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July 24, 1978

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

NRC DOCKETS 50-321, 50-366
OPERATING LICENSE DPR-57, NPF-5
EDWIN I. HATCH NUCLEAR PLANT UNITS 1, 2
CONTROL OF HEAVY LOADS NEAR SPENT FUEL

Gentlemen:

Enclosed is the information requested in your letter of May 17, 1978, pertaining to the control of heavy loads near spent fuel.

The refueling floors for Units 1 and 2 are combined; therefore, the responses provided pertain to both units. The appropriate drawings for both units are also included.

Yours very truly,

W. E. Ehrensperger

MRD/mb

Enclosure

xc: Mr. Ruble A. Thomas
George F. Trowbridge, Esquire

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Question 1:

Provide a diagram which illustrates the physical relation between the reactor core, the fuel transfer canal, the spent fuel storage pool, and the set down, receiving or storage areas for any heavy loads moved on the refueling floor.

Response:

The enclosed Unit 1 drawings (H-16031 and H-16033) and Unit 2 drawings (H-26103 and H-26105) illustrate the physical relation between the reactor core, the fuel transfer canal, the spent fuel storage pool, and the set down, receiving and storage areas for the cask. The cross-hatched sections on the drawings indicate the areas over which the crane cannot travel.

Question 2:

Provide a list of all objects that are required to be moved over the reactor core (during refueling), or the spent fuel storage pool. For each object listed, provide its approximate weight and size, a diagram of the movement path utilized (including carrying height) and the frequency of movement.

Response:

a) Reactor Pressure Vessel Head
Size - 20' diameter x 10' height
Weight - ∿ 85 tons
Carrying Height - ∿ 53 feet
Frequency of Movement - ∿ 1 per year
Movement Path - see the enclosed Unit 1 and Unit 2 drawings provided for Question 1.

b) Steam Dryer
Size - 19' diameter x 15' height
Weight - ∿ 27 tons
Carrying Height - ∿ 53 feet
Frequency of Movement - ∿ 1 per year
Movement Path - see enclosed Unit 1 and Unit 2 drawings provided for Question 1.

c) Shroud Head and Steam Separator Assembly
Size - 19' diameter x 10' height
Weight - ∿ 21 tons
Carrying Height - ∿ 53'
Frequency of Movement - ∿ 1 per year
Movement Path - see enclosed Unit 1 and Unit 2 drawings provided for Question 1.

d) Service Platform
Weight - ∿ 6000 lbs

e) Refueling Bridge
Weight - ∿ 33000 lbs

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Question 3:

What are the dimensions and weights of the spent fuel casks that are or will be used at your facility?

Response:

The dimensions and weights of the spent fuel casks that were considered for the design of Plant Hatch are given in the sections of the Unit 1 and Unit 2 FSAR's discussed below.

The response provided in Question 10.3.4 of the Unit 1 FSAR is based on the IF 400 spent fuel cask. However, as discussed in Section 9.1.4.2 of the Unit 2 FSAR, the IF 300 spent fuel cask is currently the largest cask licensed for use (NRC Certificate of Compliance No. 9001). Use of the IF 300 spent fuel cask is also discussed in Section 10.20.6 of the Unit 1 FSAR.

Question 4:

Identify any heavy load or cask drop analyses performed to date for your facility. Provide a copy of all such analyses not previously submitted to the NRC staff.

Response:

The response to Question 11.1.3 in the Unit 1 FSAR provides the results of an analysis which pertains to dropping a drywell shield plug which has been raised to its highest possible elevation over the drywell head.

The calculations and results of an analysis pertaining to dropping the spent fuel cask and reactor vessel head on the refueling floor is attached.

Question 5:

Identify any heavy loads that are carried over equipment required for the safe shutdown of a plant that is operating at the time the load is moved. Identify what equipment could be affected in the event of a heavy load handling accident (piping, cabling, pumps, etc.) and discuss the feasibility of such an accident affecting this equipment. Describe the basis for your conclusions.

Response:

Heavy loads are not carried over any equipment necessary for the safe shutdown of the plant. In the case of a handling accident, no equipment essential to the safe shutdown of the plant would be affected. Equipment is moved in through the railroad airlock, which is adjacent to the equipment hatch. This arrangement precludes any danger from a handling accident. The enclosed Unit 1 and Unit 2 drawings illustrate the position of the equipment hatch.

