both trains in normal operation at a spent fuel pool bulk temperature less than or equal to 125°F.

No special tests are required for instrumentation on the FPCCS. The instrumentation will be subjected to routine testing. The FPCCS Preoperational Test program is discussed in Chapter 14.

### 9.1.4 Fuel Handling System

#### 9.1.4.1 Design Bases

The fuel handling system provides a safe and effective means for transporting and handling fuel from the time it reaches the plant until the time it leaves the plant after postirradiation cooling.

#### 9.1.4.2 Equipment Description

Table 9.1-5 is a listing of tools and servicing equipment supplied with the nuclear system. The following paragraphs briefly describe the use of some of the major tools, servicing equipment, spent fuel shipping cask, and reactor building crane. Where applicable, safety aspects of the design are discussed. For a historical discussion of the reactor building crane and spent fuel cask-handling details, see Reference 9. The procedure for load testing at 125 percent rated load described in Section 2.3.2 of Reference 9 has been modified in accordance with the guidelines established in NUREG-0554, ANSI B30.2, and NRC BTP ASB 9-1.

##### 9.1.4.2.1 Spent Fuel Shipping Cask

Spent Fuel Shipping Cask Description

Edison does not now contemplate owning its own spent fuel shipping cask, but intends to use a licensed cask from an authorized approved vendor.

Arrangements are being made for the shipment and reprocessing of spent fuel. Since two types of spent fuel shipping casks are presently being used, the equipment and the handling techniques have been developed to utilize either type. To ensure the adequacy of the equipment and techniques, the reactor building is designed to accept the larger spent fuel cask weighing not more than 125 tons.

The spent fuel shipping cask has a cylindrical configuration with a maximum diameter of 8 ft and a maximum length of 21 ft. Two pairs of lifting lugs are furnished to provide redundancy to the lifting mechanism. All four lugs are used simultaneously for lifting the cask. The cask is designed to conform to 10 CFR 71 with regard to structural design; radiological releases, effects, and protection; allowable spent fuel shipping conditions; shielding; and continuity of decay heat removal capacity for all credible cask accident events.

Spent Fuel Shipping Cask Handling

The fuel cask is delivered through the airlock into the reactor building by truck. The truck is positioned under the equipment access hatch. The cask is upended from its horizontal shipping position by the reactor building crane main hoist.

After upending is completed, the cask is attached to the redundant hook system via either a lifting device or two sets of slings (Figure 9.1-26) that engage the cask on all four lifting lugs and to the redundant hook system. The method of providing a redundant link between the hooks and the cask will be based upon the type of cask used.

The cask is then hoisted from the first floor grade elevation to the fifth floor operating level and traversed to the cask-washdown area, where the cask head is removed and the cask is prepared for fuel storage pool entry. Depending on the cask head removal details, the cask may not have to be disengaged from the crane during this handling step.

The cask enters the pool by traversing the crane from the washdown bay due north until it is in line with the pool storage area for the cask. This line will be marked on the operating floor surface, as shown in Figure 9.1-27. The trolley will then be traversed due east for the cask centerline to follow the marker line until the cask is suspended over the cask storage area and completely clear of the pool edge. The crane operator receives his instructions from a signalman stationed on the operating floor level adjacent to the cask. The signalman remains in visual and voice contact with the crane operator.

Prior to being lowered into the pool, the cask is steadied. Lowering of the cask will be done at minimum speed until the cask has completely cleared the pool edge. Underwater lights will be used to illuminate the cask-setdown area. A 9-ft by 9-ft by 1-in.-thick stainless steel plate is provided in the pool bottom liner to accept the cask.

All of the above-described steps are reversed when the cask is extracted from the pool.

<u>Spent Fuel Shipping Cask Storage Area</u>

There is no spent fuel cask storage pit as committed to in response to PSAR Question 3.2.6. A detailed discussion regarding the elimination of the spent fuel cask storage pit is presented in Reference 3. Except when in transit or when being washed down, the spent fuel shipping cask is kept submerged in its storage area in the northwest corner of the spent fuel storage pool. It will be conveyed there from its truck by the redundant crane system. The spent fuel shipping cask storage area is described above under "Spent Fuel Shipping Cask Handling."

#### 9.1.4.2.2 Reactor Building Crane

An overhead traveling (reactor building) crane is utilized in the Fermi 2 reactor building to handle heavy objects, including the spent fuel cask. The essential design bases applicable to Fermi 2 spent fuel cask handling are:

a. To minimize, to the maximum extent practical, the probability of dropping heavy objects into the fuel storage pool resulting in damage to fuel or compromising the integrity of the pool

b. To prevent a spent fuel cask drop from exceeding the design limits for the cask as set forth in 10 CFR 71

c. To minimize the probability and the effect of dropping heavy objects, including the spent fuel cask, during movement through the reactor building, so that damage is prevented to structures, systems, and components important to safety.

