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Docket
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DRoss
TBAbernathy
JRBuchanan

Docket No. 50-331

JULY 7 1978

Iowa Electric Light & Power Company
ATTN: Mr. Duane Arnold, President
P. O. Box 351
Cedar Rapids, Iowa 52406

Gentlemen:

The Commission has issued the enclosed Amendment No. 45 to Facility License No. DPR-49 for the Duane Arnold Energy Center. This amendment consists of a change to the conditions and requirements of License No. DPR-49 and a change to the Technical Specifications in response to your application of October 13, 1977, as supplemented by letters dated December 20, 1977, March 14, 1978, May 11, 1978, May 15, 1978, June 6, 1978 and June 19, 1978 and as amended by your letter of June 29, 1978.

This amendment authorizes you to increase the storage capacity of the spent fuel pool to 2050 assemblies, including an interim increase of 160 storage spaces using the two racks described in your June 29, 1978 submittal.

Copies of the related Safety Evaluation, Environmental Impact Appraisal and the Notice of Issuance and Negative Declaration also are enclosed.

Sincerely,

Original signed by

Thomas A. Ippolito, Chief
Operating Reactors Branch #3
Division of Operating Reactors

Enclosures:
1. Amendment No. 45
2. Safety Evaluation
3. Environmental Impact Appraisal
4. Notice of Issuance and Negative Declaration

cc w/enclosures: See page 2

Const. 1
GP

OFFICE	ORB #3	ORB #3	OELD	ORB #3		
SURNAME	SSheppard	RClark:mjf	Goddard	TIppolito		
DATE	7/6/78	7/7/78	7/7/78	7/7/78		

NRC FORM 318 (9-76) NRCM 0240 ☆ U. S. GOVERNMENT PRINTING OFFICE: 1976 — 626-624 cc:

Mr. Robert Lowenstein, Esquire
Harold F. Reis, Esquire
Lowenstein, Newman, Reis and Axelrad
1025 Connecticut Avenue, N. W.
Washington, D. C. 20036

Office for Planning and Programming
523 East 12th Street
Des Moines, Iowa 50319

Chairman, Linn County
Board of Supervisors
Cedar Rapids, Iowa 52406

Iowa Electric Light & Power Company
ATTN: Ellery L. Hammond
P. O. Box 351
Cedar Rapids, Iowa 52406

Chief, Energy Systems Analysis Branch (AW-459)
Office of Radiation Programs
U. S. Environmental Protection Agency
Room 645, East Tower
401 M Street, S. W.
Washington, D. C. 20460

U. S. Environmental Protection Agency
Region VII
ATTN: EIS COORDINATOR
1735 Baltimore Avenue
Kansas City, Missouri 64108

Cedar Rapids Public Library
426 Third Avenue, S. E.
Cedar Rapids, Iowa 52401

2. Accordingly:

Paragraph 2.B(2) of Facility Operating License No. DPR-49 is hereby amended to read as follows:

(2) IELP, pursuant to the Act and 10 CFR Part 70, to receive, possess and use at any time special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, as described in the Final Safety Analysis Report, as supplemented and amended as of January 1, 1975 and as suppmented and amended by letters dated October 13, 1977, December 20, 1977, March 14, 1978, May 11, 1978, May 15, 1978, June 6, 1978, June 19, 1978 and June 29, 1978.

The license is also amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. DPR-49 is hereby amended to read as follows:

(2) <u>Technical Specifications</u>

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 45, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of its issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Brian K. Grimes, Assistant Director
for Engineering and Projects
Division of Operating Reactors

Attachment:
Changes to the Technical
Specifications

Date of Issuance: July 7, 1978

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

IOWA ELECTRIC LIGHT AND POWER COMPANY
CENTRAL IOWA POWER COOPERATIVE
CORN BELT POWER COOPERATIVE

DOCKET NO. 50-331

DUANE ARNOLD ENERGY CENTER

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 45
License No. DPR-49

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Iowa Electric Light and Power Company, Central Iowa Power Cooperative, and Corn Belt Power Cooperative (the licensees) dated October 13, 1977, as supplemented by letters dated December 20, 1977, March 14, 1978, May 11, 1978, May 15, 1978, June 6, 1978 and June 19, 1978, and as amended by letter dated June 29, 1978, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

ATTACHMENT TO LICENSE AMENDMENT NO. 45

FACILITY OPERATING LICENSE NO. DPR-49

DOCKET NO. 50-331

Replace the following page of the Appendix "A" Technical Specifications with the enclosed page. The revised page is identified by Amendment number and contains a vertical line indicating the area of change.

Remove	Replace
5.5-1	5.5-1

5.5 SPENT AND NEW FUEL STORAGE

1. The new fuel storage facility shall be such that the effective multiplication factor (k_{eff}) of the fuel, dry is less than 0.90 and flooded is less than 0.95.

2. The k_{eff} of the fuel in the spent fuel storage pool shall be less than or equal to 0.95. Fuel stored in the pool shall not contain more than 15.3 grams of uranium-235 per axial centimeter of fuel assembly.

3. Spent fuel shall only be stored in the spent fuel pool in a vertical orientation in approved storage racks.

ENVIRONMENTAL IMPACT APPRAISAL

BY

OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO INCREASE IN

STORAGE CAPACITY FOR SPENT FUEL

FACILITY OPERATING LICENSE NO. DPR-49

IOWA ELECTRIC LIGHT AND POWER COMPANY
CENTRAL IOWA POWER COOPERATIVE
CORN BELT POWER COOPERATIVE

DUANE ARNOLD ENERGY CENTER

DOCKET NO. 50-331

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

ENVIRONMENTAL IMPACT APPRAISAL BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO INCREASE IN STORAGE CAPACITY FOR SPENT FUEL POOL

FACILITY OPERATING LICENSE NO. DPR-49

IOWA ELECTRIC LIGHT AND POWER COMPANY
CENTRAL IOWA POWER COOPERATIVE
CORN BELT POWER COOPERATIVE

DUANE ARNOLD ENERGY CENTER

DOCKET NO. 50-331

1.0 Description of Proposed Action

In their submittal of October 13, 1977, supplemented by letters dated December 20, 1977, March 14, 1978, May 11, 1978, May 15, 1978, June 6, 1978 and June 19, 1978, Iowa Electric Light and Power Company, et al, (the licensee) requested an amendment to Facility Operating License No. DPR-49 for the Duane Arnold Energy Center (DAEC or the facility) to obtain authorization to increase the storage capacity of the spent fuel pool (SFP). The proposed change would increase the storage capacity of the SFP from 480 to 2050 spent fuel assemblies (i.e., from about 1.3 to about 5.6 cores). A total of 510 storage spaces are presently provided in the SFP, 480 of which are designed for storage of normal spent fuel and 30 of which are designed for storage of defective spent fuel.

By letter dated June 29, 1978, the licensee amended the above submittals to request authorization to install two racks manufactured for Boston Edison's Pilgrim Unit No. 1 facility in the DAEC spent fuel pool. The two 8x10 racks have a storage capacity of 160 fuel assemblies and would be installed on a temporary basis. Prior to installing any of the higher density racks described in the licensee's submittal of October 13, 1977, the two temporary racks would be removed from the SFP for subsequent shipment offsite.

The modification evaluated in this environmental impact appraisal is the proposal by the licensee to increase the storage capacity of the SFP. This would be accomplished in stages. Initially, the capacity of the SFP would be increased by 160 storage spaces by installing two new racks in addition to the racks that are currently in the pool. Within approximately a year, the two temporary racks would be removed along with 8 of the present racks and up to 12 new racks installed with storage space for up to 1161 assemblies. After spent fuel that is presently stored in existing racks is transferred into the new racks, the remainder of the present racks will be removed and new racks installed in their place. Eventually, 21 of the new racks will be installed with a total storage capacity for 2050 spent fuel assemblies. The increased storage capacity is achieved by using closer spaced racks than those that are currently in the SFP. The present racks have a center-to-center spacing of 11.9 x 6.6 inches. The two temporary racks have a spacing of 7 inches center-to-center and the 21 new racks that will eventually be used in the SFP have a center-to-center spacing of 6.625 inches. Figure 1 shows the arrangement of the SFP as it will be with the two temporary racks installed. Figure 2 shows the arrangement that will exist when all 21 of the new racks are installed.

2.0 Need for Increased Storage Capacity

DAEC commenced power operation in mid 1974. Since that time there have been three refueling outages during which a total of 276 spent fuel assemblies have been discharged from the reactor. No spent fuel has been shipped from the site. There are several reasons for the current need to increase the spent fuel storage capacity.

The current normal storage capacity of the SFP is 480 fuel assemblies. With 274 assemblies presently stored in the pool, (2 damaged assemblies are stored in the defective fuel cannisters) there is only storage space for an additional 206 assemblies. A full core for NMP-1 consists of 368 assemblies. Thus, DAEC does not have room in the SFP with the present storage capacity to off-load a full core.

On June 17, 1978, DAEC developed a crack in a recirculation system inlet nozzle transition piece. To facilitate repairs, it is necessary to discharge all fuel from the reactor to the SFP. As noted above, DAEC does not have space in the SFP to offload the full core. None of the racks described in the October 13, 1977 submittal have been fabricated. The licensee was awaiting NRC action and/or comments on the design of the racks and their use in the SFP prior to starting the fabrication. The manufacturer advised the licensee it would take at least a month to fabricate two racks. The same manufacturer (Programmed and Remote Systems Corporation) has fabricated spent fuel storage racks of essentially the same design for other utilities who are planning to expand the storage capacity of their onsite spent fuel pools. The Boston Edison Company has two such racks that they are proposing to use in the Pilgrim Unit No. 1. SFP, which they agreed to furnish to Iowa Electric. These two racks are available for immediate installation in the Duane Arnold SFP; hence, the request of June 29, 1978 to install these two racks on a temporary basis so Duane Arnold can offload the full core and proceed with repair operations.

Aside from the immediate need for increased storage capacity in the SFP to repair the safe end, increased storage capacity is also required for continued operation of the plant. Under the current fuel management plan, approximately 1/4 of the core (about 85 fuel assemblies) is replaced each year. With the present storage capacity of the SFP, the pool will be essentially full after the next two refuelings (i.e., after the refueling tentatively scheduled for about April 1980). If the storage capacity of the SFP is not increased or if alternate storage space for spent fuel from this facility is not located, DAEC would have to be shutdown about mid 1981. If an increase in storage capacity for the DAEC SFP is not approved, operation could continue until 1981 at which time the core would no longer have sufficient reactivity to continue operation and insufficient spent fuel pool space would be available to permit a refueling operation.

Another important consideration is the amount of open storage capacity that would be required to permit removal and replacement of the existing racks. None of the new racks can be installed until a portion of the existing racks are removed. The existing racks are constructed in two independent seismically supported groups. One must be empty of stored fuel before any dismantling can begin. The smaller of the two groups, which contains 150 storage locations, is to be removed first. This requires that at least 150 open storage locations be available at the time rack replacement begins. Removal of the first group of racks must begin, and some new racks must be in place prior to the refueling scheduled for early 1979 in order to meet this requirement.

Upon completion of the rack modification, the new storage capacity of 2050 fuel assemblies will accommodate the spent fuel from regular refueling, through the year 1993, while still allowing for discharge of a full core. Additional regular refuelings could continue through the year 1998 without the capability for discharge of a full core.

In this environmental evaluation, we have considered the impacts which may result from storing up to an additional 1570 spent fuel assemblies in the DAEC SFP on the basis that the spent fuel that is now in the SFP (the spent fuel transferred to the pool in 1975, 1976, 1977 and 1978) and the spent fuel to be stored in the pool from future refuelings will remain in the DAEC SFP through the year 2000.

The proposed modification would not alter the external physical geometry of the spent fuel pool or involve significant modifications to the SFP cooling or purification systems. The proposed modification does not affect in any manner the quantity of uranium fuel utilized in the reactor over the anticipated operating life of the facility and thus in no way effects the generation of spent uranium fuel by the facility. The rate of spent fuel generation and the total quantity of spent fuel generated during the anticipated operating lifetime of the facility remains unchanged as a result of the proposed expansion. The modification will increase the number of spent fuel assemblies that could be stored in the SFP and the length of time that some of the fuel assemblies could be stored in the pool.

