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STANDARDIZED NUHOMS®

Amendment 10 Application

NON-PROPRIETARY

UFSAR Appendix U – 32PTH1 Part 2 of 2

VOLUME 4 OF 4

TRANSNUCLEAR INC.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

U.5 Shielding Evaluation

The radiation shielding evaluation for the Standardized NUHOMS® System (during loading, transfer and storage) for the other NUHOMS® canisters is discussed in other sections and appendices of the UFSAR. The following radiation shielding evaluation specifically addresses the shielding evaluation of the NUHOMS® 32PTH1 system with design-basis PWR fuel and control components (CCs) loaded in a NUHOMS® 32PTH1 DSC.

The radiation shielding evaluation described below is for the NUHOMS® 32PTH1 DSC transferred in a NUHOMS® OS200 Transfer Cask and stored in an HSM-H module. There are three alternate configurations depending on the canister length applicable to the 32PTH1 system: 1) 32PTH1-S, 2) 32PTH1-M and 3) 32PTH1-L. Each DSC has a different length and can have alternative rail configurations. The 32PTH1 DSCs are authorized to be transferred in the OS200 TC and stored in the HSM-H module. Note that HSM and HSM-H are used interchangeably throughout this chapter. For each 32PTH1 DSC there are three Heat Load Zoning Configurations (HLZCs) described in Chapter U.2, Figures U.2-1 through Figure U.2-3. The OS200 TC is similar to the OS197FC TC described in Appendix P with modifications to accommodate the 32PTH1 DSCs.

Of the three 32PTH1 DSC configurations the 32PTH1-L DSC has the least amount of axial shielding and is used for the OS200 TC and HSM shielding evaluation. Additionally, the DSC rail configuration is modeled to calculate conservative dose rates around the OS200 TC and HSM.

Each DSC configuration is designed to store up to 32 intact (and up to 16 damaged, with remaining intact) PWR fuel assemblies. The 32PTH1 DSCs are also designed to store up to 32 intact standard PWR fuel assemblies with or without Control Components (CC); such as burnable poison rod assemblies (BPRAs), Control Rod Assemblies (CRAs), Rod Cluster Control Assemblies (RCCAs), Thimble Plug Assemblies (TPAs), Axial Power Shaping Rod Assemblies (APSRAs), Orifice Rod Assemblies (ORAs), Vibration Suppression Inserts (VSIs), Neutron Sources, and Neutron Source Assemblies (NSAs). Based on the results of Fuel Qualification Tables described in Section U.5.2, fuel with CC requires up to one more year of cooling time for fuel assemblies with 10 or fewer years of cooling time. To assure that this evaluation is conservative, the fuel source terms are not adjusted to account for the additional decay required to accommodate the CC.

The design-basis PWR fuel source terms are derived from the bounding fuel, B&W 15x15 Mark B assembly design as described in Section U.5.2.

The NUHOMS® 32PTH1 DSCs are designed to store PWR fuel assemblies with CCs with the characteristic sources for CCs described in Table U.5-10. The 32PTH1 DSCs have a maximum decay heat of 1.5 kW per assembly and a maximum heat load of 40.8 kW per canister. Fuel in the 32PTH1 DSCs may be stored in three alternate heat zoning configurations as shown in Chapter U.2, Figure U.2-1 through Figure U.2-3. Note that while the B&W, CE, and Westinghouse fuel designs are specifically listed, storing reload fuel designed by other manufacturers is also allowed provided an analysis is performed to demonstrate that the limiting

features listed in Chapter U.2, Table U.2-3 bound the specific manufacturer's replacement fuel. The limiting parameters are the design basis radiological and decay heat source terms.

The design-basis fuel source terms for this evaluation are defined as the source terms from fuel with the burnup/initial enrichment/cooling time combination given in Chapter U.2, Table U.2-6 through Table U.2-11 and located in the basket as shown in Chapter U.2, Figures U.2-1 through Figure U.2-3 that give the maximum dose rate on the surface of the HSM and/or TC. This approach is consistent with the method used to generate the fuel qualification tables for the Standardized NUHOMS® 24P and -52B DSC designs as described in Section 7.2.3, 32PT DSC design as described in Appendix M or NUHOMS® 24PTH DSC design described in Appendix P. The design basis fuel source term in conjunction with the design basis CC source term (Table U.5-10) is used to calculate dose rates for the NUHOMS® 32PTH1 system.

The enveloping heat load zoning configuration (HLZC) utilized in the shielding evaluation is shown in Figure U.5-3. This HLZC produces the highest dose rates on the surfaces of the HSM-H and OS200 TC as compared to HLZCs 1, 2 and 3 because the highest source fuel assemblies are on the outer periphery of the basket region where self-shielding due to adjacent assemblies is limited. To bound the shielding analysis for all HLZCs, fuel assemblies with a decay heat of 1.5 kW at the outer 28 locations are used along with 1.0 kW fuel assemblies in the central 4 compartments. This results in a shielding analysis corresponding to a total of 46 kW decay heat per DSC which is very conservative because the total decay heat in 32PTH1 DSC is limited to 40.8 kW. These bounding gamma and neutron source terms are then used in the radiation shielding models to conservatively calculate dose rates on and around the NUHOMS® 32PTH1 system.

The bounding burnup, minimum initial enrichment and cooling time combinations for the fuel assemblies used in the shielding analyses of the 32PTH1 DSC in the HSM-H and the OS200 TC are as follows:

- 32PTH1 DSC in HSM-H and OS200 TC inner 4 compartments (radial zone 1 in Figure U.5-3):
  62 GWd/MTU, 3.4 wt. % U-235, 20.5-year cooled fuel

- 32PTH1 DSC in HSM-H and OS200 TC middle 12 compartments (radial zone 2 in Figure U.5-3):
  62 GWd/MTU, 3.4 wt. % U-235, 8.5-year cooled fuel

- 32PTH1 DSC in HSM-H outer 16 compartments (radial zone 3 in Figure U.5-3):
  32 GWd/MTU, 2.6 wt. % U-235, 3.0-year cooled fuel

- 32PTH1 DSC in OS200 TC outer 16 compartments (radial zone 3 in Figure U.5-3):
  62 GWd/MTU, 3.4 wt. % U-235, 8.5-year cooled fuel

The method of selecting the bounding source terms is explained in detail in Section U.5.2.

The design basis CC source term that envelopes all CCs allowed in the 32PTH1 DSCs is taken from Appendix M for BPRAs. This is the same CC source term used in the 24PTH system as

described in Appendix P. The source term energy distribution is shown in Table U.5-10. Any CC to be stored in a 32PTH1 DSC must be bounded by this source term.

Reconstituted and/or damaged fuel assemblies are also acceptable for storage in the 32PTH1 DSC. The maximum number of reconstituted fuel assemblies that can be loaded per DSC is 32. Fuel assemblies may contain up to 10 rods that are reconstituted with stainless steel that is irradiated. There is no limit on the number of rods reconstituted with unirradiated stainless steel or Zircalloy or low enriched UO_2 or other non-fuel material. There is no effect on the source terms/shielding due to the position of the reconstituted rods in the fuel rod array. Reconstituted fuel has a rather small effect on the dose rate such that for cooling times less than 10 years, 1 year of cooling time is added if irradiated reconstituted rods are present in fuel assemblies that are cooled to 10 or fewer years. Damaged fuel, under normal conditions, has essentially no impact on the dose rate as the neutron and gamma source terms would not be impacted and gross axial source redistribution is not likely. Therefore, shielding analysis results with intact fuel are also applicable to the damaged fuel under normal conditions. For accident conditions, damaged fuel is assumed to redistribute and is analyzed separately.

The methodology, assumptions, and criteria used in this evaluation are summarized in the following subsections.

U.5.1 Discussion and Results

All 32PTH1 DSC, OS200 transfer cask and HSM-H dose calculations are performed using MCNP5 code [5.2] and a composite (hypothetical) DSC shielding configuration. The axial geometry of the 32PTH1-M DSC is used to accommodate the design basis B&W 15x15 Mark B fuel assembly. The shielding at the ends of the 32PTH1-M DSC is critically reduced to simulate the 32PTH1-L DSC axial shielding configuration. Steel rails are used for calculation of long term storage, transfer, welding and accident dose rates. Decontamination dose rates are calculated with solid aluminum rails which produce conservative results.

Table U.5-1 summarizes the maximum and average dose rates for the NUHOMS® 32PTH1 Design Basis (also referred to as "bounding") DSC loaded into the NUHOMS® HSM-H.

Table U.5-2 provides a summary of the dose rates on and around the OS200 TC for transfer of the 32PTH1 DSC under normal, off-normal and accident conditions.

Table U.5-3 provides a summary of the dose rates on and around the OS200 TC for decontamination and welding operations for the 32PTH1 DSC.

A discussion of the method used to determine the design-basis fuel source terms is included in Section U.5.2. The design basis CC source term which is from Appendix M is shown in Table U.5-10. The shielding material densities are given in Section U.5.3. The method used to determine the dose rates due to design-basis fuel assemblies with CCs in the various NUHOMS® 32PTH1 DSC design configurations is provided in Section U.5.4. Thermal and radiological source terms are calculated with the SAS2H/ORIGEN-S modules of SCALE 4.4 [5.1] for the fuel. The shielding evaluation is performed with the MCNP5 [5.2] code with the ENDF/B-VI cross section library. Sample input files used for calculating neutron and gamma source terms and dose rates are included in Section U.5.5.

U.5.2 Source Specification

Thermal and radiological source terms are calculated with the SAS2H/ORIGEN-S modules of SCALE 4.4 [5.1] for the fuel. The SAS2H/ORIGEN-S results are used to develop the fuel qualification tables listed in Chapter U.2, Table U.2-6 through Table U.2-11 and the design-basis fuel source terms suitable for use in the shielding calculations. The thermal and radiological source terms for the CCs which are taken from Appendix M, are shown in Table U.5-10.

The B&W 15x15 assembly is the bounding fuel assembly design for shielding purposes because it has the highest initial heavy metal loading and CO-59 content of the hardware regions as compared to the 14x14, other 15x15, 16x16, and 17x17 fuel assemblies which are also authorized contents of the NUHOMS® 32PTH1 DSC. The neutron flux during reactor operation is peaked in the in-core region of the fuel assembly and drops off rapidly outside the in-core region. Much of the fuel assembly hardware is outside of the in-core region of the fuel assembly. To account for this reduction in neutron flux, the fuel assembly is divided into four exposure "regions." The four axial regions used in the source term calculation are: the bottom (nozzle) region, the fuel (in-core) region, the (gas) plenum region, and the top (nozzle) region. The B&W 15x15 fuel assembly masses for each irradiation region are listed in Table U.5-4. The light elements that make up the various materials for the various fuel assembly materials are taken from Reference [5.4] and are listed in Table U.5-5. The design-basis heavy metal weight is 0.490 MTU. These masses are irradiated in the appropriate fuel assembly region in the SAS2H/ORIGEN-S models. To account for the reduction in neutron flux outside the In-Core regions neutron flux (fluence) scaling factors are applied to light element composition for each region. The neutron flux scaling factors which are from Reference [5.4] are given in Table U.5-6.

Evaluations of the existing data with SAS2H and the 44-group ENDF/B-V library used in the analysis are documented in References [5.11] and [5.12]. These comparisons all show generally good agreement between the calculations and measurements, and show no trend as a function of burnup in the data that would suggest that the isotopic predictions, and therefore neutron and gamma source terms, would not be in good agreement. A similar conclusion is also reached by the results documented in JAERI report [5.13]. In fact, for the case with 46,460 MWd/MTU burnup, the isotopic predictions are all within 2% of those measured. There are ongoing efforts, some of which are documented in Reference [5.10], to obtain more data for burnups above 45 GWd/MTU. There is no reason to expect that the ongoing evaluations of the higher burnup fuel will result in less favorable comparisons. Therefore, the uncertainty in the gamma source term, and associated dose rates, is estimated to be within ±5 %.

As noted in References [5.14] and [5.10], there is no public data for the neutron component currently available that bounds a fuel burnup of up to 62 GWd/MTU. However, as documented in Reference [5.14] and confirmed in the SAS2H analysis, the total neutron source with increasing burnup is more and more dominated by spontaneous fission neutrons. Reviewing the output from the SAS2H runs, the neutron source term is due almost entirely to the spontaneous fission of Cm-244 (~94% of all neutrons both spontaneous fission and (α,n)). After reviewing the measured Cm-244 content compared to the Cm-244 content predicted by SAS2H and the 44-group ENDF/B-V library documented in References [5.11] and [5.12] for burnups up to 46,460 MWd/MTU, it is readily apparent that the calculated values are within ±11 % of the measured

values, with most of the predicted values within ±5% of the measured. Finally, there is no observed trend as a function of burnup in the data that would indicate that the predicted Cm-244 content is significantly different at higher burnups. Therefore, as the Cm-244 isotope accounts for more than 94% of the total neutron source term, the uncertainty in the neutron source and associated neutron dose rates is expected to be less than ±11 %.

As documented in Reference [5.14] and as observed in preparing the fuel qualification tables, the gamma radiation source strength increases nearly linearly with burnup relative to the direct gamma component and the neutron radiation source strength increases with burnup to the fourth power. Therefore, as burnups go beyond 45 GWd/MTU, the contribution from neutron (and associated n,γ) components to the total dose rates measured on the surfaces of the DSC, TC and HSM-H increase in relative importance to that of the gamma component. However, this increase in the importance of the neutron source term has a relatively minor effect on the area dose rates on and around the HSM as these are dominated by the gamma component as shown in Table U.5-1. The surface dose rates on the HSM are dominated by the gamma component because the HSM is constructed of thick reinforced concrete, which is an excellent neutron shield. Therefore, even a postulated substantial increase in the neutron source term would have a relatively minor effect on the site dose rate evaluation presented in Chapter U.11 of the amendment application.

For the TC, the neutron source term has a relatively minor effect on the area dose rates during most of the cask handling operations, since the DSC cavity and the annulus between the TC and DSC is filled with water and most of the work is done around the top of the cask. The neutron component is of more importance on and around the TC during transfer operations but, in general, only represents a small portion of the total dose rate on the top of the TC. While the neutron dose rate on the bottom of the TC is slightly higher, relatively little occupational dose is received from this area. The dose rates for the design basis fuel on the surfaces of HSM and TC are shown in Table U.5-1 through Table U.5-3. These tables show that gamma dose rates are substantially higher than neutron dose rates.

The occupational exposure calculations demonstrate that most of the dose received by workers during cask loading and transfer operations is due to the gamma radiation on and around the cask. The only surface of the TC that is dominated by neutrons is at the bottom of the cask. A small fraction of the total occupational exposure is due to the doses around the bottom of the cask because very little work is performed on or around the bottom of the cask with fuel in the TC.

As discussed above, any impact of uncertainties in source terms is expected to be negligible for the 32PTH1 system. Therefore, isotopic depletion calculations with SAS2H for fuel burned above 45 GWd/MTU are appropriate.

The fuel qualification tables are generated based on the decay heat limits for the various HLZCs shown in Chapter U.2, Figure U.2-1 through Figure U.2-3. SAS2H is used to calculate the minimum required cooling time to the nearest 0.1 year as a function of assembly initial enrichment and burnup for each decay heat limit. These cooling times are rounded up to the nearest 0.5 year increment in the final fuel qualification tables. Because the decay heat generally increases slightly with decreasing enrichment for a given burnup, it is conservative to assume

that the required cooling time for a higher enrichment assembly is the same as that for a lower enrichment assembly with the same burnup. The required cooling time for initial enrichments that fall between any two SAS2H runs are assumed to be that of the lower enrichment case results.

The fuel qualification table for a decay heat of 1.2 kW per assembly is calculated as a linear combination of the fuel qualification tables for the 1.3 kW per fuel assembly and 1.0 kW per fuel assembly. Such a calculation is applicable and conservative because the decay heat changes exponentially as a function of cooling time over this small range of decay heat (< 500 watts). Moreover, the design basis shielding calculations are performed conservatively with a decay heat of 1.5 kW per fuel assembly and hence, the fuel qualification table for a decay heat of 1.2 kW per fuel assembly is developed only to satisfy the thermal loading criteria. Thus, the linear combination method can be utilized to determine the fuel qualification tables over a small range of decay heat (< 500 watts) to satisfy thermal loading criteria.

As discussed in Chapter U.5, reconstituted and/or damaged fuel is also acceptable for the DSC payload. Reconstituted fuel may contain up to 10 irradiated solid stainless steel rods that replace fuel rods. Reconstituted fuel has a rather small effect on the dose rate such that for cooling times less than 10 years, 1 year of cooling time is added if reconstituted irradiated stainless steel rods are present. If the cooling time is greater than 10 years, no additional cooling time is needed. Additional discussion on the method used to analyze reconstituted fuel is provided in Section U.5.2.5. Under normal conditions, damaged fuel has essentially no impact on the dose rate as the source term would not be impacted and gross axial source redistribution is not likely. Damaged fuel under accident conditions is addressed by assuming the fuel turns to rubble. This assumption is only applicable to the transfer casks shielding analysis.

The design-basis source terms are defined as the burnup/initial enrichment/cooling time combination given in the fuel qualification tables that result in the maximum dose rate on the surface of the HSM (HSM-H) or TC (OS200). Note that for a given HLZC, the design basis HSM source will not necessarily be the same as the corresponding design basis TC source. The 1-D discrete ordinates code ANISN [5.5] and the CASK-81 22 neutron, 18 gamma-ray energy group, coupled cross-section library [5.3] is used to determine the HSM and TC dose rate by radial zone for each entry in the fuel qualification tables and thereby determine the design basis source. As ANISN is a 1-D code, a single dose location must be selected for both the HSM and TC for analysis purposes. For the HSM, the middle of the roof centerline is selected as the dose location, and for the middle of the TC the cask side is selected as the dose location. This approach, described in detail in Section U.5.2.4, is consistent with the method used to determine the fuel qualification tables for the Standardized NUHOMS® canister designs described in Section 7.2.3 and Appendices M.5 and P.5. The radiological source terms generated in the SAS2H/ORIGEN-S runs are used in the ANISN evaluations to calculate the surface dose rates.

HLZC 1 (Figure U.2-1 in Chapter U.2) produced the bounding total surface dose rate for both the HSM-H and OS200 TC containing the 32PTH1 DSC. The enveloping HLZC selected for the shielding analysis (shown in Figure U.5-3) of the 32PTH1 DSC bounds the actual heat load configuration shown in Figure U.2-1 because 1.5 kW fuel is assumed in all 28 peripheral locations.

A sample SAS2H/ORIGEN-S input file for the In-Core Region for the 62 GWd/MTU, 3.4 wt. % U-235 and 8.5-years cooling case is listed in Section **Error! Reference source not found.**. Input for reconstituted fuel is similar, except for a reduced number of fuel pins from 208 to 198, light element masses that reflect reconstituted rods, and slightly different power input to maintain the same burnup for a reduced fuel mass.

U.5.2.1 Gamma Source Term for MCNP

U.5.2.1.1 Design Basis Gamma Fuel Assembly Source Terms

Once the design basis burnup/enrichment/cooling time combinations have been determined for each shielding configuration of interest, four SAS2H/ORIGEN-S runs are required for each combination to determine gamma source terms for the four fuel assembly regions (i.e., bottom, in-core, plenum and top). The only difference between the runs is in Block #10 "Light Elements" of the SAS2H input and the 82$$ card in the ORIGEN-S input. Each run includes the appropriate Light Elements for the region being evaluated and the 82$$ card is adjusted to have ORIGEN-S output the total gamma source for the in-core region and only the light element source for the plenum, bottom, and top regions. Gamma source terms for the in-core region include contributions from actinides, fission products, and activation products. The bottom, plenum and top nozzle regions include the contribution from the activation products in the specified region only. The SAS2H/ORIGEN-S gamma radiation source is output in the CASK-81 energy group structure.

A design basis source is developed for each decay heat (1.0 and 1.5 kW) and shielding structure combination used in the shielding analysis. Note that for a given decay heat, the design basis TC and HSM source may or may not be the same. The enveloping configuration evaluated in the shielding analyses is based on three radial zones. Radial zone 1 is comprised of the center 4 fuel compartments of the 32PTH1 DSC and radial zone 2 is comprised of the middle 12 assemblies. The remaining 16 outer assemblies define radial zone 3. Source terms are generated for the following enveloping (hypothetical) configuration.

(1) Radial zone 1: 1.0 kW fuel in HSM-H/OS200 TC

(2) Radial zone 2: 1.5 kW fuel in HSM-H/OS200 TC

(3) Radial zone 3: 1.5 kW fuel in HSM-H/OS200 TC

The results for radial zone 1 fuel in a 32PTH1 DSC loaded in the HSM-H/OS200 TC (1.0 kW, 62 GWd/MTU, 3.4 wt. % U-235 and 20.5-years cooling) are shown in Table U.5-7. The results for radial zone 2 fuel in a 32PTH1 DSC loaded in the HSM-H/OS200 TC (1.5 kW, 62 GWd/MTU, 3.4 wt. % U-235 and 8.5-years cooling) are shown in Table U.5-8. The results shown in Table U.5-8 are also applicable to radial zone 3 fuel in a 32PTH1 DSC loaded in the OS200 TC. The results for radial zone 3 fuel in a 32PTH1 DSC loaded in the HSM-H (1.5 kW, 32 GWd/MTU, 2.6 wt. % U-235, 3.0-years cooling) are shown in Table U.5-9.

U.5.2.1.2 Design Basis CC Source Terms

The design basis CC source terms are taken from Appendix M of the UFSAR and are listed in Table U.5-10. All CCs to be stored in the 32PTH1 DSC must be bounded by this source. The source terms from the fuel assembly and the CCs are utilized in the MCNP shielding models.

U.5.2.1.3 Uncertainty in Gamma Source Terms

Almost 100% of the gamma spectrum from light elements is in the range of 0.70 to 1.33 MeV which corresponds exactly to two of the most prominent lines of ^{60}Co. As for fission products, the main contributors after six years with a fraction greater then 5% in the range of 0.01 to 0.90 MeV are: ^{90}Sr, ^{90}Y, ^{106}Rh, ^{137}Cs, ^{144}Pr, ^{154}Eu, and ^{155}Eu. Contributions from ^{90}Y, ^{106}Rh, ^{137}Cs, ^{144}Pr, and ^{154}Eu are dominant in the range of 0.90 to 1.50 MeV. ^{106}Rh, ^{147}Sm, and ^{142}Ce are the strongest emitters at energies greater then 2.0 MeV. The accuracy of gamma spectrum is dependent upon the energy. Photon rates computed for fission products tend to be more accurate then those for actinides because the calculation of their inventory has less uncertainty [5.1].

Shortly after discharge the emission at higher energies is dominated by actinides. This is true for energies >4 MeV at all cooling times and energy above 3.5 MeV for cooling times after 10 years [5.1]. The major part of this emission comes from ^{244}Cm. Thus the uncertainty for energy groups of order 3.0 MeV and greater is bounded with the precision with which the inventory of ^{244}Cm is calculated. Per SCALE 4.4 [5.1], reported experimental ^{244}Cm densities are accurate within ± 20%. The gamma emission intensity from Cm, which is proportional to the quantity of Cm in the actinide inventory, is bounded by this value. Uncertainty in the source strength in the gamma energy range 0.5 to 2.5 MeV is in the vicinity of 10 to 15 % [5.1].

U.5.2.2 Neutron Source Term for MCNP

One SAS2H/ORIGEN-S run is required for each burnup/initial enrichment/cooling time combination to determine the total neutron source term for the in-core regions. At discharge the neutron source is almost equally produced from ^{242}Cm and ^{244}Cm. The other strong contributor is ^{252}Cf, which is approximately 1/10 of the Cm intensity, but its share vanishes after 6 years of cooling time because the half-life of ^{252}Cf is 2.65 years. The half-lives of ^{242}Cm and ^{244}Cm are 163 days and 18 years, respectively. Contributions from the next strongest emitters, ^{238}Pu and ^{240}Pu, are lower by a factor of 1000 and 100, respectively, relative to ^{244}Cm. For the ranges of exposures, enrichments, and cooling times in the fuel qualification tables, ^{244}Cm represents more than 85% of the total neutron source. The neutron spectrum is, therefore, relatively constant for the fuel parameters addressed herein.

The magnitude of the neutron source is provided as the final row in the gamma source term tables, see Table U.5-7, Table U.5-8 and Table U.5-9. Neutron source terms for use in the MCNP shielding models are calculated by multiplying the assembly source by the number of assemblies in the in-core region of interest (32). The magnitude of the neutron source is also increased to account for the axial distribution in the fuel, as explained in Section U.5.2.3.

The fixed source spectrum in MCNP is assumed to follow a ^{244}Cm spontaneous fission spectrum for all of the calculations in this chapter. It is based on the following relationship:

$$p(E) = C \exp(-E/a)\sinh(bE)^{1/2}$$

with input parameters a=0.906 MeV and b=3.848 MeV^{-1}, as given in the MCNP manual [5.2].

U.5.2.3 Axial Peaking

Axial burnup peaking factors for PWR fuel are taken from References [5.6] and [5.16]. These peaking factors are assumed to match the gamma axial source distribution because the gamma source is proportional to burnup. The neutron source is approximately proportional to the fourth power of the burnup. Therefore, the axial neutron source distribution may be determined as the fourth power of the axial burnup profile.

Axial peaking changes with increasing burnup. As the design basis source occurs at different burnups for the various decay heat and shielding configurations, different axial peaking factors are selected for the various TC and HSM calculations. The axial peaking factors used are provided in Table U.5-11. The OS200 TC calculations use peaking factors for a burnup >46 GWd/MTU because the design basis source for 1.5 kW fuel in a TC occurs at a burnup of 62 GWd/MTU.

The HSM-H calculation uses peaking factors from Reference [5.16] because the design basis source for 1.5 kW fuel in an HSM-H occurs at an average burnup of 47 ((62 + 32) x 0.5) GWd/MTU.

The neutron and gamma peaking factors are shown as a function of the active fuel region height in Table U.5-11. These factors are directly applied to each MCNP interval in the fuel region.

The average values of the axial peaking distributions are also provided in Table U.5-11. For the gamma distribution, the average value is 1.0. However, for the neutron distribution, the average value of the distribution is greater than 1.0. The average value of the axial neutron distribution may be interpreted as the ratio of the true total neutron source in an assembly to the neutron source calculated by SAS2H/ORIGEN-S for an average assembly burnup. Therefore, to properly correct the magnitude of the neutron source, the neutron source per assembly as reported in Table U.5-7, Table U.5-8 and Table U.5-9 is multiplied by the average value of the neutron source distribution as reported in Table U.5-11.

U.5.2.4 ANISN Evaluation for Bounding Source Terms

As discussed above, the fuel qualification tables are generated based on the decay heat limits for the various HLZCs shown in Chapter U.2, Figure U.2-1 through Figure U.2-3. SAS2H is used to calculate the minimum required cooling time as a function of assembly initial enrichment and burnup for each decay heat limit. To determine which combination of burnup, wt. % initial enrichment and cooling time results in the bounding dose rates on the surface of the HSM-H and OS200 TC, the total source term, which includes the contribution from the fuel as well as the hardware in the entire assembly (including end fittings) is used to calculate its total ANISN dose rate on the HSM-H roof and OS200 TC radial model using the ANISN code.

An ANISN TC model is developed for the OS200 TC. An ANISN HSM model is also developed, for the HSM-H. The CC contribution is fixed and is included in the design basis shielding evaluation as such and therefore is not included in this ANISN evaluation.

ANISN [5.5] determines the fluence of particles throughout one-dimensional geometric systems by solving the Boltzmann transport equation using the method of discrete ordinates. Particles can be generated by either particle interaction with the transport medium or extraneous sources incident upon the system. Anisotropic cross-sections can be expressed in a Legendre expansion of arbitrary order.

The ANISN code implements the discrete ordinates method as its primary mode of operation. Balance equations are solved for the flow of particles moving in a set of discrete directions in each cell of a space mesh and in each group of a multigroup energy structure. Iterations are performed until all implicitness in the coupling of cells, directions, groups, and source regeneration is resolved.

ANISN coupled with the CASK-81 22 neutron, 18 gamma-ray energy group, coupled cross-section library [5.3] and the ANSI/ANS-6.1.1-1977 flux-to-dose conversion factors [5.8] is chosen to generate the ANISN dose rates used to determine the relative strength of the various source terms from fuel assemblies to determine the design basis source terms for the HSM-H and OS200 TC. These design basis source terms are used with MCNP models of the 32PT1 system to calculate the bounding system dose rates. ANISN provides an efficient method to select the design basis source terms.

The surface dose rates are calculated using ANISN models to perform the evaluation for the fuel assembly parameters in the fuel qualification table. The ANISN model used to calculate the relative dose rates on the HSM-H surface is similar to a cut through the center of the MCNP HSM-H roof model used for the shielding evaluation. The ANISN model used to generate the relative dose rates on the TC is similar to a cut through the center of the MCNP OS200 TC side model used for the shielding evaluation. Figure U.5-1 and Figure U.5-2 provide sketches for the ANISN models of the HSM-H roof and OS200 TC centerline, respectively. An example ANISN input file is included in Section **Error! Reference source not found.**.

With the exception of the fuel region, the material densities used in the ANISN models are the same as those used in the MCNP models as provided in Table U.5-12. The ANISN and MCNP number densities in the fuel region differ because in the MCNP models, the basket is modeled explicitly, while in the ANISN models the basket is homogenized with the fuel. The ANISN number densities for the fuel/basket region are provided in Table U.5-13.

To simplify the number of ANISN calculations required, a "response function" is developed using ANISN. A separate response function is developed for both the OS200 TC and HSM-H. To generate a gamma response function, a separate ANISN model is executed with a single gamma per assembly in each of the 18 CASK-81 gamma energy groups. As ANISN requires the source in particles per second per unit volume, the volume of the homogenized source region is 6.87E+06 cm^3 (r=72.1 cm and h=420.7 cm, including the top and bottom nozzle regions), resulting in a gamma source of 32/6.87E+06=4.657E-06 γ/s-cm^3. Once the dose rate resulting from a single gamma per assembly is known for each energy group, the dose rate for an arbitrary

gamma source can be determined simply by multiplying the source strength in each group by the dose rate contribution for that group and summing the results.

The neutron response function is generated in a similar fashion to the gamma response function, although only one ANISN neutron file is required because the neutron spectrum is adequately represented by the Cm-244 spectrum provided in Table U.5-14. Therefore, the ANISN model is executed with one neutron per assembly. As ANISN requires the source in particles per second per unit volume, the volume of the homogenized source region is 5.90E+06 cm^3 (r=72.1 cm and h=361.42 cm, height for the fuel region only). The resulting neutron source for ANISN is provided in Table U.5-14. The dose rate from secondary capture gammas is calculated in addition to the neutron dose rate. This method allows for the calculation of the neutron and capture gamma dose rate on the surface of the OS200 TC or HSM-H knowing only the magnitude of the neutron source.

The response functions for the OS200 TC and HSM-H are provided in Table U.5-15 and Table U.5-16, respectively. Response functions for a uniform fuel laoding configuration are also shown in Table U.5-16. These response functions are used to compute the dose rate for each entry in the fuel qualification tables. For each qualification table, the burnup/enrichment/cooling time combination that results in the highest dose rate is selected as the design basis source.

U.5.2.5 Reconstituted Fuel

As explained in Section U.5.2, reconstituted fuel assemblies may contain up to 10 irradiated stainless steel rods that replace damaged fuel rods. Because steel rods replace fuel rods, the decay heat of a reconstituted assembly is typically less than the decay heat of an equivalent standard assembly. Conversely, because steel contains Co-59 which activates to form Co-60, for low cooling times a reconstituted assembly typically generates higher dose rates than an equivalent standard assembly. As the half-life of Co-60 is 5.27 years, after 10 years the Co-60 activity has reduced by almost a factor of four and a reconstituted assembly no longer generates higher dose rates than an equivalent standard assembly. To bound this effect, the fuel qualification tables require that for fuel assembly with irradiated reconstituted steel rods with cooling times less than 10 years, additional one year of cooling time is required. For cooling times of 10 years or greater, no additional cooling time is required to bound the reconstituted fuel with steel rods.

To quantify this statement, additional SAS2H runs are generated for reconstituted assemblies. For each burnup and enrichment corresponding to a transition point in a fuel qualification table (i.e., the point where the cooling time experiences a change of 0.5 years), reconstituted assembly SAS2H models are developed.

The SAS2H input files for a reconstituted assembly are very similar to the input files for a standard assembly except for the following changes: (1) The number of fuel rods is reduced from 208 to 198, (2) the POWER input variable is adjusted to maintain the correct burnup for the reduced fuel loading, and (3) the light elements change to reflect that 10 fuel rods have been replaced with steel rods. The constituent masses of the reconstituted fuel assembly required for the SAS2H input is provided in Table U.5-4.

Note that a reconstituted rod cannot be irradiated for more than two cycles because the first cycle will always contain fresh, undamaged fuel. To accurately model this behavior, two SAS2H models are generated for each transition point. The first SAS2H model is for only one cycle of irradiation of 10 reconstituted rods, while the second SAS2H model is for three cycles of irradiation of 10 reconstituted rods. By subtracting the single cycle source term of the reconstituted rods from the total source term (fuel and reconstituted rods) for three cycles, the source term for three cycle irradiation of fuel and two cycle irradiation of reconstituted rods is generated.

This source term is inserted into the HSM-H and OS200 TC response functions to determine the dose rates for comparison to the design basis source dose rates. If the reconstituted fuel dose rate for either the HSM-H or OS200 TC exceeded the dose rate with design basis fuel, an additional 0.5 year of cooling time is added to the reconstituted fuel source term. When the reconstituted fuel is examined in this fashion, no more than one additional year of cooling time is required for reconstituted fuel to be bounded by the design basis source if the decay time listed in the fuel qualification table is less than 10 years. After a cooling time greater than 10 years the effects of reconstituted fuel become insignificant.

U.5.3 Material Densities

The material masses given in Table U.5-4 for the fuel are used to calculate material densities for in-core, plenum, top, and bottom regions of the fuel assembly.

In order to account for sub-critical multiplication, an initial enrichment of 5.0 wt. % U-235 is used to calculate the amount of U-235 in dry fuel for the shielding models. For the shielding analyses of wet fuel an enrichment of 3.5 wt. % is considered.

Material densities used in the various MCNP models are summarized in Table U.5-12. Material densities for the homogenized fuel/basket region used only in the ANISN models are summarized in Table U.5-13.

U.5.4 Shielding Evaluation

Dose rate contributions from the bottom, in core, plenum and top regions, as appropriate, from 32 fuel assemblies are calculated with the MCNP Code [5.2] at various locations on and around the NUHOMS® 32PTH1 DSCs within the HSM and OS200 TC.

The following shielding evaluation discussion specifically addresses the NUHOMS® 32PTH1 DSC in an OS200 TC and the NUHOMS® 32PTH1 DSC in HSM-H using the design-basis source terms described in the above sections.

U.5.4.1 Computer Program

MCNP [5.2] is a general-purpose Monte Carlo N-Particle code that can be used for neutron, photon, electron, or coupled neutron/photon/electron transport. The code treats an arbitrary three-dimensional configuration of materials in geometric cells bounded by first- and second-degree surfaces and some special fourth-degree surfaces. Pointwise (continuous energy) cross-section data are used. For neutrons, all reactions given in a particular cross-section evaluation are accounted for in the cross section set. For photons, the code takes account of incoherent and coherent scattering, the possibility of fluorescent emission after photoelectric absorption, absorption in pair production with local emission of annihilation radiation, and bremsstrahlung. Important standard features that make MCNP very versatile and easy to use include a powerful general source; an extensive collection of cross-section data; and an extensive collection of variance reduction techniques that can be employed to track particles through very complex deep penetration problems. MCNP was employed to take advantage of its mesh tallies capabilities in calculating dose rates distributed over the surface of the HSM. It also allows more point detectors to be used in a single run that substantially reduces the number of input/out decks needed to perform ISFSI site dose rate calculations described in Chapter U.10.

U.5.4.2 Spatial Source Distribution

The source components are:

- The neutron sources due to the active fuel region,
- The gamma source due to the active fuel region,
- The gamma source due to the plenum,
- The gamma source due to the top region,
- The gamma source due to the bottom region,
- The gamma source due to the CC in the active fuel region,
- The gamma source due to the CC in the plenum region, and
- The gamma source due to the CC in the top region.

Axial peaking is accounted for in the active fuel region by inputting an axial shape, as discussed in Section U.5.2.3.

U.5.4.3 Cross Section Data

The cross-section data used is the continuous energy ENDF/B-VI provided with the MCNP code [5.2]. The cross-section data allows coupled neutron/gamma-ray dose rate evaluation to be made to account for secondary gamma radiation (n,γ), if desired. All of the TC and HSM-H dose rate calculations account for the dose rate due to secondary gamma radiation.

U.5.4.4 Flux-to-Dose-Rate Conversion

The flux distribution calculated by the MCNP code is converted to dose rates using flux-to-dose rate conversion factors from ANSI/ANS-6.1.1-1977 [5.8] given in Table U.5-17.

U.5.4.5 Methodology

The methodology used in the shielding analysis of the 32PTH1 system is similar to the one employed in the 24PTH system described in Appendix P.5. The MCNP computer code was utilized to perform the shielding analyses. MCNP allows for explicit 3-D modeling of any shielding configuration and reduces the number of approximations needed in comparison to the 2-D codes. The methodology used herein is summarized below.

1. Sources are developed for all fuel regions using the source term data described in Section U.5.2. Source regions include the active fuel region, bottom end fitting (including all materials below the active fuel region), plenum, and top end fitting (including all materials above the plenum region). Sources for the CCs are added group-by-group to the fuel sources.

2. Suitable shielding material densities are calculated for all regions modeled.

3. The 3-D Monte Carlo code MCNP [5.2] is used to calculate dose rates on and around the HSM-H and OS200 TC loaded with the bounding, from a shielding standpoint, fuel and DSC designs. The MCNP code is selected because of its ability to handle thick, multi-layered shields and account for streaming through both the HSM-H air vents and cask/DSC annulus using 3-D geometry.

4. MCNP results are used to calculate offsite exposures (see Chapter U.10).

5. MCNP models are also generated to determine the effects of accident scenarios, such as loss of cask neutron shield for the OS200 TC (Chapter U.11).

U.5.4.6 Assumptions

The following general assumptions are used in the analyses.

U.5.4.6.1 Source Term Assumptions

- The primary neutron source in LWR spent fuel is the spontaneous fission of ^{244}Cm. For the ranges of exposures, enrichments, and cooling times in the fuel qualification tables, ^{244}Cm represents more than 85% of the total neutron source. The neutron spectrum is, therefore, relatively constant for the fuel parameters addressed herein and is assumed to follow the ^{244}Cm fission spectrum provided in Section U.5.2.2.

- Surface gamma dose rates are calculated for the HSM and cask surfaces using the actual photon spectrum applicable for each case.

- The PWR heavy metal weight is assumed to be 0.490 MTU per assembly to bound existing PWR fuel designs.

U.5.4.6.2 HSM-H Dose Rate Analysis Assumptions

- The 32PTH1 DSC and fuel assemblies are positioned at approximately 30 cm to the HSM-H front door.

- Planes of reflection are used to simulate adjacent HSM-Hs in a side-by-side arrangement.

- Embedments and rebar in the HSM-H concrete are conservatively neglected.

- Penetrations on the exterior of the HSM-H modules for instrumentation and ease of installation are not modeled since they do not result in any significant change in dose rate distribution.

- The borated neutron absorber sheets in the 32PTH1 DSC are modeled as aluminum.

- Axial peaking factors assumed as shown in Table U.5-11.

- Fuel is homogenized within the fuel compartment, although the 32PTH1 DSC basket is modeled explicitly.

U.5.4.6.3 OS200 TC Dose Rate Analysis Assumptions

- The 32PTH1 DSC is modeled as the 32PTH1-M DSC with reduced shielding at the ends of the DSC to approximate the 32PTH1-L DSC. In the top of the DSC the total steel thickness is modeled as 2" stainless steel and 8.34" carbon steel. The steel in the bottom of the DSC is modeled as 4.25" stainless steel and 2.25" carbon steel. This ensures conservative axial dose rates. Hollow steel rails are assumed for the transfer, welding and accident calculations and solid aluminum rails are assumed for the decontamination calculations. This ensures conservative dose rates on the TC side.

- Three inches of supplemental neutron shielding and one inch of steel are assumed to be placed on top of the 32PTH1 DSC cover plates during welding operations.

- During the accident case, the cask neutron shield (water) and the neutron shield jacket (outer steel skin) is assumed to be lost.
- The borated neutron absorber sheets in the 32PTH1 DSC are modeled as aluminum.
- Axial peaking factors assumed as shown in Table U.5-11.
- Fuel is homogenized within the fuel assembly perimeter, although the 32PTH1 DSC basket is modeled explicitly.
- The OS200 TC is equipped with channels to allow air flow through the bottom and lid at top. The air gaps formed by these channels are conservatively assumed to extend around the entire circumference of the cask.

U.5.4.7 Normal Condition Models

Two classes of MCNP models are developed: (1) 32PTH1 DSC in HSM-H and (2) 32PTH1 DSC in OS200 TC. These models are described in subsequent sections.

U.5.4.7.1 32PTH1 DSC in HSM-H

Two three-dimensional MCNP models are developed for the 32PTH bounding DSC within a HSM-H: one model for neutrons and the other for gammas. Note that the DSC is loaded in HSM-H in accordance with the bounding HLZC depicted on Figure U.5-3. This is a fictitious HLZC but it results in HSM dose rates that are bounding for all DSC/HSM shielding and source terms combinations defined for NUHOMS®-32PTH1 system. These models are presented in Figure U.5-4 through Figure U.5-8. The HSM-H length is designated as the z axis, the width as the x axis, and the height as the y axis. The HSM-H door is designated as the south side and the –z direction, with the west wall as the –x direction. The roof is the +y direction. The west wall is designated as a reflective boundary and an end shield wall (3 ft thick) is attached to the east wall.

The bottom (bottom of bottom fitting) of the fuel assembly is assigned to a z plane at -135.94 cm. The center of the HSM-H is at (x,y,z)=(0,0, 380.68). The 32PTH1 DSC Type-1 lid is located at approximately 3" from the HSM-H rear wall (z=626.38 cm). The bottom of the DSC is at z=116.33 cm, about 9.65 cm in from the door interior. The 32PTH1 DSC support rails are not included in the model. The heat shields are modeled as flat plates and horizontal vent "liner" plates (2 cm thick) are modeled in the top side vents. The HSM-H door is modeled with 3 inches of stainless steel and approximately 25 inches of concrete.

Dose rates are calculated on thin cells surrounding the HSM-H and are segmented into 20 to 30 cm increments to capture the peak dose rates. Dose rates are also calculated at the inlet and outlet vents. Dose rates for this scenario are provided in Table U.5-1. Dose rates for the front, side shield wall and roof surface at DSC centerline of the HSM-H are also plotted as a function of distance in Figure U.5-14 through Figure U.5-19, respectively.

A sample MCNP model input file of HSM-H with 32PTH1 DSC is included in Section **Error! Reference source not found.**.

U.5.4.7.2 32PTH1-L DSC in OS200 TC

Two three-dimensional MCNP models are employed for shielding analyses of the 32PTH1 DSC within an OS200 TC: one model for neutrons and the other for gammas. These models are presented in Figure U.5-9 through Figure U.5-13. The z-axis in the MCNP models coincides with the axis of rotation of the cask and the 32PTH1 DSC. Select features within the cask and on its surface are neglected because they produce only localized effects and have minimal impact on operational dose rates. Examples of neglected features include the relief valves, clevises, and eyebolts. With the exception of the neutron shield support angles and the trunnions, the balance of these items are local features that increase the shielding in a small area without replacing any of the shielding material which is included in the model. The additional shielding material that these features provide is not smeared into the bulk shielding, nor is any credit taken for it in the occupational exposure calculation. The neutron shield support angles and trunnions are modeled explicitly. The density of the neutron shield water used in the cask MCNP models is 0.958 g/cm^3.

Design features relevant to the shielding analysis of the OS200 TC and 32PTH1 DSC are modeled in MCNP. The overall length of the OS200 TC is 210.72". The outer diameter of the OS200 TC is 92.12" (neutron shield included). The outer diameter excluding the neutron shield is 81.84". The bottom of the OS200 TC is designed to mate with a 32PTH1 DSC. The overall length of the 32PTH1 DSC as modeled is 192.75" (excluding the grapple) and its outer diameter is 69.75". The bottom end of the 32PTH1 DSC is elevated approximately 6.72" from the bottom of the OS200 TC.

The OS200 TC has a ventilated top lid to facilitate air circulation. In MCNP, the ventilation cutouts in the top cover assembly are modeled as a single complete annular gap. The supporting steel around the bolts is modeled by reducing the density by 50%. Likewise, the density of the neutron shielding in the top lid is also reduced by 50% to conservatively account for the bolt cutouts. The ram access cover is modeled in the shielding evaluation.

Dose rates for this scenario are provided in Table U.5-2. Dose rates on the side, top, and bottom of this cask are presented graphically in Figure U.5-20 through Figure U.5-22.

A sample MCNP model input file for OS200 TC with 32PTH1 is included in Section **Error! Reference source not found.**.

U.5.4.8 Accident Models

No accident models were developed for the HSM-H because no accident scenario in Chapter U.11 has been identified that would alter the dose rates provided in Table U.5-1.

For the OS200 TC, an accident case is performed assuming the neutron shield and steel neutron shield jacket (outer skin) of each have been torn off. This bounds the fire and cask drop accidents described in Chapter U.11. A second case is considered to analyze the effect of damaged fuel turning to rubble in the bottom of the cask following an accident. The dose rates from fuel rubble exhibit local peaking; however at far distances the accident dose rates without damaged fuel are conservative. Accident dose rates at 1m, 100m, and 500m from the side of the cask are presented in Table U.5-2

U.5.4.9 OS200 TC Models During Fuel Loading Operations

MCNP models are developed for the cask decontamination and welding operations during fuel loading using the 32PTH1 DSC.

Cask Decontamination: The 32PTH1 DSC and the OS200 TC are assumed to be completely filled with water up to the bottom surface of the DSC shield plug and including the region between 32PTH1-DSC and cask, which is referred to as the "cask/32PTH1-DSC annulus." The 32PTH1-DSC top shield plug and inner top cover plate are assumed to be in place and the temporary shielding has not yet been installed. These models are utilized axially to determine the dose rates prior to the installation of the welding system. Results for this case are provided in Table U.5-3.

Welding and 32PTH1-DSC Draining: Before the start of welding operation, approximately 60% of the water in the DSC cavity is removed due to hydrogen generation. A dry DSC cavity is assumed in all welding models to be conservative. Temporary shielding consisting of three inches of NS-3 and one inch of steel is assumed to cover the 32PTH1-DSC inner top cover plate. In addition, the DSC outer top cover plate is not present. The cask/32PTH1-DSC annulus is assumed to remain completely filled with water. Results for this case are provided in Table U.5-3.

U.5.5 Appendix

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Table U.5-1
Summary of Bounding Maximum and Average Dose Rates with NUHOMS®-32PTH1 Bounding DSC in HSM-H (2)

Dose Rate Location	Maximum Gamma (mrem/hr)	Gamma MCNP 1σ Error	Maximum Neutron (mrem/hr)	Neutron MCNP 1σ Error	Maximum Total(1) (mrem/hr)	Total MCNP 1σ Error
HSM Roof (centerline)	14.13	0.04	0.74	0.01	14.86	0.04
HSM Roof Bird screen	114.71	0.01	6.47	0.01	121.17	0.01
HSM End (Side) Shield Wall Surface	1.49	0.05	0.06	0.01	1.54	0.05
HSM Door Exterior Surface (centerline)	0.61	0.07	0.08	0.06	0.70	0.06
HSM Front Bird screen	471.28	0.04	5.89	0.02	477.17	0.04

Dose Rate Location	Gamma Average (mrem/hr)	Gamma MCNP 1σ Error	Average Neutron (mrem/hr)	Neutron MCNP 1σ Error	Average Total (mrem/hr)	Total MCNP 1σ Error
HSM Roof	11.27	0.01	0.62	<0.01	11.89	0.01
HSM End (Side) Shield Wall Surface	0.36	0.01	0.02	<0.01	0.38	0.01
HSM Front	14.87	0.06	0.31	0.02	15.19	0.06
HSM Back Shield Wall	0.07	0.01	0.004	0.01	0.07	0.01

Notes:

(1) Gamma and Neutron dose rate peaks do not always occur at same location; therefore, the maximum of total dose rate is not always the sum of the gamma plus neutron dose rate maximums.

(2) Dose is calculated using bounding 32PTH1 DSC, from the shielding performance stand point. This DSC contains the design basis assembly source loaded in accordance with bounding HLZC depicted in Figure U.5-3. Also, it is assumed that design basis CC sources are present in each fuel assembly.

Table U.5-2
Summary of NUHOMS® 32PTH1 DSC, OS200 TC Maximum Dose Rates During Transfer Operations

Dose Rate Location	Maximum Gamma (mrem/hr)	Gamma MCNP 1σ Error	Maximum Neutron (mrem/hr)	Neutron MCNP 1σ Error	Maximum Total(1) (mrem/hr)	Total MCNP 1σ Error
Cask Side Surface (Radial)	4.07E+02	0.0048	2.02E+02	0.0085	6.09E+02	0.0043
Cask Top Axial Surface	2.32E+02	0.0602	3.86E+01	0.0452	2.51E+02	0.0556
Cask Bottom Axial Surface	2.15E+03(2)	0.0181	1.40E+03(2)	0.0136	3.55E+03(2)	0.0122
50 cm from Cask Side (Radial)	2.39E+02	0.0047	1.23E+02	0.0082	3.62E+02	0.0042
50 cm from Cask Top Axial Surface	4.71E+01	0.0793	2.07E+01	0.0453	5.95E+01	0.0653
50 cm from Cask Bottom Axial Surface	9.25E+02	0.0190	3.43E+02	0.0194	1.27E+03	0.0148
1m from Cask Side (Radial)	1.61E+02	0.0046	8.39E+01	0.0082	2.45E+02	0.0041
1m from Cask Top Axial Surface	2.95E+01	0.0488	1.44E+01	0.0692	3.79E+01	0.0393
1m from Cask Bottom Axial Surface	4.65E+02	0.0200	1.40E+02	0.0299	6.05E+02	0.0169
Cask 1 m (Radial) Accident Condition	1.74E+02	0.0280	3.58E+03	0.003	3.76E+03	0.0031
Cask 100 m (Radial) Accident Condition	9.38E-02	0.0175	1.00E+00	0.0029	1.10E+00	0.0030
Cask 500 m (Radial) Accident Condition	5.25E-04	0.0188	3.40E-03	0.0043	3.92E-03	0.0045

Notes:

(1) Gamma and Neutron dose rate peaks do not always occur at same location; therefore, the total dose rate is not always the sum of the gamma plus neutron dose rate.

(2) The peak bottom surface dose rate is directly below the grapple ring cut out in the bottom of the cask. The bottom average dose rates, including the grapple area, are 113 mrem/hr gamma, 71 mrem/hr neutron for a total average dose rate of 184 mrem/hr.

Table U.5-3
Summary of NUHOMS® 32PTH1 DSC, OS200 TC Maximum Dose Rates During Decontamination and Welding Operations

Dose Rate Location	Maximum Gamma (mrem/hr)	Gamma MCNP 1σ Error	Maximum Neutron (mrem/hr)	Neutron MCNP 1σ Error	Maximum Total(1) (mrem/hr)	Total MCNP 1σ Error
Decontamination						
Cask Side Surface (Radial)	3.46E+02	0.0035	3.73E+02	0.0040	7.19E+02	0.0027
Top Axial Surface	8.32E+02	0.0226	9.34E+00	0.0308	8.33E+02	0.0226
Cask Bottom Axial Surface	1.70E+03(2)	0.0153	6.83E+01(2)	0.0424	1.77E+03(2)	0.0148
50 cm from Cask Side (Radial)	2.02E+02	0.0035	2.29E+02	0.0037	4.31E+02	0.0025
50 cm from Top Axial Surface	6.15E+02	0.0298	5.64E+00	0.0443	6.16E+02	0.0298
50 cm from Cask Bottom Axial Surface	7.31E+02	0.0160	1.82E+01	0.0534	7.49E+02	0.0157
1m from Cask Side (Radial)	1.35E+02	0.0034	1.58E+02	0.0037	2.92E+02	0.0025
1m from Top Axial Surface	4.27E+02	0.0345	3.61E+00	0.0537	4.28E+02	0.0344
1m from Cask Bottom Axial Surface	3.68E+02	0.0174	8.06E+00	0.0808	3.76E+02	0.0171
Welding						
Cask Side Surface (Radial)	3.09E+02	0.0053	1.47E+02	0.0076	4.56E+02	0.0043
Top Axial Surface	7.20E+02	0.1107	4.21E+01	0.0618	7.62E+02	0.1047
Cask Bottom Axial Surface	2.17E+03(3)	0.0164	1.22E+03(3)	0.0110	3.39E+03(3)	0.0112
50 cm from Cask Side (Radial)	1.85E+02	0.0051	8.99E+01	0.0072	2.75E+02	0.0042
50 cm from Top Axial Surface	4.25E+02	0.0214	1.74E+01	0.0592	4.42E+02	0.0207
50 cm from Cask Bottom Axial Surface	9.27E+02	0.0171	3.00E+02	0.0157	1.23E+03	0.0135
1 cm from Cask Side (Radial)	1.27E+02	0.0050	6.23E+01	0.0077	1.89E+02	0.0042
1 cm from Top Axial Surface	2.94E+02	0.0231	1.17E+01	0.0788	3.06E+02	0.0224
1 cm from Cask Bottom Axial Surface	4.66E+02	0.0182	1.21E+02	0.0244	5.87E+02	0.0153

Notes:

(1) Gamma and Neutron dose rate peaks do not always occur at same location; therefore, the total dose rate is not always the sum of the gamma plus neutron dose rate.

(2) The peak bottom surface dose rate is directly below the grapple ring cut out in the bottom of the cask. The bottom average dose rates, including the grapple area, are 86 mrem/hr gamma, 11 mrem/hr neutron for a total average dose rate of 97 mrem/hr.

(3) The peak bottom surface dose rate is directly below the grapple ring cut out in the bottom of the cask. The bottom average dose rates, including the grapple area, are 108 mrem/hr gamma, 57 mrem/hr neutron for a total average dose rate of 165 mrem/hr. Note that this bottom axial dose rate has no impact on the occupational exposure because no operations are performed near bottom axial location.

