ENCLOSURE 1

APPLICATION FOR AMENDMENT TO OPERATING LICENSE

Supplemental Spent Fuel Safety Analysis

Consolidated Edison Company of New York, Inc.
Indian Point Unit No. 2
Docket No. 50-247
Facility Operating License No. DPR-26
November, 1985

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1. SUMMARY

A detailed nuclear analysis has been completed for the existing spent fuel storage racks at the Indian Point Generating Station Unit No. 2 (IP2). The objective of this analysis was to demonstrate that the existing spent fuel storage racks can safely store unirradiated 15X15 Westinghouse fuel assemblies with initial enrichment of up to 4.3 w/o U-235, provided the fuel is loaded as specified in Section 4.0 of this report. It should be noted that this analysis is for the spent fuel racks which are currently in place and that no hardware or material changes are proposed.

The analysis was performed assuming selective loading of unirradiated fuel with enrichments up to 4.3 w/o U-235 in a checkerboard manner. This analysis takes credit for fuel depletion in the calculation of the fuel/rack reactivity state. In order to store unirradiated fuel with enrichments up to 4.3 w/o U-235, certain conditions must be met. These include the requirement that the storage cells adjacent to the four faces of the cell designated for the higher enrichment fuel must contain irradiated fuel which has accumulated a specific burnup or non-fuel material. The burnup level depends on the initial enrichment of the fuel assemblies. In this manner the reactivity of the assembly array is limited by restricting the allowable reactivity of cell contents directly adjacent to new fuel assemblies with initial enrichments of up to 4.3 w/o U-235.

The analysis contained in this report is intended to supplement the previous criticality analysis which supported the license amendment for the existing spent fuel storage racks[1]. In the previous analysis the principal method of calculation used to determine the k_{eff} of the Indian Point 2 (IP2) spent fuel storage racks was the Monte Carlo Code KENO IV[2] with 123 energy group cross sections from the XSDRN library using the AMPX[3] module NITAWL. In the present analysis the exposure level as a function of initial fuel enrichment for irradiated fuel was determined with an explicit PDQ-7[4] model. Macroscopic cross sections for the PDQ-7 model as a function of enrichment and burnup were developed with CASMO-2E[5]. A CASMO fuel rack model was developed and benchmarked against the reference KENO-IV calculation.

The best estimate k_{eff} determined from this analysis is .906. Adding variations in k_{eff} of 0.010 due to normal configuration changes, calculational uncertainties, and "worst case normal and abnormal conditions" determined from Reference 1, k_{eff} becomes .916 . It was conservatively assumed that the uncertainties in the burnup dependent isotopics contribute another .02 (see Section 5.4) to the k_{eff} of the system resulting in a k_{eff} of .936 . This value meets the criticality design criterion of $k_{eff} \leq .95$ and is substantially below 1.0. It was therefore concluded that the spent fuel storage racks, when loaded with fuel as specified in Section 4.0 of this report, are safe from a criticality standpoint.

2. INTRODUCTION

The existing spent fuel storage racks utilize four borated stainless steel sheets mechanically affixed to the outer walls of each individual storage cell to control reactivity. The general arrangement of the racks and the individual cell configurations are described in Section 3.

The nuclear analysis described in this report demonstrates that with fuel loaded as specified in Section 4.0 fuel assemblies with enrichments up to 4.3 w/o U-235 can be stored with the k_{eff} of the system conservatively calculated to be less than 0.95. The analysis is based on conservative assumptions with respect to pool water temperature and conditions, fuel geometry, etc. In addition to the reference configuration, a fuel misloading incident was also analyzed. In this case, it was assumed that the fuel racks were completely loaded with unirradiated fuel with enrichment of 4.3 w/o U-235 and the k_{eff} of the fuel racks without soluble boron in the pool water was determined.

The following sections of this report describe the general arrangement of the existing fuel storage racks, methods for criticality analysis, results of the calculations and benchmarking of the methods.

3. GENERAL ARRANGEMENT AND CONFIGURATION OF THE EXISTING SPENT FUEL STORAGE RACKS

The general arrangement of the existing spent fuel storage racks at IP2 have been described previously(1) and a brief description is included herein to aid the reader in interpreting the results of the current analysis. As shown in Figure 3.1, five sizes of fuel storage racks with 8X8, 8X9, 8X10, 9X10, and 10X10 storage cell arrays are used at IP2. The total number of fuel storage locations provided by these racks is 980.

As shown in Figure 3-2, each individual storage cell is made up of a square tube of Type 304 stainless steel with nominal thickness of 0.0825 inches and an inner dimension of 9.0 inches, nominal. On the outer face of each of the four sides of each square tube, is affixed a plate of borated stainless steel containing 1.1 w/o boron (nominal) for criticality control. The borated stainless steel sheet is 0.100 inch thick, seven inches wide, and 145 inches long, and is positioned in a central location on the outer wall of each storage cell. Welded spacers are used to maintain a cell center spacing of 10 15/16 inches.

