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GE Nuclear Energy

ABWR

Date 8/6/92

To Butch Burton
Piet Poslusny

Fax No. —

This page plus 11 page(s)

From Jack Fox

Mail Code 782
175 Curtner Avenue
San Jose, CA 95125

Phone (408) 925- 4824

FAX (408) 925-1193
or (408) 925-1687

Subject ABWR Fuel Storage and Handling

Message Proposed revision to Section 9.1. Most significant changes related to 9.1.2.1.3 and 9.1.2.1.4 recognizing fuel storage racks are purchased equipment.

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9.1 FUEL STORAGE AND HANDLING

The new-fuel storage vault stores a 40% core load of new fuel assemblies. The fuel is stored in the new fuel storage racks in the vault which are located as close as practicable to the spent fuel storage pool work area to facilitate handling during fuel preparation. The new-fuel inspection stand is close to the new-fuel storage vault to minimize fuel transport distance.

Spent fuel removed from the reactor vessel must be stored underwater while awaiting disposition ~~off-site transfer~~. Spent fuel storage racks, which are used for this purpose, are located at the bottom of the fuel storage pool under sufficient water to provide radiological shielding. This pool water is processed through the fuel pool cooling and fuel pool and cleanup FPC system to provide cooling to the spent fuel in storage and for maintenance of fuel pool water quality. The spent fuel pool storage capacity is 270% of the reactor core.

The new fuel and spent fuel storage racks are the same high density design. The new fuel racks can be used for either dry or submerged storage of fuel. The design of the spent fuel racks will be described. Information on the new fuel racks will only be presented when the design is different. ~~The detailed analysis of the rack design is contained in Subsection 9.1.3.~~

9.1.1 New Fuel Storage

9.1.1.1 Design Bases

9.1.1.1.1 Nuclear Design

A full array of loaded new fuel racks is designed to be subcritical, by at least 5% Δk.

(1) Monte Carlo techniques are employed in the calculations performed to assure that k_{eff} does not exceed 0.95 under all normal and abnormal conditions.

(2) The assumption is made that the storage array is infinite in all directions. Since no credit is taken for neutron leakage, the values reported as effective neutron multiplication factors are, in reality, infinite neutron multiplication factors.

(3) The biases between the calculated results and experimental results, as well as the uncertainty involved in the calculations, are taken into account as part of the calculational procedure to assure that the specific k_{eff} limit is met.

The new fuel storage racks are purchased equipment. The purchase specification for these racks will require the vendor to provide the information requested in Question 430.180 on criticality analysis and the inadvertent placement of a fuel assembly in other than prescribed locations. See Subsection 9.1.6.1 for ~~interface requirements~~. COL license information requirements. 430.180

9.1.1.1.2 Storage Design

The new fuel storage racks provided in the new fuel storage vault provide storage for 40% of one full core fuel load.

9.1.1.1.3 Mechanical and Structural Design

The new fuel storage racks contain storage space for fuel assemblies (with channels) or bundles (without channels). They are designed to withstand all credible static and seismic loadings. The racks are designed to protect the fuel assemblies and bundles from excessive physical damage which may cause the release of radioactive materials in excess of 10CFR20 and 10CFR100 requirements, under normal and abnormal conditions caused by impacting from either fuel assemblies, bundles or other equipment.

~~The racks are categorized as Seismic Category I.~~ See Subsection 9.1.2.1.3.~~for additional discussion of design bases and analysis.~~

9.1.1.1.4 Thermal-Hydraulic Design

See Subsection 9.1.2.1.4.

9.1.1.1.5 Material Considerations

See Subsection 9.1.2.1.5.

9.1.1.1.6 Dynamic and Impact Analysis

The new fuel storage racks are purchased equipment. The purchase specification for the new fuel storage racks will require the vendor to perform confirmatory dynamic analyses. The input excitation for these analyses will utilize the horizontal and vertical response spectra provided in new Figures 430.178.9

9.1-15 and 9.1-26. (The SSE response is two times the OBE response).

Vertical impact analysis is required because the fuel assembly is held in the storage rack by its own weight without any mechanical holddown devices. Therefore, when the downward acceleration of the storage rack exceeds 1g, contact between the fuel assembly and the storage rack is lost. Horizontal impact analysis is required because a clearance exists between the fuel assembly and the storage rack walls.