Table U.5-4
PWR Fuel Assembly Material Mass

Fuel Assembly Region, Length	Fuel Assembly Part	Material	Standard Fuel Assembly Mass (kg)	Reconstituted Fuel Assembly Mass (kg)
Top Nozzle, 6.23 in.	Top Nozzle/Misc Steel	SS-304	9.2	9.2
	Hold Down Spring	Inconel-718	1.8	1.8
Plenum, 8.73 in.	Upper Spring	Inconel-718	4.3	4.3
	Upper End Cap	Zircaloy-4	1.0	1.0
	Encompassing Clad.	Zircaloy-4	5.8	5.5
	Upper End Grid	Inconel-718	1.1	1.1
	Stainless Steel Rods	SS304	NA	1.7
In-core Region, 142.29 in.	Fuel Stack	UO_2	490	466
	Encompassing Clad.	Zircaloy-4	101.1	96.2
	Encompassing Guide Tube	Zircaloy-4	6.3	6.3
	Spacer Grids	Inconel-718	5.0	5.0
	Grid Supports	Zircaloy-4	0.64	0.64
	Stainless Steel Rods	SS304	NA	27.2
Bottom Nozzle, 8.38 in.	Lower End Plug	Zircaloy-4	8.9	8.5
	Encompassing Guide Tube	Zircaloy-4	0.1	0.1
	Lower Guide Tube Plugs	Zircaloy-4	1.4	1.4
	Lower End Fitting	SS 304	8.2	8.2
	Lower End Grid	Inconel-718	1.1	1.1
	Stainless Steel Rods	SS304	NA	0.5

Table U.5-5
Elemental Composition of LWR Fuel-Assembly Structural Materials

Element	Atomic Number	Material Composition, Grams per kg of Material				
		Zircaloy-4	Inconel-718	Inconel X-750	Stainless Steel 304	$U0_2$ Fuel
H	1	1.30E-02	-	-	-	-
Li	3	-	-	-	-	1.00E-03
B	5	3.30E-04	-	-	-	1.00E-03
C	6	1.20E-01	4.00E-01	3.99E-01	8.00E-01	8.94E-02
N	7	8.00E-02	1.30E+00	1.30E+00	1.30E+00	2.50E-02
O	8	9.50E-01	-	-	-	1.34E+02
F	9	-	-	-	-	1.07E-02
Na	11	-	-	-	-	1.50E-02
Mg	12	-	-	-	-	2.00E-03
Al	13	2.40E-02	5.99E+00	7.98E+00	-	1.67E-02
Si	14	-	2.00E+00	2.99E+00	1.00E+01	1.21E-02
P	15	-	-	-	4.50E-01	3.50E-02
S	16	3.50E-02	7.00E-02	7.00E-02	3.00E-01	-
Cl	17	-	-	-	-	5.30E-03
Ca	20	-	-	-	-	2.00E-03
Ti	22	2.00E-02	7.99E+00	2.49E+01	-	1.00E-03
V	23	2.00E-02	-	-	-	3.00E-03
Cr	24	1.25E+00	1.90E+02	1.50E+02	1.90E+02	4.00E-03
Mn	25	2.00E-02	2.00E+00	6.98E+00	2.00E+01	1.70E-03
Fe	26	2.25E+00	1.80E+02	6.78E+01	6.88E+02	1.80E-02
Co	27	1.00E-02	4.69E+00	6.49E+00	8.00E-01	1.00E-03
Ni	28	2.00E-02	5.20E+02	7.22E+02	8.92E+01	2.40E-02
Cu	29	2.00E-02	9.99E-01	4.99E-01	-	1.00E-03
Zn	30	-	-	-	-	4.03E-02
Zr	40	9.79E+02	-	-	-	-
Nb	41	-	5.55E+01	8.98E+00	-	-
Mo	42	-	3.00E+01	-	-	1.00E-02
Ag	47	-	-	-	-	1.00E-04
Cd	48	2.50E-04	-	-	-	2.50E-02
In	49	-	-	-	-	2.00E-03
Sn	50	1.60E+01	-	-	-	4.00E-03
Gd	64	-	-	-	-	2.50E-03
Hf	72	7.80E-02	-	-	-	-
W	74	2.00E-02	-	-	-	2.00E-03
Pb	82	-	-	-	-	1.00E-03
U	92	2.00E-04	-	-	-	8.81E+02

Table U.5-6
Flux Scaling Factors By Fuel Assembly Region

Fuel Assembly Region	Flux Factor
Bottom	0.20
In-Core	1.00
Plenum	0.20
Top	0.10

Table U.5-7
Gamma and Neutron Source Term for 1.0 kW Fuel (62 GWd/MTU, 3.4 wt. % U-235 and 20.5-Year Cooled)

CASK-81 Energy Group	E_{upper} (MeV)	E_{mean} (MeV)	Top Region (γ/s/assembly)	Plenum Region (γ/s/assembly)	Fuel Region (γ/s/assembly)	Bottom Region (γ/s/assembly)
23	10	9	0.00E+00	0.00E+00	5.37E+05	0.00E+00
24	8	7.25	0.00E+00	0.00E+00	2.53E+06	0.00E+00
25	6.5	5.75	0.00E+00	0.00E+00	1.29E+07	0.00E+00
26	5	4.5	0.00E+00	0.00E+00	3.21E+07	0.00E+00
27	4	3.5	3.75E-11	2.33E-10	9.56E+07	4.56E-11
28	3	2.75	1.69E+04	5.37E+04	5.62E+08	2.44E+04
29	2.5	2.25	1.09E+07	3.47E+07	4.82E+09	1.57E+07
30	2	1.83	9.53E-03	5.20E+01	8.93E+10	7.98E+01
31	1.66	1.495	4.60E+11	1.46E+12	9.16E+12	6.62E+11
32	1.33	1.165	1.63E+12	5.17E+12	5.51E+13	2.35E+12
33	1	0.9	1.40E+09	8.20E+09	2.29E+13	1.67E+09
34	0.8	0.7	1.38E+09	8.84E+09	1.85E+15	2.51E+09
35	0.6	0.5	5.54E+06	1.12E+09	3.51E+13	1.71E+09
36	0.4	0.35	8.78E+07	3.29E+08	3.46E+13	2.03E+08
37	0.3	0.25	6.76E+07	2.29E+08	5.28E+13	1.16E+08
38	0.2	0.15	1.35E+09	4.52E+09	1.75E+14	2.27E+09
39	0.1	0.075	5.59E+09	1.78E+10	2.61E+14	8.07E+09
40	0.05	0.025	4.74E+10	1.58E+11	1.31E+15	7.14E+10
Total Gamma			2.15E+12	6.83E+12	3.81E+15	3.10E+12
Total Neutron			9.33E+08 n/s/assembly			

Table U.5-8
Gamma and Neutron Source Term for 1.5 kW Fuel (62 GWd/MTU, 3.4 wt. % U-235 and 8.5-Year Cooled)

CASK-81 Energy Group	E_{upper} (MeV)	E_{mean} (MeV)	Top Region (γ/s/assembly)	Plenum Region (γ/s/assembly)	Fuel Region (γ/s/assembly)	Bottom Region (γ/s/assembly)
23	10	9	0.00E+00	0.00E+00	8.49E+05	0.00E+00
24	8	7.25	0.00E+00	0.00E+00	4.00E+06	0.00E+00
25	6.5	5.75	0.00E+00	0.00E+00	2.04E+07	0.00E+00
26	5	4.5	0.00E+00	0.00E+00	5.08E+07	0.00E+00
27	4	3.5	1.03E-09	6.19E-09	1.98E+09	1.22E-09
28	3	2.75	8.20E+04	2.61E+05	1.51E+10	1.18E+05
29	2.5	2.25	5.29E+07	1.68E+08	2.38E+11	7.62E+07
30	2	1.83	1.56E-02	6.98E+01	2.86E+11	1.07E+02
31	1.66	1.495	2.23E+12	7.08E+12	5.18E+13	3.21E+12
32	1.33	1.165	7.90E+12	2.51E+13	2.11E+14	1.14E+13
33	1	0.9	6.36E+09	1.05E+10	2.37E+14	1.03E+10
34	0.8	0.7	1.39E+09	2.04E+10	2.91E+15	2.02E+10
35	0.6	0.5	2.69E+07	2.34E+10	4.77E+14	3.58E+10
36	0.4	0.35	4.25E+08	2.40E+09	5.17E+13	2.22E+09
37	0.3	0.25	3.25E+08	1.30E+09	8.11E+13	8.74E+08
38	0.2	0.15	6.53E+09	2.52E+10	2.82E+14	1.62E+10
39	0.1	0.075	2.71E+10	8.62E+10	3.72E+14	3.94E+10
40	0.05	0.025	2.16E+11	7.46E+11	1.95E+15	3.89E+11
Total Gamma			1.04E+13	3.31E+13	6.62E+15	1.51E+13
Total Neutron			1.48E+09 n/s/assembly			

Table U.5-9
Gamma and Neutron Source Term for 1.5 kW Fuel (32 GWd/MTU, 2.6 wt. % U-235 and 3.0-Year Cooled)

CASK-81 Energy Group	E_{upper} (MeV)	E_{mean} (MeV)	Top Region (γ/s/assembly)	Plenum Region (γ/s/assembly)	Fuel Region (γ/s/assembly)	Bottom Region (γ/s/assembly)
23	10	9	0.00E+00	0.00E+00	1.21E+05	0.00E+00
24	8	7.25	0.00E+00	0.00E+00	5.68E+05	0.00E+00
25	6.5	5.75	0.00E+00	0.00E+00	2.90E+06	0.00E+00
26	5	4.5	0.00E+00	0.00E+00	7.22E+06	0.00E+00
27	4	3.5	6.50E-10	3.90E-09	3.37E+10	7.71E-10
28	3	2.75	9.21E+04	2.93E+05	2.73E+11	1.33E+05
29	2.5	2.25	5.94E+07	1.89E+08	1.07E+13	8.55E+07
30	2	1.83	7.01E+05	2.25E+06	3.55E+12	1.04E+06
31	1.66	1.495	2.50E+12	7.96E+12	7.97E+13	3.60E+12
32	1.33	1.165	8.86E+12	2.82E+13	2.48E+14	1.28E+13
33	1	0.9	1.97E+11	6.41E+10	4.49E+14	3.46E+11
34	0.8	0.7	7.56E+08	2.90E+10	2.53E+15	3.86E+10
35	0.6	0.5	7.59E+07	4.73E+10	1.22E+15	7.24E+10
36	0.4	0.35	4.77E+08	3.63E+09	1.34E+14	3.94E+09
37	0.3	0.25	3.64E+08	1.71E+09	1.77E+14	1.37E+09
38	0.2	0.15	7.33E+09	3.22E+10	6.46E+14	2.43E+10
39	0.1	0.075	3.04E+10	9.72E+10	7.36E+14	4.47E+10
40	0.05	0.025	2.51E+11	9.46E+11	3.32E+15	6.33E+11
Total Gamma			1.19E+13	3.74E+13	9.55E+15	1.75E+13
Total Neutron			2.10E+08 n/s/assembly			

Table U.5-10
Design Basis CC Source Terms

CASK-81 Energy Group	E_{upper} (MeV)	E_{mean} (MeV)	Top Region (γ/s/assembly)	Plenum Region (γ/s/assembly)	Fuel Region (γ/s/assembly)
23	10	9	0.00E+00	0.00E+00	0.00E+00
24	8	7.25	0.00E+00	0.00E+00	0.00E+00
25	6.5	5.75	0.00E+00	0.00E+00	0.00E+00
26	5	4.5	0.00E+00	0.00E+00	0.00E+00
27	4	3.5	3.95E-15	6.52E-14	7.27E-18
28	3	2.75	3.94E+04	2.18E+04	5.50E+05
29	2.5	2.25	1.27E+07	7.04E+06	1.78E+08
30	2	1.83	9.58E+01	8.81E+01	9.15E-05
31	1.66	1.495	7.14E+11	3.95E+11	9.95E+12
32	1.33	1.165	1.69E+12	9.34E+11	2.36E+13
33	1	0.9	6.95E+09	4.18E+09	4.70E+09
34	0.8	0.7	4.16E+09	1.78E+10	2.84E+09
35	0.6	0.5	3.24E+07	3.85E+10	4.51E+08
36	0.4	0.35	7.01E+07	2.43E+10	9.78E+08
37	0.3	0.25	2.06E+08	3.48E+09	2.87E+09
38	0.2	0.15	1.22E+09	3.53E+09	1.70E+10
39	0.1	0.075	8.19E+09	5.18E+09	1.14E+11
40	0.05	0.025	8.48E+10	1.38E+11	1.17E+12
Total Gamma			2.51E+12	1.56E+12	3.48E+13

Table U.5-11
Source Term Peaking Factor Summary

Active Fuel Zone Number	Active Fuel Zone Center (% of height)	OS200 Transfer Cask	
		Gamma	Neutron
1	2.78	0.573	0.108
2	8.33	0.917	0.707
3	13.89	1.066	1.291
4	19.44	1.106	1.496
5	25	1.114	1.540
6	30.56	1.111	1.524
7	36.11	1.106	1.496
8	41.69	1.101	1.469
9	47.22	1.097	1.448
10	52.78	1.093	1.427
11	58.33	1.089	1.406
12	63.89	1.086	1.391
13	69.44	1.081	1.366
14	75	1.073	1.326
15	80.56	1.051	1.220
16	86.11	0.993	0.972
17	91.67	0.832	0.479
18	97.22	0.512	0.069
Average		1.000	1.152

Active Fuel Zone Number	Active Fuel Zone Center (% of height)	HSM-H	
		Gamma	Neutron
1	2.5	0.655	0.184
2	7.5	0.911	0.689
3	12.5	1.009	1.036
4	17.5	1.041	1.174
5	22.5	1.069	1.306
6	27.5	1.072	1.321
7	32.5	1.072	1.321
8	37.5	1.071	1.316
9	42.5	1.07	1.311
10	47.5	1.069	1.306
11	52.5	1.069	1.306
12	57.5	1.068	1.301
13	62.5	1.068	1.301
14	67.5	1.069	1.306
15	72.5	1.068	1.301
16	77.5	1.066	1.291
17	82.5	1.041	1.174
18	87.5	0.994	0.976
19	92.5	0.879	0.597
20	97.5	0.639	0.167
Average		1.000	1.084

Table U.5-12
Shielding Material Densities and Assembly Region Material Densities

Element	Atomic Number	Number Density (atom/b-cm)			
		Bottom End Fitting	Fuel	Plenum	Top End Fitting
O	8	-	1.47E-02	-	-
Al	13	1.43E-05	3.93E-06	6.95E-05	3.24E-05
Ti	22	1.07E-05	2.95E-06	5.22E-05	2.43E-05
Cr	24	2.05E-03	7.19E-05	1.15E-03	3.25E-03
Mn	25	1.79E-04	-	-	2.71E-04
Fe	26	6.48E-03	9.19E-05	1.40E-03	9.97E-03
Ni	28	1.31E-03	1.56E-04	2.76E-03	2.42E-03
Zr	40	6.77E-03	4.12E-03	4.23E-03	-
Mo	42	2.01E-05	5.53E-06	9.77E-05	4.56E-05
Sn	50	8.49E-05	5.16E-05	5.30E-05	-
U-235	92	-	3.69E-04	-	-
U-238	92	-	6.93E-03	-	-
Total		1.69E-02	2.65E-02	9.81E-03	1.60E-02

Other Shielding Materials

Element/ Isotope	Atomic Number	Number Density (atom/b-cm)							
		NS-3	Water	Air	Lead	Carbon Steel	Concrete	Stainless Steel	Aluminum
H	1	4.498E-2	6.405E-2	-	-	-	7.677E-3	-	-
B-10	5	3.054E-4	-	-	-	-	-	-	-
B-11	5	1.229E-3	-	-	-	-	-	-	-
C	6	8.469E-3	-	-	-	3.921E-3	-	3.177E-4	-
N	7	-	-	3.717E-5	-	-	-	-	-
O	8	3.704E-2	3.202E-2	9.894E-6	-	-	4.356E-2	-	-
Na	11	-	-	-	-	-	1.036E-3	-	-
Al	13	6.887E-3	-	-	-	-	2.360E-3	-	6.031E-2
Si	14	1.243E-3	-	-	-	-	1.572E-2	1.698E-3	-
P	15	-	-	-	-	-	-	6.929E-5	-
Ar	18	-	-	-	-	-	-	-	-
K	19	-	-	-	-	-	6.850E-4	-	-
Ca	20	1.454E-3	-	-	-	-	2.881E-3	-	-
Cr	24	-	-	-	-	-	-	1.743E-2	-
Mn	25	-	-	-	-	-	-	1.736E-3	-
Fe	26	1.042E-4	-	-	-	8.350E-2	3.091E-4	5.840E-2	-
Ni	28	-	-	-	-	-	-	7.720E-3	-
Zn	30	-	-	-	-	-	-	-	-
Pb	82	-	-	-	3.248E-2	-	-	-	-
Total		1.017E-01	9.607E-02	4.707E-05	3.248E-02	8.742E-02	7.424E-2	8.736E-02	6.031E-02

Table U.5-13
Material Densities for Fuel/Basket Region Used in ANISN Models

Element	Atomic Number	Number Density (atom/b-cm)
O	8	1.01E-02
Al	13	1.02E-02
Ti	22	2.04E-06
Cr	24	1.78E-03
Mn	25	1.72E-04
Fe	26	6.00E-03
Ni	28	8.26E-04
Zr	40	2.85E-03
Mo	42	3.82E-06
Sn	50	3.57E-05
U-235	92	2.55E-04
U-238	92	4.79E-03
Total		3.70E-02

Table U.5-14
Neutron Source for ANISN Calculation

CASK-81 Energy Group	E_{upper} (MeV)	E_{mean} (MeV)	Normalized Cm-244 Fission Source	ANISN Neutron Source (n/s-cm^3)
1	1.49E+01	1.36E+01	1.26E-04	5.063E-10
2	1.22E+01	1.11E+01	1.07E-03	4.299E-09
3	1.00E+01	9.09E+00	2.94E-03	1.181E-08
4	8.18E+00	7.27E+00	1.46E-02	5.866E-08
5	6.36E+00	5.66E+00	3.71E-02	1.491E-07
6	4.96E+00	4.51E+00	4.90E-02	1.969E-07
7	4.06E+00	3.54E+00	1.23E-01	4.942E-07
8	3.01E+00	2.74E+00	1.01E-01	4.058E-07
9	2.46E+00	2.41E+00	2.46E-02	9.884E-08
10	2.35E+00	2.09E+00	1.27E-01	5.103E-07
11	1.83E+00	1.47E+00	2.27E-01	9.121E-07
12	1.11E+00	8.30E-01	2.01E-01	8.076E-07
13	5.50E-01	3.31E-01	9.25E-02	3.717E-07
14	1.11E-01	5.72E-02	3.99E-06	1.603E-11
15	3.35E-03	1.97E-03	0	0
16	5.83E-04	3.42E-04	0	0
17	1.01E-04	6.50E-05	0	0
18	2.90E-05	1.96E-05	0	0
19	1.01E-05	6.58E-06	0	0
20	3.06E-06	2.09E-06	0	0
21	1.12E-06	7.67E-07	0	0
22	4.14E-07	2.12E-07	0	0
Total			1.00E+00	4.02E-06

Table U.5-15
ANISN Response Function for the OS200 TC

Response Function	Lower Energy (MeV)	Upper Energy (Mev)	32PTH1 Zone 1		32PTH1 Zone 2		32PTH1 Zone 3		32PTH1 Uniform	
			neutron (mrem/hr)	gamma (mrem/hr)(1)	neutron (mrem/hr)	gamma (mrem/hr)(1)	neutron (mrem/hr)	gamma (mrem/hr)(1)	neutron (mrem/hr)	gamma (mrem/hr)(1)
Neutrons	0.00	20.00	8.53E-10	1.69E-09	8.13E-09	1.07E-08	4.37E-08	3.29E-08	5.27E-08	4.52E-08
Group 40	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Group 39	0.05	0.10	0.0	0.0	0.0	0.0	0.0	2.83E-40	0.0	2.93E-40
Group 38	0.10	0.20	0.0	0.0	0.0	0.00E+00	0.0	2.19E-31	0.0	2.24E-31
Group 37	0.20	0.30	0.0	3.29E-43	0.0	1.46E-32	0.0	3.99E-23	0.0	3.99E-23
Group 36	0.30	0.40	0.0	2.45E-38	0.0	2.69E-28	0.0	2.28E-19	0.0	2.28E-19
Group 35	0.40	0.60	0.0	1.75E-32	0.0	6.28E-25	0.0	1.24E-18	0.0	1.25E-18
Group 34	0.60	0.80	0.0	1.69E-25	0.0	1.64E-20	0.0	1.82E-16	0.0	1.82E-16
Group 33	0.80	1.00	0.0	4.45E-22	0.0	4.67E-18	0.0	8.02E-15	0.0	8.02E-15
Group 32	1.00	1.33	0.0	1.99E-19	0.0	3.63E-16	0.0	1.50E-13	0.0	1.50E-13
Group 31	1.33	1.66	0.0	7.51E-18	0.0	5.21E-15	0.0	9.48E-13	0.0	9.49E-13
Group 30	1.66	2.00	0.0	6.40E-17	0.0	2.53E-14	0.0	2.82E-12	0.0	2.85E-12
Group 29	2.00	2.50	0.0	3.62E-16	0.0	8.91E-14	0.0	6.73E-12	0.0	6.82E-12
Group 28	2.50	3.00	0.0	1.12E-15	0.0	2.05E-13	0.0	1.21E-11	0.0	1.23E-11
Group 27	3.00	4.00	0.0	2.80E-15	0.0	3.97E-13	0.0	1.90E-11	0.0	1.94E-11
Group 26	4.00	5.00	0.0	4.61E-15	0.0	5.70E-13	0.0	2.43E-11	0.0	2.49E-11
Group 25	5.00	6.50	0.0	5.83E-15	0.0	6.68E-13	0.0	2.70E-11	0.0	2.76E-11
Group 24	6.50	8.00	0.0	5.83E-15	0.0	6.55E-13	0.0	2.62E-11	0.0	2.69E-11
Group 23	8.00	10.00	0.0	4.50E-15	0.0	5.19E-13	0.0	2.16E-11	0.0	2.21E-11

Note:

1. Response function for capture gamma.

Table U.5-16
ANISN Response Function for the HSM-H

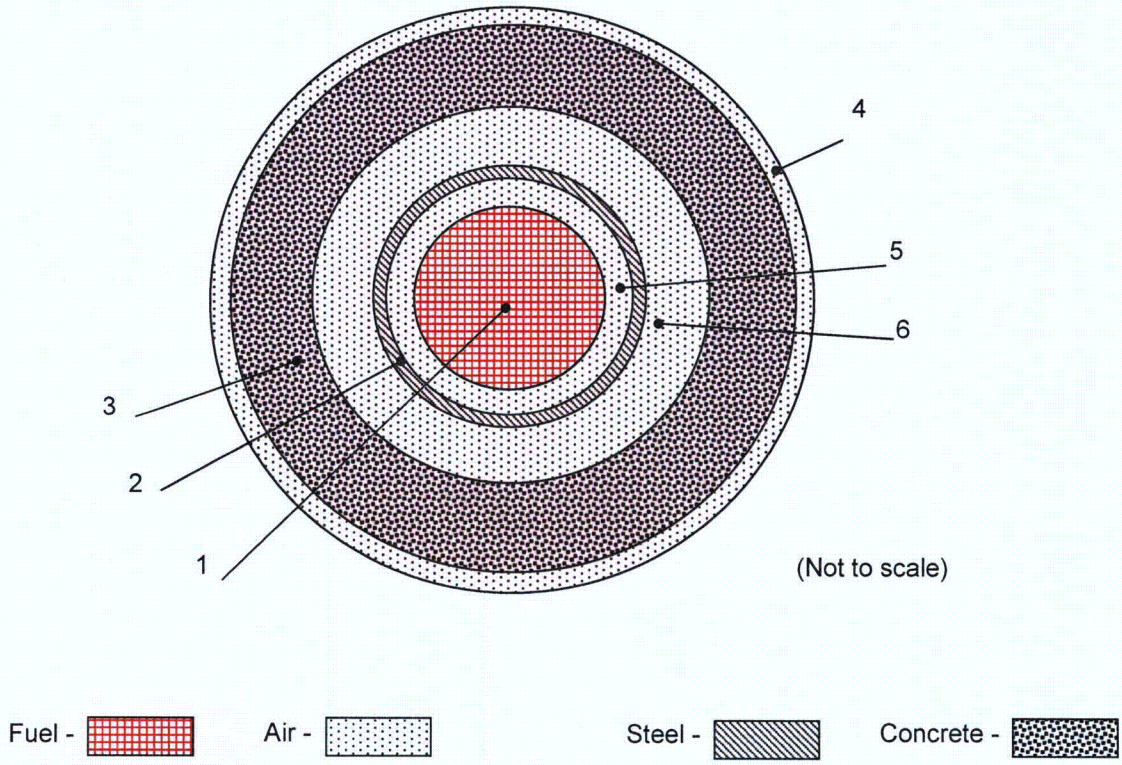
Response Function	Lower Energy (MeV)	Upper Energy (Mev)	32PTH1 Zone 1		32PTH1 Zone 2		32PTH1 Zone 3		32PTH1 Uniform	
			neutron (mrem/hr)	gamma (mrem/hr)(1)	neutron (mrem/hr)	gamma (mrem/hr)(1)	neutron (mrem/hr)	gamma (mrem/hr)(1)	neutron (mrem/hr)	gamma (mrem/hr)(1)
Neutrons	0.00	20.00	4.12E-13	3.91E-12	5.33E-12	2.58E-11	4.03E-11	8.99E-11	4.60E-11	1.20E-10
Group 40	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Group 39	0.05	0.10	0.0	0.0	0.0	0.0	0.0	3.03E-35	0.0	4.24E-35
Group 38	0.10	0.20	0.0	0.0	0.0	4.68E-39	0.0	1.79E-23	0.0	1.82E-23
Group 37	0.20	0.30	0.0	6.15E-42	0.0	2.74E-31	0.0	8.45E-22	0.0	8.45E-22
Group 36	0.30	0.40	0.0	2.79E-39	0.0	2.94E-29	0.0	2.31E-20	0.0	2.31E-20
Group 35	0.40	0.60	0.0	3.13E-32	0.0	1.12E-24	0.0	1.65E-18	0.0	1.65E-18
Group 34	0.60	0.80	0.0	1.92E-26	0.0	1.88E-21	0.0	2.61E-17	0.0	2.61E-17
Group 33	0.80	1.00	0.0	8.69E-24	0.0	9.25E-20	0.0	2.02E-16	0.0	2.02E-16
Group 32	1.00	1.33	0.0	2.08E-21	0.0	3.85E-18	0.0	1.97E-15	0.0	2.00E-15
Group 31	1.33	1.66	0.0	7.57E-20	0.0	5.35E-17	0.0	1.21E-14	0.0	1.23E-14
Group 30	1.66	2.00	0.0	8.04E-19	0.0	3.30E-16	0.0	4.80E-14	0.0	4.84E-14
Group 29	2.00	2.50	0.0	6.87E-18	0.0	1.79E-15	0.0	1.80E-13	0.0	1.82E-13
Group 28	2.50	3.00	0.0	3.23E-17	0.0	6.48E-15	0.0	5.31E-13	0.0	5.37E-13
Group 27	3.00	4.00	0.0	1.57E-16	0.0	2.52E-14	0.0	1.72E-12	0.0	1.75E-12
Group 26	4.00	5.00	0.0	4.60E-16	0.0	6.80E-14	0.0	4.44E-12	0.0	4.51E-12
Group 25	5.00	6.50	0.0	1.04E-15	0.0	1.50E-13	0.0	9.73E-12	0.0	9.88E-12
Group 24	6.50	8.00	0.0	1.70E-15	0.0	2.54E-13	0.0	1.75E-11	0.0	1.77E-11
Group 23	8.00	10.00	0.0	1.90E-15	0.0	3.22E-13	0.0	2.54E-11	0.0	2.57E-11

Note:

1. Response function for capture gamma.

Table U.5-17
Flux to Dose Rate Conversion Factors

Neutron		Gamma	
E (MeV)	(mrem/hr)/(n/cm^2/s)	E (MeV)	(mrem/hr)/(γ/cm^2/s)
2.50E-08	3.67E-03	0.01	3.96E-03
1.00E-07	3.67E-03	0.03	5.82E-04
1.00E-06	4.46E-03	0.05	2.90E-04
1.00E-05	4.54E-03	0.07	2.58E-04
1.00E-04	4.18E-03	0.1	2.83E-04
0.001	3.76E-03	0.15	3.79E-04
0.01	3.56E-03	0.2	5.01E-04
0.1	2.17E-02	0.25	6.31E-04
0.5	9.26E-02	0.3	7.59E-04
1	1.32E-01	0.35	8.78E-04
2.5	1.25E-01	0.4	9.85E-04
5	1.56E-01	0.45	1.08E-03
7	1.47E-01	0.5	1.17E-03
10	1.47E-01	0.55	1.27E-03
14	2.08E-01	0.6	1.36E-03
20	2.27E-01	0.65	1.44E-03
		0.7	1.52E-03
		0.8	1.68E-03
		1	1.98E-03
		1.4	2.51E-03
		1.8	2.99E-03
		2.2	3.42E-03
		2.6	3.82E-03
		2.8	4.01E-03
		3.25	4.41E-03
		3.75	4.83E-03
		4.25	5.23E-03
		4.75	5.60E-03
		5	5.80E-03
		5.25	6.01E-03
		5.75	6.37E-03
		6.25	6.74E-03
		6.75	7.11E-03
		7.5	7.66E-03
		9	8.77E-03
		11	1.03E-02
		13	1.18E-02
		15	1.33E-02

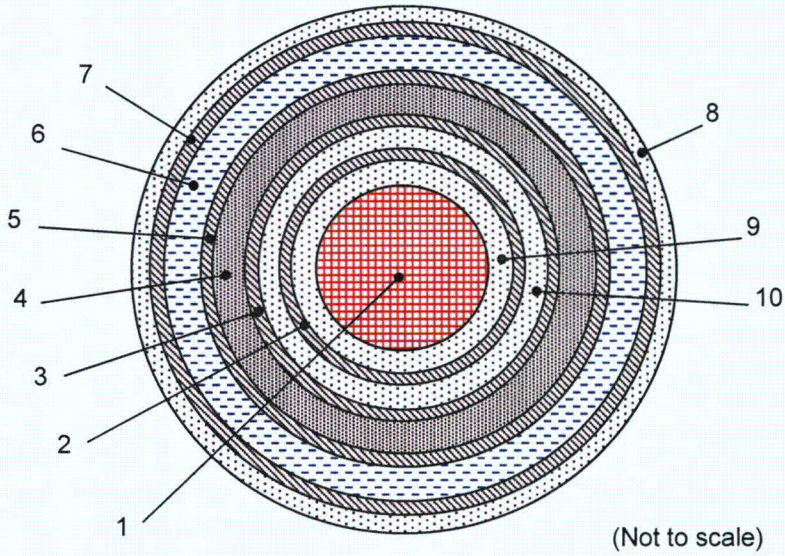


1. Active Fuel (in-core region)
2. DSC Structural Shell
3. HSM Concrete

4, 5, 6. Air

Item No.	Zone Description	Outer Radius (cm)
1	Zone 1	29.43
1	Zone 2	58.87
1	Zone 3	83.25
5	Air gap between fuel and DSC	85.80
2	DSC/Rail OD	88.58
6	Air gap between DSC and HSM	193.04
3	HSM concrete OD	304.80
4	Air outside HSM	420.00

Figure U.5-1
ANISN HSM-H Model



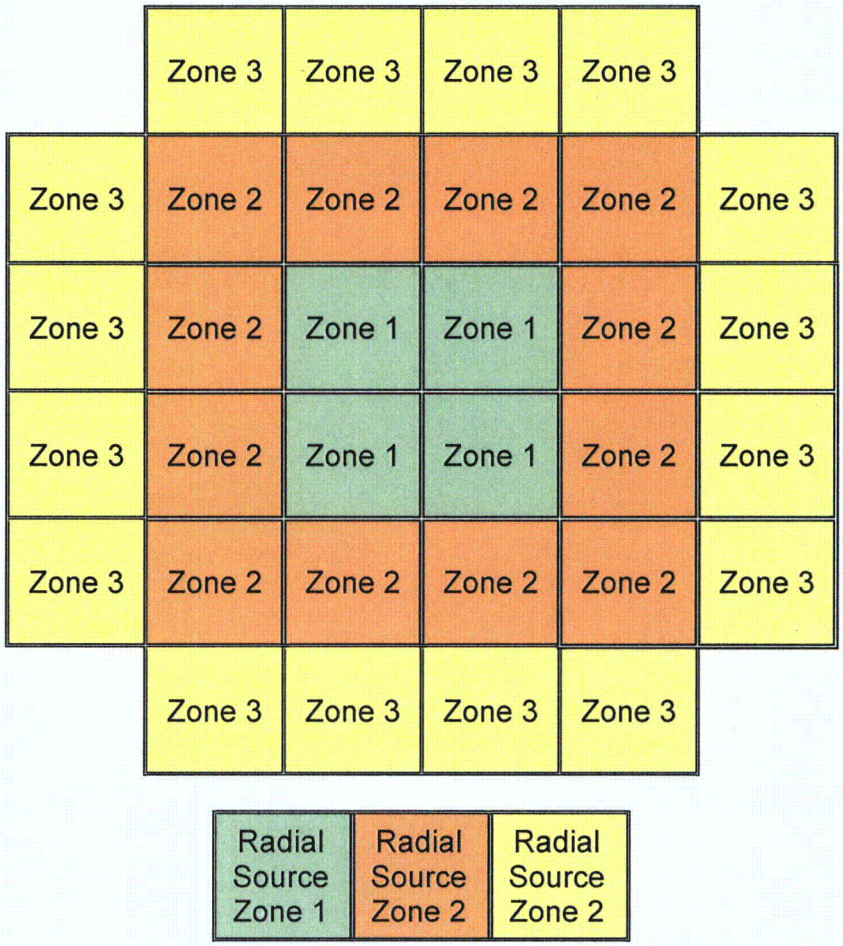
Fuel - Air - Steel - Lead - Water -

1. Cask Outer Shell
2. Cask Neutron Shield
3. Cask Neutron Shield Jacket Housing
4. Active Fuel (in-core region)
5. DSC Structural Shell
6. Cask Inner Shell
7. Cask Gamma Shield

8, 9, 10. Air

Item No.	Zone Description	Outer Radius (cm)
1	Zone 1	29.43
1	Zone 2	58.87
1	Zone 3	83.25
9	Air gap between fuel and DSC	85.80
2	DSC/Rail OD	88.58
10	Air gap between DSC and TC	89.54
3	TC inner shell OD	91.08
4	TC lead OD	100.18
5	TC outer shell OD	105.26
6	TC water OD	116.51
7	TC jacket OD	116.98
8	~1" from TC	120.00

Figure U.5-2
ANISN OS200 TC Model



Heat Zone	Zone 1	Zone 2	Zone 3
Number of Fuel Assemblies	4	12	16
Maximum Decay Heat (kW/FA)	1.0	1.5	1.5
Maximum Decay Heat per Zone (kW)	4.0	18.0	24.0
Maximum Decay Heat per DSC (kW)	46.0		

Figure U.5-3
32PTH1 DSC Bounding HLZC Used for Shielding Analysis

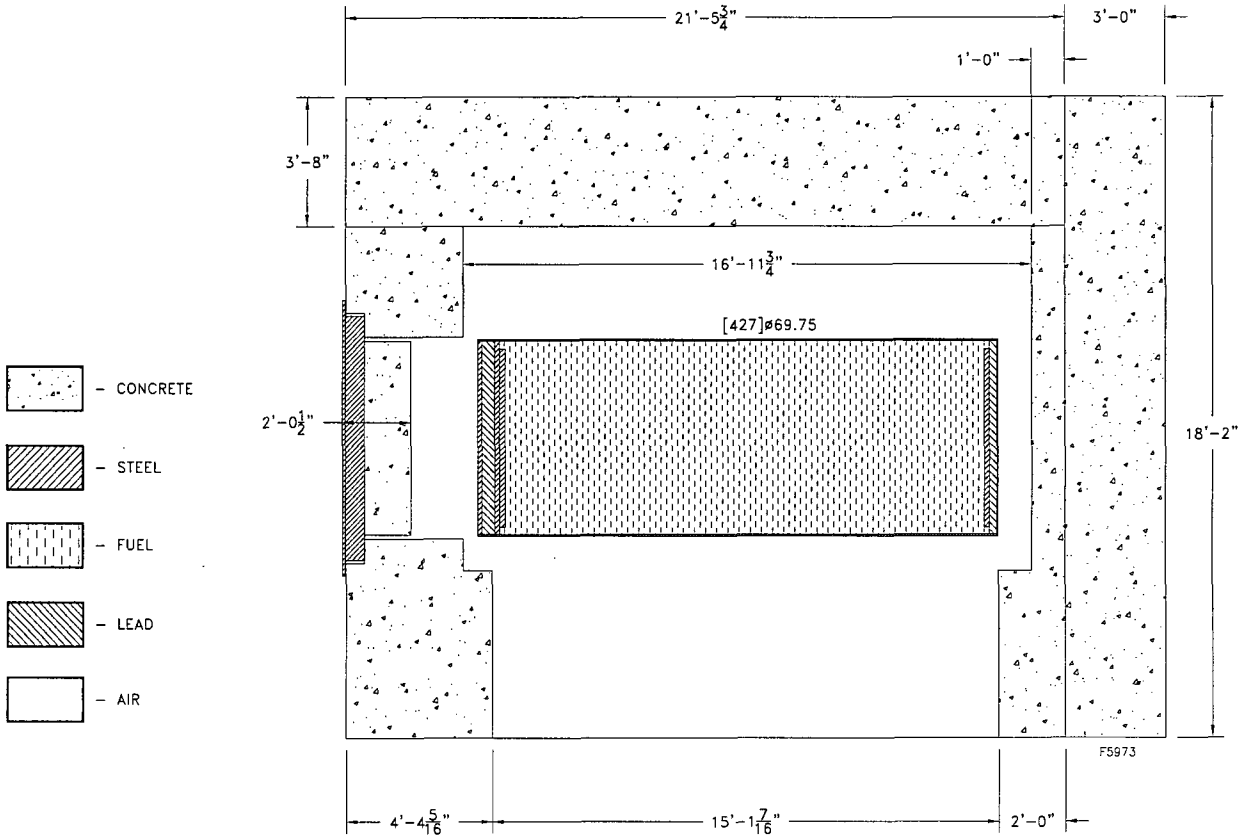


Figure U.5-4
32PTH1 DSC within HSM-H, Side View at Centerline of DSC

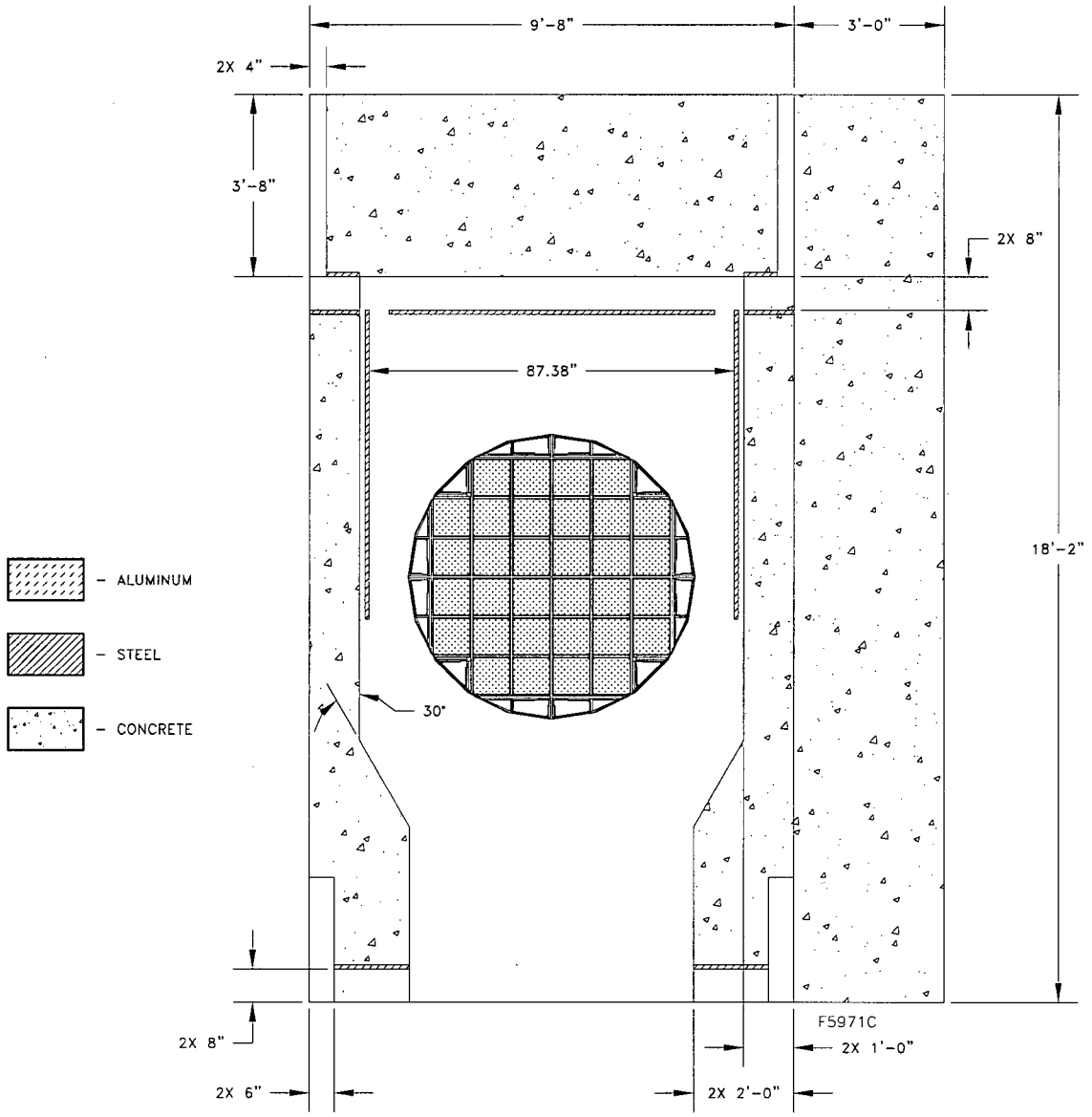


Figure U.5-5
32PTH1 DSC within HSM-H, Head-on View at Z=300 cm

(Top vents caps are not shown)

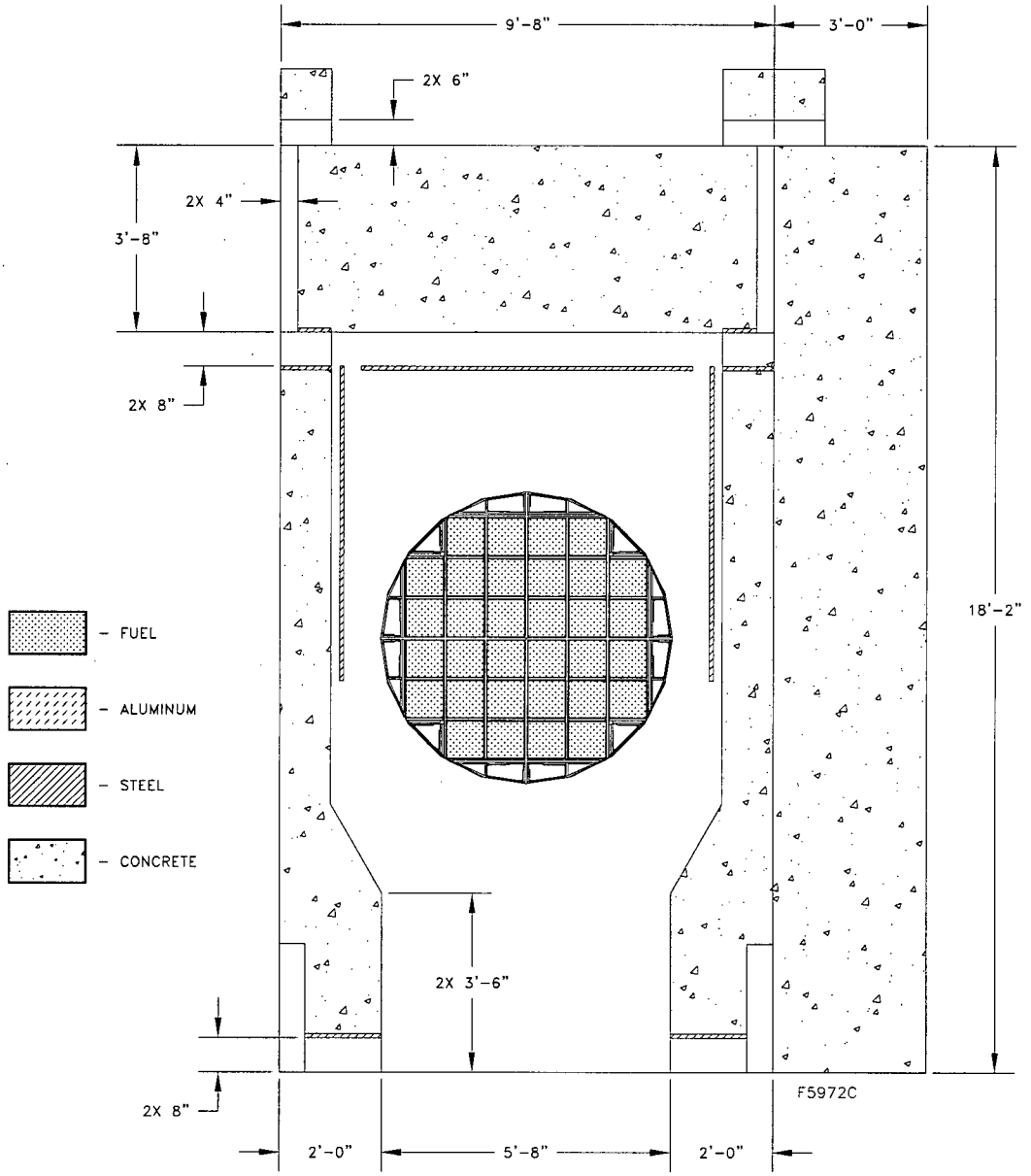


Figure U.5-6
32PTH1 DSC within HSM-H, Head-on View Showing Top Vents (Z=300 cm)

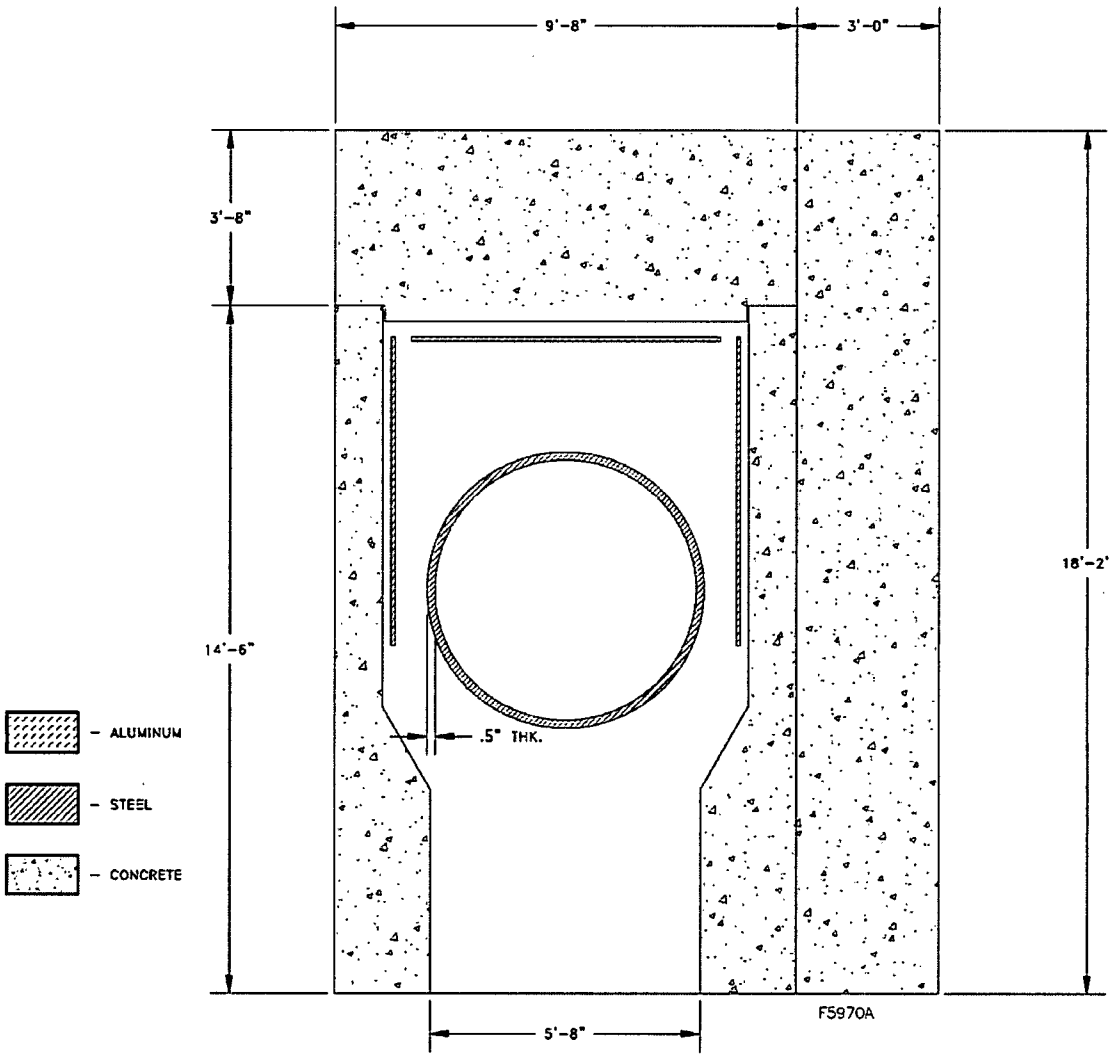


Figure U.5-7
32PTH1 DSC within HSM-H, Head-on View at Lid End of DSC (Z=560 cm)

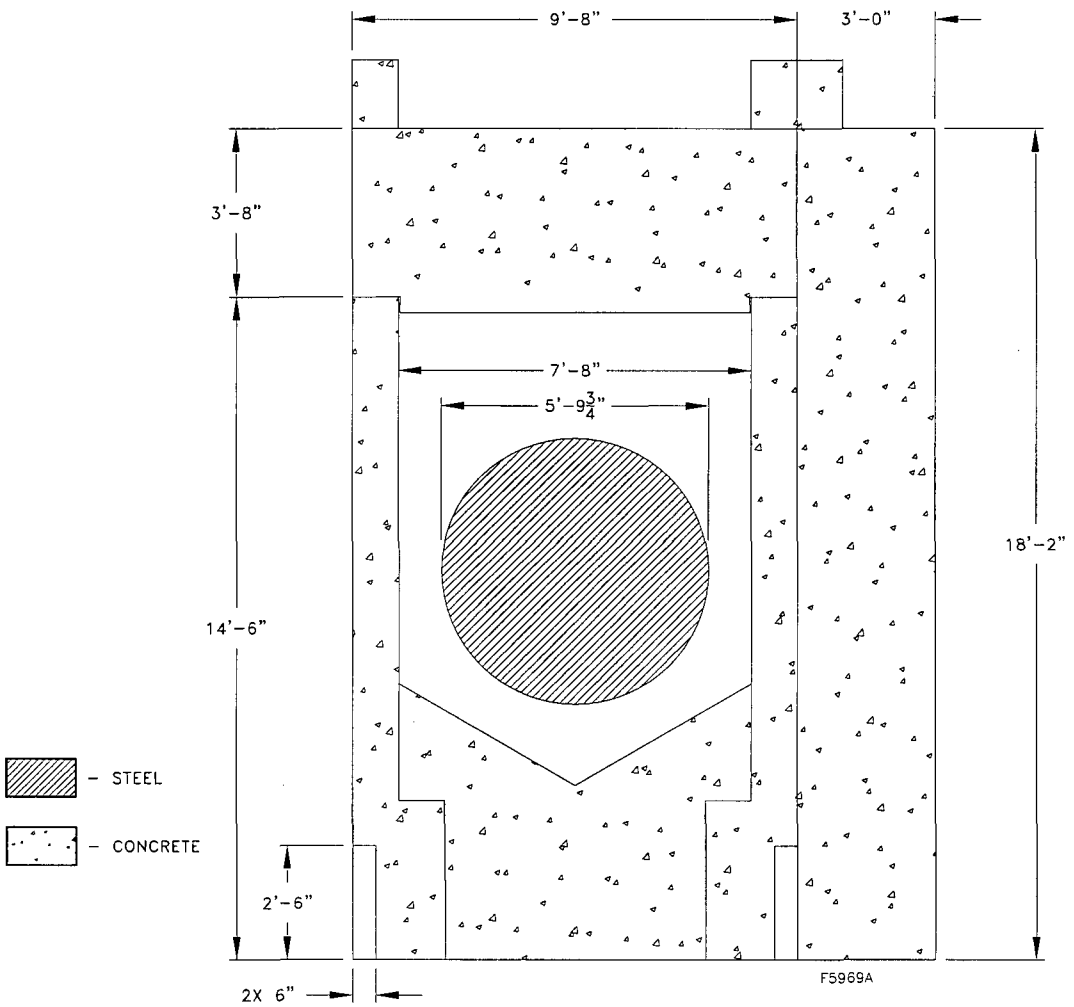
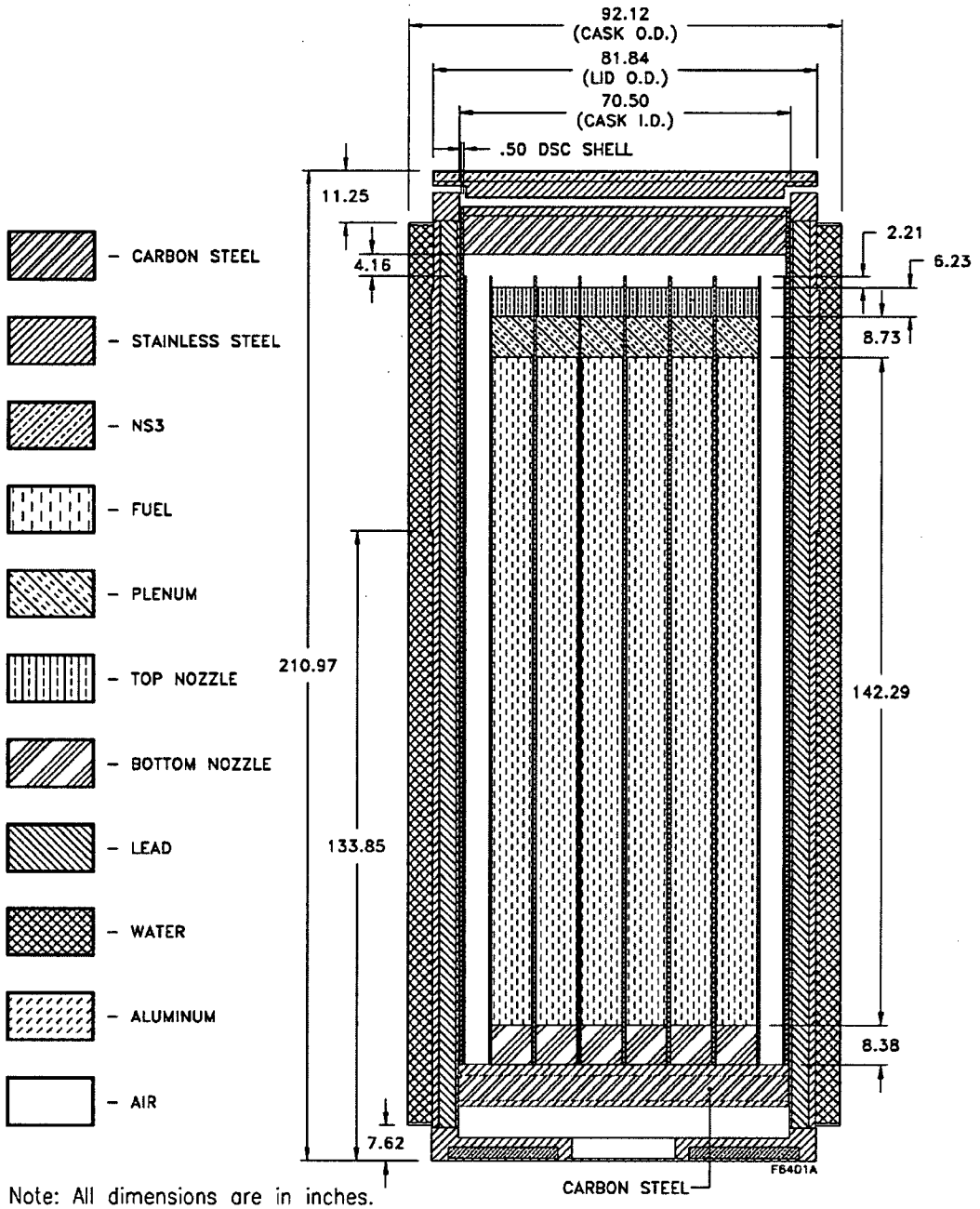
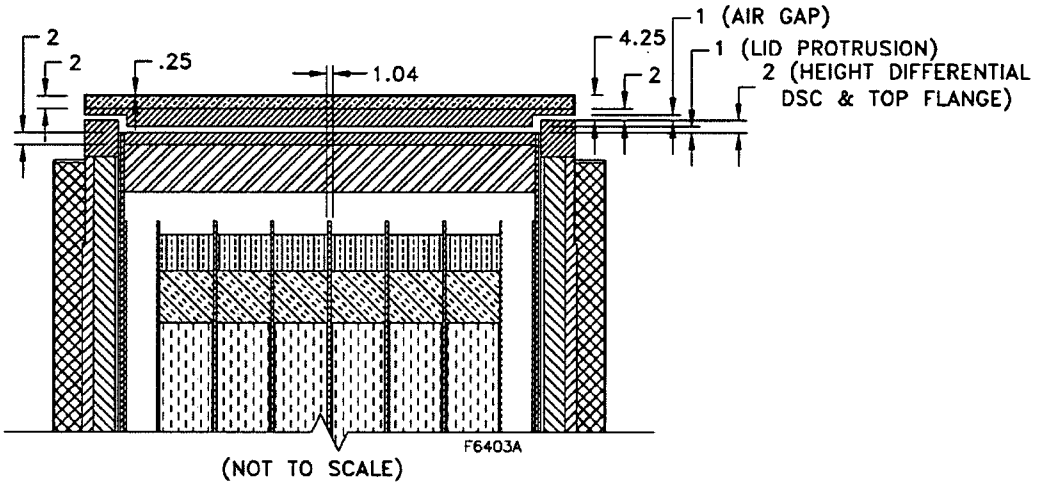


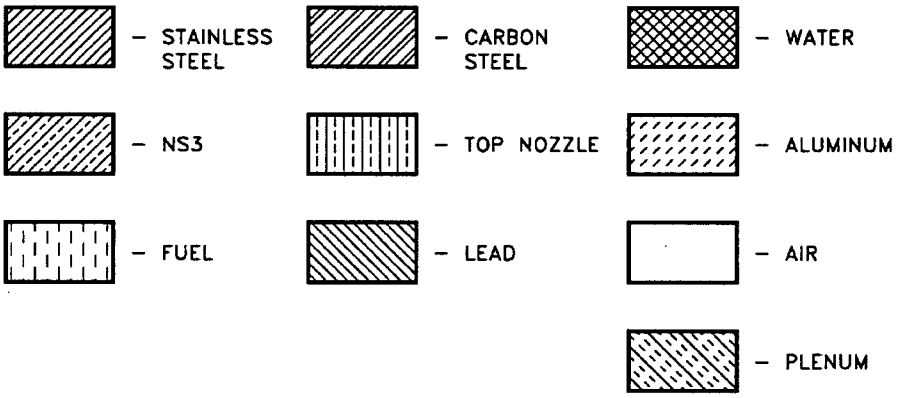
Figure U.5-8
32PTH1 DSC within HSM-H, Head-on View at Bottom End of DSC (Z=120 cm)



Note: All dimensions in inches.

