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RESPONSE TO NRC"S REQUEST OF 11/14/77... FURNISHING ADDL INFO TO 26 SPECIFIC ADD INFO REQUESTS RE SPENT FUEL MODIFICATIONS.

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WISCONSIN PUBLIC SERVICE CORPORATION

Public Service

P.O. Box 1200, Green Bay, Wisconsin 54305

March 13, 1978

Division of Operating Reactors
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention Mr. A. Schwencer, Chief
Operating Reactors Branch #1

Gentlemen:

Docket No. 50-305
Operating License DPR-43
Spent Fuel Pool Modifications

On November 14, 1977, we submitted a description of the proposed modification to the Kewaunee Nuclear Power Plant Spent Fuel Pool and a proposed Amendment to the Operating License. On January 30, 1978, Operating Reactors Branch No. 1 requested additional information in regard to the November 14, 1977, submittal.

Please find attached forty (40) copies of the responses to the 26 specific additional information requests.

Very truly yours,

E. W. James

E. W. James
Senior Vice President
Power Supply & Engineering

sa

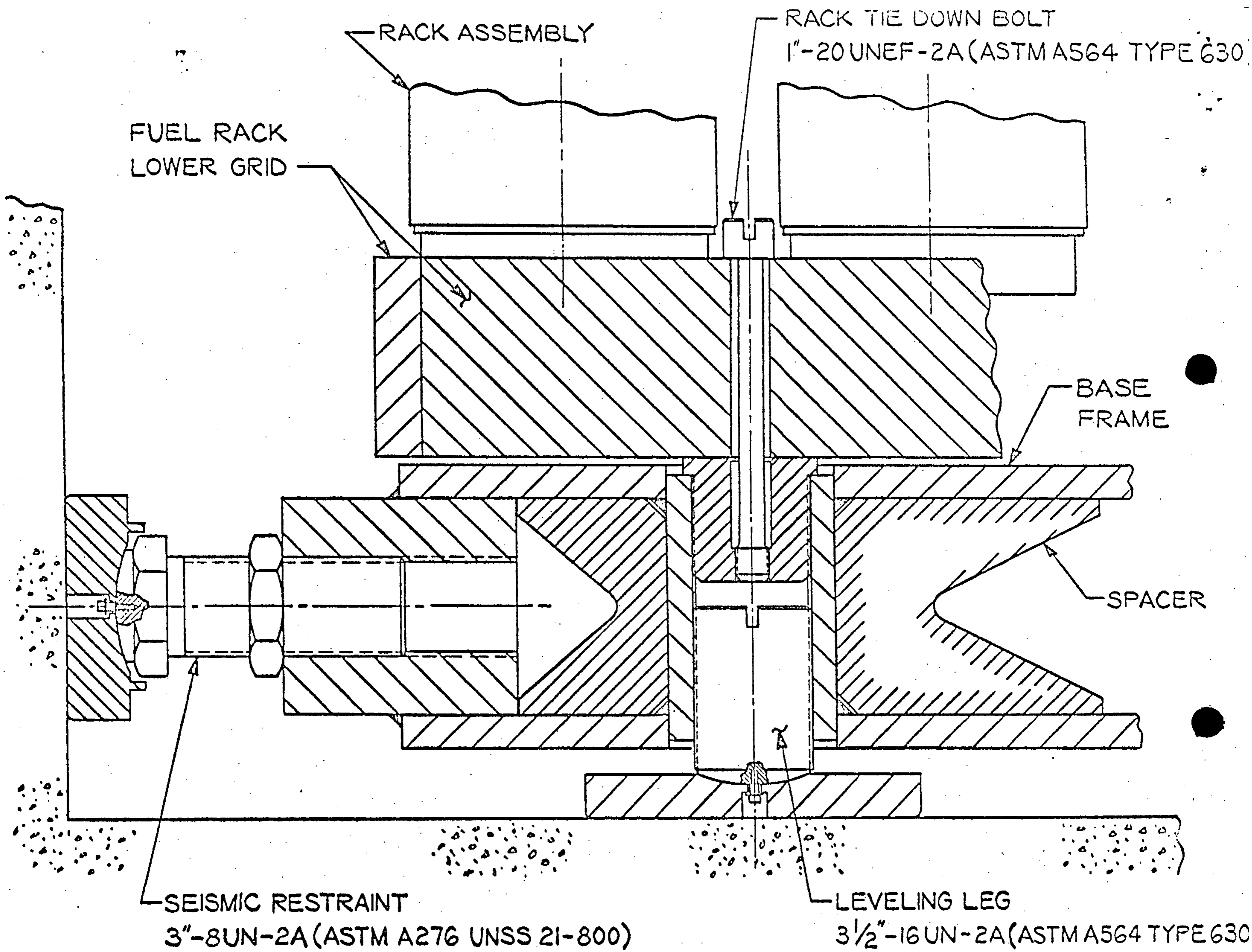
Attach.