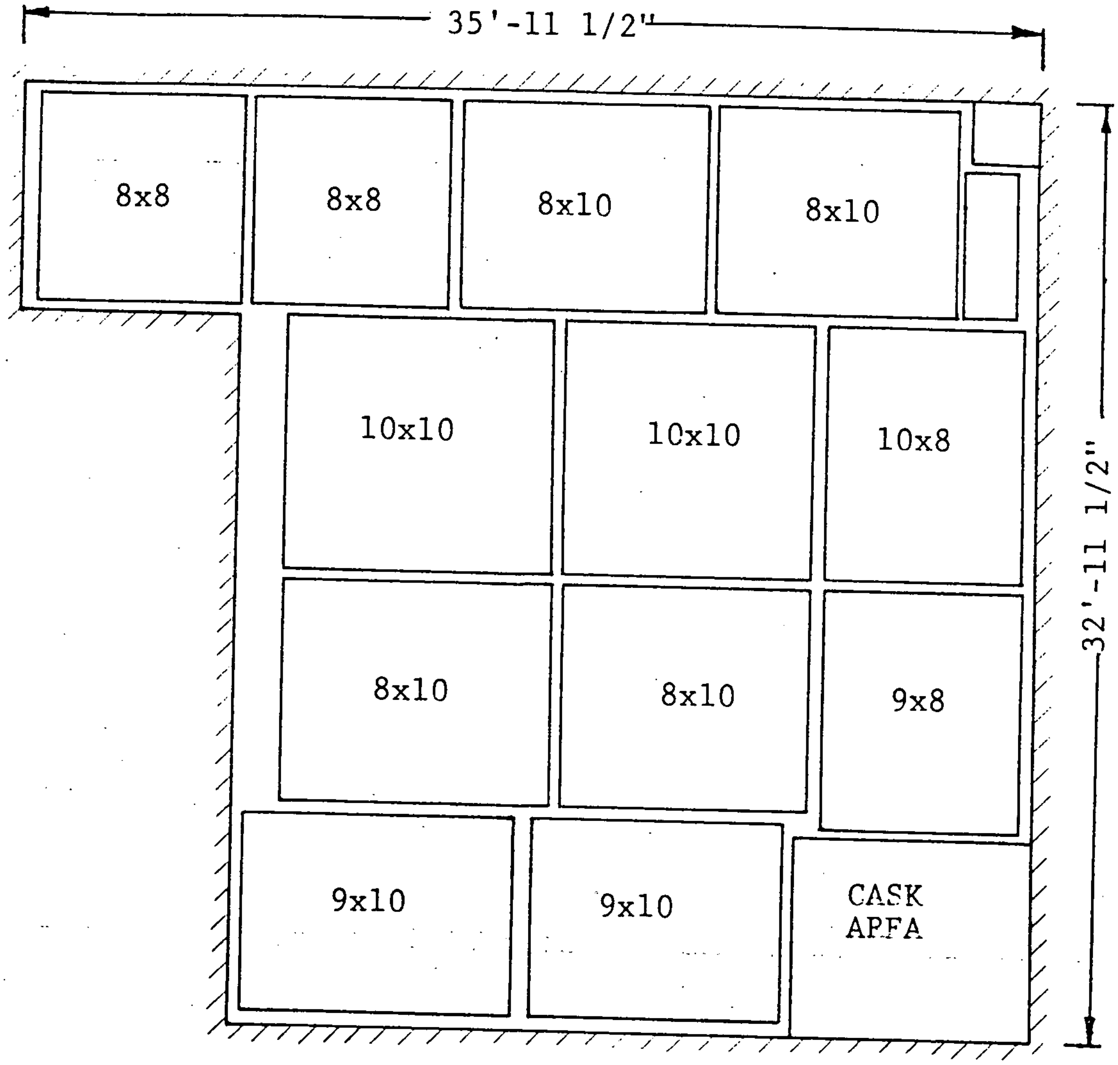

FIGURE 3-1

INDIAN POINT 2 SPENT FUEL STORAGE POOL: SPENT FUEL STORAGE RACK ARRANGEMENT

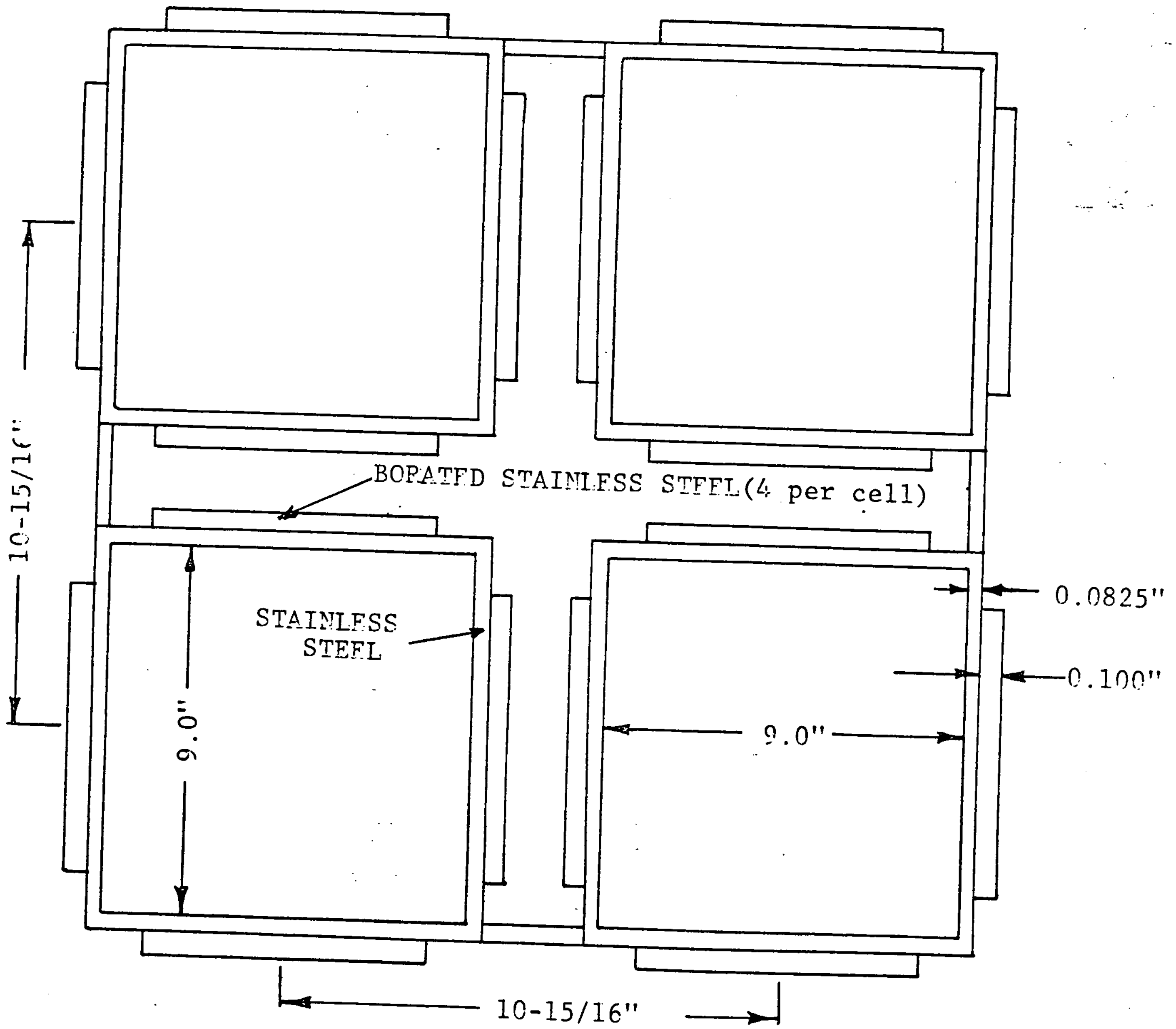

FIGURE 3-2

INDIAN POINT UNIT NO. 2
SPENT FUEL STORAGE CELL CONFIGURATION

4. FUEL STORAGE CONFIGURATION

The nuclear analysis which supports the existing Plant Technical Specifications (Reference 1) demonstrates that fuel with initial enrichments of up to 3.5 w/0 U-235 and zero exposure can be safely stored in all storage cells of the existing IP2 spent fuel storage racks. That analysis is based on the assumption of an infinitely repeating array of 3.5 w/o U-235 assemblies in the x-y directions.