On the basis of the evaluation discussed herein, we have concluded that the storage capacity of the Duane Arnold Spent Fuel Pool should be increased.

3.0 Fuel Reprocessing History

Currently, spent fuel is not being reprocessed on a commerical basis in the United States. The Nuclear Fuel Services (NFS) plant at West Valley, New York, was shut down in 1972 for alterations and expansions; on September 22, 1977, NFS informed the Commission that they were withdrawing from the nuclear fuel reprocessing business. The Allied-General Nuclear Services (AGNS) proposed plant in Barnwell, South Carolina is not licensed to operate. The General Electric Company's (GE) Midwest Fuel Recovery Plant in Morris, Illinois, now referred to as Morris Operation (MO), is in a decommissioned condition. Although no plants are licensed for reprocessing fuel, the storage pool at Morris, Illinois and the storage pool at West Valley, New York (on land owned by the State of New York and leased to NFS through 1980) are licensed to store spent fuel. The storage pool at West Valley is not full but NFS is presently not accepting any additional spent fuel for storage, even from those power generating facilities that had contractual arrangements with NFS. Construction of the AGNS receiving and storage station has been completed. AGNS has applied for - but has not been granted - a license to receive and store irradiated fuel assemblies in the storage pool at Barnwell. Further proceedings on this licensing action have not been scheduled. An application has been received from the Exxon Corporation for construction of a proposed spent fuel storage and reprocessing facility in Tennessee; licensing review of this application is suspended.

4.0 The Plant

The Duane Arnold Energy Center (plant) is described in the Final Environmental Statement (FES) related to operation of the facility issued by the Commission in March 1973. The plant has a single boiling water reactor, manufactured by the General Electric Company, which generates steam at 1000 psig to drive the turbine-generator. The reactor has a rating of 1658 megawatts thermal (Mwt), corresponding to a net electrical output of 569 megawatts electrical (Mwe). Pertinent descriptions of principal features of the Plant as it currently exists are summarized below to aid the reader in following the evaluations in subsequent sections of this appraisal.

4.1 Fuel Inventory

The reactor core, which contains 368 fuel assemblies, is refueled each year, with about one-fourth of the core (88 fuel assemblies) replaced during each refueling period. The assemblies now in use were manufactured by General Electric Corporation.

4.2 Plant Cooling Water Systems

Plant water usage is described in Section 3.3 of the FES. Condenser cooling water is provided by a closed-cycle system using forced draft cooling towers. Under design plant operating conditions, water is pumped into the plant from the Cedar River at the rate of

11,000 gpm, and from two onsite wells at the rate of 1600 gpm. With exception of water lost to the atmosphere as vapor (including vaporized drift) from the cooling towers, all water used during plant operation is ultimately discharged to the river. The quantity of water lost by vaporization varies somewhat with air conditions. Design vapor and drift losses account for 7000 gpm, and "blowdown" for 4000 gpm, so a total of 11,000 gpm of makeup water is required.

In addition to the circulating water system used to cool the condenser and the onsite wells which supply makeup water to the demineralized water makeup system and containment air-cooling system, there are three service water systems and the fire protection system. The three service water systems are the General Service Water system, the Residual Heat Removal (RHR) service water system and the Emergency service water system.

Service water from the Cedar River is used for plant cooling purposes in both normal and emergency operating conditions. Except for fire protection water usage during a fire, there is no net consumptive use of service water. The residual heat removal (RHR) system is used to remove heat from the reactor core during reactor cooldown and may be used for possible postaccident flooding of the reactor core. The emergency service water system supplies cooling water under conditions of loss of offsite power to the center or a loss-of-coolant accident. General service water is used for cooling equipment throughout the center other than equipment cooled by well water (normal conditions) or emergency service water (emergency conditions).

The General Service Water system provides cooling water to the Reactor Building Closed Cooling Water System (RBCWS), the Turbine Lube Oil Coolers, the Isolated Phase Bus Duct Cooler, the Generator Hydrogen Coolers, the Stator Winding Liquid Coolers, the Condensate Pump Motor Coolers, the Exciter Air Cooler, the oil and motor coolers for the reactor feed pumps, the EHC system coolers, the Recirculation Pump MG coolers, the chlorination system and the Circulating Water Pump motor coolers. Three vertical centrifugal pumps are provided in the Service Water System Pumphouse. Two pumps are normally operating with the third on automatic standby. Each pump is rated for 4800 gpm at 160 feet head.

The RBCWS is a closed, circulating water system used to provide cooling of equipment in the reactor building which may contain or have the potential to contain radioactive fluids. The RBCWS consists of a forced circulation loop which contains three heat exchangers and three pumps. The system provides cooling for the two spent fuel pool heat exchangers, the drywell equipment drain sump cooler, the two reactor water cleanup nonregenerative heat exchangers, the reactor building sample cooler, the turbine building sample cooler, the two radwaste building sample coolers, the two control rod drive pump coolers, the two reactor cleanup recirculating pump seal coolers, the two reactor recirculating pump heat exchangers and the reactor building equipment drain sump heat exchanger.

As discussed above, the heat exchangers in the SFP cooling system are cooled by the RBCWS, which in turn is cooled by the General Service Water System. However, the two SFP heat exchangers are only one of 16 heat exchangers cooled by the RBCWS and the RBCWS heat exchangers are, in turn, only one of 12 items cooled by the General Service Water System.

4.3 Heat Dissipation

Heat dissipation for the DAEC is discussed in Section 3.4 of the FES. The plant dissipates about 3.6 x 10^9 Btu/hr at normal full-load operation through a closed-cycle cooling system employing forced draft evaporation cooling towers. About 95% of this heat is removed in the main condenser, the balance in residual heat-removal systems.

As described in the FES, even at very low river flows, such as the drought conditions that prevailed during the summer of 1977, the area of the Cedar River subjected to a 5°F rise in temperature is less than 0.04 acres. In all cases, the thermal plumes involve less than 25% of the total river width.

4.4 Radioactive Wastes

The Plant contains waste handling and treatment systems designed to collect and process gaseous, liquid and solid waste that might contain radioactive material. The waste handling and treatment systems are evaluated in Section 3.5 of the FES and in Section 11.0 of the "Safety Evaluation (SE) of the Duane Arnold Energy Center" issued by the Commission on January 23, 1973. The proposed modification will not result in any change in the waste treatment systems or in the conclusions of the evaluation of these systems from that which is described in the SE and FES.

4.5 Purpose of SFP

The SFP at DAEC was designed to store spent fuel assemblies prior to shipment to a reprocessing facility. These assemblies may be transferred to a reprocessing facility. These assemblies may be transferred from the reactor core to the SFP during a core refueling, or to allow for inspection repair and/or modification to core internals. The latter may require the removal and storage of up to a full core, as is presently required to repair the recirculation riser nozzle transition piece. The assemblies are initially intensely radioactive due to their fission product content and have a high thermal output. They are stored in the SFP to allow for radioactive and thermal decay.

The major portion of decay occurs during the first 150-day period following removal from the reactor core. After this period, the assemblies may be withdrawn and placed into a heavily shielded fuel cask for offsite shipment. Space permitting, the assemblies may be stored for an additional period allowing continued fission product decay and thermal cooling prior to shipment.

4.6 Spent Fuel Pool Cleanup System

The SFP cleanup loop consists of two 500 gpm circulating pumps, two heat exchangers, two filter-demineralizers and the required piping, valves and instrumentation. The SFP cooling and cleanup system pumps draw water from the two skimmer surge tanks which are connected to the pool. This flow is passed through the filter-demineralizers. The water is then returned to the pool.

5.0 Environmental Impacts of Proposed Action

5.1 Land Use

The proposed mofication will not alter the external physical geometry of the SFP. The SFP is entirely contained within the existing reactor building structure. No additional commitment of land is required. The SFP was designed to store spent fuel assemblies under water for a period of time to allow shorter-lived radioactive isotopes to decay and to reduce their thermal heat output. The Commission has never set a limit on how long spent fuel assemblies could be stored onsite. The longer the fuel assemblies decay, the less radioactivity they contain. The proposed modification will not change the basic land use of the SFP. The pool was designed to store the spent fuel assemblies from up to five normal refuelings. The modification would provide storage for up to twenty three normal refuelings. The pool was intended to store spent fuel. This use will remain unchanged by the proposed modification. The proposed modification will make more efficient use of the land already designated for spent fuel storage.

5.2 Water Use

There will be no significant change in plant water usage as a result of the proposed modification. As discussed subsequently, storing additional spent fuel in the SFP will increase the heat load on the SFP cooling system, which is transferred to the Reactor Building Cooling Water System and thence to the plant General Service Water System. The modification will not change the flow rate within these cooling systems. As discussed in Section 10.5 of the DAEC Final Safety Analysis Report (FSAR), the design bases for the SFP cooling system was that for a normal refueling cycle the fuel pool cooling system must be capable of maintaining the bulk pool temperature below 150°F. For maximum possible heat load, (i.e., the decay heat of a full core at the end of a full cycle plus the decay heat from fuel discharged at previous refuelings), the fuel pool cooling system in conjunction with the Residual Heat Removal (RHR) system must be capable of maintaining the bulk pool temperature below 150°F. For this maximum possible heat load, it is assumed that the storage rack assemblies are fully loaded after the full core is inserted. This design bases will not be changed by the proposed modification. As discussed subsequently, and in the accompanying staff Safety Evaluation, we conclude that the SFP cooling systems are adequate to maintain the temperature of the pool water below 150°F, and thus no significant change in evaporation rates. The increased storage will add a small but relatively insignificant amount of heat to the pool water. The increased in water makeup attributable to the modification because of increase evaporation from the pool will be undetectable in the total plant makeup water requirement.

5.3 Heat Rejection

The increased storage will slightly increase the rate of heat load from the fuel. This increase will be insignificant particularly compared to the heat rejected from the secondary system heat cycle at the main condenser and further does not constitute a net increase of effect on the environment because this heat loss would occur regardless of the location where the spent fuel is stored.

We find that the maximum incremental heat load in the DAEC spent fuel pool that will be added by increasing the number of fuel assemblies stored in the pool from 510 to 2050 will be 1.6×10^6 Btu/hr. As noted in Section 4.3 of this evaluation, DAEC dissipates about 3.6×10^9 Btu/hr at normal full load operation with negligible thermal impact on the Cedar River. The incremental heat load from the SFP will have a negligible incremental impact and is so low that it could not be differentiated in thermal plume measurements.

5.4 Radiological

5.4.1 Introduction

The potential offsite radiological environmental impacts associated with the expansion of the spent fuel storage capacity were evaluated and determined to be environmentally insignificant as addressed below.

The additional spent fuel which would be stored due to the expansion is fuel which should have decayed about five years. During the storage of the spent fuel under water, both volatile and nonvolatile radioactive nuclides may be released to the water from the surface of the assemblies or from defects in the fuel cladding. Most of the material released from the surface of the assemblies consists of activated corrosion products such as Co-58, Co-60, Fe-59 and Mn-54 which are not volatile. The radionuclides that might be released to the water through defects in the cladding, such as Cs-134, Cs-137, Sr-89 and Sr-90 are also predominately nonvolatile. The primary impact of such nonvolatile radioactive nuclides is their contribution to radiation levels to which workers in and near the SFP would be exposed. The volatile fission product nuclides of most concern that might be released through defects in the fuel cladding are the noble gases (xenon and krypton), tritium and the iodine isotopes.

5.4.2 Effect of Fuel Failures on the SFP

Experience indicates that there is little radionuclide leakage from Zircaloy clad spent fuel stored in pools for over a decade. The predominance of radionuclides in the spent fuel pool water appears to be radionuclides that were present in the reactor coolant system prior to refueling (which become mixed with water in the spent fuel pool during refueling operations) or crud dislodged from the surface of the spent fuel during transfer from the reactor core to the SFP. During and after refueling, the spent fuel pool cleanup system reduces the radioactivity concentrations considerably.