A001
s
1/40
REPRO
LTRS

RESPONSE TO QUESTIONS IN LETTER DATED 1/30/78

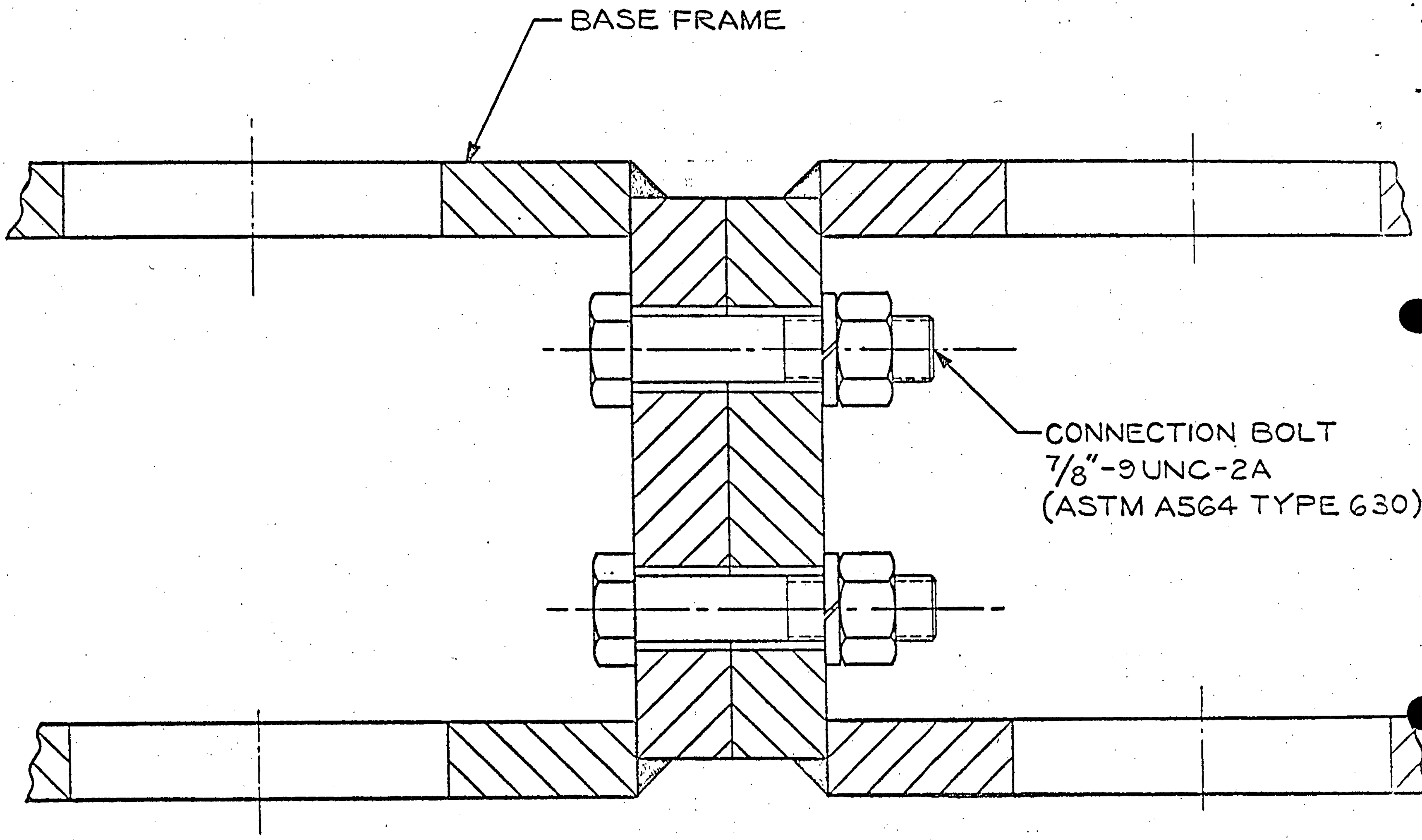
QUESTION NO. 1 Provide detailed sketches of the supports and bearing pads for the individual cans in the fuel rack assemblies. In addition, since Figures 3-1 and 3-2 do not show sufficient details of the rack base structure, provide clear sketches of a typical base and its interconnecting structure to other bases and to the pool walls.

RESPONSE The two attached sketches (1-1 and 1-2) provide the information requested noting that the individual cans are formed into 9 x 10 racks by welding to upper and lower grid structures and the racks are in turn bolted to the base frames which are bolted together to entirely fill the pool and are restrained from moving by "compression only" seismic restraints to the pool walls.



SKETCH 1-1

DETAIL OF ① FUEL RACK TO BASE FRAME CONNECTION,
② BASE FRAME LEVELING LEG AND
③ BASE FRAME SEISMIC RESTRAINT



BOLTED CONNECTION BETWEEN BASE FRAMES

SKETCH 1-2

QUESTION NO. 2

Provide sketches of the mathematical models of the fuel pool, the fuel storage rack, and the fuel assembly system which were used in the STARDYNE analysis. Illustrate on the sketches the mechanism of shear and load transfer to the fuel pool walls and floor slab. Discuss the effects of sloshing water. Also, provide the resulting significant modal frequencies of the fuel racks in air and water up to 33Hz, and the corresponding mode shapes and participation factors. Justify your statement that only the first three modes of the rack modules are dynamically significant.

RESPONSE

A sketch of the STARDYNE finite element model used in the frequency and structural analysis of the racks is given on page 5-7 of the licensing submittal (dated November 14, 1977). Horizontal loads are applied to the walls of the fuel pool by the rack lateral restraints. These restraints are modeled as tension/compression members. The vertical loading on the rack is transmitted to the floor by the rack support feet.

Since sloshing effects are significant only within the upper third of the fuel pool and the fuel racks are located within the lower third of the pool, sloshing effects on the racks are insignificant. The effect of submergence of the racks was accounted for by including a virtual mass of water with the mass of the fuel storage cans.

The modal frequencies, participation factors, generalized weights, and modal effective weights are given in the table below. These differ slightly from those given in Table 5-1 of the licensing submittal due to some minor design changes.

TABLE 5-1

HQR RESULTS - X1 MODAL EFFECTIVE WEIGHT

Mode Number	Freq. (HZ)	Part Factor	Generalized Wt. (LB)	Modal Effective Wt. (LB)
1	4.496	1.379	185859	353438
2	6.821	1.315	163650	282988
3	14.051	0.943	119512	106276
4	16.680	0.001	40210	0
			TOTAL	742702

QUESTION NO. 2
(Cont.)

Note from Table 5-1 that the total modal effective weight of the first three modes represents 88% of the total weight. Therefore, use of the first three modes in the model is sufficient.

Mode shapes are given in the sketches on pages 5-8 and 5-9 of the licensing submittal.

Modal frequencies of the fuel racks in air were not taken into consideration since the fuel racks will be employed only in water.

QUESTION NO. 3 Provide the response spectra used for the SSE and the OBE conditions. Also state the damping values assumed for the fuel racks in air and in water.

RESPONSE The seismic analysis employed the response spectra as noted in Report JAB-PS-03, which was submitted as Amendment 9 to the Kewaunee FSAR. For the basis of this design, the analysis employed a damping factor of 1% in water. Since these racks will not be employed in air, the analysis did not address this environment.