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See Subsection 9.1.6.2 for ~~interface~~ COL licensing information requirements.

9.1.1.1.7 (Deleted)

9.1.1.2 Facilities Description (New Fuel Storage)

(1) The location of the new fuel storage vault in the reactor building as shown in Section 1.2.

(2) The new fuel storage racks are top entry racks designed to preclude the possibility of criticality under normal and abnormal conditions. The upper tieplate of the fuel element rests against the module to provide lateral support. The lower tieplate sits in the bottom of the rack, which supports the weight of the fuel.

(3) The rack arrangement is designed to prevent accidental insertion of fuel assemblies or bundles between adjacent racks. The storage rack is designed to provide accessibility to the fuel bail for grappling purposes.

(4) The floor of new fuel storage vault is sloped to a drain located at the low point. This drain removes any water that may be accidentally and unknowingly introduced into the vault. The drain is part of the floor drain subsystem of the liquid radwaste system.

(5) The radiation monitoring equipment for the new fuel storage areas is described in Section 7.1.

9.1.1.3 Safety Evaluation

9.1.1.3.1 Criticality Control

The design of the new fuel storage racks provides for an effective multiplication factor (k_{eff}) for both normal and abnormal storage conditions equal to or less than 0.95 in the new fuel storage racks. To ensure design criteria are met, the following normal and abnormal new fuel storage conditions ~~were~~ will be analyzed: 430177

(1) normal positioning in the new fuel array, and

(2) eccentric positioning in the new fuel array

The new fuel storage area will accommodate fuel (k_{inf} < 1.35 at 20°C in standard core geometry) with no safety implications.

9.1.1.3.2 Structural Design

(1) The new fuel vault contains one or more fuel storage racks which provides storage for fuel a maximum of 40% of one full core fuel load.

(2) The new fuel storage racks are designed to be freestanding (i.e., no supports above the base).

(3) The racks include individual solid tube storage compartments which provide lateral restraints over the entire length of the fuel assembly.

(4) The weight of the fuel assembly or bundle is supported axially by the rack lower support.

(5) The racks are fabricated from materials used for construction are specified in accordance with the latest issue of applicable ASTM specifications.

(6) Lead-in guides at the top of the storage spaces provide guidance of the fuel during insertion.

(7) The racks are designed to withstand, while maintaining the nuclear safety design basis, the impact force generated by the vertical free-fall drop of a fuel assembly from a height of ~~6 feet~~ 1.8 meter.

(8) The rack is designed to withstand a pullup force of ~~1717 kg (4000 lb)~~ 1814 kg and a horizontal force of 454 kg (1000 lb). There are no readily definable horizontal forces in excess of ~~1000 lb~~ 454 kg and, in the event a fuel assembly should jam, the maximum lifting force of the fuel-handling platform grapple (assumes limit switches fail) is ~~3000 lb.~~ 1361 kg.

(9) The new fuel storage racks require no periodic special testing or inspection for nuclear safety purposes.

9.1.1.3.3 Protection Features of the New Fuel Storage Facilities

The new fuel storage vault is housed in the reactor building. The vault and reactor building are Seismic Category I natural phenomena such as tornadoes, tornado missiles, floods and high winds. Fire protection features are described in Subsection 9.5.1 and Appendix 9A.

The storage rack structure is designed to withstand the impact resulting from a falling weight. Tests using a simulated fuel bundle have been conducted to verify that the rack casting can withstand the impact form a bundle dropped from a maximum allowable height above the array. Procedural fuel-handling requirements and equipment design [illegible] that no more than one bundle at a time can [illegible] handled over the storage racks and at a maximum height of 6 feet above the upper rack. Therefore, the racks cannot be displaced in a manner causing critical spacing as a result of impact from a falling object.

The auxiliary hook on the reactor building crane can traverse the full length of the refueling floor. This hook is used to move new fuel from the entry point into the reactor building, up the main equipment hatch to the refueling floor and from there to the new fuel storage vault. This hook can move fuel to the new fuel inspection stand and rechanneling area at the end of the spent fuel storage pool.