Operators at several reactors have discharged, stored, and/or shipped relatively large numbers of Zircaloy-clad fuel which developed defects during reactor exposures, e.g., Ginna, Oyster Creek, Nine Mile Point, and Dresden Unit Nos. 1 and 2. Several hundred Zircaloy-clad assemblies which developed one or more defects in-reactor are stored in the GE-Morris pool without need for isolation in special cans. Detailed analysis of the radioactivity in the pool water indicates that the defects are not continuing to release significant quantities of radioactivity. Normal radioactivity concentrations in the Morris pool water are about $3x10^{-4}$ μCi/ml which is near the maximum desired concentration for occupational exposure considerations in bathing and culinary uses. The radioactivity concentrations rose to $2x\ 10^{-3}$ μCi/ml during a month when the water cleanup system was removed from service.

Based on the operational reports submitted by the licensees and discussions with the operators, there has not been any significant leakage of fission products from spent light water reactor fuel stored in the Morris Operation (MO) pool (formerly Midwest Recovery Plant) at Morris, Illinois, or at Nuclear Fuel Services' (NFS) storage pool at West Valley, New York. Spent fuel has been stored in these two pools which, while it was in a reactor, was determined to have significant leakage and was, therefore, removed from the core. After storage in the onsite spent fuel pool, this fuel was later shipped to either MO or NFS for extended storage. Although the fuel exhibited significant leakage at reactor operating conditions, there was no significant leakage from this fuel in the offsite storage facility.

A recent Battelle Northwest Laboratory (BNL) report, "Behavior of Spent Nuclear Fuel in Water Pool Storage" (BNWL-2256 dated September 1977), states that radioactivity concentrations may approach a value up to 0.5 μCi/ml during fuel discharge in the SFP. After the refueling, the SFP ion exchange and filtration units will reduce and maintain the pool water in the range of 10^{-3} to 10^{-4} μCi/ml.

It is theorized that most failed fuel contains small, pinhole-like perforations in the fuel cladding at reactor operating conditions of approximately 800°F. A few weeks after refueling, the spent fuel cools in the spent fuel pool so that fuel clad temperature is relatively cool, approximately 180°F. This substantial temperature reduction should reduce the rate of release of fission products from the fuel pellets and decrease the gas pressure in the gap between pellets and clad, thereby tending to retain the fission products within the gap. In addition, most of the gaseous fission products have short half-lives and decay to insignificant levels within a few months.

In handling defective fuel, the BNL study found that the vast majority of failed fuel does not require special handling and is stored in the same manner as intact fuel. Two aspects of the defective fuel account for its favorable storage characteristics. First, when a fuel rod perforates in-reactor, the radioactive gas inventory is released to the reactor primary coolant. Therefore, upon discharge, little additional gas release occurs. Only if the failure occurs by mechanical damage in the basin are radioactive gases released in detectable amounts, and this type of damage is extremely rare. In addition, most of the gaseous fission products have short half-lives and decay to insignificant levels. The second favorable aspect is the inert character of the uranium oxide pellets in contact with water. This has been demonstrated in laboratory studies and also by casual observations of pellet behavior when broken rods are stored in pools.

5.4.3 Radioactive Material Released to Atmosphere

With respect to gaseous releases, the only significant noble gas isotope attributable to storing additional assemblies for a longer period of time would be krypton-85. As discussed previously, experience has demonstrated that after spent fuel has decayed 4 to 6 months, there is no significant release of fission products from defected fuel. However, we have conservatively estimated that an additional 50 curies per year of Krypton-85 may be released from the SFP when the modified pool is completely filled. This increase would result in an additional total body dose at the site boundary to an individual of less than 0.0001 man-rem/year. This dose is insignificant when compared to the approximately 100 man-rem/year that an individual receives from natural background radiation. The additional total body dose to the estimated population within a 50-mile radius of the plant is less than 0.0002 man-rem/year. This is less than the natural fluctuations in the dose this population would receive from natural background radiation. Under our conservative assumptions, these exposures represent an increase of less than 0.1% of the exposures from the plant evaluated in the FES for the individual and the population (Table 5.4). Thus, we conclude that the proposed modification will not have any significant impact on the exposures offsite.

Assuming that the spent fuel will be stored onsite for several years, Iodine-131 releases from spent fuel assemblies to the SFP water will not be significantly increased because of the expansion of the fuel storage capacity since the Iodine-131 inventory in the fuel will decay to negligible levels between refuelings for each unit.

Storing additional spent fuel assemblies in the SFP will not increase the bulk water temperature during normal refuelings above the 150°F maximum temperature used in the design analysis. Therefore, it is expected that there will not be any significant change in the previously evaluated annual release of tritium or iodine as a result of the proposed modification.

Most airborne releases from the plant result from leakage of reactor coolant which contains tritium and iodine in higher concentrations than the spent fuel pool. Therefore, even if there were a slightly higher evaporation rate from the spent fuel pool, the increase in tritium and iodine released from the plant as a result of the increase in stored spent fuel would be small compared to the amount normally released from the plant and that which was previously evaluated in the FES. If levels of radioiodine become too high, the air can be diverted to charcoal filters for the removal of radioiodine before release to the environment. In addition, the station Technical Specifications, which are not being changed by this action, limit the releases of gaseous activity from the entire facility, including the spent fuel pool.

5.4.4 Solid Radioactive Wastes

The concentration of radionuclides in the pool is controlled by the filter-demineralizers and by decay of short-lived isotopes. The activity is high during refueling operations while reactor coolant water is introduced into the pool and decreases as the pool water is processed through the filter and demineralizer. The increase of radioactivity, if any, due to increased storage should be minor because the additional spent fuel to be stored is relatively cool, thermally, and radionuclides in the fuel will have decayed significantly.

While we believe that there should not be an increase in solid radwaste due to the modification, as a conservative estimate we have assumed that the amount of solid radwaste may be increased by 48 cubic feet of resin a year from the demineralizer (twelve additional resin beds/year). The annual average amount of solid waste shipped from Duane Arnold during 1975 to 1977 is 15,800 cubic feet per year. If the storage of additional spent fuel does increase the amount of solid waste from the SFP purification systems by about 48 cubic feet per year, the increase in total waste volume shipped would be less than 0.5% and would not have any significant environmental impact.

The present spent fuel racks to be removed from the SFP are contaminated and will be disposed of as low level waste. We have estimated that about 11,000 cubic feet of solid radwaste will be removed from SFP because of the proposed modification. This includes disposal of the two Pilgrim I racks, which will be used for a limited period of time, as low level waste at a licensed burial site in the event that the racks cannot be sufficiently decontaminated to return to Boston Edison Company. Therefore, the total waste shipped from the plant will be increased by less than 2% per year when averaged over the lifetime of the plant. This will not have any significant environmental impact.

5.4.5 Radioactivity Released to Receiving Waters

There should not be a significant increase in the liquid release of radionuclides from the station as a result of the proposed modification. The amount of radioactivity on the SFP filter-demineralizer might slightly increase due to the additional spent fuel in the pool but this increase of radioactivity should not be released in liquid effluents from the station.

The filter medium resins are periodically flushed with water to the condensate phase separator tank. The water used to transfer the spent resin is decanted from the tank and returned to the liquid radwaste system for processing. The soluble radioactivity will be retained on the resins. If any activity should be transferred from the spent resin to this flush water, it would be removed by the liquid radwaste system.

5.4.6 Occupational Exposures

We have evaluated the installation of two uncontaminated Pilgrim Unit No. 1 high density fuel storage racks in the Duane Arnold SFP, their use in the pool for up to a year to store part of a full core offload, and subsequent removal, decontamination and shipment of the two racks offsite. The two racks will be placed in open areas in the pool away from the existing racks. The two racks will have no effect on the existing racks in the pool nor will the existing racks affect the two temporary racks. The two racks will be installed in the pool without the need for divers to assist by lowering them into place with the crane. The racks are free standing and will not be bolted or welded to the pool structure. The occupational exposure for installation of the racks is estimated by the licensee to be about 0.33 man-rem, based on about 8 hours total installation time by 8 persons. This includes exposures to the crane operator, health physics personnel, operators, quality control personnel, riggers and supervision. We consider this to be a reasonable exposure estimate.

The licensee has stated that the two Pilgrim Unit No. 1 temporary racks will be removed from the Duane Arnold SFP within a year and prior to the installation of the 21 high density racks proposed in the submittal of October 13, 1977. The temporary racks will be washed down, crated whole and shipped offsite - either to Pilgrim Unit No. 1 to be installed in that SFP or to a licensed burial site. We estimate that the occupational exposure to wash down the two racks, crate them for shipment and ship them offsite to Pilgrim Unit No. 1 or a licensed burial site to be less than 2 man-rem. This estimate is based on the occupational exposure to remove 17 contaminated racks from the Prairie Island SRP, wash them down and crate them whole. We consider this estimated exposure to be reasonable.

We have also reviewed the licensee's plan for the removal, crating and disposal of the existing low density racks and the installation of the high density racks with respect to occupational radiation exposure. The occupational exposure for this operation is estimated by the licensee to be about 8.5 man-rem. The total occupational exposure for the overall proposed modification (i.e., offload of the core during the summer of 1978 and installation of the high density racks) is estimated to be less than 11 man-rem. We consider this to be a reasonable estimate. This operation is expected to be performed only once during the lifetime of the station and will therefore be a small fraction of the total man-rem burden from occupational exposure.

We have estimated the increment in onsite occupational dose resulting from the proposed increase in stored fuel assemblies on the basis of information supplied by the licensee and by utilizing relevant assumptions for occupancy times and for dose rates in the spent fuel pool area from radionuclide concentrations in the SFP water. The spent fuel assemblies themselves contribute a negligible amount to dose rates in the pool area because of the depth of water shielding the fuel. The occupational radiation exposure from spent fuel resulting from the proposed action represents a negligible burden. Based on present and projected operations in the spent fuel pool area, we estimate that the proposed modification should add less than one percent to the total annual occupational radiation exposure burden at this facility. Thus, we conclude that storing additional fuel in the SFP should not result in any significant increase in doses received by occupational workers.

5.4.7 Evaluation of Radiological Impact

As discussed above, the proposed modification does not significantly change the radiological impact evaluated in the FES.

5.5 Nonradiological Effluents

There will be no change in the chemical or biocidal effluents from the plant a result of the proposed modification.

The only potential offsite nonradiological environmental impact that could arise from this proposed action would be additional discharge of heat to the atmosphere and to the Cedar River. Storing spent fuel in the SFP for a longer period of time will add more heat to the SFP water. The spent fuel pool heat exchangers are cooled by the reactor building cooling water system which in turn is cooled by the plant General Service Water System. An evaluation of the augmented spent fuel storage facility was made to determine the effects of the increased heat generation on the plant cooling water systems, and ultimately, on the environment.

As discussed in the staff's Safety Evaluation, the maximum incremental heat load that will be added by use of the proposed rack modification is that from unloading a full core which would fill the pool. The maximum calculated heat generation rate in this case would be about 1.6×10^6 Btu/hr.

The total heat load on the environment from DAEC used in the evaluation in the FES was 3.6×10^9 Btu/hr. The incremental heat load attributable to the proposed modification would be about 0.04% of the total heat rejection rate. Compared to the existing heat load, which was evaluated in the FES and has been evaluated by continuing environmental monitoring programs, the additional thermal impact from the proposed modification will be negligible.

5.6 Impacts on the Community

The new storage racks will be fabricated offsite and shipped to the plant. The two Pilgrim Unit No. 1 racks were also fabricated offsite. No environmental impacts on the environs outside the spent fuel storage building are expected during removal of the existing racks and installation of the new racks. The impacts within this building are expected to be limited to those normally associated with metal working activities and fuel handling operations. No significant environmental impact on the community is expected to result from the fuel rack conversion or from subsequent operation with the increased storage of spent fuel in the SFP.

5.7 Transportation and Handling

Delivery of material for the new high density storage racks and disposal of the existing racks for off-site burial will involve truck and/or rail transportation activity. The number of such shipments will be less than would be required to ship the spent fuel offsite at this time. By deferring offsite shipment of spent fuel, a number of factors can be considered that will reduce the overall environmental impact: More fuel might be loaded per shipping cask, reducing the number of miles in transport; a lighter shipping cask may be used, reducing the tonnage in transport; the reduced radiation level of spent fuel will further reduce the already minimal environmental impact of spent fuel shipments which are covered by the Final Environmental Statement.