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Question 6

If heavy loads are required to be carried over the spent fuel storage pool or fuel transfer canal at your facility, discuss the feasibility of a handling accident which could result in water leakage severe enough to uncover the spent fuel. Describe the basis for your conclusions.

Response:

The spent fuel storage pool contains no drain pipes or other apparatus that, if damaged by a handling accident of a heavy load, could cause leakage severe enough to uncover the spent fuel. The only way this leakage could occur would be if the pool, which is concrete plated with stainless steel, was breached. The design of the spent fuel pools include provisions for such accidents. A description of the Hatch 1 spent fuel storage facility is located in Section 10.3.4 of the FSAR.

Question 7:

Describe any design features of your facility which affect the potential for a heavy load handling accident involving spent fuel, e.g., utilization of a single failure-proof crane.

Response:

The reactor building crane serves both units at Plant Hatch. It is designed to be a single failure-proof as discussed in Section 10.20.6 of the Unit 1 FSAR. In addition, interlocks prevent the crane from traveling over the cross-hatched areas shown on the drawings provided in the response to Question 1. These safety features remove the potential for a heavy load handling accident involving spent fuel.

Question 8:

Provide copies of all procedures currently in effect at your facility for the movement of heavy loads over the reactor core during refueling, the spent fuel storage pool, or equipment required for the safe shutdown of a plant that is operating at the time the move occurs.

Response:

There are no general procedures directed toward the movement of heavy loads over the areas mentioned above. There are installation and removal procedures for the pieces of equipment that must be moved near or over the specified areas. The equipment moved near these areas include the reactor pressure vessel head, steam dryer, shroud head and steam separator assemblies. The installation and removal procedures contain instructions including restricted areas of movement of this equipment.

Question 9:

Discuss the degree to which your facility complies with the eight (8) regulatory positions delineated in Regulatory Guide 1.13 (Revision 1, December, 1975) regarding Spent Fuel Storage Facility Design Basis.

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Response:

The degree of compliance with Safety Guide 13 (March 1971) at Plant Hatch was provided in the response to Question 10.3.5.1 of the Unit 1 FSAR and Section 9.1.3.4 of the Unit 2 FSAR. Regulatory Guide 1.13, Revision 1 (December 1974) contains nearly the same requirements as those presented in Safety Guide 13. A position-by-position discussion of compliance with Regulatory Guide 1.13 is provided below:

Position 1 - The Unit 1 and Unit 2 spent fuel storage facilities, except for the condensate storage tank and the normal spent fuel pool cooling trains, are designed to seismic Category 1 requirements. A seismic Category 1 alternate pool makeup water supply (plant service water) and a seismic Category 1 alternate pool cooling system (RHR system and associated spent fuel pool cooling system piping) are provided. Section 10.3 of the Unit 1 FSAR and Sections 9.1.2 and 9.1.3 of the Unit 2 FSAR provide a detailed description of these system features.

Position 2 - The Unit 1 and Unit 2 spent fuel storage facilities have been designed to withstand tornado loadings and tornado-generated missiles from causing significant loss of water-tight integrity of the fuel storage pools. The response to Question 130.19 in the Unit 2 FSAR evaluates the postulated impact of tornado missiles on the reactor building tornado relief vents and its effect on seismic Category 1 structures, systems, and components.

Position 3 - Interlocks are provided to prevent the reactor building crane from traveling over the Unit 1 and Unit 2 fuel storage areas as shown by the cross-hatched areas of the drawings provided in the response to Question 1. If required during fuel handling operations (e.g., handling of spent fuel racks), the interlocks can be bypassed and the crane travel can be administratively controlled.

Position 4 - The Unit 1 and Unit 2 spent fuel storage areas are located within the Unit 1 secondary containment. The Unit 1 secondary containment atmosphere is processed through both the Unit 1 and the Unit 2 standby gas treatment systems to prevent the release of significant amounts of radioactivity to the environs should the integrity of any fuel assembly be breached during the refueling process. Section 7.3.6 of the Unit 2 FSAR provides a detailed description of the logic pertaining to the joint operation of both units' standby gas treatment systems.