New fuel can also be carried from the new fuel vault to the inspection stand or spent fuel pool using the fuel-handling platform. During positioning of new fuel into the new fuel racks with either the main crane auxiliary hook or the refueling platform, the fuel grapple is always above the upper fuel rack casting and the grapple interfaces only with the fuel bundle bail and can not engage the fuel rack. Thus, the transfer devices used for new fuel handling to the new fuel vault cannot impose uplift loads on the rack castings.

Should it become necessary to move major loads along or over the pools, administrative controls require that the load be moved over the empty portion of the spent fuel pool and avoid the area of the new fuel storage vault. The shipping cask will not be lifted or moved above the new fuel vault because of their relative locations on the refueling floor.

9.1.2 Spent Fuel Storage

9.1.2.1 Design Bases

9.1.2.1.1 Nuclear Design

(1) A full array in the loaded spent fuel rack is designed to be subcritical, by at least 5% Δk. Neutron-absorbing material, as an integral part of the design, is employed to assure that the calculated k_{eff}, including biases and uncertainties, will not exceed 0.95 under all normal and abnormal conditions.

(a) Monte Carlo techniques are employed in the calculations performed to assure that k_{eff} does not exceed 0.95 under all normal and abnormal conditions.

(b) The assumption is made that the storage array is infinite in all directions. Since no credit is taken for neutron leakage, the values reported as effective neutron multiplication factors are, in reality, infinite neutron multiplication factors.

(c) The biases between the calculated results and experimental results, as well as the uncertainty involved in the calculations, are taken into account as part of the calculational procedure to assure that the specific k_{eff} limit is met.

9.1.2.1.2 Storage Design

The fuel storage racks provided in the spent fuel storage pool provide storage for 270% of one full core fuel load.

The fuel storage pool liner seismic classification is provided in Table 3.2-1.

9.1.2.1.3 Mechanical and Structural Design

The spent fuel storage racks in the reactor building contain storage space for fuel assemblies (with channels) or bundles (without channels). They are designed to withstand all credible static and seismic loadings. The racks are designed to protect the fuel assemblies and bundles from excessive physical damage which may cause the release of radioactive materials in excess of 10CFR20 and 10CFR100 requirements under normal and abnormal conditions caused by impacting from either fuel assemblies, bundles or other equipment.

The spent fuel pool is a reinforced concrete structure with a stainless steel liner. The bottoms of all pool gates are sufficiently high to maintain the water level over the spent fuel storage racks form adequate shielding and cooling. All pool fill and drain lines enter the pool above the safe shielding water level. Redundant anti-siphon vacuum breakers are located at the high point of the pool circulation lines to preclude a pipe break from siphoning the water from the pool and jeopardizing the safe water level.

The racks include individual solid tube storage compartments, which provide lateral restraints over the entire length of the fuel assembly or bundle. The weight of the fuel assembly or bundle is supported axially by the rack fuel support. Lead-in guides at the top of the storage spaces provide guidance of the fuel during insertion.

The racks are fabricated from materials used for construction are specified in accordance with the latest issue of applicable ASTM specifications. The racks are constructed in accordance with a quality assurance program that ensures the design, construction and testing requirements are met.

The racks are designed to withstand, while maintaining the nuclear safety design basis, the impact force generated by the vertical free-fall drop of a fuel assembly from a height of 6 feet. The rack is designed to withstand a pullup force of 4000 pounds and a horizontal force of 1000 pounds. There are no readily definable horizontal forces in excess of 1000 pounds, and in the event a fuel assembly should jam, the maximum lifting force of the fuelhandling platform grapple (assumes limit switches fail) is 3000 pounds.

The fuel storage racks are designed to handle irradiated fuel assemblies. The expected radiation levels are well below the design levels.

In accordance with Regulatory Guide 1.29, the fuel storage racks are designated Safety Class 2 and Seismic Category I. The structural integrity of the rack ~~has been~~ will be demonstrated for the load combinations described below using linear elastic design methods.

The applied loads to the rack are:

(1) dead loads, which are weight of rack and fuel assemblies, and hydrostatic loads;

(2) live loads - effect of lifting an empty rack during installation;

(3) thermal loads - the uniform thermal expansion due to pool temperature changes;

(4) seismic forces of OBE and SSE;

(5) accidental drop of fuel assembly from maximum possible height ~~6 feet~~ 1.8 meters above rack; and

(6) postulated stuck fuel assembly causing an upward force of ~~3000 pounds.~~ 1361 kg.