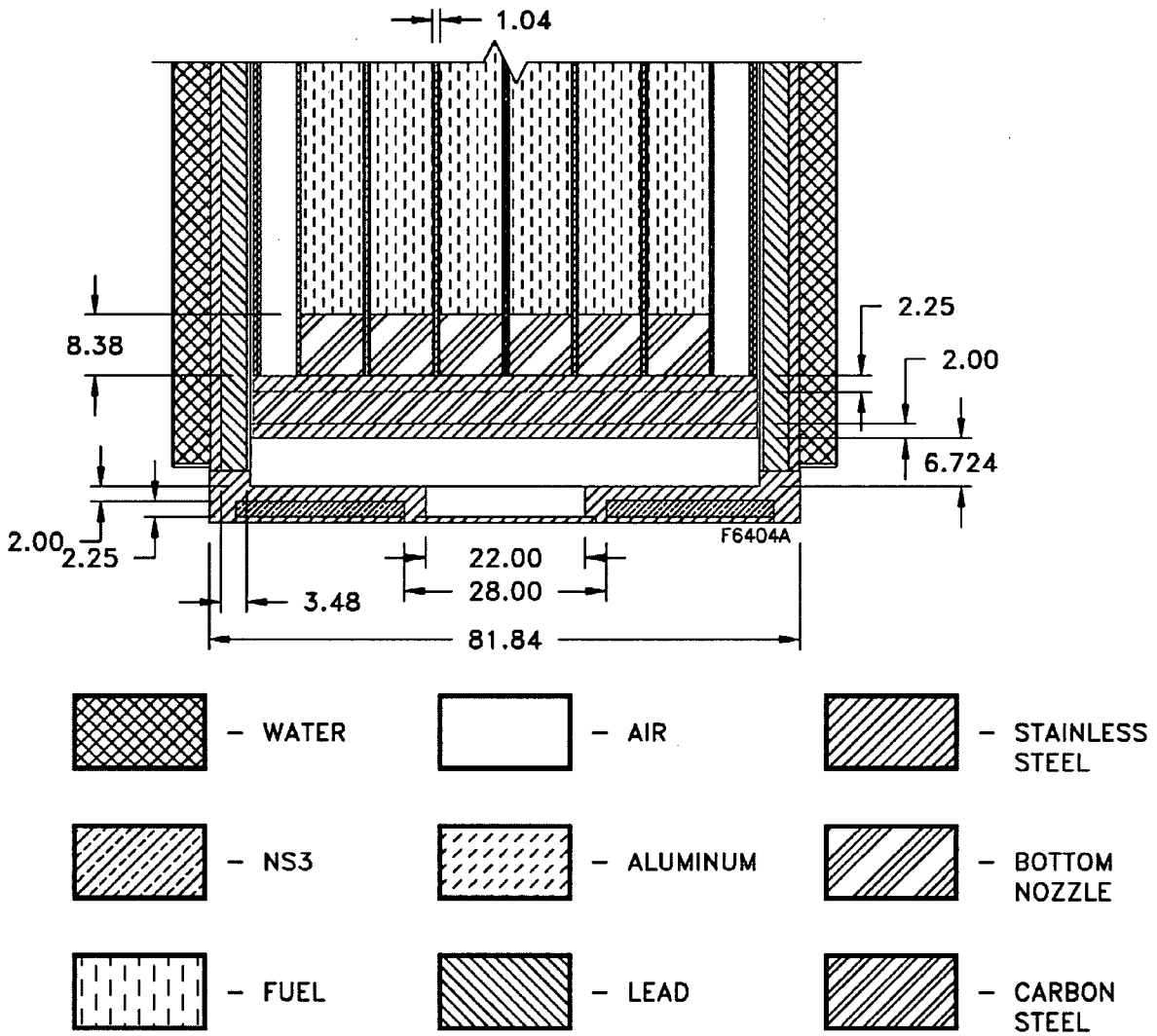
Figure U.5-9
32PTH1 DSC within OS200 TC, Axial View of Transfer Model





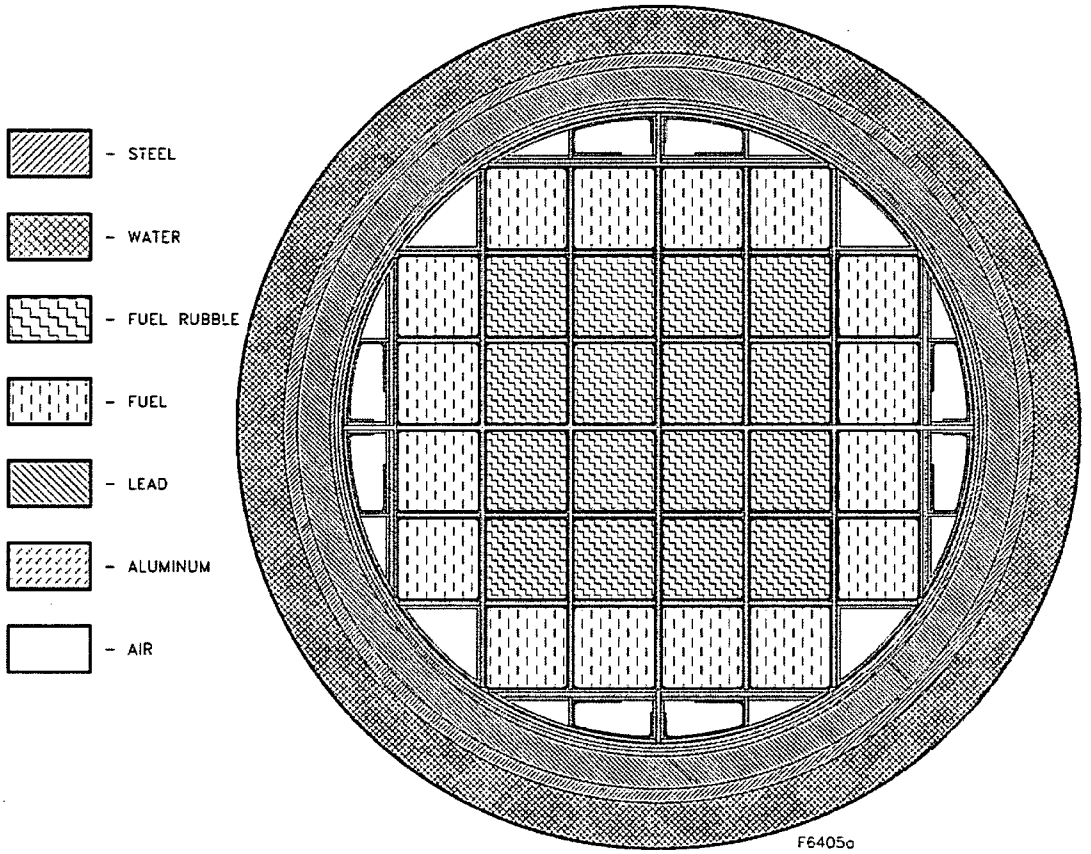
Note: All dimensions in inches.

Figure U.5-10
32PTH1 DSC within OS200 TC, Top View of Transfer Model Showing Lid with Gap, Top Nozzle and Plenum



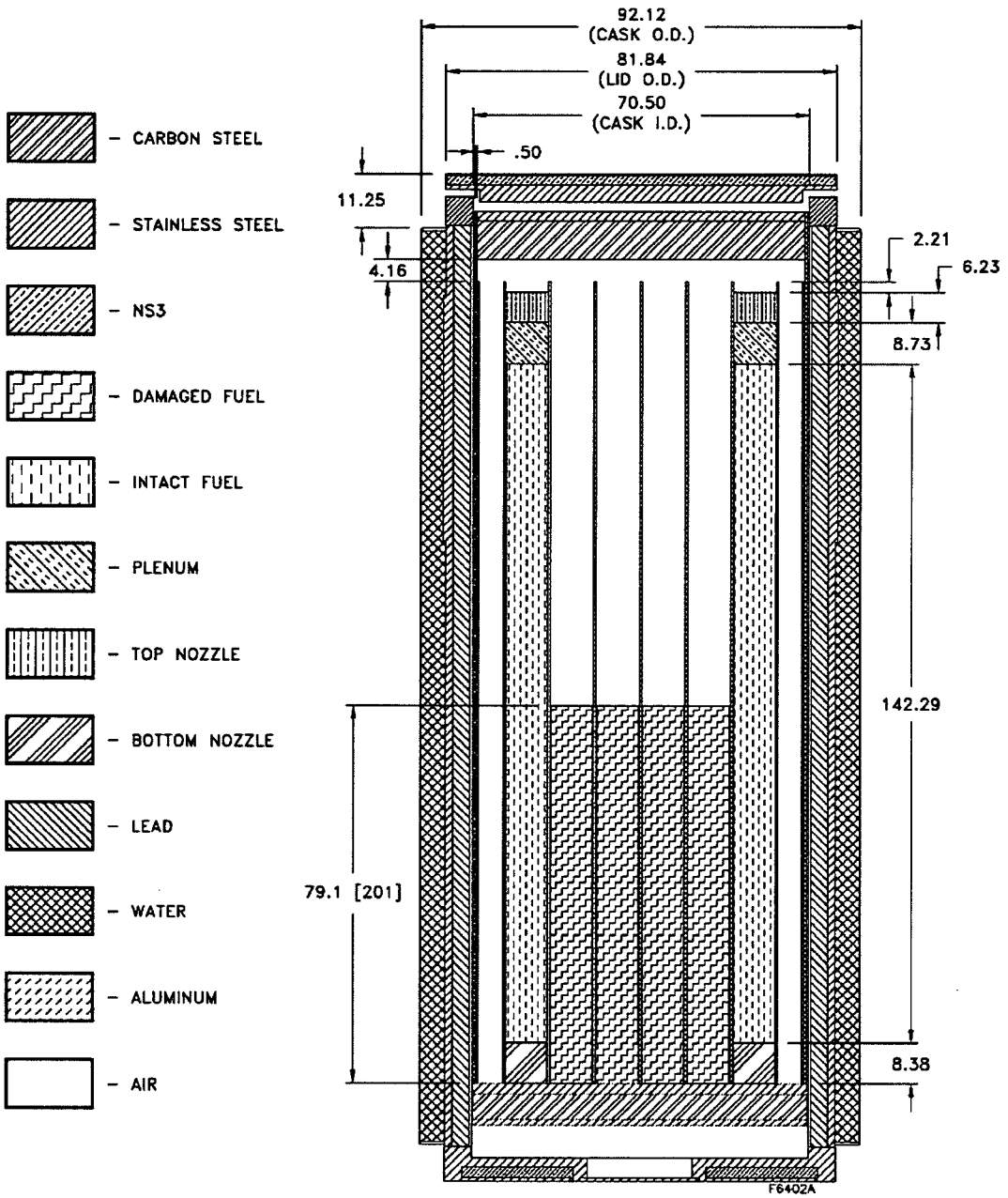
Note: All dimensions in inches.

Figure U.5-11
32PTH1 DSC within OS200 TC, Bottom View of Transfer Model Showing Cask Bottom and Bottom Nozzle



Note: All dimensions are in inches.

Figure U.5-12
32PTH1 DSC within OS200 TC, Radial Cut View of Transfer Model Showing Fuel Locations



Note: All dimensions are in inches.

Figure U.5-13
32PTH1 DSC within OS200 TC, Axial View of Transfer Model Showing Intact and Damaged Fuel Locations and Damaged Fuel Height

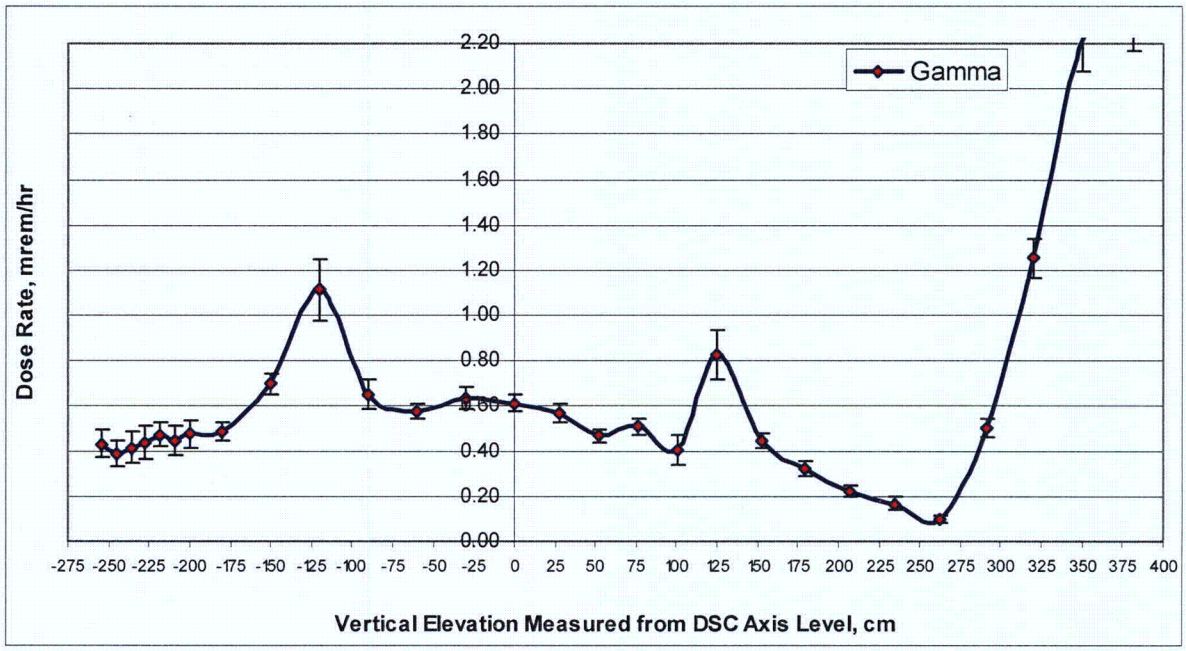


Figure U.5-14
Gamma Radiation Dose Rate along HSM-H Front Centerline in Vertical Elevation

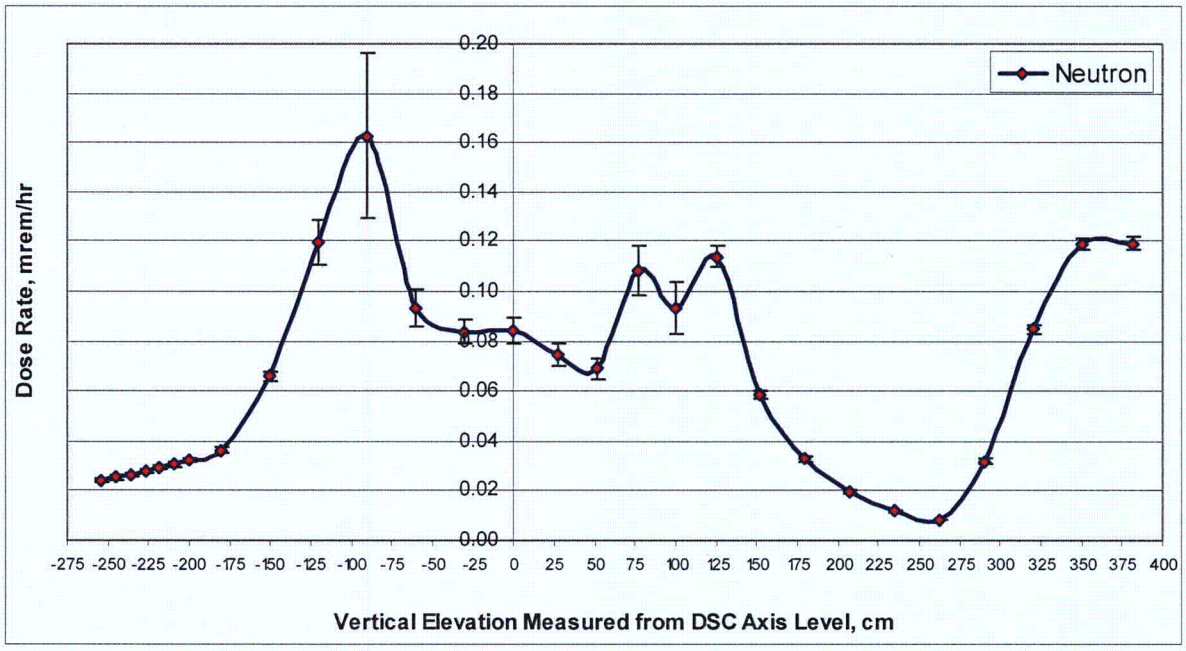


Figure U.5-15
Neutron Radiation Dose Rate along HSM-H Front Centerline in Vertical Elevation

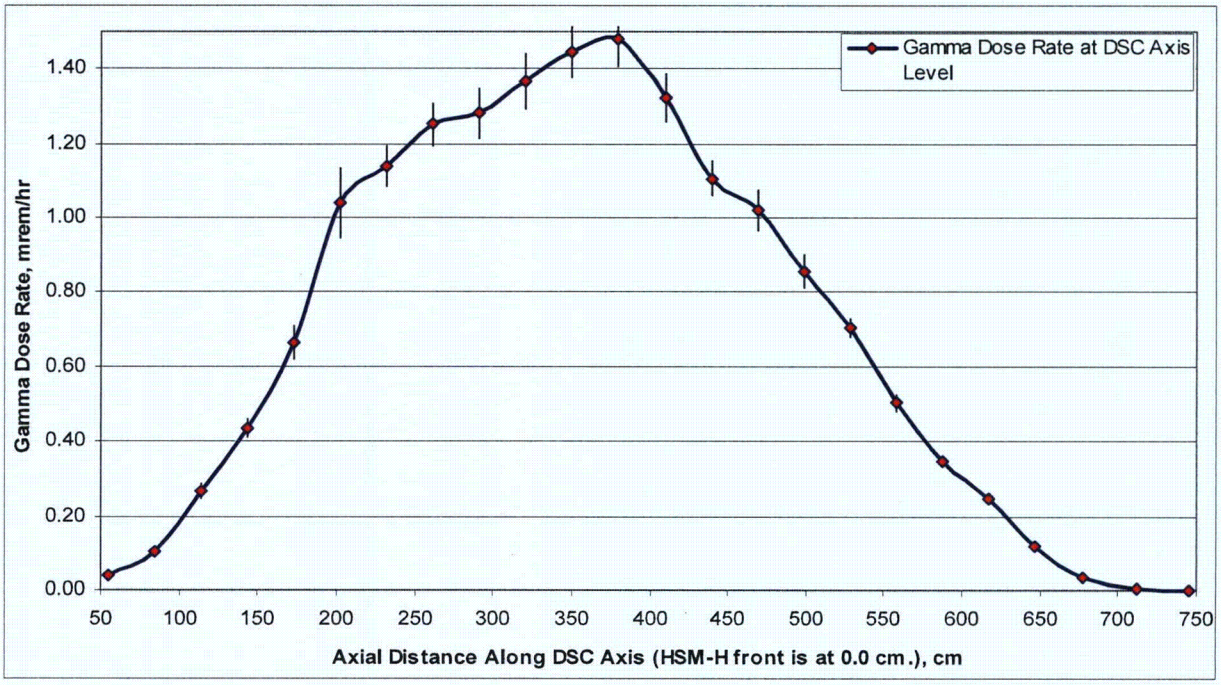


Figure U.5-16
Gamma Radiation Dose Rate on Side of 3' thk. End Module Side Shield Wall at DSC Axis Level

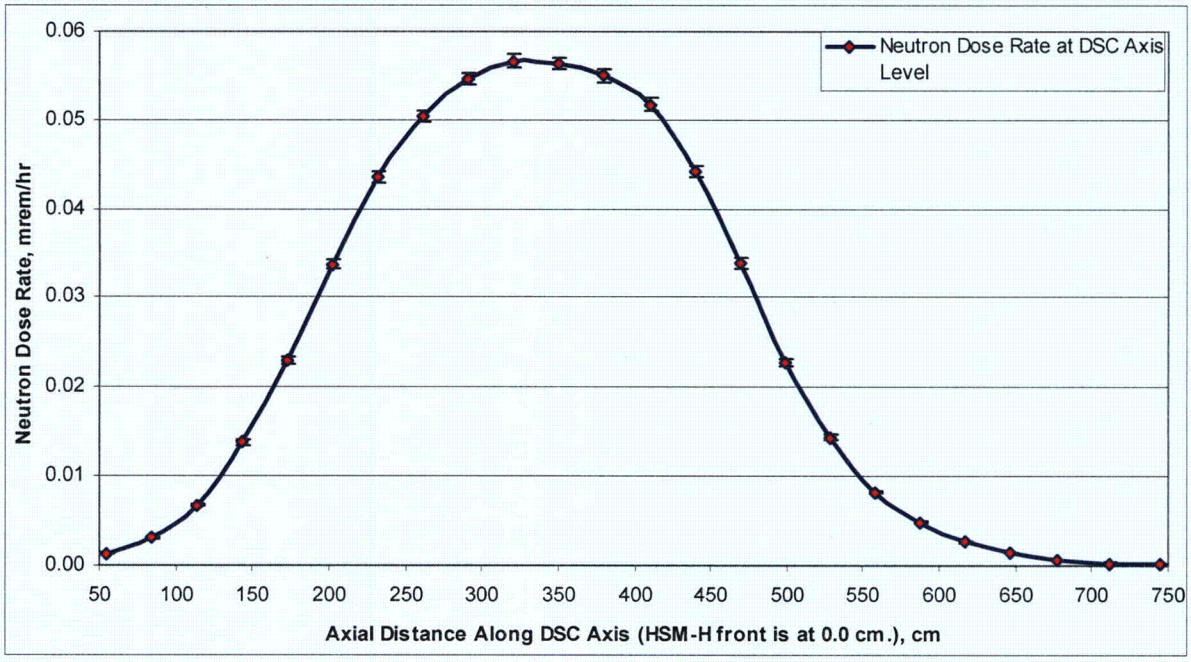


Figure U.5-17
Neutron Radiation Dose Rate on Side of 3' thk. End Module Side Shield Wall at DSC Axis Level

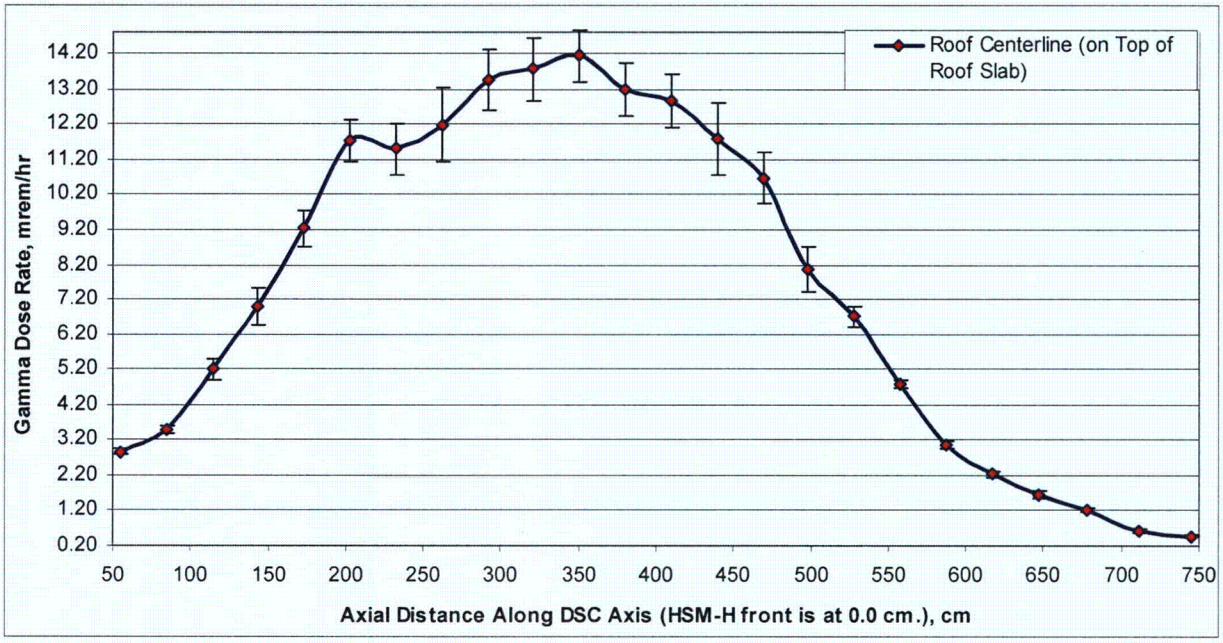


Figure U.5-18
HSM-H with 32PTH1 Bounding DSC, Gamma Radiation Dose Rate along Roof Centerline

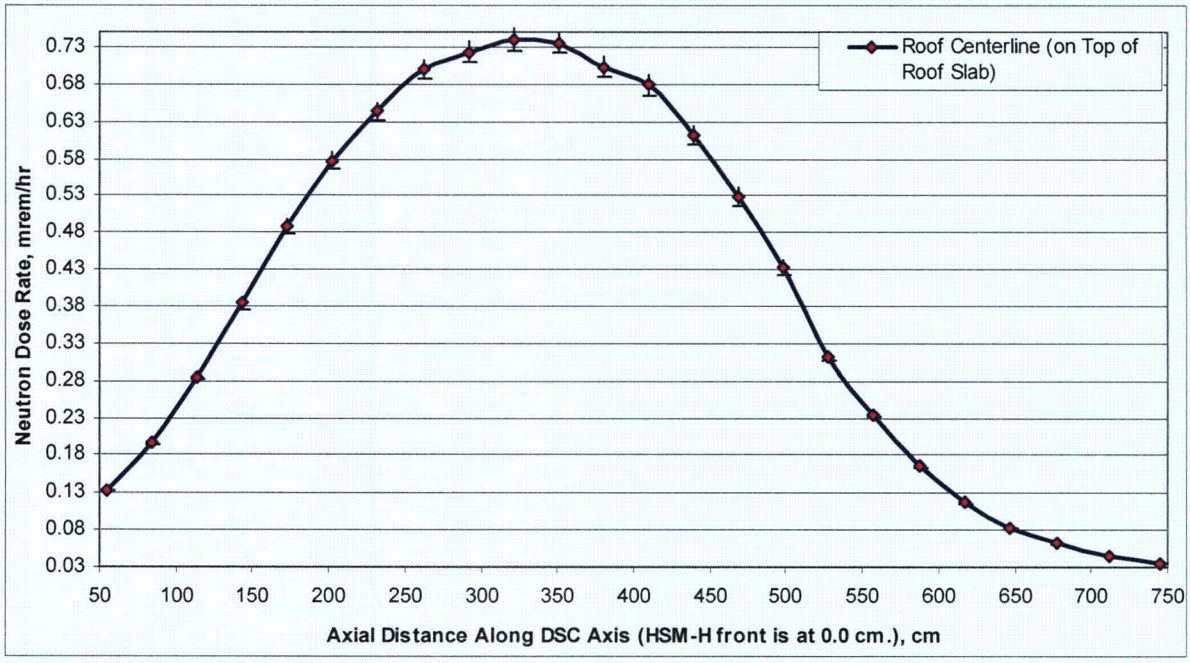


Figure U.5-19
HSM-H with 32PTH1 Bounding DSC, Neutron Radiation Dose Rate along Roof Centerline

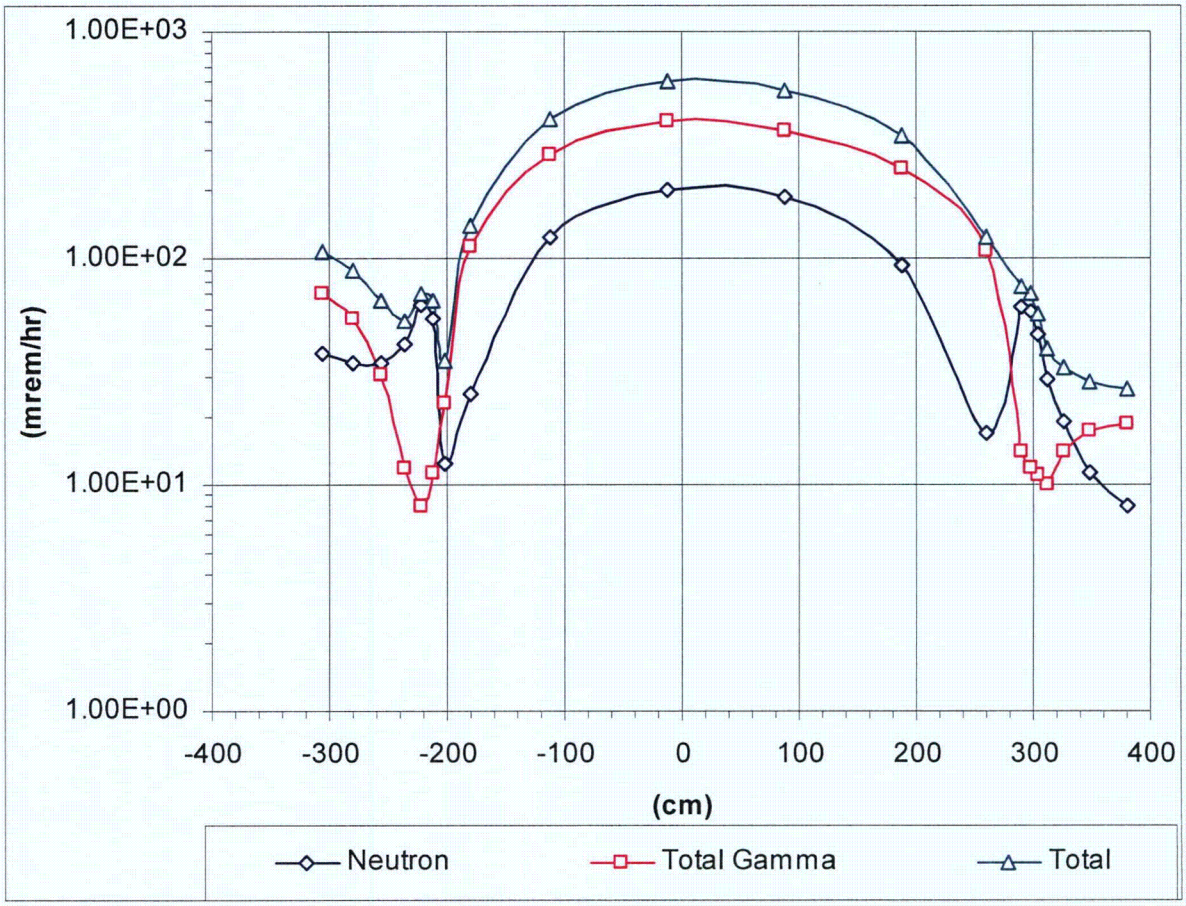


Figure U.5-20
OS200 TC with 32PTH1 DSC, Side Surface (Radial) Dose Rate, Normal Transfer Conditions

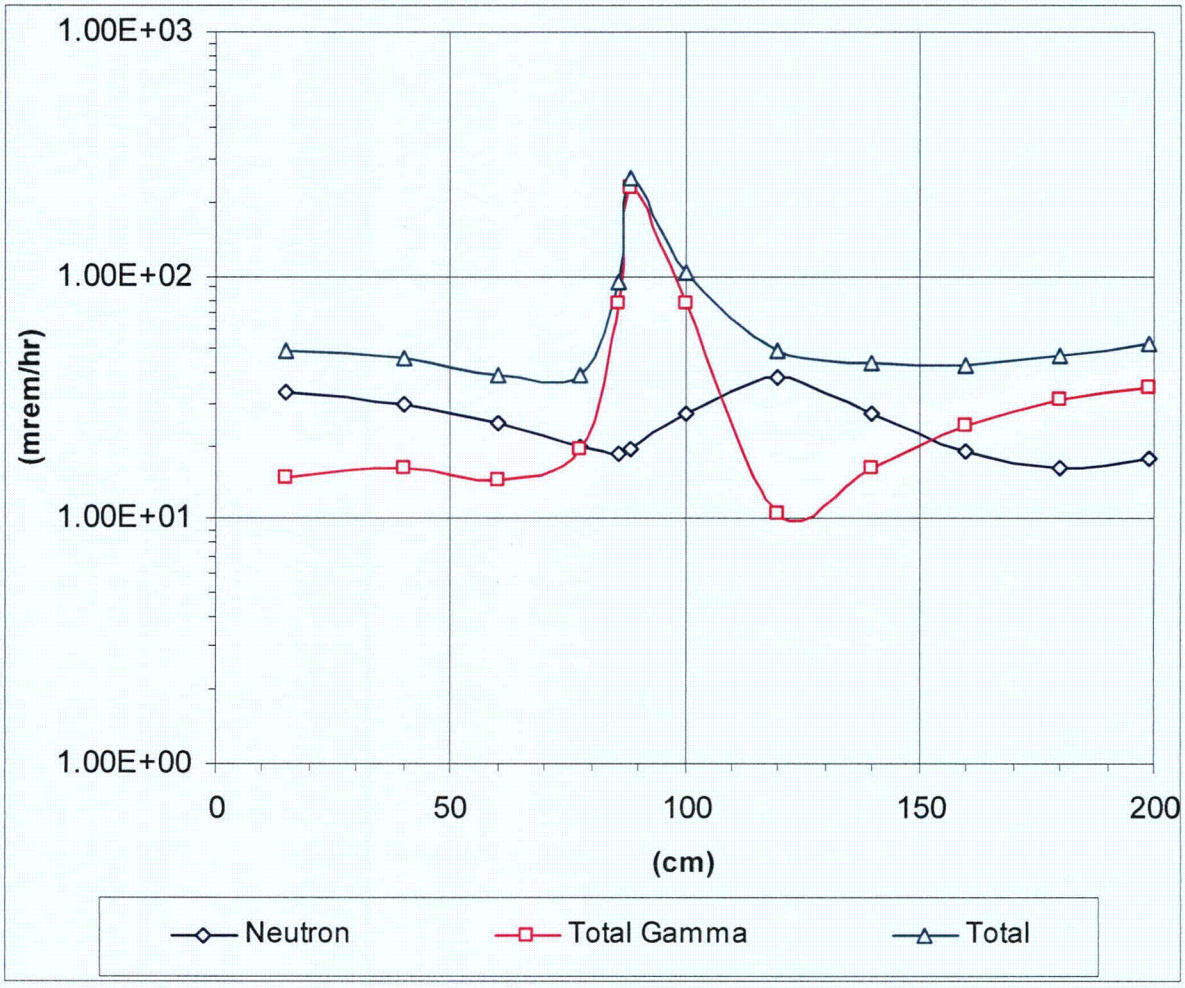


Figure U.5-21
OS200 TC with 32PTH1 DSC, Top Axial Surface Dose Rate, Normal Transfer Conditions

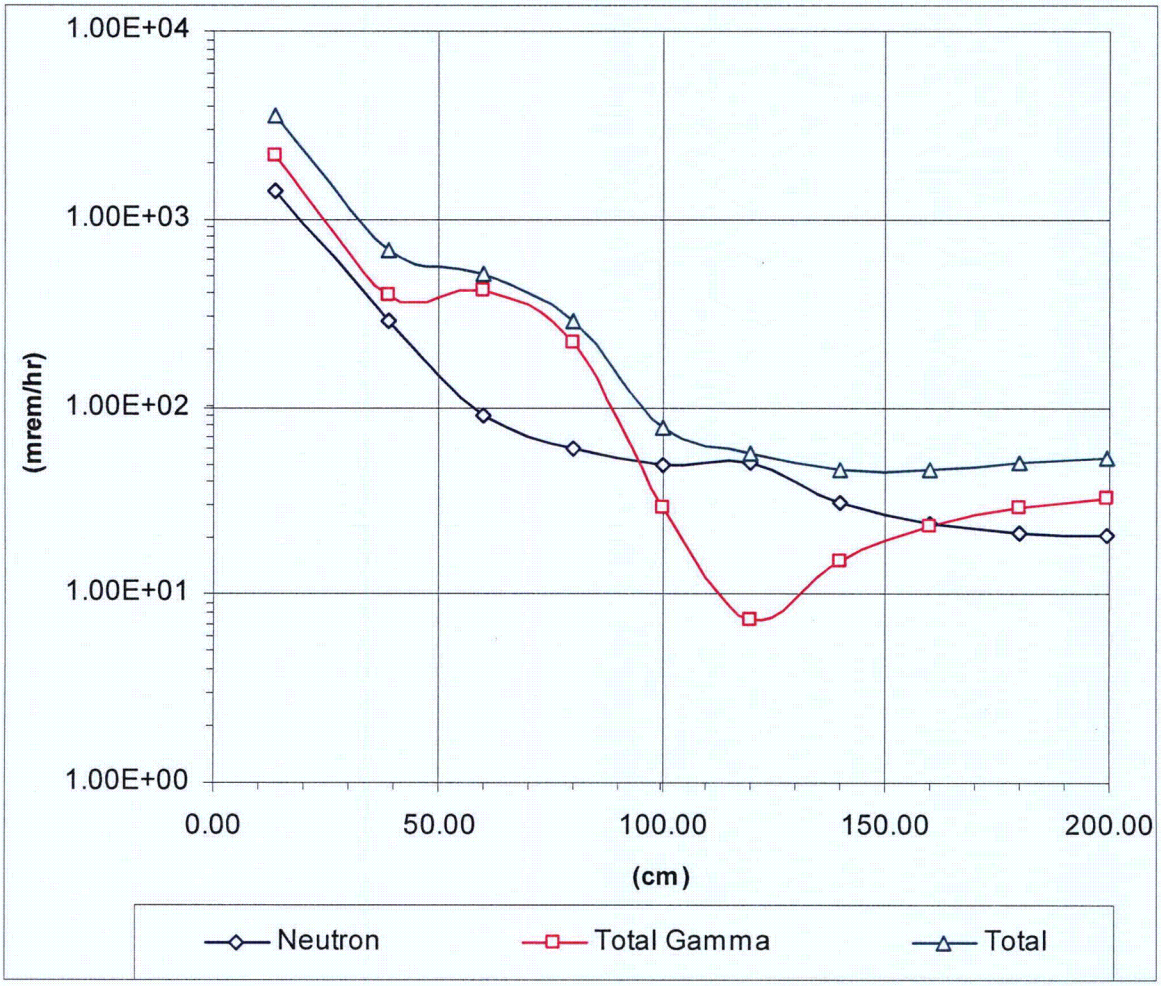


Figure U.5-22
OS200 TC with 32PTH1 DSC, Bottom Axial Surface Dose Rate, Normal Transfer Conditions

U.6 Criticality Evaluation

The design criteria for the NUHOMS® 32PTH1 DSC requires that the fuel loaded in the DSC remain subcritical under normal, and accident conditions as defined in 10CFR Part 72.

The NUHOMS® 32PTH1 system's criticality safety is ensured by fixed neutron absorbers in the basket, soluble boron in the pool and favorable basket geometry. Burnup credit is not taken in this criticality evaluation. The DSC basket uses a Borated-Aluminum alloy, Aluminum/B_4C metal matrix composite or Boral® as its fixed neutron poison material. These materials are ideal for long-term use in the radiation and thermal environments of a DSC. Justification is required for the use of 75% and 90% credit for the poison materials. This justification is typically provided in Chapter U.9 that also addresses the issues identified in the Standard Review Plan [6.4] and ISG-15 [6.5]. The collective term B-Al refers to all those fixed poison materials (Borated-Aluminum alloy, Aluminum/B_4C metal matrix composite) where 90% credit will be justified in the Application. A credit of 75% is taken for the presence of neutron poison for Boral® plates.

Each 32PTH1 DSC basket is provided with two alternate options: with aluminum transition rails (Type 1) or with stainless steel rails (Type 2). In addition, depending on the boron content in the basket poison plates, each basket type is designated as Type A through Type E which results in ten (10) different basket types (Types 1A, 1B, 1C, 1D, 1E, 2A, 2B, 2C, 2D, or 2E). The only difference between the basket types is the fixed poison loading and transition rails. Table U.6-1 lists the minimum B10 poison loading required for the various poison materials and the corresponding poison content modeled in the analyses for each basket type.

In addition to utilizing five (5) different fixed poison loadings, the soluble boron concentration in the pool credited in the analysis is also varied from 2000 ppm to 3000 ppm.

U.6.1 Discussion and Results

Figure U.6-1 shows the cross section of the NUHOMS® 32PTH1 DSC. The NUHOMS® 32PTH1 DSC stainless steel basket consists of an "egg-crate" plate design. The fuel assemblies are housed in 32 stainless steel fuel compartment tubes. The basket structure, including the fuel compartment tubes, is held together with stainless steel insert plates and the poison and aluminum plates that form the "egg-crate" structure. The basket compartment structure is connected to perimeter transition rail assemblies, portions of it comprising of aluminum interface. The fuel compartment tube structure is connected to perimeter transition rail assemblies as shown on the drawings in Section U.1.5. The poison/aluminum plates are located between the fuel compartment tubes, as shown in Figure U.6-1.

The criticality analysis presented herein is performed for a NUHOMS® 32PTH1 DSC in the NUHOMS® OS200 Transfer Cask (TC) during normal, off-normal and accident loading conditions. This analysis also bounds all conditions of storage in the HSM (HSM-H). The OS200 TC design includes two lid designs, one lid "seals" the cask closed and the second includes a modified lid design to allow for air circulation for enhanced heat removal. The TC consists of an inner stainless steel shell, lead gamma shield, a stainless steel structural shell and a hydrogenous neutron shield. This analysis is applicable to any licensed cask of similar construction including those with liquid or solid hydrogenous neutron shields. The NUHOMS® 32PTH1 DSC/TC configuration is shown to be subcritical under normal, off-normal and accident conditions of loading, transfer and storage.

Table U.6-2 lists the fuel assemblies considered as authorized contents of the NUHOMS® 32PTH1 System. The criticality analysis begins by determining the most reactive assembly type for each assembly class identified in Table U.6-2. Then the most reactive configuration for the basket (including transition rail configuration) and fuel assembly position is determined. Next, criticality calculations are performed to determine the maximum allowed initial enrichment for each fuel assembly class as a function of basket poison type and soluble boron concentration in the spent fuel pool which are listed in Table U.6-3. The calculations determine k_{eff} with the CSAS25 control module of SCALE-4.4 [6.1] for each assembly type and initial enrichment, including all uncertainties to assure criticality safety under all credible conditions.

The damaged fuel criticality analysis determines the most reactive damaged fuel assembly (design basis damaged fuel assembly) configuration for each fuel assembly class. Next, damaged assembly criticality calculations are performed to determine the maximum allowed initial enrichment for each fuel assembly class as a function of basket poison type and soluble boron concentration. These results are shown in Table U.6-4. These calculations determine k_{eff} with the CSAS25 control module of SCALE-4.4 [6.1] for each assembly type and initial enrichment, including all uncertainties to assure criticality safety under all credible conditions.

The Control Components (CCs) are also authorized for storage in the 32PTH1 DSCs. The authorized CCs are Burnable Poison Rod Assemblies (BPRAs), Control Rod Assemblies (CRAs), Thimble Plug Assemblies (TPAs), Axial Power Shaping Rod Assemblies (APSRAs), Control Element Assemblies (CEAs), Vibration Suppressor Inserts (VSIs), Orifice Rod Assemblies (ORAs) and Neutron Source Assemblies (NSAs).

The results of the evaluation demonstrate that the maximum expected k_{eff}, including statistical uncertainty, are less than the Upper Subcritical Limit (USL) determined from a statistical analysis of benchmark criticality experiments. The statistical analysis procedure includes a confidence band with an administrative safety margin of 0.05.

U.6.2 Package Fuel Loading

The NUHOMS® 32PTH1 DSC is capable of transferring and storing a maximum of 32 intact PWR fuel assemblies. In addition, a maximum of 16 damaged and remaining intact (for a total of 32) PWR fuel assemblies can also be stored within the NUHOMS® 32PTH1 DSC. The reactivity of a DSC loaded with less than 32 PWR fuel assemblies is lower than that calculated here since the more absorbing borated water replaces the fuel in the empty locations. Reconstituted fuel assemblies, where the fuel pins are replaced by lower enriched fuel pins or non-fuel pins that displace the same amount of borated water, are considered intact fuel assemblies in the criticality evaluation.

Table U.6-5 lists the fuel parameters for the PWR fuel assemblies considered in this evaluation. Reload fuel from other manufacturers with the same parameters are also considered as authorized contents.

For the WE 17x17, CE 16x16, BW 15x15, CE 15x15, WE 15x15, CE 14x14, and WE 14x14 class assemblies CCs are also included as authorized contents. The only change to the package fuel loading to evaluate the addition of these CCs is replacing the borated water in the water holes with $^{11}B_4C$. Since these CCs displace borated moderator in the assembly guide and or instrument tubes, an evaluation is performed to determine the potential impact of storage of CCs that extend into the active fuel region on the system reactivity. For CCs such as CRAs, CEAs and BPRAs no credit is taken for the cladding and absorbers; rather the CCs are modeled as $^{11}B_4C$ in the entire tube of the respective design. Thus, the highly borated moderator in the tube is modeled as $^{11}B_4C$. The inclusion of more Boron-11 and carbon enhances neutron scattering causing the neutron population in the fuel assembly to be slightly increased which increases reactivity. Therefore, these calculations bound any CC design that is compatible with WE 17x17, CE 16x16, BW 15x15, CE 15x15, WE 15x15, CE 14x14, and WE 14x14 class assemblies. CCs that do not extend into the active fuel region of the assembly do not have any effect on the reactivity of the system as evaluated because only the active fuel region is modeled in this evaluation with periodic boundary conditions making the model infinite in the axial direction. The fuel assembly dimensions reported in Table U.6-5 remain unchanged for the CC cases. The models that include CCs only differ in that the region inside the guide tubes and instrument tube are modeled as $^{11}B_4C$ instead of moderator. Additionally, the presences of non-multiplying sources like the NSAs have no impact on criticality calculations.

Since the criticality analysis models simulate only the active fuel height, any CC that is inserted into the fuel assembly such that it does not extend into the active fuel region is considered as authorized for storage without adjustment to the soluble boron content or initial enrichment as required for control components that extend into the active fuel region. For example, TPAs or ORAs are permitted for storage within a fuel assembly without adjusting the maximum initial enrichment or minimum soluble boron content given in Table U.6-3 and Table U.6-4, since TPAs or ORAs do not extend into the active fuel region.

U.6.3 Model Specification

The following subsections describe the physical models and materials of the NUHOMS® 32PTH1 DSC as loaded and transferred in the NUHOMS® OS200 TC (or other TCs of similar design) used for input to the CSAS25 module of SCALE-4.4 [6.1] to perform the criticality evaluation. The reactivity of canister under storage conditions is bounded by the TC analysis with zero internal moderator density case. The TC analysis with zero internal moderator density case bounds the storage conditions in the HSM because (1) the canister internals are always dry (purged and backfilled with He) while in the HSM, and (2) the TC contains materials such as steel and lead which provide close reflection of fast neutrons back into the fueled basket while the HSM materials (concrete) are much further from the sides of the DSC and thereby tend to reflect thermalized neutrons back to the canister which are absorbed in the canister materials reducing the system reactivity. The criticality analysis methodology for the intact and damaged fuel assemblies in the 32PTH1 DSC is the same as that used for the NUHOMS®-24PTH DSC described in the Appendix P, Chapter P.6 of the UFSAR.

U.6.3.1 Description of Calculational Model

The TC and canister are explicitly modeled using the appropriate geometry options in KENO V.a of the CSAS25 module in SCALE-4.4. Several models are developed to evaluate the fabrication tolerances of the canister, fuel clad outer diameter, fuel assembly locations, fuel assembly type, initial enrichments, fixed poison loading, soluble boron concentration and storage of CCs (BPRAs, CRAs, TPAs, APSRAs, CEAs, VSIs, ORAs, NSAs, etc.) with the fuel.

The criticality evaluation is performed using an "egg-crate" section length of 13.48 inches in the basket. The actual "egg-crate" length is 15.0 inches in the active fuel region of the assembly. This represents a more reactive design than the actual basket because of the shorter "egg-crate" section length. Utilizing a shorter section length in the calculational model ensures that the model is conservative since the amount of poison per unit length is minimized. The key basket dimensions utilized in the calculation are shown in Table U.6-6.

The fixed poison modeled in the calculation is based on a poison plate thickness of 0.075 inches consistent with that specified for Boral®. The important parameter is the minimum B-10 areal density; therefore the modeled thickness of the poison plate does not affect the results of the calculation.

The basic calculational KENO model, as discussed above, is a 13.48-inch axial section and full-radial cross section of the canister and cask with periodic boundary conditions at the axial boundaries (top and bottom) and reflective boundary conditions at the radial boundaries (sides). This axial section essentially models one building block of the egg crate basket structure. Periodic boundary conditions ensure that the resulting KENO model is essentially infinite in the axial direction. The model does not explicitly include the water neutron shield; however the infinite array of casks without the neutron shield does contain unborated water between the casks and in the canister - transfer cask gap. For the purpose of storage, the DSC / TC configuration is not expected to encounter any regions containing fresh water once the fuel assemblies are loaded. Therefore, this hypothetical configuration that models an infinite array of casks in close reflection is conservative.

The fuel assemblies within the basket are modeled as arrays of fuel pins and guide/instrument tubes. Spacer grids and sub-components like oversleeves are not modeled since their effect on reactivity is insignificant. The fuel compartment tubes surround each fuel assembly that is in-turn bounded by the basket plates consisting of 0.50" aluminum/poison plates. These plates are arranged to represent an egg-crate design with the 0.425"- Aluminum and a 0.075"-poison plate. The thermal expansion and egg-crate slot gaps are not modeled (conservative) assuming plate continuity, thus replacing the more absorbing borated water (internal moderator) with aluminum. KENO model plots in 2D for the various views of the basket compartment are shown in Figure U.6-2 through Figure U.6-8.

The NUHOMS® 32PTH1 basket poison plates are located at all the faces where six fuel assemblies are lined up. Thus, all the interior 16 fuel assemblies are surrounded by poison plates on all four faces and the outer 16 fuel assemblies do not have poison plates on the radially outward looking face. The fuel assembly and poison plate positions (and the aluminum plate positions) in the KENO model of the basket is shown in Figure U.6-9. Even though the poison and aluminum plates have been shown as discrete plates around the fuel compartment, they are all continuous running from one end of the basket to the other.

The basket structure is connected to the DSC shell by perimeter transition rail assemblies. The transition rail material is either "solid" aluminum or a combination of aluminum and SS304. The rails provide a structural function as well as provide a heat conduction path from the basket to the DSC shell. Between the rail options, the most reactive case is for that of solid aluminum rails. Therefore, the rails are modeled as solid aluminum between the outside of the "egg-crate" structure of the basket and the ID of the DSC shell.

A list of all the geometry units used in the basic KENO model is shown in Table U.6-7. Figure U.6-10 shows the various radial "cylinders" utilized in the KENO model surrounding the fuel assemblies. Basically, this shows the canister and transfer cask details.

The first model developed uses nominal dimensions for the fuel compartments, fuel compartment thickness, poison plate thickness and the fuel assemblies centered in the fuel compartment. This basic KENO model is used to determine the most reactive fuel assembly for each assembly class, the most reactive assembly-to-assembly pitch, and to determine the most reactive canister configuration accounting for manufacturing tolerances. The second model is of the most reactive configuration identified above. This model is used to determine the maximum allowable initial enrichment for each assembly class as a function of the soluble boron concentration and basket type (fixed poison loading). Appropriate KENO plots of these models for each assembly class are included in Figure U.6-11 through Figure U.6-17.

The design basis intact assembly KENO models for each fuel assembly class are utilized as starting KENO models for the damaged assembly calculations. These KENO models (for each assembly class) are modified to evaluate the various damaged fuel configurations like single shear, double shear, optimum pitch and axial fuel shifting. These models are then analyzed to determine the most reactive damaged fuel configuration for each fuel assembly class. The calculational KENO model for damaged fuel criticality analysis is based on the most reactive configuration (for each fuel assembly class) identified above. This model is used to determine the maximum allowable initial enrichment for each assembly type as a function of the soluble

boron concentration and fixed poison loading, as appropriate. Appropriate KENO plots of the calculational damaged assembly KENO models for each assembly class are included in Figure U.6-18 through Figure U.6-24.

U.6.3.2 Package Regional Densities

The Oak Ridge National Laboratory (ORNL) SCALE code package [6.1] contains a standard material data library for common elements, compounds, and mixtures. All the materials used for the TC and canister analysis are available in this data library.

Table U.6-8 provides a complete list of all the relevant materials used for the criticality evaluation. The material density for the B10 in the poison plates includes a 10% reduction (90% credit) for B-Al poison and a 25% reduction (75% credit) for Boral® poison.

U.6.4 Criticality Calculations

This section describes the analysis methodology utilized for the criticality analysis. The analyses are performed with the CSAS25 module of the SCALE system. A series of calculations are performed to determine the relative reactivity of the various fuel assembly designs to determine the most reactive assembly type without CCs and to determine the most reactive assembly type for each assembly class without CCs. The most reactive intact fuel design, for a given enrichment, and canister/basket configuration as demonstrated by the analyses, is the B&W 15x15 Mark B-10 assembly. The most reactive credible configuration is an infinite array of flooded casks, each containing 32 fuel assemblies, with minimum fuel compartment tube ID, minimum fuel compartment tube thickness, poison thickness of 0.075 inches, and minimum assembly-to-assembly pitch.

A series of calculations are also performed to determine the relative reactivity of the various damaged fuel configurations for each fuel assembly class. The most reactive damaged fuel configuration occurs when the fuel rods are in near optimum pitch for all fuel assembly classes except for the WE 15x15 class where double shear is the most reactive configuration. These configurations are independent of the soluble boron concentration levels. All damaged assembly calculations are carried out with 32 damaged assemblies in the DSC for simplicity. The most reactive credible configuration, that is modeled, is an infinite array of flooded casks, each containing 32 damaged fuel assemblies, with minimum fuel compartment tube ID, minimum fuel compartment tube thickness, poison thickness of 0.075 inches, and minimum assembly-to-assembly pitch.

Finally, using the most reactive credible configuration determined for intact and damaged assemblies, the maximum initial enrichment (with and without CCs) for each assembly class is calculated as a function of basket poison material (A-E) and soluble boron content (2000 – 3000 ppm boron).

U.6.4.1 Calculational Method

U.6.4.1.1 Computer Codes

The CSAS25 control module of SCALE-4.4 [6.1] is used to calculate the effective multiplication factor (k_{eff}) of the fuel in the TC (bounds fuel in HSM). The CSAS25 control module allows simplified data input to the functional modules BONAMI-S, NITAWL-II, and KENO V.a. These modules process the required cross sections and calculate the k_{eff} of the system. BONAMI-S performs resonance self-shielding calculations for nuclides that have Bondarenko data associated with their cross sections. NITAWL-II applies a Nordheim resonance self-shielding correction to nuclides having resonance parameters. Finally, KENO V.a calculates the k_{eff} of a three-dimensional system. A sufficiently large number of neutron histories are run so that the standard deviation is below 0.0015 for all calculations.

U.6.4.1.2 Physical and Nuclear Data

The physical and nuclear data required for the criticality analysis include the fuel assembly data and cross-section data as described below.

Table U.6-5 provides the pertinent data for criticality analysis for each fuel assembly evaluated in the NUHOMS® 32PTH1 DSC.

The criticality analysis used the 44-group cross-section library built into the SCALE system. ORNL used ENDF/B-V data to develop this broad-group library specifically for criticality analysis of a wide variety of thermal systems.

U.6.4.1.3 Bases and Assumptions

The analytical results reported in Chapter U.3, Section U.3.7 demonstrate that the TC containment boundary and canister basket structure do not experience any significant distortion under hypothetical accident conditions. The fuel assembly drop analyses documented in Section U.3-5 also demonstrate that the fuel rods do not experience any deformation significant enough to cause a change in the fuel geometry. Therefore, for both normal and hypothetical accident conditions the TC geometry is identical except for the neutron shield and neutron shield jacket (outer skin). As discussed above, the neutron shield and neutron shield jacket (outer skin) are conservatively removed and the interstitial space modeled as water.

The TC is modeled with KENO V.a using the available geometry input. This option allows a model to be constructed that uses regular geometric shapes to define the material boundaries. The following conservative assumptions are also incorporated into the criticality calculations for intact fuel:

1. No burnable poisons such as Gadolinia, Erbia or any other absorber, accounted for in the fuel.

2. CCs that extend into the active fuel region, such as BPRAs, CRAs, APSRAs, CEAs, and NSAs are conservatively assumed to exhibit neutronic properties of $^{11}B_4C$. There is no neutron absorption from any of these hardware and are collectively referred to as CCs.

3. Water density at optimum moderator density.

4. Unirradiated fuel – no credit taken for fissile depletion due to burnup or fission product poisoning.

5. For intact fuel, the lattice average fuel enrichment is modeled as uniform everywhere throughout the assembly. Natural Uranium blankets and axial or radial enrichment zones are modeled as enriched uranium at the lattice average enrichment. A benchmark comparison of an Exxon 15x15 CE fuel assembly with a uniform fuel and one with radial variation in fuel pin enrichment is performed in Appendix P, Chapter P.6 for generalization. The results demonstrate that the lattice average uniform enrichment assumption is justified and conservative when compared with variable axial or radial enrichment zone. The results are assumed to be valid for all fuel assembly classes.

6. All fuel rods are filled with full density fresh water in the pellet/cladding gap.

7. Only a 13.48-inch section of the basket (actual is 15.0-inches) with fuel assemblies is explicitly modeled with periodic axial boundary conditions, therefore the model is

effectively infinitely long and the actual poison height for each section is conservatively modeled to be approximately 1.5 inches shorter.

8. It is assumed that for all cases the neutron shield and stainless steel neutron shield jacket (outer skin) of the cask are stripped away and the infinite array of casks are pushed close together with moderator in the interstitial spaces.

9. Only 90% credit is taken for the B10 in the B-Al poison plates or less than 75% credit for the B-10 in Boral® in the KENO models.

10. The fuel rods are modeled assuming a stack density of 97.5% theoretical density with no allowance for dishing or chamfer. This assumption conservatively increases the total fuel content in the model.

11. Temperature at 20°C (293K).

12. All stainless steel is modeled as SS304. The small differences in the composition of the various stainless steels have no effect on results of the calculation.

13. All zirconium based materials in the fuel are modeled as Zircalloy-4. The small differences in the composition of the various clad / guide tube materials have no effect on the results of the calculation.

14. The thermal expansion and egg-crate gaps are conservatively replaced with the basket material wherever present. This results in replacing the soluble boron moderator in the gap regions with Aluminum thereby decreasing the neutron absorption around the fuel.

15. The transition rails between the basket and the canister shell are modeled as Aluminum with no credit for borated water in the gaps between components. This also bounds the stainless rails.

16. The cask containment boundary and canister basket structure do not experience any significant distortion under hypothetical accident conditions based on the results from Chapter U.3.

In addition, the damaged fuel criticality calculations also employ the following conservative assumptions:

1. The worst case gross damage resulting from a cask-drop accident is assumed to be either a single-ended or double-ended rod shear with flooding in borated water (during fuel loading and unloading operations). A maximum of 4 inches of fuel may be uncovered by the poison plates due to shifting of the sheared rods.

2. The cases with bare fuel (no clad) and rubble are not modeled since replacing the clad with borated water results in an increase in absorption. Hence, damaged fuel cases are modeled with the presence of the clad around the fuel pellet.

3. The bent or bowed fuel rod cases after the drop accidents assume that the fuel is intact but that the rod pitch is allowed to vary from its nominal fuel rod pitch.

4. The single-ended fuel rod shear cases assume that fuel rods that form one assembly face shear in one place and are displaced to new locations. The fuel pellets are assumed to remain in the fuel rods.

5. The double-ended fuel rod shear cases assume that fuel rods that form one assembly face shear in two places and the sheared fuel rod pieces are separated from the parent fuel rods.

U.6.4.1.4 Determination of k_{eff}

The Monte Carlo calculations performed with CSAS25 (KENO V.a) use a flat neutron starting distribution. The total number of histories traced for each calculation is approximately 800,000. This number of histories is sufficient to achieve source convergence and produce standard deviations of less than 0.0015 in Δk_{eff}. The maximum k_{eff} for the calculation is determined with the following formula:

$$k_{eff} = k_{KENO} + 2\sigma_{KENO}$$

U.6.4.2 Fuel Loading Optimization

A. Determination of the Most Reactive Fuel Type

All fuel lattices listed in Table U.6-5 are evaluated to determine the most reactive fuel assembly type with initial enrichments of 4.25 wt. % U-235. The fuel types are analyzed with fresh water in the fuel pellet cladding annulus and are centered in the fuel compartment tubes. A soluble boron concentration of 2500 ppm and a fixed poison loading of 18.75 mg B10/cm^2 (a representative poison content) were utilized for these calculations. Nominal basket dimensions are used in the KENO. The fuel assemblies were also arranged in a "centered" arrangement. The results of each run are also used to determine the most reactive fuel type for each fuel assembly class.