6.0 Environmental Impact of Postulated Accidents

Although the new high density racks will accommodate a larger inventory of spent fuel, we have determined that the installation and use of the racks will not change the radiological consequences of a postulated fuel handling accident in the SFP area from those values reported in the FES for Duane Arnold dated March 1973.

Additionally, the NRC staff has under way a generic review of load handling operations in the vicinity of spent fuel pools to determine the likelihood of a heavy load impacting fuel in the pool and, if necessary, the radiological consequences of such an event. Because Duane Arnold prohibits the movement of loads in excess of the combined weight of a fuel assembly and grapple hoist over fuel assemblies in the SFP, we have concluded that the likelihood of a heavy load handling accident is sufficiently small that the proposed modification is acceptable and no additional restrictions on load handling operations in the vicinity of the SFP are necessary while our review is under way. Additionally, no shielded cask movement will be permitted on the refueling deck prior to the completion of the cask drop analysis review.

7.0 Alternatives

In regard to this licensing action, the NRC staff has considered that following alternatives: (1) shipment of spent fuel to a fuel reprocessing facility, (2) shipment of spent fuel to a separate fuel storage facility, (3) shipment of spent fuel to another reactor site, and (4) ceasing operation of the facility. These alternatives are considered in turn.

The total installed capital cost of the proposed 21 high density fuel storage racks, which will eventually be installed in the SFP, is estimated to be $2,500,000 including all labor, materials, engineering, overhead, and allowance for funds during construction. Plant operating costs will not be affected by the modifications. This equates to about $1,600 for each of the additional 1540 storage spaces that would be provided by the proposed modification. If Iowa Electric has to purchase two replacement racks for the two Pilgrim Unit No. 1 racks which they propose to install in the SFP on a temporary basis, the estimated cost of the racks is $200,000. In this case, the total capital cost would be $2.7 million.

It was originally intended that spent fuel from DAEC would be shipped to the Morris Operations facility owned by General Electric for reprocessing. Contractual arrangements for reprocessing spent fuel from DAEC at Morris were never completed. General Electric has since withdrawn from the reprocessing business and operates the Morris facility as an independent spent fuel storage installation. No contract presently exists between Iowa Electric and any existing or planned facility capable of storing spent fuel.

7.1 Reprocessing of Spent Fuel

As discussed earlier, none of the three commercial reprocessing facilities in the U.S. is currently operating. The General Electric Company's Midwest Fuel Recovery Plant at Morris, Illinois is in a decommissioned condition. On September 22, 1976, Nuclear Fuel Services, Inc. (NFS) informed the Nuclear Regulatory Commission that they were "withdrawing from the nuclear fuel reprocessing business." The Allied-General Nuclear Services (AGNS) reprocessing plant received a construction permit on December 18, 1970. In October 1973, AGNS applied for an operating license for the reprocessing facility; construction of the reprocessing facility is essentially complete but no operating license has been granted. On July 3, 1974, AGNS applied for a materials license to receive and store up to 400 MTU of spent fuel in the onsite storage pool, on which construction has also been completed but hearings with respect to this application have not yet commenced and no license has been granted.

In 1976, Exxon Nuclear Company, Inc. submitted an application for a proposed Nuclear Fuel Recovery and Recycling Center (NFRRC) to be located at Oak Ridge, Tennessee. The plant would include a storage pool that could store up to 7,000 MTU in spent fuel. The application for the construction permit is under review.

On April 7, 1977, the President issued a statement outlining his policy on continued development of nuclear energy in the U.S. The President stated that: "We will defer indefinitely the commercial reprocessing and recycling of the plutonium produced in the U.S. nuclear power programs. From our own experience, we have concluded that a viable and economic nuclear power program can be sustained without such reprocessing and recycling."

On December 23, 1977, the Nuclear Regulatory Commission announced that it would order the termination of the now-pending fuel cycle licensing actions involving GESMO (Docket No. RM-50-5), Barnwell Nuclear Fuel Plant
and Plutonium Product Facility (Docket No. 50-332, 70-1327 and 70-1821), the Exxon Nuclear Company, Inc. Nuclear Fuel Recovery and Recycling Center (Docket No. 50-564), the Westinghouse Electric Corporation Recycle Fuels Plants (Docket No. 70-1432), and the Nuclear Fuel Services, Inc. West Valley Reprocessing Plant (Docket No. 50-201). The Commission also announced that it would not at this time consider any other applications for commercial facilities for reprocessing spent fuel, fabricating mixed-oxide fuel, and related functions. At this time, any considerations of these or comparable facilities has been deferred for the indefinite future. Accordingly, the Staff considers that shipment of spent fuel to such facilities for reprocessing is not a reasonable alternative to the proposed expansion of the DAEC spent fuel pool especially when considered in the relevant time frame - i.e., from now until 1980 - when expanded capacity at DAEC will be needed.

The licensee had intended to reprocess the spent fuel to recover and recycle the uranium and plutonium in the fuel. Due to a change in national policy and circumstances beyond the licensee's control, reprocessing of the spent fuel is not an available option at this time.

7.2 Independent Spent Fuel Storage Facility

An alternative to expansion of onsite spent fuel pool storage is the construction of new "independent spent fuel storage installations" (ISFSI). Such installations could provide storage space in excess of 1,000 MTU of spent fuel. This is far greater than the capacities of onsite storage pools. Fuel storage pools at GE Morris and NFS are functioning as ISFSIs although this was not the orignial design intent. Likewise, if the receiving and storage station at AGNS is licensed to accept spent fuel, it would be functioning as an ISFSI until the reprocessing facility is licensed to operate. The license for the GE facility at Morris, Illinois was amended on December 3, 1975 to increase the storage capacity to about 750 MTU:* as of November 1, 1977 295 MTU was stored in the pool in the form of over 1,000 assemblies. The staff has discussed the status of storage space at MO with GE personnel. We have been informed that GE is primarily operating the MO facility to store either fuel owned by GE (which had been leased to utilities on an energy basis) or fuel which GE had previously contracted to reprocess. We were informed that the present GE policy is not to accept spent fuel for storage

*An application for an 1100 MTU capacity addition is pending. Present schedule calls for completion in 1980 if approved. However by motion dated November 8, 1977 General Electric Company requested the Atomic Safety and Licensing Board to suspend indefinitely further proceedings on this application. This motion was granted.

except for that fuel for which GE has a previous commitment. The NFS facility has capacity for about 260 MTU, with approximately 170 MTU presently stored in the pool. The storage pool at West Valley, New York, is on land owned by the State of New York and leased to NFS thru 1980. Although the storage pool at West Valley is not full, since NFS withdrew from the fuel reprocessing business, correspondence we have received indicates that they are not at present accepting additional spent fuel for storage even from the reactor facilities with which they had contracts. The status of the storage pool at AGNS was discussed above.

With respect to construction of new ISFSIs, Regulatory Guide 3.24, "Guidance on the License Application, Siting, Design, and Plant Protection for an Independent Spent Fuel Storage Installation," issued in December 1974, recognizes the possible need for ISFSIs and provides recommended criteria and requirements for water-cooled ISFSIs. Pertinent sections of 10 CFR Parts 19, 20, 30, 40, 51, 70, 71 and 73 would also apply.

The staff has estimated that at least five years would be required for completion of an independent fuel storage facility. This estimate assumes one year for preliminary design; one year for preparation of the license application, Environmental Report, and licensing review in parallel with one year for detail design; two and one-half years for construction and receipt of an operating license; and one-half year for plant and equipment testing and startup.

Industry proposals for independent spent fuel storage facilities are scarce to date. In late 1974, E. R. Johnson Associates, Inc. and Merrill Lynch, Pierce, Fenner and Smith, Inc. issued a series of joint proposals to a number of electric utility companies having nuclear plants in operation or contemplated for operation, offering to provide independent storage services for spent nuclear fuel. A paper on this proposed project was presented at the American Nuclear Society meeting in November 1975 (ANS Transactions, 1975 Winter Meeting, Vol. 22, TANSAO 22-1-836, 1975). In 1974, E. R. Johnson Associates estimated their construction cost at about $20 million.

Several licensees have evaluated construction of a separate independent spent fuel storage facility and have provided cost estimates. In 1975, Connecticut Yankee, for example, estimated that to build an independent facility with a storage capacity of 1,000 MTU (BWR and/or PWR assemblies) would cost approximately $54 million and take about 5 years to put into operation. Commonwealth Edison estimated the construction cost to build a fuel storage facility at about $10,000 per fuel assembly. To this would be added the costs for maintenance, operation, safeguards, security, interest on investment, overhead, transportation and other costs.

On December 2, 1976, Stone and Webster Corporation submitted a topical report requesting approval for a standard design for an independent spent fuel storage facility. No specific locations were proposed, although the design is based on location near a nuclear power facility. No estimated costs for fuel storage were included in the topical report.

The licensee has evaluated the storage of spent fuel at an ISFSI and concluded that it would involve large capital costs in comparison to the proposed modification. They estimated that annual storage and facility investment costs would be on the order of $2,000 per year per bundle, and that transportation costs would be on the order of $4,000 per bundle. At the planned refueling rate of 88 fuel assemblies per year, shipping, storage and investment costs would be over $500,000 the first year and the amount of fuel stored would increase this by approximately $180,000 each year. These costs compare to the estimated annual cost of $360,000 for the proposed modifications.

On a short-term basis (i.e., prior to 1983) an independent spent fuel storage installation does not appear to be a viable alternative based on cost or availability in time to meet the licensee's needs. In addition, constructing an ISFSI would have a greater environmental impact than the proposed action. A new or expanded facility would require additional land use and constructing considerable equipment and structures, whereas installing new racks at Duane Arnold requires only the small amount of material necessary to construct the racks and the modest personnel exposure during installation.

In the long-term, the U.S. Department of Energy (USDOE) is modifying its program for nuclear waste management to include design and evaluation of a retrievable storage facility to provide Government storage at central locations for unreprocessed spent fuel rods. The pilot plant is expected to be completed by late 1985 or 1986. It is estimated that the long-term storage facility will start accepting commercial spent fuel about 1990. The design is based on storing the spent fuel in a retrievable condition for a minimum of 25 years. The criteria for acceptance is expected to be that the spent fuel must have decayed a minimum of ten years so it can be stored in dry condition without need for forced air circulation. An interim alternative to the long term retrievable storage facility, on October 18, 1977, USDOE announced a new "spent nuclear fuel policy." USDOE will determine industry interest in providing interim fuel storage services on a contract basis. If adequate private storage services cannot be provided, the Government will provide interim fuel storage facilities. It was announced by USDOE at a public meeting held on October 26, 1977, that this interim storage is expected to be available in the 1981-1982 time frame. USDOE thru their Savannah River Operations Office is preparing a conceptual design for a possible spent fuel storage pool of about 5000 MTU capacity. DOE has requested, but has not received, Congressional authorization for design and construction of an interim spent fuel storage facility. Based on our discussions with USDOE personnel, it appears that the earliest such a pool could be licensed to accept spent fuel would be about 1983. The interim facility(s) would be designed for storage of the spent under water. USDOE stated that it was their intent to not accept any spent fuel that had not decayed a minimum of five (5) years.

As indicated in the President's energy policy statement of April 29, 1977, the preferred solution to the spent fuel storage program is to have the nuclear power plants store their spent fuel on-site until the government long term storage facility is operable, which is now estimated to be about 1990. For those nuclear power plants that cannot store the spent fuel on-site until the permanent long-term storage facility is available, USDOE intends to provide limited interim storage facilities.

The Duane Arnold plant does not now have space in the SFP to discharge a full core, which is restricting the facility in repairing the crack in the recirculation line. Even if the crack could be repaired without offloading the full core, the SFP will be essentially full after the refueling scheduled for 1980. Unless the storage capacity of the SFP or alternate storage space is found offsite, DAEC would have to shutdown in 1981. However, neither the licensee or the staff have been able to identify any offsite storage facilities that would be available except on a short term emergency basis.

The staff concludes that even if offsite storage facilities are available, it is more economical to store spent fuel onsite and that there are no environmental benefits associated with offsite storage compared to the proposed action.