Position 5 - The reactor building crane is designed to provide single failure-proof handling of heavy loads such that a single failure will not result in the loss of the capacity of the crane handling system to perform its safety function. Refer to the response to Question 7 for more details concerning the crane.

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7/24/78

Position 7 - Low water level in the spent fuel storage pool is alarmed locally and in the main control room for both units. Area radiation monitors on the refueling floor will also alarm locally and in the main control room if radiation levels exceed the normal background activity. Radiation monitors located in the refueling floor ventilation exhaust systems for Unit 1 and Unit 2 will automatically initiate the Unit 1 and Unit 2 standby gas treatment systems on a high radiation signal and provide a control room alarm. These design features are discussed in Section 10.3.4 of the Unit 1 FSAR and Sections 7.3.6, 9.1.2.2, and and 12.3.4 of the Unit 2 FSAR. The refueling floor exhaust ventilation radiation monitoring equipment is periodically tested in accordance with the plant Technical Specifications.

Position 8 - Each unit has a condensate storage tank which provides normal makeup to the spent fuel storage pool. As discussed in Position 1 this equipment is nonseismic; however, the seismic Category 1 plant service water acts as a backup for providing makeup to the Unit 1 and Unit 2 spent fuel storage pools.

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Method of Analysis
Dropping of the Cask to the Refueling Floor

The potential failure of the refueling floor due to an accidental dropping of the cask was investigated using an energy balance method. This method calls for the evaluation of the kinetic energy of the dropping object and the strain energy of the resisting elements. The computation of the kinetic energy is straight forward. It is simply the work done by the dropping object through its dropping height. However, since the floor assembly consists of concrete slab, steel decking and steel framing, it would be necessary to have a few simplified, but conservative, assumptions in order to compute the strain energy of the resisting elements. The following assumptions were made in the analysis:

1. The cask would travel along a triangular path formed by three locations, namely, the cask storage pit, the washdown area and the equipment hatch.
2. The impact from the drop of the cask was resisted by either the steel girders or the steel beams along the path. The resistance from the concrete slab was completely ignored.
3. The impact was considered as a concentrated load applied at the mid-span of the assumed beams or girders.
4. The maximum allowable ductility ratio was assumed to be 12. No strain-hardening effect of the material was considered.

Let K denote the kinetic energy of the dropping cask and Mp denote the plastic moment of the resisting elements. The balance of energies gives the following relationship:

$$K = M_p \, \phi \, (\mu - \tfrac{1}{2})$$

in which ϕ is the total angle change at the mid-span of the resisting elements and μ is the ductility ratio of the elements.

K, Mp and ϕ were computed for each of the cases assumed. Using the above expression, the ductility ratio required for the elements to resist the impact was then evaluated and compared with the allowable values. It was found that the lifting height of the cask should be limited to no more than 10 inches above the refueling floor.

Based on the same approach, the dropping of the vessel head and the drywell head onto the refueling floor was also examined. It was found that the floor system is strong enough to stop the vessel head or the drywell head dropping from 3.5 ft. above the floor.

FORM E-6V 100M

CALCULATION SHEET

DESIGNER P. T. [illegible] DATE 3/21/73 CHECKER C. Y. Wang DATE 8/17/73

TITLE JOB NO. 6511-01

SUBJECT CASK DROP ON REFUELING FLOOR @ EL. 228'-0 SHEET NO. 1 OF 8

PROBLEM: Study the failure potential of the refueling floor due to the drop of the cask from 2'-0 above the floor. Cask weight is 200 kips.

ASSUMPTIONS:

1. The cask will travel along a triangular path formed by three locations, namely, the cask storage pit, the washdown area and the equipment hatch.

2. The impact from the drop of the cask is resisted only by either the girder or the beam along the path. The contribution from the slab is neglected.