QUESTION NO. 4 Provide a summary of the highest stresses, the corresponding safety margins, the locations where these occur, and the maximum displacements at the top of the racks for the loading conditions considered in the analysis of the rack structure.

RESPONSE The following exerpted from the licensing report (dated November 14, 1977) is a summary of results which includes maximum calculated stresses, allowable stress values, and margins for critical locations on the spent fuel racks and base frames.

Load Combination "a" (Dead Loads Plus Live Loads)

Dead weight stresses alone are not presented since they have been included in other load combinations which are limiting.

Hydrostatic forces cause a uniform compressive stress on the complete structure, which is negligible and is omitted from this analysis.

In the analysis for lifting of an empty fuel rack by four lift points, assuming a dynamic load factor of 2.0, the limiting stress is bending stress at the lifting hole, of 14278 psi versus an allowable value of 14700 psi (margin=1.03). In addition, the minimum length of engagement for the lifting bolts is 1-5/8".

Load combinations b (Dead Loads Plus DE); c (Dead Loads Plus Thermal Loads Plus DE); d (Dead Loads Plus Thermal Loads Plus MCE):

(See Tables Attached)

Location	Load Combination	Calculated Stress in PSI	Allowable Stress in PSI	Margin
Fuel Cans	b	10164	14700	1.45
	c	15919	22050	1.39
	d*	17285	23520	1.36
	d**	23040	26400	1.15
Inner to Outer Can Welds	b	6840	9800	1.43
	c	10040	14700	1.46
	d	14799	15680	1.06
Can To Grid Welds At Lower Corners	b	7210	9800	1.36
	c	12161	14700	1.21
	d*	12339	15680	1.27
	d**	17034	17600	1.03
Can to Grid Welds All Other Locations	b	6809	9800	1.44
	c	12405	14700	1.19
	d*	11546	15680	1.36
	d**	17147	17600	1.03
Upper Grid Small Beams	b	2216	14700	6.63
	c	4697	22050	4.69
	d	6556	23520	3.59
Upper Grid Large Grid Beams	b	9087	14700	1.62
	c	18051	22050	1.22
	d*	17334	23520	1.36
	d**	26298	26400	1.004
Lower Grid Beams	b	16469	26256	1.59
	c	19484	39384	2.02
	d	29334	42010	1.43

* Without thermal gradients compared to allowable @ 220°F

** With thermal gradients compared to allowable @ 150°F

Location	Load Combination	Calculated*** Stress in PSI	Allowable*** Stress in PSI	Margin
Base Frame Connecting Bolts	b (Limiting)	92334	95000	1.03
Base Frame Connecting Flange Welds (Weld Thicknesses)	b d	.471" min. .561"	.62" act. .62	1.32 1.11
Base Leveling Leg	b d	63100 101000	63200 101200	1.002 1.002
Leveling Leg Pad	b d	73100 116800	82200 131520	1.12 1.13
Wall Support Screw (Buckling Stress)	b d	6020 12030	21800 34880	3.62 2.90
Wall Support Pad Pad Thickness	d (Limiting Case)	1.41" min.	1.5" act.	1.06
Wall Support Screw Boss Welds	d (Limiting Case)	.25" min.	.38" act.	1.52
Base Gusset Thickness (inches)	b (Limiting Case)	0.95" min.	1.0" act.	1.05
Gusset To Boss Weld Thickness (inches)	b (Limiting)	0.7125" min.	0.75" act.	1.05
Gusset To Flange Weld	b (Limiting)	8988	17500	1.95
North Pool Frame Beams	d (Limiting)	15574	23520	1.51

*** Unless Otherwise Noted

Location	Load Combination	Calculated* ** Stress in PSI	Allowable* ** Stress in PSI	Margin
Lower Grid Large Grid To Large Grid Welds	b	11541	17504	1.52
	c	15467	26256	1.70
	d	22625	28006	1.24
Small Lower Grid to Large Grid Welds	b	15826	17504	1.11
	c	18553	26256	1.42
	d*	25976	28006	1.08
	d**	28701	31360	1.09
Lower Grid Small Grid To Small Grid Welds	b	7814	17504	2.24
	c	13809	26256	1.90
	d	18677	28006	1.50
Rack to Base Bolts (Tensile Stress)	b	40298	91100	2.26
	c	57445	136650	2.38
	d*	117933	145760	1.24
	d**	135079	148800	1.10
Upper Lateral Bumper Screws	d (Limiting Case)	15937	23520	1.48
Fuel Support Plate To Grid Welds	b (Limiting Case)	2113	9800	4.64
Base Truss Members (Buckling Coefficient)	b	0.89	1.0	1.12
	d	0.8	1.0	1.25
Base Truss To Flange Welds (Weld Size)	b	0.25" min.	0.32" act.	1.28
	d	0.28"	0.32"	1.14
Rack Base Flange (Buckling Coefficients)	b	0.70	1.0	1.43
	d	0.75	1.0	1.33

* Without thermal gradients compared to allowable @ 220°F

** With thermal gradients compared to allowable @ 150°F

*** Unless Otherwise noted

Location	Load Combination	Calculated*** Stress in PSI	Allowable*** Stress in PSI	Margin
North Pool Frame (Buckling Coefficients)	d (Limiting)	.561	1.0	1.78
North Pool Column to Base Beam Welds	d (Limiting)	14817	15680	1.06
North Pool Boss to Base Welds	d (Limiting)	12225	15680	1.28
North Pool Frame Hold-Down Bolts (Axial Stress)	d (Limiting)	49803	142200	2.86

Load Combination e (Dead Loads Plus Thermal Loads Plus Stuck Fuel Assembly)

Location	Calculated Stress in PSI	Allowable Stress in PSI	Margin
Fuel Can to Grid Welds	6668	15680	2.35

Load Combination f (Dead Loads Plus Thermal Loads Plus Fuel Assembly Drop)

See the response to question #9.

*** Unless Otherwise Noted

The maximum displacement at the top of the racks for the loading conditions considered was .0196 inches.