7.3 Storage at Another Reactor Site

Storage of spent fuel at another reactor facility would be physically possible but is not considered a realistic alternative. Most operating reactors in the United States are experiencing shortages in spent fuel storage capacity and could not efficiently provide storage space for other plants. Iowa Electric does not have another nuclear power plant in its system and would have to make arrangements with another utility to obtain any storage space which might be available. Furthermore, no current power plants are licensed to receive spent fuel from offsite. Storage of DAEC spent fuel at another reactor facility is, therefore, not considered a viable alternative.

According to a survey conducted and documented by the former Energy Research and Development Administration, up to 27 of the operating nuclear power plants will lose the ability to refuel during the period 1977-1986 without additional spent fuel storage pool expansions or access to offsite storage facilities. Thus, the licensee cannot assuredly rely on any other power facility to provide additional storage capability except on a short-term emergency basis. If space were available in another reactor facility, it is unlikely that the cost would be less than storage onsite as proposed.

7.4 Shutdown of Facility

As discussed previously, the Duane Arnold facility is currently shutdown because of a crack that developed on June 17, 1978 in the recirculation riser nozzle transition piece. To repair the crack, it is necessary to offload the core. However, DAEC does not have sufficient space in the SFP to offload the full core. Unless the facility is authorized to increase the storage capacity by at least 160 spaces, the facility may remain shutdown. The DAEC is rated at 515 MW electrical output. This constitutes over half of Iowa Electric Light & Power's generating capacity. The utility does have several small fossil units that it uses for peaking service. Iowa Electric experiences their peak loads during the summer and early fall due to air conditioning loads, operating of corn drying equipment, etc. During the summer months, all generating facilities in the system are generally operating during the peak load periods. With DAEC out of service, Iowa Electric has to purchase replacement power - if it is available - or institute voltage reductions, load shedding or selected brownouts. Since the facility has been shutdown, the utility has been able to purchanse sufficient replacement power to preclude any of the conservation measures. For example, on Monday, July 3, 1978, the utility was purchasing 520 MW of electrical energy or slightly more than the maximum rated output of the Duane Arnold facility. However, if a prolonged heat spell were experienced in the central part of the country, it is doubtful that sufficient replacement power would be available from either the Iowa Power Pool or the Mid-Contenent Area Reliability Coordination Agreement (MARCA) utilities for Iowa Electric to maintain normal service. Even when replacement power is available, it is much more expensive to the customers of Iowa Electric. During the current outage, replacement power costs have averaged over $1,000,000 a week, ranging from $240,000 on most weekdays to $85,000 to $120,000 on light load days such as the weekends.

In addition to the cost for replacement power, there are other overhead type costs which continue whether the Duane Arnold facility is operating or shutdown. It costs about $18,800,000 a year at present for operational, maintenance and security expenses, most of which is personnel costs. There is also the annual costs for interest and principal on the $270 million invested in the facility.

If the proposed modification is not approved and the licensee is able to repair the existing crack without offloading the full core, the facility could only operate until 1981. Iowa Electric estimates that replacement energy in 1981 would cost $73 million for the first year, based upon the additional costs for fuel only, assuming that energy would be available for purchase.

7.5 Summary of Alternatives

In summary, the alternatives (1) to (3) described above are presently not available to the licensee or could not be made available in time to meet the licensee's need. Even if available, alternatives (2) and (3) are likely to be more expensive than the proposed modification and do not offer any advantages in terms of environmental impacts. The alternative of ceasing operation of the facility would be much more expensive than the proposed action because of the need to provide replacement power. In addition to the economic advantages of the proposed action, we have determined that the expansion of the storage capacity of the spent fuel pool for DAEC would have a negligible environmental impact. Accordingly, deferral or severe restriction of the proposed action proposed would result in substantial harm to the public interest.

The proposed modifications accomplish the design objective of providing the required storage capacity while at the same time making more efficient use of the existing facilities at DAEC and minimizing costs of capital, environmental effects, and resources committed. None of the alternatives available presently would provide the storage capacity required to support continued operation of DAEC and none result in lower overall costs. The only alternative presently available is a plant shutdown, which is economically not viable. Offsite storage alternatives, should they become available, would require relatively high capital expenditures. Environmental costs and resources committed for the proposed modifications are minimal and in general would result regardless of where the spent fuel would be stored. The proposed modifications have advantages in several areas such as land use and increased time for decay prior to shipment.

8.0 Evaluation of Proposed Action

8.1 Unavoidable Adverse Environmental Impacts

8.1.1 Physical Impacts

As discussed above, expansion of the storage capacity of the SFP would not result in any significant adverse environmental impacts on the land, water, air or biota of the area.

8.1.2 Radiological Impacts

Expansion of the storage capacity of the SFP will not create any significant additional radiological effects. As discussed in Section 5.3, the additional total body dose that might be received by an individual or the estimated population within a 50-mile radius is less than 0.001 mrem/yr and 0.002 man-rem/yr, respectively, and is less than the natural fluctuations in the dose this population would receive from background radiation. The total occupational exposure of workers during removal of the present storage racks and installation of the new racks is estimated to be less than 11 man-rem. This includes the installation and removal of two Pilgrim Unit No. 1 racks in the Duane Arnold SFP. This is a small fraction of the total annual man-rem burden from occupational exposure at the station. Operation of the plant with additional spent fuel in the SFP is not expected to increase the occupational radiation exposure by more than one percent of the present total annual occupational exposure at this facility.

8.2 Relationships Between Local Short-Term Use of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

Expansion of the storage capacity of the SFP, which would permit the plant to continue to operate until 1991 when offsite storage facilities are expected to be available for interim or long-term storage of spent fuel, will not change the evaluation in the FES.

8.3 Irreversible and Irretrievable Commitments of Resources

8.3.1 Water, Land and Air Resources

The proposed action will not result in any significant change in the commitments of water, land and air resources as identified in the FES. No additional allocation of land would be made; the land area now used for the SFP would be used more efficiently by reducing the spacings between fuel assemblies.

8.3.2 Material Resources

As described in Section 1.0, the proposed modification will be accomplished in three stages. Initially, two temporary racks purchased for Pilgrim Unit No. 1 will be installed in the SFP. These two 8 x 10 racks will provide storage space for 160 additional spent fuel assemblies, permitting DAEC to offload the core. In the second, and third stages, the two temporary racks and all of the present standard 20 element storage racks will be removed and replaced with the proposed new higher density storage racks. This will increase the storage capacity for spent fuel from 510 to 2050 assemblies.

The construction features and materials used in the temporary racks are essentially the same as for the 21 new racks which the licensee will eventially install in the SFP.

The new spent fuel racks are a bolted all anodized aluminum construction having a neutron absorber medium of natural B_4C in an aluminum matrix core clad with 1100 series aluminum. The neutron absorber, marketed under the trade name of Boral, is sealed within two concentric square aluminum tubes forming the "poison can". The minimum weight of total boron per unit area of poison material is 0.129 grams/cm^2.

Figure 2 shows the arrangement of the new spent fuel racks in the SFP. There are a total of 21 racks for a total of 2050 cavities. The following table summarizes the different rack sizes:

Quantity	Size	Rack Dead Wt. (#)
1	8 x 8	8,700
2	8 x 10	10,880
9	8 x 11	11,975
5	10 x 11	14,960
4	11 x 11	16,456

The racks are a free standing design. The only interface with the floor are the four stainless bearing pads attached to the corner leveling screws. A 1/4 inch ABS plastic sheet separates this pad and the aluminum leveling screw to prevent galvanic corrosion. The ABS plastic sheet is held in place by the geometric configuration of the adjustable foot.

Each component of the racks is anodized separately. The top and bottom grids are machined to accurately maintain nominal fuel element spacing of 6.625 inches center to center within the rack. The spacing between the outermost fuel elements in adjacent racks is 9.375 inches center to center.

The proposed spent fuel assembly racks are to be made up of alternating, double-walled aluminum containers. These will be about 14 feet long and will have a square cross section with an inner dimension of 5.9 inches.

The irreversible commitment of materials used to construct the proposed storage racks is compared to the annual consumption of these materials in the United States as follows:

Material	Amount Consumed in Racks (lbs)	Annual US Consumption (lbs)
Stainless Steel	630	10^{11}
Boron Carbide	61,500	10^{6}
Aluminum	217,300	10^{10}

The material required is seen to be insignificant with respect to the annual U. S. consumption and does not represent a significant irreversible commitment of material resources. In any event, an equivalent amount of these or similar materials would be required wherever the fuel is stored.

The longer term storage of spent fuel assemblies withdraws the unburned uranium from the fuel cycle for a longer period of time. Its usefulness as a resource in the future, however, is not changed. The provision of longer onsite storage does not result in any cumulative effects due to plant operation since the throughput of materials does not change. Thus, the same quantity of radioactive material will have been produced when averaged over the life of the plant. This licensing action would not constitute a commitment of resources that would affect the alternatives available to other nuclear power plants or other actions that might be taken by the industry in the future to alleviate fuel storage problems. No other resources need be allocated because the design characteristics of the SFP remain unchanged.

We conclude that the expansion of the SFP at the DAEC facility does not constitute a commitment of either material or nonmaterial resources that would tend to significantly foreclose the alternatives available with respect to any other individual licensing actions designed to ameliorate a possible shortage of spent fuel storage capacity.

8.4 Commission Policy Statement Regarding Spent Fuel Storage

On September 16, 1975, the Commission announced (40FR42801) its intent to prepare a generic environmental impact statement on handling the storage of spent fuel from light water reactors. In this notice, the Commission also announced its conclusion that it would not be in the public interest to defer all licensing actions intended to ameliorate a possible shortage of spent fuel storage capacity pending completion of the generic environmental impact statement. The draft statement was issued for comment on March 17, 1978, (Draft Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel" NUREG-0404, March 1978).

The Commission directed that in the consideration of any such proposed licensing action, among other things, the following five specific factors should be applied, balanced, and weighed in the context of the required environmental statement or appraisal:

1. Is it likely that the licensing action proposed here would have a utility that is independent of the utility of other licensing actions designed to ameliorate a possible shortage of spent fuel capacity?

A reactor core for DAEC contains 368 fuel assemblies. Typically, the reactor is refueled annually. Each refueling replaces about 1/4 of the core (about 88 assemblies). The SFP was designed on the basis that a fuel cycle would be in existence that would only require storage of spent fuel for a year or two prior to shipment to a reprocessing facility. Initially, sufficient racks were installed to store 510 spent fuel assemblies (1 1/3 cores), which was a typical design basis for BWRs in the late sixties and early seventies. When DAEC was designed, a SFP storage capacity for 1 1/3 cores was considered adequate. This provided for complete unloading of the reactor even if the spent fuel from a previous refueling were in the pool. While not required from the standpoint of safety considerations, it is a desirable engineering practice to reserve space in the SFP to receive an entire reactor core, should this be necessary to inspect or repair core internals or because of other operational considerations. This is the situation which presently confronts the licensee as discussed in Section 2.0.

If the proposed expansion in storage capacity of the SFP is not approved, the licensee may not be able to repair the crack in the recirculation riser nozzle transition piece. If the crack cannot be satisfactority repaired, the facility would have to be shutdown and decommissioned. Aside from the immediate need to increase the SFP storage capability, if the licensee can repair the crack and continue operation of the facility, the existing storage racks will only accommodate two more refuelings (i.e., those scheduled for the spring of 1979 and 1980). After 1980, the spent fuel must be stored onsite or elsewhere if the facility is to be refueled. If expansion of the SFP capacity is not approved or if an alternate storage facility is not located, the licensee will have to shutdown DAEC about mid 1980. As discussed under alternatives, an alternate storage facility is not now available. Storage onsite is an interim solution to allow the plant to continue to operate.

The proposed licensing action (i.e., installing new racks of a design that permits storing more assemblies in the same space) would provide the licensee with additional flexibility which is desirable even if adequate offsite storage facilities hereafter become available to the licensee.

We have concluded that a need for additional spent fuel storage capacity exists at DAEC which is independent of the utility of other licensing actions designed to ameliorate a possible shortage of spent fuel capacity.

2. Is it likely that the taking of the action here proposed prior to the preparation of the generic statement would constitute a commitment of resources that would tend to significantly foreclose the alternatives available with respect to any other licensing actions designed to ameliorate a possible shortage of spent fuel storage capacity?