3. The impact is considered as a concentrated load applied at the mid-span of a beam or a girder.

4. The maximum allowable ductility ratio is assumed to be 12. No strain-hardening of the material will be considered.

FORM E-4V 100M

CALCULATION SHEET

DESIGNER D. T. K DATE 3/21/73 CHECKER C J Wang DATE 8/17/73

TITLE JOB NO. 65-11-01

SUBJECT CASK DROP ON REFUELING FLOOR @ EL. 228'-0 SHEET NO. 2 OF 8

Total kinetic energy due to the 2'-0 drop

$$K = \frac{1}{2} m v^2 = W h = 200 \times 2 = 400^{\text{K-ft}}$$

GIRDER #5

Total LOADS = 1600 kips
Deflection @ mid-span ≈ 0.6 in
Moment of inertia I = 217,114 in^4
Span L = 41 ft

} from M. Dixit

Area A = 259.50 in^2, depth d = 68 in.

Plastic Modulus

$$Z = A\left(\frac{d}{2} - y_1\right)$$

where y_1 is the distance from the top of the cross section to the centroid.

$$Z = 259.50\left(\frac{68}{2} - 6.42\right) = 7150 \text{ in}^3$$

$$M_p = \sigma_y Z = 36 \times 7150 = 257,400 \text{ K-in}$$

$$\phi_y = \frac{M_p}{EI} = \frac{257400}{30000 \times 217114} = 0.396 \times 10^{-4} \ ^1/_{\text{in}}$$

FORM E 8V 100M

CALCULATION SHEET

DESIGNER P. T. K DATE 3/21/73 CHECKER C Y Wang DATE 8/17/73

TITLE JOB NO. 6T11-01

SUBJECT CASK DROP ON REFUELING FLOOR @ EL. 228'-0 SHEET NO. 3 OF 8

The total angle change at the mid-span is thus equal to

$$\phi = 2\int_0^{L/2} \frac{M}{EI}\,dx = 2\int_0^{L/2} \frac{M_p}{EI}\,\frac{2x}{L}\,dx = \frac{\phi_y L}{2}$$

$$\phi = \frac{0.396\times10^{-4}\times 41\times12}{2} = 97.5\times10^{-4}$$

Balance of energy

$$400\times12 = M_p\,\phi\,\left(\mu-\frac{1}{2}\right)$$

$$= 257400\times0.00975\,\left(\mu-\frac{1}{2}\right)$$

$$\mu = \frac{400\times12}{257400\times0.00975}+\frac{1}{2} = 2.4 < 12 \quad \text{ok.}$$

FORM - 6V 100M

CALCULATION SHEET

DESIGNER P. T. K DATE 3/21/73 CHECKER C.Y. Wang DATE 5/17/73

TITLE JOB NO. 6511-01

SUBJECT CASK DROP ON REFUELING FLOOR @ EL 228'-0 SHEET NO. 4 OF 8

BEAM - 30 WF 108, NON-COMPOSITE SECTION

$I = 4470 \text{ in}^4$

$Z = 346 \text{ in}^3$

$L = 24 \text{ ft}$

$$M_p = 36 \times 346 = 12{,}500 \quad \text{K-in}$$

$$\phi_y = \frac{M_p}{EI} = \frac{12500}{30000 \times 4470} = 0.93 \times 10^{-4}$$

Total angle change at the mid-span of the beam

$$\phi = \frac{\phi_y L}{2} = \frac{0.93 \times 10^{-4} \times 24 \times 12}{2} = 0.0134$$

Ductility ratio required to stop the 2' drop

$$\mu = \frac{4800}{12500 \times 0.0134} + \frac{1}{2} = 29.1 \qquad \text{N.G.}$$

The permissible travelling height if μ is limited to 12

$$K = 12500 \times 0.0134 \left(12 - \frac{1}{2}\right) = 1926 \quad \text{K-in}$$

$$h = \frac{1926}{200} = 9.6 \text{ in}$$

FORM E-4V 100M

CALCULATION SHEET

DESIGNER P. T. [illegible] DATE 3/21/73 CHECKER Cy Wang DATE 5/17/73

TITLE JOB NO. 6511-01

SUBJECT CASK DROP ON REFUELING FLOOR @ EL. 2[illegible]'-0 SHEET NO. 5 OF 8

BEAM - 30 WF 99, Composite section

$I = 20000 \text{ in}^4$

$L = 24 \text{ ft}$

$A = 155 \text{ in}^4$

$d = 48.14 \text{ in}$

$\bar{y} = 36.34$ in from bottom

$Z = A\left(\frac{d}{2} - y_1\right)$ $\qquad y_1 = 48.14 - 36.34 = 11.8 \text{ in}$