QUESTION NO. 5 Provide a detailed summary of the stresses and safety margins due to the increased loading of the fuel pool walls and floor for the critical load combinations. Discuss the possibility of shear failures in the areas of contact of the rack supports with the floor and walls. Compare numerically these results to those for the previous rack structure.

RESPONSE The increased number of spent fuel assemblies within the spent fuel pool necessitated an evaluation of the structural adequacy of the fuel pool walls and floor. The load combination considered in that evaluation was per U. S. Nuclear Regulatory Commission Standard Review Plan Section 3.8.3.II.3. The applicable code limits for load combinations included in this evaluation are noted below along with the allowable bearing stress for the pool surfaces:

Load Combination	Allowable Loads	Pool Bearing Stress KSI
1, 2, 1a & 2a	Allowable stresses of ACI 318-63	1.5
3, 4, 5, & 6	Ultimate strengths as per ACI 318-63	2.85

The south pool is the more critical of the two pools since the same reinforcement details are provided in each pool and the higher loads are available within the south pool. The computer program SAP was employed in the analysis of the south pool. The rack loads associated with a N-S Quake were determined to be limiting and were utilized in the evaluation. The additional pool side wall loads are due to the side restraint pads of the fuel rack which are located 6" above the pool floor slab. The additional shear loads due to the side loads were included in the evaluation. The attached table presents a comparison of the evaluation results and allowable loads.

SUMMARY OF RESULTS

NO.	STRUCTURAL SYSTEM DESCRIPTION	LOAD COMBINATION SRP 3.8.3.II.3	TOTAL STRESS/LOAD (INCLUDING RACK LOADS)	ALLOWABLE STRESS/CAPACITY
1	Pool Bottom Slab @ El. 607'-8"			
	SOUTH POOL			
	Bending Moments & Shear (K-FT) (KIPS)			
	A. Slab over Col. Row L support wall:			
	i. Moment for top steel-	2a	605	903
	ii. Moment for bottom steel-	2a	273	558
		6	454	1307
	iii. Shear-	2a	86	102
	B. Slab over Col. Row M support wall:			
	i. Moment for top steel-	2a	99	241
	ii. Moment for bottom steel-	2a	234	673
		6	495	1571
	iii. Shear-	2a	90	102
	C. Slab over middle support wall:			
	i. Moment for top steel-	2a	153	472
	ii. Shear-	2a	97	102
	D. Span Between Middle and Col. Row M support walls:			
	i. Moment for bottom steel-	2a	561	594
		6	965	1393

SUMMARY OF RESULTS

NO.	STRUCTURAL SYSTEM DESCRIPTION	LOAD COMBINATION SRP 3.8.3.II.3	TOTAL STRESS/LOAD (INCLUDING RACK LOADS)	ALLOWABLE STRESS/CAPACITY
2	Pool Vertical Walls above Elevation 607'-8" under horizontal loading			
	- Shear Stress (PSI)	2a	101	126
3	Bearing walls under the pool base slab:			
	i. Middle wall between Col. Rows L & M	2a	$\frac{fa}{Fa} + \frac{fb}{Fb} = .33$	$\frac{fa}{Fa} + \frac{fb}{Fb} \leq 1.0$
	ii. Wall @ Col. Row L	2a	$\frac{A_s}{bd}$ (req'd) = .002	$\frac{A_s}{bd}$ (provided) = .0031
	iii. Wall @ Col. Row M	2a	$\frac{A_s}{bd}$ (req'd)=.0015	$\frac{A_s}{bd}$ (provided) = .0031
4	Shear Walls			
	A. Walls @ Col. Rows L & M			
	i. Shear (KIPS)	6	5041	12189
	ii. Steel for flexure (IN^2)	2a	10.09	124.2
	B. Wall @ Col. Row 9			
	i. Shear (KIPS)	6	9330	17390
	ii. Stress in flexural steel (KSI)	2a	3.78	24

SUMMARY OF RESULTS

NO.	STRUCTURAL SYSTEM DESCRIPTION	LOAD COMBINATION SRP 3.8.3.II.3	TOTAL STRESS/LOAD (INCLUDING RACK LOADS)	ALLOWABLE STRESS/CAPACITY
5	Counterforts			
	i. Maximum toe pressure (PSI)	6	94.1	1677
	ii. Shear Stress (PSI)	6	61.4	107
6	Columns M-9 & L-9 Bellow Elevation 607'-8"			
	i. Bending moment (K-FT)	2a	612	1747
	ii. Axial Compression (KIPS)	2a	1898	2295

QUESTION NO. 6 It is our position that the strength limit for combinations (e) and (f) should be 1.5S.

RESPONSE Both the stuck fuel condition and the dropped fuel condition were considered to be abnormal conditions. Therefore, the 1.6S allowable was appropriate per the Standard Review Plan Section 3.8.4.

QUESTION NO. 7 Provide the details of the non-linear dynamic analysis of a single can and a single fuel assembly which was performed using the ANSYS computer program. Tabulate the shear force and bending moment which may occur at cricital sections of the can as a result of the fuel assembly impacting the can at the maximum velocity. Compare the results to the static case.

RESPONSE The non-linear dynamic analysis of a single fuel/can aseembly was performed using the model shown in Figure 5-4 of the licensing submittal (dated November 14, 1977). Several cases were run, using various values of friction and gap sizes. The worst case considered is with maximum floor friction (μ=0.65) and nominal rack-to-wall gap. The can loads for the non-linear ANSYS run are compared to the static case below:

	ANSYS	STATIC (SSE)
Moment @ top	23159 in. #	38092 in. #
Shear @ top	671 #	509 #
Moment @ bottom	33443 in. #	62335 in. #
Shear @ bottom	714 #	766 #

QUESTION NO. 8 Quantify the kinetic energy of a dropped rack module, and the energy absorption capacities of the rack bases and fuel pool floor for the case of a rack module impacting on either of these structures with its corner or edge. State the effects on the structural integrity of the rack base, and fuel pool liner and floor.