With respect to this proposed licensing action, we have considered commitment of both material and nonmaterial resources. The material resources considered are those to be utilized in the expansion of the SFP. The nonmaterial resources are primarily the labor and talent needed to accomplish the proposed modification.

The increased storage capacity of the DAEC spent fuel pool was also considered as a nonmaterial resource and was evaluated relative to proposed similar licensing actions at other nuclear power plants, fuel reprocessing facilities and fuel storage facilities. We have determined that the proposed expansion in the storage capacity of the SFP is only a measure to allow for continued operation and to provide operational flexibility at the facility, and will not affect similar licensing actions at other nuclear power plants. Similarly, taking this action would not commit the NRC to repeat this action or a related action in 1998, at which time the modified pool is estimated to be full if no fuel is removed.

Preparation of the generic statement was initiated in the fall of 1975. The draft statement, NUREG-0404 was issued in March 1978. As discussed in Section 2.0, there is an immediate need to increase the storage capacity of the DAEC SFP to permit repairs to be made to the facility. Even if this were not the case, it is necessary to install the permanent racks prior to the spring 1979 refueling because of space restrictions. Issuance of the final generic statement and Commission action on the statement is not expected to be completed prior to this time.

We conclude that the expansion of the SFP at DAEC, prior to issuance of the final generic statement, does not constitute a commitment of either material or nonmaterial resources that would tend to significantly foreclose the alternatives available with respect to any other individual licensing actions, designed to ameriorate a possible shortage of spent fuel storage capacity.

3. Can the environmental impacts associated with the licensing action here proposed be adequately addressed within the context of the present application without overlooking any cumulative environmental impacts?

Potential nonradiological and radiological impacts resulting from the fuel rack conversion and subsequent operation of the expanded SFP at this facility were considered by the staff.

No environmental impacts on the environs outside the spent fuel storage building are expected during removal of the existing racks and installation of the new racks. The impacts within this building are expected to be limited to those normally associated with metal working activities and to the occupational radiation exposure to the personnel involved.

The potential nonradiological environmental impact atributable to the additional heat load in the SFP was determined to be negligible compared to the existing thermal effluents from the facility.

We have considered the potential radiological environmental impacts associated with the expansion of the SFP and have concluded that they would not result in radioactive effluent releases that significantly affect the quality of the human environment during either normal operation of the expanded SFP or under postulated fuel handling accident conditions.

4. Have the technical issues which have arisen during the review of this application been resolved?

This Environmental Impact Appraisal and the accompanying Safety Evaluation respond to the questions concerning health, safety and environmental concerns. All technical issues which have arisen in connection with this application have been resolved with the licensee.

5. Would a deferral or severe restriction on this licensing action result in substantial harm to the public interest?

We have evaluated the alternatives to the proposed action, including storage of the additional spent fuel offsite and ceasing power generation from the plant when the existing SFP is full. We have determined that there are significant economic advantages associated with the proposed action and that expansion of the storage capacity of the SFP will have a negligible environmental impact. Accordingly, deferral or severe restriction of the action here proposed would not be in the public interest.

9.0 Benefit-Cost-Balance

This section summarizes and compares the cost and the benefits resulting from the proposed modification to those that would be derived from the selection and implementation of each alternative. The table below presents a tabular comparison of these costs and benefits. The benefit that is derived from three of these alternatives is the continued operation of NMP-1 and production of electrical energy. As shown in the table, the reactor shutdown and subsequent storage of fuel in the reactor vessel results in the cessation of electrical energy production. While this would have the "benefit" of eliminating thermal, chemical and radiological releases from DAEC, these effluents have been evaluated in the FES and it has been determined that the environmental impacts of these releases are not significant. Therefore, there would be no significant environmental benefit in their cessation. The remaining alternative, storage at other nuclear plants, is not possible at this time or in the foreseeable future except on a short term emergency basis.

From examination of the table, it can be seen that the most cost-effective alternative is the proposed spent fuel pool modification. As evaluated in the proceeding sections, the environmental impacts associated with the proposed modification would not be significantly changed from those analyzed in the Final Environmental Statement related to operation of the Duane Arnold Energy Center issued by the Commission in March 1973.

10.0 Basis and Conclusion for not Preparing an Environmental Impact Statement

We have reviewed this proposed facility modification relative to the requirements set forth in 10 CFR Part 51 and the Council of Environmental Quality's Guidelines, 40 CFR 1500.6 and have applied, weighed, and balanced the five factors specified by the Nuclear Regulatory Commission in 40 FR 42801. We have determined that the proposed license amendment will not significantly affect the quality of the human environment and that there will be no significant environmental impact attributable to the proposed action other than that which has already been predicted and described in the Commission's Final Environmental Statement for the facility dated January 1974. Therefore, the staff has found that an environmental impact statement need not be prepared, and that pursuant to 10 CFR 51.5(c), the issuance of a negative declaration to this effect is appropriate.

Dated:

SUMMARY OF COST-BENEFITS

Alternative	Cost	Benefit
Reprocessing of Spent Fuel	> $10,000/assembly	Continued operation of DAEC and production of electrical energy. This alternative is not available either now or in the foreseeable future.
Increase storage capacity of DAEC	$1600/assembly	Continued operation of DAEC and production of electrical energy.
Storage at Independent Facility	$6,000/assembly	Continued operation of DAEC and production of electrical energy. This alternative is not available for several years.
Storage at Reprocessor's Facility	$3000 to $5000/ assembly plus shipping costs to facility and annual costs	Continued operation of DAEC and production of electrical energy. However, this alternative is not available now. It is uncertain whether this alternative will be available in the future.
Storage of Other Nuclear Plants	Comparable to storage at DAEC	Continued operation of DAEC and production of electrical energy. However, this alternative is not available.
Reactor Shutdown	Replacement power costs are estimated to be $73 million in 1981 plus $18,800,000/year for maintenance and security of the facility.	None - No production of electrical energy.

*In order to use this alternative a minimum commitment of seven to ten years of storage is required.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 45 TO LICENSE NO. DPR-49

IOWA ELECTRIC LIGHT AND POWER COMPANY
CENTRAL IOWA POWER COOPERATIVE
CORN BELT POWER COOPERATIVE

DOCKET NO. 50-331

DUANE ARNOLD ENERGY CENTER

1.0 Introduction

By letter dated October 13, 1977, supplemented by letters dated December 20, 1977, March 14, 1978, May 11, 1978, May 15, 1978, June 6, 1978 and June 19, 1978, Iowa Electric Light and Power Company et.al. (IELPC or the licensee) requested an amendment to Facility Operating License No. DPR-49 for the Duane Arnold Energy Center (DAEC or facility) to authorize an increase in the storage capacity of the spent fuel pool (SFP). The requested amendment would authorize up to 2050 spent fuel assemblies to be stored in the onsite pool by removing the present storage racks and installing 21 new racks in stages which are designed for closer center-to-center spacing of the spent fuel assemblies. By letter dated June 29, 1978, the licensee amended the above submittal to request authorization to install, as an initial step, two racks to the SFP on a temporary basis; these two racks would be removed prior to installing any of the 21 new racks proposed in the licensee's submittal of October 13, 1977 and shipped offsite.

Notice of Proposed Issuance of Amendment to Facility Operating License No. DPR-49 was published in the Federal Register on Wednesday, December 14, 1977 (42 FR 62984).

2.0 Discussion

A total of 510 storage spaces are presently provided in the Duane Arnold SFP, 480 of which are designed for the storage of normal spent fuel and 30 of which are designed for the storage of defective fuel. There are presently 276 spent fuel assemblies stored in the pool (two of these in the defective fuel cans) as a result of three refuelings. The remaining 206 normal storage spaces remaining are only sufficient for two more refuelings. More importantly, DAEC does not at present have space in the SFP to offload a full core.

On June 17, 1978, DAEC developed a crack in a recirculation system inlet nozzle transition piece. The facility is shutdown and will remain shutdown until the crack is repaired. To facilitate repairs, it is necessary to discharge all fuel from the reactor to the SFP. If the crack is successfully repaired, and the facility is authorized to resume operation, the fuel will be transferred back to the reactor vessel from the SFP. As noted above, the DAEC does not have sufficient storage space in the SFP to offload a full core. It would take a month or more to fabricate two of the new racks described in the licensee's submittal of October 13, 1977. However, the licensee has obtained two racks which are essentially the same in construction materials and features as those described in the October 13, 1977 submittal. These racks are new and were designed for Boston Edison's Pilgrim Unit No. 1. These two 8 x 10 "temporary" racks would provide storage space for an additional 160 spent fuel assemblies and permit offloading of the core.

The licensee had proposed to install the 21 new racks in two stages. The licensee's amended request of June 29, 1978 would add a third stage. The two temporary racks would be installed in open areas of the SFP in addition to the racks that are currently in the pool. The core would be transferred to SFP, the crack repaired and the core returned to the reactor vessel. The two temporary racks would be removed along with 8 of the present racks and up to 12 of the new racks installed. After spent fuel that is presently stored in the existing racks is transferred to the new racks, the remainder of the present racks will be removed and new racks installed in their place. Eventially, 21 of the new racks will be installed with a total storage capacity for 2050 spent fuel assemblies. Figure 1 shows the arrangement with the two temporary free standing racks in the SFP. The temporary racks will have no effect on the existing racks in the pool nor will the existing racks affect the two temporary racks. No alterations to existing racks will be made.

The increased storage capacity is achieved by storing the spent fuel assemblies closer together. The present racks in the pool have a center-to-center spacing of 11.9 inches by 6.6 inches between stored assemblies. The two temporary racks have a spacing of 7 inches center-to-center; the 21 new permanent racks have a center-to-center spacing of 6.625 inches.

Our review and evaluation considered the following:

1. Structural and material considerations
2. Criticality considerations
3. Spent fuel pool cooling capacity
4. Fuel handling and installation of the modified spent fuel racks
5. Occupational radiation exposure and radioactive waste treatment

3.0 Evaluation

3.1 Criticality Considerations

The proposed spent fuel assembly racks are to be made up of alternating, double-walled aluminum containers. These will be about 14 feet long and will have a square cross section with an inner dimension of 5.9 inches.

The nominal pitch between fuel assemblies is 6.625 inches. This results in an overall fuel region volume fraction of 0.60 in the nominal storage lattice cell. A Boral plate is to be seal welded in the cavity between the double walls. Thus, in this arrangement there will be only one Boral plate between adjacent fuel assemblies. IELPC's October 13, 1977 submittal states that the minimum amount of boron ten per unit area of Boral plate will be 0.023 grams per square centimeter. This is equivalent to 1.4×10^{21} boron-ten atoms per square centimeter.

3.1.1 Criticality Analyses

As stated in IELPC's March 14, 1978 submittal, the fuel pool criticality calculations are based on an unirradiated BWR fuel assembly with no burnable poison and a fuel loading of 15.3 grams of uranium-235 per axial centimeter of fuel assembly.

The Nuclear Associates International Corporation (NAI) performed the criticality analyses for IELPC. NAI made parametric calculations by using the CHEETAH-B computer program to obtain four-group cross sections for PDQ-7 diffusion theory calculations. The effective boron cross sections for the Boral plates were calculated with the CORC-Blade program. NAI stated that these programs have been extensively tested by using them to make benchmark experiment calculations and core physics calculations for several existing operating power reactors.

These computer programs were first used to calculate the neutron multiplication factor for an infinite array of fuel assemblies in the nominal storage lattice at 20°C with the minimum boron concentration in the Boral i.e., 0.023 grams of boron-ten per square centimeter. NAI then performed calculations to determine: (1) the highest neutron multiplication factor as a function of pool water temperature; (2) the effect of a possible reduction in the lattice pitch; and (3) the effect of eccentrically positioning fuel assemblies in the storage lattice. IELPC's October 13, 1977 submittal states that the calculations showed that when all of these effects are accounted for, the maximum effective neutron multiplication factor (K_{eff}) in the fuel pool will be less than 0.92. The accuracy of the siffusion theory method for this storage rack application was then checked by calculating the nominal reference case with the KENO-IV Monte Carlo program using 123 group cross sections from the GAM-THERMOS library, and it was found that the results of the diffusion theory method are conservative.

