant Manager shall be in accordance with Section 4.2.1, "Plant Manager," of ANSI/ANS-3.1-1978.

12. The minimum technical qualifications for the Radiation Protection Supervisor shall be in accordance with that for the "Radiation Protection Manager" specified in Regulatory Guide 1.8, September 1975.

13. The minimum technical qualifications for the Senior Reactor Operators shall be in accordance with Section 4.3.1, "Supervisors Requiring NRC Licenses," of ANSI/ANS-3.1-1978.

14. The minimum technical qualifications for the Nuclear Engineer shall be a bachelor of science degree in engineering or a physical science, 1 year nuclear power plant experience, and shall have completed the General Electric Station Nuclear Engineer Training Course.

15. No more than three fuel assemblies shall be outside their shipping containers and storage racks at any one time.

16. The minimum edge-to-edge distance between the group of three fuel assemblies and all other fuel assemblies shall be 12 inches.

17. Fuel assemblies, when stored in the New Fuel Storage Vault, shall be stored under the following conditions:

a. No more than 12 rows of fuel assemblies shall remain uncovered during the loading or unloading of fuel assemblies.

b. Metal covers shall cover all other rows containing fuel assemblies during loading and unloading of fuel assemblies.

c. When loading or unloading of fuel assemblies is not in progress, metal covers shall cover all rows of fuel assemblies.

18. All firehoses servicing the New Fuel Storage Vault area shall be equipped with solid stream nozzles.

19. Fuel assemblies shall be stored in such a manner that water would drain freely from the assemblies in the event of flooding and subsequent draining of the fuel storage area.

20. Fresh fuel assemblies shall be stored in the Containment Fuel Storage Pool only under water.

21. No fuel assemblies shall be stored in the control rod racks.

22. The antimony-124 startup sources shall be leak tested within 31 days prior to installation in the reactor core vessel and following repair or maintenance.

23. The approved "Clinton Power Station, Unit 1, Physical Protection Plan for Special Nuclear Material (SNM)," submitted by letter dated May 18, 1982, and as revised by letters dated November 17, 1982, and May 14, 1985, for the fixed site and in-transit protection of special nuclear material of low strategic significance shall be fully implemented by the date of fuel receipt and shall be in effect whenever fresh fuel is stored onsite.

Original Signed by
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Uranium Process Licensing Section
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Approved by: Original Signed by
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TABLE 1
CHANGED REQUIREMENTS FOR SHUTDOWN FACILITIES

Subject Item	Spec. Vol. Sec.	Existing Requirement	New Requirement	Comment or Condition
Internal Inspections				
Health Physics	3.6.1	Quarterly	Annual	HTGR & Hot Cell Particulate exposures essentially eliminated by nothing in storage
Nuclear Safety	"	Quarterly	Annual	Where mtl is vault stored in stable forms, e.g., oxide or encapsulated
Personnel Monitoring				
U-235 bioassay	4.1.3	Includes guards	Eliminate guards	During shutdown of fuel fab
Surveys				
Wipes	4.1.4.1	Daily	Monthly Weekly	In shutdown fuel fab areas in QC Lab & other Type II workplaces
Air Velocity	"	Quarterly	No Survey when hoods are unused	Enclosure cleaned to minimize potential for airborne release of material
Glove Box	"	"	"	"
Air Samples				
Work place	4.1.4.2	Shift	Monthly	In shutdown fuel fab areas
"		Weekly	Weekly	In QC Lab & other Type II work places
Analysis Interval	"	Within 24 hours	1 week	
Stack	"	Weekly	Monthly	In shutdown processing areas
Water Sampling				
Sewage	4.1.4.3	Collected daily Samples evaluated daily	Collected weekly Samples evaluated monthly plus sample and evaluate on days of discharge	
Alarm checks & Calibration				
*Calibration	4.2.1 & 4.2.1.4	Semiannual recalibration to NBS Traceable Sources	Eliminate CWAS from requirement of 4.2.1	Functionally test monthly with builtin check or portable sources or other system features
Work Place				
Air changes	4.1.2.1	All work places 4 air changes/hr	Eliminate requirement in areas when all material is stored and equipment is cleaned out.	
HCl Monitoring	6.6.1	Quarterly	0 furnace operations	No planned HCl
Environmental Air Sampling	6.1	Weekly	Monthly	
Suspended Particulate	6.6.1	Semiannual	No change	
Tap Water Sampling	4.1.4.3	Daily Evaluation	Weekly Evaluation	
Sewage Sampling	6.2	Daily	Sampled daily Analyzed weekly	

*Requested change under all levels of operation