In all other respects, the model is the same as that described in Section U.6.3.1.

The canister/cask model for this evaluation differs from the actual design in the following ways:

- The boron 10 content is representative of the range of allowed poison contents,
- The neutron shield and the neutron shield jacket (outer skin) of the cask are conservatively replaced with water between the casks.
- The stainless steel and aluminum basket rails, which provide support to the fuel compartment tube grid, are modeled as aluminum.
- The "egg-crate" section length is modeled as 13.48 inches high (11.66" basket section + 1.75" steel insert plate + 0.07 gap). The actual design for the 32PTH1 has an "egg-crate" section length of 15.0 inches (13.18" basket section + 1.75" steel insert plate + 0.07 gap).

The results of this evaluation are provided in Table U.6-9.

The most reactive fuel type is the B&W 15x15 Mark B10. The most reactive assembly type for each assembly class is bolded in Table U.6-9. An example input file is included in Section U.6.6.2.

B. Determination of the Most Reactive Configuration

The fuel-loading configuration of the canister/cask affects the reactivity of the package. Several series of analyses determined the most reactive configuration for the canister/cask.

For this analysis, the most reactive fuel type is used to determine the most reactive configuration. The canister/cask is modeled with the B&W 15x15 Mark B 10 assembly, over a 13.48-inch axial section with periodic axial boundary conditions and reflective radial boundary conditions. This represents an infinite array in the x-y direction of canister/TCs that is infinite in length, which is conservative for criticality analysis. The starting model is identical to the model used above. The canister/cask model for this evaluation differs from the actual design in the following ways:

- The boron 10 content is representative of the range of allowed poison contents,
- The neutron shield and the neutron shield jacket (outer skin) of the cask are conservatively replaced with water between the casks.
- The stainless steel and aluminum basket transition rails, which provide support to the fuel compartment tube grid, are modeled as aluminum.
- The "egg-crate" section length is modeled as 13.48 inches high (11.66" basket section + 1.75" steel insert plate + 0.07 gap). The actual design for the 32PTH1 has an "egg-crate" section length of 15.0 inches (13.18" basket section + 1.75" steel insert plate + 0.07 gap).

Each evaluation is performed at various internal moderator density (IMD) values to determine the optimum moderator density where the reactivity is maximized.

The first set of analyses evaluates the effect of fuel assembly position within the fuel compartments. Three sets of analysis are performed, one with the assemblies pushed to the outside corners of each fuel compartment, one with the assemblies centered within the fuel compartment and the last with the fuel assemblies pushed toward the center of the basket ("inward" position). The results of the evaluation are provided in Table U.6-10. The results demonstrate that the most reactive position is with the fuel assemblies pushed toward the center of the basket.

The second set of analyses evaluates the effect of fuel compartment tube thickness on reactivity. The model starts with the B&W 15x15 Mark B 10 assemblies pushed toward the center of the basket model above. The compartment tube thickness is varied from 0.1775 to 0.2325 inches. The results in Table U.6-11 show that the most reactive calculated condition occurs with minimum compartment tube thickness.

The third set of analyses evaluates the effect of poison plate thickness on the system reactivity. The model starts with the B&W 15x15 Mark B 10 assemblies pushed toward the center of the basket model above. The poison plate thickness is varied from 0.050" to 0.187" while the poison

loading is maintained at 18.75 mg B10/cm^2. While the poison plate thickness is varied, the aluminum plate thickness is adjusted such that the total thickness remains at 0.50". The effect of poison plate thickness variation on the system reactivity is shown to be statistically insignificant based on the results in Table U.6-12. Therefore, a thickness of 0.075" is used for the remainder of the analyses. These results also indicate that poison plates of higher and lower thicknesses can be used as long as the minimum absorber loading is maintained. These results also demonstrate that there is no effect on the reactivity due to the aluminum panels when Boral® poison is used. These results further indicate that effect of a change in the thickness of the egg-crate plates (poison and aluminum) is statistically insignificant provided the total thickness remains constant.

The fourth set of analyses evaluates the effect of fuel compartment tube internal width on the system reactivity. The model starts with the nominal poison plate thickness modeled as above. For this evaluation the fuel compartment tube internal width is varied from 8.65 to 8.75 inches square. The results of the evaluation are given in Table U.6-13. The results show that the most reactive configuration is with the minimum fuel compartment tube size. The balance of this evaluation uses the minimum fuel compartment tube width because it represents the most reactive configuration.

Based on these evaluations the most reactive canister/cask configuration is for:

- Fuel assemblies pushed toward the center of the basket,
- Minimum fuel compartment tube wall thickness,
- Nominal poison plate thickness, and
- Minimum fuel compartment tube internal width.

C. Determination of the Maximum Initial Enrichment for each Fuel

The analysis performed in this section is performed using the most reactive configuration as determined in Section U.6.4.2 B above. The following analysis uses this configuration to determine the maximum allowed initial enrichment as a function of Basket Type (poison plate loading) and soluble boron concentration for each assembly class. The most reactive assembly type for each assembly class is used for each evaluation. Only the fuel assembly type and the fixed and soluble poison loading are changed for each model. In addition, for each case the IMD is varied to determine the peak reactivity for the specific configuration. The maximum initial enrichment for each assembly class as a function of soluble boron concentration and poison plate loading is documented in Table U.6-3 for intact fuel with and without CCs.

The canister/cask model for this evaluation differs from the actual design in the following ways:

- The boron 10 content is at least 10% lower than the minimum required in the B-Al poison plates and at least 25% lower than the minimum required in the Boral® plates,

- The neutron shield and the neutron shield jacket (outer skin) of the cask are conservatively replaced with water between the casks,

- The stainless steel and aluminum basket rails, which provide support to the fuel compartment tube grid, are modeled as aluminum,

- The worst case geometry and material conditions, as determined in the previous section above, are modeled,

- The "egg-crate" section length is modeled as 13.48 inches high (11.66" basket section + 1.75" steel insert plate + 0.07 gap). The actual design for the 32PTH1 has an "egg-crate" section length of 15.0 inches (13.18" basket section + 1.75" steel insert plate + 0.07 gap).

Five (5) different fixed poison loadings (Basket Types 1A or 2A, 1B or 2B, 1C or 2C, 1D or 2D, and 1E or 2E) are analyzed in the criticality calculations as described in Chapter U.6. The soluble boron concentration is varied from 2000 ppm to 3000 ppm. The maximum analyzed initial enrichment is 5.0 wt. % U-235. An example input file for the CE 16x16 fuel assembly design is included in Section **Error! Reference source not found.**.

WE 17x17 Class Assemblies

The most reactive WE 17x17 class assembly is the WE 17x17 RFA assembly as demonstrated in Table U.6-9. The results for the WE 17x17 class assembly calculations without CCs are listed in Table U.6-14. The results for the WE 17x17 class assembly calculations with CCs are listed in Table U.6-15. The results demonstrate that the reduction in the initial enrichment by 0.05 wt. % is sufficient to offset the increase in reactivity due to the presence of CCs.

CE 16x16 Class Assemblies

The most reactive CE 16x16 class assembly is the CE 16x16 System 80 assembly as demonstrated in Table U.6-9. The results for the CE 16x16 class assembly calculations without CCs are listed in Table U.6-16. The results for the CE 16x16 class assembly calculations with CCs are listed in Table U.6-17. The results demonstrate that the reduction in the initial enrichment by 0.10 wt. % is sufficient to offset the increase in reactivity due to the presence of CCs.

BW 15x15 Class Assemblies

The most reactive BW 15x15 class assembly is the BW 15x15 Mark B10 assembly as demonstrated in Table U.6-9. The results for the BW 15x15 class assembly calculations without CCs are listed in Table U.6-18. The results for the BW 15x15 class assembly calculations with CCs are listed in Table U.6-19. The results demonstrate that the reduction in the initial enrichment by 0.10 wt. % is sufficient to offset the increase in reactivity due to the presence of CCs.

CE 15x15 Class Assemblies

The most reactive CE 15x15 class assembly is the CE 15x15 Palisades assembly as demonstrated in Table U.6-9. The results for the CE 15x15 class assembly calculations without CCs are listed in Table U.6-20. The results for the CE 15x15 class assembly calculations with CCs are listed in

Table U.6-21. The results demonstrate that the reduction in the initial enrichment by 0.10 wt. % is sufficient to offset the increase in reactivity due to the presence of CCs.

WE 15x15 Class Assemblies

The most reactive WE 15x15 class assembly is the WE 15x15 Standard/ZC assembly as demonstrated in Table U.6-9. The results for the WE 15x15 class assembly calculations without CCs are listed in Table U.6-22. The results for the WE 15x15 class assembly calculations with CCs are listed in Table U.6-23. The results demonstrate that the reduction in the initial enrichment by 0.10 wt. % is sufficient to offset the increase in reactivity due to the presence of CCs.

CE 14x14 Class Assemblies

The most reactive CE 14x14 class assembly is the CE 14x14 Ft. Calhoun assembly as demonstrated in Table U.6-9. The results for the CE 14x14 class assembly calculations without CCs are listed in Table U.6-24. The results for the CE 14x14 class assembly calculations with CCs are listed in Table U.6-25. The results demonstrate that the reduction in the initial enrichment by 0.25 wt. % is sufficient to offset the increase in reactivity due to the presence of CCs.

WE 14x14 Class Assemblies

The most reactive WE 14x14 class assembly is the WE 14x14 Standard/LOPAR/ ZCA/ZCB assembly as demonstrated in Table U.6-9. The results for the WE 14x14 class assembly calculations without CCs are listed in Table U.6-26. The results for the WE 14x14 class assembly calculations with CCs are listed in Table U.6-27. The results demonstrate that the no reduction in the initial enrichment is required due to the presence of CCs.

D. Evaluation of the Various Damaged Fuel Configurations

There are several mechanisms by which a fuel rod may be breached. These mechanisms may occur while the fuel is loaded in the reactor core, in the spent fuel pool, during transport, while in temporary dry storage, and while in permanent dry storage. In addition, the type and extent of fuel rod breach can be broken down into several categories. For this calculation, the method by which the fuel rod is breached is not as important as the extent of the resultant damage. The methodology used for the damaged fuel criticality evaluations in the 32PTH1 DSC is the same as that used for 24PTH DSC described in Appendix P, Chapter P.6 of the UFSAR. The worst case gross damage resulting from a cask-drop accident is assumed to be either a single-ended or double-ended rod shear with flooding in borated water. The bent or bowed fuel rod cases assume that the fuel is intact but not in its nominal fuel rod pitch. It is possible that the fuel rods may be crushed inwards or bowed outwards to a certain degree. Therefore, this will be evaluated by varying the fuel rod pitch from a minimum pitch (based on clad OD) to a maximum based on the fuel compartment size for each fuel assembly class. All pitch variations assume a uniform rod pitch throughout the entire fuel matrix.

The single-ended fuel rod shear cases assume that a fuel rod shears in one place and is displaced to a new location. The fuel pellets are assumed to remain in the fuel rod. This case will be

evaluated by displacing one row of rods from the base fuel assembly matrix at small increments towards the side of the fuel compartment. The base fuel assembly matrix will be at nominal pitch and positioned in the "inward" position within the 32PTH1 DSC to maximize the separation distance between the fuel array and the sheared row of fuel rods. A smaller rod pitch for the base fuel assembly matrix was not chosen because it has been shown from the pitch cases that decreasing the rod pitch decreases reactivity. Increasing the base fuel assembly rod pitch will increase reactivity, however, the resulting model is similar to and is bounded by the rod pitch varying cases presented above and therefore will not be duplicated here. The single shear cases are analyzed for all fuel assembly classes.

The double-ended fuel rod shear cases assume that the fuel rod shears in two places and the intact fuel rod piece is separated from the parent fuel rod. Three resulting conditions are exhibited by the occurrence of a double-ended rod shear. These are, the fuel rod piece can remain in place, it can be displaced in the same plane, or it can be displaced to a different plane. The "remain in place" situation results in no deviation from the base fuel assembly matrix, and is therefore considered trivial and will not be evaluated separately. The fuel rod piece displaced in the same plane is equivalent to the single-ended rod shear case discussed above and will not be reevaluated in these cases. The fuel rod piece displaced in a different plane results in two possibilities: an added rod or a removed rod. As in the single-ended shear cases, the base fuel assembly matrix will be positioned in the "inward" position of the 32PTH1 DSC to allow room for a row of displaced fuel rods. One row of fuel rods will be removed from a section of the assembly and added to another so that half the fuel assembly contains one lesser row and the other half contains one greater row of fuel rods. The nominal rod pitch is used for the base fuel matrix just as in the single-ended shear rod cases. Due to the size of the B&W 15x15 fuel assembly relative to the fuel compartment, the double-ended rod shear case will be analyzed with the nominal fuel compartment size since the size of the postulated 15x16 fuel assembly exceeds the minimum fuel compartment size. However, all the other fuel assembly classes are analyzed for the double-ended shear configuration with the minimum fuel compartment size.

The first step is to determine the most reactive damaged fuel assembly geometry. This was completed using representative fixed poison loading, soluble boron concentration and assembly enrichment for the various fuel assembly classes. The representative parameters used for this study are shown in Table U.6-28. All 32 assembly locations were filled with damaged fuel assemblies. In addition, all the most reactive damaged fuel calculations are carried out with internal moderator replacing the guide tubes. This was done to effect simplicity and is not expected to impact the results of this evaluation. The design basis damaged assembly calculations, however, employ the guide tubes in their respective KENO models. The intent of these calculations was to determine the most reactive geometry, not to meet the USL. The following is a breakdown of runs made in this analysis:

- Optimum Rod Pitch Study.
- Single-ended Shear Study.
- Double-ended Shear Study.
- Shifting of fuel assemblies beyond (4 inches above) the poison sheet height.

D.1 Rod Pitch Study

The first set of damaged fuel analyses involved a study on the effect of the fuel rod pitch on system reactivity. KENO models with rod pitches ranging from a minimum corresponding to the clad OD to a maximum limited by the fuel compartment size are developed for each fuel assembly class. For cases with larger pitch, additional units (#101 through #108) are included that model the fuel rods in the outermost row of the fuel assembly. This is done to maximize the pitch for a given size of the fuel compartment. The results of the rod pitch study are shown in Table U.6-29. These results indicate that the optimum pitch for all assembly classes occurs at near maximum. A variation in this evaluation was performed by using the nominal compartment size for the B&W 15x15 fuel assembly class to determine whether a larger pitch would result in a more reactive configuration. These results are also shown in Table U.6-29 and show that the increase in reactivity due to an increase in the fuel rod pitch is offset (within statistical uncertainty of the method) by a reduction in the reactivity due to the increased assembly-to-assembly pitch. The highlighted text in Table U.6-29 indicates the most reactive case for each fuel assembly class. This study also demonstrates that the results of the parametric study in Section U.6.4.2 B above for fuel compartment ID are also applicable to the damaged assembly evaluations.

This study also bounds damaged fuel configurations with missing rods. A separate study to determine the effect on reactivity due to removal of fuel rods at optimum pitch is not necessary due to the presence of soluble boron in the moderator. The removal of fuel rods would ensure that the fissile fuel rods are replaced with boron poison and would result in a reduction in k_{eff}. Therefore, the rod pitch study is completed by determining the optimum pitch and the associated maximum k_{eff} at optimum moderator density. An example input file for optimum pitch calculation based on the WE 17x17 fuel assembly class at optimum pitch is given in Section **Error! Reference source not found.**.

D.2 Single Ended Rod Shear Study

The next set of analyses performed is for the single ended rod shear. This study depicts the fuel assembly with its last row of rods separated from the rest of the assembly. The displacement of the sheared row of rods varies radially from fuel assembly up to a maximum that is governed by the fuel assembly width and the fuel compartment size.

To model this in KENO, the base case was slightly modified. First, for a given fuel lattice, the fuel assemblies are modeled as a XX by (XX-1) array where XX corresponds to the fuel assembly class. For example, the WE 15 fuel assembly is modeled as a 15x14 array. Unit 200 is a XX by 1 array comprising of the single sheared row of rods. The units 201, 204, 211 and 214, therefore consist of two arrays, the array describing the truncated fuel assembly and the sheared row of fuel rods. The displaced rod array (single rod of rods) is then shifted (separation distance is "d") away from the fuel assembly. The amount of fuel remains the same, i.e. no new fuel is added to the system. Nominal rod pitch for all of the fuel assembly classes is used for the base XX by (XX-1) fuel assembly. In the cask drop accident scenarios, it is more likely that the fuel assembly will be crushed as a result of the drop and therefore cause local decreases in the rod pitch of the assembly. However, the rod pitch studies outlined above show that a decrease in the fuel rod pitch results in a decrease in system reactivity, therefore for the single-ended rod shear

study runs, rod pitch is modeled at nominal value. The study is repeated for the all the fuel assembly classes and at a single moderator density (80% of full density) for important separation distances.

At minimum shear distance, the results of this evaluation are compared to those given in Table U.6-29 to determine whether two different KENO models of the same geometry result in statistically insignificant differences. An example plot of a single ended shear configuration with WE 14x14 fuel assembly is shown in Figure U.6-24. The results of this evaluation are shown in Table U.6-30. As done in the previous evaluation, the results for most reactive case for each fuel assembly class are shown as highlighted text. The results indicate that there exists an optimum shear row separation distance for each class of fuel assembly where the reactivity is highest. The results also indicate that the different KENO model at zero separation produced statistically insignificant results when compared to the previous model (pitch variation).

D.3 Double Ended Rod Shear Study

The double ended rod shear evaluations model a row (XX by 1 array) of dislocated rods severed at different sections axially and then displacing to other sections of the DSC in order to define a bounding condition for fuel rod location subsequent to a double ended rod shear. To model this in KENO, the base case was accordingly modified. A new KENO unit, UNIT 11 forms one axial section of the basket that models the un-sheared fuel assemblies. The sheared fuel assemblies depleted by one row of fuel rods are modeled as a XX by (XX-1) array where XX corresponds to the fuel assembly class. The corresponding KENO units for the fuel assembly positions are 301, 304, 311, 314, 302, 303, 305 and 312. The unit 12 forms the axial section of the basket that models this depleted array of fuel assemblies. The fuel assemblies that contain the sheared-migrated row of fuel rods are modeled as a XX by (XX+1) array where XX corresponds to the fuel assembly class. The corresponding KENO units for the fuel assembly positions are 401, 404, 411 414, 402, 403, 405 and 412. The unit 13 forms the axial section of the basket that models this enhanced array of fuel assemblies. Depending on the fraction of double shear, the array 11 (an axial array of units 11, 12 and 13) is constructed to calculate the reactivity effect. Fraction of double shear is just a measure of where the rods shear axially. In general, it is conservative to assume that the rods are split right in the middle so that half the fuel assembly contains the depleted array of rods while the other half contains the enhanced array of rods. Due to the height of a single axial segment (13.48"), the total axial height of the model for these studies is 134.80" (13.48*10). However, periodic axial boundary conditions are applied making the model essentially infinite. The same rod pitch assumptions made for the single ended shear runs also apply here. This study is repeated for all fuel assembly classes and the internal moderator density is varied to determine the k_{eff} at optimum density. For the B&W 15x15 fuel assembly, the double shear evaluation could not be performed at minimum fuel compartment ID and therefore, the nominal fuel compartment ID was utilized.

An example plot of a double ended shear configuration with WE 15x15 fuel assembly is shown in Figure U.6-22. The results of this evaluation are shown in Table U.6-31. As done in the previous evaluations, the results for most reactive case for each fuel assembly class are shown as highlighted text.

D.4 Shifting of Fuel Beyond Poison

This study analyzes the effect of shifting of loose rods beyond the height of the poison plates. The calculational model assumes that a four-inch axial section of the entire fuel assembly shifts beyond the poison plates. The height of the axial shift, four-inches, is more than the maximum difference between the basket height and the canister cavity height (about 3.5 inches). These models conservatively bound all the cases associated with the shifting of fuel rods beyond poison like sliding of a single rod, sliding of a row of single sheared rods etc. This evaluation is performed using nominal pitch.

To model these in KENO, the base case was modified. First, a new KENO unit, UNIT 11 forms one axial section of the basket that models the fuel assemblies covered with poison. For the shifting of fuel assemblies (4″ shift model), a four-inch axial section of the fuel assemblies containing the uncovered fuel assemblies are modeled with the KENO units 301, 304, 311 and 314. The unit 12 forms the axial section of the basket that models this uncovered section of fuel assemblies. Finally, the array 11 (an axial array of units 11 and 12) is constructed to calculate the reactivity effect. Thus the basket is modeled as an array containing 10 "regular basket" sections (UNIT 11) and 1 "uncovered basket" section (UNIT 12). Thus the length modeled is 134.8 inches of covered fuel and 4 inches of uncovered fuel. Periodic axial boundary conditions are utilized to make this model essentially infinite in length. This study is performed for all the fuel assembly classes with varying moderator density.

The results of these evaluations are shown in Table U.6-32. An example plot of a shifting configuration with CE 15x15 fuel assembly is shown in Figure U.6-21. As done in the previous evaluations, the results for most reactive case for each fuel assembly class are shown as highlighted text.

E. Determination of the Most Reactive Damaged Fuel Configuration

The fuel-loading configuration of the canister/cask affects the reactivity of the package. Several series of analyses performed in the previous sections evaluated the various damaged assembly configurations. A comparison of the maximum k_{eff} due to the various damaged assembly configurations is shown in Table U.6-33. The most reactive damaged assembly configuration is based on the one with the optimum rod pitch for all the fuel assembly classes except the B&W 15x15 and WE 15x15 fuel assembly classes. The double ended rod shear configuration is the design basis configuration for the WE 15x15 fuel assembly class. For the B&W 15x15 fuel assembly class, all the damaged mechanisms resulted in approximately the same reactivity and therefore, all mechanisms are considered statistically similar. Since, the optimum pitch model generally resulted in a conservative prediction of reactivity for other fuel assembly classes, the B&W 15x15 design basis damaged assembly calculations will also be performed with the optimum pitch configuration. Shifted cases are modeled with nominal pitch because, the basis for these cases is to determine the reactivity effects of shifting of isolated single rods or a row of rods leaving the bulk of the fuel assembly essentially intact and surrounded by poison.

In addition, the guide tubes in the CE 14x16 and CE 16x16 fuel assembly classes are modeled as cuboids instead of cylinders. This simplification would enable these fuel assemblies to be modeled as arrays of rods with fewer KENO units and KENO arrays due to these guide tubes occupying four fuel rod positions. These cuboids are modeled such that they result in the same annular area as the cylindrical guide tubes. These results are also shown in Table U.6-33. These

results indicate that the simplified modeling of the guide tubes with cuboids is conservative. These results also demonstrate that it is conservative to model the guide tubes with the guide tube material (Zircalloy) than with internal moderator. Therefore, all the design basis calculations will model the guide tubes with Zircalloy.

F. Determination of the Maximum Initial Enrichment for each Assembly Class

The analysis performed in this section is performed using the reactive configuration as determined in Section U.6.4.2 E above. The following analysis uses this configuration to determine the maximum allowed initial enrichment as a function of Basket Type (poison plate loading) and soluble boron concentration for each assembly class. The most reactive damaged assembly configuration for each assembly class is used for each evaluation. Only the damaged assembly configuration (damaged assembly model for each class) and the fixed and soluble poison loading are changed for each model. In addition, for each case the internal moderator density is varied to determine the peak reactivity for the specific configuration. The maximum initial enrichment for each assembly class as a function of soluble boron concentration and poison plate loading is documented in Table U.6-4 for damaged fuel assemblies with and without CCs.

The canister/cask model for this evaluation differs from the actual design in the following ways:

- The boron 10 content is at least 10% lower than the minimum required in the B-Al poison plates and at least 25% lower than the minimum required in the Boral® plates,
- Damaged assemblies are loaded in all 32 fuel compartments,
- The neutron shield and the neutron shield jacket (outer skin) of the cask are conservatively replaced with water between the casks,
- The stainless steel and aluminum basket rails, which provide support to the fuel compartment tube grid, are modeled as aluminum,
- The worst case geometry and material conditions, from Section U.6.4.2 B above are modeled,
- The "egg-crate" section length is modeled as 13.48 inches high (11.66" basket section + 1.75" steel insert plate + 0.07 gap). The actual design for the 32PTH1 has an "egg-crate" section length of 15.0 inches (13.18" basket section + 1.75" steel insert plate + 0.07 gap).

Five (5) different fixed poison loadings (Basket Types 1A or 2A, 1B or 2B, 1C or 2C, 1D or 2D, and 1E or 2E) are analyzed in the criticality calculations as described in Chapter U.6. The soluble boron concentration is varied from 2000 ppm to 3000 ppm. The maximum analyzed initial enrichment is 5.0 wt. % U-235. An example input file for the WE 15x15 damaged fuel assembly with the double shear configuration is included in Section **Error! Reference source not found.**.

WE 17x17 Class Assemblies

All the damaged assembly configurations are based on the optimum pitch model. The results for the WE 17x17 class assembly calculations without CCs are listed in Table U.6-34. The results for the WE 17x17 class assembly calculations with CCs are listed in Table U.6-35.

CE 16x16 Class Assemblies

All the damaged assembly configurations are based on the optimum pitch model. The results for the CE 16x16 class assembly calculations without CCs are listed in Table U.6-36. The results for the WE 17x17 class assembly calculations with CCs are listed in Table U.6-37.

BW 15x15 Class Assemblies

All the damaged assembly configurations are based on the optimum pitch model. The results for the BW 15x15 class assembly calculations without CCs are listed in Table U.6-38. The results for the BW 15x15 class assembly calculations with CCs are listed in Table U.6-39.

CE 15x15 Class Assemblies

All the damaged assembly configurations are based on the optimum pitch model. The results for the CE 15x15 class assembly calculations without CCs are listed in Table U.6-40. The results for the CE 15x15 class assembly calculations with CCs are listed in Table U.6-41.

WE 15x15 Class Assemblies

All the damaged assembly configurations are based on the double shear model. The results for the WE 15x15 class assembly calculations without CCs are listed in Table U.6-42. The results for the WE 15x15 class assembly calculations with CCs are listed in Table U.6-43.

CE 14x14 Class Assemblies

All the damaged assembly configurations are based on the optimum pitch model. The results for the CE 14x14 class assembly calculations without CCs are listed in Table U.6-44. The results for the CE 14x14 class assembly calculations with CCs are listed in Table U.6-45.

WE 14x14 Class Assemblies

All the damaged assembly configurations are based on the optimum pitch model. The results for the WE 14x14 class assembly calculations without CCs are listed in Table U.6-46. The results for the WE 14x14 class assembly calculations with CCs are listed in Table U.6-47.

As done in the previous evaluations, the results for most reactive case for each fuel assembly class in Table U.6-34 through Table U.6-47 is shown as highlighted text.

U.6.4.3 Criticality Results

Table U.6-48 lists the bounding results for intact fuel assemblies for all conditions of storage. The highest calculated k_{eff}, including 2σ uncertainty, is for the B&W 15x15 Mark B-10 fuel assembly with an initial U-235 enrichment of 4.4 wt. %, 2400 ppm boron with CCs in a Type 1D or 2D Basket. The maximum allowed initial enrichment for each assembly type (with and without CCs) as a function of fixed poison loading and soluble boron concentration level is listed in Table U.6-3 for intact fuel configuration. The minimum boron content for the poison plates

for the various basket types are shown in Table U.6-1. The input file listing for the most reactive case is provided in Section **Error! Reference source not found.**.

Table U.6-49 lists the bounding results for damaged fuel assemblies for all conditions of storage. The highest calculated k_{eff}, including 2σ uncertainty, is for the CE 16x16 fuel assembly with an initial U-235 enrichment of 4.4 wt. %, 3000 ppm boron with CCs, in a Type 1A or 2A Basket. The maximum allowed initial enrichment for each assembly type as a function of fixed poison loading and soluble boron concentration level is listed in Table U.6-4. The input file listing for the most reactive case is provided in Section **Error! Reference source not found.**.

These criticality calculations were performed with CSAS25 of SCALE-4.4. For each case, the result includes (1) the KENO-calculated k_{KENO}, (2) the one sigma uncertainty σ_{KENO}, and (3) the final k_{eff}, which is equal to $k_{KENO} + 2\sigma_{KENO}$.

The criterion for subcriticality is that

$$k_{KENO} + 2\sigma_{KENO} \leq USL,$$

Where USL is the upper subcritical limit established by an analysis of benchmark criticality experiments. From Section U.6.5 the minimum USL over the parameter range is 0.9417. From Table U.6-48 for the most reactive case,

$$k_{KENO} + 2\sigma_{KENO} = 0.9397 + 2\ (0.0007) = 0.9411 \leq 0.9417.$$

U.6.5 Critical Benchmark Experiments

The criticality safety analysis of the NUHOMS® 32PTH1 System uses the CSAS25 module of the SCALE system of codes. The CSAS25 control module allows simplified data input to the functional modules BONAMI-S, NITAWL-II, and KENO V.a. These modules process the required cross-section data and calculate the keff of the system. BONAMI-S performs resonance self-shielding calculations for nuclides that have Bondarenko data associated with their cross sections. NITAWL-S applies a Nordheim resonance self-shielding correction to nuclides having resonance parameters. Finally, KENO V.a calculates the effective neutron multiplication (k_{eff}) of a 3-D system.

The analysis presented herein uses the fresh fuel assumption for criticality analysis. The analysis employs the 44-group ENDF/B-V cross-section library because it has a small bias, as determined by 121 benchmark calculations. The Upper Subcritical Limit (USL-1) was determined using the results of these 121 benchmark calculations.

The benchmark problems used to perform this verification are representative of benchmark arrays of commercial light water reactor (LWR) fuels with the following characteristics:

(1) water moderation,

(2) boron neutron absorbers,

(3) unirradiated light water reactor type fuel (no fission products or "burnup credit") near room temperature (vs. reactor operating temperature),

(4) close reflection, and

(5) uranium oxide.

The 121 uranium oxide experiments were chosen to model a wide range of uranium enrichments, fuel pin pitches, assembly separation, soluble boron concentration and control elements in order to test the codes ability to accurately calculate k_{eff}. These experiments are discussed in detail in Reference [6.2].

U.6.5.1 Benchmark Experiments and Applicability

A summary of all of the pertinent parameters for each experiment is included in Table U.6-50 along with the results of each run. The best correlation is observed for fuel assembly separation distance with a correlation of 0.66. All other parameters show much lower correlation ratios indicating no real correlation. All parameters were evaluated for trends and to determine the most conservative USL.

The USL is calculated in accordance to NUREG/CR-6361 [6.2]. USL Method 1 (USL-1) applies a statistical calculation of the bias and its uncertainty plus an administrative margin (0.05) to the linear fit of results of the experimental benchmark data. The basis for the administrative margin is from reference [6.3]. Results from the USL evaluation are presented in Table U.6-51.

The criticality evaluation used the same cross section set, fuel materials and similar material/geometry options that were used in the 121 benchmark calculations as shown in Table U.6-50. The modeling techniques and the applicable parameters listed in Table U.6-52 for the actual criticality evaluations fall within the range of those addressed by the benchmarks in Table U.6-50.

U.6.5.2 Results of the Benchmark Calculations

The results from the comparisons of physical parameters of each of the fuel assembly types (bounding for both intact and damaged assembly configurations) to the applicable USL value are presented in Table U.6-52. The minimum value of the USL is determined to be 0.9417 based on comparisons to the limiting assembly parameters as shown in Table U.6-52.

U.6.6 Appendix

U.6.6.1 References

6.1 Oak Ridge National Laboratory, RSIC Computer Code Collection, "SCALE: A Modular Code System for Performing Standardized Computer Analysis for Licensing Evaluations for Workstations and Personal Computers," NUREG/CR-0200, Revision 6, ORNL/NUREG/CSD-2/V2/R6.

6.2 U.S. Nuclear Regulatory Commission, "Criticality Benchmark Guide for Light-Water-Reactor fuel in Transportation and Storage Packages," NUREG/CR-6361, Published March 1997, ORNL/TM-13211.

6.3 U.S. Nuclear Regulatory Commission, "Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packages," NUREG/CR-5661, Published April 1997, ORNL/TM-11936.

6.4 U.S. Nuclear Regulatory Commission, "Standard Review Plan for Dry Cask Storage Systems," NUREG-1536, Published January 1997.

6.5 U.S. Nuclear Regulatory Commission Interim Staff Guidance (ISG)-15: Materials Evaluation.

U.6.6.2 Most Reactive Fuel Type Example Input File

Proprietary Information withheld under 10CFR2.390

Proprietary Information withheld under 10CFR2.390

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Table U.6-1
Minimum B10 Content in the Neutron Poison Plates

Basket Type	Minimum B10 Content for Boral® (mg/cm^2)	Minimum B10 Content for B-Al[1] (mg/cm^2)	B10 Content Used in Criticality Evaluation (mg/cm^2)
1A or 2A	9.0	7.0	6.3
1B or 2B	19.0	15.0	13.5
1C or 2C	25.0	20.0	18.0
1D or 2D	N/A	32.0	28.8
1E or 2E	N/A	50.0	45.0

Note:

(1) B-Al = Metal Matrix Composites and Borated Aluminum Alloys.

Table U.6-2
Authorized Contents for NUHOMS® 32PTH1 System

Assembly Type[1]	Array	Assembly Class
Westinghouse 17x17 LOPAR/Standard	17x17	WE 17x17
Westinghouse 17x17 OFA/Vantage 5[2]	17x17	WE 17x17
Framatome 17x17 MK BW	17x17	WE 17x17
Westinghouse 17x17 RFA	17x17	WE 17x17
CE 16x16 System 80	16x16	CE 16x16
CE 16x16 Standard	16x16	CE 16x16
B&W 15x15 Mark B (through B11)	15x15	BW 15x15
B&W 17x17 Mark C	17x17	BW 15x15
CE 15x15 Palisades	15x15	CE 15x15
Exxon/ANF (ANP) 15x15 CE	15x15	CE 15x15
Exxon/ANF (ANP) 15x15 WE	15x15	WE 15x15
Westinghouse 15x15 Standard/ZC	15x15	WE 15x15
Westinghouse 15x15 LOPAR/OFA/ DRFA/Vantage 5	15x15	WE 15x15
CE 14x14 Standard/Generic	14x14	CE 14x14
CE 14x14 Fort Calhoun	14x14	CE 14x14
Framatome-ANP 14x14 CE	14x14	CE 14x14
Exxon/ANF (ANP) 14x14 WE	14x14	WE 14x14
Exxon/ANF (ANP) 14x14 Toprod	14x14	WE 14x14
Westinghouse 14x14 Standard/LOPAR/ZCA/ZCB	14x14	WE 14x14
Westinghouse 14x14 OFA	14x14	WE 14x14

Note:

(1) Reload fuel from other manufacturers with these parameters are also acceptable.
(2) Includes all Vantage versions (5, +, ++, 5H, etc.)

Table U.6-3
Maximum Assembly Average Initial Enrichment for Each Configuration (Intact Fuel)

Fuel Assembly Class[1]	Maximum Assembly Average Initial Enrichment (wt. % U-235) as a Function of Soluble Boron Concentration and Basket Type (Fixed Poison Loading)					
	Minimum Soluble Boron (ppm)	Basket Type				
		1A or 2A	1B or 2B	1C or 2C	1D or 2D	1E or 2E
WE 17x17 Assembly Class[4]	2000	3.40	3.80	3.90	4.10	4.30
WE 17x17 LOPAR/Standard	2300	3.70	4.00	4.20	4.40	4.70
WE 17x17 OFA/Vantage 5 [2]	2400	3.70	4.10	4.30	4.50	4.80
Fram 17x17 MK BW	2500	3.80	4.20	4.40	4.60	4.90
WE 17x17 RFA	2800	4.00	4.50	4.70	5.00	5.00
	3000	4.20	4.60	4.80	5.00	5.00
CE 16x16 Assembly Class[5]	2000	3.90	4.30	4.50	4.80	5.00
CE 16x16 System 80	2300	4.10	4.60	4.80	5.00	5.00
CE 16x16 Standard	2400	4.20	4.70	4.90	5.00	5.00
	2500	4.30	4.80	5.00	5.00	5.00
	2800	4.60	5.00	5.00	5.00	5.00
	3000	4.70	5.00	5.00	5.00	5.00
BW 15x15 Assembly Class[5]	2000	3.30	3.60	3.80	4.00	4.20
BW 15x15 Mark B [3]	2300	3.50	3.90	4.10	4.30	4.60
BW 17x17 Mark C	2400	3.60	4.00	4.20	4.40	4.70
	2500	3.70	4.10	4.30	4.50	4.80
	2800	3.90	4.30	4.50	4.80	5.00
	3000	4.10	4.50	4.70	5.00	5.00
CE 15x15 Assembly Class[5]	2000	3.50	3.90	4.00	4.20	4.40
CE 15x15 Palisades	2300	3.80	4.10	4.30	4.60	4.80
Exxon/ANF (ANP) 15x15 CE	2400	3.90	4.30	4.40	4.70	4.90
	2500	3.90	4.35	4.50	4.80	5.00
	2800	4.20	4.60	4.80	5.00	5.00
	3000	4.30	4.80	5.00	5.00	5.00

Table U.6-3
Maximum Assembly Average Initial Enrichment for Each Configuration (Intact Fuel)

(Concluded)

Fuel Assembly Class[1]	Maximum Assembly Average Initial Enrichment (wt. % U-235) as a Function of Soluble Boron Concentration and Basket Type (Fixed Poison Loading)					
	Minimum Soluble Boron (ppm)	Basket Type				
		1A or 2A	1B or 2B	1C or 2C	1D or 2D	1E or 2E
WE 15x15 Assembly Class[5]	2000	3.50	3.80	3.90	4.20	4.40
Exxon/ANF (ANP) 15x15 WE WE 15x15 Standard/ZC WE 15x15 LOPAR/OFA/DRFA/Vantage 5	2300	3.70	4.10	4.20	4.50	4.80
	2400	3.80	4.20	4.40	4.60	4.90
	2500	3.90	4.30	4.50	4.70	5.00
	2800	4.10	4.50	4.70	5.00	5.00
	3000	4.20	4.70	4.90	5.00	5.00
CE 14x14 Assembly Class[6]	2000	3.90	4.40	4.60	4.90	5.00
CE 14x14 Standard/Generic CE 14x14 Fort Calhoun Fram 14x14 CE	2300	4.20	4.70	5.00	5.00	5.00
	2400	4.30	4.80	5.00	5.00	5.00
	2500	4.40	5.00	5.00	5.00	5.00
	2800	4.60	5.00	5.00	5.00	5.00
	3000	4.80	5.00	5.00	5.00	5.00
WE 14x14 Assembly Class[7]	2000	4.20	4.70	4.90	5.00	5.00
Exxon/ANF (ANP) 14x14 WE Exxon/ANF (ANP) 14x14 Toprod WE 14x14 Std/LOPAR/ZCA/ZCB WE 14x14 OFA	2300	4.50	5.00	5.00	5.00	5.00
	2400	4.60	5.00	5.00	5.00–	5.00
	2500	4.70	5.00	5.00	5.00	5.00
	2800	5.00	5.00	5.00	5.00–	5.00
	3000	5.00	5.00	5.00	5.00	5.00

Notes:

(1) Reload fuel from other manufacturers with these parameters are also acceptable.
(2) Includes all Vantage versions (5, +, ++, 5H, etc.)
(3) Mark B through B11
(4) Reduce Enrichment by 0.05 wt. % U-235 for assemblies with CCs that extend into the active fuel region.
(5) Reduce Enrichment by 0.10 wt. % U-235 for assemblies with CCs that extend into the active fuel region.
(6) Reduce Enrichment by 0.25 wt. % U-235 for assemblies with CCs that extend into the active fuel region.
(7) No reduction in Enrichment required for assemblies with CCs that extend into the active fuel region.

Table U.6-4
Maximum Assembly Average Initial Enrichment for Each Configuration (Damaged Fuel)

Fuel Assembly Class[1]	Maximum Assembly Average Initial Enrichment (wt. % U-235) as a Function of Soluble Boron Concentration and Basket Type (Fixed Poison Loading)					
	Minimum Soluble Boron (ppm)	Basket Type				
		1A or 2A	1B or 2B	1C or 2C	1D or 2D	1E or 2E
WE 17x17 Assembly Class (without CCs) WE 17x17 LOPAR/Standard WE 17x17 OFA/Vantage 5 [2] Fram 17x17 MK BW WE 17x17 RFA	2000	3.40	3.70	3.80	4.05	4.25
	2300	3.60	3.95	4.10	4.35	4.65
	2400	3.70	4.05	4.20	4.45	4.75
	2500	3.75	4.15	4.30	4.55	4.85
	2800	4.00	4.40	4.60	4.85	5.00
	3000	4.15	4.55	4.75	5.00	5.00
WE 17x17 Assembly Class (with CCs) WE 17x17 LOPAR/Standard WE 17x17 OFA/Vantage 5 [2] Fram 17x17 MK BW WE 17x17 RFA	2000	3.35	3.65	3.75	4.00	4.20
	2300	3.55	3.90	4.05	4.30	4.55
	2400	3.65	4.00	4.15	4.40	4.70
	2500	3.70	4.10	4.25	4.50	4.75
	2800	3.95	4.35	4.55	4.80	5.00
	3000	4.10	4.50	4.70	5.00	5.00
CE 16x16 Assembly Class (without CCs) CE 16x16 System 80 CE 16x16 Standard	2000	3.65	4.05	4.20	4.50	4.75
	2300	3.90	4.30	4.50	4.80	5.00
	2400	4.00	4.40	4.60	4.90	5.00
	2500	4.05	4.50	4.70	5.00	5.00
	2800	4.30	4.80	5.00	5.00	5.00
	3000	4.50	4.95	5.00	5.00	5.00
CE 16x16 Assembly Class (with CCs) CE 16x16 System 80 CE 16x16 Standard	2000	3.60	3.95	4.10	4.40	4.65
	2300	3.80	4.20	4.40	4.70	4.90
	2400	3.90	4.30	4.50	4.80	5.00
	2500	4.00	4.40	4.60	4.90	5.00
	2800	4.20	4.70	4.90	5.00	5.00
	3000	4.40	4.85	5.00	5.00	5.00

Table U.6-4
Maximum Assembly Average Initial Enrichment for Each Configuration (Damaged Fuel)

(Continued)

Fuel Assembly Class[1]	Maximum Assembly Average Initial Enrichment (wt. % U-235) as a Function of Soluble Boron Concentration and Basket Type (Fixed Poison Loading)					
	Minimum Soluble Boron (ppm)	Basket Type				
		1A or 2A	1B or 2B	1C or 2C	1D or 2D	1E or 2E
BW 15x15 Assembly Class (without CCs) BW 15x15 Mark B [3] BW 17x17 Mark C	2000	3.30	3.60	3.75	3.95	4.20
	2300	3.50	3.90	4.05	4.30	4.50
	2400	3.60	4.00	4.15	4.40	4.65
	2500	3.65	4.05	4.20	4.50	4.75
	2800	3.90	4.30	4.50	4.75	5.00
	3000	4.05	4.45	4.65	5.00	5.00
BW 15x15 Assembly Class (with CCs) BW 15x15 Mark B [3] BW 17x17 Mark C	2000	3.20	3.50	3.65	3.90	4.10
	2300	3.40	3.80	3.95	4.20	4.40
	2400	3.50	3.90	4.05	4.30	4.55
	2500	3.60	4.00	4.15	4.40	4.65
	2800	3.80	4.20	4.40	4.65	4.90
	3000	3.95	4.40	4.55	4.90	5.00
CE 15x15 Assembly Class (without CCs) CE 15x15 Palisades Exxon/ANF (ANP) 15x15 CE	2000	3.35	3.70	3.80	4.05	4.25
	2300	3.60	3.95	4.10	4.30	4.60
	2400	3.65	4.05	4.20	4.45	4.70
	2500	3.75	4.15	4.30	4.55	4.80
	2800	4.00	4.40	4.60	4.85	5.00
	3000	4.15	4.55	4.75	5.00	5.00
CE 15x15 Assembly Class (with CCs) CE 15x15 Palisades Exxon/ANF (ANP) 15x15 CE	2000	3.30	3.65	3.80	4.00	4.20
	2300	3.55	3.90	4.05	4.30	4.55
	2400	3.65	4.00	4.15	4.45	4.65
	2500	3.70	4.10	4.25	4.50	4.80
	2800	3.95	4.35	4.55	4.80	5.00
	3000	4.10	4.55	4.70	5.00	5.00

Table U.6-4
Maximum Assembly Average Initial Enrichment for Each Configuration (Damaged Fuel)

(Continued)

Fuel Assembly Class[1]	Maximum Assembly Average Initial Enrichment (wt. % U-235) as a Function of Soluble Boron Concentration and Basket Type (Fixed Poison Loading)					
	Minimum Soluble Boron (ppm)	Basket Type				
		1A or 2A	1B or 2B	1C or 2C	1D or 2D	1E or 2E
WE 15x15 Assembly Class (without CCs) Exxon/ANF (ANP) 15x15 WE WE 15x15 Standard/ZC WE 15x15 LOPAR/OFA/DRFA/Vantage 5	2000	3.40	3.75	3.90	4.15	4.30
	2300	3.65	4.00	4.20	4.45	4.70
	2400	3.75	4.10	4.30	4.55	4.80
	2500	3.80	4.20	4.40	4.65	4.90
	2800	4.05	4.45	4.60	4.90	5.00
	3000	4.20	4.60	4.80	5.00	5.00
WE 15x15 Assembly Class (with CCs) Exxon/ANF (ANP) 15x15 WE WE 15x15 Standard/ZC WE 15x15 LOPAR/OFA/DRFA/Vantage 5	2000	3.35	3.65	3.80	4.00	4.20
	2300	3.55	3.90	4.10	4.35	4.60
	2400	3.65	4.00	4.20	4.45	4.70
	2500	3.70	4.10	4.30	4.55	4.80
	2800	3.95	4.35	4.50	4.80	5.00
	3000	4.10	4.50	4.70	5.00	5.00
CE 14x14 Assembly Class (without CCs) CE 14x14 Standard/Generic CE 14x14 Fort Calhoun Fram 14x14 CE	2000	3.70	4.10	4.30	4.60	4.85
	2300	3.95	4.40	4.60	4.95	5.00
	2400	4.05	4.50	4.70	5.00	5.00
	2500	4.15	4.60	4.80	5.00	5.00
	2800	4.40	4.90	5.00	5.00	5.00
	3000	4.55	5.00	5.00	5.00	5.00
CE 14x14 Assembly Class (with CCs) CE 14x14 Standard/Generic CE 14x14 Fort Calhoun Fram 14x14 CE	2000	3.55	3.95	4.10	4.35	4.60
	2300	3.80	4.20	4.40	4.70	4.90
	2400	3.9	4.30	4.50	4.80	5.00
	2500	4.00	4.40	4.60	4.90	5.00
	2800	4.20	4.65	4.90	5.00	5.00
	3000	4.35	4.85	5.00	5.00	5.00

Table U.6-4
Maximum Assembly Average Initial Enrichment for Each Configuration (Damaged Fuel)

(Concluded)

Fuel Assembly Class[1]	Maximum Assembly Average Initial Enrichment (wt. % U-235) as a Function of Soluble Boron Concentration and Basket Type (Fixed Poison Loading)					
	Minimum Soluble Boron (ppm)	Basket Type				
		1A or 2A	1B or 2B	1C or 2C	1D or 2D	1E or 2E
WE 14x14 Assembly Class (without CCs) Exxon/ANF (ANP) 14x14 WE Exxon/ANF (ANP) 14x14 Toprod WE 14x14 Std/LOPAR/ZCA/ZCB WE 14x14 OFA	2000	3.75	4.15	4.30	4.60	4.85
	2300	3.95	4.45	4.65	5.00	5.00
	2400	4.05	4.55	4.75	5.00	5.00
	2500	4.15	4.65	4.85	5.00	5.00
	2800	4.40	4.90	5.00	5.00	5.00
	3000	4.60	5.00	5.00	5.00	5.00
WE 14x14 Assembly Class (with CCs) Exxon/ANF (ANP) 14x14 WE Exxon/ANF (ANP) 14x14 Toprod WE 14x14 Std/LOPAR/ZCA/ZCB WE 14x14 OFA	2000	3.70	4.10	4.20	4.50	4.75
	2300	3.90	4.40	4.60	4.90	5.00
	2400	4.00	4.50	4.65	5.00	5.00
	2500	4.10	4.55	4.80	5.00	5.00
	2800	4.30	4.80	5.00	5.00	5.00
	3000	4.50	5.00	5.00	5.00	5.00

Notes:

(1) Reload fuel from other manufacturers with these parameters are also acceptable.
(2) Includes all Vantage versions (5, +, ++, 5H, etc.)
(3) Mark B through B11

Table U.6-5
Parameters For PWR Assemblies[6]

Manufacturer[1]	Array	Version	Active Fuel Length (in)	Number Fuel Rods per Assembly	Pitch (in)	Fuel Pellet OD (in)
WE	17x17	LOPAR	144	264	0.496	0.3225
WE	17x17	OFA/Van 5	144	264	0.496	0.3088
Framatome	17x17	MK BW	144	264	0.496	0.3195
WE	17x17	RFA	144	264	0.496	0.3225
CE	16x16	System 80	150	236	0.506	0.3255
CE	16x16	Standard	150	236	0.506	0.3255
B&W	15x15	Mark B2 – B8	141.8	208	0.568	0.3686
B&W	15x15	Mark B9	140.6	208	0.568	0.3700
B&W	15x15	Mark B10	142.3	208	0.568	0.3735
B&W	15x15	Mark B11	142.3	208	0.568	0.3615
B&W	17x17	Mark C	144	265	0.502	0.3232
CE	15x15	Palisades	132	216	0.550	0.3600[2]
Exxon/ANF (ANP)	15x15	CE	131.4	216	0.550	0.3565
Exxon/ANF (ANP)	15x15	WE	144	204	0.563	0.3565
WE	15x15	Std/ZC	144	204	0.563	0.3659
WE	15x15	LOPAR/OFA/ DRFA/Van 5	144	204	0.563	0.3659
CE	14x14	Std/Gen	136.7	176	0.580	0.3765
CE	14x14	Ft. Calhoun	128	176	0.580	0.3815
Framatome	14x14	CE	136.7	176	0.580	0.3805
Exxon/ANF (ANP)	14x14	WE	142	179	0.556	0.3505
Exxon/ANF (ANP)	14x14	Toprod	142	179	0.556	0.3505
WE	14x14	Std/LOPAR/ ZCA/ZCB	144	179	0.556	0.3674
WE	14x14	OFA	144	179	0.556	0.3444

Table U.6-5
Parameters For PWR Assemblies[6]

(Continued)

Manufacturer[1]	Array	Version	Clad Thickness (in)	Clad OD (in)	Water Hole OD (in)	Water Hole ID (in)
WE	17x17	LOPAR	0.0225	0.374	24@0.474 1@0.480	24@0.422 1@0.450
WE	17x17	OFA/Van 5	0.0225	0.360	24@0.482 1@0.476	24@0.450 1@0.460
Framatome	17x17	MK BW	0.0225	0.374	25@0.482	25@0.450
WE	17x17	RFA	0.0225	0.374	24@0.474 1@0.480	24@0.422 1@0.450
CE	16x16	System 80	0.0230	0.382	5@0.768	5@0.687
CE	16x16	Standard	0.0250	0.382	5@0.768	5@0.687
B&W	15x15	Mark B2 – B8	0.0265	0.430	16@0.530 1@0.493	16@0.498 1@441
B&W	15x15	Mark B9	0.0265	0.430	16@0.530 1@0.493	16@0.498 1@441
B&W	15x15	Mark B10	0.0250	0.430	16@0.530 1@0.493	16@0.498 1@441
B&W	15x15	Mark B11	0.0240	0.416	16@0.530 1@0.493	16@0.498 1@441
B&W	17x17	Mark C	0.0240	0.379	24@0.482 1@0.442	24@0.430 1@0.390
CE	15x15	Palisades	0.0260[3]	0.418[4]	8@0.4135	8@0.3655
Exxon/ANF (ANP)	15x15	CE	0.0300	0.417	8Guide Bars[5] 1@0.417	1@0.363
Exxon/ANF (ANP)	15x15	WE	0.0300	0.424	21@0.544	2@0.510
WE	15x15	Std/ZC	0.0242	0.422	20@0.546 1@0.546	20@0.512 1@0.516[6]
WE	15x15	LOPAR/OFA/ DRFA/Van 5	0.0280	0.440	21@0.546	21@0.5166
CE	14x14	Std/Gen	0.0280	0.440	5@1.115	5@1.035
CE	14x14	Ft. Calhoun	0.0280	0.440	5@1.115	5@1.035
Framatome	14x14	CE	0.0260	0.440	5@1.115	5@1.035

Table U.6-5
Parameters For PWR Assemblies[6]

(Concluded)

Manufacturer[1]	Array	Version	Clad Thickness (in)	Clad OD (in)	Water Hole OD (in)	Water Hole ID (in)
Exxon/ANF (ANP)	14x14	WE	0.0300	0.424	16@0.541 1@0.480	16@0.507 1@0.448
Exxon/ANF (ANP)	14x14	Toprod	0.0295	0.417	16@0.541 1@0.424	16@0.507 1@0.370
WE	14x14	Std/LOPAR/ ZCA/ZCB	0.0225	0.422	16@0.539 1@0.422	16@0.505 1@0.392
WE	14x14	OFA	0.0243	0.400	16@0.526 1@0.400	16@0.492 1@0.353

Notes:

(1) Reload fuel assemblies from other manufacturers with these parameters are also acceptable.
(2) Pellet OD ranges from 0.3510 to 0.3600 inches.
(3) Clad thickness ranges from 0.0240 to 0.0295 inches
(4) Clad OD ranges from 0.4135 to 0.4175 inches
(5) Guide Bars are solid Zircaloy-4 approximately 0.40 inches x 0.45 inches
(6) All dimensions shown are nominal

Table U.6-6
NUHOMS® 32PTH1 Basket Dimensions

Basket Component Description	Actual Dimension inches	Dimension Used in Model inches (cm)
Compartment Inside (Maximum) Compartment Inside (Nominal) Compartment Inside (Minimum)	8.75 8.70 8.65	8.75 (22.225) 8.70 (22.098) 8.65 (21.971)
Compartment wall (Maximum) Compartment wall (Nominal) Compartment wall (Minimum)	0.2325 0.1875 0.1775	0.2325 (0.59055) 0.1875 (0.47625) 0.1775 (0.45085)
Stainless steel insert plate height	1.75	1.75 (4.445)
Stainless steel insert plate thickness	0.50	0.50 (1.26998)
Poison/Al plate height	13.18	9.91 (25.1714)
Poison plate thickness(1)	0.075	0.075 (0.19049)
Al plate thickness(1)	0.425	0.425 (1.07949)
Horizontal gap	0.07	Modeled as Aluminum 0.07 (0.1778)
Vertical slot width / height	1.00 / 5.75	No Slot (Replaced with Basket)
DSC inside radius	34.375	34.50 (87.6250)
DSC wall thickness	0.500	0.500 (1.270)
Section Height	15.00	13.48 (34.2392)

Note:

(1) Dimensions given are based on 0.075 inch thick poison plate which is consistent with Boral®.