The load combinations considered in the rack design are:

(1) live loads

(2) dead loads plus OBE

(3) dead loads plus SSE; and

(4) dead loads plus fuel drop.

Thermal loads ~~were~~ are not included in the above combinations because they ~~were~~ are negligible due to the design of the rack (i.e., the rack is ~~attached only at its base and is~~ free to expand/contract under pool temperature changes).

The loads experienced under a stuck fuel assembly condition are typically less than those calculated for the seismic conditions and, therefore, ~~have not been~~ need not be included as a load combination.

The storage racks are ~~attached to the support structure by bolting, sufficient~~ designed to counteract the tendency to overturn from horizontal loads and to lift from vertical loads. The analysis of the rack assumed an adequate supporting structure, and loads were generated accordingly.

Stress analyses ~~were~~ will be performed by the vendor using classical methods based upon shears and moments developed by the dynamic method. Using the given loads, load conditions and analytical methods, stresses ~~were~~ will be calculated at critical sections of the rack and compared to acceptance criteria referenced in ASME Section III subsection NF. Compressive stability ~~was~~ will be calculated according to the AISI code for light gage structures.

The loads in the three orthogonal directions ~~were~~ are considered to be acting simultaneously and ~~were~~ combined using the SRSS method suggested in Regulatory Guide 1.92. The loads due to the OBE event are approximately 90% of those due to an SSE event, and allowable stress levels for OBE are 50% of SSE, therefore making the OBE event the limiting load condition except for stability, where SSE acceptance criteria of 67% of critical buckling strength is limiting.

Under fuel drop loading conditions, the acceptance criterion is that, although deformation may occur, K_{eff} must remain <0.95. The rack is designed such that, should the drop of a fuel assembly damage the tubes and dislodge a plate of poison material, the K_{eff} would still be <0.95 as required.

The effect of the gap between the fuel and the storage tube ~~has been~~ is taken into account on a local effect basis. Dynamic response analysis ~~shows~~ has shown that the fuel contacts the tube over a large portion of its length, thus preventing an overloaded condition of both fuel and tube.

The vertical impact load of the fuel onto its seat ~~has been~~ is considered conservatively as being slowly applied without any benefit for strain rate effects. See Subsection 9.1.6.7 for COL license information requirements.

9.1.2.1.4 Thermal-Hydraulic Design

The fuel storage racks ~~is~~ are designed to provide sufficient natural convection coolant flow to remove ~~60,000 Btu/hr/bundle of~~ decay heat without reaching excessive water temperatures (100 °C).

The support structure must be designed to provide an adequate flow rate to prevent water reaching excessive temperatures 212 F. The flow rate is dependent on the decay heat load, the ΔP losses through the structure and the losses through the rack and bundle.

In the spent fuel storage pool, the bundle decay heat is removed by recirculation flow to the fuel pool cooling heat exchanger to maintain the pool temperature. Although the design pool exit temperature (1) within the rack is high, depending on the naturally induced bundle flow which carries away the decay heat generated by the spent fuel. (2) The rate of naturally circulated flow and the maximum rack water exit temperature ~~have been evaluated.~~ See Subsection 9.1.6.7 for COL license information requirements.

The parameters which will affect the water flow

(1) to the fuel pool cooling heat exchanger is far below boiling, the coolant temperature

(2) The purchase specification for the fuel storage racks require the vendor to perform the thermal-hydraulic analyses to evaluate

through the fuel storage rack and consequently the water temperature exiting the top of the storage space are:

(1) hole size through the fitting;

(2) flow area through the base plate;

(3) flow resistance through the bundle;

(4) height of the module above the pool liner;

(5) support structure restriction to horizontal flow under module; and

(6) loading pattern of fuel in pool (e.g., fresh fuel loaded in center of array would result in higher cooling water exit temperatures).