RESPONSE The new rack and baseplate module weights are considerably less than that of a shipping cask and, therefore, have less energy. During the initial baseplate and rack installation, no special precaution would be taken other than removal of all fuel from the pool.

For future rack addition with fuel in the pool redundant rigging (cables and hoists) would be utilized to limit overall energy to less than the energy assumed in the dropped rod analysis discussed in our response to Question No. 9.

QUESTION NO. 9

Discuss and quantify the local and gross effects on the rack modules, and fuel pool liner and floor for the following three cases of a dropped fuel assembly:

a. a straight drop on the top of a rack module

b. an inclined drop on the top of a rack module

c. a straight drop through a can with the fuel assembly impacting the bottom of the can

Include the kinetic energies and the height of drop considered for each of the three cases. In addition, consider the effects of the loading which will result from a fuel assembly sticking inside a can. (This loading is defined in ANSI Standard N210-197). The upward loading should be the binding load that could be generated by the maximum force the crane is allowed to exert on a fuel assembly.

RESPONSE

The maximum drop height of a fuel assembly above the top of the rack is 2 feet. There are two ways the falling fuel can impact the top of the rack. Either in the directly vertical position or in an indirect position which in the limit would be horizontal. In the case of a vertical drop or a drop at some inclined position other than horizontal, the bottom of the fuel assembly would strike first followed by the fuel assembly laying over on its side. In the horizontal position the whole side of the assembly could strike the rack at once. In either case, damage to the fuel rack would be of a local nature and would not affect the ability of the rack to maintain criticality control. Energy would be absorbed by bending of the lead-in guides and deformation of the fuel assembly.

It is also possible that the fuel assembly could fall into an empty or full storage location. The empty location would be worse than a full location since the amount of energy to be absorbed would be higher due to the greater drop height and there would be no energy absorbed by an in-place fuel assembly. Should the assembly fall into an empty storage location, the energy would be absorbed by fuel deformation and by deformation of the fuel support system at the bottom of the can.

The weight of a fuel assembly with a control rod is 1404 lb. The maximum drop distance to the support at the bottom of a storage location is 15.73 feet. Therefore, ignoring the hydraulic effect of water the maximum kinetic energy of a falling fuel assembly is 22100 ft-lb in a vacuum.

The 4000 lb upward force of a stuck fuel assembly has been considered along with other normal operating loads. The calculated stresses resulting from these operating loads were compared with allowable limits and found to be a factor of 2.35 below those limits.

QUESTION NO. 10 Compare the most severe temperature distribution used for the structural design of the fuel pool structure for both the original rack design and the new rack design.

RESPONSE Both the original and new fuel pool structural evaluations considered bulk boiling in the pool and an outside wall ambient temperature of $70^{\circ}F$.

QUESTION NO. 11 State clearly if temperature loading was considered for the case of a temperature gradient across a rack module (e.g., consider the case of an empty module with a full rack module on one side and an empty rack module on the opposite side).

RESPONSE The case of a single hot fuel storage location surrounded in the same rack module by cold storage location was considered. These separate locations were considered, a corner can, an edge can and an interior can. The constraint provided by surrounding cans makes this a worse thermal condition than a thermal gradient across an empty rack which has a full rack on one side and an empty rack on the opposite side.

QUESTION NO. 12 Provide the water chemistry which will be maintained in the spent fuel pool. Include the boron concentration, pH, chloride, fluoride and any heavy metal concentrations.

RESPONSE

Item	Normal Concentrations
Solution pH	Determined by concentration of boric acid present. Expected range is 4.0 to 4.7.
Boric Acid as ppm B	2100
Chloride	$<$0.15 ppm, maximum
Fluoride	$<$0.15 ppm, maximum
Makeup Water	Shall meet reactor coolant makeup water specifications.

QUESTION NO. 13

Describe the proposed qualification test program for the absorber plates. Discuss how the effects of temperature and radiation on the mechanical properties will be determined. Provide assurance that densification, settling, or stratification of the absorber material will not occur during service.

RESPONSE

As indicated in Reference (1), a boron carbide (B_4C) plate qualification test program was performed to verify the suitability of this material under the environmental conditions which may be found in spent fuel storage pools. These environmental conditions include both the expected irradiation from spent fuel and the abnormal loadings imposed by seismic events. To evaluate the behavior of the neutron absorber plates under these conditions, a three-phase program was performed.

1. physical property characterization
2. simulated seismic loading
3. irradiation

The neutron absorber plates used for the test program consisted of B_4C powder with a suitable binder formed and bonded into solid plates. In terms of composition, these plates were representative of the actual neutron absorber materials to be used in spent fuel racks.

These tests were completed in 1976 and confirmed the suitability of these plates for their intended use in spent fuel storage racks. A summary of the results of this test program is as follows:

A. <u>Irradiation Stability</u>

The plates were subjected to an exposure of 2×10^{11} rads using an electron beam. After irradiation, the coupons exhibited no visible surface degradation or dimensional changes (i.e., no swelling, physical distortion, etc.). After irradiation, the modulus of elasticity did not change significantly, and the modulus of rupture decreased by 50% from the unirradiated material, but remained well above that required to assure that the plates would not fracture during a seismic event.

B. <u>Seismic Testing</u>

A full scale half-length section of a fuel box assembly containing neutron absorber plates was subjected to loadings of up to 0.6 in three orthogonal directions over frequency spectrum of 7 to 33 Hz following the seismic qualification testing requirements set forth in IEEE-344. The purpose of this testing was to evaluate the wear, abrasion, and cracking propensity of the plates due to the absorber plate-fuel can interaction. The results demonstrated that an

QUESTION NO. 13
(Cont.)

insignificant (less than 0.5%) loss in plate mass in form of loose powder occurred after more than five OBE and one SSE simulation in each of the three directions over the entire frequency spectrum. There was no cracking or breakage of any plates observed during these tests.

C. Physical Properties Evaluation

The following tests were undertaken to verify that no deterimental effects occur from expected as well as abnormal environmental conditions in the spent fuel pool:

Test	Results
1. Resistance to extended exposure to water	No swelling, no significant loss of boron
2. Thermal cycling from room temperature to 305°F	No cracking, no change dimensions after sixteen cycles
3. Modulus of rupture, modulus of elasticity	Conservative with respect to values used for structural analysis of fuel racks

Other physical properties were evaluated, including compressive strength, coefficient of thermal expansion, void fracture, and izod impact strength; and no adverse characteristics were identified.