Table U.6-7
Description of the Basic KENO Model Units

Geometry Units	Description
1	Fuel Pin Cell
2	Guide Tube
3	Instrument Tube
21 - 23	Basket Cells with Poison along the West Face of F/A
31 - 33	Basket Cells without Poison along North Face of F/A
41 - 43	Basket Cells without Poison along the East Face of F/A
51 - 53	Basket Cells with Poison along the South Face of F/A
25,35,45,55	Arrays that define the West, North, East and South Faces of the Basket Cell without fuel
61 - 63	Basket Cells without Poison along the West Face of F/A
71 - 73	Basket Cells without Poison along North Face of F/A
81 - 83	Basket Cells without Poison along the East Face of F/A
91 - 93	Basket Cells without Poison along the South Face of F/A
65,75,85,95	Arrays that define the West, North, East and South Faces of the Basket Cell without fuel and poison
201	Basket Cell with Fuel Assembly Positions 201, 202, 205, 206 representing the South West Interior Positions
204	Basket Cell with Fuel Assembly Positions 203, 204, 207, 208, 235, 236 representing the South East Positions
211	Basket Cell with Fuel Assembly Positions 211, 212, 215, 216, 231, 232 representing the North West Positions
214	Basket Cell with Fuel Assembly Positions 213, 214, 217, 218, 233, 234, 237, 238 representing the North East Positions
202	Basket Cell with Fuel Assembly Positions 225, 226 representing West Facing Corner (South West) Positions
203	Basket Cell with Fuel Assembly Positions 221, 222 representing South Facing Corner (South West) Positions
205	Basket Cell with Fuel Assembly Positions 223, 224 representing the South Facing Corner (South East) Positions
212	Basket Cell with Fuel Assembly Positions 227, 228 representing West Facing Corner (North West) Positions
241 - 245	Array of Basket Cells defining the outer 16 locations
245	Array of Basket Cells defining the inner 16 locations
10	Global Unit

Table U.6-8
Material Property Data

Material	ID	Density g/cm^3	Element	Weight %	Atom Density (atoms/b-cm)
UO_2 (Enrichment - 5.0 wt. %)	1	10.686	U-235	4.407	1.20673E-03
			U-238	83.743	2.26382E-02
			O	11.850	4.76898E-02
Zircaloy-4	2	6.56	Zr	98.23	4.2541E-02
			Sn	1.45	4.8254E-04
			Fe	0.21	1.4856E-04
			Cr	0.10	7.5978E-05
			Hf	0.01	2.2133E-06
Water (Pellet Clad Gap)	3	0.998	H	11.1	6.6769E-02
			O	88.9	3.3385E-02
Stainless Steel (SS304)	4	7.94	C	0.080	3.1877E-04
			Si	1.000	1.7025E-03
			P	0.045	6.9468E-05
			Cr	19.000	1.7473E-02
			Mn	2.000	1.7407E-03
			Fe	68.375	5.8545E-02
			Ni	9.500	7.7402E-03
Borated Water (3000 ppm Boron)	5	1.00	H	11.08	6.67692E-02
			O	88.62	3.33846E-02
			B10	0.06	3.32551E-05
			B11	0.24	1.33856E-04
$^{11}B_4C$ in CC	7	2.555	B11	78.56	1.0988E-01
			C	21.44	2.7470E-02
Aluminum	8	2.702	Al	100.0	6.0307E-02
Aluminum - Boron Poison Plate for Type 1A or 2A Basket (6.30 mg B-10/cm^2)	9	2.620	B10	0.01	1.33020E-05
			B11	0.14	2.01002E-04
			Al	99.85	5.83483E-02
Water	10	0.998	H	11.1	6.6769E-02
			O	88.9	3.3385E-02
Lead	11	11.344	Pb	100.0	3.2969E-02

Table U.6-8
Material Property Data

(Concluded)

Material	ID	Density g/cm3	Element	Weight %	Atom Density (atoms/b-cm)
Aluminum - Boron Poison Plate for Type 1B or 2B Basket (13.5 mg B-10/cm^2)	9	2.695	B10	2.63	4.26233E-03
			B11	0.29	4.30729E-04
			Al	97.08	5.83483E-02
Aluminum - Boron Poison Plate for Type 1C or 2C Basket (18.0 mg B-10/cm^2)	9	2.721	B10	3.47	5.68315E-03
			B11	0.39	5.74311E-04
			Al	96.15	5.83483E-02
Aluminum - Boron Poison Plate for Type 1D or 2D Basket (28.8 mg B-10/cm^2)	9	2.784	B10	5.42	9.09302E-03
			B11	0.60	9.18894E-04
			Al	93.97	5.83483E-02
Aluminum - Boron Poison Plate for Type 1E or 2E Basket (45.0 mg B-10/cm^2)	9	2.878	B10	8.20	1.42078E-02
			B11	0.91	1.43577E-03
			Al	90.89	5.83483E-02

Table U.6-9
Most Reactive Fuel Type Evaluation Results

Fuel Assembly Type	k_{KENO}	1σ	k_{eff}
WE 17x17 Assembly Class			
WE 17x17 LOPAR	0.9138	0.0007	0.9152
WE 17x17 OFA/Van 5	0.8893	0.0007	0.8907
Framatome 17x17 MK BW	0.9113	0.0007	0.9127
WE 17x17 RFA	**0.9148**	**0.0008**	**0.9164**
CE 16x16 Assembly Class			
CE 16x16 System 80	**0.8676**	**0.0007**	**0.8690**
CE 16x16 Standard	0.8666	0.0006	0.8678
BW 15x15 Assembly Class			
B&W 15x15 Mark B2 – B8	0.9173	0.0006	0.9185
B&W 15x15 Mark B9	0.9181	0.0007	0.9195
B&W 15x15 Mark B10	**0.9256**	**0.0007**	**0.9270**
B&W 15x15 Mark B11	0.9043	0.0006	0.9055
B&W 17x17 Mark C	0.9204	0.0007	0.9218
CE 15x15 Assembly Class			
CE 15x15 Palisades	**0.9096**	**0.0008**	**0.9112**
Exxon/ANF (ANP) 15x15 CE	0.8995	0.0007	0.9009
WE 15x15 Assembly Class			
Exxon/ANF (ANP) 15x15 WE	0.8926	0.0007	0.8940
WE 15x15 Std/ZC	**0.9058**	**0.0007**	**0.9072**
WE 15x15 LOPAR/OFA/DRFA/Van 5	0.9055	0.0007	0.9069
CE 14x14 Assembly Class			
CE 14x14 Std/Gen	0.8546	0.0007	0.8560
CE 14x14 Ft. Calhoun	**0.8578**	**0.0007**	**0.8592**
Framatome 14x14 CE	0.8594	0.0007	0.8608
WE 14x14 Assembly Class			
Exxon/ANF (ANP) 14x14 WE	0.8215	0.0007	0.8229
Exxon/ANF (ANP) 14x14 Toprod	0.8193	0.0007	0.8207
WE 14x14 Std/LOPAR/ ZCA/ZCB	**0.8437**	**0.0008**	**0.8453**
WE 14x14 OFA	0.8092	0.0008	0.8108

Table U.6-10
Evaluation of Assembly Position with Fuel Compartment

Model Description	k_{KENO}	1σ	k_{eff}
Fuel Assembly Position within the Fuel Compartment – Outward			
Internal Moderator Density = 100 %	0.9192	0.0006	0.9204
Internal Moderator Density = 90 %	0.9250	0.0006	0.9262
Internal Moderator Density = 80 %	0.9274	0.0007	0.9288
Internal Moderator Density = 70 %	0.9256	0.0008	0.9272
Internal Moderator Density = 60 %	0.9169	0.0007	0.9183
Fuel Assembly Position within the Fuel Compartment – Centered			
Internal Moderator Density = 100 %	0.9256	0.0007	0.9270
Internal Moderator Density = 90 %	0.9299	0.0007	0.9313
Internal Moderator Density = 80 %	0.9312	0.0007	0.9326
Internal Moderator Density = 70 %	0.9281	0.0007	0.9295
Internal Moderator Density = 60 %	0.9191	0.0007	0.9205
Fuel Assembly Position within the Fuel Compartment – Inward			
Internal Moderator Density = 100 %	0.9261	0.0006	0.9273
Internal Moderator Density = 90 %	0.9327	0.0006	0.9339
Internal Moderator Density = 80 %	**0.9335**	**0.0008**	**0.9351**
Internal Moderator Density = 70 %	0.9313	0.0008	0.9329
Internal Moderator Density = 60 %	0.9201	0.0007	0.9215

Table U.6-11
Fuel Compartment Tube Wall Thickness Evaluation Results

Model Description	k_{KENO}	1σ	k_{eff}
Fuel Compartment Tube Wall Thickness – 0.2325 inches			
Internal Moderator Density = 100 %	0.9263	0.0006	0.9275
Internal Moderator Density = 90 %	0.9322	0.0007	0.9336
Internal Moderator Density = 80 %	0.9339	0.0007	0.9353
Internal Moderator Density = 70 %	0.9311	0.0007	0.9325
Internal Moderator Density = 60 %	0.9211	0.0008	0.9227
Fuel Compartment Tube Wall Thickness – 0.1875 inches			
Internal Moderator Density = 100 %	0.9256	0.0007	0.9270
Internal Moderator Density = 90 %	0.9299	0.0007	0.9313
Internal Moderator Density = 80 %	0.9312	0.0007	0.9326
Internal Moderator Density = 70 %	0.9281	0.0007	0.9295
Internal Moderator Density = 60 %	0.9191	0.0007	0.9205
Fuel Compartment Tube Wall Thickness – 0.1775 inches			
Internal Moderator Density = 100 %	0.9289	0.0007	0.9303
Internal Moderator Density = 90 %	0.9328	0.0007	0.9342
Internal Moderator Density = 80 %	**0.9346**	**0.0007**	**0.9360**
Internal Moderator Density = 70 %	0.9311	0.0009	0.9329
Internal Moderator Density = 60 %	0.9217	0.0007	0.9231

Table U.6-12
Poison Plate Thickness Evaluation Results

Model Description	k_{KENO}	1σ	k_{eff}
Poison Plate Thickness – 0.187 inches			
Internal Moderator Density = 100 %	0.9260	0.0008	0.9276
Internal Moderator Density = 90 %	0.9292	0.0007	0.9306
Internal Moderator Density = 80 %	0.9318	0.0007	0.9332
Internal Moderator Density = 70 %	0.9293	0.0008	0.9309
Internal Moderator Density = 60 %	0.9209	0.0007	0.9223
Poison Plate Thickness – 0.075 inches			
Internal Moderator Density = 100 %	0.9261	0.0006	0.9273
Internal Moderator Density = 90 %	0.9327	0.0006	0.9339
Internal Moderator Density = 80 %	**0.9335**	**0.0008**	**0.9351**
Internal Moderator Density = 70 %	0.9313	0.0008	0.9329
Internal Moderator Density = 60 %	0.9201	0.0007	0.9215
Poison Plate Thickness – 0.050 inches			
Internal Moderator Density = 100 %	0.9260	0.0008	0.9276
Internal Moderator Density = 90 %	0.9305	0.0006	0.9317
Internal Moderator Density = 80 %	0.9331	0.0007	0.9345
Internal Moderator Density = 70 %	0.9308	0.0007	0.9322
Internal Moderator Density = 60 %	0.9218	0.0007	0.9232

Table U.6-13
Fuel Compartment Tube Internal Diameter Evaluation Results

Model Description	k_{KENO}	1σ	k_{eff}
Compartment Inside Dimension, Maximum – 8.75 inches			
Internal Moderator Density = 100 %	0.9208	0.0007	0.9222
Internal Moderator Density = 90 %	0.9270	0.0007	0.9284
Internal Moderator Density = 80 %	0.9294	0.0007	0.9308
Internal Moderator Density = 70 %	0.9262	0.0008	0.9278
Internal Moderator Density = 60 %	0.9157	0.0007	0.9171
Compartment Inside Dimension, Nominal – 8.70 inches			
Internal Moderator Density = 100 %	0.9261	0.0006	0.9273
Internal Moderator Density = 90 %	0.9327	0.0006	0.9339
Internal Moderator Density = 80 %	0.9335	0.0008	0.9351
Internal Moderator Density = 70 %	0.9313	0.0008	0.9329
Internal Moderator Density = 60 %	0.9201	0.0007	0.9215
Compartment Inside Dimension, Minimum – 8.65 inches			
Internal Moderator Density = 100 %	0.9273	0.0007	0.9287
Internal Moderator Density = 90 %	0.9336	0.0007	0.9350
Internal Moderator Density = 80 %	**0.9354**	**0.0008**	**0.9370**
Internal Moderator Density = 70 %	0.9310	0.0007	0.9324
Internal Moderator Density = 60 %	0.9210	0.0007	0.9224

Table U.6-14
WE 17x17 Class Intact Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9227	0.0007	0.9241
Internal Moderator Density = 90 %	0.9304	0.0007	0.9318
Internal Moderator Density = 80 %	0.9328	0.0008	0.9344
Internal Moderator Density = 70 %	0.9336	0.0008	0.9352
Internal Moderator Density = 60 %	0.9267	0.0007	0.9281
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9350	0.0007	0.9364
Internal Moderator Density = 90 %	0.9383	0.0007	0.9397
Internal Moderator Density = 80 %	0.9391	0.0007	0.9405
Internal Moderator Density = 70 %	0.9357	0.0007	0.9371
Internal Moderator Density = 60 %	0.9232	0.0007	0.9246
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9336	0.0006	0.9348
Internal Moderator Density = 90 %	0.9371	0.0008	0.9387
Internal Moderator Density = 80 %	0.9351	0.0007	0.9365
Internal Moderator Density = 70 %	0.9292	0.0007	0.9306
Internal Moderator Density = 60 %	0.9166	0.0008	0.9182
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9345	0.0007	0.9359
Internal Moderator Density = 90 %	0.9363	0.0007	0.9377
Internal Moderator Density = 80 %	0.9318	0.0007	0.9332
Internal Moderator Density = 70 %	0.9212	0.0007	0.9226
Internal Moderator Density = 60 %	0.9054	0.0007	0.9068
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9346	0.0008	0.9362
Internal Moderator Density = 90 %	0.9323	0.0007	0.9337
Internal Moderator Density = 80 %	0.9259	0.0007	0.9273
Internal Moderator Density = 70 %	0.9153	0.0007	0.9167
Internal Moderator Density = 60 %	0.8961	0.0007	0.8975

Table U.6-14
WE 17x17 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9238	0.0006	0.9250
Internal Moderator Density = 90 %	0.9323	0.0007	0.9337
Internal Moderator Density = 80 %	0.9384	0.0007	0.9398
Internal Moderator Density = 70 %	0.9385	0.0007	0.9399
Internal Moderator Density = 60 %	0.9348	0.0006	0.9360
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9266	0.0006	0.9278
Internal Moderator Density = 90 %	0.9314	0.0007	0.9328
Internal Moderator Density = 80 %	0.9353	0.0006	0.9365
Internal Moderator Density = 70 %	0.9294	0.0007	0.9308
Internal Moderator Density = 60 %	0.9216	0.0007	0.9230
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9327	0.0006	0.9339
Internal Moderator Density = 90 %	0.9371	0.0007	0.9385
Internal Moderator Density = 80 %	0.9375	0.0007	0.9389
Internal Moderator Density = 70 %	0.9318	0.0007	0.9332
Internal Moderator Density = 60 %	0.9226	0.0007	0.9240
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9322	0.0007	0.9336
Internal Moderator Density = 90 %	0.9345	0.0007	0.9359
Internal Moderator Density = 80 %	0.9331	0.0007	0.9345
Internal Moderator Density = 70 %	0.9260	0.0008	0.9276
Internal Moderator Density = 60 %	0.9113	0.0007	0.9127
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9359	0.0007	0.9373
Internal Moderator Density = 90 %	0.9365	0.0007	0.9379
Internal Moderator Density = 80 %	0.9312	0.0007	0.9326
Internal Moderator Density = 70 %	0.9235	0.0008	0.9251
Internal Moderator Density = 60 %	0.9058	0.0008	0.9074

Table U.6-14
WE 17x17 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9142	0.0007	0.9156
Internal Moderator Density = 90 %	0.9248	0.0006	0.9260
Internal Moderator Density = 80 %	0.9297	0.0008	0.9313
Internal Moderator Density = 70 %	0.9316	0.0008	0.9332
Internal Moderator Density = 60 %	0.9276	0.0007	0.9290
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9263	0.0006	0.9275
Internal Moderator Density = 90 %	0.9318	0.0007	0.9332
Internal Moderator Density = 80 %	0.9329	0.0007	0.9343
Internal Moderator Density = 70 %	0.9315	0.0007	0.9329
Internal Moderator Density = 60 %	0.9234	0.0007	0.9248
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9300	0.0007	0.9314
Internal Moderator Density = 90 %	0.9358	0.0007	0.9372
Internal Moderator Density = 80 %	0.9378	0.0008	0.9394
Internal Moderator Density = 70 %	0.9337	0.0007	0.9351
Internal Moderator Density = 60 %	0.9222	0.0007	0.9236
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9309	0.0007	0.9323
Internal Moderator Density = 90 %	0.9346	0.0006	0.9358
Internal Moderator Density = 80 %	0.9309	0.0007	0.9323
Internal Moderator Density = 70 %	0.9247	0.0008	0.9263
Internal Moderator Density = 60 %	0.9125	0.0008	0.9141
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9354	0.0007	0.9368
Internal Moderator Density = 90 %	0.9357	0.0007	0.9371
Internal Moderator Density = 80 %	0.9326	0.0007	0.9340
Internal Moderator Density = 70 %	0.9239	0.0007	0.9253
Internal Moderator Density = 60 %	0.9074	0.0007	0.9088

Table U.6-14
WE 17x17 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9161	0.0006	0.9173
Internal Moderator Density = 90 %	0.9258	0.0007	0.9272
Internal Moderator Density = 80 %	0.9323	0.0006	0.9335
Internal Moderator Density = 70 %	0.9346	0.0007	0.9360
Internal Moderator Density = 60 %	0.9309	0.0006	0.9321
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9252	0.0007	0.9266
Internal Moderator Density = 90 %	0.9320	0.0006	0.9332
Internal Moderator Density = 80 %	0.9365	0.0007	0.9379
Internal Moderator Density = 70 %	0.9337	0.0008	0.9353
Internal Moderator Density = 60 %	0.9242	0.0006	0.9254
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9316	0.0007	0.9330
Internal Moderator Density = 90 %	0.9356	0.0007	0.9370
Internal Moderator Density = 80 %	0.9363	0.0007	0.9377
Internal Moderator Density = 70 %	0.9347	0.0007	0.9361
Internal Moderator Density = 60 %	0.9241	0.0007	0.9255
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9290	0.0007	0.9304
Internal Moderator Density = 90 %	0.9325	0.0008	0.9341
Internal Moderator Density = 80 %	0.9322	0.0006	0.9334
Internal Moderator Density = 70 %	0.9263	0.0007	0.9277
Internal Moderator Density = 60 %	0.9140	0.0008	0.9156
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9338	0.0007	0.9352
Internal Moderator Density = 90 %	0.9338	0.0008	0.9354
Internal Moderator Density = 80 %	0.9308	0.0008	0.9324
Internal Moderator Density = 70 %	0.9228	0.0007	0.9242
Internal Moderator Density = 60 %	0.9078	0.0008	0.9094

Table U.6-14
WE 17x17 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9083	0.0007	0.9097
Internal Moderator Density = 90 %	0.9192	0.0007	0.9206
Internal Moderator Density = 80 %	0.9283	0.0006	0.9295
Internal Moderator Density = 70 %	0.9330	0.0007	0.9344
Internal Moderator Density = 60 %	0.9308	0.0007	0.9322
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9242	0.0007	0.9256
Internal Moderator Density = 90 %	0.9319	0.0006	0.9331
Internal Moderator Density = 80 %	0.9368	0.0007	0.9382
Internal Moderator Density = 70 %	0.9376	0.0007	0.9390
Internal Moderator Density = 60 %	0.9309	0.0007	0.9323
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9291	0.0007	0.9305
Internal Moderator Density = 90 %	0.9250	0.0007	0.9264
Internal Moderator Density = 80 %	0.9391	0.0007	0.9405
Internal Moderator Density = 70 %	0.9389	0.0008	0.9405
Internal Moderator Density = 60 %	0.9294	0.0007	0.9308
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9326	0.0008	0.9342
Internal Moderator Density = 90 %	0.9387	0.0007	0.9401
Internal Moderator Density = 80 %	0.9379	0.0007	0.9393
Internal Moderator Density = 70 %	0.9335	0.0007	0.9349
Internal Moderator Density = 60 %	0.9215	0.0008	0.9231
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9186	0.0007	0.9200
Internal Moderator Density = 90 %	0.9205	0.0007	0.9219
Internal Moderator Density = 80 %	0.9202	0.0007	0.9216
Internal Moderator Density = 70 %	0.9145	0.0007	0.9159
Internal Moderator Density = 60 %	0.9020	0.0007	0.9034

Table U.6-14
WE 17x17 Class Intact Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9098	0.0007	0.9112
Internal Moderator Density = 90 %	0.9218	0.0006	0.9230
Internal Moderator Density = 80 %	0.9303	0.0007	0.9317
Internal Moderator Density = 70 %	0.9370	0.0006	0.9382
Internal Moderator Density = 60 %	0.9354	0.0007	0.9368
Enrichment = 4.60 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9171	0.0007	0.9185
Internal Moderator Density = 90 %	0.9269	0.0006	0.9281
Internal Moderator Density = 80 %	0.9315	0.0007	0.9329
Internal Moderator Density = 70 %	0.9333	0.0007	0.9347
Internal Moderator Density = 60 %	0.9288	0.0008	0.9304
Enrichment = 4.80 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9222	0.0007	0.9236
Internal Moderator Density = 90 %	0.9287	0.0007	0.9301
Internal Moderator Density = 80 %	0.9331	0.0008	0.9347
Internal Moderator Density = 70 %	0.9330	0.0007	0.9344
Internal Moderator Density = 60 %	0.9253	0.0007	0.9267

Table U.6-15
WE 17x17 Class Intact Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9319	0.0006	0.9331
Internal Moderator Density = 90 %	0.9363	0.0006	0.9375
Internal Moderator Density = 80 %	0.9361	0.0007	0.9375
Internal Moderator Density = 70 %	0.9293	0.0006	0.9305
Internal Moderator Density = 60 %	0.9200	0.0007	0.9214
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9376	0.0006	0.9388
Internal Moderator Density = 90 %	0.9370	0.0007	0.9384
Internal Moderator Density = 80 %	0.9329	0.0007	0.9343
Internal Moderator Density = 70 %	0.9240	0.0007	0.9254
Internal Moderator Density = 60 %	0.9104	0.0007	0.9118
Enrichment = 3.85 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9385	0.0007	0.9399
Internal Moderator Density = 90 %	0.9343	0.0007	0.9357
Internal Moderator Density = 80 %	0.9288	0.0007	0.9302
Internal Moderator Density = 70 %	0.9173	0.0007	0.9187
Internal Moderator Density = 60 %	0.9011	0.0007	0.9025
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9387	0.0007	0.9401
Internal Moderator Density = 90 %	0.9346	0.0008	0.9362
Internal Moderator Density = 80 %	0.9273	0.0007	0.9287
Internal Moderator Density = 70 %	0.9147	0.0007	0.9161
Internal Moderator Density = 60 %	0.8945	0.0007	0.8959
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9360	0.0008	0.9376
Internal Moderator Density = 90 %	0.9303	0.0007	0.9317
Internal Moderator Density = 80 %	0.9205	0.0008	0.9221
Internal Moderator Density = 70 %	0.9069	0.0007	0.9083
Internal Moderator Density = 60 %	0.8837	0.0007	0.8851

Table U.6-15
WE 17x17 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9315	0.0007	0.9329
Internal Moderator Density = 90 %	0.9357	0.0007	0.9371
Internal Moderator Density = 80 %	0.9353	0.0007	0.9367
Internal Moderator Density = 70 %	0.9347	0.0007	0.9361
Internal Moderator Density = 60 %	0.9248	0.0007	0.9262
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9343	0.0007	0.9357
Internal Moderator Density = 90 %	0.9362	0.0007	0.9376
Internal Moderator Density = 80 %	0.9339	0.0007	0.9353
Internal Moderator Density = 70 %	0.9284	0.0007	0.9298
Internal Moderator Density = 60 %	0.9132	0.0007	0.9146
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9320	0.0007	0.9334
Internal Moderator Density = 90 %	0.9350	0.0007	0.9364
Internal Moderator Density = 80 %	0.9328	0.0007	0.9342
Internal Moderator Density = 70 %	0.9229	0.0007	0.9243
Internal Moderator Density = 60 %	0.9084	0.0001	0.9086
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9374	0.0007	0.9388
Internal Moderator Density = 90 %	0.9344	0.0007	0.9358
Internal Moderator Density = 80 %	0.9301	0.0007	0.9315
Internal Moderator Density = 70 %	0.9172	0.0008	0.9188
Internal Moderator Density = 60 %	0.9002	0.0007	0.9016
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9397	0.0007	0.9411
Internal Moderator Density = 90 %	0.9347	0.0007	0.9361
Internal Moderator Density = 80 %	0.9274	0.0008	0.9290
Internal Moderator Density = 70 %	0.9132	0.0007	0.9146
Internal Moderator Density = 60 %	0.8931	0.0008	0.8947

Table U.6-15
WE 17x17 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9262	0.0007	0.9276
Internal Moderator Density = 90 %	0.9353	0.0007	0.9367
Internal Moderator Density = 80 %	0.9337	0.0007	0.9351
Internal Moderator Density = 70 %	0.9309	0.0007	0.9323
Internal Moderator Density = 60 %	0.9228	0.0006	0.9240
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9263	0.0006	0.9275
Internal Moderator Density = 90 %	0.9358	0.0006	0.9370
Internal Moderator Density = 80 %	0.9337	0.0007	0.9351
Internal Moderator Density = 70 %	0.9290	0.0007	0.9304
Internal Moderator Density = 60 %	0.9164	0.0008	0.9180
Enrichment = 4.25 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9360	0.0006	0.9372
Internal Moderator Density = 90 %	0.9374	0.0007	0.9388
Internal Moderator Density = 80 %	0.9335	0.0008	0.9351
Internal Moderator Density = 70 %	0.9251	0.0008	0.9267
Internal Moderator Density = 60 %	0.9110	0.0006	0.9122
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9339	0.0007	0.9353
Internal Moderator Density = 90 %	0.9322	0.0007	0.9336
Internal Moderator Density = 80 %	0.9268	0.0008	0.9284
Internal Moderator Density = 70 %	0.9155	0.0008	0.9171
Internal Moderator Density = 60 %	0.8978	0.0007	0.8992
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9369	0.0006	0.9381
Internal Moderator Density = 90 %	0.9331	0.0007	0.9345
Internal Moderator Density = 80 %	0.9254	0.0008	0.9270
Internal Moderator Density = 70 %	0.9116	0.0007	0.9130
Internal Moderator Density = 60 %	0.8920	0.0007	0.8934

Table U.6-15
WE 17x17 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9273	0.0007	0.9287
Internal Moderator Density = 90 %	0.9332	0.0006	0.9344
Internal Moderator Density = 80 %	0.9358	0.0007	0.9372
Internal Moderator Density = 70 %	0.9342	0.0006	0.9354
Internal Moderator Density = 60 %	0.9277	0.0007	0.9291
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9373	0.0008	0.9389
Internal Moderator Density = 90 %	0.9373	0.0006	0.9385
Internal Moderator Density = 80 %	0.9362	0.0007	0.9376
Internal Moderator Density = 70 %	0.9301	0.0007	0.9315
Internal Moderator Density = 60 %	0.9180	0.0007	0.9194
Enrichment = 4.35 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9353	0.0007	0.9367
Internal Moderator Density = 90 %	0.9372	0.0004	0.9380
Internal Moderator Density = 80 %	0.9334	0.0008	0.9350
Internal Moderator Density = 70 %	0.9273	0.0007	0.9287
Internal Moderator Density = 60 %	0.9114	0.0008	0.9130
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9359	0.0007	0.9373
Internal Moderator Density = 90 %	0.9350	0.0007	0.9364
Internal Moderator Density = 80 %	0.9310	0.0007	0.9324
Internal Moderator Density = 70 %	0.9201	0.0007	0.9215
Internal Moderator Density = 60 %	0.9041	0.0007	0.9055
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9389	0.0007	0.9403
Internal Moderator Density = 90 %	0.9362	0.0008	0.9378
Internal Moderator Density = 80 %	0.9287	0.0007	0.9301
Internal Moderator Density = 70 %	0.9155	0.0007	0.9169
Internal Moderator Density = 60 %	0.8943	0.0008	0.8959

Table U.6-15
WE 17x17 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9227	0.0007	0.9241
Internal Moderator Density = 90 %	0.9297	0.0007	0.9311
Internal Moderator Density = 80 %	0.9329	0.0006	0.9341
Internal Moderator Density = 70 %	0.9347	0.0007	0.9361
Internal Moderator Density = 60 %	0.9289	0.0007	0.9303
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9317	0.0007	0.9331
Internal Moderator Density = 90 %	0.9348	0.0006	0.9360
Internal Moderator Density = 80 %	0.9358	0.0007	0.9372
Internal Moderator Density = 70 %	0.9318	0.0007	0.9332
Internal Moderator Density = 60 %	0.9221	0.0006	0.9233
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9366	0.0006	0.9378
Internal Moderator Density = 90 %	0.9375	0.0007	0.9389
Internal Moderator Density = 80 %	0.9367	0.0007	0.9381
Internal Moderator Density = 70 %	0.9309	0.0009	0.9327
Internal Moderator Density = 60 %	0.9201	0.0007	0.9215
Enrichment = 4.95 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9380	0.0007	0.9394
Internal Moderator Density = 90 %	0.9387	0.0007	0.9401
Internal Moderator Density = 80 %	0.9353	0.0008	0.9369
Internal Moderator Density = 70 %	0.9262	0.0007	0.9276
Internal Moderator Density = 60 %	0.9111	0.0007	0.9125
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9265	0.0007	0.9279
Internal Moderator Density = 90 %	0.9244	0.0007	0.9258
Internal Moderator Density = 80 %	0.9189	0.0007	0.9203
Internal Moderator Density = 70 %	0.9079	0.0008	0.9095
Internal Moderator Density = 60 %	0.8907	0.0007	0.8921

Table U.6-15
WE 17x17 Class Intact Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9248	0.0007	0.9262
Internal Moderator Density = 90 %	0.9333	0.0007	0.9347
Internal Moderator Density = 80 %	0.9368	0.0008	0.9384
Internal Moderator Density = 70 %	0.9391	0.0007	0.9405
Internal Moderator Density = 60 %	0.9339	0.0006	0.9351
Enrichment = 4.60 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9304	0.0007	0.9318
Internal Moderator Density = 90 %	0.9326	0.0008	0.9342
Internal Moderator Density = 80 %	0.9349	0.0007	0.9363
Internal Moderator Density = 70 %	0.9319	0.0007	0.9333
Internal Moderator Density = 60 %	0.9232	0.0008	0.9248
Enrichment = 4.80 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9328	0.0007	0.9342
Internal Moderator Density = 90 %	0.9361	0.0008	0.9377
Internal Moderator Density = 80 %	0.9361	0.0007	0.9375
Internal Moderator Density = 70 %	0.9302	0.0007	0.9316
Internal Moderator Density = 60 %	0.9194	0.0007	0.9208

Table U.6-16
CE 16x16 Class Intact Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9306	0.0008	0.9322
Internal Moderator Density = 80 %	0.9367	0.0007	0.9381
Internal Moderator Density = 70 %	0.9383	0.0007	0.9397
Internal Moderator Density = 60 %	0.9368	0.0007	0.9382
Internal Moderator Density = 50 %	0.9248	0.0008	0.9264
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9353	0.0007	0.9367
Internal Moderator Density = 80 %	0.9364	0.0008	0.9380
Internal Moderator Density = 70 %	0.9357	0.0007	0.9371
Internal Moderator Density = 60 %	0.9274	0.0007	0.9288
Internal Moderator Density = 50 %	0.9120	0.0007	0.9134
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 90 %	0.9359	0.0007	0.9373
Internal Moderator Density = 80 %	0.9388	0.0008	0.9404
Internal Moderator Density = 70 %	0.9348	0.0008	0.9364
Internal Moderator Density = 60 %	0.9244	0.0008	0.9260
Internal Moderator Density = 50 %	0.9081	0.0007	0.9095
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9347	0.0008	0.9363
Internal Moderator Density = 90 %	0.9382	0.0008	0.9398
Internal Moderator Density = 80 %	0.9391	0.0008	0.9407
Internal Moderator Density = 70 %	0.9317	0.0008	0.9333
Internal Moderator Density = 60 %	0.9185	0.0008	0.9201
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9334	0.0008	0.9350
Internal Moderator Density = 90 %	0.9340	0.0008	0.9356
Internal Moderator Density = 80 %	0.9306	0.0008	0.9322
Internal Moderator Density = 70 %	0.9212	0.0009	0.9230
Internal Moderator Density = 60 %	0.9065	0.0008	0.9081

Table U.6-16
CE 16x16 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9199	0.0007	0.9213
Internal Moderator Density = 80 %	0.9270	0.0007	0.9284
Internal Moderator Density = 70 %	0.9320	0.0009	0.9338
Internal Moderator Density = 60 %	0.9327	0.0007	0.9341
Internal Moderator Density = 50 %	0.9245	0.0007	0.9259
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9303	0.0007	0.9317
Internal Moderator Density = 80 %	0.9359	0.0007	0.9373
Internal Moderator Density = 70 %	0.9358	0.0008	0.9374
Internal Moderator Density = 60 %	0.9295	0.0009	0.9313
Internal Moderator Density = 50 %	0.9179	0.0008	0.9195
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 90 %	0.9314	0.0007	0.9328
Internal Moderator Density = 80 %	0.9352	0.0007	0.9366
Internal Moderator Density = 70 %	0.9340	0.0007	0.9354
Internal Moderator Density = 60 %	0.9271	0.0009	0.9289
Internal Moderator Density = 50 %	0.9133	0.0008	0.9149
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9231	0.0009	0.9249
Internal Moderator Density = 90 %	0.9275	0.0008	0.9291
Internal Moderator Density = 80 %	0.9268	0.0007	0.9282
Internal Moderator Density = 70 %	0.9235	0.0007	0.9249
Internal Moderator Density = 60 %	0.9163	0.0008	0.9179

Table U.6-16
CE 16x16 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9210	0.0007	0.9224
Internal Moderator Density = 80 %	0.9286	0.0007	0.9300
Internal Moderator Density = 70 %	0.9333	0.0008	0.9349
Internal Moderator Density = 60 %	0.9338	0.0008	0.9354
Internal Moderator Density = 50 %	0.9268	0.0007	0.9282
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9284	0.0007	0.9298
Internal Moderator Density = 80 %	0.9344	0.0007	0.9358
Internal Moderator Density = 70 %	0.9348	0.0008	0.9364
Internal Moderator Density = 60 %	0.9317	0.0009	0.9335
Internal Moderator Density = 50 %	0.9191	0.0007	0.9205
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 90 %	0.9313	0.0008	0.9329
Internal Moderator Density = 80 %	0.9344	0.0007	0.9358
Internal Moderator Density = 70 %	0.9342	0.0007	0.9356
Internal Moderator Density = 60 %	0.9295	0.0007	0.9309
Internal Moderator Density = 50 %	0.9134	0.0007	0.9148

Table U.6-16
CE 16x16 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9176	0.0009	0.9194
Internal Moderator Density = 80 %	0.9288	0.0008	0.9304
Internal Moderator Density = 70 %	0.9338	0.0006	0.9350
Internal Moderator Density = 60 %	0.9359	0.0006	0.9371
Internal Moderator Density = 50 %	0.9301	0.0006	0.9313
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9282	0.0007	0.9296
Internal Moderator Density = 80 %	0.9324	0.0007	0.9338
Internal Moderator Density = 70 %	0.9353	0.0007	0.9367
Internal Moderator Density = 60 %	0.9302	0.0007	0.9316
Internal Moderator Density = 50 %	0.9211	0.0008	0.9227
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 90 %	0.9298	0.0007	0.9312
Internal Moderator Density = 80 %	0.9345	0.0008	0.9361
Internal Moderator Density = 70 %	0.9360	0.0008	0.9376
Internal Moderator Density = 60 %	0.9283	0.0010	0.9303
Internal Moderator Density = 50 %	0.9142	0.0007	0.9156

Table U.6-16
CE 16x16 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9181	0.0007	0.9195
Internal Moderator Density = 80 %	0.9281	0.0007	0.9295
Internal Moderator Density = 70 %	0.9347	0.0008	0.9363
Internal Moderator Density = 60 %	0.9375	0.0008	0.9391
Internal Moderator Density = 50 %	0.9337	0.0007	0.9351
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9185	0.0008	0.9201
Internal Moderator Density = 80 %	0.9252	0.0008	0.9268
Internal Moderator Density = 70 %	0.9289	0.0008	0.9305
Internal Moderator Density = 60 %	0.9288	0.0007	0.9302
Internal Moderator Density = 50 %	0.9199	0.0007	0.9213

Table U.6-16
CE 16x16 Class Intact Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.70 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9127	0.0007	0.9141
Internal Moderator Density = 80 %	0.9204	0.0007	0.9218
Internal Moderator Density = 70 %	0.9305	0.0006	0.9317
Internal Moderator Density = 60 %	0.9351	0.0008	0.9367
Internal Moderator Density = 50 %	0.9315	0.0007	0.9329

Table U.6-17
CE 16x16 Class Intact Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.85 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9351	0.0007	0.9365
Internal Moderator Density = 80 %	0.9379	0.0008	0.9395
Internal Moderator Density = 70 %	0.9381	0.0007	0.9395
Internal Moderator Density = 60 %	0.9326	0.0008	0.9342
Internal Moderator Density = 50 %	0.9191	0.0006	0.9203
Enrichment = 4.25 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9380	0.0008	0.9396
Internal Moderator Density = 80 %	0.9380	0.0008	0.9396
Internal Moderator Density = 70 %	0.9337	0.0007	0.9351
Internal Moderator Density = 60 %	0.9241	0.0007	0.9255
Internal Moderator Density = 50 %	0.9044	0.0008	0.9060
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9358	0.0008	0.9374
Internal Moderator Density = 90 %	0.9371	0.0009	0.9389
Internal Moderator Density = 80 %	0.9355	0.0007	0.9369
Internal Moderator Density = 70 %	0.9294	0.0007	0.9308
Internal Moderator Density = 60 %	0.9188	0.0008	0.9204
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9389	0.0007	0.9403
Internal Moderator Density = 90 %	0.9389	0.0008	0.9405
Internal Moderator Density = 80 %	0.9360	0.0008	0.9376
Internal Moderator Density = 70 %	0.9262	0.0008	0.9278
Internal Moderator Density = 60 %	0.9115	0.0007	0.9129
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9358	0.0008	0.9374
Internal Moderator Density = 90 %	0.9339	0.0007	0.9353
Internal Moderator Density = 80 %	0.9282	0.0007	0.9296
Internal Moderator Density = 70 %	0.9154	0.0009	0.9172
Internal Moderator Density = 60 %	0.8984	0.0008	0.9000

Table U.6-17
CE 16x16 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9318	0.0007	0.9332
Internal Moderator Density = 80 %	0.9347	0.0008	0.9363
Internal Moderator Density = 70 %	0.9371	0.0007	0.9385
Internal Moderator Density = 60 %	0.9344	0.0007	0.9358
Internal Moderator Density = 50 %	0.9225	0.0007	0.9239
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9343	0.0007	0.9357
Internal Moderator Density = 80 %	0.9374	0.0007	0.9388
Internal Moderator Density = 70 %	0.9369	0.0009	0.9387
Internal Moderator Density = 60 %	0.9258	0.0007	0.9272
Internal Moderator Density = 50 %	0.9108	0.0007	0.9122
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9298	0.0007	0.9312
Internal Moderator Density = 90 %	0.9348	0.0007	0.9362
Internal Moderator Density = 80 %	0.9346	0.0007	0.9360
Internal Moderator Density = 70 %	0.9296	0.0007	0.9310
Internal Moderator Density = 60 %	0.9216	0.0007	0.9230
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9333	0.0009	0.9351
Internal Moderator Density = 90 %	0.9349	0.0008	0.9365
Internal Moderator Density = 80 %	0.9333	0.0008	0.9349
Internal Moderator Density = 70 %	0.9266	0.0007	0.9280
Internal Moderator Density = 60 %	0.9124	0.0008	0.9140

Table U.6-17
CE 16x16 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9294	0.0008	0.9310
Internal Moderator Density = 80 %	0.9343	0.0008	0.9359
Internal Moderator Density = 70 %	0.9374	0.0008	0.9390
Internal Moderator Density = 60 %	0.9343	0.0008	0.9359
Internal Moderator Density = 50 %	0.9257	0.0008	0.9273
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9307	0.0008	0.9323
Internal Moderator Density = 90 %	0.9349	0.0009	0.9367
Internal Moderator Density = 80 %	0.9371	0.0007	0.9385
Internal Moderator Density = 70 %	0.9361	0.0007	0.9375
Internal Moderator Density = 60 %	0.9285	0.0007	0.9299
Enrichment = 4.85 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9322	0.0007	0.9336
Internal Moderator Density = 90 %	0.9367	0.0007	0.9381
Internal Moderator Density = 80 %	0.9369	0.0007	0.9383
Internal Moderator Density = 70 %	0.9331	0.0007	0.9345
Internal Moderator Density = 60 %	0.9242	0.0008	0.9258

Table U.6-17
CE 16x16 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9290	0.0008	0.9306
Internal Moderator Density = 80 %	0.9350	0.0007	0.9364
Internal Moderator Density = 70 %	0.9395	0.0008	0.9411
Internal Moderator Density = 60 %	0.9357	0.0007	0.9371
Internal Moderator Density = 50 %	0.9285	0.0007	0.9299
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9369	0.0008	0.9385
Internal Moderator Density = 80 %	0.9391	0.0008	0.9407
Internal Moderator Density = 70 %	0.9380	0.0006	0.9392
Internal Moderator Density = 60 %	0.9303	0.0007	0.9317
Internal Moderator Density = 50 %	0.9174	0.0007	0.9188
Enrichment = 4.95 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9306	0.0008	0.9322
Internal Moderator Density = 90 %	0.9366	0.0008	0.9382
Internal Moderator Density = 80 %	0.9367	0.0007	0.9381
Internal Moderator Density = 70 %	0.9334	0.0008	0.9350
Internal Moderator Density = 60 %	0.9258	0.0007	0.9272

Table U.6-17
CE 16x16 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9211	0.0007	0.9225
Internal Moderator Density = 80 %	0.9313	0.0007	0.9327
Internal Moderator Density = 70 %	0.9350	0.0007	0.9364
Internal Moderator Density = 60 %	0.9340	0.0008	0.9356
Internal Moderator Density = 50 %	0.9276	0.0008	0.9292
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9288	0.0008	0.9304
Internal Moderator Density = 80 %	0.9323	0.0009	0.9341
Internal Moderator Density = 70 %	0.9336	0.0008	0.9352
Internal Moderator Density = 60 %	0.9290	0.0008	0.9306
Internal Moderator Density = 50 %	0.9166	0.0007	0.9180

Table U.6-17
CE 16x16 Class Intact Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.70 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9220	0.0007	0.9234
Internal Moderator Density = 80 %	0.9308	0.0007	0.9322
Internal Moderator Density = 70 %	0.9363	0.0007	0.9377
Internal Moderator Density = 60 %	0.9378	0.0007	0.9392
Internal Moderator Density = 50 %	0.9314	0.0008	0.9330

Table U.6-18
BW 15x15 Class Intact Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9226	0.0006	0.9238
Internal Moderator Density = 90 %	0.9308	0.0006	0.9320
Internal Moderator Density = 80 %	0.9320	0.0007	0.9334
Internal Moderator Density = 70 %	0.9329	0.0007	0.9343
Internal Moderator Density = 60 %	0.9252	0.0006	0.9264
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9268	0.0007	0.9282
Internal Moderator Density = 90 %	0.9317	0.0006	0.9329
Internal Moderator Density = 80 %	0.9315	0.0007	0.9329
Internal Moderator Density = 70 %	0.9260	0.0008	0.9276
Internal Moderator Density = 60 %	0.9267	0.0007	0.9281
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9356	0.0008	0.9372
Internal Moderator Density = 90 %	0.9384	0.0007	0.9398
Internal Moderator Density = 80 %	0.9350	0.0007	0.9364
Internal Moderator Density = 70 %	0.9309	0.0007	0.9323
Internal Moderator Density = 60 %	0.9167	0.0008	0.9183
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9348	0.0006	0.9360
Internal Moderator Density = 90 %	0.9364	0.0007	0.9378
Internal Moderator Density = 80 %	0.9317	0.0007	0.9331
Internal Moderator Density = 70 %	0.9231	0.0008	0.9247
Internal Moderator Density = 60 %	0.9167	0.0008	0.9183
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9356	0.0008	0.9372
Internal Moderator Density = 90 %	0.9332	0.0007	0.9346
Internal Moderator Density = 80 %	0.9284	0.0007	0.9298
Internal Moderator Density = 70 %	0.9175	0.0007	0.9189
Internal Moderator Density = 60 %	0.8970	0.0008	0.8986

Table U.6-18
BW 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.50 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9154	0.0007	0.9168
Internal Moderator Density = 90 %	0.9251	0.0006	0.9263
Internal Moderator Density = 80 %	0.9306	0.0006	0.9318
Internal Moderator Density = 70 %	0.9312	0.0006	0.9324
Internal Moderator Density = 60 %	0.9272	0.0008	0.9288
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9275	0.0007	0.9289
Internal Moderator Density = 90 %	0.9321	0.0007	0.9335
Internal Moderator Density = 80 %	0.9348	0.0008	0.9364
Internal Moderator Density = 70 %	0.9318	0.0008	0.9334
Internal Moderator Density = 60 %	0.9240	0.0007	0.9254
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9332	0.0007	0.9346
Internal Moderator Density = 90 %	0.9366	0.0008	0.9382
Internal Moderator Density = 80 %	0.9379	0.0007	0.9393
Internal Moderator Density = 70 %	0.9341	0.0008	0.9357
Internal Moderator Density = 60 %	0.9211	0.0009	0.9229
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9312	0.0008	0.9328
Internal Moderator Density = 90 %	0.9335	0.0008	0.9351
Internal Moderator Density = 80 %	0.9323	0.0007	0.9337
Internal Moderator Density = 70 %	0.9266	0.0008	0.9282
Internal Moderator Density = 60 %	0.9119	0.0007	0.9133
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9377	0.0008	0.9393
Internal Moderator Density = 90 %	0.9380	0.0007	0.9394
Internal Moderator Density = 80 %	0.9339	0.0008	0.9355
Internal Moderator Density = 70 %	0.9238	0.0008	0.9254
Internal Moderator Density = 60 %	0.9072	0.0007	0.9086

Table U.6-18
BW 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9160	0.0007	0.9174
Internal Moderator Density = 90 %	0.9253	0.0007	0.9267
Internal Moderator Density = 80 %	0.9316	0.0006	0.9328
Internal Moderator Density = 70 %	0.9329	0.0007	0.9343
Internal Moderator Density = 60 %	0.9300	0.0006	0.9312
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9266	0.0007	0.9280
Internal Moderator Density = 90 %	0.9331	0.0006	0.9343
Internal Moderator Density = 80 %	0.9362	0.0007	0.9376
Internal Moderator Density = 70 %	0.9332	0.0007	0.9346
Internal Moderator Density = 60 %	0.9252	0.0007	0.9266
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9334	0.0007	0.9348
Internal Moderator Density = 90 %	0.9379	0.0006	0.9391
Internal Moderator Density = 80 %	0.9385	0.0007	0.9399
Internal Moderator Density = 70 %	0.9354	0.0006	0.9366
Internal Moderator Density = 60 %	0.9251	0.0006	0.9263
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9317	0.0008	0.9333
Internal Moderator Density = 90 %	0.9336	0.0007	0.9350
Internal Moderator Density = 80 %	0.9330	0.0007	0.9344
Internal Moderator Density = 70 %	0.9272	0.0007	0.9286
Internal Moderator Density = 60 %	0.9152	0.0007	0.9166
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9360	0.0007	0.9374
Internal Moderator Density = 90 %	0.9370	0.0007	0.9384
Internal Moderator Density = 80 %	0.9340	0.0008	0.9356
Internal Moderator Density = 70 %	0.9250	0.0008	0.9266
Internal Moderator Density = 60 %	0.9088	0.0007	0.9102

Table U.6-18
BW 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9162	0.0006	0.9174
Internal Moderator Density = 90 %	0.9255	0.0007	0.9269
Internal Moderator Density = 80 %	0.9347	0.0006	0.9359
Internal Moderator Density = 70 %	0.9349	0.0006	0.9361
Internal Moderator Density = 60 %	0.9315	0.0007	0.9329
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9162	0.0006	0.9174
Internal Moderator Density = 90 %	0.9255	0.0007	0.9269
Internal Moderator Density = 80 %	0.9347	0.0006	0.9359
Internal Moderator Density = 70 %	0.9349	0.0006	0.9361
Internal Moderator Density = 60 %	0.9315	0.0007	0.9329
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9162	0.0006	0.9174
Internal Moderator Density = 90 %	0.9255	0.0007	0.9269
Internal Moderator Density = 80 %	0.9347	0.0006	0.9359
Internal Moderator Density = 70 %	0.9349	0.0006	0.9361
Internal Moderator Density = 60 %	0.9315	0.0007	0.9329
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9162	0.0006	0.9174
Internal Moderator Density = 90 %	0.9255	0.0007	0.9269
Internal Moderator Density = 80 %	0.9347	0.0006	0.9359
Internal Moderator Density = 70 %	0.9349	0.0006	0.9361
Internal Moderator Density = 60 %	0.9315	0.0007	0.9329
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9162	0.0006	0.9174
Internal Moderator Density = 90 %	0.9255	0.0007	0.9269
Internal Moderator Density = 80 %	0.9347	0.0006	0.9359
Internal Moderator Density = 70 %	0.9349	0.0006	0.9361
Internal Moderator Density = 60 %	0.9315	0.0007	0.9329

Table U.6-18
BW 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9098	0.0006	0.9110
Internal Moderator Density = 90 %	0.9217	0.0007	0.9231
Internal Moderator Density = 80 %	0.9285	0.0006	0.9297
Internal Moderator Density = 70 %	0.9339	0.0007	0.9353
Internal Moderator Density = 60 %	0.9327	0.0007	0.9341
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9186	0.0006	0.9198
Internal Moderator Density = 90 %	0.9276	0.0007	0.9290
Internal Moderator Density = 80 %	0.9312	0.0006	0.9324
Internal Moderator Density = 70 %	0.9320	0.0007	0.9334
Internal Moderator Density = 60 %	0.9258	0.0007	0.9272
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9235	0.0007	0.9249
Internal Moderator Density = 90 %	0.9311	0.0007	0.9325
Internal Moderator Density = 80 %	0.9343	0.0007	0.9357
Internal Moderator Density = 70 %	0.9337	0.0007	0.9351
Internal Moderator Density = 60 %	0.9268	0.0007	0.9282
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9278	0.0007	0.9292
Internal Moderator Density = 90 %	0.9336	0.0006	0.9348
Internal Moderator Density = 80 %	0.9345	0.0007	0.9359
Internal Moderator Density = 70 %	0.9299	0.0007	0.9313
Internal Moderator Density = 60 %	0.9193	0.0007	0.9207
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9263	0.0007	0.9277
Internal Moderator Density = 90 %	0.9293	0.0007	0.9307
Internal Moderator Density = 80 %	0.9285	0.0007	0.9299
Internal Moderator Density = 70 %	0.9236	0.0007	0.9250
Internal Moderator Density = 60 %	0.9072	0.0007	0.9086

Table U.6-18
BW 15x15 Class Intact Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.10 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9124	0.0008	0.9140
Internal Moderator Density = 90 %	0.9241	0.0006	0.9253
Internal Moderator Density = 80 %	0.9325	0.0007	0.9339
Internal Moderator Density = 70 %	0.9370	0.0006	0.9382
Internal Moderator Density = 60 %	0.9378	0.0008	0.9394
Enrichment = 4.50 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9182	0.0009	0.9200
Internal Moderator Density = 90 %	0.9279	0.0006	0.9291
Internal Moderator Density = 80 %	0.9350	0.0007	0.9364
Internal Moderator Density = 70 %	0.9347	0.0007	0.9361
Internal Moderator Density = 60 %	0.9306	0.0007	0.9320
Enrichment = 4.70 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9240	0.0006	0.9252
Internal Moderator Density = 90 %	0.9315	0.0008	0.9331
Internal Moderator Density = 80 %	0.9354	0.0006	0.9366
Internal Moderator Density = 70 %	0.9348	0.0007	0.9362
Internal Moderator Density = 60 %	0.9288	0.0007	0.9302
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9271	0.0008	0.9287
Internal Moderator Density = 90 %	0.9337	0.0007	0.9351
Internal Moderator Density = 80 %	0.9353	0.0008	0.9369
Internal Moderator Density = 70 %	0.9326	0.0007	0.9340
Internal Moderator Density = 60 %	0.9233	0.0007	0.9247

Table U.6-19
BW 15x15 Class Intact Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9327	0.0008	0.9343
Internal Moderator Density = 90 %	0.9361	0.0006	0.9373
Internal Moderator Density = 80 %	0.9356	0.0006	0.9368
Internal Moderator Density = 70 %	0.9336	0.0006	0.9348
Internal Moderator Density = 60 %	0.9214	0.0007	0.9228
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9356	0.0006	0.9368
Internal Moderator Density = 90 %	0.9364	0.0007	0.9378
Internal Moderator Density = 80 %	0.9316	0.0007	0.9330
Internal Moderator Density = 70 %	0.9226	0.0007	0.9240
Internal Moderator Density = 60 %	0.9075	0.0007	0.9089
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9381	0.0006	0.9393
Internal Moderator Density = 90 %	0.9369	0.0007	0.9383
Internal Moderator Density = 80 %	0.9319	0.0007	0.9333
Internal Moderator Density = 70 %	0.9213	0.0007	0.9227
Internal Moderator Density = 60 %	0.9055	0.0007	0.9069
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9358	0.0006	0.9370
Internal Moderator Density = 90 %	0.9343	0.0007	0.9357
Internal Moderator Density = 80 %	0.9262	0.0009	0.9280
Internal Moderator Density = 70 %	0.9126	0.0008	0.9142
Internal Moderator Density = 60 %	0.8937	0.0007	0.8951
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9384	0.0007	0.9398
Internal Moderator Density = 90 %	0.9336	0.0009	0.9354
Internal Moderator Density = 80 %	0.9222	0.0007	0.9236
Internal Moderator Density = 70 %	0.9090	0.0007	0.9104
Internal Moderator Density = 60 %	0.8859	0.0007	0.8873

Table U.6-19
BW 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.50 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9280	0.0007	0.9294
Internal Moderator Density = 90 %	0.9319	0.0007	0.9333
Internal Moderator Density = 80 %	0.9347	0.0008	0.9363
Internal Moderator Density = 70 %	0.9312	0.0007	0.9326
Internal Moderator Density = 60 %	0.9222	0.0006	0.9234
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9370	0.0007	0.9384
Internal Moderator Density = 90 %	0.9395	0.0007	0.9409
Internal Moderator Density = 80 %	0.9357	0.0008	0.9373
Internal Moderator Density = 70 %	0.9307	0.0007	0.9321
Internal Moderator Density = 60 %	0.9167	0.0006	0.9179
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9386	0.0007	0.9400
Internal Moderator Density = 90 %	0.9395	0.0006	0.9407
Internal Moderator Density = 80 %	0.9350	0.0008	0.9366
Internal Moderator Density = 70 %	0.9274	0.0007	0.9288
Internal Moderator Density = 60 %	0.9131	0.0007	0.9145
Enrichment = 4.25 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9364	0.0007	0.9378
Internal Moderator Density = 90 %	0.9365	0.0008	0.9381
Internal Moderator Density = 80 %	0.9289	0.0007	0.9303
Internal Moderator Density = 70 %	0.9194	0.0007	0.9208
Internal Moderator Density = 60 %	0.9002	0.0007	0.9016
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9369	0.0008	0.9385
Internal Moderator Density = 90 %	0.9321	0.0007	0.9335
Internal Moderator Density = 80 %	0.9243	0.0007	0.9257
Internal Moderator Density = 70 %	0.9118	0.0008	0.9134
Internal Moderator Density = 60 %	0.8926	0.0007	0.8940

Table U.6-19
BW 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9296	0.0006	0.9308
Internal Moderator Density = 90 %	0.9357	0.0007	0.9371
Internal Moderator Density = 80 %	0.9363	0.0007	0.9377
Internal Moderator Density = 70 %	0.9330	0.0008	0.9346
Internal Moderator Density = 60 %	0.9248	0.0006	0.9260
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9338	0.0008	0.9354
Internal Moderator Density = 90 %	0.9363	0.0006	0.9375
Internal Moderator Density = 80 %	0.9341	0.0007	0.9355
Internal Moderator Density = 70 %	0.9287	0.0008	0.9303
Internal Moderator Density = 60 %	0.9148	0.0008	0.9164
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9376	0.0008	0.9392
Internal Moderator Density = 90 %	0.9389	0.0008	0.9405
Internal Moderator Density = 80 %	0.9369	0.0007	0.9383
Internal Moderator Density = 70 %	0.9296	0.0008	0.9312
Internal Moderator Density = 60 %	0.9148	0.0007	0.9162
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	**0.9397**	**0.0007**	**0.9411**
Internal Moderator Density = 90 %	0.9375	0.0007	0.9389
Internal Moderator Density = 80 %	0.9333	0.0007	0.9347
Internal Moderator Density = 70 %	0.9218	0.0008	0.9234
Internal Moderator Density = 60 %	0.9064	0.0007	0.9078
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9357	0.0007	0.9371
Internal Moderator Density = 90 %	0.9331	0.0007	0.9345
Internal Moderator Density = 80 %	0.9258	0.0007	0.9272
Internal Moderator Density = 70 %	0.9137	0.0007	0.9151
Internal Moderator Density = 60 %	0.8947	0.0008	0.8963

Table U.6-19
BW 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9293	0.0007	0.9307
Internal Moderator Density = 90 %	0.9354	0.0008	0.9370
Internal Moderator Density = 80 %	0.9385	0.0006	0.9397
Internal Moderator Density = 70 %	0.9370	0.0007	0.9384
Internal Moderator Density = 60 %	0.9287	0.0007	0.9301
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9381	0.0008	0.9397
Internal Moderator Density = 90 %	0.9387	0.0007	0.9401
Internal Moderator Density = 80 %	0.9394	0.0007	0.9408
Internal Moderator Density = 70 %	0.9328	0.0008	0.9344
Internal Moderator Density = 60 %	0.9213	0.0007	0.9227
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9361	0.0007	0.9375
Internal Moderator Density = 90 %	0.9355	0.0007	0.9369
Internal Moderator Density = 80 %	0.9344	0.0007	0.9358
Internal Moderator Density = 70 %	0.9279	0.0007	0.9293
Internal Moderator Density = 60 %	0.9129	0.0007	0.9143
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9362	0.0008	0.9378
Internal Moderator Density = 90 %	0.9353	0.0007	0.9367
Internal Moderator Density = 80 %	0.9314	0.0008	0.9330
Internal Moderator Density = 70 %	0.9214	0.0006	0.9226
Internal Moderator Density = 60 %	0.9044	0.0007	0.9058
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9384	0.0007	0.9398
Internal Moderator Density = 90 %	0.9364	0.0008	0.9380
Internal Moderator Density = 80 %	0.9298	0.0007	0.9312
Internal Moderator Density = 70 %	0.9174	0.0007	0.9188
Internal Moderator Density = 60 %	0.8986	0.0007	0.9000

Table U.6-19
BW 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9253	0.0008	0.9269
Internal Moderator Density = 90 %	0.9329	0.0007	0.9343
Internal Moderator Density = 80 %	0.9363	0.0007	0.9377
Internal Moderator Density = 70 %	0.9374	0.0006	0.9386
Internal Moderator Density = 60 %	0.9307	0.0007	0.9321
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9324	0.0007	0.9338
Internal Moderator Density = 90 %	0.9362	0.0007	0.9376
Internal Moderator Density = 80 %	0.9354	0.0007	0.9368
Internal Moderator Density = 70 %	0.9331	0.0007	0.9345
Internal Moderator Density = 60 %	0.9232	0.0007	0.9246
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9359	0.0006	0.9371
Internal Moderator Density = 90 %	0.9387	0.0006	0.9399
Internal Moderator Density = 80 %	0.9376	0.0007	0.9390
Internal Moderator Density = 70 %	0.9319	0.0007	0.9333
Internal Moderator Density = 60 %	0.9218	0.0007	0.9232
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9389	0.0007	0.9403
Internal Moderator Density = 90 %	0.9381	0.0007	0.9395
Internal Moderator Density = 80 %	0.9364	0.0008	0.9380
Internal Moderator Density = 70 %	0.9287	0.0007	0.9301
Internal Moderator Density = 60 %	0.9128	0.0008	0.9144
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9359	0.0007	0.9373
Internal Moderator Density = 90 %	0.9327	0.0008	0.9343
Internal Moderator Density = 80 %	0.9297	0.0007	0.9311
Internal Moderator Density = 70 %	0.9184	0.0007	0.9198
Internal Moderator Density = 60 %	0.9014	0.0007	0.9028