These storage racks are designed to prohibit the insertion of a fuel assembly anywhere except in the prescribed locations. However, it will be possible to place a fuel assembly between the outer periphery of the storage racks and the fuel pool walls. IELPC's October 13, 1977 submittal states that this situation was conservatively analyzed by assuming that a fuel assembly is adjacent to an off-centered assembly in the outermost cavity, and that the analysis shows the K_{eff} to be less than 0.95.

In response to our request for additional information, IELPC stated in its March 14, 1978 submittal that a neutron source and detector will be used on site to verify the presence of all the Boral plates in a poison can and that they will make a sufficient number of measurements to statistically show with ninety-five percent confidence that there will be enough Boral plates present to maintain K_{eff} less than or equal to 0.95.

3.1.2 Criticality

Evaluation

The above described results compare favorably with the results of parametric calculations made with other methods for similar fuel pool storage lattices. By assuming new, unirradiated fuel with no burnable poison or control rods, these calculations yield the maximum neutron multiplication factor that could be obtained throughout the life of the fuel assemblies. This includes the effect of the plutonium which is generated during the fuel cycle.

We find that all factors that could affect the neutron multiplication factor in this pool have been conservatively accounted for and that the maximum neutron multiplication factor in this pool with the proposed racks will not exceed 0.95. This is NRC's acceptance criterion for the maximum (worst case) calculated neutron multiplication factor in a spent fuel pool. This 0.95 acceptance criterion is based on the uncertainties associated with the calculational methods and provides sufficient margins to preclude criticality in the fuel pool.

The center-to-center spacing of the two temporary racks that will be used in the SFP are larger than the pitch in the permanent racks. The Boral plates in the temporary racks are 0.5 inches wider, 0.005 inches thicker core and have a 2% greater areal density than the permanent racks. Our evaluation confirms that the above criticality analysis results on the permanent racks are conservative with respect to the temporary racks and are bounded by the above evaluation.

3.1.3 Summary of Criticality Evaluation

We find that when any number of the fuel assemblies which IELPC described in these submittals, which have no more than 15.3 grams of uranium-235 per axial centimeter of fuel assembly, are loaded into the proposed racks, the neutron multiplication factor will be less than 0.95.

On this basis, we conclude that when the plant's Technical Specifications are amended to prohibit the storage of fuel assemblies that contain more than 15.3 grams of uranium-235 per axial centimeter of fuel assembly, there is reasonable assurance that the health and safety of the public will not be endangered by the use of the proposed racks.

3.2 Spent Fuel Cooling

The licensed thermal power for the Duane Arnold Energy Center is 1593 MWt. IELPC plans to refuel this plant annually. This will require the replacement of about 88 of the 368 fuel assemblies in the core every year. In its October 13, 1977 submittal, IELPC assumed a 181 hour time interval between a reactor shutdown and the time either a one quarter core refueling or a full core offload is completed. IELPC stated that the decay heat loads were calculated for this cooling time with the method given on pages 9.2.5-8 through 14 of the NRC Standard Review Plan.

The spent fuel pool cooling system consists of two pumps and two heat exchangers in parallel. Each pump is designed to pump 450 gpm (2.25×10^5 pounds per hour). Each heat exchanger is designed to transfer 4.74×10^6 BTU/hr from 125^oF fuel pool water to 95^oF water in the Reactor Building Closed Cooling Water System, which is flowing through the heat exchanger at a rate of 3.98×10^5 pounds per hour. IELC stated that when a full core is offloaded into the spent fuel pool, the Residual Heat Removal (RHR) system will be used to maintain the fuel pool water temperature below 150^oF.

In its October 13, 1977 submittal, IELPC stated that in addition to the normal makeup water capabilities for the spent fuel pool cooling system and the RHR system, makeup water for the spent fuel pool is available from the Emergency Service Water System.

3.2.1 Evaluation of SFP Cooling Capacity

We find that the maximum incremental heat load in this spent fuel pool that will be added by increasing the number of fuel assemblies stored in the pool from 510 to 2050 will be 1.6×10^6 BTU/hr.

This is the difference in peak heat loads for full core offloads that essentially fill the present and modified pools.

IELPC's calculated fuel pool outlet water temperatures are consistent with the stated flow rates and the design of the heat exchangers. We calculate that with both spent fuel cooling pumps operating at design capacity and with IELPC's peak heat load for any refueling (i.e., 5.85×10^6 BTU/hr), the maximum spent fuel pool outlet water temperature will be about 118^oF. The 51.3×10^6 BTU/hr capacity of the RHR system is adequate to remove the maximum full core heat load of 15.8×10^6 BTU/hr and maintain the spent fuel pool outlet water temperature below 150^oF.

Assuming a maximum fuel pool temperature of 150^oF, the minimum possible time to achieve bulk pool boiling after any credible accident will be 7.6 hours. After bulk boiling commences, the maximum evaporation rate will be 32 gpm. We find that seven hours would be sufficient time for IELPC to establish a 32 gpm makeup rate from the Emergency Service Water System. We also find that under bulk boiling conditions the temperature of the fuel will not exceed 350^oF. This is an acceptable temperature from the standpoint of fuel element integrity and surface corrosion.

3.2.2 Summary of SFP Cooling Capacity

We find that the present cooling capacity in the spent fuel pool of the Duane Arnold Energy Center will be sufficient to handle the incremental heat load that will be added by the proposed modifications. We also find that this incremental heat load will not alter the safety considerations of spent fuel pool cooling from that which we previously reviewed and found to be acceptable. We conclude that there is reasonable assurance that the health and safety of the public will not be endangered by the use of the proposed design.

3.3 Installation of Racks and Fuel Handling

In response to our request for additional information, IELPC stated in their March 14, 1978 submittal that the 100-ton capacity reactor building crane will be used to remove the old racks and install the new ones, the heaviest of which will weigh about 8.2 tons, and that a specially designed lifting fixture with pneumatically operated latches will be used for handling the new racks. IELPC also stated in this submittal that the existing administrative procedures, which now prohibit the movement of heavy loads over stored fuel, will be supplemented as required to ensure the safety of the fuel stored in the pool.

3.3.1 Evaluation of Rack and Fuel Handling

In order to keep all loaded racks seismically supported throughout the installation period, all of the fuel within an independently supported group of racks must be removed before dismantling can begin. The smallest of the two independent groups contains 150 storage locations. Therefore IELPC must have 150 vacant storage locations to assure that the discharged fuel is stored in Seismic Category I racks at all times.

Since after the 1978 refueling there will be 276 fuel assemblies in the spent fuel pool and since another refueling offload of 88 assemblies would leave less than 150 vacant storage spaces, IELC must commence the installation of the new racks prior to the next refueling. At that time 234/510 or about 46 percent of the pool area will not have spent fuel assemblies in it. This should be sufficient vacant space so that it will not be necessary to move any of the rack components over spent fuel assemblies.

IELPC'c supplemental administrative procedures for fuel rack handling shall include testing requirements for the lifting fixture for the new racks. These shall include tests for: (1) 125 percent of the rated load; (2) its ability to prevent a rack drop with any single failure; and (3) the fail-safe feature of the pneumatically operated latches. IELPC has agreed to adopt the staff requirements detailed above.

After the racks are installed in the pool, the fuel handling procedures in and around the pool will be the same as those procedures that were in effect prior to the proposed modifications.

3.3.2 Summary of Rack and Fuel Handling

We conclude that there is reasonable assurance that the health and safety of the public will not be endnagered by the installation and use of the proposed racks.

3.4 Fuel Handling Accidents

The NRC staff has under way a generic review of load handling operations in the vicinity of spent fuel pools to determine the likelihood of a heavy load impacting fuel in the pool and, if necessary, the radiological consequences of such an event. Because Duane Arnold prohibits the movement of loads in excess of the combined weight of a fuel assembly and grapple hoist over fuel assemblies in the SFP, we have concluded that the likelihood of a heavy load handling accident is sufficiently small that the proposed modification is acceptable and no additional restrictions on load handling operations in the vicinity of the SFP are necessary while our review is under way. Additionally, no shielded cask movement will be permitted on the refueling deck prior to the completion of the cask drop analysis review.

The consequences of fuel handling accidents in the spent fuel pool area are not changed from those presented in the Safety Evaluation (SE) of the Duane Arnold Energy Center issued by the Commission on January 23, 1973.

3.5 Occupational Radiation Exposure

We have reviewed the installation of the two new, uncontaminated high density racks which the licensee obtained from Pilgrim Unit No. 1 into the DAEC spent fuel pool. The two racks will be placed in open areas in the pool away from the existing racks in the pool and the existing racks will not affect the two temporary racks. They will be installed in the pool without use of divers by lowering them into place with the crane. The two temporary racks are free standing and will not be bolted or welded to the SFP structure. The occupational exposure for this operation is estimated by the licensee to be about 0.33 man-rem total to the personel involved in the operation (crane operator, health physicists, quality control, riggers, supervisors, etc.) We consider this to be a reasonable estimate.

The licensee has stated that the two temporary racks will be removed from the SFP prior to installation of any of the 21 new racks which are to be installed on a permanent basis. The temporary racks are to be installed only to permit discharge of all fuel from reactor vessel to facilitate repairs to the recirculation line. When the repairs are completed and the fuel is returned to the reactor vessel, the two temporary racks will be washed down, crated, and shipped offsite - either to Pilgrim Nuclear Station Unit No. 1 to be installed in the Pilgrim, SFP or shipped whole as low level waste to a licensed burial site. If the two racks are returned to Pilgrim Unit 1, the occupationa xposure is estimated to be less than 2 man-rem. This estimate is bas on the occupational exposure to remove 17 contaminated racks from the Prairie Island SFP, crate them whole and ship them offsite for burial. We also estimate that the occupational exposure will be less than 2 man-rem if the two temporary racks are crated whole and disposed of at a licensed burial site. The racks removed from the Prairie Island SFP were contaminated by being submerged in the pool water for about 3 years, during which time the spent fuel from 5 refuelings of Prairie Island Units 1 and 2 were transferred into the common spent fuel pool. The two temporary racks are not expected to be in the Duane Arnold SFP for more than a year. Considering the length of time the racks will be in the pool water, the number of fuel assemblies to be moved and activity in the pool water, we consider the application of the occupational exposure results from Prairie Island conservatively upper bound the expected exposure associated with removal, cleanup and crating of the two temporary racks from the Duane Arnold .

3.5.2 Permanent Racks

We have also reviewed the licensee's plan for the removal, crating and disposal of the low density racks and the installation of the high density racks with respect to occupational radiation exposure. The occupational exposure for this operation is estimated by the licensee to be about 8.5 man-rem. We consider this to be a reasonable estimate. The total exposure for the proposed modification of the Duane Arnold SFP is estimated to be less than 11 man-rem. This is a small fraction of the annual man-rem burden from occupational exposure for Duane Arnold. Based on our review, we conclude that the occupational exposures should be as low as is reasonably achievable.

We have estimated the increment in onsite occupational dose resulting from the proposed increase in stored fuel assemblies on the basis of information supplied by the licensee and by utilizing realistic assumptions for occupancy times and for dose rates in the spent fuel area from radionuclide concentrations in the SFP water. The spent fuel assemblies themselves contribute a negligible amount to dose rates in the pool area because of the depth of water shielding the fuel. The occupational radiation exposure resulting from the proposed action represents a negligible burden. Based on present and projected operations in the spent fuel pool area, we estimate that the proposed modification should add less than one percent to the total annual occupational radiation exposure burden at this facility. The small increase in radiation exposure should not affect the licensee's ability to maintain individual occupational doses to as low as is reasonably achievable and within the limits of 10 CFR 20. Thus, we conclude that storing additional fuel in the SFP should not result in any significant increase in doses received by occupational workers.

3.5.3 Summary of Accidents and Radiological Considerations

Our evaluation supports the conclusion that the proposed modification to the Duane Arnold SFP is acceptable because:

(1) The increase in occupational radiation exposure to individuals due to the storage of additional fuel in the SFP would be negligible.

(2) The installation and use of the new fuel racks does not alter the consequences of the design basis accident for the SFP, i.e., the rupture of a fuel assembly and subsequent release of the assembly's radioactive inventory within the gap.

(3) The likelihood of an accident involving heavy loads in the vicinity of the spent fuel pool is sufficiently small that no additional restrictions on load movement are necessary while our generic review of the issues is under way.