In summary, the above program has shown that B_4C neutron absorber material plates are suitable for use in typical spent fuel storage rack environment.

Reference (1) Docket 50-213 Letter D. C. Switzer (Connecticut Yankee Atomic Power Company) to R. A. Purple (US Nuclear Regulatory Commission), dated April 15, 1976.

QUESTION NO. 14 Using data during and following past refueling operations, identify the principal radionuclides and their concentrations in the spent fuel pool water found by gamma isotopic analysis and indicate the range of the resulting surface radiation levels at the pool center and pool edge. Specify the expected concentrations of these radionuclides and the expected radiation levels during and following a refueling as a result of the modification.

RESPONSE The principle radionuclides and their concentrations are Cobalt 60 and Cesium 137 at 6.85×10^{-3} and 1.32×10^{-3} µc/ml respectively.

The resulting surface radiation levels at the pool center and pool edge range from 10 to 15 mr/hr.

No increase in radionuclide concentration and radiation levels is anticipated as a result of this modification. Operating experience at fuel stroage facilities such as Morris, Illinois, has shown no significant increase in radiation due to long term, increased storage.

QUESTION NO. 15 It is stated on page 3-3 of the submittal that the old spent fuel racks in the South Pool will be cleaned, disassembled and shipped offsite. Demonstrate that the occupational exposure for this disposal method is as low as reasonably achievable (10 CFR Part 20.1(c)) as compared to alternative methods (e.g., crating and shipping intact racks). Include the estimated number of workers, occupancy times and the dose rates associated with each phase of the operation in each comparison.

RESPONSE Presently, several alternatives for old rack cleaning and disposal are being evaluated including the new electrodecon process developed by BNWL at the Hanford site.

The basis for this ongoing evaluation is demonstration that the occupational exposure for the selected disposal method will be as low as reasonably achievable.

QUESTION NO. 16

Explain in detail the model referred to on page 7-1 of the submittal used to calculate an increase in dose rate of 35.7 mrem/hour and 25.3 mrem/hour five feet above the water surface at the pool center and pool-side, respectively, due to the proposed SFP modification. Discuss if these increases in the dose rate are during or following a refueling. Provide any conservatism used in the model. These dose rates with these increases are an order of magnitude greater than those reported at the same locations by other licensees performing the same modification. Explain why such higher dose rates if expected, are acceptable.

RESPONSE

The model referred to on page 7.1 of the submittal was a material balance of activity in the pool water considering input of fission products from leaking failed fuel and input of corrosion products from the surface of fuel placed in the pool during each refueling. Removal mechanisms considered were purification and decay. The activity concentrations were normalized to the pool activity observed at Kewaunee during the first few months after the first refuelint, and this normalized source term was used to project the activity following subsequent refuelings.

For conservatism, the purification removal constant was neglected in making the pool water activity level and subsequent dose rate calculations reported on page 7.1. This unrealistically predicts significant buildup of Co^{60} with time and neglects the effects of routine purification, filtration, and pool vacuum cleaning measures which are a part of normal housekeeping. Experience at plants which have much more spent fuel storage experience than Kewaunee, and particularly at the GE Morris facility where only "aged" fuel is stored, has demonstrated that such "aged" fuel contributes a negligible quantity of radioactivity to the pool during one refueling. Therefore, it is concluded that the pool activity and the dose rates 5 feet above the pool and at pool side will not increase as a result of this modification, as was indicated in the licensing submittal.

QUESTION NO. 17 Your submittal indicates that personnel exposures due to refueling operations would be 3 man-rem. Provide the calculations used to predict this man-rem burden including dose rates, occupancy factors and numbers of personnel involved. Discuss what fraction this man-rem exposure represents of the total annual exposure expected from all operations in the spent fuel area.

RESPONSE The three man-rem exposure is based on experience during previous refuelings and is based, therefore, on record rather than calculation. Additionally, this exposure represents the greatest part of the total exposure expected from all operations in the spent fuel area. As stated in our licensing submittal (dated November 14, 1977), the balance of operations in this area is related to periodic radiological and chemical sampling.

The average exposure from refueling operation is 300 mr per person.

QUESTION NO. 18

The present modification calls for the immediate installation of four high density racks in the south pool and three high density racks in the north pool after removal of the low density racks. Four additional high density racks will also be added to the south pool at a later date. Compare the man-rem exposures for the proposed stepwise pool modification and for the complete modification at one time. Show that your proposed course of action is consistent with the ALARA philosophy of 10 CFR 20.1(c). Provide the radionuclide concentrations and dose rates, number of personnel that will be involved, the occupancy factors, etc., expected for each step of the proposed modification.

RESPONSE

As there is no anticipated increase in radionuclide concentrations and resulting radiation levels and since no in-pool (diver) work will be necessary during the installation of the last four racks, man-rem exposures for the proposed stepwise pool modification will be the same as that for performing the whole modification at one time. Giving consideration to government estimates of off-site fuel storage availability in 1985, and our current schedule for final rack addition in the late 1980's, the last increment of man-rem exposure may not be necessary.