Table U.6-19
BW 15x15 Class Intact Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.05 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9234	0.0007	0.9248
Internal Moderator Density = 90 %	0.9320	0.0007	0.9334
Internal Moderator Density = 80 %	0.9360	0.0007	0.9374
Internal Moderator Density = 70 %	0.9360	0.0007	0.9374
Internal Moderator Density = 60 %	0.9338	0.0008	0.9354
Enrichment = 4.50 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9329	0.0007	0.9343
Internal Moderator Density = 90 %	0.9372	0.0006	0.9384
Internal Moderator Density = 80 %	0.9396	0.0007	0.9410
Internal Moderator Density = 70 %	0.9364	0.0006	0.9376
Internal Moderator Density = 60 %	0.9284	0.0006	0.9296
Enrichment = 4.65 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9322	0.0007	0.9336
Internal Moderator Density = 90 %	0.9367	0.0007	0.9381
Internal Moderator Density = 80 %	0.9377	0.0007	0.9391
Internal Moderator Density = 70 %	0.9327	0.0007	0.9341
Internal Moderator Density = 60 %	0.9218	0.0007	0.9232
Enrichment = 4.95 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9333	0.0008	0.9349
Internal Moderator Density = 90 %	0.9372	0.0006	0.9384
Internal Moderator Density = 80 %	0.9356	0.0007	0.9370
Internal Moderator Density = 70 %	0.9273	0.0007	0.9287
Internal Moderator Density = 60 %	0.9159	0.0007	0.9173

Table U.6-20
CE 15x15 Class Intact Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 3.50 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9289	0.0008	0.9305
Internal Moderator Density = 90 %	0.9311	0.0007	0.9325
Internal Moderator Density = 80 %	0.9332	0.0007	0.9346
Internal Moderator Density = 70 %	0.9332	0.0007	0.9346
Internal Moderator Density = 60 %	0.9241	0.0007	0.9255
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9385	0.0007	0.9399
Internal Moderator Density = 90 %	0.9392	0.0007	0.9406
Internal Moderator Density = 80 %	0.9370	0.0007	0.9384
Internal Moderator Density = 70 %	0.9297	0.0008	0.9313
Internal Moderator Density = 60 %	0.9158	0.0008	0.9174
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9360	0.0008	0.9376
Internal Moderator Density = 90 %	0.9372	0.0007	0.9386
Internal Moderator Density = 80 %	0.9324	0.0008	0.9340
Internal Moderator Density = 70 %	0.9255	0.0007	0.9269
Internal Moderator Density = 60 %	0.9108	0.0008	0.9124
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9361	0.0007	0.9375
Internal Moderator Density = 90 %	0.9322	0.0007	0.9336
Internal Moderator Density = 80 %	0.9278	0.0008	0.9294
Internal Moderator Density = 70 %	0.9170	0.0008	0.9186
Internal Moderator Density = 60 %	0.8990	0.0007	0.9004
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9346	0.0007	0.9360
Internal Moderator Density = 90 %	0.9303	0.0008	0.9319
Internal Moderator Density = 80 %	0.9222	0.0007	0.9236
Internal Moderator Density = 70 %	0.9092	0.0007	0.9106
Internal Moderator Density = 60 %	0.8893	0.0007	0.8907

Table U.6-20
CE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9300	0.0007	0.9314
Internal Moderator Density = 90 %	0.9349	0.0008	0.9365
Internal Moderator Density = 80 %	0.9382	0.0007	0.9396
Internal Moderator Density = 70 %	0.9376	0.0007	0.9390
Internal Moderator Density = 60 %	0.9322	0.0007	0.9336
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9284	0.0007	0.9298
Internal Moderator Density = 90 %	0.9329	0.0007	0.9343
Internal Moderator Density = 80 %	0.9330	0.0007	0.9344
Internal Moderator Density = 70 %	0.9279	0.0007	0.9293
Internal Moderator Density = 60 %	0.9167	0.0007	0.9181
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9344	0.0008	0.9360
Internal Moderator Density = 90 %	0.9349	0.0007	0.9363
Internal Moderator Density = 80 %	0.9336	0.0008	0.9352
Internal Moderator Density = 70 %	0.9278	0.0007	0.9292
Internal Moderator Density = 60 %	0.9161	0.0007	0.9175
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9389	0.0008	0.9405
Internal Moderator Density = 90 %	0.9386	0.0006	0.9398
Internal Moderator Density = 80 %	0.9348	0.0007	0.9362
Internal Moderator Density = 70 %	0.9260	0.0008	0.9276
Internal Moderator Density = 60 %	0.9088	0.0007	0.9102
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9356	0.0007	0.9370
Internal Moderator Density = 90 %	0.9347	0.0008	0.9363
Internal Moderator Density = 80 %	0.9278	0.0007	0.9292
Internal Moderator Density = 70 %	0.9162	0.0007	0.9176
Internal Moderator Density = 60 %	0.8986	0.0008	0.9002

Table U.6-20
CE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9294	0.0007	0.9308
Internal Moderator Density = 90 %	0.9363	0.0008	0.9379
Internal Moderator Density = 80 %	0.9394	0.0008	0.9410
Internal Moderator Density = 70 %	0.9381	0.0006	0.9393
Internal Moderator Density = 60 %	0.9326	0.0006	0.9338
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9359	0.0007	0.9373
Internal Moderator Density = 90 %	0.9393	0.0008	0.9409
Internal Moderator Density = 80 %	0.9395	0.0007	0.9409
Internal Moderator Density = 70 %	0.9351	0.0007	0.9365
Internal Moderator Density = 60 %	0.9263	0.0007	0.9277
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9333	0.0007	0.9347
Internal Moderator Density = 90 %	0.9373	0.0006	0.9385
Internal Moderator Density = 80 %	0.9345	0.0007	0.9359
Internal Moderator Density = 70 %	0.9280	0.0008	0.9296
Internal Moderator Density = 60 %	0.9165	0.0007	0.9179
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9387	0.0007	0.9401
Internal Moderator Density = 90 %	0.9370	0.0007	0.9384
Internal Moderator Density = 80 %	0.9343	0.0007	0.9357
Internal Moderator Density = 70 %	0.9262	0.0008	0.9278
Internal Moderator Density = 60 %	0.9110	0.0008	0.9126
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9349	0.0007	0.9363
Internal Moderator Density = 90 %	0.9333	0.0008	0.9349
Internal Moderator Density = 80 %	0.9286	0.0007	0.9300
Internal Moderator Density = 70 %	0.9162	0.0007	0.9176
Internal Moderator Density = 60 %	0.8996	0.0009	0.9014

Table U.6-20
CE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9210	0.0009	0.9228
Internal Moderator Density = 90 %	0.9283	0.0007	0.9297
Internal Moderator Density = 80 %	0.9336	0.0008	0.9352
Internal Moderator Density = 70 %	0.9338	0.0008	0.9354
Internal Moderator Density = 60 %	0.9283	0.0006	0.9295
Enrichment = 4.35 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9313	0.0007	0.9327
Internal Moderator Density = 90 %	0.9347	0.0007	0.9361
Internal Moderator Density = 80 %	0.9361	0.0007	0.9375
Internal Moderator Density = 70 %	0.9320	0.0008	0.9336
Internal Moderator Density = 60 %	0.9240	0.0007	0.9254
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9330	0.0007	0.9344
Internal Moderator Density = 90 %	0.9349	0.0007	0.9363
Internal Moderator Density = 80 %	0.9348	0.0007	0.9362
Internal Moderator Density = 70 %	0.9295	0.0008	0.9311
Internal Moderator Density = 60 %	0.9185	0.0007	0.9199
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9371	0.0007	0.9385
Internal Moderator Density = 90 %	0.9374	0.0007	0.9388
Internal Moderator Density = 80 %	0.9334	0.0007	0.9348
Internal Moderator Density = 70 %	0.9256	0.0007	0.9270
Internal Moderator Density = 60 %	0.9117	0.0008	0.9133
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9337	0.0008	0.9353
Internal Moderator Density = 90 %	0.9316	0.0008	0.9332
Internal Moderator Density = 80 %	0.9282	0.0008	0.9298
Internal Moderator Density = 70 %	0.9176	0.0007	0.9190
Internal Moderator Density = 60 %	0.9011	0.0007	0.9025

Table U.6-20
CE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9225	0.0007	0.9239
Internal Moderator Density = 90 %	0.9311	0.0007	0.9325
Internal Moderator Density = 80 %	0.9363	0.0007	0.9377
Internal Moderator Density = 70 %	0.9393	0.0007	0.9407
Internal Moderator Density = 60 %	0.9352	0.0007	0.9366
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9271	0.0007	0.9285
Internal Moderator Density = 90 %	0.9326	0.0008	0.9342
Internal Moderator Density = 80 %	0.9356	0.0007	0.9370
Internal Moderator Density = 70 %	0.9334	0.0008	0.9350
Internal Moderator Density = 60 %	0.9257	0.0008	0.9273
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9321	0.0007	0.9335
Internal Moderator Density = 90 %	0.9368	0.0008	0.9384
Internal Moderator Density = 80 %	0.9365	0.0008	0.9381
Internal Moderator Density = 70 %	0.9319	0.0006	0.9331
Internal Moderator Density = 60 %	0.9226	0.0007	0.9240
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9284	0.0007	0.9298
Internal Moderator Density = 90 %	0.9308	0.0007	0.9322
Internal Moderator Density = 80 %	0.9292	0.0008	0.9308
Internal Moderator Density = 70 %	0.9218	0.0008	0.9234
Internal Moderator Density = 60 %	0.9116	0.0008	0.9132

Table U.6-20
CE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.30 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9150	0.0007	0.9164
Internal Moderator Density = 90 %	0.9237	0.0007	0.9251
Internal Moderator Density = 80 %	0.9327	0.0007	0.9341
Internal Moderator Density = 70 %	0.9354	0.0007	0.9368
Internal Moderator Density = 60 %	0.9332	0.0007	0.9346
Enrichment = 4.80 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9258	0.0007	0.9272
Internal Moderator Density = 90 %	0.9326	0.0007	0.9340
Internal Moderator Density = 80 %	0.9364	0.0007	0.9378
Internal Moderator Density = 70 %	0.9377	0.0007	0.9391
Internal Moderator Density = 60 %	0.9285	0.0006	0.9297
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9304	0.0007	0.9318
Internal Moderator Density = 90 %	0.9357	0.0006	0.9369
Internal Moderator Density = 80 %	0.9373	0.0007	0.9387
Internal Moderator Density = 70 %	0.9352	0.0007	0.9366
Internal Moderator Density = 60 %	0.9265	0.0007	0.9279

Table U.6-21
CE 15x15 Class Intact Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.50 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9329	0.0006	0.9341
Internal Moderator Density = 90 %	0.9349	0.0006	0.9361
Internal Moderator Density = 80 %	0.9367	0.0007	0.9381
Internal Moderator Density = 70 %	0.9335	0.0007	0.9349
Internal Moderator Density = 60 %	0.9237	0.0008	0.9253
Enrichment = 3.85 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9380	0.0007	0.9394
Internal Moderator Density = 90 %	0.9375	0.0007	0.9389
Internal Moderator Density = 80 %	0.9348	0.0007	0.9362
Internal Moderator Density = 70 %	0.9265	0.0007	0.9279
Internal Moderator Density = 60 %	0.9137	0.0007	0.9151
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9358	0.0007	0.9372
Internal Moderator Density = 90 %	0.9344	0.0007	0.9358
Internal Moderator Density = 80 %	0.9310	0.0008	0.9326
Internal Moderator Density = 70 %	0.9213	0.0008	0.9229
Internal Moderator Density = 60 %	0.9067	0.0007	0.9081
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9386	0.0007	0.9400
Internal Moderator Density = 90 %	0.9346	0.0007	0.9360
Internal Moderator Density = 80 %	0.9291	0.0007	0.9305
Internal Moderator Density = 70 %	0.9177	0.0007	0.9191
Internal Moderator Density = 60 %	0.8973	0.0007	0.8987
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9377	0.0007	0.9391
Internal Moderator Density = 90 %	0.9320	0.0007	0.9334
Internal Moderator Density = 80 %	0.9220	0.0008	0.9236
Internal Moderator Density = 70 %	0.9079	0.0007	0.9093
Internal Moderator Density = 60 %	0.8867	0.0008	0.8883

Table U.6-21
CE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9291	0.0007	0.9305
Internal Moderator Density = 90 %	0.9338	0.0007	0.9352
Internal Moderator Density = 80 %	0.9354	0.0007	0.9368
Internal Moderator Density = 70 %	0.9358	0.0008	0.9374
Internal Moderator Density = 60 %	0.9290	0.0007	0.9304
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9333	0.0007	0.9347
Internal Moderator Density = 90 %	0.9348	0.0008	0.9364
Internal Moderator Density = 80 %	0.9346	0.0007	0.9360
Internal Moderator Density = 70 %	0.9292	0.0007	0.9306
Internal Moderator Density = 60 %	0.9173	0.0007	0.9187
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9379	0.0008	0.9395
Internal Moderator Density = 90 %	0.9367	0.0007	0.9381
Internal Moderator Density = 80 %	0.9368	0.0007	0.9382
Internal Moderator Density = 70 %	0.9288	0.0007	0.9302
Internal Moderator Density = 60 %	0.9156	0.0007	0.9170
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9365	0.0009	0.9383
Internal Moderator Density = 90 %	0.9364	0.0008	0.9380
Internal Moderator Density = 80 %	0.9328	0.0009	0.9346
Internal Moderator Density = 70 %	0.9212	0.0009	0.9230
Internal Moderator Density = 60 %	0.9071	0.0008	0.9087
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9363	0.0008	0.9379
Internal Moderator Density = 90 %	0.9339	0.0008	0.9355
Internal Moderator Density = 80 %	0.9252	0.0008	0.9268
Internal Moderator Density = 70 %	0.9129	0.0008	0.9145
Internal Moderator Density = 60 %	0.8950	0.0007	0.8964

Table U.6-21
CE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.85 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9268	0.0007	0.9282
Internal Moderator Density = 90 %	0.9348	0.0007	0.9362
Internal Moderator Density = 80 %	0.9385	0.0007	0.9399
Internal Moderator Density = 70 %	0.9366	0.0006	0.9378
Internal Moderator Density = 60 %	0.9309	0.0006	0.9321
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9328	0.0008	0.9344
Internal Moderator Density = 90 %	0.9359	0.0008	0.9375
Internal Moderator Density = 80 %	0.9349	0.0007	0.9363
Internal Moderator Density = 70 %	0.9296	0.0007	0.9310
Internal Moderator Density = 60 %	0.9187	0.0008	0.9203
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9358	0.0007	0.9372
Internal Moderator Density = 90 %	0.9373	0.0006	0.9385
Internal Moderator Density = 80 %	0.9358	0.0008	0.9374
Internal Moderator Density = 70 %	0.9291	0.0008	0.9307
Internal Moderator Density = 60 %	0.9168	0.0009	0.9186
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9370	0.0008	0.9386
Internal Moderator Density = 90 %	0.9378	0.0007	0.9392
Internal Moderator Density = 80 %	0.9328	0.0007	0.9342
Internal Moderator Density = 70 %	0.9231	0.0008	0.9247
Internal Moderator Density = 60 %	0.9082	0.0007	0.9096
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9374	0.0007	0.9388
Internal Moderator Density = 90 %	0.9345	0.0008	0.9361
Internal Moderator Density = 80 %	0.9289	0.0008	0.9305
Internal Moderator Density = 70 %	0.9174	0.0008	0.9190
Internal Moderator Density = 60 %	0.8975	0.0008	0.8991

Table U.6-21
CE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9297	0.0007	0.9311
Internal Moderator Density = 90 %	0.9347	0.0007	0.9361
Internal Moderator Density = 80 %	0.9393	0.0007	0.9407
Internal Moderator Density = 70 %	0.9384	0.0007	0.9398
Internal Moderator Density = 60 %	0.9336	0.0009	0.9354
Enrichment = 4.35 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9352	0.0007	0.9366
Internal Moderator Density = 90 %	0.9380	0.0007	0.9394
Internal Moderator Density = 80 %	0.9388	0.0007	0.9402
Internal Moderator Density = 70 %	0.9340	0.0007	0.9354
Internal Moderator Density = 60 %	0.8978	0.0007	0.8992
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9361	0.0006	0.9373
Internal Moderator Density = 90 %	0.9381	0.0008	0.9397
Internal Moderator Density = 80 %	0.9363	0.0007	0.9377
Internal Moderator Density = 70 %	0.9295	0.0008	0.9311
Internal Moderator Density = 60 %	0.9185	0.0007	0.9199
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9371	0.0007	0.9385
Internal Moderator Density = 90 %	0.9374	0.0007	0.9388
Internal Moderator Density = 80 %	0.9334	0.0007	0.9348
Internal Moderator Density = 70 %	0.9256	0.0007	0.9270
Internal Moderator Density = 60 %	0.9117	0.0008	0.9133
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9372	0.0008	0.9388
Internal Moderator Density = 90 %	0.9353	0.0007	0.9367
Internal Moderator Density = 80 %	0.9282	0.0008	0.9298
Internal Moderator Density = 70 %	0.9166	0.0007	0.9180
Internal Moderator Density = 60 %	0.8991	0.0008	0.9007

Table U.6-21
CE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9207	0.0009	0.9225
Internal Moderator Density = 90 %	0.9315	0.0006	0.9327
Internal Moderator Density = 80 %	0.9356	0.0008	0.9372
Internal Moderator Density = 70 %	0.9376	0.0008	0.9392
Internal Moderator Density = 60 %	0.9344	0.0007	0.9358
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9318	0.0007	0.9332
Internal Moderator Density = 90 %	0.9377	0.0006	0.9389
Internal Moderator Density = 80 %	0.9382	0.0008	0.9398
Internal Moderator Density = 70 %	0.9342	0.0007	0.9356
Internal Moderator Density = 60 %	0.9268	0.0007	0.9282
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9357	0.0007	0.9371
Internal Moderator Density = 90 %	0.9373	0.0008	0.9389
Internal Moderator Density = 80 %	0.9395	0.0007	0.9409
Internal Moderator Density = 70 %	0.9335	0.0007	0.9349
Internal Moderator Density = 60 %	0.9224	0.0007	0.9238
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9321	0.0008	0.9337
Internal Moderator Density = 90 %	0.9334	0.0007	0.9348
Internal Moderator Density = 80 %	0.9315	0.0007	0.9329
Internal Moderator Density = 70 %	0.9242	0.0008	0.9258
Internal Moderator Density = 60 %	0.9113	0.0007	0.9127

Table U.6-21
CE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.30 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9189	0.0006	0.9201
Internal Moderator Density = 90 %	0.9283	0.0007	0.9297
Internal Moderator Density = 80 %	0.9335	0.0006	0.9347
Internal Moderator Density = 70 %	0.9355	0.0007	0.9369
Internal Moderator Density = 60 %	0.9344	0.0007	0.9358
Enrichment = 4.80 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9301	0.0007	0.9315
Internal Moderator Density = 90 %	0.9355	0.0007	0.9369
Internal Moderator Density = 80 %	0.9383	0.0008	0.9399
Internal Moderator Density = 70 %	0.9381	0.0008	0.9397
Internal Moderator Density = 60 %	0.9304	0.0007	0.9318
Enrichment = 4.95 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9304	0.0007	0.9318
Internal Moderator Density = 90 %	0.9351	0.0007	0.9365
Internal Moderator Density = 80 %	0.9364	0.0008	0.9380
Internal Moderator Density = 70 %	0.9334	0.0006	0.9346
Internal Moderator Density = 60 %	0.9244	0.0008	0.9260

Table U.6-22
WE 15x15 Class Intact Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.50 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9257	0.0006	0.9269
Internal Moderator Density = 90 %	0.9341	0.0007	0.9355
Internal Moderator Density = 80 %	0.9367	0.0007	0.9381
Internal Moderator Density = 70 %	0.9390	0.0007	0.9404
Internal Moderator Density = 60 %	0.9335	0.0007	0.9349
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9295	0.0007	0.9309
Internal Moderator Density = 90 %	0.9351	0.0006	0.9363
Internal Moderator Density = 80 %	0.9350	0.0008	0.9366
Internal Moderator Density = 70 %	0.9329	0.0008	0.9345
Internal Moderator Density = 60 %	0.9225	0.0007	0.9239
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9258	0.0007	0.9272
Internal Moderator Density = 90 %	0.9321	0.0007	0.9335
Internal Moderator Density = 80 %	0.9328	0.0007	0.9342
Internal Moderator Density = 70 %	0.9270	0.0007	0.9284
Internal Moderator Density = 60 %	0.9169	0.0008	0.9185
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9340	0.0007	0.9354
Internal Moderator Density = 90 %	0.9364	0.0008	0.9380
Internal Moderator Density = 80 %	0.9350	0.0007	0.9364
Internal Moderator Density = 70 %	0.9267	0.0008	0.9283
Internal Moderator Density = 60 %	0.9137	0.0008	0.9153
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9337	0.0009	0.9355
Internal Moderator Density = 90 %	0.9339	0.0007	0.9353
Internal Moderator Density = 80 %	0.9311	0.0007	0.9325
Internal Moderator Density = 70 %	0.9203	0.0007	0.9217
Internal Moderator Density = 60 %	0.9028	0.0007	0.9042

Table U.6-22
WE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9158	0.0006	0.9170
Internal Moderator Density = 90 %	0.9244	0.0007	0.9258
Internal Moderator Density = 80 %	0.9324	0.0007	0.9338
Internal Moderator Density = 70 %	0.9360	0.0008	0.9376
Internal Moderator Density = 60 %	0.9335	0.0008	0.9351
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9267	0.0007	0.9281
Internal Moderator Density = 90 %	0.9330	0.0006	0.9342
Internal Moderator Density = 80 %	0.9366	0.0007	0.9380
Internal Moderator Density = 70 %	0.9363	0.0007	0.9377
Internal Moderator Density = 60 %	0.9288	0.0007	0.9302
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9243	0.0007	0.9257
Internal Moderator Density = 90 %	0.9297	0.0007	0.9311
Internal Moderator Density = 80 %	0.9335	0.0007	0.9349
Internal Moderator Density = 70 %	0.9302	0.0007	0.9316
Internal Moderator Density = 60 %	0.9229	0.0006	0.9241
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9307	0.0007	0.9321
Internal Moderator Density = 90 %	0.9325	0.0007	0.9339
Internal Moderator Density = 80 %	0.9357	0.0008	0.9373
Internal Moderator Density = 70 %	0.9289	0.0008	0.9305
Internal Moderator Density = 60 %	0.9168	0.0008	0.9184
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9344	0.0007	0.9358
Internal Moderator Density = 90 %	0.9361	0.0007	0.9375
Internal Moderator Density = 80 %	0.9356	0.0009	0.9374
Internal Moderator Density = 70 %	0.9266	0.0008	0.9282
Internal Moderator Density = 60 %	0.9109	0.0007	0.9123

Table U.6-22
WE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9151	0.0006	0.9163
Internal Moderator Density = 90 %	0.9276	0.0006	0.9288
Internal Moderator Density = 80 %	0.9343	0.0007	0.9357
Internal Moderator Density = 70 %	0.9375	0.0006	0.9387
Internal Moderator Density = 60 %	0.9349	0.0007	0.9363
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9248	0.0007	0.9262
Internal Moderator Density = 90 %	0.9327	0.0007	0.9341
Internal Moderator Density = 80 %	0.9362	0.0007	0.9376
Internal Moderator Density = 70 %	0.9371	0.0007	0.9385
Internal Moderator Density = 60 %	0.9302	0.0007	0.9316
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9306	0.0008	0.9322
Internal Moderator Density = 90 %	0.9376	0.0007	0.9390
Internal Moderator Density = 80 %	0.9383	0.0008	0.9399
Internal Moderator Density = 70 %	0.9386	0.0008	0.9402
Internal Moderator Density = 60 %	0.9295	0.0008	0.9311
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9280	0.0007	0.9294
Internal Moderator Density = 90 %	0.9329	0.0008	0.9345
Internal Moderator Density = 80 %	0.9349	0.0008	0.9365
Internal Moderator Density = 70 %	0.9281	0.0007	0.9295
Internal Moderator Density = 60 %	0.9188	0.0007	0.9202
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9335	0.0008	0.9351
Internal Moderator Density = 90 %	0.9334	0.0007	0.9348
Internal Moderator Density = 80 %	0.9353	0.0007	0.9367
Internal Moderator Density = 70 %	0.9257	0.0007	0.9271
Internal Moderator Density = 60 %	0.9118	0.0007	0.9132

Table U.6-22
WE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9357	0.0007	0.9371
Internal Moderator Density = 90 %	0.9267	0.0007	0.9281
Internal Moderator Density = 80 %	0.9350	0.0007	0.9364
Internal Moderator Density = 70 %	0.9385	0.0007	0.9399
Internal Moderator Density = 60 %	0.9378	0.0007	0.9392
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9287	0.0008	0.9303
Internal Moderator Density = 90 %	0.9329	0.0007	0.9343
Internal Moderator Density = 80 %	0.9371	0.0007	0.9385
Internal Moderator Density = 70 %	0.9381	0.0007	0.9395
Internal Moderator Density = 60 %	0.9314	0.0007	0.9328
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9295	0.0007	0.9309
Internal Moderator Density = 90 %	0.9345	0.0007	0.9359
Internal Moderator Density = 80 %	0.9387	0.0007	0.9401
Internal Moderator Density = 70 %	0.9389	0.0007	0.9403
Internal Moderator Density = 60 %	0.9309	0.0008	0.9325
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9276	0.0007	0.9290
Internal Moderator Density = 90 %	0.9313	0.0006	0.9325
Internal Moderator Density = 80 %	0.9336	0.0007	0.9350
Internal Moderator Density = 70 %	0.9302	0.0007	0.9316
Internal Moderator Density = 60 %	0.9195	0.0007	0.9209
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9316	0.0007	0.9330
Internal Moderator Density = 90 %	0.9363	0.0007	0.9377
Internal Moderator Density = 80 %	0.9355	0.0007	0.9369
Internal Moderator Density = 70 %	0.9267	0.0008	0.9283
Internal Moderator Density = 60 %	0.9126	0.0008	0.9142

Table U.6-22
WE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9082	0.0006	0.9094
Internal Moderator Density = 90 %	0.9195	0.0006	0.9207
Internal Moderator Density = 80 %	0.9299	0.0006	0.9311
Internal Moderator Density = 70 %	0.9371	0.0006	0.9383
Internal Moderator Density = 60 %	0.9355	0.0008	0.9371
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9193	0.0008	0.9209
Internal Moderator Density = 90 %	0.9229	0.0006	0.9241
Internal Moderator Density = 80 %	0.9318	0.0007	0.9332
Internal Moderator Density = 70 %	0.9345	0.0008	0.9361
Internal Moderator Density = 60 %	0.9305	0.0007	0.9319
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9192	0.0007	0.9206
Internal Moderator Density = 90 %	0.9282	0.0008	0.9298
Internal Moderator Density = 80 %	0.9336	0.0007	0.9350
Internal Moderator Density = 70 %	0.9333	0.0007	0.9347
Internal Moderator Density = 60 %	0.9291	0.0007	0.9305
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9235	0.0007	0.9249
Internal Moderator Density = 90 %	0.9309	0.0007	0.9323
Internal Moderator Density = 80 %	0.9328	0.0007	0.9342
Internal Moderator Density = 70 %	0.9319	0.0007	0.9333
Internal Moderator Density = 60 %	0.9227	0.0007	0.9241

Table U.6-22
WE 15x15 Class Intact Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 80 %	0.9250	0.0007	0.9264
Internal Moderator Density = 70 %	0.9321	0.0008	0.9337
Internal Moderator Density = 60 %	0.9325	0.0007	0.9339
Internal Moderator Density = 50 %	0.9274	0.0007	0.9288
Internal Moderator Density = 40 %	0.9106	0.0006	0.9118
Enrichment = 4.70 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9140	0.0008	0.9156
Internal Moderator Density = 90 %	0.9236	0.0006	0.9248
Internal Moderator Density = 80 %	0.9319	0.0006	0.9331
Internal Moderator Density = 70 %	0.9366	0.0007	0.9380
Internal Moderator Density = 60 %	0.9334	0.0007	0.9348
Enrichment = 4.90 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9188	0.0007	0.9202
Internal Moderator Density = 90 %	0.9262	0.0006	0.9274
Internal Moderator Density = 80 %	0.9344	0.0007	0.9358
Internal Moderator Density = 70 %	0.9352	0.0008	0.9368
Internal Moderator Density = 60 %	0.9310	0.0007	0.9324

Table U.6-23
WE 15x15 Class Intact Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.45 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9335	0.0007	0.9349
Internal Moderator Density = 90 %	0.9378	0.0007	0.9392
Internal Moderator Density = 80 %	0.9377	0.0007	0.9391
Internal Moderator Density = 70 %	0.9349	0.0007	0.9363
Internal Moderator Density = 60 %	0.9258	0.0007	0.9272
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9363	0.0007	0.9377
Internal Moderator Density = 90 %	0.9355	0.0007	0.9369
Internal Moderator Density = 80 %	0.9315	0.0008	0.9331
Internal Moderator Density = 70 %	0.9238	0.0007	0.9252
Internal Moderator Density = 60 %	0.9111	0.0007	0.9125
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9350	0.0007	0.9364
Internal Moderator Density = 90 %	0.9345	0.0007	0.9359
Internal Moderator Density = 80 %	0.9321	0.0007	0.9335
Internal Moderator Density = 70 %	0.9228	0.0008	0.9244
Internal Moderator Density = 60 %	0.9077	0.0007	0.9091
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9375	0.0007	0.9389
Internal Moderator Density = 90 %	0.9370	0.0007	0.9384
Internal Moderator Density = 80 %	0.9300	0.0008	0.9316
Internal Moderator Density = 70 %	0.9169	0.0008	0.9185
Internal Moderator Density = 60 %	0.8995	0.0007	0.9009
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9398	0.0006	0.9410
Internal Moderator Density = 90 %	0.9343	0.0007	0.9357
Internal Moderator Density = 80 %	0.9264	0.0008	0.9280
Internal Moderator Density = 70 %	0.9110	0.0070	0.9250
Internal Moderator Density = 60 %	0.8889	0.0007	0.8903

Table U.6-23
WE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9304	0.0008	0.9320
Internal Moderator Density = 90 %	0.9370	0.0006	0.9382
Internal Moderator Density = 80 %	0.9390	0.0007	0.9404
Internal Moderator Density = 70 %	0.9376	0.0006	0.9388
Internal Moderator Density = 60 %	0.9298	0.0006	0.9310
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9332	0.0007	0.9346
Internal Moderator Density = 90 %	0.9369	0.0007	0.9383
Internal Moderator Density = 80 %	0.9363	0.0007	0.9377
Internal Moderator Density = 70 %	0.9300	0.0007	0.9314
Internal Moderator Density = 60 %	0.9185	0.0007	0.9199
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9355	0.0006	0.9367
Internal Moderator Density = 90 %	0.9366	0.0008	0.9382
Internal Moderator Density = 80 %	0.9345	0.0008	0.9361
Internal Moderator Density = 70 %	0.9267	0.0007	0.9281
Internal Moderator Density = 60 %	0.9138	0.0008	0.9154
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9373	0.0007	0.9387
Internal Moderator Density = 90 %	0.9366	0.0007	0.9380
Internal Moderator Density = 80 %	0.9313	0.0007	0.9327
Internal Moderator Density = 70 %	0.9198	0.0007	0.9212
Internal Moderator Density = 60 %	0.9031	0.0007	0.9045
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9384	0.0008	0.9400
Internal Moderator Density = 90 %	0.9381	0.0007	0.9395
Internal Moderator Density = 80 %	0.9297	0.0008	0.9313
Internal Moderator Density = 70 %	0.9163	0.0007	0.9177
Internal Moderator Density = 60 %	0.8970	0.0009	0.8988

Table U.6-23
WE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9304	0.0007	0.9318
Internal Moderator Density = 90 %	0.9368	0.0007	0.9382
Internal Moderator Density = 80 %	0.9391	0.0007	0.9405
Internal Moderator Density = 70 %	0.9379	0.0006	0.9391
Internal Moderator Density = 60 %	0.9326	0.0006	0.9338
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9338	0.0007	0.9352
Internal Moderator Density = 90 %	0.9381	0.0008	0.9397
Internal Moderator Density = 80 %	0.9369	0.0007	0.9383
Internal Moderator Density = 70 %	0.9315	0.0007	0.9329
Internal Moderator Density = 60 %	0.9203	0.0008	0.9219
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9360	0.0008	0.9376
Internal Moderator Density = 90 %	0.9370	0.0007	0.9384
Internal Moderator Density = 80 %	0.9336	0.0007	0.9350
Internal Moderator Density = 70 %	0.9274	0.0007	0.9288
Internal Moderator Density = 60 %	0.9152	0.0007	0.9166
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9384	0.0006	0.9396
Internal Moderator Density = 90 %	0.9388	0.0009	0.9406
Internal Moderator Density = 80 %	0.9333	0.0008	0.9349
Internal Moderator Density = 70 %	0.9243	0.0007	0.9257
Internal Moderator Density = 60 %	0.9092	0.0008	0.9108
Enrichment = 4.85 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9385	0.0007	0.9399
Internal Moderator Density = 90 %	0.9359	0.0007	0.9373
Internal Moderator Density = 80 %	0.9294	0.0007	0.9308
Internal Moderator Density = 70 %	0.9179	0.0007	0.9193
Internal Moderator Density = 60 %	0.8986	0.0006	0.8998

Table U.6-23
WE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.85 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9286	0.0006	0.9298
Internal Moderator Density = 90 %	0.9345	0.0007	0.9359
Internal Moderator Density = 80 %	0.9382	0.0007	0.9396
Internal Moderator Density = 70 %	0.9369	0.0006	0.9381
Internal Moderator Density = 60 %	0.9311	0.0008	0.9327
Enrichment = 4.25 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9355	0.0007	0.9369
Internal Moderator Density = 90 %	0.9376	0.0008	0.9392
Internal Moderator Density = 80 %	0.9372	0.0006	0.9384
Internal Moderator Density = 70 %	0.9337	0.0007	0.9351
Internal Moderator Density = 60 %	0.9224	0.0007	0.9238
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9357	0.0007	0.9371
Internal Moderator Density = 90 %	0.9373	0.0008	0.9389
Internal Moderator Density = 80 %	0.9367	0.0008	0.9383
Internal Moderator Density = 70 %	0.9302	0.0007	0.9316
Internal Moderator Density = 60 %	0.9155	0.0008	0.9171
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9378	0.0007	0.9392
Internal Moderator Density = 90 %	0.9384	0.0008	0.9400
Internal Moderator Density = 80 %	0.9348	0.0007	0.9362
Internal Moderator Density = 70 %	0.9251	0.0008	0.9267
Internal Moderator Density = 60 %	0.9103	0.0008	0.9119
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9390	0.0007	0.9404
Internal Moderator Density = 90 %	0.9384	0.0007	0.9398
Internal Moderator Density = 80 %	0.9319	0.0008	0.9335
Internal Moderator Density = 70 %	0.9198	0.0007	0.9212
Internal Moderator Density = 60 %	0.9027	0.0007	0.9041

Table U.6-23
WE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9225	0.0006	0.9237
Internal Moderator Density = 90 %	0.9285	0.0008	0.9301
Internal Moderator Density = 80 %	0.9351	0.0008	0.9367
Internal Moderator Density = 70 %	0.9368	0.0008	0.9384
Internal Moderator Density = 60 %	0.9326	0.0008	0.9342
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9310	0.0006	0.9322
Internal Moderator Density = 90 %	0.9348	0.0007	0.9362
Internal Moderator Density = 80 %	0.9357	0.0007	0.9371
Internal Moderator Density = 70 %	0.9338	0.0007	0.9352
Internal Moderator Density = 60 %	0.9254	0.0007	0.9268
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9344	0.0007	0.9358
Internal Moderator Density = 90 %	0.9372	0.0007	0.9386
Internal Moderator Density = 80 %	0.9391	0.0007	0.9405
Internal Moderator Density = 70 %	0.9342	0.0007	0.9356
Internal Moderator Density = 60 %	0.9219	0.0008	0.9235
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9368	0.0009	0.9386
Internal Moderator Density = 90 %	0.9378	0.0007	0.9392
Internal Moderator Density = 80 %	0.9350	0.0007	0.9364
Internal Moderator Density = 70 %	0.9285	0.0008	0.9301
Internal Moderator Density = 60 %	0.9143	0.0006	0.9155

Table U.6-23
WE 15x15 Class Intact Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9287	0.0007	0.9301
Internal Moderator Density = 80 %	0.9349	0.0007	0.9363
Internal Moderator Density = 70 %	0.9369	0.0008	0.9385
Internal Moderator Density = 60 %	0.9333	0.0007	0.9347
Internal Moderator Density = 50 %	0.9218	0.0007	0.9232
Enrichment = 4.70 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9323	0.0007	0.9337
Internal Moderator Density = 90 %	0.9380	0.0007	0.9394
Internal Moderator Density = 80 %	0.9390	0.0008	0.9406
Internal Moderator Density = 70 %	0.9374	0.0006	0.9386
Internal Moderator Density = 60 %	0.9296	0.0007	0.9310
Enrichment = 4.85 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9308	0.0008	0.9324
Internal Moderator Density = 90 %	0.9358	0.0007	0.9372
Internal Moderator Density = 80 %	0.9364	0.0006	0.9376
Internal Moderator Density = 70 %	0.9322	0.0006	0.9334
Internal Moderator Density = 60 %	0.9243	0.0006	0.9255

Table U.6-24
CE 14x14 Class Intact Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Internal Moderator Density =90 %	0.9231	0.0008	0.9247
Internal Moderator Density = 80 %	0.9287	0.0007	0.9301
Internal Moderator Density = 70 %	0.9336	0.0007	0.9350
Internal Moderator Density = 60 %	0.9318	0.0008	0.9334
Internal Moderator Density = 50 %	0.9230	0.0007	0.9244
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9334	0.0007	0.9348
Internal Moderator Density = 80 %	0.9352	0.0007	0.9366
Internal Moderator Density = 70 %	0.9354	0.0007	0.9368
Internal Moderator Density = 60 %	0.9290	0.0007	0.9304
Internal Moderator Density = 50 %	0.9136	0.0008	0.9152
Internal Moderator Density = 90 %	0.9347	0.0008	0.9363
Internal Moderator Density = 80 %	0.9357	0.0007	0.9371
Internal Moderator Density = 70 %	0.9342	0.0008	0.9358
Internal Moderator Density = 60 %	0.9265	0.0008	0.9281
Internal Moderator Density = 50 %	0.9097	0.0007	0.9111
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9325	0.0007	0.9339
Internal Moderator Density = 90 %	0.9359	0.0009	0.9377
Internal Moderator Density = 80 %	0.9356	0.0008	0.9372
Internal Moderator Density = 70 %	0.9307	0.0008	0.9323
Internal Moderator Density = 60 %	0.9196	0.0007	0.9210
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9256	0.0008	0.9272
Internal Moderator Density = 90 %	0.9275	0.0007	0.9289
Internal Moderator Density = 80 %	0.9243	0.0007	0.9257
Internal Moderator Density = 70 %	0.9164	0.0008	0.9180
Internal Moderator Density = 60 %	0.9011	0.0008	0.9027

Table U.6-24
CE 14x14 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9199	0.0008	0.9215
Internal Moderator Density = 80 %	0.9294	0.0007	0.9308
Internal Moderator Density = 70 %	0.9350	0.0007	0.9364
Internal Moderator Density = 60 %	0.9346	0.0008	0.9362
Internal Moderator Density = 50 %	0.9277	0.0007	0.9291
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9271	0.0008	0.9287
Internal Moderator Density = 80 %	0.9329	0.0007	0.9343
Internal Moderator Density = 70 %	0.9341	0.0008	0.9357
Internal Moderator Density = 60 %	0.9301	0.0009	0.9319
Internal Moderator Density = 50 %	0.9176	0.0007	0.9190
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 90 %	0.9270	0.0008	0.9286
Internal Moderator Density = 80 %	0.9349	0.0007	0.9363
Internal Moderator Density = 70 %	0.9386	0.0007	0.9400
Internal Moderator Density = 60 %	0.9377	0.0008	0.9393
Internal Moderator Density = 50 %	0.9332	0.0008	0.9348

Table U.6-24
CE 14x14 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9179	0.0007	0.9193
Internal Moderator Density = 80 %	0.9280	0.0007	0.9294
Internal Moderator Density = 70 %	0.9348	0.0007	0.9362
Internal Moderator Density = 60 %	0.9368	0.0007	0.9382
Internal Moderator Density = 50 %	0.9282	0.0007	0.9296
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9258	0.0008	0.9274
Internal Moderator Density = 80 %	0.9322	0.0006	0.9334
Internal Moderator Density = 70 %	0.9340	0.0007	0.9354
Internal Moderator Density = 60 %	0.9325	0.0008	0.9341
Internal Moderator Density = 50 %	0.9193	0.0007	0.9207

Table U.6-24
CE 14x14 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9172	0.0007	0.9186
Internal Moderator Density = 80 %	0.9278	0.0008	0.9294
Internal Moderator Density = 70 %	0.9336	0.0008	0.9352
Internal Moderator Density = 60 %	0.9366	0.0007	0.9380
Internal Moderator Density = 50 %	0.9316	0.0007	0.9330
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 90 %	0.9301	0.0008	0.9317
Internal Moderator Density = 80 %	0.9378	0.0007	0.9392
Internal Moderator Density = 70 %	0.9396	0.0007	0.9410
Internal Moderator Density = 60 %	0.9377	0.0008	0.9393
Internal Moderator Density = 50 %	0.9273	0.0007	0.9287

Table U.6-24
CE 14x14 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9081	0.0006	0.9093
Internal Moderator Density = 80 %	0.9214	0.0007	0.9228
Internal Moderator Density = 70 %	0.9302	0.0007	0.9316
Internal Moderator Density = 60 %	0.9346	0.0007	0.9360
Internal Moderator Density = 50 %	0.9296	0.0007	0.9310

Table U.6-24
CE 14x14 Class Intact Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.80 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9080	0.0007	0.9094
Internal Moderator Density = 90 %	0.9209	0.0007	0.9223
Internal Moderator Density = 80 %	0.9311	0.0008	0.9327
Internal Moderator Density = 70 %	0.9359	0.0007	0.9373
Internal Moderator Density = 60 %	0.9335	0.0007	0.9349

Table U.6-25
CE 14x14 Class Intact Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.85 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9330	0.0008	0.9346
Internal Moderator Density = 90 %	0.9367	0.0007	0.9381
Internal Moderator Density = 80 %	0.9391	0.0008	0.9407
Internal Moderator Density = 70 %	0.9362	0.0008	0.9378
Internal Moderator Density = 60 %	0.9289	0.0007	0.9303
Enrichment = 4.25 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9360	0.0006	0.9372
Internal Moderator Density = 90 %	0.9394	0.0007	0.9408
Internal Moderator Density = 80 %	0.9374	0.0008	0.9390
Internal Moderator Density = 70 %	0.9292	0.0007	0.9306
Internal Moderator Density = 60 %	0.9167	0.0007	0.9181
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9384	0.0007	0.9398
Internal Moderator Density = 90 %	0.9393	0.0007	0.9407
Internal Moderator Density = 80 %	0.9355	0.0008	0.9371
Internal Moderator Density = 70 %	0.9262	0.0008	0.9278
Internal Moderator Density = 60 %	0.9151	0.0007	0.9165
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9386	0.0007	0.9400
Internal Moderator Density = 90 %	0.9361	0.0007	0.9375
Internal Moderator Density = 80 %	0.9301	0.0008	0.9317
Internal Moderator Density = 70 %	0.9196	0.0007	0.9210
Internal Moderator Density = 60 %	0.9020	0.0008	0.9036
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9365	0.0008	0.9381
Internal Moderator Density = 90 %	0.9319	0.0007	0.9333
Internal Moderator Density = 80 %	0.9230	0.0008	0.9246
Internal Moderator Density = 70 %	0.9081	0.0008	0.9097
Internal Moderator Density = 60 %	0.8876	0.0007	0.8890

Table U.6-25
CE 14x14 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9294	0.0008	0.9310
Internal Moderator Density = 90 %	0.9358	0.0006	0.9370
Internal Moderator Density = 80 %	0.9393	0.0008	0.9409
Internal Moderator Density = 70 %	0.9388	0.0007	0.9402
Internal Moderator Density = 60 %	0.9336	0.0007	0.9350
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9324	0.0008	0.9340
Internal Moderator Density = 90 %	0.9360	0.0007	0.9374
Internal Moderator Density = 80 %	0.9355	0.0008	0.9371
Internal Moderator Density = 70 %	0.9309	0.0007	0.9323
Internal Moderator Density = 60 %	0.9193	0.0007	0.9207
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9355	0.0007	0.9369
Internal Moderator Density = 90 %	0.9383	0.0008	0.9399
Internal Moderator Density = 80 %	0.9353	0.0008	0.9369
Internal Moderator Density = 70 %	0.9303	0.0008	0.9319
Internal Moderator Density = 60 %	0.9165	0.0007	0.9179
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9347	0.0007	0.9361
Internal Moderator Density = 90 %	0.9335	0.0007	0.9349
Internal Moderator Density = 80 %	0.9296	0.0007	0.9310
Internal Moderator Density = 70 %	0.9203	0.0007	0.9217
Internal Moderator Density = 60 %	0.9065	0.0007	0.9079

Table U.6-25
CE 14x14 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9269	0.0008	0.9285
Internal Moderator Density = 90 %	0.9314	0.0009	0.9332
Internal Moderator Density = 80 %	0.9368	0.0008	0.9384
Internal Moderator Density = 70 %	0.9361	0.0009	0.9379
Internal Moderator Density = 60 %	0.9321	0.0007	0.9335
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9375	0.0007	0.9389
Internal Moderator Density = 90 %	0.9389	0.0007	0.9403
Internal Moderator Density = 80 %	0.9388	0.0008	0.9404
Internal Moderator Density = 70 %	0.9345	0.0007	0.9359
Internal Moderator Density = 60 %	0.9255	0.0007	0.9269

Table U.6-25
CE 14x14 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9252	0.0007	0.9266
Internal Moderator Density = 90 %	0.9327	0.0007	0.9341
Internal Moderator Density = 80 %	0.9363	0.0008	0.9379
Internal Moderator Density = 70 %	0.9385	0.0007	0.9399
Internal Moderator Density = 60 %	0.9335	0.0007	0.9349
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9358	0.0007	0.9372
Internal Moderator Density = 90 %	0.9371	0.0007	0.9385
Internal Moderator Density = 80 %	0.9396	0.0007	0.9410
Internal Moderator Density = 70 %	0.9347	0.0009	0.9365
Internal Moderator Density = 60 %	0.9259	0.0007	0.9273

Table U.6-25
CE 14x14 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9287	0.0007	0.9301
Internal Moderator Density = 80 %	0.9324	0.0006	0.9336
Internal Moderator Density = 70 %	0.9358	0.0007	0.9372
Internal Moderator Density = 70 %	0.9341	0.0008	0.9357
Internal Moderator Density = 50 %	0.9254	0.0009	0.9272

Table U.6-25
CE 14x14 Class Intact Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.75 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9271	0.0007	0.9285
Internal Moderator Density = 80 %	0.9355	0.0007	0.9369
Internal Moderator Density = 70 %	0.9398	0.0007	0.9412
Internal Moderator Density = 70 %	0.9382	0.0008	0.9398
Internal Moderator Density = 50 %	0.9299	0.0007	0.9313

Table U.6-26
WE 14x14 Class Intact Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9180	0.0007	0.9194
Internal Moderator Density = 90 %	0.9274	0.0008	0.9290
Internal Moderator Density = 80 %	0.9313	0.0009	0.9331
Internal Moderator Density = 70 %	0.9342	0.0007	0.9356
Internal Moderator Density = 60 %	0.9322	0.0008	0.9338
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9308	0.0008	0.9324
Internal Moderator Density = 90 %	0.9342	0.0007	0.9356
Internal Moderator Density = 80 %	0.9341	0.0008	0.9357
Internal Moderator Density = 70 %	0.9341	0.0008	0.9357
Internal Moderator Density = 60 %	0.9268	0.0008	0.9284
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9314	0.0008	0.9330
Internal Moderator Density = 90 %	0.9350	0.0008	0.9366
Internal Moderator Density = 80 %	0.9367	0.0008	0.9383
Internal Moderator Density = 70 %	0.9322	0.0008	0.9338
Internal Moderator Density = 60 %	0.9233	0.0008	0.9249
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9232	0.0008	0.9248
Internal Moderator Density = 90 %	0.9265	0.0008	0.9281
Internal Moderator Density = 80 %	0.9245	0.0007	0.9259
Internal Moderator Density = 70 %	0.9168	0.0008	0.9184
Internal Moderator Density = 60 %	0.9056	0.0008	0.9072
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9130	0.0009	0.9148
Internal Moderator Density = 90 %	0.9122	0.0007	0.9136
Internal Moderator Density = 80 %	0.9068	0.0008	0.9084
Internal Moderator Density = 70 %	0.8975	0.0008	0.8991
Internal Moderator Density = 60 %	0.8839	0.0007	0.8853

Table U.6-26
WE 14x14 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9141	0.0008	0.9157
Internal Moderator Density = 90 %	0.9222	0.0007	0.9236
Internal Moderator Density = 80 %	0.9298	0.0008	0.9314
Internal Moderator Density = 70 %	0.9344	0.0007	0.9358
Internal Moderator Density = 60 %	0.9327	0.0007	0.9341
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9246	0.0007	0.9260
Internal Moderator Density = 90 %	0.9277	0.0008	0.9293
Internal Moderator Density = 80 %	0.9312	0.0008	0.9328
Internal Moderator Density = 70 %	0.9320	0.0008	0.9336
Internal Moderator Density = 60 %	0.9274	0.0007	0.9288

Table U.6-26
WE 14x14 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9199	0.0007	0.9213
Internal Moderator Density = 80 %	0.9287	0.0008	0.9303
Internal Moderator Density = 70 %	0.9321	0.0007	0.9335
Internal Moderator Density = 60 %	0.9342	0.0007	0.9356
Internal Moderator Density = 50 %	0.9278	0.0008	0.9294

Table U.6-26
WE 14x14 Class Intact Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9189	0.0009	0.9207
Internal Moderator Density = 80 %	0.9282	0.0007	0.9296
Internal Moderator Density = 70 %	0.9350	0.0007	0.9364
Internal Moderator Density = 60 %	0.9346	0.0008	0.9362
Internal Moderator Density = 50 %	0.9292	0.0008	0.9308

Table U.6-26
WE 14x14 Class Intact Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9164	0.0008	0.9180
Internal Moderator Density = 80 %	0.9258	0.0008	0.9274
Internal Moderator Density = 70 %	0.9314	0.0009	0.9332
Internal Moderator Density = 60 %	0.9354	0.0007	0.9368
Internal Moderator Density = 50 %	0.9325	0.0008	0.9341

Table U.6-27
WE 14x14 Class Intact Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9226	0.0008	0.9242
Internal Moderator Density = 90 %	0.9284	0.0007	0.9298
Internal Moderator Density = 80 %	0.9317	0.0007	0.9331
Internal Moderator Density = 70 %	0.9292	0.0007	0.9306
Internal Moderator Density = 60 %	0.9247	0.0008	0.9263
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9331	0.0007	0.9345
Internal Moderator Density = 90 %	0.9320	0.0009	0.9338
Internal Moderator Density = 80 %	0.9313	0.0009	0.9331
Internal Moderator Density = 70 %	0.9262	0.0008	0.9278
Internal Moderator Density = 60 %	0.9157	0.0008	0.9173
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 100 %	0.9332	0.0007	0.9346
Internal Moderator Density = 90 %	0.9344	0.0008	0.9360
Internal Moderator Density = 80 %	0.9296	0.0008	0.9312
Internal Moderator Density = 70 %	0.9252	0.0008	0.9268
Internal Moderator Density = 60 %	0.9116	0.0008	0.9132
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 100 %	0.9246	0.0008	0.9262
Internal Moderator Density = 90 %	0.9222	0.0008	0.9238
Internal Moderator Density = 80 %	0.9165	0.0008	0.9181
Internal Moderator Density = 70 %	0.9081	0.0008	0.9097
Internal Moderator Density = 60 %	0.8936	0.0007	0.8950
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 100 %	0.9118	0.0007	0.9132
Internal Moderator Density = 90 %	0.9073	0.0008	0.9089
Internal Moderator Density = 80 %	0.9001	0.0007	0.9015
Internal Moderator Density = 70 %	0.8879	0.0008	0.8895
Internal Moderator Density = 60 %	0.8704	0.0007	0.8718

Table U.6-27
WE 14x14 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9199	0.0008	0.9215
Internal Moderator Density = 90 %	0.9239	0.0008	0.9255
Internal Moderator Density = 80 %	0.9306	0.0008	0.9322
Internal Moderator Density = 70 %	0.9303	0.0008	0.9319
Internal Moderator Density = 60 %	0.9264	0.0007	0.9278
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 100 %	0.9265	0.0009	0.9283
Internal Moderator Density = 90 %	0.9290	0.0007	0.9304
Internal Moderator Density = 80 %	0.9288	0.0009	0.9306
Internal Moderator Density = 70 %	0.9236	0.0009	0.9254
Internal Moderator Density = 60 %	0.9185	0.0008	0.9201

Table U.6-27
WE 14x14 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9242	0.0008	0.9258
Internal Moderator Density = 80 %	0.9291	0.0007	0.9305
Internal Moderator Density = 70 %	0.9292	0.0008	0.9308
Internal Moderator Density = 60 %	0.9291	0.0008	0.9307
Internal Moderator Density = 50 %	0.9202	0.0008	0.9218

Table U.6-27
WE 14x14 Class Intact Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 100 %	0.9161	0.0008	0.9177
Internal Moderator Density = 90 %	0.9237	0.0007	0.9251
Internal Moderator Density = 80 %	0.9299	0.0010	0.9319
Internal Moderator Density = 70 %	0.9319	0.0008	0.9335
Internal Moderator Density = 60 %	0.9274	0.0008	0.9290

Table U.6-27
WE 14x14 Class Intact Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 90 %	0.9218	0.0007	0.9232
Internal Moderator Density = 80 %	0.9269	0.0008	0.9285
Internal Moderator Density = 70 %	0.9314	0.0008	0.9330
Internal Moderator Density = 60 %	0.9314	0.0007	0.9328
Internal Moderator Density = 50 %	0.9262	0.0007	0.9276

Table U.6-28
Key Parameters Utilized in the Damaged Assembly Calculations

Fuel Assembly Class	Enrichment (Wt. % U-235)	Poison Loading (mg B-10/cm^2)	Soluble Boron Concentration
WE 17x17 Class	4.30	18.0	2400 ppm
CE 16x16 Class	4.90	18.0	2400 ppm
B&W 15x15 Class	4.20	18.0	2400 ppm
CE 15x15 Class	4.40	18.0	2400 ppm
WE 15x15 Class	4.40	18.0	2400 ppm
CE 14x14 Class	5.00	18.0	2300 ppm
WE 14x14 Class	5.00	13.5	2300 ppm

Table U.6-29
Rod Pitch Study Results

Model Description	k_{KENO}	1σ	k_{eff}
Westinghouse 17x17 Class Fuel Assembly			
Pitch=0.3740", IMD=080%	0.6903	0.0008	0.6919
Pitch=0.4000", IMD=080%	0.7657	0.0008	0.7673
Pitch=0.4250", IMD=080%	0.8296	0.0008	0.8312
Pitch=0.4500", IMD=080%	0.8814	0.0007	0.8828
Pitch=0.4750", IMD=080%	0.9205	0.0007	0.9219
Pitch=0.4960", IMD=080%	0.9387	0.0007	0.9401
Pitch=0.5050", IMD=050%	0.9126	0.0007	0.9140
Pitch=0.5050", IMD=060%	0.9303	0.0007	0.9317
Pitch=0.5050", IMD=070%	0.9383	0.0007	0.9397
Pitch=0.5050", IMD=080%	0.9405	0.0007	0.9419
Pitch=0.5050", IMD=090%	0.9303	0.0007	0.9317
Pitch=0.5125", IMD=060%	0.9322	0.0007	0.9336
Pitch=0.5125", IMD=070%	0.9397	0.0007	0.9411
Pitch=0.5125", IMD=080%	**0.9427**	**0.0008**	**0.9443**
Pitch=0.5125", IMD=090%	0.9375	0.0008	0.9391
Pitch=0.5172", IMD=050%	0.9197	0.0008	0.9213
Pitch=0.5172", IMD=060%	0.9343	0.0007	0.9357
Pitch=0.5172", IMD=070%	0.9401	0.0007	0.9415
Pitch=0.5172", IMD=080%	0.9412	0.0007	0.9426
Pitch=0.5172", IMD=090%	0.9343	0.0007	0.9357
CE 16x16 Class Fuel Assembly			
Pitch=0.3820", IMD=080%	0.6889	0.0008	0.6905
Pitch=0.4000", IMD=080%	0.7389	0.0008	0.7405
Pitch=0.4250", IMD=080%	0.7971	0.0009	0.7989
Pitch=0.4500", IMD=080%	0.8476	0.0007	0.8490
Pitch=0.4750", IMD=080%	0.8938	0.0008	0.8954
Pitch=0.5060", IMD=080%	0.9338	0.0007	0.9352
Pitch=0.5200", IMD=050%	0.9278	0.0007	0.9292
Pitch=0.5200", IMD=060%	0.9397	0.0009	0.9415
Pitch=0.5200", IMD=070%	0.9455	0.0008	0.9471
Pitch=0.5200", IMD=080%	0.9431	0.0007	0.9445
Pitch=0.5200", IMD=090%	0.9382	0.0007	0.9396