$Z = 155\left(\frac{48.14}{2} - 11.8\right) = 1905 \text{ in}^3$

$M_p = 36 \times 1905 = 68{,}800 \text{ K-in}$

$\phi_y = \frac{M_p}{EI} = \frac{68{,}800}{30000 \times 20000} = 1.145 \times 10^{-4} \ 1/\text{in}$

$\phi = \frac{\phi_y L}{2} = \frac{1.145 \times 10^{-4} \times 24 \times 12}{2} = 0.0165$

$\mu = \frac{4800}{68800 \times .0165} + \frac{1}{2} = 4.8 < 12$ ok

FORM E-87 100M

CALCULATION SHEET

DESIGNER P. T. DATE 3/21/73 CHECKER Cywang DATE 8/17/73

TITLE JOB NO. 6511-01

SUBJECT CASK DROP ON REFUELING FLOOR @ EL. 228'-0 SHEET NO. 6 OF 8

BEAM - 36 WF 160 . Composite section

$I = 67{,}860\ in^4$

$A = 242\ in^2$

$y_1 = 19.2\ in$

$d = 66\ in$

$L = 24\ ft$

$$Z = 242\left(\frac{66}{2} - 19.2\right) = 3340\ in^3$$

$$M_p = 36 \times 3340 = 120{,}000\ \text{k-in}$$

$$\phi_y = \frac{M_p}{EI} = \frac{120000}{30000 \times 67860} = 0.59 \times 10^{-4}$$

$$\phi = \frac{\phi_y L}{2} = \frac{0.59 \times 10^{-4} \times 24 \times 12}{2} = 85 \times 10^{-4}$$

$$\mu = \frac{4800}{120000 \times 0.0085} + \frac{1}{2} = 5.2 < 12 \quad \text{ok.}$$

CONCLUSION

The controlling member is Beam 30 WF 108, non-composite section. The lifting height of the cask should be limited to no more than 10 inches.

FORM E 8V 100M

CALCULATION SHEET

DESIGNER P. T. DATE 3/21/73 CHECKER Cy Wang DATE 5/17/73

TITLE JOB NO. 6511-01

SUBJECT VESSEL HEAD DROP ON REFUELING FLOOR @ EL. 228'-0 SHEET NO. 7 OF 8

Data

Weight of Head = 60 tons = 120 Kips

Lifting height of head = 3.5 ft

Diameter of head = 17 ft

Assume that the vessel head will travel along the path between its operating position and washdown area and that the head will drop directly onto the slab.

The Kinetic energy

$$K = \frac{1}{2} m v^2 = W h = 120 \times 3.5 = 420^{\text{K-ft}}$$

Assume that the energy will be taken by 3 - 36 WF 160 beams. Each beam takes one-thirds of the energy. i.e., 140 K-ft. Assume that the impact load is concentrated at the mid-span of the beam. The ductility ratio required to stop the drop of the head is

$$\mu = \frac{140 \times 12}{120000 \times 0.0085} + \frac{1}{2} = 2.15 \qquad \underline{\text{OK}}$$

FORM E-6V 100M

CALCULATION SHEET

DESIGNER P. T. K DATE 3/21/73 CHECKER CYWang DATE 5/17/73

TITLE

JOB NO. 65-11-01

SUBJECT VESSEL HEAD DROP ON REFUELING FLOOR @ EL. 228'-0 SHEET NO. 8 OF 8

Assume that the hooks on one side of the head break and that it is tipping when it reaches the floor slab. The center of gravity of the head travels approximately one-half of that of the side, i.e., $3.5/2 = 1.75$ ft. The potential energy is then $K = Wh = 120 \times 1.75 = 210$ K-ft

This energy is assumed to be absorbed by one beam. The ductility ratio required

$$\mu = \frac{210 \times 12}{120000 \times 0.0085} + \frac{1}{2} = 2.97 < 12 \quad \underline{\text{OK}}$$

Conclusion

The beams are strong enough to stop the drop of the vessel head from 3.5 ft above the floor. Since the drywell head has approximately the same weight as the vessel head, no further investigation is required.