The analysis was performed with the bundle flow channel in place, since this is the most restrictive (all bundle cooling flow must enter through the lowest tieplate orifice). Also, heat is generated in the water space between the channel and the tube by gamma capture in the water and metal, thus creating a need for additional flow opening into this space. Heat generation rates for the BWR bundle irradiated 44 GWd/Mt and cooled 7 days were calculated using the ORIGEN computer code. These rates are:

Bundle	68,000 Btu/hr
Zr Channel	752 Btu/hr
H_2O Space	2,510 Btu/hr
Stainless Boral Tube	256 Btu/hr

In no case does the cooling water exit temperature at the top of the rack approach boiling. With exit water at 115 °F and the pool return water temperature at 100 °F, the cladding temperature will be 122 °F and the Boral Tube centerline temperature will be 165 °F.

The following relationships, are used to solve the cooling water temperature increase as it flows upward through the bundle. The driving force to generate flow through the bundle is given by:

$$\text{Driving Force} = h_c\left(1 - \frac{Mt + 1 + \rho_c}{2\rho_c}\right) \times$$

$$\left(V_b - \frac{h_c MQ}{2C_p\left(\frac{A_b}{144}\right)\rho_c^{\ 2}}\right)$$

This force if equal to the various pressure drops the water encounters in moving up through the bundle, or $V_b\ \Sigma\ H_i$, where $\Sigma\ H_i$ is the sum of these pressure drops given below:

Bundle Head Loss:

$$H_b = 7.95\left(\frac{V_b^2}{2g}\right) \quad \left(\frac{A_b}{A_k}\right)^2$$

Definitions of the above terms are given in Table 9.1-1. The factor a_n is the ratio of flow rates to the previous quadrants and the flow rate to the quadrant in question. A quadrant in this case is one-fourth of the bundles in a module. A quadrant of a module is used, since the support structures essentially divide the module into four equal areas. Assume the module quadrant in question is four quadrants from the edge of the pool array. The cooling water to this quadrant must flow horizontally under the four other module quadrants and supply cooling water to these modules. If the heat load in each quadrant is equal, then the flow to the outer quadrant is five times the flow to the quadrant in question, and $a_5 = 5$. As we move closer to the quadrant in question, a_n becomes 5, 4, 3, 2 and finally, 1.

Thus, $\sum_{i}^{i}$ is the sum of the five pressure loss factors given above. These relationships may be summed up as a cubic equation having the following form:

$$\theta V_b^3 + \gamma V_b^2 + \alpha V_b + \beta = 0$$

where

$\theta = \sum_{1}^{i} H_i;$

γ = 0, since there are no V_b terms:

$$\alpha = h_c \left(1 - \frac{Mt + \quad + \rho_c}{2\rho_c}\right) \quad ;\text{and}$$

$$\beta = \frac{h_c MQ}{2C_p \left(\frac{A_b}{144}\right) \rho_c^2}$$

For a given geometry of fuel, inlet water temperature and heat from the bundle α and β will be constants and θ is the only coefficient that changes. Thus, under the conditions above, defining θ will set the value of V_b. The cubic was solved for a series of arbitrary values for θ. Knowing the value for θ permits rapid determination of V_b and the temperature increase across the bundle.

A solution is presented for the case where the module is supported 8 inches above the floor and the support structures occupy 25% of the area under the module. Using the relationships above and the other factors as defined, the amount each factor contributes to θ is as follows:

Factor	θ
Bundle Head Loss	0.257
Base Plate	0.0137
Holes in Castings	0.0127
Area Under Module	0.0188
Reduction of Area under Module	0.0513
Total	0.354

$$\alpha = -1.129 \times 10^{-3}$$

$$\beta = -4.66 \times 10^{-3}$$

and the equation to be solved is:

$$0.354\,V_b^3 + 1.129 \times 10^{-3} V_b - 4\ldots \times 10^{-3} = 0$$

For a coefficient of 0.354 ... 0.23... ft/sec and the temperature increase of the ...owing water is 12.3°F.

It can be noted that the minimum temperature increase will be determined when θ = 0.257, which is the pressure drop through the bundle alone, and this increase will be 11.1°F.

The effects of changing the design parameters can be quickly determined using the above relationships. The results obtained will be conservative due to the high bundle heat loads assumed and assumptions made as to module location in the pool.

Design of the storage module is fixed. However, details of the module support structure will probably vary between facilities.