In order to increase the enrichment of fuel which can be stored in the existing spent fuel storage racks, two categories of fuel are defined, category A and category B. Category A fuel is defined as having combinations of initial fuel enrichment and exposures above and to the left of the curve in Figure 4-1. Category B fuel is defined as having initial fuel enrichment and corresponding exposures below and to the right of the curve in Figure 4-1 as represented by the cross-hatched portion. In order to store category B fuel in the spent fuel storage racks, category A fuel must have previously been loaded into the racks in a checkerboard fashion with the intermediate storage cells reserved for category B fuel. Alternatively, the locations designated for Category A fuel may be left vacant or occupied by non-fuel materials. In this manner, the reactivity of the assembly array is limited by requiring that the reactivity of the cell contents directly adjacent to Category B assemblies be less than or equal to the reactivity of depleted fuel (Category A).

The supplemental nuclear analyses described in this report are the basis for the constant rack reactivity curve shown in Figure 4-1.

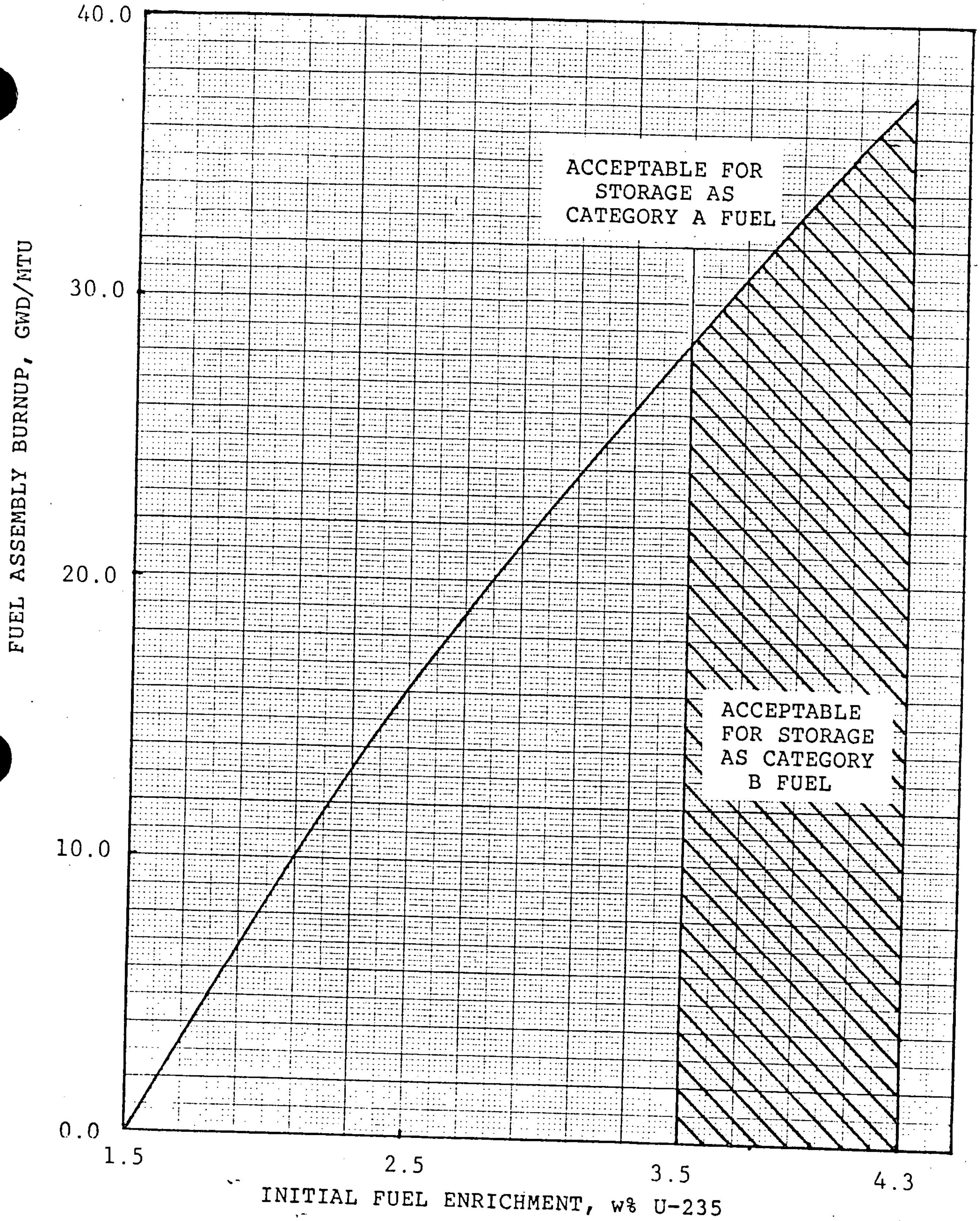

FIGURE 4-1

LIMITING FUEL BURNUP VERSUS INITIAL ENRICHMENT

CATEGORY A - AREA ALONG THE CURVE AND ABOVE
CATEGORY B - AREA BELOW THE CURVE AND 3.5<ε≤4.3 w% U-235

5. NUCLEAR CRITICALITY ANALYSIS

5.1 NUCLEAR DESIGN BASIS, ASSUMPTIONS AND METHODS

To assure that the k_{eff} of the IP2 spent fuel racks is less than 0.95 when fully loaded with fuel, the maximum enrichment permitted is 4.3 w/o U-235 for unirradiated fuel provided the fuel is loaded as specified in Section 4.0. With all uncertainties included, there is a 95% probability at a 95% confidence level that the effective multiplication factor is less than .95 as recommended in ASNI N210-1976 and the NRC document "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications" (6).

The analysis which has been performed utilizes the following conservative assumptions in demonstrating that the design basis has been met:

1. The pool water was conservatively assumed to have a density corresponding to 68°F.
2. Soluble boron in the pool water is ignored.
3. Neutron absorption in the fuel assembly grid spacers is ignored.
4. No credit is taken for burnable poison fixtures.
5. The analysis assumes that the fuel and rack array are infinite in the axial and lateral directions.

6. The 15 X 15 fuel assembly is assumed to be of the Westinghouse 15 X 15 LOPAR design (Zircaloy guide tubes) which is a more reactive assembly than the HIPAR (stainless steel guide tubes) fuel design.