Table U.6-29
Rod Pitch Study Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Pitch=0.5450", IMD=050%	0.9405	0.0007	0.9419
Pitch=0.5450", IMD=060%	0.9501	0.0008	0.9517
Pitch=0.5450", IMD=070%	**0.9537**	**0.0007**	**0.9551**
Pitch=0.5450", IMD=080%	0.9470	0.0007	0.9484
Pitch=0.5450", IMD=090%	0.9399	0.0007	0.9413
Pitch=0.5511", IMD=050%	0.9406	0.0008	0.9422
Pitch=0.5511", IMD=060%	0.9517	0.0007	0.9531
Pitch=0.5511", IMD=070%	0.9509	0.0007	0.9523
Pitch=0.5511", IMD=080%	0.9448	0.0006	0.9460
Pitch=0.5511", IMD=090%	0.9358	0.0006	0.9370
B&W 15x15 Class Fuel Assembly, Minimum Compartment ID			
Pitch=0.4300", IMD=080%	0.6951	0.0008	0.6967
Pitch=0.4500", IMD=080%	0.7490	0.0008	0.7506
Pitch=0.4750", IMD=080%	0.8089	0.0008	0.8105
Pitch=0.5000", IMD=080%	0.8589	0.0008	0.8605
Pitch=0.5250", IMD=080%	0.9000	0.0007	0.9014
Pitch=0.5500", IMD=080%	0.9287	0.0007	0.9301
Pitch=0.5680", IMD=080%	0.9382	0.0007	0.9396
Pitch=0.5750", IMD=050%	0.9102	0.0008	0.9118
Pitch=0.5750", IMD=060%	0.9294	0.0007	0.9308
Pitch=0.5750", IMD=070%	0.9374	0.0007	0.9388
Pitch=0.5750", IMD=080%	0.9405	0.0007	0.9419
Pitch=0.5750", IMD=090%	0.9378	0.0007	0.9392
Pitch=0.5825", IMD=050%	0.9151	0.0006	0.9163
Pitch=0.5825", IMD=060%	0.9333	0.0007	0.9347
Pitch=0.5825", IMD=070%	0.9405	0.0006	0.9417
Pitch=0.5825", IMD=080%	**0.9415**	**0.0007**	**0.9429**
Pitch=0.5825", IMD=090%	0.9382	0.0006	0.9394
Pitch=0.5870", IMD=050%	0.9167	0.0007	0.9181
Pitch=0.5870", IMD=060%	0.9327	0.0007	0.9341
Pitch=0.5870", IMD=070%	0.9411	0.0007	0.9425
Pitch=0.5870", IMD=080%	0.9408	0.0006	0.9420
Pitch=0.5870", IMD=090%	0.9357	0.0007	0.9371

Table U.6-29
Rod Pitch Study Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
B&W 15x15 Class Fuel Assembly, Nominal Compartment ID			
Pitch=0.5825", IMD=060%	0.9333	0.0007	0.9347
Pitch=0.5825", IMD=070%	0.9410	0.0007	0.9424
Pitch=0.5825", IMD=080%	0.9402	0.0007	0.9416
Pitch=0.5825", IMD=090%	0.9366	0.0007	0.9380
Pitch=0.5900", IMD=060%	0.9343	0.0006	0.9355
Pitch=0.5900", IMD=070%	0.9397	0.0006	0.9409
Pitch=0.5900", IMD=080%	0.9403	0.0006	0.9415
Pitch=0.5900", IMD=090%	0.9339	0.0007	0.9353
CE 15x15 Class Fuel Assembly			
Pitch=0.4180", IMD=080%	0.6589	0.0007	0.6603
Pitch=0.4500", IMD=080%	0.7498	0.0008	0.7514
Pitch=0.4750", IMD=080%	0.8092	0.0008	0.8108
Pitch=0.5000", IMD=080%	0.8609	0.0008	0.8625
Pitch=0.5250", IMD=080%	0.9042	0.0007	0.9056
Pitch=0.5500", IMD=080%	0.9339	0.0007	0.9353
Pitch=0.5750", IMD=050%	0.9157	0.0007	0.9171
Pitch=0.5750", IMD=060%	0.9353	0.0007	0.9367
Pitch=0.5750", IMD=070%	0.9447	0.0007	0.9461
Pitch=0.5750", IMD=080%	0.9474	0.0006	0.9486
Pitch=0.5750", IMD=090%	0.9458	0.0007	0.9472
Pitch=0.5825", IMD=060%	0.9393	0.0008	0.9409
Pitch=0.5825", IMD=070%	0.9472	0.0007	0.9486
Pitch=0.5825", IMD=080%	**0.9496**	**0.0007**	**0.9510**
Pitch=0.5825", IMD=090%	0.9477	0.0007	0.9491
Pitch=0.5879", IMD=050%	0.9215	0.0008	0.9231
Pitch=0.5879", IMD=060%	0.9400	0.0008	0.9416
Pitch=0.5879", IMD=070%	0.9476	0.0006	0.9488
Pitch=0.5879", IMD=080%	0.9489	0.0007	0.9503
Pitch=0.5879", IMD=090%	0.9463	0.0007	0.9477

Table U.6-29
Rod Pitch Study Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Westinghouse 15x15 Class Fuel Assembly			
Pitch=0.4220", IMD=080%	0.6975	0.0008	0.6991
Pitch=0.4500", IMD=080%	0.7665	0.0008	0.7681
Pitch=0.4750", IMD=080%	0.8231	0.0008	0.8247
Pitch=0.5000", IMD=080%	0.8703	0.0007	0.8717
Pitch=0.5250", IMD=080%	0.9079	0.0008	0.9095
Pitch=0.5500", IMD=080%	0.9318	0.0008	0.9334
Pitch=0.5630", IMD=050%	0.9152	0.0008	0.9168
Pitch=0.5630", IMD=060%	0.9302	0.0007	0.9316
Pitch=0.5630", IMD=070%	0.9378	0.0007	0.9392
Pitch=0.5630", IMD=080%	0.9405	0.0007	0.9419
Pitch=0.5630", IMD=090%	0.9358	0.0007	0.9372
Pitch=0.5750", IMD=050%	0.9182	0.0007	0.9196
Pitch=0.5750", IMD=060%	0.9355	0.0006	0.9367
Pitch=0.5750", IMD=070%	0.9418	0.0007	0.9432
Pitch=0.5750", IMD=080%	0.9407	0.0007	0.9421
Pitch=0.5750", IMD=090%	0.9358	0.0006	0.9370
Pitch=0.5850", IMD=060%	0.9392	0.0006	0.9404
Pitch=0.5850", IMD=070%	**0.9440**	**0.0007**	**0.9454**
Pitch=0.5850", IMD=080%	0.9421	0.0007	0.9435
Pitch=0.5850", IMD=090%	0.9343	0.0007	0.9357
Pitch=0.5877", IMD=050%	0.9253	0.0006	0.9265
Pitch=0.5877", IMD=060%	0.9387	0.0007	0.9401
Pitch=0.5877", IMD=070%	0.9433	0.0007	0.9447
Pitch=0.5877", IMD=080%	0.9415	0.0007	0.9429
Pitch=0.5877", IMD=090%	0.9338	0.0007	0.9352
CE 14x14 Class Fuel Assembly			
Pitch=0.4400", IMD=080%	0.6989	0.0008	0.7005
Pitch=0.4750", IMD=080%	0.7771	0.0008	0.7787
Pitch=0.5000", IMD=080%	0.8274	0.0008	0.8290
Pitch=0.5250", IMD=080%	0.8675	0.0009	0.8693
Pitch=0.5500", IMD=080%	0.9060	0.0008	0.9076
Pitch=0.5800", IMD=080%	0.9382	0.0009	0.9400
Pitch=0.6000", IMD=080%	0.9482	0.0007	0.9496

Table U.6-29
Rod Pitch Study Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Pitch=0.6250", IMD=050%	0.9457	0.0007	0.9471
Pitch=0.6250", IMD=060%	0.9562	0.0007	0.9576
Pitch=0.6250", IMD=070%	**0.9569**	**0.0008**	**0.9585**
Pitch=0.6250", IMD=080%	0.9509	0.0007	0.9523
Pitch=0.6250", IMD=090%	0.9408	0.0008	0.9424
Pitch=0.6315", IMD=050%	0.9478	0.0006	0.9490
Pitch=0.6315", IMD=060%	0.9565	0.0007	0.9579
Pitch=0.6315", IMD=070%	0.9564	0.0007	0.9578
Pitch=0.6315", IMD=080%	0.9505	0.0007	0.9519
Pitch=0.6315", IMD=090%	0.9385	0.0007	0.9399
Westinghouse 14x14 Class Fuel Assembly			
Pitch=0.4220", IMD=080%	0.6861	0.0008	0.6877
Pitch=0.4500", IMD=080%	0.7535	0.0009	0.7553
Pitch=0.4800", IMD=080%	0.8149	0.0009	0.8167
Pitch=0.5100", IMD=080%	0.8678	0.0008	0.8694
Pitch=0.5400", IMD=080%	0.9118	0.0008	0.9134
Pitch=0.5560", IMD=080%	0.9321	0.0008	0.9337
Pitch=0.5800", IMD=080%	0.9555	0.0008	0.9571
Pitch=0.6100", IMD=050%	0.9593	0.0008	0.9609
Pitch=0.6100", IMD=060%	0.9704	0.0009	0.9722
Pitch=0.6100", IMD=070%	**0.9727**	**0.0008**	**0.9743**
Pitch=0.6100", IMD=080%	0.9674	0.0006	0.9686
Pitch=0.6100", IMD=090%	0.9567	0.0007	0.9581
Pitch=0.6329", IMD=050%	0.9648	0.0007	0.9662
Pitch=0.6329", IMD=060%	0.9725	0.0007	0.9739
Pitch=0.6329", IMD=070%	0.9702	0.0007	0.9716
Pitch=0.6329", IMD=080%	0.9627	0.0007	0.9641
Pitch=0.6329", IMD=090%	0.9501	0.0007	0.9515

Table U.6-30
Single Ended Rod Shear Study Results

Model Description	k_{KENO}	Iσ	k_{eff}
Westinghouse 17x17 Class Fuel Assembly			
Nominal Pitch, IMD=080%	0.9387	0.0007	0.9401
D=0.000 cm, IMD=080%	0.9391	0.0008	0.9407
D=0.150 cm, IMD=080%	0.9394	0.0007	0.9408
D=0.300 cm, IMD=080%	0.9394	0.0007	0.9408
D=0.450 cm, IMD=080%	**0.9401**	**0.0007**	**0.9415**
D=0.554 cm, IMD=080%	0.9390	0.0008	0.9406
CE 16x16 Class Fuel Assembly			
Nominal Pitch, IMD=080%	0.9338	0.0007	0.9352
D=0.000 cm, IMD=080%	0.9339	0.0008	0.9355
D=0.300 cm, IMD=080%	0.9364	0.0007	0.9378
D=0.600 cm, IMD=080%	**0.9377**	**0.0007**	**0.9391**
D=0.900 cm, IMD=080%	0.9370	0.0007	0.9384
D=1.200 cm, IMD=080%	0.9374	0.0008	0.9390
D=1.407 cm, IMD=080%	0.9348	0.0007	0.9362
B&W 15x15 Class Fuel Assembly			
Nominal Pitch, IMD=080%	0.9382	0.0007	0.9396
D=0.000 cm, IMD=080%	0.9382	0.0008	0.9398
D=0.100 cm, IMD=080%	**0.9409**	**0.0008**	**0.9425**
D=0.200 cm, IMD=080%	0.9401	0.0007	0.9415
D=0.300 cm, IMD=080%	0.9399	0.0007	0.9413
D=0.330 cm, IMD=080%	0.9399	0.0007	0.9413
CE 15x15 Class Fuel Assembly			
Nominal Pitch, IMD=080%	0.9339	0.0007	0.9353
D=0.000 cm, IMD=080%	0.9352	0.0008	0.9368
D=0.250 cm, IMD=080%	0.9360	0.0007	0.9374
D=0.500 cm, IMD=080%	**0.9364**	**0.0008**	**0.9380**
D=0.750 cm, IMD=080%	0.9354	0.0008	0.9370
D=1.016 cm, IMD=080%	0.9351	0.0007	0.9365

Table U.6-30
Single Ended Rod Shear Study Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Westinghouse 15x15 Class Fuel Assembly			
Nominal Pitch, IMD=080%	0.9405	0.0007	0.9419
D=0.000 cm, IMD=080%	0.9407	0.0007	0.9421
D=0.150 cm, IMD=080%	0.9409	0.0007	0.9423
D=0.300 cm, IMD=080%	0.9413	0.0007	0.9427
D=0.450 cm, IMD=080%	0.9398	0.0007	0.9412
D=0.521 cm, IMD=080%	**0.9427**	**0.0007**	**0.9441**
CE 14x14 Class Fuel Assembly			
Nominal Pitch, IMD=080%	0.9382	0.0009	0.9400
D=0.000 cm, IMD=080%	0.9398	0.0007	0.9412
D=0.300 cm, IMD=080%	0.9395	0.0009	0.9413
D=0.600 cm, IMD=080%	**0.9420**	**0.0008**	**0.9436**
D=0.900 cm, IMD=080%	0.9419	0.0007	0.9433
D=1.200 cm, IMD=080%	0.9405	0.0008	0.9421
D=1.346 cm, IMD=080%	0.9392	0.0007	0.9406
Westinghouse 14x14 Class Fuel Assembly			
Nominal Pitch, IMD=080%	0.9321	0.0008	0.9337
D=0.000 cm, IMD=080%	0.9338	0.0007	0.9352
D=0.400 cm, IMD=080%	0.9359	0.0007	0.9373
D=0.800 cm, IMD=080%	0.9384	0.0008	0.9400
D=1.200 cm, IMD=080%	**0.9391**	**0.0007**	**0.9405**
D=1.600 cm, IMD=080%	0.9376	0.0008	0.9392
D=2.000 cm, IMD=080%	0.9365	0.0008	0.9381
D=2.199 cm, IMD=080%	0.9333	0.0007	0.9347

Table U.6-31
Double Ended Rod Shear Study Results

Model Description	k_{KENO}	1σ	k_{eff}
Westinghouse 17x17 Class Fuel Assembly			
IMD=060%	0.9259	0.0009	0.9277
IMD=070%	0.9366	0.0007	0.9380
IMD=080%	**0.9405**	**0.0008**	**0.9421**
IMD=090%	0.9398	0.0007	0.9412
CE 16x16 Class Fuel Assembly			
IMD=060%	0.9372	0.0007	0.9386
IMD=070%	**0.9457**	**0.0008**	**0.9473**
IMD=080%	0.9449	0.0008	0.9465
IMD=090%	0.9413	0.0009	0.9431
B&W 15x15 Class Fuel Assembly			
IMD=060%	0.9271	0.0008	0.9287
IMD=070%	0.9372	0.0008	0.9388
IMD=080%	**0.9414**	**0.0008**	**0.9430**
IMD=090%	0.9398	0.0007	0.9412
CE 15x15 Class Fuel Assembly			
IMD=060%	0.9221	0.0007	0.9235
IMD=070%	0.9357	0.0009	0.9375
IMD=080%	0.9449	0.0007	0.9463
IMD=090%	**0.9472**	**0.0007**	**0.9486**
Westinghouse 15x15 Class Fuel Assembly			
IMD=060%	0.9313	0.0008	0.9329
IMD=070%	0.9404	0.0007	0.9418
IMD=080%	**0.9453**	**0.0007**	**0.9467**
IMD=090%	0.9407	0.0008	0.9423
CE 14x14 Class Fuel Assembly			
IMD=060%	0.9435	0.0008	0.9451
IMD=070%	0.9515	0.0008	0.9531
IMD=080%	**0.9514**	**0.0009**	**0.9532**
IMD=090%	0.9487	0.0008	0.9503
Westinghouse 14x14 Class Fuel Assembly			
IMD=060%	0.9453	0.0008	0.9469
IMD=070%	0.9534	0.0008	0.9550
IMD=080%	**0.9562**	**0.0009**	**0.9580**
IMD=090%	0.9520	0.0008	0.9536

Table U.6-32
Shifting of Fuel Beyond Poison - Results

Model Description	k_{KENO}	1σ	k_{eff}
Westinghouse 17x17 Class Fuel Assembly			
IMD=060%	0.9188	0.0007	0.9202
IMD=070%	0.9294	0.0008	0.9310
IMD=080%	**0.9328**	**0.0007**	**0.9342**
IMD=090%	0.9324	0.0008	0.9340
CE 16x16 Class Fuel Assembly			
IMD=060%	0.9323	0.0008	0.9339
IMD=070%	**0.9375**	**0.0007**	**0.9389**
IMD=080%	0.9355	0.0007	0.9369
IMD=090%	0.9288	0.0007	0.9302
B&W 15x15 Class Fuel Assembly			
IMD=060%	0.9308	0.0008	0.9324
IMD=070%	0.9399	0.0007	0.9413
IMD=080%	**0.9417**	**0.0007**	**0.9431**
IMD=090%	0.9382	0.0007	0.9396
CE 15x15 Class Fuel Assembly			
IMD=060%	0.9211	0.0008	0.9227
IMD=070%	0.9325	0.0007	0.9339
IMD=080%	**0.9374**	**0.0007**	**0.9388**
IMD=090%	0.9364	0.0006	0.9376
Westinghouse 15x15 Class Fuel Assembly			
IMD=060%	0.9254	0.0007	0.9268
IMD=070%	0.9343	0.0007	0.9357
IMD=080%	**0.9358**	**0.0007**	**0.9372**
IMD=090%	0.9323	0.0007	0.9337
CE 14x14 Class Fuel Assembly			
IMD=060%	0.9379	0.0007	0.9393
IMD=070%	**0.9401**	**0.0008**	**0.9417**
IMD=080%	0.9399	0.0007	0.9413
IMD=090%	0.9323	0.0007	0.9337
Westinghouse 14x14 Class Fuel Assembly			
IMD=060%	0.9311	0.0007	0.9325
IMD=070%	**0.9356**	**0.0007**	**0.9370**
IMD=080%	0.9334	0.0007	0.9348
IMD=090%	0.9298	0.0008	0.9314

Table U.6-33
Most Reactive Damaged Configuration

Model Description	k_{KENO}	1σ	k_{eff}
Westinghouse 17x17 Class Fuel Assembly			
Optimum Pitch	0.9427	0.0008	0.9443
Single Shear	0.9401	0.0007	0.9415
Double Shear	0.9405	0.0008	0.9421
4"Shift	0.9328	0.0007	0.9342
CE 16x16 Class Fuel Assembly			
Optimum Pitch	0.9537	0.0007	0.9551
Single Shear	0.9377	0.0007	0.9391
Double Shear	0.9457	0.0008	0.9473
4"Shift	0.9375	0.0007	0.9389
B&W 15x15 Class Fuel Assembly			
Optimum Pitch	0.9415	0.0007	0.9429
Single Shear	0.9409	0.0008	0.9425
Double Shear	0.9414	0.0008	0.9430
4"Shift	0.9417	0.0007	0.9431
CE 15x15 Class Fuel Assembly			
Optimum Pitch	0.9496	0.0007	0.9510
Single Shear	0.9364	0.0008	0.9380
Double Shear	0.9472	0.0007	0.9486
4"Shift	0.9374	0.0007	0.9388
Westinghouse 15x15 Class Fuel Assembly			
Optimum Pitch	0.9440	0.0007	0.9454
Single Shear	0.9427	0.0007	0.9441
Double Shear	0.9453	0.0007	0.9467
4"Shift	0.9358	0.0007	0.9372
CE 14x14 Class Fuel Assembly			
Optimum Pitch	0.9569	0.0008	0.9585
Single Shear	0.9420	0.0008	0.9436
Double Shear	0.9514	0.0009	0.9532
4"Shift	0.9401	0.0008	0.9417
Westinghouse 14x14 Class Fuel Assembly			
Optimum Pitch	0.9727	0.0008	0.9743
Single Shear	0.9391	0.0007	0.9405
Double Shear	0.9562	0.0009	0.9580
4"Shift	0.9356	0.0007	0.9370

Table U.6-33
Most Reactive Damaged Configuration

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
CE 14x14 Class Fuel Assembly, Guide Tubes			
Zircalloy tube	0.9575	0.0008	0.9591
Water tube	0.9567	0.0008	0.9583
CE 14x14 Class Fuel Assembly, Guide Cuboids			
Zircalloy tube	0.9585	0.0008	0.9601
Water tube	0.9569	0.0008	0.9585
CE 16x16 Class Fuel Assembly, Guide Cuboids			
Zircalloy tube	0.9412	0.0007	0.9426
Water tube	0.9378	0.0007	0.9392

Table U.6-34
WE 17x17 Class Damaged Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9338	0.0007	0.9352
Internal Moderator Density = 070 %	0.9374	0.0007	0.9388
Internal Moderator Density = 080 %	0.9373	0.0007	0.9387
Internal Moderator Density = 090 %	0.9310	0.0007	0.9324
Internal Moderator Density = 100 %	0.9213	0.0006	0.9225
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9225	0.0008	0.9241
Internal Moderator Density = 070 %	0.9323	0.0006	0.9335
Internal Moderator Density = 080 %	0.9354	0.0007	0.9368
Internal Moderator Density = 090 %	0.9338	0.0008	0.9354
Internal Moderator Density = 100 %	0.9264	0.0006	0.9276
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9178	0.0007	0.9192
Internal Moderator Density = 070 %	0.9285	0.0007	0.9299
Internal Moderator Density = 080 %	0.9330	0.0006	0.9342
Internal Moderator Density = 090 %	0.9307	0.0007	0.9321
Internal Moderator Density = 100 %	0.9266	0.0006	0.9278
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9124	0.0007	0.9138
Internal Moderator Density = 070 %	0.9272	0.0008	0.9288
Internal Moderator Density = 080 %	0.9334	0.0007	0.9348
Internal Moderator Density = 090 %	0.9339	0.0007	0.9353
Internal Moderator Density = 100 %	0.9316	0.0006	0.9328
Enrichment = 4.25 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9030	0.0008	0.9046
Internal Moderator Density = 070 %	0.9203	0.0008	0.9219
Internal Moderator Density = 080 %	0.9304	0.0008	0.9320
Internal Moderator Density = 090 %	0.9326	0.0007	0.9340
Internal Moderator Density = 100 %	0.9328	0.0007	0.9342

Table U.6-34
WE 17x17 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9332	0.0007	0.9346
Internal Moderator Density = 070 %	0.9339	0.0006	0.9351
Internal Moderator Density = 080 %	0.9317	0.0006	0.9329
Internal Moderator Density = 090 %	0.9240	0.0007	0.9254
Internal Moderator Density = 100 %	0.9126	0.0007	0.9140
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9247	0.0007	0.9261
Internal Moderator Density = 070 %	0.9321	0.0007	0.9335
Internal Moderator Density = 080 %	0.9334	0.0007	0.9348
Internal Moderator Density = 090 %	0.9283	0.0007	0.9297
Internal Moderator Density = 100 %	0.9216	0.0007	0.9230
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9225	0.0007	0.9239
Internal Moderator Density = 070 %	0.9318	0.0007	0.9332
Internal Moderator Density = 080 %	0.9328	0.0007	0.9342
Internal Moderator Density = 090 %	0.9315	0.0008	0.9331
Internal Moderator Density = 100 %	0.9250	0.0007	0.9264
Enrichment = 4.35 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9169	0.0008	0.9185
Internal Moderator Density = 070 %	0.9280	0.0007	0.9294
Internal Moderator Density = 080 %	0.9340	0.0008	0.9356
Internal Moderator Density = 090 %	0.9321	0.0006	0.9333
Internal Moderator Density = 100 %	0.9279	0.0007	0.9293
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9136	0.0007	0.9150
Internal Moderator Density = 070 %	0.9289	0.0007	0.9303
Internal Moderator Density = 080 %	0.9365	0.0007	0.9379
Internal Moderator Density = 090 %	0.9364	0.0007	0.9378
Internal Moderator Density = 100 %	0.9341	0.0008	0.9357

Table U.6-34
WE 17x17 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9358	0.0007	0.9372
Internal Moderator Density = 070 %	0.9369	0.0007	0.9383
Internal Moderator Density = 080 %	0.9323	0.0006	0.9335
Internal Moderator Density = 090 %	0.9244	0.0007	0.9258
Internal Moderator Density = 100 %	0.9135	0.0006	0.9147
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9278	0.0006	0.9290
Internal Moderator Density = 070 %	0.9344	0.0007	0.9358
Internal Moderator Density = 080 %	0.9328	0.0007	0.9342
Internal Moderator Density = 090 %	0.9280	0.0006	0.9292
Internal Moderator Density = 100 %	0.9201	0.0006	0.9213
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9255	0.0007	0.9269
Internal Moderator Density = 070 %	0.9315	0.0007	0.9329
Internal Moderator Density = 080 %	0.9342	0.0007	0.9356
Internal Moderator Density = 090 %	0.9301	0.0007	0.9315
Internal Moderator Density = 100 %	0.9232	0.0006	0.9244
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9187	0.0007	0.9201
Internal Moderator Density = 070 %	0.9305	0.0007	0.9319
Internal Moderator Density = 080 %	0.9334	0.0006	0.9346
Internal Moderator Density = 090 %	0.9326	0.0007	0.9340
Internal Moderator Density = 100 %	0.9264	0.0007	0.9278
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9139	0.0007	0.9153
Internal Moderator Density = 070 %	0.9280	0.0008	0.9296
Internal Moderator Density = 080 %	0.9344	0.0007	0.9358
Internal Moderator Density = 090 %	0.9360	0.0008	0.9376
Internal Moderator Density = 100 %	0.9329	0.0006	0.9341

Table U.6-34
WE 17x17 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9328	0.0007	0.9342
Internal Moderator Density = 070 %	0.9354	0.0007	0.9368
Internal Moderator Density = 080 %	0.9299	0.0006	0.9311
Internal Moderator Density = 090 %	0.9206	0.0007	0.9220
Internal Moderator Density = 100 %	0.9085	0.0007	0.9099
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9294	0.0007	0.9308
Internal Moderator Density = 070 %	0.9359	0.0007	0.9373
Internal Moderator Density = 080 %	0.9341	0.0007	0.9355
Internal Moderator Density = 090 %	0.9295	0.0007	0.9309
Internal Moderator Density = 100 %	0.9198	0.0007	0.9212
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9263	0.0007	0.9277
Internal Moderator Density = 070 %	0.9333	0.0006	0.9345
Internal Moderator Density = 080 %	0.9356	0.0006	0.9368
Internal Moderator Density = 090 %	0.9314	0.0007	0.9328
Internal Moderator Density = 100 %	0.9225	0.0006	0.9237
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9206	0.0008	0.9222
Internal Moderator Density = 070 %	0.9298	0.0007	0.9312
Internal Moderator Density = 080 %	0.9330	0.0007	0.9344
Internal Moderator Density = 090 %	0.9318	0.0008	0.9334
Internal Moderator Density = 100 %	0.9262	0.0007	0.9276
Enrichment = 4.85 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9151	0.0009	0.9169
Internal Moderator Density = 070 %	0.9290	0.0007	0.9304
Internal Moderator Density = 080 %	0.9363	0.0007	0.9377
Internal Moderator Density = 090 %	0.9357	0.0007	0.9371
Internal Moderator Density = 100 %	0.9311	0.0007	0.9325

Table U.6-34
WE 17x17 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9356	0.0007	0.9370
Internal Moderator Density = 070 %	0.9358	0.0007	0.9372
Internal Moderator Density = 080 %	0.9302	0.0007	0.9316
Internal Moderator Density = 090 %	0.9193	0.0007	0.9207
Internal Moderator Density = 100 %	0.9057	0.0007	0.9071
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9303	0.0007	0.9317
Internal Moderator Density = 070 %	0.9344	0.0006	0.9356
Internal Moderator Density = 080 %	0.9317	0.0008	0.9333
Internal Moderator Density = 090 %	0.9250	0.0006	0.9262
Internal Moderator Density = 100 %	0.9161	0.0007	0.9175
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9318	0.0007	0.9332
Internal Moderator Density = 070 %	0.9362	0.0007	0.9376
Internal Moderator Density = 080 %	0.9363	0.0007	0.9377
Internal Moderator Density = 090 %	0.9295	0.0007	0.9309
Internal Moderator Density = 100 %	0.9205	0.0006	0.9217
Enrichment = 4.85 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9241	0.0007	0.9255
Internal Moderator Density = 070 %	0.9327	0.0008	0.9343
Internal Moderator Density = 080 %	0.9334	0.0007	0.9348
Internal Moderator Density = 090 %	0.9301	0.0006	0.9313
Internal Moderator Density = 100 %	0.9225	0.0008	0.9241
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9089	0.0007	0.9103
Internal Moderator Density = 070 %	0.9218	0.0007	0.9232
Internal Moderator Density = 080 %	0.9262	0.0007	0.9276
Internal Moderator Density = 090 %	0.9231	0.0007	0.9245
Internal Moderator Density = 100 %	0.9176	0.0008	0.9192

Table U.6-34
WE 17x17 Class Damaged Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.15 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9366	0.0006	0.9378
Internal Moderator Density = 070 %	0.9361	0.0007	0.9375
Internal Moderator Density = 080 %	0.9274	0.0007	0.9288
Internal Moderator Density = 090 %	0.9164	0.0007	0.9178
Internal Moderator Density = 100 %	0.9026	0.0006	0.9038
Enrichment = 4.55 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9317	0.0007	0.9331
Internal Moderator Density = 070 %	0.9336	0.0006	0.9348
Internal Moderator Density = 080 %	0.9309	0.0006	0.9321
Internal Moderator Density = 090 %	0.9220	0.0007	0.9234
Internal Moderator Density = 100 %	0.9115	0.0006	0.9127
Enrichment = 4.75 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9302	0.0007	0.9316
Internal Moderator Density = 070 %	0.9346	0.0007	0.9360
Internal Moderator Density = 080 %	0.9332	0.0006	0.9344
Internal Moderator Density = 090 %	0.9257	0.0007	0.9271
Internal Moderator Density = 100 %	0.9167	0.0006	0.9179
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9229	0.0007	0.9243
Internal Moderator Density = 070 %	0.9305	0.0007	0.9319
Internal Moderator Density = 080 %	0.9296	0.0006	0.9308
Internal Moderator Density = 090 %	0.9265	0.0007	0.9279
Internal Moderator Density = 100 %	0.9176	0.0007	0.9190
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9016	0.0007	0.9030
Internal Moderator Density = 070 %	0.9125	0.0008	0.9141
Internal Moderator Density = 080 %	0.9125	0.0007	0.9139
Internal Moderator Density = 090 %	0.9102	0.0007	0.9116
Internal Moderator Density = 100 %	0.9033	0.0008	0.9049

Table U.6-35
WE 17x17 Class Damaged Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.35 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9248	0.0006	0.9260
Internal Moderator Density = 070 %	0.9344	0.0007	0.9358
Internal Moderator Density = 080 %	0.9361	0.0007	0.9375
Internal Moderator Density = 090 %	0.9355	0.0006	0.9367
Internal Moderator Density = 100 %	0.9307	0.0007	0.9321
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9132	0.0006	0.9144
Internal Moderator Density = 070 %	0.9263	0.0006	0.9275
Internal Moderator Density = 080 %	0.9326	0.0007	0.9340
Internal Moderator Density = 090 %	0.9338	0.0007	0.9352
Internal Moderator Density = 100 %	0.9321	0.0007	0.9335
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9057	0.0007	0.9071
Internal Moderator Density = 070 %	0.9210	0.0007	0.9224
Internal Moderator Density = 080 %	0.9282	0.0007	0.9296
Internal Moderator Density = 090 %	0.9323	0.0007	0.9337
Internal Moderator Density = 100 %	0.9310	0.0006	0.9322
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9015	0.0008	0.9031
Internal Moderator Density = 070 %	0.9192	0.0007	0.9206
Internal Moderator Density = 080 %	0.9293	0.0007	0.9307
Internal Moderator Density = 090 %	0.9355	0.0007	0.9369
Internal Moderator Density = 100 %	0.9360	0.0006	0.9372
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8898	0.0008	0.8914
Internal Moderator Density = 070 %	0.9105	0.0009	0.9123
Internal Moderator Density = 080 %	0.9243	0.0007	0.9257
Internal Moderator Density = 090 %	0.9336	0.0006	0.9348
Internal Moderator Density = 100 %	0.9360	0.0007	0.9374

Table U.6-35
WE 17x17 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.55 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9255	0.0007	0.9269
Internal Moderator Density = 070 %	0.9330	0.0007	0.9344
Internal Moderator Density = 080 %	0.9332	0.0007	0.9346
Internal Moderator Density = 090 %	0.9304	0.0006	0.9316
Internal Moderator Density = 100 %	0.9231	0.0007	0.9245
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9178	0.0007	0.9192
Internal Moderator Density = 070 %	0.9294	0.0007	0.9308
Internal Moderator Density = 080 %	0.9340	0.0007	0.9354
Internal Moderator Density = 090 %	0.9326	0.0007	0.9340
Internal Moderator Density = 100 %	0.9289	0.0006	0.9301
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9143	0.0007	0.9157
Internal Moderator Density = 070 %	0.9287	0.0006	0.9299
Internal Moderator Density = 080 %	0.9328	0.0006	0.9340
Internal Moderator Density = 090 %	0.9336	0.0007	0.9350
Internal Moderator Density = 100 %	0.9309	0.0006	0.9321
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9061	0.0007	0.9075
Internal Moderator Density = 070 %	0.9225	0.0008	0.9241
Internal Moderator Density = 080 %	0.9319	0.0007	0.9333
Internal Moderator Density = 090 %	0.9355	0.0007	0.9369
Internal Moderator Density = 100 %	0.9347	0.0007	0.9361
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8988	0.0007	0.9002
Internal Moderator Density = 070 %	0.9181	0.0007	0.9195
Internal Moderator Density = 080 %	0.9310	0.0007	0.9324
Internal Moderator Density = 090 %	0.9354	0.0007	0.9368
Internal Moderator Density = 100 %	0.9355	0.0007	0.9369

Table U.6-35
WE 17x17 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9295	0.0007	0.9309
Internal Moderator Density = 070 %	0.9349	0.0007	0.9363
Internal Moderator Density = 080 %	0.9361	0.0007	0.9375
Internal Moderator Density = 090 %	0.9322	0.0006	0.9334
Internal Moderator Density = 100 %	0.9233	0.0006	0.9245
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9191	0.0007	0.9205
Internal Moderator Density = 070 %	0.9305	0.0007	0.9319
Internal Moderator Density = 080 %	0.9352	0.0006	0.9364
Internal Moderator Density = 090 %	0.9342	0.0007	0.9356
Internal Moderator Density = 100 %	0.9276	0.0007	0.9290
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9160	0.0006	0.9172
Internal Moderator Density = 070 %	0.9291	0.0007	0.9305
Internal Moderator Density = 080 %	0.9339	0.0007	0.9353
Internal Moderator Density = 090 %	0.9341	0.0007	0.9355
Internal Moderator Density = 100 %	0.9311	0.0006	0.9323
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9080	0.0007	0.9094
Internal Moderator Density = 070 %	0.9226	0.0007	0.9240
Internal Moderator Density = 080 %	0.9323	0.0007	0.9337
Internal Moderator Density = 090 %	0.9362	0.0007	0.9376
Internal Moderator Density = 100 %	0.9348	0.0006	0.9360
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9031	0.0007	0.9045
Internal Moderator Density = 070 %	0.9229	0.0008	0.9245
Internal Moderator Density = 080 %	0.9326	0.0007	0.9340
Internal Moderator Density = 090 %	0.9367	0.0007	0.9381
Internal Moderator Density = 100 %	**0.9379**	**0.0007**	**0.9393**

Table U.6-35
WE 17x17 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9286	0.0008	0.9302
Internal Moderator Density = 070 %	0.9334	0.0007	0.9348
Internal Moderator Density = 080 %	0.9316	0.0007	0.9330
Internal Moderator Density = 090 %	0.9275	0.0006	0.9287
Internal Moderator Density = 100 %	0.9205	0.0007	0.9219
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9236	0.0007	0.9250
Internal Moderator Density = 070 %	0.9317	0.0007	0.9331
Internal Moderator Density = 080 %	0.9360	0.0006	0.9372
Internal Moderator Density = 090 %	0.9327	0.0007	0.9341
Internal Moderator Density = 100 %	0.9293	0.0007	0.9307
Enrichment = 4.25 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9187	0.0007	0.9201
Internal Moderator Density = 070 %	0.9302	0.0007	0.9316
Internal Moderator Density = 080 %	0.9337	0.0008	0.9353
Internal Moderator Density = 090 %	0.9356	0.0006	0.9368
Internal Moderator Density = 100 %	0.9321	0.0007	0.9335
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9115	0.0008	0.9131
Internal Moderator Density = 070 %	0.9240	0.0008	0.9256
Internal Moderator Density = 080 %	0.9334	0.0007	0.9348
Internal Moderator Density = 090 %	0.9352	0.0007	0.9366
Internal Moderator Density = 100 %	0.9334	0.0007	0.9348
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9025	0.0007	0.9039
Internal Moderator Density = 070 %	0.9204	0.0007	0.9218
Internal Moderator Density = 080 %	0.9298	0.0007	0.9312
Internal Moderator Density = 090 %	0.9350	0.0006	0.9362
Internal Moderator Density = 100 %	0.9341	0.0007	0.9355

Table U.6-35
WE 17x17 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9328	0.0007	0.9342
Internal Moderator Density = 070 %	0.9369	0.0006	0.9381
Internal Moderator Density = 080 %	0.9336	0.0007	0.9350
Internal Moderator Density = 090 %	0.9285	0.0007	0.9299
Internal Moderator Density = 100 %	0.9191	0.0006	0.9203
Enrichment = 4.35 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9264	0.0006	0.9276
Internal Moderator Density = 070 %	0.9343	0.0006	0.9355
Internal Moderator Density = 080 %	0.9361	0.0007	0.9375
Internal Moderator Density = 090 %	0.9323	0.0008	0.9339
Internal Moderator Density = 100 %	0.9265	0.0006	0.9277
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9241	0.0007	0.9255
Internal Moderator Density = 070 %	0.9344	0.0007	0.9358
Internal Moderator Density = 080 %	0.9376	0.0007	0.9390
Internal Moderator Density = 090 %	0.9365	0.0007	0.9379
Internal Moderator Density = 100 %	0.9303	0.0007	0.9317
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9154	0.0007	0.9168
Internal Moderator Density = 070 %	0.9279	0.0006	0.9291
Internal Moderator Density = 080 %	0.9353	0.0006	0.9365
Internal Moderator Density = 090 %	0.9346	0.0007	0.9360
Internal Moderator Density = 100 %	0.9313	0.0007	0.9327
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9035	0.0007	0.9049
Internal Moderator Density = 070 %	0.9181	0.0007	0.9195
Internal Moderator Density = 080 %	0.9278	0.0007	0.9292
Internal Moderator Density = 090 %	0.9307	0.0007	0.9321
Internal Moderator Density = 100 %	0.9286	0.0007	0.9300

Table U.6-35
WE 17x17 Class Damaged Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.10 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9332	0.0007	0.9346
Internal Moderator Density = 070 %	0.9377	0.0006	0.9389
Internal Moderator Density = 080 %	0.9335	0.0007	0.9349
Internal Moderator Density = 090 %	0.9271	0.0007	0.9285
Internal Moderator Density = 100 %	0.9167	0.0006	0.9179
Enrichment = 4.50 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9271	0.0008	0.9287
Internal Moderator Density = 070 %	0.9336	0.0008	0.9352
Internal Moderator Density = 080 %	0.9346	0.0007	0.9360
Internal Moderator Density = 090 %	0.9304	0.0006	0.9316
Internal Moderator Density = 100 %	0.9227	0.0007	0.9241
Enrichment = 4.70 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9252	0.0007	0.9266
Internal Moderator Density = 070 %	0.9354	0.0007	0.9368
Internal Moderator Density = 080 %	0.9353	0.0007	0.9367
Internal Moderator Density = 090 %	0.9343	0.0007	0.9357
Internal Moderator Density = 100 %	0.9277	0.0006	0.9289
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9190	0.0006	0.9202
Internal Moderator Density = 070 %	0.9296	0.0008	0.9312
Internal Moderator Density = 080 %	0.9356	0.0007	0.9370
Internal Moderator Density = 090 %	0.9347	0.0007	0.9361
Internal Moderator Density = 100 %	0.9314	0.0007	0.9328
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8954	0.0007	0.8968
Internal Moderator Density = 070 %	0.9107	0.0007	0.9121
Internal Moderator Density = 080 %	0.9171	0.0007	0.9185
Internal Moderator Density = 090 %	0.9188	0.0008	0.9204
Internal Moderator Density = 100 %	0.9158	0.0007	0.9172

Table U.6-36
CE 16x16 Class Damaged Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9289	0.0007	0.9303
Internal Moderator Density = 060 %	0.9369	0.0007	0.9383
Internal Moderator Density = 070 %	0.9347	0.0007	0.9361
Internal Moderator Density = 080 %	0.9298	0.0007	0.9312
Internal Moderator Density = 090 %	0.9176	0.0006	0.9188
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9334	0.0007	0.9348
Internal Moderator Density = 070 %	0.9363	0.0007	0.9377
Internal Moderator Density = 080 %	0.9329	0.0007	0.9343
Internal Moderator Density = 090 %	0.9280	0.0007	0.9294
Internal Moderator Density = 100 %	0.9159	0.0007	0.9173
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9313	0.0008	0.9329
Internal Moderator Density = 070 %	0.9365	0.0007	0.9379
Internal Moderator Density = 080 %	0.9338	0.0007	0.9352
Internal Moderator Density = 090 %	0.9286	0.0007	0.9300
Internal Moderator Density = 100 %	0.9189	0.0007	0.9203
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9278	0.0007	0.9292
Internal Moderator Density = 070 %	0.9357	0.0007	0.9371
Internal Moderator Density = 080 %	0.9378	0.0007	0.9392
Internal Moderator Density = 090 %	0.9338	0.0007	0.9352
Internal Moderator Density = 100 %	0.9275	0.0007	0.9289
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9213	0.0007	0.9227
Internal Moderator Density = 070 %	0.9307	0.0007	0.9321
Internal Moderator Density = 080 %	0.9376	0.0007	0.9390
Internal Moderator Density = 090 %	0.9354	0.0008	0.9370
Internal Moderator Density = 100 %	0.9289	0.0007	0.9303

Table U.6-36
CE 16x16 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9325	0.0007	0.9339
Internal Moderator Density = 060 %	0.9369	0.0006	0.9381
Internal Moderator Density = 070 %	0.9328	0.0007	0.9342
Internal Moderator Density = 080 %	0.9238	0.0008	0.9254
Internal Moderator Density = 090 %	0.9116	0.0007	0.9130
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9323	0.0006	0.9335
Internal Moderator Density = 070 %	0.9329	0.0007	0.9343
Internal Moderator Density = 080 %	0.9284	0.0008	0.9300
Internal Moderator Density = 090 %	0.9198	0.0007	0.9212
Internal Moderator Density = 100 %	0.9068	0.0007	0.9082
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9308	0.0006	0.9320
Internal Moderator Density = 070 %	0.9343	0.0007	0.9357
Internal Moderator Density = 080 %	0.9315	0.0008	0.9331
Internal Moderator Density = 090 %	0.9240	0.0007	0.9254
Internal Moderator Density = 100 %	0.9119	0.0006	0.9131
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9292	0.0007	0.9306
Internal Moderator Density = 070 %	0.9345	0.0008	0.9361
Internal Moderator Density = 080 %	0.9340	0.0007	0.9354
Internal Moderator Density = 090 %	0.9284	0.0007	0.9298
Internal Moderator Density = 100 %	0.9190	0.0007	0.9204
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9184	0.0008	0.9200
Internal Moderator Density = 070 %	0.9269	0.0008	0.9285
Internal Moderator Density = 080 %	0.9278	0.0008	0.9294
Internal Moderator Density = 090 %	0.9236	0.0007	0.9250
Internal Moderator Density = 100 %	0.9169	0.0006	0.9181

Table U.6-36
CE 16x16 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9343	0.0007	0.9357
Internal Moderator Density = 060 %	0.9368	0.0007	0.9382
Internal Moderator Density = 070 %	0.9327	0.0006	0.9339
Internal Moderator Density = 080 %	0.9236	0.0006	0.9248
Internal Moderator Density = 090 %	0.9107	0.0006	0.9119
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9334	0.0007	0.9348
Internal Moderator Density = 070 %	0.9339	0.0006	0.9351
Internal Moderator Density = 080 %	0.9275	0.0007	0.9289
Internal Moderator Density = 090 %	0.9188	0.0007	0.9202
Internal Moderator Density = 100 %	0.9060	0.0006	0.9072
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9326	0.0007	0.9340
Internal Moderator Density = 070 %	0.9336	0.0007	0.9350
Internal Moderator Density = 080 %	0.9315	0.0006	0.9327
Internal Moderator Density = 090 %	0.9231	0.0008	0.9247
Internal Moderator Density = 100 %	0.9107	0.0007	0.9121
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9269	0.0007	0.9283
Internal Moderator Density = 070 %	0.9333	0.0007	0.9347
Internal Moderator Density = 080 %	0.9325	0.0007	0.9339
Internal Moderator Density = 090 %	0.9259	0.0007	0.9273
Internal Moderator Density = 100 %	0.9162	0.0007	0.9176
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9127	0.0007	0.9141
Internal Moderator Density = 070 %	0.9198	0.0008	0.9214
Internal Moderator Density = 080 %	0.9203	0.0008	0.9219
Internal Moderator Density = 090 %	0.9164	0.0007	0.9178
Internal Moderator Density = 100 %	0.9088	0.0007	0.9102

Table U.6-36
CE 16x16 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9308	0.0007	0.9322
Internal Moderator Density = 060 %	0.9348	0.0006	0.9360
Internal Moderator Density = 070 %	0.9304	0.0006	0.9316
Internal Moderator Density = 080 %	0.9199	0.0007	0.9213
Internal Moderator Density = 090 %	0.9062	0.0006	0.9074
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9329	0.0008	0.9345
Internal Moderator Density = 070 %	0.9336	0.0008	0.9352
Internal Moderator Density = 080 %	0.9272	0.0007	0.9286
Internal Moderator Density = 090 %	0.9161	0.0006	0.9173
Internal Moderator Density = 100 %	0.9036	0.0007	0.9050
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9318	0.0007	0.9332
Internal Moderator Density = 070 %	0.9343	0.0008	0.9359
Internal Moderator Density = 080 %	0.9305	0.0007	0.9319
Internal Moderator Density = 090 %	0.9204	0.0008	0.9220
Internal Moderator Density = 100 %	0.9086	0.0007	0.9100
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9287	0.0007	0.9301
Internal Moderator Density = 070 %	0.9321	0.0008	0.9337
Internal Moderator Density = 080 %	0.9316	0.0007	0.9330
Internal Moderator Density = 090 %	0.9246	0.0007	0.9260
Internal Moderator Density = 100 %	0.9131	0.0007	0.9145
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9077	0.0007	0.9091
Internal Moderator Density = 070 %	0.9138	0.0007	0.9152
Internal Moderator Density = 080 %	0.9138	0.0008	0.9154
Internal Moderator Density = 090 %	0.9093	0.0007	0.9107
Internal Moderator Density = 100 %	0.9003	0.0008	0.9019

Table U.6-36
CE 16x16 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9359	0.0007	0.9373
Internal Moderator Density = 060 %	0.9357	0.0007	0.9371
Internal Moderator Density = 070 %	0.9290	0.0007	0.9304
Internal Moderator Density = 080 %	0.9172	0.0007	0.9186
Internal Moderator Density = 090 %	0.9015	0.0006	0.9027
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 050 %	0.9308	0.0007	0.9322
Internal Moderator Density = 060 %	0.9350	0.0008	0.9366
Internal Moderator Density = 070 %	0.9328	0.0009	0.9346
Internal Moderator Density = 080 %	0.9267	0.0007	0.9281
Internal Moderator Density = 090 %	0.9149	0.0007	0.9163
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 050 %	0.9263	0.0006	0.9275
Internal Moderator Density = 060 %	0.9352	0.0007	0.9366
Internal Moderator Density = 070 %	0.9330	0.0007	0.9344
Internal Moderator Density = 080 %	0.9271	0.0007	0.9285
Internal Moderator Density = 090 %	0.9181	0.0007	0.9195

Table U.6-36
CE 16x16 Class Damaged Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.50 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 040 %	0.9278	0.0007	0.9292
Internal Moderator Density = 050 %	0.9384	0.0007	0.9398
Internal Moderator Density = 060 %	0.9379	0.0006	0.9391
Internal Moderator Density = 070 %	0.9310	0.0007	0.9324
Internal Moderator Density = 080 %	0.9182	0.0006	0.9194
Enrichment = 4.95 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 050 %	0.9307	0.0007	0.9321
Internal Moderator Density = 060 %	0.9352	0.0007	0.9366
Internal Moderator Density = 070 %	0.9308	0.0006	0.9320
Internal Moderator Density = 080 %	0.9203	0.0007	0.9217
Internal Moderator Density = 090 %	0.9095	0.0007	0.9109

Table U.6-37
CE 16x16 Class Damaged Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9255	0.0007	0.9269
Internal Moderator Density = 060 %	0.9353	0.0008	0.9369
Internal Moderator Density = 070 %	0.9380	0.0007	0.9394
Internal Moderator Density = 080 %	0.9347	0.0006	0.9359
Internal Moderator Density = 090 %	0.9261	0.0006	0.9273
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9274	0.0007	0.9288
Internal Moderator Density = 070 %	0.9354	0.0007	0.9368
Internal Moderator Density = 080 %	0.9353	0.0008	0.9369
Internal Moderator Density = 090 %	0.9303	0.0008	0.9319
Internal Moderator Density = 100 %	0.9220	0.0007	0.9234
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9245	0.0006	0.9257
Internal Moderator Density = 070 %	0.9334	0.0007	0.9348
Internal Moderator Density = 080 %	0.9358	0.0006	0.9370
Internal Moderator Density = 090 %	0.9312	0.0007	0.9326
Internal Moderator Density = 100 %	0.9245	0.0007	0.9259
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9218	0.0007	0.9232
Internal Moderator Density = 070 %	0.9337	0.0007	0.9351
Internal Moderator Density = 080 %	0.9383	0.0007	0.9397
Internal Moderator Density = 090 %	0.9364	0.0007	0.9378
Internal Moderator Density = 100 %	0.9322	0.0008	0.9338
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9155	0.0007	0.9169
Internal Moderator Density = 070 %	0.9293	0.0007	0.9307
Internal Moderator Density = 080 %	0.9380	0.0007	0.9394
Internal Moderator Density = 090 %	0.9384	0.0007	0.9398
Internal Moderator Density = 100 %	0.9353	0.0007	0.9367

Table U.6-37
CE 16x16 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9238	0.0007	0.9252
Internal Moderator Density = 060 %	0.9330	0.0008	0.9346
Internal Moderator Density = 070 %	0.9321	0.0006	0.9333
Internal Moderator Density = 080 %	0.9275	0.0007	0.9289
Internal Moderator Density = 090 %	0.9169	0.0007	0.9183
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9282	0.0007	0.9296
Internal Moderator Density = 070 %	0.9321	0.0006	0.9333
Internal Moderator Density = 080 %	0.9302	0.0008	0.9318
Internal Moderator Density = 090 %	0.9242	0.0007	0.9256
Internal Moderator Density = 100 %	0.9141	0.0007	0.9155
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9298	0.0008	0.9314
Internal Moderator Density = 070 %	0.9337	0.0007	0.9351
Internal Moderator Density = 080 %	0.9344	0.0007	0.9358
Internal Moderator Density = 090 %	0.9288	0.0007	0.9302
Internal Moderator Density = 100 %	0.9206	0.0007	0.9220
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9247	0.0007	0.9261
Internal Moderator Density = 070 %	0.9332	0.0008	0.9348
Internal Moderator Density = 080 %	0.9360	0.0007	0.9374
Internal Moderator Density = 090 %	0.9325	0.0008	0.9341
Internal Moderator Density = 100 %	0.9252	0.0008	0.9268
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9125	0.0007	0.9139
Internal Moderator Density = 070 %	0.9267	0.0008	0.9283
Internal Moderator Density = 080 %	0.9317	0.0007	0.9331
Internal Moderator Density = 090 %	0.9302	0.0007	0.9316
Internal Moderator Density = 100 %	0.9268	0.0008	0.9284

Table U.6-37
CE 16x16 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9281	0.0007	0.9295
Internal Moderator Density = 060 %	0.9346	0.0007	0.9360
Internal Moderator Density = 070 %	0.9329	0.0007	0.9343
Internal Moderator Density = 080 %	0.9270	0.0007	0.9284
Internal Moderator Density = 090 %	0.9158	0.0006	0.9170
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9298	0.0007	0.9312
Internal Moderator Density = 070 %	0.9331	0.0007	0.9345
Internal Moderator Density = 080 %	0.9314	0.0006	0.9326
Internal Moderator Density = 090 %	0.9231	0.0007	0.9245
Internal Moderator Density = 100 %	0.9138	0.0007	0.9152
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9288	0.0007	0.9302
Internal Moderator Density = 070 %	0.9355	0.0007	0.9369
Internal Moderator Density = 080 %	0.9327	0.0006	0.9339
Internal Moderator Density = 090 %	0.9273	0.0007	0.9287
Internal Moderator Density = 100 %	0.9185	0.0007	0.9199
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9247	0.0007	0.9261
Internal Moderator Density = 070 %	0.9343	0.0007	0.9357
Internal Moderator Density = 080 %	0.9347	0.0008	0.9363
Internal Moderator Density = 090 %	0.9322	0.0008	0.9338
Internal Moderator Density = 100 %	0.9247	0.0007	0.9261
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9079	0.0007	0.9093
Internal Moderator Density = 070 %	0.9193	0.0007	0.9207
Internal Moderator Density = 080 %	0.9236	0.0007	0.9250
Internal Moderator Density = 090 %	0.9217	0.0007	0.9231
Internal Moderator Density = 100 %	0.9157	0.0007	0.9171

Table U.6-37
CE 16x16 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9310	0.0007	0.9324
Internal Moderator Density = 060 %	0.9365	0.0008	0.9381
Internal Moderator Density = 070 %	0.9348	0.0007	0.9362
Internal Moderator Density = 080 %	0.9278	0.0006	0.9290
Internal Moderator Density = 090 %	0.9170	0.0007	0.9184
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9318	0.0006	0.9330
Internal Moderator Density = 070 %	0.9344	0.0007	0.9358
Internal Moderator Density = 080 %	0.9299	0.0007	0.9313
Internal Moderator Density = 090 %	0.9223	0.0006	0.9235
Internal Moderator Density = 100 %	0.9127	0.0007	0.9141
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9298	0.0006	0.9310
Internal Moderator Density = 070 %	0.9338	0.0009	0.9356
Internal Moderator Density = 080 %	0.9330	0.0007	0.9344
Internal Moderator Density = 090 %	0.9271	0.0007	0.9285
Internal Moderator Density = 100 %	0.9181	0.0006	0.9193
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9257	0.0007	0.9271
Internal Moderator Density = 070 %	0.9336	0.0007	0.9350
Internal Moderator Density = 080 %	0.9351	0.0007	0.9365
Internal Moderator Density = 090 %	0.9310	0.0007	0.9324
Internal Moderator Density = 100 %	0.9235	0.0008	0.9251
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9087	0.0008	0.9103
Internal Moderator Density = 070 %	0.9203	0.0008	0.9219
Internal Moderator Density = 080 %	0.9240	0.0008	0.9256
Internal Moderator Density = 090 %	0.9215	0.0007	0.9229
Internal Moderator Density = 100 %	0.9140	0.0007	0.9154

Table U.6-37
CE 16x16 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9304	0.0008	0.9320
Internal Moderator Density = 060 %	0.9343	0.0007	0.9357
Internal Moderator Density = 070 %	0.9311	0.0007	0.9325
Internal Moderator Density = 080 %	0.9221	0.0007	0.9235
Internal Moderator Density = 090 %	0.9088	0.0007	0.9102
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9341	0.0007	0.9355
Internal Moderator Density = 070 %	0.9358	0.0007	0.9372
Internal Moderator Density = 080 %	0.9308	0.0007	0.9322
Internal Moderator Density = 090 %	0.9202	0.0006	0.9214
Internal Moderator Density = 100 %	0.9080	0.0007	0.9094
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9337	0.0006	0.9349
Internal Moderator Density = 070 %	0.9363	0.0007	0.9377
Internal Moderator Density = 080 %	0.9324	0.0007	0.9338
Internal Moderator Density = 090 %	0.9245	0.0007	0.9259
Internal Moderator Density = 100 %	0.9131	0.0007	0.9145

Table U.6-37
CE 16x16 Class Damaged Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.40 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9365	0.0007	0.9379
Internal Moderator Density = 060 %	**0.9386**	**0.0006**	**0.9398**
Internal Moderator Density = 070 %	0.9328	0.0007	0.9342
Internal Moderator Density = 080 %	0.9233	0.0007	0.9247
Internal Moderator Density = 090 %	0.9093	0.0006	0.9105
Enrichment = 4.85 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9325	0.0006	0.9337
Internal Moderator Density = 070 %	0.9334	0.0007	0.9348
Internal Moderator Density = 080 %	0.9263	0.0007	0.9277
Internal Moderator Density = 090 %	0.9172	0.0006	0.9184
Internal Moderator Density = 100 %	0.9039	0.0006	0.9051

Table U.6-38
BW 15x15 Class Damaged Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9309	0.0007	0.9323
Internal Moderator Density = 070 %	0.9360	0.0007	0.9374
Internal Moderator Density = 080 %	0.9347	0.0007	0.9361
Internal Moderator Density = 090 %	0.9306	0.0007	0.9320
Internal Moderator Density = 100 %	0.9212	0.0006	0.9224
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9218	0.0007	0.9232
Internal Moderator Density = 070 %	0.9318	0.0006	0.9330
Internal Moderator Density = 080 %	0.9347	0.0006	0.9359
Internal Moderator Density = 090 %	0.9314	0.0006	0.9326
Internal Moderator Density = 100 %	0.9261	0.0006	0.9273
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9203	0.0008	0.9219
Internal Moderator Density = 070 %	0.9315	0.0008	0.9331
Internal Moderator Density = 080 %	0.9341	0.0007	0.9355
Internal Moderator Density = 090 %	0.9339	0.0006	0.9351
Internal Moderator Density = 100 %	0.9305	0.0006	0.9317
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9111	0.0006	0.9123
Internal Moderator Density = 070 %	0.9255	0.0007	0.9269
Internal Moderator Density = 080 %	0.9333	0.0007	0.9347
Internal Moderator Density = 090 %	0.9334	0.0007	0.9348
Internal Moderator Density = 100 %	0.9315	0.0007	0.9329
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9054	0.0007	0.9068
Internal Moderator Density = 070 %	0.9236	0.0007	0.9250
Internal Moderator Density = 080 %	0.9333	0.0007	0.9347
Internal Moderator Density = 090 %	0.9369	0.0007	0.9383
Internal Moderator Density = 100 %	0.9358	0.0007	0.9372