If it is assumed that the module is 10 inches above the floor and with all other parameters as given above, then the temperature increase is determined as follows:

	θ
Area Under Module	0.00986
Area Reduction Under Module	0.0301
Base Plate	0.0137
Holes in Castings	0.0127
Bundle	0.257
Total	0.323

Using this value of Σ, V_b = 0.238 ft/sec and temperature increase is 11.8°F.

9.1.2.1.5 Material Considerations

All structural material used in the fabrication of the fuel storage racks is in accordance with the latest issue of the applicable ASTM specification at the time of equipment order. This material is chosen due to its corrosion resistance and its ability to be formed and welded with consistent quality. The normal pool water operating temperatures is [redacted] 16 to [redacted] 66 °C.

The storage tube material is permanently marked with identification traceable to the material certifications. The fuel storage tube assembly is compatible with the environment of treated water and provides a design life of 60 years.

9.1.2.2 Facilities Description (Spent Fuel Storage)

(1) The spent fuel storage racks provide storage in the reactor building spent fuel pool for spent fuel received from the reactor vessel during the refueling operation. The spent fuel storage racks are top entry racks designed to preclude the possibility of criticality under normal and abnormal conditions. The upper tieplate of the fuel elements rests against the rack to provide lateral support. The lower tieplate sits in the bottom of the rack, which supports the weight of the fuel.

(2) The rack arrangement is designed to prevent accidental insertion of fuel assemblies or bundles between adjacent modules. The storage rack is designed to provide accessibility to the fuel bail for grappling purposes.

(3) The location of the spent fuel pool is shown in Section 1.2

9.1.2.3 Safety Evaluation

9.1.2.3.1 Criticality Control

430.190 The spent fuel storage racks are purchased equipment. The purchase specification for the spent fuel storage racks will require the vendor to provide the information requested in Question 430.190 om criticality analysis of the spent fuel storage including the uncertainity value and associated probability and confidence level for the K_{eff} value. See Subsection 9.1.6.3 for interface requirements.

9.1.2.3.2 Structural Design and Material Compatibility Requirements

(1) The spent fuel pool racks provide storage for 270% of the reactor core.

(2) The fuel storage racks are designed to be supported above the pool floor by a support structure. The support structure allows sufficient pool water flow for natural convection cooling of the stored fuel. Since the modules are freestanding (i.e., no supports above the base), the support structure also provides the required dynamic stability.

(3) The racks include individual solid tube storage compartments, which provide lateral restraints over the entire length of the fuel assembly or bundle.

(4) The racks are fabricated from materials used for construction and are specified in accordance with the latest issue of applicable ASTM specifications at the time of equipment order.

(5) Lead-in guides at the top of the storage spaces provide guidance of the fuel during insertion.

(6) The racks are designed to withstand, while maintaining the nuclear safety design basis, the impact force generated by the vertical free-fall drop of a fuel assembly from a height of ~~6 feet.~~ 1.8 meters

(7) The rack is designed to withstand a pullup force of ~~4000 lb~~ 1814 Kg and a horizontal force of ~~1000 lb.~~ 454 Kg There are no readily definable horizontal forces in ~~excess of 1000 lb~~ 454 Kg and in the event a fuel assembly should jam, the maximum lifting force of the fuel-handling platform grapple (assumes limit switches fail) is ~~3000 lb.~~ 1361 Kg

(8) The fuel storage racks are designed to handle irradiated fuel assemblies. The expected radiation levels are well below the design levels.

The fuel storage facilities will be designed to Seismic Category I requirements to prevent earthquake damage to the stored fuel.

The fuel storage pools have adequate water shielding for the stored spent fuel. Adequate shielding for transporting the fuel is also provided. Liquid level sensors are installed to detect a low pool water level, and adequate makeup water is available to assure that the fuel will not be uncovered should a leak occur.

Since the fuel storage racks are made of noncombustible material and are stored under water, there is no potential fire hazard. The large water volume also protects the spent fuel storage racks from potential pipe breaks and associated jet impingement loads.

Fuel storage racks are made in accordance with the latest issue of the applicable ASTM specification at the time of equipment order. The storage tubes are permanently marked with identification traceable to the material certifications. The fuel storage tube assembly is compatible with the environment of treated water and provides a design life of 60 years, including allowances for corrosion.