In order to obviate the possibility and to minimize the probability, to the greatest extent practical, of occurrence of events a, b, or c above, the special crane design features and improvements that have been incorporated are the following:

a. A completely redundant hoisting system

b. An upgrading of the crane for SSE and design-basis tornado

c. Upgrading of the crane quality assurance criteria

d. Crane control redundancy

e. A crane surveillance and test program

f. Administrative control of crane movements.

Crane operations over the spent fuel storage pool when fuel assemblies are stored therein are not allowed when either of the following conditions occur:

a. less than 22 feet of water over the top of irradiated fuel assemblies seated in the spent fuel storage pool racks.

b. less than the Technical Specification required ac electrical power sources operable, when in modes 4, 5 and when handling irradiated fuel in the secondary containment.

Prior to suspending crane operations, fuel assemblies shall be placed in a safe condition.

The reactor building crane is of the single trolley top running type, carried on two main girders. The girders have a rated lifting capacity of 125 short tons and a span of 113 ft 9 in. Power is applied by twin hoist motors through two gearboxes to the two drum gear rings, located on each end of the drum. In this manner, the hoist mechanism is duplicated. In normal operation, the twin hoist trains share the load, but each is separately able to carry the rated load at allowable code stresses, thus providing adequate safety should one gear train fail. Both hoist trains are provided with electrical and electromechanical type brakes; each of the latter is capable of sustaining the load should a mechanical failure occur in a gear train. Each mechanical brake is sized for 150 percent motor torque or 300 percent for redundant systems. (This is based on a required brake torque of 277.5 ft-lb, and a rating of each of the two 13-in. brakes of 550 ft-lb. The required brake torque, $B_T$, is calculated by using

$$B_T = 1.5 \times 33{,}000\ {}^{P_{hp}}/_{2\pi N}$$

where $P_{hp}$ is the motor horsepower of 20, and N is equal to 570 rpm.)

The electrical brakes (Magnetorque) complement the mechanical brakes. The Magnetorque brakes can limit the hoist-lowering speed to 1.6 fpm at rated load in the event of failure of both the redundant mechanical brakes. If there should also be a loss of normal power to the Magnetorque brakes, an integrated alternator generates enough power to the Magnetorque units to prevent the lowering speed from exceeding the fully rated load speed.

For the main hoist, this speed is 4.7 fpm at rated load. The reactor building floor and the floor under the equipment hatch have sufficient strength to withstand the impact of a fully rated load at this speed.

The redundant wire rope system consists of two balanced reeving systems utilizing two individual wire ropes. These two wire ropes are reeved side by side from double-scoured drum groovings at each end of a single drum through the upper and lower block sheaves and to the double-sheave-type equalizer. Breakage of one cable system would reduce the factor of safety, but since each system is reeved to both sides of the bottom block and upper block system, there is no swinging or pendulum action of the block upon failure of one system. Equalizer sheaves are used in preference to equalizer bars so that ropes may more readily adjust to differences in length without the need for physical maintenance. Each of the equalizers is hung from a main pivot mechanism which is designed to be redundant within itself.

For the Fermi 2 crane, the wire rope safety factor for each single wire rope is a minimum of 10. This is determined by dividing the design rated load (125 tons) by the number of load-carrying parts (l6) and the efficiency factors (0.933) and comparing the result with the published breaking strength of 102 (nominal) tons for the 1-1/4 in. (nominal) diameter rope. The design of the dual reeving system is consistent with paragraph 3.f of BTP ASB 9-1.

In both the lower and upper blocks, the sheaves are mounted in a structural cage system having supporting plates on each side of each sheave. Thus, the load being carried by the sheave pin is shared by each of these support plates. Should a pin fail on any one particular sheave group, the adjacent sheave still maintains its integrity. This allows either reeving system to take over the entire load.

The main hook block is provided with a conventional hook, and the redundant feature is provided by two smaller hooks, each capable of sustaining 50 percent of the rated load at code stresses. The two additional hooks are individually mounted on their own pins and supported directly in the main block frame. They are intended for use only when handling the fuel cask.