In addition, the present analysis is intended to be an extension of the reference analysis(1). The present analysis assesses the trade-off of fuel enrichment in one half of the fuel storage locations against fuel depletion and/or enrichment in the other one half of the fuel storage locations. The reference analysis(1) has been performed for the IP2 racks fully loaded with unirradiated fuel with a maximum enrichment of 3.5 w/o U-235. For the purpose of the current analysis, the following are assumed to apply:

1. Uncertainties in k_{eff} attributable to rack dimensional variations, fuel assembly tolerances, boron concentrations and thickness variations, etc. from the previous reference calculations apply to the present analysis.
2. The model biases and uncertainties for the reference calculations apply to the present analysis.
3. The effect of "worst case" normal configurations and eccentricity on fuel/rack reactvity from the reference analysis apply.
4. Conclusions with respect to abnormal configurations

developed in the reference analysis apply.

In addition, in the present analysis it is conservatively assumed that uncertainties in the reactivity of the depletion dependent fission products and other isotopics introduce an additional uncertainty in the rack k_{eff} of 0.02 as discussed in Section 5.4.

The methods utilized in the present analysis include the use of CASMO-2E and PDQ-7 to assess the trade-off of initial fuel enrichment versus fuel depletion. A CASMO-2E model of the IP2 fuel and rack was utilized to 1) serve as a completely independent benchmark calculation against the reference analysis and 2) provide macroscopic cross sections for the non-fuel (rack structure, poison and water exterior to the fuel assembly) for use in a PDQ-7 model of the rack and fuel. Depletion dependent macroscopic cross sections as a function of initial fuel enrichment were developed with a 1/8 assembly CASMO model of the IP2 fuel assembly. Using the depletion dependent isotopics from this model a series of restart calculations in the cold condition with no xenon or soluble boron were performed to provide fuel macroscopic cross sections as a function of initial fuel enrichment and burnup. These cross sections were subsequently used as input to a 4-1/4 assembly PDQ model to determine, iteratively, fuel burnup as a function of initial enrichment which provides a constant rack k_{eff}. A detailed description of the models is contained in Section 5.2.

5.2 FUEL/RACK MODELS AND METHODS OF ANALYSIS

5.2.1 Reference Fuel Assembly Design Parameters

All models described subsequently are based on the Westinghouse 15 X 15 LOPAR fuel assembly. This assembly is characterized by a 15 X 15 array of fuel rods with 20 rods replaced with control rod guide tubes and the central rod replaced with an instrumentation thimble. Table 5-1 summarizes the IP2 fuel design parameters.

5.2.2 CASMO Fuel Rack Model

A CASMO fuel/rack model--in which all fuel assembly components, rack structure, inner and outer water gaps and poison are represented explicitly--was developed and is shown in Figure 5-1. It should be noted in Figure 5-1 that a limitation in the existing version of the CASMO program is that the borated stainless steel must be assumed to completely cover the face of the square stainless tube of the storage cell. The borated stainless steel on IP2 racks does not completely cover the face of the tube as shown in Figure 3-2. The effect of this additional borated stainless steel was accounted for by subsequent PDQ-7 calculations.

The purpose of the CASMO rack model is two-fold. First, calculation of the fuel/rack reactivity with initial fuel enrichment of 3.5 w/o serves as a benchmark of the CASMO method and cross sections against the reference KENO-IV calculation. Second, the model provides macroscopic cross sections for the water regions, borated stainless steel and stainless steel structure for subsequent use in a PDQ model. In this respect, the H factor option available in CASMO-2E was used to develop transport corrected cross sections in the borated stainless steel rack regions for PDQ. By using the H-factor option in CASMO, the macroscopic absorption cross sections are adjusted so that the k_{eff} of the PDQ diffusion theory calculation matches the k_{eff} provided by the transport theory (CASMO) calculation. CASMO first completes the transport calculation and then performs a series of diffusion theory calculations (DIXY) which are identical to those performed by PDQ. During each subsequent DIXY calculation, the macroscopic absorption cross sections in the borated stainless steel are adjusted until the k_{eff} of the DIXY calculation matches the transport calculation. In this manner, the diffusion theory bias (generally a 2-3% underprediction of k_{eff} in regions containing black absorbers) is eliminated and the diffusion theory calculation is normalized to the more exact transport theory calculation. The accuracy of this method has been demonstrated via CASMO and PDQ benchmark calculations for many critical experiments(7) as well as for operating cores with control rods(8).

5.2.3 CASMO Fuel Assembly Model

In order to generate macroscopic cross sections as a function of initial fuel enrichment and fuel assembly exposure, a 1/8 assembly CASMO model was used. In this model all fuel rods, guide thimbles and the narrow water gap between assemblies are represented explicitly as shown in Figure 5-2. The model was depleted at hot full power reactor conditions and isotopic concentrations were retained at various burnup steps. The procedure was repeated several times for fuel assembles with initial enrichments over the range of 1.5 to 4.3 w/o U-235. Subsequently, using the isotopic concentrations as a function of exposure so developed, restart calculations were performed at cold zero power conditions with zero xenon and zero soluble boron. These restart calculations provide fuel assembly average macroscopic cross sections for the fuel regions in the PDQ model.

5.2.4 PDQ-7 Fuel/Rack Model

In order to assess the trade-off between fuel enrichment in one half of the assemblies stored in the fuel rack against fuel depletion and/or enrichment in the other half of assemblies, a 4-1/4 assembly and rack model was used. This model is shown in Figure 5-3. All regions of the rack structure, borated stainless steel and water gaps are represented explicitly. The spatial mesh distribution in the PDQ model is identical to that in the CASMO rack model consistent with the use of the H factor option described previously. Macroscopic cross sections for the water gaps, rack structure and poison were developed using the CASMO rack model described previously. Fuel assembly macroscopic cross sections from the CASMO 1/8 assembly calculations were used in the PDQ fuel regions.

The PDQ model was first applied to determine the fuel rack reactivity with two 1/4 assemblies containing fuel of initial enrichment of 4.3 w/o U-235 (zero burnup) and two 1/4 assemblies at a lower enrichment of 1.5 w/o U-235 (zero burnup). Subsequently, the 1.5 w/o fuel was replaced with fuel of intermediate enrichments which had achieved some level of exposure. The exposure (i.e., fuel macroscopic cross sections) were varied iteratively until the k_{eff} of the rack with irradiated fuel matched the k_{eff} of the rack with two 1/4 assemblies at 4.3 w/o U-235 at 0 GWD/MTU and two 1/4 assemblies at 1.5 w/o U-235 at 0 GWD/MTU. This process was repeated as a function of initial enrichment to develop a curve of fuel assembly exposure _versus_ initial enrichment as shown in Figure 4-1. The curve in Figure 4-1 represents constant rack reactivity with 4.3 w/o U-235 fuel at zero burnup loaded in 1/2 of the rack locations and category A fuel in the other half of the locations.