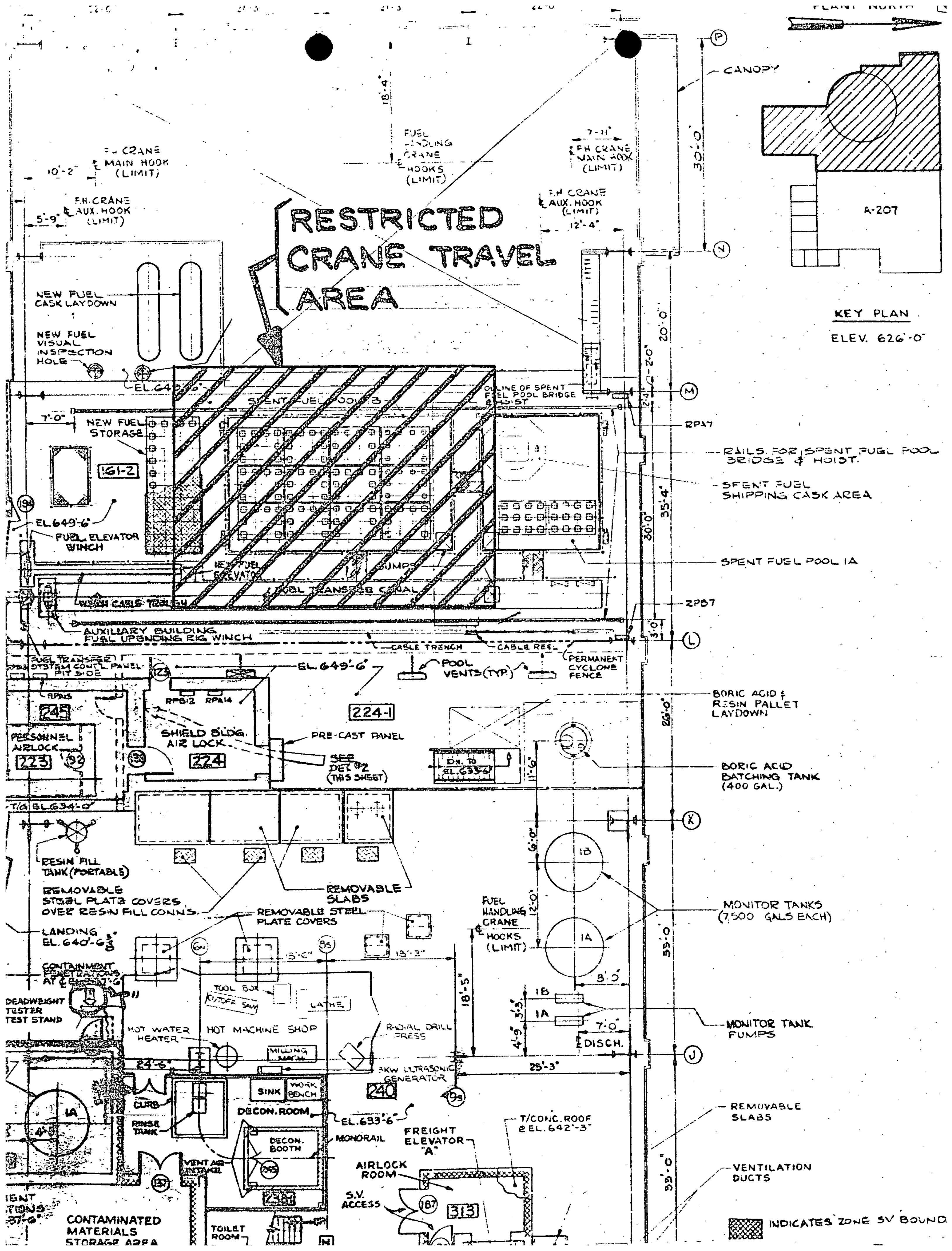
Refer to Table 3-1 of our licensing submittal (dated November 14, 1977) for typical dose rates, number of personnel involved and occupancy factors.

QUESTION NO. 19 Provide a list of representative loads that might be allowed near or over the spent fuel pool. Provide the gross weight and dimensions (height and horizontal area) of each of these loads as rigged and suspended. Discuss the load transit paths, including which of these loads must be carried over the pool, the maximum height at which they could be carried and the expected heights during transfer. Provide a description of any written procedures instructing crane operators about loads allowed to be carried near or over the pool. Provide the number of spent fuel assemblies that could be damaged by dropping each representative load carried over the pool.

RESPONSE Proposed Amendment No. 31 to the Kewaunee Technical Specifications states "Heavy loads greater than the weight of a fuel assembly will not be transported over or placed in either spent fuel pool when spent fuel is stored in that pool. Placement of additional fuel storage racks is permitted, however, these racks may not traverse directly above spent fuel stored in the pools".

The response to question No. 8 details the precautions to be taken when racks are installed with fuel in the pool.

The attached sketch depicts existing crane corridor and restricted areas of travel.



PLANT NORTH
CANOPY
KEY PLAN
ELEV. 626'-0"
A-207
RESTRICTED CRANE TRAVEL AREA
F.H CRANE MAIN HOOK (LIMIT)
F.H. CRANE AUX. HOOK (LIMIT)
FUEL HANDLING CRANE HOOKS (LIMIT)
NEW FUEL CASK LAYDOWN
NEW FUEL VISUAL INSPECTION HOLE
EL. 649'-6"
NEW FUEL STORAGE
161-2
FUEL ELEVATOR WINCH
SPENT FUEL POOL B
OUTLINE OF SPENT FUEL POOL BRIDGE & HOIST
NEW FUEL ELEVATOR
SUMPS
FUEL TRANSFER CANAL
WINCH CABLE TROUGH
AUXILIARY BUILDING FUEL UPENDING RIG WINCH
CABLE TRENCH
CABLE REEL
PERMANENT CYCLONE FENCE
RPA7
RAILS FOR SPENT FUEL POOL BRIDGE & HOIST.
SPENT FUEL SHIPPING CASK AREA
SPENT FUEL POOL 1A
RPB7
FUEL TRANSFER SYSTEM CONT. PANEL PIT SIDE
POOL VENTS (TYP.)
224-1
RPB12
RPA14
245
PERSONNEL AIRLOCK
223
SHIELD BLDG. AIR LOCK
224
PRE-CAST PANEL
SEE DET #2 (THIS SHEET)
DN. TO EL. 633'-6"
BORIC ACID & RESIN PALLET LAYDOWN
BORIC ACID BATCHING TANK (400 GAL.)
T/G EL. 634'-0"
RESIN FILL TANK (PORTABLE)
REMOVABLE STEEL PLATE COVERS OVER RESIN FILL CONNS.
REMOVABLE SLABS
REMOVABLE STEEL PLATE COVERS
LANDING EL. 640'-6 3/8"
CONTAINMENT PENETRATIONS AT EL. 637'-6"
DEADWEIGHT TESTER TEST STAND
FUEL HANDLING CRANE HOOKS (LIMIT)
1B
1A
MONITOR TANKS (7,500 GALS EACH)
TOOL BOX
CUTOFF SAW
LATHE
HOT WATER HEATER
HOT MACHINE SHOP
RADIAL DRILL PRESS
MILLING MACH.
MONITOR TANK PUMPS
DISCH.
3KW ULTRASONIC GENERATOR
240
SINK
WORK BENCH
CURB
RINSE TANK
DECON. ROOM
EL. 633'-6"
DECON. BOOTH
MONORAIL
FREIGHT ELEVATOR "A"
T/CONC. ROOF @ EL. 642'-3"
REMOVABLE SLABS
VENT AIR INTAKE
AIRLOCK ROOM
S.V. ACCESS
187
313
VENTILATION DUCTS
CONTAMINATED MATERIALS STORAGE AREA
TOILET ROOM
INDICATES ZONE SV BOUND