To ensure against damage due to a tornado, the crane is provided with electrically operated locking bars that effectively connect the unloaded crane to the runway when it is not in use. These locking bars are capable of withstanding a tornado windforce of 410 lb/ft$^2$ intensity at a maximum of 90 percent of the yield strength of the crane components.

Earthquake protection is provided by restraints on the crane and trolley to prevent either from leaving its respective rails due to horizontal and/or vertical displacement. Seismic responses of the crane, based on its fundamental frequency in the vertical and two horizontal directions (perpendicular and parallel to the girder), have been calculated for the SSE and are 0.65g.

The crane is designed to accommodate SSE forces and deflections with the rated load suspended in the cask-hoisting position. Crane accelerations for the vertical SSE in the unloaded condition were also determined and found in all cases to be less than 1.0g. Seismic uplift forces are therefore not encountered.

The crane responses to the SSE, as determined above, are well below the design limits of the reactor building crane. Thus, the crane will remain within its restraints if subjected to an SSE.

Crane control can be either from the cab or by radio control. In the event that the crane cab becomes uninhabitable, control may be continued by means of the remote radio control provided. The only crane components that are actuated by the crane electrical control system

and are an integral part of the mechanical load-retaining hoist system are the two shoe-type hoist holding brakes. The two electrical control components that actuate the hoist holding brakes are either the raise or lower hoist reversing contactors. If either the raise or lower hoist reversing contactor fails to open when called upon, the backup is the stop button in either the cab or in the radio control, which will interrupt the main power to the crane, causing the two independent hoist holding brakes to set and thereby stop the load.

To ensure that crane control can only be executed from one position at a time, a master control transfer switch is situated on the bridge, just outside the cab. This switch must be manually operated by the operator and thus interrupts all of the control circuits so there can be no simultaneous operation of the crane from both the radio control and the cab control.

The crane control system is protected from actuation by signals from an outside source by use of a Security Start circuit. With this feature, the control system cannot be enabled until multiple conditions have been met which are unique to each receiver and its companion transmitter. To activate the equipment under control, the specific companion transmitter must be used. With this security start feature, there is no possibility of an outside source radio transmitter interfering with this system or causing inadvertent actuation since these foreign signals could not match the security circuit's multiple enabling conditions.

The crane test and surveillance programs include both preoperational tests and periodic testing, surveillance, and inspection programs.

Preoperational tests include crane hook certification to 100 percent overload, gear train no-load running tests, and complete functional tests after final crane assembly.

Periodic testing, surveillance, and inspection programs will be performed no more than 1 year prior to any usage of the crane. However, these tests and inspections will be performed just prior to each major refueling outage. Periodic testing will be conducted not more than 1 month prior to lifting of the first cask for a spent fuel transfer. The programs include magnetic particle or liquid penetrant examination of all hook surfaces; inspection of wire ropes for wear or damage, and measurements of wire rope diameters; other periodic testing, maintenance, and surveillance conducted in accordance with Occupational Safety and Health Administration (OSHA) requirements as set forth in 29 CFR 1910.179, Paragraphs (j), (k), (m), and (n); and periodic inspections as recommended by the crane manufacturer. Testing prior to refueling also includes a full test run of all motions of a typical fuel cask unloading and loading sequence.

The spent fuel cask-handling operation is performed under strict procedural control and under the direct supervision of the Shift Manager or his designated operator. The crane operator receives his instructions from the flagman by verbal communication. All operations that cannot be visually observed by the crane operator from his cab are transferred to radio control.

Personnel carrying out cask- and fuel-handling operations are qualified to meet the guidelines set forth in Regulatory Guide 1.8.

The reactor building crane is designed in accordance with the requirements of:

a. EOCI No. 61, Class A Service, and the structural guidelines of CMAA Specification No. 70

b. Seismic response spectra for Fermi 2

c. Material Specifications: ASTM; AISI; SAE; ASA

d. Electrical Specifications: N.E.C.; NEMA; IEEE; NBFU

e. Welding: AWS

f. Federal, State, and local codes, including OSHA.

Welding specifications used in the crane fabrication are as follows:

a. Manual shielded metal-arc welding (SMAW) in accordance with AWS D1.1 and AWS D14.1 for welding of structural steel of unlimited thickness and base metals of ASTM-A36, ASTM-A242, ASTM-A441, and ASTM-A572. The required preheat and interpass temperatures are as follows:

| Plate Thickness (in.) | Minimum Preheat and Interpass Temperature (°F) | | |
|---|---|---|---|
| Up to 3/4 | 50 | 50 | |
| 3/4 to 1-1/2 | 150 | 70 | For FCAW |
| 1-1/2 to 2-1/2 | 225 | 150 | |
| Over 2-1/2 | 300 | 225 | |

(Reference: P&H welding procedure WP-SC of September 1972)

b. Flux cored arc welding (FCAW), same application as above

c. Submerged arc welding (SAW), same application as above, with preheat and interpass temperatures as for FCAW

d. Joint welding procedure classification tests were performed for all welding processes, including groove and fillet type welds

e. No postweld heat treatment was performed.