5.3 RESULTS OF THE CRITICALITY ANALYSIS

5.3.1 _CASMO and PDQ-7 Reference Calculations_

For the reference condition with 3.5 w/o U-235 fuel assemblies loaded in all locations, the CASMO fuel rack model provides a k_{eff} of .924. As discussed previously, the CASMO model is not an exact representation of the IP2 fuel racks owing to the additional borated stainless steel on the faces of the rack structure of the CASMO model which is not in the IP2 racks. To determine the reactivity worth of the additional borated stainless steel in the CASMO calculation the following multi-step procedure was adopted. A PDQ-7 model of the IP2 rack was used which exactly duplicated the geometry of the CASMO model. Using macroscopic fuel cross sections developed as described previously and uncorrected (i.e., uncorrected by the H-Factor) macroscopic cross sections from the CASMO rack calculations for the rack structure, poison and water slot regions , a k_{eff} of .897 was calculated. Using the H Factor option in CASMO, the macroscopic absorption cross sections in the borated steel were adjusted to preserve k_{eff} in the CASMO/PDQ models. The H Factor corrected cross sections when used in the PDQ-7 model provide a k_{eff} of .923. The difference between the uncorrected and H Factor corrected PDQ calculations of 0.026 in k_{eff} represent the bias in the diffusion theory calculation.

The final step in determining the worth of the extra borated stainless steel in the CASMO model was to develop an explicit rack model for PDQ-7 which correctly accounted for the actual poison width in the IP2 racks. The PDQ-7 k_{eff} for 3.5 w/o fuel using this model is 0.935. It was therefore concluded that the correction to be applied to the CASMO model is .935-.923 or 0.012.

When this correction of 0.012 for the additional poison, not present in the IP2 racks, is applied to the CASMO-2E calculated k_{eff} of .924, a best estimate k_{eff} of .936 is obtained. This can be compared with the k_{eff} from the reference KENO IV calculation[1] for the IP2 fuel racks of 0.933 +/- 0.006. The agreement between the transport theory and Monte Carlo calculation serves to demonstrate the accuracy of the methods.

5.3.2 PDQ-7 Fuel/Rack Calculations with Depleted Fuel

Using the 4 - 1/4 assembly rack model shown in Figure 5-3, the rack k_{eff} with 2 - 1/4 fuel assemblies at 4.3 w/o U-235 and 2 - 1/4 assemblies at 1.5 w.o U-235, (all fuel at zero burnup) was determined to be 0.906. Using this point as the reference case, fuel with higher initial enrichments and which had experienced some burnup was substituted in the model for the 2 - 1/4 assemblies at 1.5 w/o U-235. In all subsequent calculations, 2 - 1/4 assemblies remained at 4.3 w/o U-235 (unirradiated). The burnup of this fuel was varied until a rack k_{eff} of .906 was obtained. Using this procedure, the specific exposure for a fuel with a given initial enrichment was determined such that the rack k_{eff} is constant. Table 5-2 contains the exposure level for fuel assemblies with initial enrichments greater than 1.5 w/o

U-235 which provide the same rack reactivity as the 1.5 w/o U-235 case at zero burnup. These analyses are the basis for the curve shown in Figure 4-1 which defines the category A fuel type.

5.4 MODEL UNCERTAINTIES, BIASES, AND CONSERVATISMS

As part of the reference calculations[1], the following variation in k_{eff} for the normal configuration were determined:

	Δk_{eff}
Eccentric fuel configuration	0.004
Enrichment variations	0.000(max used)
Cell pitch	0.0013
Cell wall thickness	0.0003
Poison concentration	0.004
Poison sheet thickness	0.0013
Storage cell inside dimension	0.006
Statistical uncertainty in KENO	0.006

Combining the preceding normal variations statistically (root mean square sense), the total variation in k_{eff} was found to be +/- 0.010. Variations in k_{eff} due to water temperature increase were found to be negative.

Furthermore, changes in k_{eff} caused by a single storage cell displacement, fuel handling accident, fuel drop accident, heavy object drop and seismic incident were found to be neglible. Benchmarking of KENO-IV to critical experiments showed the calculated k_{eff} values to be greater than the experimental values so that the KENO-IV calculations are conservative. It was therefore assumed that the bias in the KENO reference calculation was zero. When total variations in k_{eff} of +0.01 was added to the k_{eff} calculated with KENO-IV, .933, the k_{eff} of the IP2 rack was 0.943.

For the present analysis, it is assumed that the variations in k_{eff} are the same as in the reference analysis. As in the reference analysis and as discussed in Section 5.6, the model bias is also conservatively assumed to be zero. In lieu of benchmarking analysis of depleted fuel, the uncertainty in burnup dependent isotopics are conservatively assumed to contribute +0.02 to the calculated k_{eff}. It is therefore concluded that the k_{eff} of the fuel and racks with all uncertainties accounted for is:

	Δk_{eff}	k_{eff}
Reference k_{eff}, 1/2 fuel assemblies at 1.5 and 1/2 fuel assemblies at 4.3 w/o U-235 (0 Burnup)		.906

Model bias	0.000	
Variations in k_{eff} (Ref. 1)	0.010	.916
Uncertainty in depletion dependent isotopics	0.020	.936

5.5 FUEL MISLOADING

As a worst case upper bound analysis, the inadvertent loading of unirradiated 4.3 w/o fuel in every location of the fuel storage racks was considered. It should be noted that over 40% of the spent fuel pool already contains spent fuel that had initial enrichment of less than 3.5 w/o U-235. It was furthermore assumed that a zero soluble boron concentration condition prevailed with pool water.

This highly unlikely worst case condition was analyzed using the CASMO-2E fuel rack model described previously. The base k_{eff} calculated is .963. When the CASMO model is corrected to the actual IP2 rack configuration ($\Delta k = +.012$), the k_{eff} becomes .975. It is therefore concluded that for this multiple failure condition (i.e., complete loading of racks with unirradiated 4.3 w/o fuel as well as no soluble boron in the pool) the fuel/rack configuration is still subcritical by 0.025.

5.6 BENCHMARKING

The CASMO/PDQ method used in the present analysis has been benchmarked against the reference KENO-IV calculation[1] for the IP2 racks as described in Section 5.3.1. The reference KENO-IV calculation provides a k_{eff} of 0.933 +/- 0.006 for the IP2 racks loaded with 3.5 w/o unirradiated fuel. The CASMO fuel rack analysis for the corresponding case provides a k_{eff} of 0.936 which is within the statistical uncertainty of the KENO result. With the 4 - 1/4 assembly PDQ model, and using the H-Factor corrected absorption cross sections in the poison region, a k_{eff} of 0.935 was calculated. The agreement between the CASMO and KENO-IV calculation supports the accuracy of these methods for determining the reactivity state of fuel/rack geometries.