QUESTION NO. 20 Provide the basis for your statement on page 7-2 of the submittal that the modified racks are designed so that the drop of a fuel assembly or handling tool will not cause damage to any fuel assembly in a storage location.

RESPONSE See answer to question number 9. The lead in portion of the rack will absorb the kinetic energy of a dropped fuel assembly hitting the fuel cell and prevent deforming of the rack to the extent that the k_{eff} is changed. The consequence of the drop of a fuel assembly directly onto a stored fuel assembly will be no more severe than that before the modification. Therefore, the dropped fuel assembly analysis in Section 14 of the FSAR remains valid.

QUESTION NO. 21 For past operations provide the normal frequency for replacing the SFP filter and demineralizer, the normal flow through them during and after refueling outages and the expected solid wastes (volume and radioactivity) generated by them.

RESPONSE Approximately ten filter elements are disposed of annually as low level waste. Approximately one demineralizer resin charge ($\approx$25 cubic feet) is disposed of annually. As various plant resins are mixed prior to drumming, specific level of activity due to the Spent Fuel Pool Demineralizer resin is not known but estimates indicated that it represents less than 5% of the total wastes generated by resins.

Normal flows through these components during and following refueling outages are 450 gpm through the filters and 60 gpm through the demineralizer.

QUESTION NO. 22 Provide the maximum incremental heat load that will be added on the spent fuel cooling system by increasing the storage capacity of spent fuel from 168 to 990 assemblies.

RESPONSE

Heat Generation Rates In The Kewaunee Spent Fuel Pool

Fuel Cycle Number	Year Loaded Into Pool	Normal Refueling Heat Loads		Core Offloaded Heat Loads	
		Number of Assemblies In Cycle	Heat Generation Rates BTU/hr	Number of Assemblies In Cycle	Heat Generation Rates BTU/hr
1	1976	32	1.16 + 4	32	1.14 + 4
2	1977	48	3.70 + 4	48	3.63 + 4
3	1978	41	5.14 + 4	41	5.03 + 4
4	1979	40	5.72 + 4	40	5.59 + 4
5	1980	40	5.86 + 4	40	5.72 + 4
6	1981	41	6.14 + 4	41	6.00 + 4
7	1982	40	5.74 + 4	40	5.59 + 4
8	1983	40	5.90 + 4	40	5.74 + 4
9	1984	41	6.24 + 4	41	6.05 + 4
10	1985	40	6.29 + 4	40	6.08 + 4
11	1986	40	6.54 + 4	40	6.29 + 4
12	1987	41	7.02 + 4	41	6.71 + 4
13	1988	40	7.26 + 4	40	6.85 + 4
14	1989	40	7.77 + 4	40	7.26 + 4
15	1990	41	8.76 + 4	41	7.96 + 4
16	1991	40	9.67 + 4	40	8.54 + 4
17	1992	40	1.16 + 5	40	9.67 + 4
18	1993	41	1.53 + 5	41	1.18 + 5
19	1994	40	2.12 + 5	40	1.49 + 5
20	1995	40	3.39 + 5	40	2.12 + 5
21	1996	41	6.62 + 5	41	3.47 + 5
22	1997	40	6.71 + 6	40	6.30 + 5
23	1998	--	--	121	1.65 + 7
Totals		887	9.18 + 6	1008	1.90 + 7

QUESTION NO. 23 Provide the maximum increase in the spent fuel pool outlet water temperature due to this incremental heat load, and provide the length of time after the final refueling that the spent fuel pool outlet water temperature will be above 120°F.

RESPONSE No increase in spent fuel pool outlet water temperature is anticipated due to the incremental heat load from normal refuelings. Additionally, exceeding 120°F is not expected except possibly in the case of a full core off load.

QUESTION NO. 24 State whether the residual heat removal system (RHR) would normally be relied upon to cool the spent fuel pool after a full core offload.

RESPONSE The Residual Heat Removal System would be available to assure not exceeding the maximum design temperature in the case of a full core offload. Use of the Residual Heat Removal system would be dependent on the specific schedule of the full core offload refueling.

QUESTION NO. 25 Describe the procedure that would be used for aligning the RHR system to provide spent fuel pool cooling.

RESPONSE The RHR heat exchanger is connected to the spent fuel pool cooling system with spectacle flanges and isolation valves. In the event of a need to use this heat exchanger, the appropriate valve lineup will be made.

Reference Figure 9.3-4 of the Kewaunee Final Safety Analysis Report.

QUESTION NO. 26 Describe the available sources of spent fuel pool makeup water in the event of water loss following an SSE or other emergency. Include both the safety classifications of these makeup systems and the possible flow rates to the spent fuel pool.

RESPONSE Figure 9.3-4 of the Kewaunee FSAR shows the normal water sources to the spent fuel pool and the emergency water supply. Safety classifications of the systems providing water to the spent fuel pool cooling system and the pool itself were designed to safety class I.

Six inch emergency service water supply	>1000	GPM available
Boric acid addition line	≈ 40	GPM available
Reactor makeup water line	≈ 95	GPM available