Girders, trolley frame, and general structures are constructed of ASTM, A-36 steel. The end ties are of ASTM, A-514 material.

9.1.4.2.3 Fuel Servicing Equipment

Two fuel-preparation machines are used to remove the channels from fuel assemblies and to reinstall the channels on fuel bundles. Additionally, the fuel preparation machines are used for fuel inspections and new fuel receipt/transfer activities. Strict administrative control on the fuel preparation machine's full-up end stop is required for personnel protection. These machines are designed to be removed from the pool for servicing.

The new-fuel transfer crane is a 1500 lb, wall-mounted, traveling-hinged boom crane which services the area (B, E, 15, 17) in Figure 9.1-3.

A new fuel uprighting stand is used to hold the steel shipping box in a vertical position while the fuel assembly is removed. A new-fuel inspection stand is used to restrain the fuel bundle in a vertical position for inspection. The inspection stand can hold two bundles. The new

The aforementioned design meets the criterion of GDC 63, "Monitoring Fuel and Waste Storage." Additionally, Fermi 2 personnel are instructed to evacuate areas in which radiation or criticality alarms are activated. Evacuation of plant areas is periodically tested by the conduct of emergency response drills.

Depending on the laydown area, the metal containers can be placed in the new fuel uprighting stand using the auxiliary hoist, the new-fuel transfer crane, or a mobile crane. Any of these cranes can be used to transfer fuel from the new fuel uprighting stand to the inspection stand and to the fuel pool. Transfer of fuel from the new fuel storage vault can be done only with the auxiliary hoist. However, due to the lack of criticality detector redundancy, Fermi 2 does not strictly comply with 10 CFR 70.24 with regard to the new fuel storage vault. Accordingly, the spent fuel pool is used for storage of new fuel rather than the new fuel storage vault.

#### 9.1.4.3.2 Refueling Procedure

Figure 9.1-28 defines, in general, the steps that make up a refueling outage. The heavy lines on the chart define the critical path in a normal outage. Deviations from this path may be encountered under normal circumstances for various reasons, such as scheduling and convenience. The reactor shall be determined to have been subcritical for at least 24 hours by verification of the date and time of subcriticality prior to movement of irradiated fuel in the reactor pressure vessel.

#### 9.1.4.3.3 Departure of Fuel From the Fermi Site

Fuel assemblies from the spent fuel pool are conveyed by the fuel-handling bridge crane into the spent fuel cask located in the fuel storage pool. After insertion into the spent fuel cask, the cask head is replaced, and the flooded container with fuel is raised out of the pool by the reactor building crane for transfer to the cleaning station. The cleaning station is a depression in the floor adjacent to the pool and is designed for 1000 pounds per square foot load. The cask head is bolted down, and the cask is thoroughly cleaned. Final transfer from the cleaning station down the shaft to the vehicle-loading station is by crane. The cask is laid on its side on a flatbed, one to a flatbed, for return to the fuel processing/storage facility.

### 9.1.4.4 Control of Heavy Loads in Close Proximity to Irradiated Fuel or Safety Systems

The NRC in Reference 10 concluded that Fermi 2 meets the guidelines of NUREG-0612 for the handling of heavy loads near spent fuel. Travel paths for the handling of these loads have been graphically described, and the procedures controlling adherence to these travel paths have been identified.

The reactor building crane, Subsection 9.1.4.2.2, main hoist is single-failure proof. There are no heavy-load handling applications at Fermi 2 other than those that can be handled by the main hoist, that require handling within single-failure-proof guidelines. In order to meet NUREG-0612 guidelines, the reactor building crane auxiliary hoist has a load-limit feature that restricts the hoist from handling heavy loads (greater than 2000 lb) over the spent fuel pool and open reactor vessel.

The training and qualification of crane and hoist operators are in accordance with NUREG-0612 guidelines. The testing, inspection, and maintenance of these cranes and hoists also conform to these guidelines. Hoisting of all heavy loads around critical equipment will be covered by written procedures.

Cranes, hoists, and slings used to handle heavy loads around critical equipment are in conformance with the standards specified in NUREG-0612. The matrix analysis performed on all heavy load hoist combinations has identified all potentially affected safety system components and has defined the hazard elimination category under the NUREG-0612 guidelines for each of these components.