Regulatory Guide 1.13 is applicable to spent fuel storage facilities. The reactor building contains the fuel storage facilities, including the storage racks and pool, is designed to protect the fuel from damage caused by:

(1) natural events such as earthquake, high winds and flooding, and

(2) mechanical damage caused by dropping of fuel assemblies bundles, or other objects onto stored fuel.

9.1.2.4 Summary of Radiological Considerations

By adequate design and careful operational procedures, the safety design bases of the spent fuel storage arrangement are satisfied. Thus, the exposure of plant personnel to radiation is maintained well below published guideline values. Further details of radiological considerations, including those for the spent fuel storage arrangement, are presented in Chapter 12.

430.191 The pool liner leakage detection system and water level monitoring system are discussed in Subsection 9.1.3. The corrective action for loss of heat removal capability is in Subsection 9.1.3. The radiation monitoring system and the corrective action for excessive radiation levels are discussed in Subsections 11.5.2.1.2(1) and 11.5.2.1.3.

9.1.6 COL License Information

9.1.6.1 New Fuel Storage Racks Criticality Analysis

The COL applicant referencing the ABWR design shall provide the NRC confirmatory criticality analysis as required by Subsection 9.1.1.1.1.

9.1.6.2 Dynamic and Impact Analyses of New Fuel Storage Racks

The COL applicant referencing the ABWR design shall provide the NRC confirmatory dynamic and impact analyses of the new fuel storage racks. See Subsection 9.1.1.1.6.

9.1.6.3 Spent Fuel Storage Racks Criticality Analysis

The COL applicant referencing the ABWR design shall provide the NRC confirmatory critically analysis as required by Subsection 9.1.2.3.1.

9.1.6.4 Spent Fuel Racks Load Drop Analysis

The COL applicant referencing the ABWR design shall provide the NRC confirmatory load drop analysis as required by Subsection 9.1.4.3.

9.1.6.6 Overhead Load Handling System Information

The COL applicant shall provide the NRC for confirmatory review: (1) heavy load handling system and equipment maintenance procedures, (2) heavy load handling system and equipment maintenance procedures and/or manuals, (3) heavy load handling system and equipment inspection and test plans; NDE, Visual, etc., (4) heavy load handling safe load paths and routing plans, (5) QA program to monitor and assure implementation and compliance of heavy load handling operations and controls, (6) operator qualifications, training and control program.

9.1.6.5 New Fuel Inspection Stand Seismic Capability

The COL applicant referencing the ABWR design will install the new fuel inspection stand firmly to the wall so that it does not fall into or dump personnel into the spent fuel pool during an SSE. (See Subsection 9.1.4.2.3.2.)

9.1.6.7 Spent Fuel Racks Structura Evaluation

The COL applicant will provide the NRC confirmatory structural evaluation of the spent fuel racks as outlined in Subsection 9.1.2.1.3.

9.1.6.8 Spent Fuel Racks Thermal-Hydraulic Analysis

The COL applicant will provide the NRC confirmatory thermal hydraulic analysis that evaluates the rate of naturally circulated flow and the maximum rack water exit temperature as required by Subsection 9.1.2.1.

9.1.7 References

1. *General Electric Standard Application for Reactor Fuel*, (NEDE-24011-P-A, latest approved revision)

Table 9.1-1
(Deleted)

DEFINITION OF TERMS

A_b	Flow area through bundles = 15.353 in^2.
A_k	Arbitrary area used in bundle friction correlation = 10 in^2
C_p	Specific heat of water = 1.0 Btu/lb- ^oF.
g	Gravitational constant 32.2 ft/sec^2.
H_b	Head loss through bundle (ft H_2O).
h_c	Effective depth of cold water over entrance point into bundle = 13.5 ft in this example
I	Intercept in ρ versus t correlation = 63.45 lb/ft^3.
M	Slope of ρ versus t correlation = -0.0145 lb/ft^3-^oF.
ρ_c	Density of water = 62.00 lb/ft^3 (at 100^{o}F).
Q	Heat evolution rate from bundle = 68,000/3,600 Btu/sec.
t	Inlet water temperature (100^{o}F).
V_b	Velocity of water through bundle (ft/sec).

< TRANSACTION REPORT >

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