The CASMO/PDQ method employed in the present analysis has been extensively benchmarked against critical experiments which simulate close-packed storage of LWR fuel assemblies [7]. In this benchmarking exercise, 16 of the 21 Babcock and Wilcox (B&W) critical experiments[9] were analyzed. The CASMO/PDQ results show very good agreement with the experiments and average calculated k_{eff} for the 16 criticals of 1.002 +/- 0.003. This can be compared with KENO results for the same experiments of 0.997 +/- 0.010 as calculated by B&W. The agreement between the CASMO/PDQ calculations and experiment and the remarkably low magnitude of the standard deviation clearly demonstrates the applicability of this method for criticality calculations.

The previous discussion has addressed benchmarking against clean, cold critical experiments. With respect to burnup dependent reactivity calculations, it is more difficult to accurately define uncertainties. CASMO has been benchmarked against reactor operating data and heavy element composition in irradiated fuel(10). In all cases analyzed CASMO predicts reactivities, fission rate distributions, heavy element concentrations and poison depletion with good accuracy. Specifically, eleven critical experiments (10) have been analyzed some of which contained plutonium bearing fuel. The average calculated k_{eff} for these experiments was 1.002 +/- 0.004 which demonstrates accurate treatment of the plutonium isotopes.

TABLE 5-1

FUEL ASSEMBLY DESIGN PARAMETERS

Fuel Rod Data	
Outside dimension, in.	0.422
Cladding thickness, in.	0.0243
Cladding material	Zr-4
Pellet diameter, in.	0.3659
UO_2 density, % T.D.	94.5
UO_2 stack density, g/cm^3	10.357
Maximum enrichment, wt. % U-235	4.3
Fuel Assembly Data	
Number of fuel rods	204
Fuel rod pitch, in.	0.563
Control rod guide tube	
Number	20
O.D., in.	0.546
Thickness, in.	0.017
Material	Zr-4
Instrument thimble	
Number	1
O.D., in.	0.546
Thickness, in.	0.017
Material	Zr-4
U-235 loading	
g/axial cm of assembly @ 4.3 w/o enrichment	54.33
g/axial cm of assembly @ 3.5 w/o enrichment	44.22
g/axial cm of assembly @ 1.5 w/o enrichment	18.95

TABLE 5-2

EQUIVALENT REACTIVITY EXPOSURE

15 X 15 WESTINGHOUSE LOPAR FUEL

Initial Enrichment, w/o U-235	Equivalent Burnup, GWD/MTU
1.5	0.0
2.5	16.0
3.5	28.27
4.3	37.14

Fuel Assemblies Depleted Under Hot Full Power Reactor Conditions and Modeled in the IP2 Spent Fuel Storage Racks, Cold with 0 ppm Soluble Boron and No Xenon.