The special lifting devices at Fermi 2 are the reactor pressure vessel head strongback and the dryer/separator lifting device. These special lifting devices were found acceptable by the NRC in Reference 10.

Periodic testing of these special lifting devices meets the guidelines of NUREG-0612 by following ANSI N14.6-1978 and the NRC's interpretation of the NUREG-0612 guidelines provided with Reference 11.

## 9.1 FUEL STORAGE AND HANDLING

## REFERENCES


1. Holtec Report HI-992154, "Licensing Report for Spent Fuel Rack Installation at Fermi Unit 2", (DECo File Number R1-7696)

1a Letter from Holtec to B. Cummings, Impact of Proposed Rack Height Reduction on Existing Calculations, March 17, 2006 (DECo File Number P1-16952)

2. NRC Position Paper, subject: "Fuel Pool Storage and Handling Application," April 1978 and amended January 1979.

3. Joseph Oat Corporation, Licensing Input on High Density Spent Fuel Racks for Fermi II Project, Report TM-586, Camden, New Jersey.

3a. Deleted

3b. Holtec Proprietary Report HI-961465 – WPMR Analysis User Manual for Pre&Post Processors & Solver, August, 1997.

3c. Singh, K.P. and Soler, A.I., Dynamic Coupling in a Closely Spaced Two-Body System Vibrating in Liquid Medium: The Case of Fuel Racks, 3rd International Conference on Nuclear Power Safety, Keswick, England, May 1982.

3d. Fritz, R.J., The Effects of Liquids on the Dynamic Motions of Immersed Solids, Journal of Engineering for Industry, Trans. of the ASME, February 1972, pp 167-172.

4. S. Levy and J. P. D. Wilkinson, The Component Element Method in Dynamics with Application to Earthquake and Vehicle Engineering, McGraw-Hill, New York, New York, 1976.

5. Joseph Oat Corporation, A Method for Hydro-Thermal Analysis of High Density Fuel Racks, Standard Document No. 20, Camden, New Jersey.

6. Southern Science Applications, Inc., Benchmark Calculations for Spent Fuel Storage Racks, Report SSA-127, Dunedin, Florida.

7. Global Nuclear Fuel, GE-14 Boraflex Spent Fuel Storage Rack Criticality Analysis for Fermi 2 Unit 2.

7a. General Electric Company, General Electric Standard Application for Reactor Fuel, Latest Revision.

7b. Global Nuclear Fuel, GE-14 Boral Spent Fuel Storage Rack Criticality Analysis for Fermi 2 Unit 2.

7c. Holtec Report HI-992207, Bulk SFP Thermal-Hydraulic Analyses For Reracking of Fermi Unit 2. (R6-422)

7d. Global Nuclear Fuel, GE-14 Defective Fuel Storage Rack Criticality Analysis for Fermi 2 Unit 2.

8. Letter from G. W. Knighton, NRC, to H. Tauber, Detroit Edison, April 26, 1976.

9. Detroit Edison Co., "Summary Report, FSAR Stage Open Item, Fuel Cask Storage Pool Reactor Building, Crane Redundancy Fuel Cask Drop Accident," EF2-25622, June 25, 1974.

## 9.1 FUEL STORAGE AND HANDLING

## REFERENCES


10. Letter from B. J. Youngblood, NRC, to Wayne Jens, Detroit Edison, subject: Issuance of Supplement No. 5 to NUREG-0798-Fermi 2, March 21, 1985.

11. Letter from B. J. Youngblood, NRC, to H. Tauber, Detroit Edison, subject: Control of Heavy Loads at Fermi 2 in Accordance with NUREG-0612, November 1, 1983.

12. Letter from General Electric (RDW:98-037) to Detroit Edison, "Detroit Edison Company Fuel Handling Criticality Assessment," dated April 9, 1998. Superseded by Reference 16.

13. Detroit Edison Letter NRC-98-0063, "Request for Exemption from 10 CFR 70.24, Criticality Accident Requirements," dated April 17, 1998.

14. NRC Letter, "Fermi 2 - Issuance of Exemption from the Requirements of 10 CFR 70.24 (TAC NO. MA1645)," dated June 2, 1998.

15. Detroit Edison Design Calculation DC-4231 Vol I, "Loss of Decay Heat Removal – High Density Fuel Storage Pool."

16. RAJ II Safety Analysis Report, Docket No. 71-9307, Chapter 6, Criticality Evalation.