3.6 Radioactive Waste Treatment

The plant contains waste treatment systems designed to collect and process the gaseous, liquid and solid wastes that might contain radioactive material. The waste treatment systems were evaluated in the Safety Evaluation (SE). There will be no change in the waste treatment systems or in the conclusions of the evaluation of these systems as described in Section 11.0 of the SE because of the proposed modification.

3.7 Structural and Material Considerations

The proposed spent fuel pool modification consists of replacing the existing fuel storage racks (GE type) with new spent fuel racks to increase the storage capacity to 2050 fuel assemblies. The new racks are a bolted anodized aluminum construction. They consist of six basic components: top grid castings, bottom grid casting, poison can assembly, side plates, corner angle clips, and adjustable foot assembly. Each complenet is anodized separately. The top and bottom grids maintain nominal fuel element spacing of 6.625 inches center-to-center within the rack. The grid structures and bolted and riveted together by four corner angles and four side shear panels. Large leveling screws are located at the rack corners to adjust for variations in pool flow level. Stainless steel bearing pads at the bottom of the screws pivot to allow for maintaining a flat uniform contact area. The closely spaced arrangement of the storage racks is such that a fuel assembly cannot be inserted between racks or anywhere within the rack other than in a designed location.

Pockets are cast in alternate cavity openings of the grids into which poison cans rest. A poison can consists of two concentric square aluminum tubes. Sealed within these tubes are Boral (B_4C) poison plates. Each poison can is capable of containing one fuel assembly. The outer can is formed into the inner can at the ends and totally seal welded to isolate the boral from the pool water. Each can is pressure and vacuum leak tested. The design of the racks is such that no structural loads will be imposed on the poison cans.

Five different rack sizes are utilized as follows" 8 x 8, 8 x 10, 8 x 11, 10 x 11, and 11 x 11.

The racks are a free standing design with no connections between racks and no lateral restraints to the pool walls. The only interface with the floor are the four stainless bearing pads attached to the corner leveling screws. These pads do not provide vertical support against upward movement. Lateral loads are transferred to shear developed by friction between the pads and the pool floor. A 1/4 inch ABS plastic sheet separates the stainless steel pad and aluminim leveling screw to prevent galvanic corrosion. The ABS plastic sheet is held in place by the geometric configuration of the adjustable foot. Figures 3-3 thru 3-5 of the licensee's October 13, 1977 submittal and Figures I, II, and III of the March 14, 1978, submittal illustrate further details of the racks.

The design, fabrication, and installation procedures; the structural design and analyses procedures for all loadings, including seismic and impact loading; the load combinations and structural acceptance criteria; the quality control for the design, fabrication, and installation; and the applicable industry codes were all reviewed in accordance with the Branch Technical Position (BTP) entitled "Review and Acceptance of Spent Fuel Storage and Handling Applications."

The loads, loading combinations, and acceptance criteria are in accordance with section 3.8.4 of the Standard Review Plan. The allowable stresses for stainless steel are in accordance with Appendix XVII of Section III of the ASME Boiler and Pressure Vessel Code. The allowable stresses for aluminum members are based on the "Aluminum Construction Manual, Section I, Specifications for Aluminum Structures - the Aluminum Association."

The seismic analysis performed was a combination time history/static analysis. New horizontal floor response spectra were developed consistent with NRC Regulatory Guide 1.60. A horizontal time history was developed such that the corresponding response spectra enveloped the previously developed floor response spectra.

Since the original seismic analyses determined that the building will cause no amplification in the vertical direction; a vertical time history was developed such that the corresponding spectra would conservatively envelope the ground response spectra. The horizontal and vertical time histories were then input simultaneously to the dynamic model and the computed force applied to the static model. The time history analyses was performed using the ANSYS computer program while SAP IV was utilized for the static analyses. All water entrapped within the rack envelop is added to the horizontal mass, but not to the vertical mass. The non-linear effects of rack module racking and sliding, and fuel rattling were also considered. The coefficients of friction values between the stainless steel feet and liner are based on the following test reports: "Simulated Rack Minimum Coefficient of Friction" by Programmed & Remove Systems Corporation and "Friction Coefficients of Water-Lubricated Stainless Steels for a Spent Fuel Rack Facility" by Professor Ernest Rabinowicz of MIT.

Results of the seismic analyses show that the racks are capable of withstanding the loads associated with all the design loading conditions without exceeding allowable stresses. Interface loads transmitted to the fuel pool floor, due to racking are within the load carrying capability of the floor and rack legs. The maximum calculated sliding of 1.05 inches shows that the racks will not impact the pool walls existing swing bolts on the pool floor, or other structures present at anytime during replacement. Rack to rack impact loadings result in acceptable stress levels. Also, fuel rattling results in no damage to the racks or fuel assemblies themselves. Calculations show that the plastic will remain within its elastic limits and will withstand the design loadings.

The racks have been designed to withstand the local as well as gross effects of a dropped fuel assembly. The following drop conditions were examined: 18 inch fuel drop on the corner of the top grid castings and fuel rollover, 18 inch drop in the middle of the top castings, and a fuel drop full length through the cavity impacting on the bottom grid. The impact loads applied to the first two cases have been verified by full-size tests on an actual top grid casting. For the last case the bottom fuel support shears out and the fuel bundle impacts the pool floor liner plate. Results of these analyses show that applicable stress allowables are satisfied and no adverse effects on the racks or pool floor results.

The effects from a postulated stuck fuel assembly have been examined. A maximum uplift load of 4000 pounds (capacity of the crane) results in stresses below those allowed for the applicable loading combination.

Because of the increase loading imparted to the pool resulting from this increase in storage capacity, a structural analysis was made to establish the maximum load carrying capacity of the existing spent fuel pool. This analysis was based on the actual material strength and latest ACI code requirements (ACI 318-71). The compressive strength of concrete and the yield strength of reinforcing steel were by laboratory analyses of actual samples drawn from each pour of concrete and each heat of reinforcing steel. The most limiting of the results obtained were used as the bases for performing the structural analysis. Results of the analysis show that the present load carrying capacity of the pool is adequate. No increase in thermal loading was required since a thermal excursion to 212°F was considered in the original design.

Since the possibility of long term storage of spent fuel exists, the effects of the pool environment on the racks and fuel cladding must be examined. The pool water is unborated and constantly being purified. No corrosion problems have been experienced on the existing unanodized aluminum racks during their service at Duane Arnold. The new racks are anodized and, therefore, have greater resistance to corrosion. It is highly unlikely that the racks or fuel cladding will incur any corrosion problems during the life of the plant. No corrosion of the plastic, used to eliminate possible galvanic effects, in expected. Also, corrosion of the boral will not be a problem since the material is sealed within the poison cans and vacuum and pressure tests performed to verify leak-tightness. Even in the event a leak developed, a recent study by the manufacturer shows that a 40 year life would be expected for the boral with no reduction in neutron absorbing capability.

The new racks will be installed on a phased basis. The original schedule called for all fuel to be stored in the larger of the two existing rack groups during the initial phase of rack replacement. These racks are structurally and seismically supported independent of the smaller group. The smaller group of racks would then be removed, new racks installed, fuel transferred, and the remaining old racks removed. After removal of the final group of existing racks, the new racks may be installed on an as-needed basis since the analyses do not require the full array of new racks to meet any of the design requirements. During these construction phases no objects will be moved over stored fuel.

The original replacement plans, as discussed above, have been modified due to the urgent need to remove all the fuel from the reactor to facilitate repairs to the recirculation riser nozzle safe end. Current plans call for the use of two 8 x 10 spent fuel storage racks manufactured for Boston Edison's Pilgrim 1 plant as an initial step in the expansion of the SFP storage capacity. These racks are to be installed in the Duane Arnold spent fuel pool prior to removal of any existing racks and removed after about a year.

A comparison of the Pilgrim I racks indicated that the construction features and materials are essentially the same as the new DAEC racks. Both the Pilgrim racks and DAEC racks were designed by the Programmed & Remote Systems Corporation. The deminsional differences include the fuel spacing, rack height, and dimensions of the boral poison sheets.

The fuel spacing is 3/8 inches greater in the temporary (Pilgrim) racks. The temporary racks are also 5.5 inches shorter. The boral plates in the temporary racks are 0.5 inches wider and 0.005 inches thicker core. The temporary racks are 20% heavier when empty and 4% heavier when full of fuel.

The physical differences between the DAEC and Pilgrim racks result in greater load carrying capacity for the Pilgrim racks. The temporary racks have equal or greater section properties due to thicker material sections. The Pilgrim racks were designed for a seismic environment approximately three times what they could experience in the DAEC fuel pool. The height difference yields a lower center of gravity for the temporary racks which will decrease rack rocking, displacement, rack-to-rack impact loads, and foot impact loads transferred to the pool floor. The rack sliding displacement of 1.05 inches calculated for the DAEC racks bound, the expected displacement of the Pilgrim racks.

The two temporary racks will be placed in an open area of the DAEC pool a minimum of 6 inches from the walls and other structures and will not interact in any way under any condition with the pool walls or existing DAEC racks.

Based on the discussion/evaluation presented above, we find that the new proposed DAEC spent fuel storage racks and the design and analyses performed for the racks and pool are in conformance with established criteria, codes, and standards specified in the staff position for acceptance of spent fuel storage and handling applications. Additionally, we have determined that the temporary use of two Pilgrim I racks does not present non-conservative alterations to the results of the analyses performed for the DAEC racks and pool and, therefore, these racks may be used in the DAEC spent fuel pool.

We find that the subject modification proposed by the licensee is acceptable, and satisfies the applicable requirements of the General Design Criteria 2, 4, 61 and 62 of 10 CFR, Part 50, Appendix A.

4.0 Conclusion

We have concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (2) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

Dated: July 7, 1978

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NO. 50-331

IOWA ELECTRIC LIGHT AND POWER COMPANY
CENTRAL IOWA POWER COOPERATIVE
CORN BELT POWER COOPERATIVE

NOTICE OF ISSUANCE OF AMENDMENT TO FACILITY
OPERATING LICENSE
AND NEGATIVE DECLARATION

The U. S. Nuclear Regulatory Commission (the Commission) has issued Amendment No. 45 to Facility Operating License No. DPR-49 issued to Iowa Electric Light and Power Company, Central Iowa Power Cooperative, and Corn Belt Power Cooperative, which revised the conditions and requirements of License No. DPR-49 and the Technical Specifications for operation of the Duane Arnold Energy Center, located in Linn County, Iowa. The amendment is effective as of its date of issuance.

The amendment increases the storage capacity of the spent fuel pool from 510 to 2050 fuel assemblies.

The application for the amendment complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations. The Commission has made appropriate findings as required by the Act and the Commission's rules and regulations in 10 CFR Chapter I, which are set forth in the license amendment. Notice of Proposed Issuance of Amendment to Facility Operating License in connection with this action was published in the FEDERAL REGISTER on December 14, 1977 (42 FR 62984). No request for a hearing or petition for leave to intervene was filed following notice of the proposed action.

The Commission has prepared an enviornmental impact appraisal for the amendment and has concluded that an environmental impact statement for this particular action is not warranted because there will be no environmental impact attributable to the action other than that which has already been predicted and described in the Commission's Final Environmental Statement for the facility dated March 1973.

For further details with respect to this action, see (1) the application for amendment dated October 13, 1977, as supplemented by letters dated December 20, 1977, March 14, 1978, May 11, 1978, May 15, 1978, June 6, 1978 and June 19, 1978 and as amended by letter dated June 29, 1978, (2) Amendment No. 45 to License No. DPR-49, (3) the Commission's related Safety Evaluation and (4) the Commission's Environmental Impact Appraisal. All of these items are available for public inspection at the Commission's Public Document Room, 1717 H Street, N. W., Washington, D. C. and at the Cedar Rapids Public Library, 426 Third Avenue, S.E., Cedar Rapids, Iowa 52401. A copy of items (2), (3) and (4) may be obtained upon request addressed to the U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, Attention: Director, Division of Operating Reactors.

Dated at Bethesda, Maryland, this 7th day of July 1978.

FOR THE NUCLEAR REGULATORY COMMISSION

TAppolito

Thomas A. Ippolito, Chief
Operating Reactors Branch #3
Division of Operating Reactors