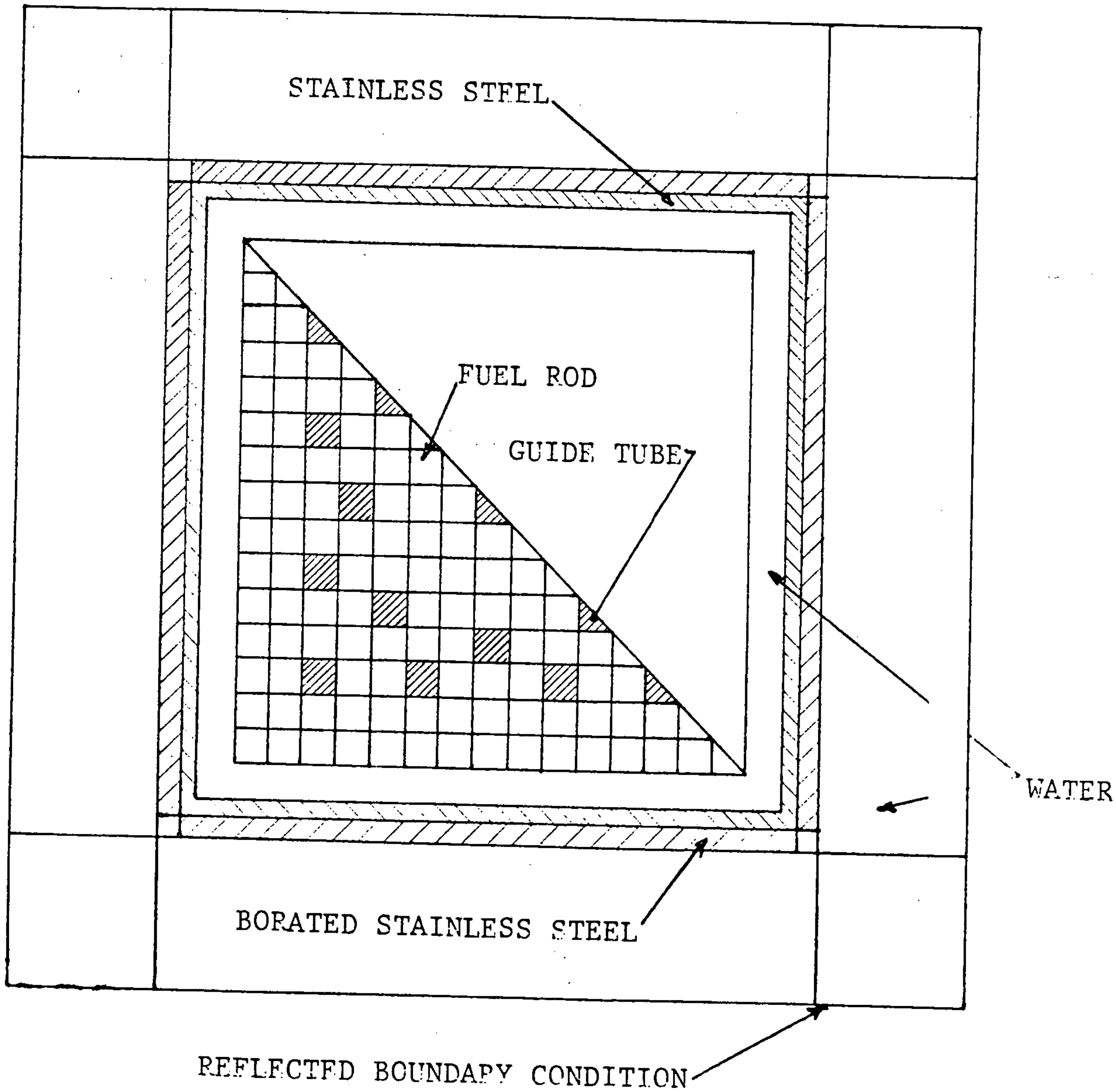

FIGURE 5-1

CASMO-2E FUEL RACK MODEL

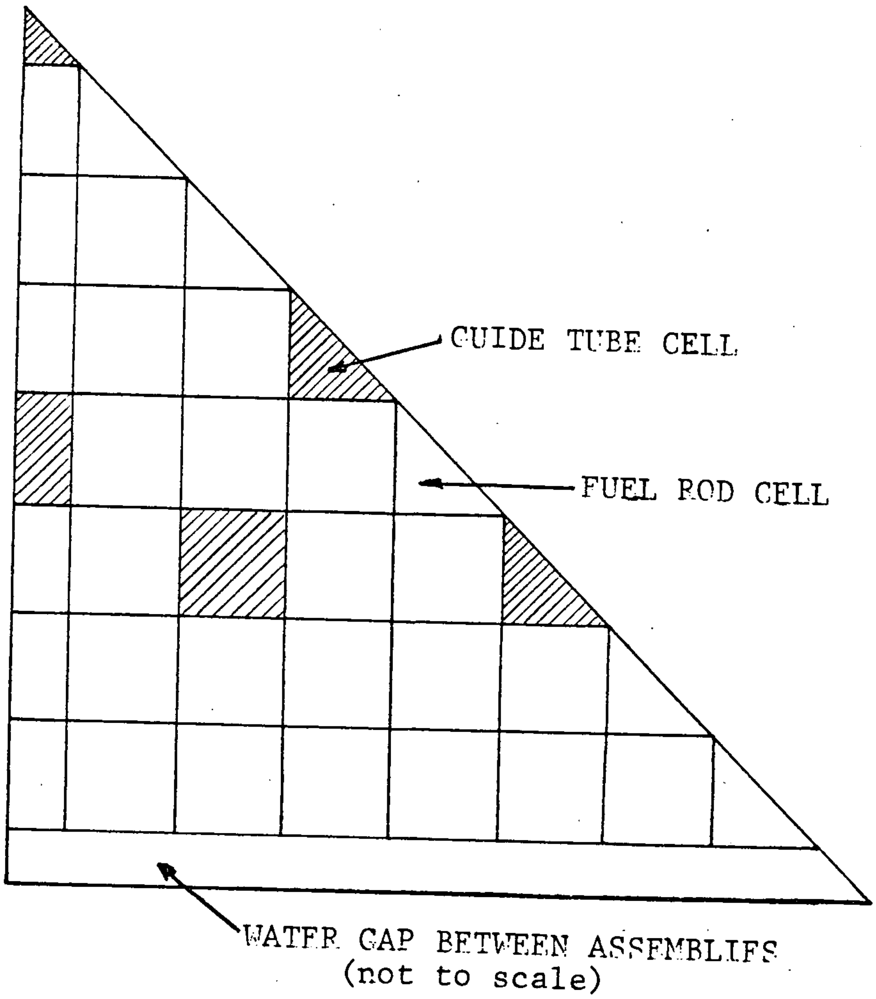

FIGURE 5-2

CASMO 1/8 FUEL ASSEMBLY MODEL

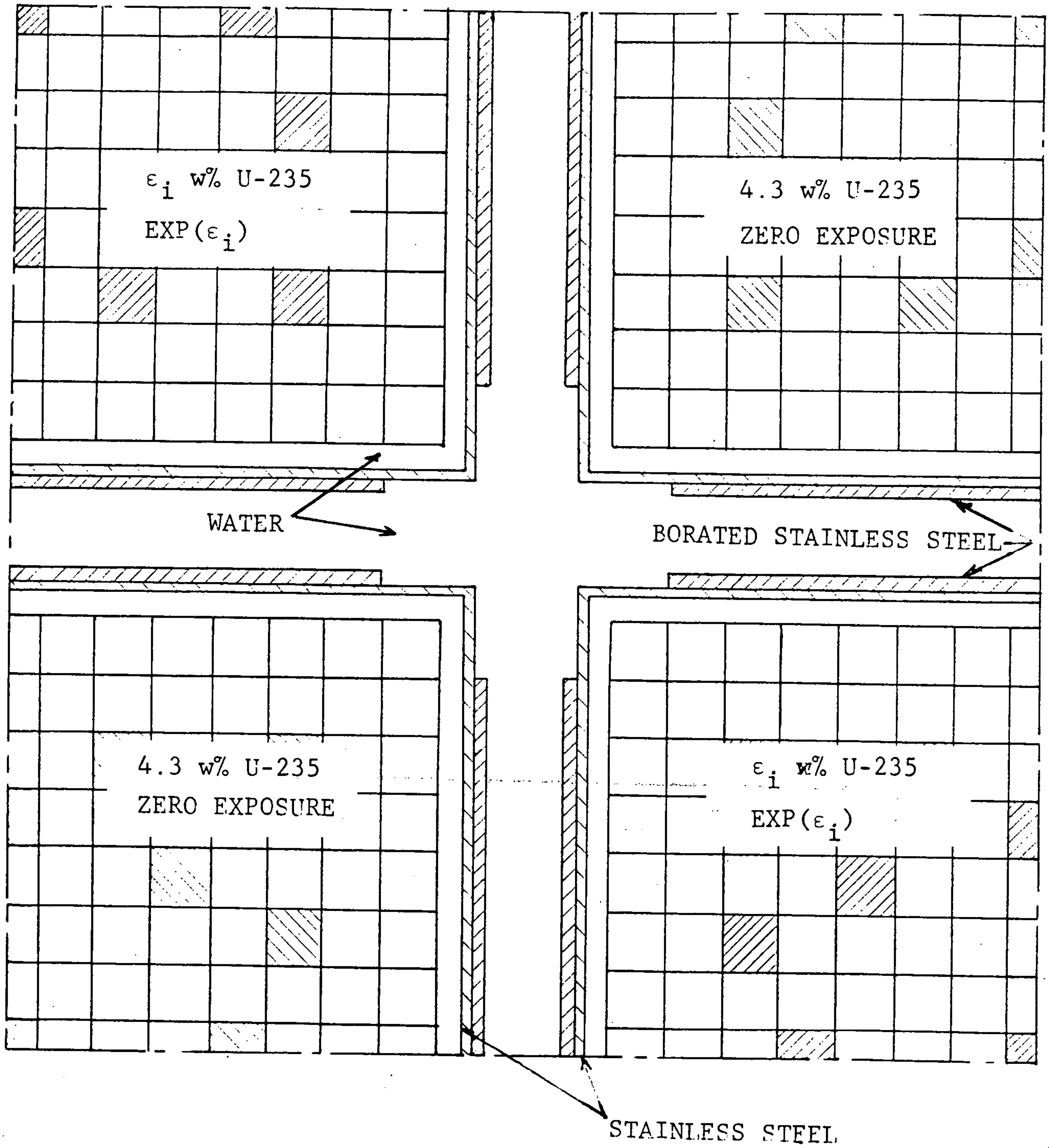

FIGURE 5-3

4 - 1/4 ASSEMBLY PDQ MODEL

6. CONCLUSIONS

Nuclear analysis has been completed to demonstrate that the existing spent fuel storage racks at Indian Point 2 can safely store fuel with initial enrichments of up to 4.3 w/o U-235 provided fuel assemblies are loaded in the racks as specified in Section 4.0 of this report. The results of the analysis show that the k_{eff} of the fuel/rack is 0.936 with due allowance for all variations in k_{eff}, model uncertainties, biases and uncertainties in depletion dependent isotopics. This meets the criticality design criteria of $k_{eff} < 0.95$ and is substantially below 1.0. It is therefore concluded that the spent fuel storage racks, when loaded with fuel as specified in Section 4.0, are safe from a criticality standpoint.

7. REFERENCES

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ENCLOSURE 2

APPLICATION FOR AMENDMENT
TO OPERATING LICENSE

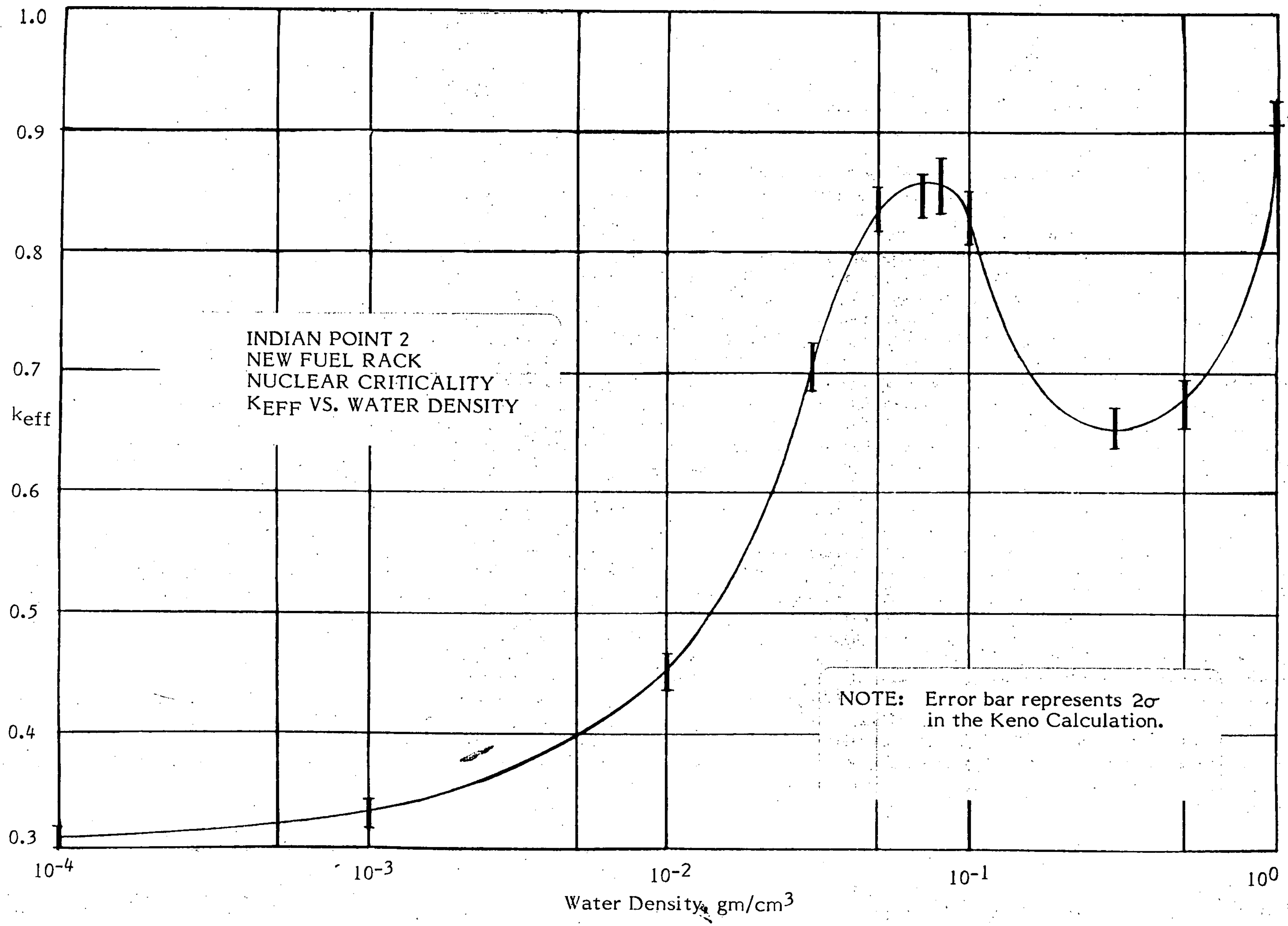
Summary of the New Fuel Storage
Rack Criticality Analysis

Consolidated Edison Company of New York, Inc.
Indian Point Unit No. 2
Docket No. 50-247
Facility Operating License No. DPR-26
November, 1985

A criticality analysis was performed for the new fuel assembly rack. The calculations included the variation of water density surrounding the fresh fuel assemblies to account for optimum moderating conditions. The results of this analysis are presented in Figure 1.

The Monte Carlo code KENO IV was used for this analysis. The working cross section libraries used as input to KENO IV were prepared from the XSDRN 123 group cross section library, by the NITAWL computer code.

The maximum k-effective occurs at maximum water density (.99823 gms/cm^3). This k-effective, including all uncertainties and calculational biases, is 0.947 for all normal and abnormal conditions and configurations. This value is less than the 0.95 Technical Specification requirement for IP-2. Therefore, the new fuel racks meet the criticality design criteria specified in the NRC Standard Review Plan (NUREG-0800) with 15x15 Westinghouse fuel assemblies enriched with 4.3 w/o U-235.



INDIAN POINT 2
NEW FUEL RACK
NUCLEAR CRITICALITY
K_{EFF} VS. WATER DENSITY
NOTE: Error bar represents 2σ in the Keno Calculation.
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
k_{eff}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Water Density, gm/cm^3

FIGURE 1