Table U.6-38
BW 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.50 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9308	0.0007	0.9322
Internal Moderator Density = 070 %	0.9341	0.0007	0.9355
Internal Moderator Density = 080 %	0.9308	0.0006	0.9320
Internal Moderator Density = 090 %	0.9226	0.0006	0.9238
Internal Moderator Density = 100 %	0.9147	0.0006	0.9159
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9298	0.0007	0.9312
Internal Moderator Density = 070 %	0.9361	0.0007	0.9375
Internal Moderator Density = 080 %	0.9367	0.0006	0.9379
Internal Moderator Density = 090 %	0.9329	0.0007	0.9343
Internal Moderator Density = 100 %	0.9242	0.0008	0.9258
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9264	0.0006	0.9276
Internal Moderator Density = 070 %	0.9352	0.0007	0.9366
Internal Moderator Density = 080 %	0.9372	0.0007	0.9386
Internal Moderator Density = 090 %	0.9350	0.0007	0.9364
Internal Moderator Density = 100 %	0.9284	0.0007	0.9298
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9200	0.0008	0.9216
Internal Moderator Density = 070 %	0.9315	0.0007	0.9329
Internal Moderator Density = 080 %	0.9365	0.0008	0.9381
Internal Moderator Density = 090 %	0.9361	0.0007	0.9375
Internal Moderator Density = 100 %	0.9310	0.0007	0.9324
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9097	0.0007	0.9111
Internal Moderator Density = 070 %	0.9246	0.0008	0.9262
Internal Moderator Density = 080 %	0.9326	0.0008	0.9342
Internal Moderator Density = 090 %	0.9330	0.0007	0.9344
Internal Moderator Density = 100 %	0.9310	0.0007	0.9324

Table U.6-38
BW 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9339	0.0007	0.9353
Internal Moderator Density = 070 %	0.9369	0.0007	0.9383
Internal Moderator Density = 080 %	0.9320	0.0007	0.9334
Internal Moderator Density = 090 %	0.9241	0.0007	0.9255
Internal Moderator Density = 100 %	0.9137	0.0007	0.9151
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9315	0.0007	0.9329
Internal Moderator Density = 070 %	0.9375	0.0007	0.9389
Internal Moderator Density = 080 %	0.9372	0.0007	0.9386
Internal Moderator Density = 090 %	0.9321	0.0008	0.9337
Internal Moderator Density = 100 %	0.9249	0.0007	0.9263
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9283	0.0007	0.9297
Internal Moderator Density = 070 %	0.9375	0.0007	0.9389
Internal Moderator Density = 080 %	0.9375	0.0007	0.9389
Internal Moderator Density = 090 %	0.9349	0.0006	0.9361
Internal Moderator Density = 100 %	0.9273	0.0007	0.9287
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9215	0.0008	0.9231
Internal Moderator Density = 070 %	0.9324	0.0007	0.9338
Internal Moderator Density = 080 %	0.9376	0.0008	0.9392
Internal Moderator Density = 090 %	0.9348	0.0007	0.9362
Internal Moderator Density = 100 %	0.9306	0.0007	0.9320
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9145	0.0007	0.9159
Internal Moderator Density = 070 %	0.9287	0.0007	0.9301
Internal Moderator Density = 080 %	0.9362	0.0007	0.9376
Internal Moderator Density = 090 %	0.9375	0.0007	0.9389
Internal Moderator Density = 100 %	0.9324	0.0007	0.9338

Table U.6-38
BW 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9318	0.0006	0.9330
Internal Moderator Density = 070 %	0.9344	0.0008	0.9360
Internal Moderator Density = 080 %	0.9293	0.0007	0.9307
Internal Moderator Density = 090 %	0.9203	0.0007	0.9217
Internal Moderator Density = 100 %	0.9095	0.0006	0.9107
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9294	0.0008	0.9310
Internal Moderator Density = 070 %	0.9342	0.0007	0.9356
Internal Moderator Density = 080 %	0.9343	0.0007	0.9357
Internal Moderator Density = 090 %	0.9292	0.0006	0.9304
Internal Moderator Density = 100 %	0.9208	0.0006	0.9220
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9263	0.0008	0.9279
Internal Moderator Density = 070 %	0.9335	0.0007	0.9349
Internal Moderator Density = 080 %	0.9353	0.0006	0.9365
Internal Moderator Density = 090 %	0.9310	0.0007	0.9324
Internal Moderator Density = 100 %	0.9225	0.0006	0.9237
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9226	0.0007	0.9240
Internal Moderator Density = 070 %	0.9356	0.0006	0.9368
Internal Moderator Density = 080 %	0.9374	0.0007	0.9388
Internal Moderator Density = 090 %	0.9347	0.0007	0.9361
Internal Moderator Density = 100 %	0.9292	0.0006	0.9304
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9147	0.0008	0.9163
Internal Moderator Density = 070 %	0.9304	0.0007	0.9318
Internal Moderator Density = 080 %	0.9349	0.0007	0.9363
Internal Moderator Density = 090 %	0.9373	0.0006	0.9385
Internal Moderator Density = 100 %	0.9308	0.0007	0.9322

Table U.6-38
BW 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9363	0.0007	0.9377
Internal Moderator Density = 070 %	0.9360	0.0006	0.9372
Internal Moderator Density = 080 %	0.9313	0.0006	0.9325
Internal Moderator Density = 090 %	0.9199	0.0007	0.9213
Internal Moderator Density = 100 %	0.9068	0.0006	0.9080
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9322	0.0006	0.9334
Internal Moderator Density = 070 %	0.9351	0.0006	0.9363
Internal Moderator Density = 080 %	0.9341	0.0007	0.9355
Internal Moderator Density = 090 %	0.9271	0.0007	0.9285
Internal Moderator Density = 100 %	0.9165	0.0008	0.9181
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9316	0.0007	0.9330
Internal Moderator Density = 070 %	0.9365	0.0007	0.9379
Internal Moderator Density = 080 %	0.9371	0.0007	0.9385
Internal Moderator Density = 090 %	0.9306	0.0006	0.9318
Internal Moderator Density = 100 %	0.9217	0.0006	0.9229
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9253	0.0008	0.9269
Internal Moderator Density = 070 %	0.9343	0.0006	0.9355
Internal Moderator Density = 080 %	0.9354	0.0008	0.9370
Internal Moderator Density = 090 %	0.9314	0.0006	0.9326
Internal Moderator Density = 100 %	0.9246	0.0007	0.9260
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9179	0.0007	0.9193
Internal Moderator Density = 070 %	0.9281	0.0007	0.9295
Internal Moderator Density = 080 %	0.9337	0.0007	0.9351
Internal Moderator Density = 090 %	0.9308	0.0007	0.9322
Internal Moderator Density = 100 %	0.9255	0.0006	0.9267

Table U.6-38
BW 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.05 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9320	0.0007	0.9334
Internal Moderator Density = 060 %	0.9365	0.0008	0.9381
Internal Moderator Density = 070 %	0.9357	0.0006	0.9369
Internal Moderator Density = 080 %	0.9294	0.0007	0.9308
Internal Moderator Density = 090 %	0.9183	0.0007	0.9197
Enrichment = 4.45 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9334	0.0007	0.9348
Internal Moderator Density = 070 %	0.9357	0.0006	0.9369
Internal Moderator Density = 080 %	0.9326	0.0007	0.9340
Internal Moderator Density = 090 %	0.9238	0.0007	0.9252
Internal Moderator Density = 100 %	0.9142	0.0007	0.9156
Enrichment = 4.65 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9311	0.0007	0.9325
Internal Moderator Density = 070 %	0.9366	0.0006	0.9378
Internal Moderator Density = 080 %	0.9353	0.0007	0.9367
Internal Moderator Density = 090 %	0.9272	0.0006	0.9284
Internal Moderator Density = 100 %	0.9165	0.0007	0.9179
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9306	0.0007	0.9320
Internal Moderator Density = 070 %	0.9369	0.0006	0.9381
Internal Moderator Density = 080 %	0.9379	0.0008	0.9395
Internal Moderator Density = 090 %	0.9341	0.0007	0.9355
Internal Moderator Density = 100 %	0.9257	0.0006	0.9269

Table U.6-39
BW 15x15 Class Damaged Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9199	0.0007	0.9213
Internal Moderator Density = 070 %	0.9287	0.0007	0.9301
Internal Moderator Density = 080 %	0.9303	0.0007	0.9317
Internal Moderator Density = 090 %	0.9285	0.0007	0.9299
Internal Moderator Density = 100 %	0.9246	0.0007	0.9260
Enrichment = 3.50 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9082	0.0007	0.9096
Internal Moderator Density = 070 %	0.9222	0.0007	0.9236
Internal Moderator Density = 080 %	0.9286	0.0006	0.9298
Internal Moderator Density = 090 %	0.9300	0.0006	0.9312
Internal Moderator Density = 100 %	0.9281	0.0007	0.9295
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9061	0.0007	0.9075
Internal Moderator Density = 070 %	0.9217	0.0008	0.9233
Internal Moderator Density = 080 %	0.9300	0.0007	0.9314
Internal Moderator Density = 090 %	0.9327	0.0007	0.9341
Internal Moderator Density = 100 %	0.9306	0.0007	0.9320
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.8570	0.0006	0.8582
Internal Moderator Density = 070 %	0.9190	0.0007	0.9204
Internal Moderator Density = 080 %	0.9286	0.0007	0.9300
Internal Moderator Density = 090 %	0.9344	0.0007	0.9358
Internal Moderator Density = 100 %	0.9349	0.0007	0.9363
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8910	0.0008	0.8926
Internal Moderator Density = 070 %	0.9118	0.0007	0.9132
Internal Moderator Density = 080 %	0.9264	0.0008	0.9280
Internal Moderator Density = 090 %	0.9322	0.0008	0.9338
Internal Moderator Density = 100 %	0.9359	0.0009	0.9377

Table U.6-39
BW 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.40 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9247	0.0007	0.9261
Internal Moderator Density = 070 %	0.9319	0.0006	0.9331
Internal Moderator Density = 080 %	0.9325	0.0007	0.9339
Internal Moderator Density = 090 %	0.9295	0.0006	0.9307
Internal Moderator Density = 100 %	0.9223	0.0007	0.9237
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9175	0.0007	0.9189
Internal Moderator Density = 070 %	0.9281	0.0007	0.9295
Internal Moderator Density = 080 %	0.9344	0.0006	0.9356
Internal Moderator Density = 090 %	0.9323	0.0007	0.9337
Internal Moderator Density = 100 %	0.9302	0.0008	0.9318
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9146	0.0007	0.9160
Internal Moderator Density = 070 %	0.9269	0.0007	0.9283
Internal Moderator Density = 080 %	0.9332	0.0008	0.9348
Internal Moderator Density = 090 %	0.9349	0.0007	0.9363
Internal Moderator Density = 100 %	0.9319	0.0006	0.9331
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.8597	0.0008	0.8613
Internal Moderator Density = 070 %	0.9234	0.0007	0.9248
Internal Moderator Density = 080 %	0.9320	0.0007	0.9334
Internal Moderator Density = 090 %	0.9367	0.0007	0.9381
Internal Moderator Density = 100 %	0.9365	0.0007	0.9379
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8965	0.0008	0.8981
Internal Moderator Density = 070 %	0.9158	0.0007	0.9172
Internal Moderator Density = 080 %	0.9271	0.0007	0.9285
Internal Moderator Density = 090 %	0.9320	0.0007	0.9334
Internal Moderator Density = 100 %	0.9338	0.0008	0.9354

Table U.6-39
BW 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.50 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9242	0.0006	0.9254
Internal Moderator Density = 070 %	0.9314	0.0006	0.9326
Internal Moderator Density = 080 %	0.9307	0.0006	0.9319
Internal Moderator Density = 090 %	0.9262	0.0006	0.9274
Internal Moderator Density = 100 %	0.9186	0.0006	0.9198
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9190	0.0006	0.9202
Internal Moderator Density = 070 %	0.9308	0.0007	0.9322
Internal Moderator Density = 080 %	0.9364	0.0007	0.9378
Internal Moderator Density = 090 %	0.9346	0.0007	0.9360
Internal Moderator Density = 100 %	0.9290	0.0007	0.9304
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9165	0.0006	0.9177
Internal Moderator Density = 070 %	0.9296	0.0007	0.9310
Internal Moderator Density = 080 %	0.9346	0.0008	0.9362
Internal Moderator Density = 090 %	0.9359	0.0007	0.9373
Internal Moderator Density = 100 %	0.9317	0.0007	0.9331
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.8615	0.0008	0.8631
Internal Moderator Density = 070 %	0.9246	0.0007	0.9260
Internal Moderator Density = 080 %	0.9320	0.0007	0.9334
Internal Moderator Density = 090 %	0.9370	0.0007	0.9384
Internal Moderator Density = 100 %	0.9333	0.0007	0.9347
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9025	0.0008	0.9041
Internal Moderator Density = 070 %	0.9205	0.0008	0.9221
Internal Moderator Density = 080 %	0.9308	0.0007	0.9322
Internal Moderator Density = 090 %	0.9356	0.0008	0.9372
Internal Moderator Density = 100 %	0.9346	0.0007	0.9360

Table U.6-39
BW 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9268	0.0008	0.9284
Internal Moderator Density = 070 %	0.9318	0.0007	0.9332
Internal Moderator Density = 080 %	0.9327	0.0007	0.9341
Internal Moderator Density = 090 %	0.9294	0.0007	0.9308
Internal Moderator Density = 100 %	0.9211	0.0006	0.9223
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9221	0.0008	0.9237
Internal Moderator Density = 070 %	0.9331	0.0006	0.9343
Internal Moderator Density = 080 %	0.9373	0.0007	0.9387
Internal Moderator Density = 090 %	0.9350	0.0008	0.9366
Internal Moderator Density = 100 %	0.9307	0.0006	0.9319
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9202	0.0007	0.9216
Internal Moderator Density = 070 %	0.9304	0.0006	0.9316
Internal Moderator Density = 080 %	0.9360	0.0006	0.9372
Internal Moderator Density = 090 %	0.9360	0.0007	0.9374
Internal Moderator Density = 100 %	0.9322	0.0007	0.9336
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.8626	0.0006	0.8638
Internal Moderator Density = 070 %	0.9260	0.0008	0.9276
Internal Moderator Density = 080 %	0.9341	0.0007	0.9355
Internal Moderator Density = 090 %	0.9358	0.0007	0.9372
Internal Moderator Density = 100 %	0.9335	0.0006	0.9347
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9040	0.0007	0.9054
Internal Moderator Density = 070 %	0.9206	0.0006	0.9218
Internal Moderator Density = 080 %	0.9318	0.0007	0.9332
Internal Moderator Density = 090 %	0.9358	0.0008	0.9374
Internal Moderator Density = 100 %	0.9348	0.0007	0.9362

Table U.6-39
BW 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9285	0.0006	0.9297
Internal Moderator Density = 070 %	0.9322	0.0006	0.9334
Internal Moderator Density = 080 %	0.9298	0.0007	0.9312
Internal Moderator Density = 090 %	0.9245	0.0006	0.9257
Internal Moderator Density = 100 %	0.9157	0.0007	0.9171
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9240	0.0007	0.9254
Internal Moderator Density = 070 %	0.9308	0.0007	0.9322
Internal Moderator Density = 080 %	0.9331	0.0008	0.9347
Internal Moderator Density = 090 %	0.9304	0.0006	0.9316
Internal Moderator Density = 100 %	0.9238	0.0006	0.9250
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9231	0.0007	0.9245
Internal Moderator Density = 070 %	0.9329	0.0007	0.9343
Internal Moderator Density = 080 %	0.9347	0.0008	0.9363
Internal Moderator Density = 090 %	0.9343	0.0007	0.9357
Internal Moderator Density = 100 %	0.9290	0.0007	0.9304
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.8617	0.0006	0.8629
Internal Moderator Density = 070 %	0.9265	0.0008	0.9281
Internal Moderator Density = 080 %	0.9341	0.0007	0.9355
Internal Moderator Density = 090 %	0.9336	0.0007	0.9350
Internal Moderator Density = 100 %	0.9303	0.0007	0.9317
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9069	0.0007	0.9083
Internal Moderator Density = 070 %	0.9209	0.0006	0.9221
Internal Moderator Density = 080 %	0.9287	0.0007	0.9301
Internal Moderator Density = 090 %	0.9326	0.0008	0.9342
Internal Moderator Density = 100 %	0.9317	0.0006	0.9329

Table U.6-39
BW 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.95 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9344	0.0007	0.9358
Internal Moderator Density = 070 %	**0.9385**	**0.0006**	**0.9397**
Internal Moderator Density = 080 %	0.9348	0.0007	0.9362
Internal Moderator Density = 090 %	0.9274	0.0006	0.9286
Internal Moderator Density = 100 %	0.9187	0.0006	0.9199
Enrichment = 4.40 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9288	0.0008	0.9304
Internal Moderator Density = 070 %	0.9344	0.0008	0.9360
Internal Moderator Density = 080 %	0.9354	0.0008	0.9370
Internal Moderator Density = 090 %	0.9319	0.0006	0.9331
Internal Moderator Density = 100 %	0.9241	0.0007	0.9255
Enrichment = 4.55 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9240	0.0007	0.9254
Internal Moderator Density = 070 %	0.9318	0.0006	0.9330
Internal Moderator Density = 080 %	0.9342	0.0007	0.9356
Internal Moderator Density = 090 %	0.9331	0.0007	0.9345
Internal Moderator Density = 100 %	0.9261	0.0007	0.9275
Enrichment = 4.90 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.8681	0.0007	0.8695
Internal Moderator Density = 070 %	0.9334	0.0007	0.9348
Internal Moderator Density = 080 %	0.9376	0.0007	0.9390
Internal Moderator Density = 090 %	0.9373	0.0007	0.9387
Internal Moderator Density = 100 %	0.9337	0.0007	0.9351
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9044	0.0008	0.9060
Internal Moderator Density = 070 %	0.9171	0.0007	0.9185
Internal Moderator Density = 080 %	0.9243	0.0007	0.9257
Internal Moderator Density = 090 %	0.9253	0.0006	0.9265
Internal Moderator Density = 100 %	0.9231	0.0007	0.9245

Table U.6-40
CE 15x15 Class Damaged Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.35 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9291	0.0008	0.9307
Internal Moderator Density = 070 %	0.9343	0.0006	0.9355
Internal Moderator Density = 080 %	0.9329	0.0007	0.9343
Internal Moderator Density = 090 %	0.9279	0.0006	0.9291
Internal Moderator Density = 100 %	0.9203	0.0006	0.9215
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9227	0.0007	0.9241
Internal Moderator Density = 070 %	0.9336	0.0007	0.9350
Internal Moderator Density = 080 %	0.9377	0.0007	0.9391
Internal Moderator Density = 090 %	0.9344	0.0007	0.9358
Internal Moderator Density = 100 %	0.9307	0.0008	0.9323
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9160	0.0008	0.9176
Internal Moderator Density = 070 %	0.9282	0.0006	0.9294
Internal Moderator Density = 080 %	0.9340	0.0007	0.9354
Internal Moderator Density = 090 %	0.9345	0.0006	0.9357
Internal Moderator Density = 100 %	0.9292	0.0007	0.9306
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9130	0.0008	0.9146
Internal Moderator Density = 070 %	0.9266	0.0007	0.9280
Internal Moderator Density = 080 %	0.9350	0.0007	0.9364
Internal Moderator Density = 090 %	0.9382	0.0007	0.9396
Internal Moderator Density = 100 %	0.9363	0.0007	0.9377
Enrichment = 4.25 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9031	0.0007	0.9045
Internal Moderator Density = 070 %	0.9214	0.0007	0.9228
Internal Moderator Density = 080 %	0.9317	0.0008	0.9333
Internal Moderator Density = 090 %	0.9351	0.0007	0.9365
Internal Moderator Density = 100 %	0.9374	0.0007	0.9388

Table U.6-40
CE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.60 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9331	0.0007	0.9345
Internal Moderator Density = 070 %	0.9360	0.0007	0.9374
Internal Moderator Density = 080 %	0.9333	0.0008	0.9349
Internal Moderator Density = 090 %	0.9259	0.0006	0.9271
Internal Moderator Density = 100 %	0.9179	0.0006	0.9191
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9253	0.0007	0.9267
Internal Moderator Density = 070 %	0.9350	0.0006	0.9362
Internal Moderator Density = 080 %	0.9352	0.0007	0.9366
Internal Moderator Density = 090 %	0.9310	0.0007	0.9324
Internal Moderator Density = 100 %	0.9251	0.0007	0.9265
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9234	0.0008	0.9250
Internal Moderator Density = 070 %	0.9326	0.0008	0.9342
Internal Moderator Density = 080 %	0.9363	0.0007	0.9377
Internal Moderator Density = 090 %	0.9340	0.0006	0.9352
Internal Moderator Density = 100 %	0.9286	0.0006	0.9298
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9152	0.0006	0.9164
Internal Moderator Density = 070 %	0.9266	0.0007	0.9280
Internal Moderator Density = 080 %	0.9306	0.0007	0.9320
Internal Moderator Density = 090 %	0.9321	0.0007	0.9335
Internal Moderator Density = 100 %	0.9280	0.0008	0.9296
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9104	0.0007	0.9118
Internal Moderator Density = 070 %	0.9252	0.0007	0.9266
Internal Moderator Density = 080 %	0.9354	0.0009	0.9372
Internal Moderator Density = 090 %	0.9352	0.0007	0.9366
Internal Moderator Density = 100 %	0.9362	0.0007	0.9376

Table U.6-40
CE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9316	0.0007	0.9330
Internal Moderator Density = 070 %	0.9336	0.0007	0.9350
Internal Moderator Density = 080 %	0.9304	0.0008	0.9320
Internal Moderator Density = 090 %	0.9233	0.0006	0.9245
Internal Moderator Density = 100 %	0.9128	0.0007	0.9142
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9264	0.0007	0.9278
Internal Moderator Density = 070 %	0.9351	0.0007	0.9365
Internal Moderator Density = 080 %	0.9369	0.0007	0.9383
Internal Moderator Density = 090 %	0.9316	0.0006	0.9328
Internal Moderator Density = 100 %	0.9247	0.0007	0.9261
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9256	0.0008	0.9272
Internal Moderator Density = 070 %	0.9337	0.0007	0.9351
Internal Moderator Density = 080 %	0.9354	0.0007	0.9368
Internal Moderator Density = 090 %	0.9342	0.0006	0.9354
Internal Moderator Density = 100 %	0.9270	0.0007	0.9284
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9179	0.0007	0.9193
Internal Moderator Density = 070 %	0.9308	0.0007	0.9322
Internal Moderator Density = 080 %	0.9371	0.0007	0.9385
Internal Moderator Density = 090 %	0.9348	0.0008	0.9364
Internal Moderator Density = 100 %	0.9312	0.0007	0.9326
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9105	0.0008	0.9121
Internal Moderator Density = 070 %	0.9252	0.0008	0.9268
Internal Moderator Density = 080 %	0.9328	0.0007	0.9342
Internal Moderator Density = 090 %	0.9364	0.0007	0.9378
Internal Moderator Density = 100 %	0.9334	0.0007	0.9348

Table U.6-40
CE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9342	0.0007	0.9356
Internal Moderator Density = 070 %	0.9362	0.0007	0.9376
Internal Moderator Density = 080 %	0.9339	0.0006	0.9351
Internal Moderator Density = 090 %	0.9252	0.0006	0.9264
Internal Moderator Density = 100 %	0.9148	0.0006	0.9160
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9297	0.0007	0.9311
Internal Moderator Density = 070 %	0.9363	0.0007	0.9377
Internal Moderator Density = 080 %	0.9368	0.0007	0.9382
Internal Moderator Density = 090 %	0.9333	0.0007	0.9347
Internal Moderator Density = 100 %	0.9230	0.0006	0.9242
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9257	0.0008	0.9273
Internal Moderator Density = 070 %	0.9353	0.0007	0.9367
Internal Moderator Density = 080 %	0.9365	0.0007	0.9379
Internal Moderator Density = 090 %	0.9336	0.0007	0.9350
Internal Moderator Density = 100 %	0.9281	0.0007	0.9295
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9204	0.0007	0.9218
Internal Moderator Density = 070 %	0.9306	0.0007	0.9320
Internal Moderator Density = 080 %	0.9352	0.0007	0.9366
Internal Moderator Density = 090 %	0.9351	0.0007	0.9365
Internal Moderator Density = 100 %	0.9293	0.0007	0.9307
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9126	0.0008	0.9142
Internal Moderator Density = 070 %	0.9261	0.0007	0.9275
Internal Moderator Density = 080 %	0.9346	0.0007	0.9360
Internal Moderator Density = 090 %	0.9355	0.0006	0.9367
Internal Moderator Density = 100 %	0.9338	0.0008	0.9354

Table U.6-40
CE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9374	0.0006	0.9386
Internal Moderator Density = 070 %	0.9381	0.0006	0.9393
Internal Moderator Density = 080 %	0.9331	0.0006	0.9343
Internal Moderator Density = 090 %	0.9235	0.0006	0.9247
Internal Moderator Density = 100 %	0.9109	0.0006	0.9121
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9315	0.0006	0.9327
Internal Moderator Density = 070 %	0.9372	0.0007	0.9386
Internal Moderator Density = 080 %	0.9359	0.0007	0.9373
Internal Moderator Density = 090 %	0.9287	0.0008	0.9303
Internal Moderator Density = 100 %	0.9204	0.0007	0.9218
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9317	0.0007	0.9331
Internal Moderator Density = 070 %	**0.9384**	**0.0007**	**0.9398**
Internal Moderator Density = 080 %	0.9366	0.0007	0.9380
Internal Moderator Density = 090 %	0.9332	0.0007	0.9346
Internal Moderator Density = 100 %	0.9261	0.0007	0.9275
Enrichment = 4.85 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9242	0.0007	0.9256
Internal Moderator Density = 070 %	0.9346	0.0007	0.9360
Internal Moderator Density = 080 %	0.9361	0.0008	0.9377
Internal Moderator Density = 090 %	0.9332	0.0006	0.9344
Internal Moderator Density = 100 %	0.9279	0.0006	0.9291
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9095	0.0007	0.9109
Internal Moderator Density = 070 %	0.9226	0.0007	0.9240
Internal Moderator Density = 080 %	0.9261	0.0008	0.9277
Internal Moderator Density = 090 %	0.9283	0.0006	0.9295
Internal Moderator Density = 100 %	0.9244	0.0007	0.9258

Table U.6-40
CE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.15 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9330	0.0006	0.9342
Internal Moderator Density = 060 %	0.9382	0.0006	0.9394
Internal Moderator Density = 070 %	0.9378	0.0008	0.9394
Internal Moderator Density = 080 %	0.9316	0.0006	0.9328
Internal Moderator Density = 090 %	0.9194	0.0006	0.9206
Enrichment = 4.55 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9327	0.0007	0.9341
Internal Moderator Density = 070 %	0.9361	0.0007	0.9375
Internal Moderator Density = 080 %	0.9338	0.0007	0.9352
Internal Moderator Density = 090 %	0.9270	0.0007	0.9284
Internal Moderator Density = 100 %	0.9148	0.0007	0.9162
Enrichment = 4.75 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9306	0.0007	0.9320
Internal Moderator Density = 070 %	0.9359	0.0006	0.9371
Internal Moderator Density = 080 %	0.9363	0.0007	0.9377
Internal Moderator Density = 090 %	0.9307	0.0007	0.9321
Internal Moderator Density = 100 %	0.9212	0.0007	0.9226
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9225	0.0007	0.9239
Internal Moderator Density = 070 %	0.9324	0.0007	0.9338
Internal Moderator Density = 080 %	0.9335	0.0008	0.9351
Internal Moderator Density = 090 %	0.9302	0.0006	0.9314
Internal Moderator Density = 100 %	0.9231	0.0006	0.9243
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9016	0.0006	0.9028
Internal Moderator Density = 070 %	0.9119	0.0007	0.9133
Internal Moderator Density = 080 %	0.9166	0.0007	0.9180
Internal Moderator Density = 090 %	0.9146	0.0007	0.9160
Internal Moderator Density = 100 %	0.9103	0.0008	0.9119

Table U.6-41
CE 15x15 Class Damaged Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9246	0.0007	0.9260
Internal Moderator Density = 070 %	0.9306	0.0007	0.9320
Internal Moderator Density = 080 %	0.9329	0.0006	0.9341
Internal Moderator Density = 090 %	0.9280	0.0006	0.9292
Internal Moderator Density = 100 %	0.9201	0.0006	0.9213
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9192	0.0007	0.9206
Internal Moderator Density = 070 %	0.9320	0.0007	0.9334
Internal Moderator Density = 080 %	0.9355	0.0008	0.9371
Internal Moderator Density = 090 %	0.9341	0.0007	0.9355
Internal Moderator Density = 100 %	0.9305	0.0007	0.9319
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9176	0.0007	0.9190
Internal Moderator Density = 070 %	0.9309	0.0006	0.9321
Internal Moderator Density = 080 %	0.9360	0.0006	0.9372
Internal Moderator Density = 090 %	0.9377	0.0007	0.9391
Internal Moderator Density = 100 %	0.9349	0.0007	0.9363
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9083	0.0007	0.9097
Internal Moderator Density = 070 %	0.9256	0.0007	0.9270
Internal Moderator Density = 080 %	0.9339	0.0007	0.9353
Internal Moderator Density = 090 %	0.9350	0.0006	0.9362
Internal Moderator Density = 100 %	0.9352	0.0007	0.9366
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9018	0.0007	0.9032
Internal Moderator Density = 070 %	0.9193	0.0007	0.9207
Internal Moderator Density = 080 %	0.9305	0.0009	0.9323
Internal Moderator Density = 090 %	0.9355	0.0008	0.9371
Internal Moderator Density = 100 %	0.9364	0.0007	0.9378

Table U.6-41
CE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.55 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9311	0.0007	0.9325
Internal Moderator Density = 070 %	0.9342	0.0007	0.9356
Internal Moderator Density = 080 %	0.9328	0.0007	0.9342
Internal Moderator Density = 090 %	0.9263	0.0007	0.9277
Internal Moderator Density = 100 %	0.9191	0.0007	0.9205
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9237	0.0007	0.9251
Internal Moderator Density = 070 %	0.9324	0.0006	0.9336
Internal Moderator Density = 080 %	0.9350	0.0007	0.9364
Internal Moderator Density = 090 %	0.9318	0.0007	0.9332
Internal Moderator Density = 100 %	0.9246	0.0008	0.9262
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9217	0.0007	0.9231
Internal Moderator Density = 070 %	0.9331	0.0008	0.9347
Internal Moderator Density = 080 %	0.9346	0.0007	0.9360
Internal Moderator Density = 090 %	0.9339	0.0007	0.9353
Internal Moderator Density = 100 %	0.9288	0.0006	0.9300
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9137	0.0007	0.9151
Internal Moderator Density = 070 %	0.9281	0.0007	0.9295
Internal Moderator Density = 080 %	0.9332	0.0007	0.9346
Internal Moderator Density = 090 %	0.9363	0.0008	0.9379
Internal Moderator Density = 100 %	0.9309	0.0007	0.9323
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9080	0.0007	0.9094
Internal Moderator Density = 070 %	0.9252	0.0007	0.9266
Internal Moderator Density = 080 %	0.9325	0.0007	0.9339
Internal Moderator Density = 090 %	0.9354	0.0007	0.9368
Internal Moderator Density = 100 %	0.9354	0.0007	0.9368

Table U.6-41
CE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9339	0.0007	0.9353
Internal Moderator Density = 070 %	0.9366	0.0006	0.9378
Internal Moderator Density = 080 %	0.9358	0.0008	0.9374
Internal Moderator Density = 090 %	0.9282	0.0006	0.9294
Internal Moderator Density = 100 %	0.9167	0.0007	0.9181
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9258	0.0008	0.9274
Internal Moderator Density = 070 %	0.9338	0.0007	0.9352
Internal Moderator Density = 080 %	0.9357	0.0007	0.9371
Internal Moderator Density = 090 %	0.9320	0.0006	0.9332
Internal Moderator Density = 100 %	0.9252	0.0007	0.9266
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9220	0.0007	0.9234
Internal Moderator Density = 070 %	0.9326	0.0007	0.9340
Internal Moderator Density = 080 %	0.9352	0.0008	0.9368
Internal Moderator Density = 090 %	0.9321	0.0007	0.9335
Internal Moderator Density = 100 %	0.9281	0.0007	0.9295
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9197	0.0008	0.9213
Internal Moderator Density = 070 %	0.9316	0.0007	0.9330
Internal Moderator Density = 080 %	0.9378	0.0007	0.9392
Internal Moderator Density = 090 %	0.9377	0.0006	0.9389
Internal Moderator Density = 100 %	0.9364	0.0008	0.9380
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9080	0.0007	0.9094
Internal Moderator Density = 070 %	0.9243	0.0008	0.9259
Internal Moderator Density = 080 %	0.9314	0.0007	0.9328
Internal Moderator Density = 090 %	0.9365	0.0007	0.9379
Internal Moderator Density = 100 %	0.9358	0.0007	0.9372

Table U.6-41
CE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9304	0.0006	0.9316
Internal Moderator Density = 070 %	0.9345	0.0007	0.9359
Internal Moderator Density = 080 %	0.9309	0.0006	0.9321
Internal Moderator Density = 090 %	0.9242	0.0007	0.9256
Internal Moderator Density = 100 %	0.9138	0.0006	0.9150
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9275	0.0007	0.9289
Internal Moderator Density = 070 %	0.9349	0.0007	0.9363
Internal Moderator Density = 080 %	0.9359	0.0007	0.9373
Internal Moderator Density = 090 %	0.9321	0.0007	0.9335
Internal Moderator Density = 100 %	0.9267	0.0008	0.9283
Enrichment = 4.25 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9243	0.0006	0.9255
Internal Moderator Density = 070 %	0.9337	0.0007	0.9351
Internal Moderator Density = 080 %	0.9359	0.0007	0.9373
Internal Moderator Density = 090 %	0.9343	0.0006	0.9355
Internal Moderator Density = 100 %	0.9280	0.0007	0.9294
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9177	0.0007	0.9191
Internal Moderator Density = 070 %	0.9302	0.0008	0.9318
Internal Moderator Density = 080 %	0.9361	0.0007	0.9375
Internal Moderator Density = 090 %	0.9346	0.0008	0.9362
Internal Moderator Density = 100 %	0.9309	0.0008	0.9325
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9126	0.0007	0.9140
Internal Moderator Density = 070 %	0.9273	0.0007	0.9287
Internal Moderator Density = 080 %	0.9364	0.0007	0.9378
Internal Moderator Density = 090 %	0.9371	0.0007	0.9385
Internal Moderator Density = 100 %	0.9370	0.0008	0.9386

Table U.6-41
CE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9367	0.0008	0.9383
Internal Moderator Density = 070 %	0.9368	0.0007	0.9382
Internal Moderator Density = 080 %	0.9315	0.0007	0.9329
Internal Moderator Density = 090 %	0.9233	0.0006	0.9245
Internal Moderator Density = 100 %	0.9122	0.0007	0.9136
Enrichment = 4.35 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9300	0.0007	0.9314
Internal Moderator Density = 070 %	0.9371	0.0007	0.9385
Internal Moderator Density = 080 %	0.9350	0.0007	0.9364
Internal Moderator Density = 090 %	0.9306	0.0008	0.9322
Internal Moderator Density = 100 %	0.9209	0.0006	0.9221
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9296	0.0008	0.9312
Internal Moderator Density = 070 %	0.9375	0.0007	0.9389
Internal Moderator Density = 080 %	0.9370	0.0007	0.9384
Internal Moderator Density = 090 %	0.9346	0.0007	0.9360
Internal Moderator Density = 100 %	0.9273	0.0007	0.9287
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9214	0.0008	0.9230
Internal Moderator Density = 070 %	0.9310	0.0006	0.9322
Internal Moderator Density = 080 %	0.9357	0.0007	0.9371
Internal Moderator Density = 090 %	0.9343	0.0006	0.9355
Internal Moderator Density = 100 %	0.9282	0.0007	0.9296
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9108	0.0007	0.9122
Internal Moderator Density = 070 %	0.9246	0.0008	0.9262
Internal Moderator Density = 080 %	0.9301	0.0007	0.9315
Internal Moderator Density = 090 %	0.9304	0.0008	0.9320
Internal Moderator Density = 100 %	0.9271	0.0007	0.9285

Table U.6-41
CE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Concuded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.10 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9288	0.0007	0.9302
Internal Moderator Density = 060 %	0.9364	0.0007	0.9378
Internal Moderator Density = 070 %	0.9359	0.0006	0.9371
Internal Moderator Density = 080 %	0.9310	0.0006	0.9322
Internal Moderator Density = 090 %	0.9213	0.0006	0.9225
Enrichment = 4.55 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9343	0.0007	0.9357
Internal Moderator Density = 070 %	0.9367	0.0007	0.9381
Internal Moderator Density = 080 %	0.9374	0.0006	0.9386
Internal Moderator Density = 090 %	0.9302	0.0007	0.9316
Internal Moderator Density = 100 %	0.9210	0.0007	0.9224
Enrichment = 4.70 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9291	0.0007	0.9305
Internal Moderator Density = 070 %	0.9362	0.0007	0.9376
Internal Moderator Density = 080 %	0.9356	0.0007	0.9370
Internal Moderator Density = 090 %	0.9308	0.0007	0.9322
Internal Moderator Density = 100 %	0.9229	0.0007	0.9243
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9253	0.0007	0.9267
Internal Moderator Density = 070 %	0.9333	0.0007	0.9347
Internal Moderator Density = 080 %	0.9367	0.0007	0.9381
Internal Moderator Density = 090 %	0.9334	0.0007	0.9348
Internal Moderator Density = 100 %	0.9279	0.0007	0.9293
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9041	0.0007	0.9055
Internal Moderator Density = 070 %	0.9150	0.0007	0.9164
Internal Moderator Density = 080 %	0.9186	0.0007	0.9200
Internal Moderator Density = 090 %	0.9181	0.0008	0.9197
Internal Moderator Density = 100 %	0.9132	0.0007	0.9146

Table U.6-42
WE 15x15 Class Damaged Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.40 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9256	0.0007	0.9270
Internal Moderator Density = 070 %	0.9337	0.0006	0.9349
Internal Moderator Density = 080 %	0.9337	0.0007	0.9351
Internal Moderator Density = 090 %	0.9302	0.0008	0.9318
Internal Moderator Density = 100 %	0.9238	0.0007	0.9252
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9206	0.0009	0.9224
Internal Moderator Density = 070 %	0.9304	0.0008	0.9320
Internal Moderator Density = 080 %	0.9345	0.0007	0.9359
Internal Moderator Density = 090 %	0.9348	0.0009	0.9366
Internal Moderator Density = 100 %	0.9317	0.0007	0.9331
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9191	0.0008	0.9207
Internal Moderator Density = 070 %	0.9299	0.0008	0.9315
Internal Moderator Density = 080 %	**0.9381**	**0.0008**	**0.9397**
Internal Moderator Density = 090 %	0.9368	0.0008	0.9384
Internal Moderator Density = 100 %	0.9323	0.0007	0.9337
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9100	0.0007	0.9114
Internal Moderator Density = 070 %	0.9266	0.0007	0.9280
Internal Moderator Density = 080 %	0.9367	0.0007	0.9381
Internal Moderator Density = 090 %	0.9376	0.0009	0.9394
Internal Moderator Density = 100 %	0.9356	0.0007	0.9370
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8987	0.0008	0.9003
Internal Moderator Density = 070 %	0.9178	0.0008	0.9194
Internal Moderator Density = 080 %	0.9277	0.0007	0.9291
Internal Moderator Density = 090 %	0.9327	0.0008	0.9343
Internal Moderator Density = 100 %	0.9338	0.0008	0.9354

Table U.6-42
WE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9307	0.0006	0.9319
Internal Moderator Density = 070 %	0.9362	0.0007	0.9376
Internal Moderator Density = 080 %	0.9325	0.0006	0.9337
Internal Moderator Density = 090 %	0.9277	0.0007	0.9291
Internal Moderator Density = 100 %	0.9195	0.0006	0.9207
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9228	0.0007	0.9242
Internal Moderator Density = 070 %	0.9308	0.0008	0.9324
Internal Moderator Density = 080 %	0.9324	0.0008	0.9340
Internal Moderator Density = 090 %	0.9316	0.0007	0.9330
Internal Moderator Density = 100 %	0.9247	0.0008	0.9263
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9219	0.0008	0.9235
Internal Moderator Density = 070 %	0.9329	0.0008	0.9345
Internal Moderator Density = 080 %	0.9374	0.0007	0.9388
Internal Moderator Density = 090 %	0.9357	0.0006	0.9369
Internal Moderator Density = 100 %	0.9317	0.0006	0.9329
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9153	0.0007	0.9167
Internal Moderator Density = 070 %	0.9287	0.0009	0.9305
Internal Moderator Density = 080 %	0.9367	0.0007	0.9381
Internal Moderator Density = 090 %	0.9362	0.0007	0.9376
Internal Moderator Density = 100 %	0.9322	0.0007	0.9336
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9070	0.0007	0.9084
Internal Moderator Density = 070 %	0.9242	0.0008	0.9258
Internal Moderator Density = 080 %	0.9327	0.0007	0.9341
Internal Moderator Density = 090 %	0.9363	0.0009	0.9381
Internal Moderator Density = 100 %	0.9354	0.0009	0.9372

Table U.6-42
WE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9349	0.0007	0.9363
Internal Moderator Density = 070 %	0.9371	0.0007	0.9385
Internal Moderator Density = 080 %	0.9345	0.0007	0.9359
Internal Moderator Density = 090 %	0.9281	0.0007	0.9295
Internal Moderator Density = 100 %	0.9185	0.0007	0.9199
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9241	0.0007	0.9255
Internal Moderator Density = 070 %	0.9334	0.0007	0.9348
Internal Moderator Density = 080 %	0.9337	0.0007	0.9351
Internal Moderator Density = 090 %	0.9309	0.0009	0.9327
Internal Moderator Density = 100 %	0.9238	0.0007	0.9252
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9241	0.0007	0.9255
Internal Moderator Density = 070 %	0.9333	0.0007	0.9347
Internal Moderator Density = 080 %	0.9368	0.0007	0.9382
Internal Moderator Density = 090 %	0.9357	0.0006	0.9369
Internal Moderator Density = 100 %	0.9308	0.0007	0.9322
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9152	0.0008	0.9168
Internal Moderator Density = 070 %	0.9292	0.0007	0.9306
Internal Moderator Density = 080 %	0.9356	0.0008	0.9372
Internal Moderator Density = 090 %	0.9360	0.0008	0.9376
Internal Moderator Density = 100 %	0.9323	0.0007	0.9337
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9094	0.0008	0.9110
Internal Moderator Density = 070 %	0.9248	0.0008	0.9264
Internal Moderator Density = 080 %	0.9326	0.0007	0.9340
Internal Moderator Density = 090 %	0.9366	0.0009	0.9384
Internal Moderator Density = 100 %	0.9335	0.0009	0.9353

Table U.6-42
WE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9302	0.0008	0.9318
Internal Moderator Density = 070 %	0.9347	0.0007	0.9361
Internal Moderator Density = 080 %	0.9313	0.0007	0.9327
Internal Moderator Density = 090 %	0.9247	0.0007	0.9261
Internal Moderator Density = 100 %	0.9157	0.0007	0.9171
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9265	0.0007	0.9279
Internal Moderator Density = 070 %	0.9339	0.0007	0.9353
Internal Moderator Density = 080 %	0.9347	0.0008	0.9363
Internal Moderator Density = 090 %	0.9316	0.0007	0.9330
Internal Moderator Density = 100 %	0.9252	0.0007	0.9266
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9279	0.0008	0.9295
Internal Moderator Density = 070 %	0.9362	0.0008	0.9378
Internal Moderator Density = 080 %	0.9380	0.0007	0.9394
Internal Moderator Density = 090 %	0.9346	0.0006	0.9358
Internal Moderator Density = 100 %	0.9291	0.0009	0.9309
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9189	0.0007	0.9203
Internal Moderator Density = 070 %	0.9295	0.0007	0.9309
Internal Moderator Density = 080 %	0.9353	0.0008	0.9369
Internal Moderator Density = 090 %	0.9343	0.0008	0.9359
Internal Moderator Density = 100 %	0.9313	0.0008	0.9329
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9088	0.0007	0.9102
Internal Moderator Density = 070 %	0.9248	0.0008	0.9264
Internal Moderator Density = 080 %	0.9326	0.0008	0.9342
Internal Moderator Density = 090 %	0.9340	0.0008	0.9356
Internal Moderator Density = 100 %	0.9314	0.0009	0.9332

Table U.6-42
WE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9352	0.0008	0.9368
Internal Moderator Density = 070 %	0.9355	0.0007	0.9369
Internal Moderator Density = 080 %	0.9309	0.0007	0.9323
Internal Moderator Density = 090 %	0.9235	0.0007	0.9249
Internal Moderator Density = 100 %	0.9151	0.0008	0.9167
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9287	0.0007	0.9301
Internal Moderator Density = 070 %	0.9337	0.0007	0.9351
Internal Moderator Density = 080 %	0.9311	0.0007	0.9325
Internal Moderator Density = 090 %	0.9279	0.0007	0.9293
Internal Moderator Density = 100 %	0.9187	0.0007	0.9201
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9245	0.0008	0.9261
Internal Moderator Density = 070 %	0.9320	0.0007	0.9334
Internal Moderator Density = 080 %	0.9325	0.0008	0.9341
Internal Moderator Density = 090 %	0.9295	0.0008	0.9311
Internal Moderator Density = 100 %	0.9201	0.0007	0.9215
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9219	0.0008	0.9235
Internal Moderator Density = 070 %	0.9313	0.0008	0.9329
Internal Moderator Density = 080 %	0.9350	0.0008	0.9366
Internal Moderator Density = 090 %	0.9333	0.0007	0.9347
Internal Moderator Density = 100 %	0.9289	0.0008	0.9305
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9036	0.0008	0.9052
Internal Moderator Density = 070 %	0.9144	0.0007	0.9158
Internal Moderator Density = 080 %	0.9208	0.0007	0.9222
Internal Moderator Density = 090 %	0.9197	0.0008	0.9213
Internal Moderator Density = 100 %	0.9172	0.0008	0.9188

Table U.6-42
WE 15x15 Class Damaged Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9282	0.0007	0.9296
Internal Moderator Density = 060 %	0.9361	0.0007	0.9375
Internal Moderator Density = 070 %	0.9348	0.0007	0.9362
Internal Moderator Density = 080 %	0.9309	0.0007	0.9323
Internal Moderator Density = 090 %	0.9204	0.0006	0.9216
Enrichment = 4.60 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9289	0.0007	0.9303
Internal Moderator Density = 070 %	0.9337	0.0007	0.9351
Internal Moderator Density = 080 %	0.9325	0.0008	0.9341
Internal Moderator Density = 090 %	0.9244	0.0007	0.9258
Internal Moderator Density = 100 %	0.9162	0.0006	0.9174
Enrichment = 4.80 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9289	0.0007	0.9303
Internal Moderator Density = 070 %	0.9339	0.0007	0.9353
Internal Moderator Density = 080 %	0.9331	0.0007	0.9345
Internal Moderator Density = 090 %	0.9289	0.0007	0.9303
Internal Moderator Density = 100 %	0.9195	0.0006	0.9207
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9168	0.0008	0.9184
Internal Moderator Density = 070 %	0.9255	0.0007	0.9269
Internal Moderator Density = 080 %	0.9272	0.0009	0.9290
Internal Moderator Density = 090 %	0.9236	0.0007	0.9250
Internal Moderator Density = 100 %	0.9171	0.0007	0.9185
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8935	0.0008	0.8951
Internal Moderator Density = 070 %	0.9052	0.0007	0.9066
Internal Moderator Density = 080 %	0.9078	0.0007	0.9092
Internal Moderator Density = 090 %	0.9075	0.0007	0.9089
Internal Moderator Density = 100 %	0.9027	0.0007	0.9041

Table U.6-43
WE 15x15 Class Damaged Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 3.35 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9184	0.0006	0.9196
Internal Moderator Density = 070 %	0.9299	0.0007	0.9313
Internal Moderator Density = 080 %	0.9347	0.0007	0.9361
Internal Moderator Density = 090 %	0.9349	0.0008	0.9365
Internal Moderator Density = 100 %	0.9318	0.0008	0.9334
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9060	0.0007	0.9074
Internal Moderator Density = 070 %	0.9212	0.0007	0.9226
Internal Moderator Density = 080 %	0.9286	0.0007	0.9300
Internal Moderator Density = 090 %	0.9317	0.0008	0.9333
Internal Moderator Density = 100 %	0.9320	0.0007	0.9334
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9031	0.0008	0.9047
Internal Moderator Density = 070 %	0.9183	0.0007	0.9197
Internal Moderator Density = 080 %	0.9286	0.0008	0.9302
Internal Moderator Density = 090 %	0.9343	0.0007	0.9357
Internal Moderator Density = 100 %	0.9364	0.0007	0.9378
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.8907	0.0007	0.8921
Internal Moderator Density = 070 %	0.9097	0.0007	0.9111
Internal Moderator Density = 080 %	0.9244	0.0007	0.9258
Internal Moderator Density = 090 %	0.9314	0.0008	0.9330
Internal Moderator Density = 100 %	0.9342	0.0008	0.9358
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8809	0.0007	0.8823
Internal Moderator Density = 070 %	0.9015	0.0007	0.9029
Internal Moderator Density = 080 %	0.9188	0.0006	0.9200
Internal Moderator Density = 090 %	0.9276	0.0007	0.9290
Internal Moderator Density = 100 %	0.9340	0.0007	0.9354

Table U.6-43
WE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.55 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9206	0.0006	0.9218
Internal Moderator Density = 070 %	0.9292	0.0007	0.9306
Internal Moderator Density = 080 %	0.9329	0.0006	0.9341
Internal Moderator Density = 090 %	0.9307	0.0007	0.9321
Internal Moderator Density = 100 %	0.9257	0.0007	0.9271
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9107	0.0007	0.9121
Internal Moderator Density = 070 %	0.9238	0.0008	0.9254
Internal Moderator Density = 080 %	0.9310	0.0007	0.9324
Internal Moderator Density = 090 %	0.9325	0.0008	0.9341
Internal Moderator Density = 100 %	0.9304	0.0006	0.9316
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9092	0.0008	0.9108
Internal Moderator Density = 070 %	0.9266	0.0009	0.9284
Internal Moderator Density = 080 %	0.9324	0.0007	0.9338
Internal Moderator Density = 090 %	0.9358	0.0007	0.9372
Internal Moderator Density = 100 %	0.9367	0.0007	0.9381
Enrichment = 4.35 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9017	0.0008	0.9033
Internal Moderator Density = 070 %	0.9170	0.0007	0.9184
Internal Moderator Density = 080 %	0.9294	0.0007	0.9308
Internal Moderator Density = 090 %	0.9348	0.0008	0.9364
Internal Moderator Density = 100 %	0.9379	0.0008	0.9395
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8909	0.0007	0.8923
Internal Moderator Density = 070 %	0.9122	0.0007	0.9136
Internal Moderator Density = 080 %	0.9263	0.0006	0.9275
Internal Moderator Density = 090 %	0.9331	0.0007	0.9345
Internal Moderator Density = 100 %	0.9374	0.0006	0.9386

Table U.6-43
WE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.65 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9237	0.0008	0.9253
Internal Moderator Density = 070 %	0.9336	0.0007	0.9350
Internal Moderator Density = 080 %	0.9349	0.0007	0.9363
Internal Moderator Density = 090 %	0.9320	0.0007	0.9334
Internal Moderator Density = 100 %	0.9272	0.0007	0.9286
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9122	0.0007	0.9136
Internal Moderator Density = 070 %	0.9246	0.0007	0.9260
Internal Moderator Density = 080 %	0.9306	0.0007	0.9320
Internal Moderator Density = 090 %	0.9323	0.0008	0.9339
Internal Moderator Density = 100 %	0.9295	0.0006	0.9307
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9108	0.0007	0.9122
Internal Moderator Density = 070 %	0.9257	0.0007	0.9271
Internal Moderator Density = 080 %	0.9347	0.0006	0.9359
Internal Moderator Density = 090 %	0.9365	0.0008	0.9381
Internal Moderator Density = 100 %	0.9355	0.0007	0.9369
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9012	0.0007	0.9026
Internal Moderator Density = 070 %	0.9209	0.0008	0.9225
Internal Moderator Density = 080 %	0.9293	0.0007	0.9307
Internal Moderator Density = 090 %	0.9362	0.0007	0.9376
Internal Moderator Density = 100 %	0.9373	0.0007	0.9387
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8931	0.0007	0.8945
Internal Moderator Density = 070 %	0.9132	0.0007	0.9146
Internal Moderator Density = 080 %	0.9245	0.0006	0.9257
Internal Moderator Density = 090 %	0.9351	0.0008	0.9367
Internal Moderator Density = 100 %	0.9359	0.0007	0.9373

Table U.6-43
WE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9227	0.0007	0.9241
Internal Moderator Density = 070 %	0.9287	0.0008	0.9303
Internal Moderator Density = 080 %	0.9317	0.0007	0.9331
Internal Moderator Density = 090 %	0.9294	0.0007	0.9308
Internal Moderator Density = 100 %	0.9253	0.0007	0.9267
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9149	0.0008	0.9165
Internal Moderator Density = 070 %	0.9258	0.0007	0.9272
Internal Moderator Density = 080 %	0.9326	0.0007	0.9340
Internal Moderator Density = 090 %	0.9329	0.0008	0.9345
Internal Moderator Density = 100 %	0.9322	0.0007	0.9336
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9146	0.0008	0.9162
Internal Moderator Density = 070 %	0.9268	0.0007	0.9282
Internal Moderator Density = 080 %	0.9342	0.0007	0.9356
Internal Moderator Density = 090 %	0.9374	0.0007	0.9388
Internal Moderator Density = 100 %	0.9353	0.0009	0.9371
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9039	0.0007	0.9053
Internal Moderator Density = 070 %	0.9211	0.0007	0.9225
Internal Moderator Density = 080 %	0.9310	0.0008	0.9326
Internal Moderator Density = 090 %	0.9362	0.0007	0.9376
Internal Moderator Density = 100 %	0.9369	0.0009	0.9387
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8956	0.0008	0.8972
Internal Moderator Density = 070 %	0.9134	0.0008	0.9150
Internal Moderator Density = 080 %	0.9272	0.0007	0.9286
Internal Moderator Density = 090 %	0.9352	0.0008	0.9368
Internal Moderator Density = 100 %	0.9356	0.0007	0.9370

Table U.6-43
WE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9267	0.0007	0.9281
Internal Moderator Density = 070 %	0.9339	0.0008	0.9355
Internal Moderator Density = 080 %	0.9341	0.0009	0.9359
Internal Moderator Density = 090 %	0.9306	0.0006	0.9318
Internal Moderator Density = 100 %	0.9240	0.0008	0.9256
Enrichment = 4.35 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9184	0.0008	0.9200
Internal Moderator Density = 070 %	0.9295	0.0008	0.9311
Internal Moderator Density = 080 %	0.9353	0.0007	0.9367
Internal Moderator Density = 090 %	0.9327	0.0008	0.9343
Internal Moderator Density = 100 %	0.9305	0.0007	0.9319
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9146	0.0009	0.9164
Internal Moderator Density = 070 %	0.9250	0.0007	0.9264
Internal Moderator Density = 080 %	0.9316	0.0008	0.9332
Internal Moderator Density = 090 %	0.9327	0.0008	0.9343
Internal Moderator Density = 100 %	0.9292	0.0008	0.9308
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9102	0.0008	0.9118
Internal Moderator Density = 070 %	0.9237	0.0007	0.9251
Internal Moderator Density = 080 %	0.9320	0.0008	0.9336
Internal Moderator Density = 090 %	0.9350	0.0007	0.9364
Internal Moderator Density = 100 %	0.9352	0.0008	0.9368
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8936	0.0007	0.8950
Internal Moderator Density = 070 %	0.9119	0.0008	0.9135
Internal Moderator Density = 080 %	0.9229	0.0007	0.9243
Internal Moderator Density = 090 %	0.9276	0.0008	0.9292
Internal Moderator Density = 100 %	0.9292	0.0008	0.9308

Table U.6-43
WE 15x15 Class Damaged Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.10 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9285	0.0007	0.9299
Internal Moderator Density = 070 %	0.9350	0.0007	0.9364
Internal Moderator Density = 080 %	0.9350	0.0007	0.9364
Internal Moderator Density = 090 %	0.9313	0.0007	0.9327
Internal Moderator Density = 100 %	0.9209	0.0007	0.9223
Enrichment = 4.50 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9210	0.0008	0.9226
Internal Moderator Density = 070 %	0.9295	0.0007	0.9309
Internal Moderator Density = 080 %	0.9337	0.0007	0.9351
Internal Moderator Density = 090 %	0.9310	0.0007	0.9324
Internal Moderator Density = 100 %	0.9267	0.0007	0.9281
Enrichment = 4.70 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9182	0.0008	0.9198
Internal Moderator Density = 070 %	0.9294	0.0008	0.9310
Internal Moderator Density = 080 %	0.9328	0.0006	0.9340
Internal Moderator Density = 090 %	0.9339	0.0007	0.9353
Internal Moderator Density = 100 %	0.9318	0.0007	0.9332
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9120	0.0007	0.9134
Internal Moderator Density = 070 %	0.9239	0.0008	0.9255
Internal Moderator Density = 080 %	0.9316	0.0009	0.9334
Internal Moderator Density = 090 %	0.9338	0.0008	0.9354
Internal Moderator Density = 100 %	0.9313	0.0008	0.9329
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8878	0.0007	0.8892
Internal Moderator Density = 070 %	0.9042	0.0007	0.9056
Internal Moderator Density = 080 %	0.9139	0.0008	0.9155
Internal Moderator Density = 090 %	0.9178	0.0007	0.9192
Internal Moderator Density = 100 %	0.9166	0.0008	0.9182

Table U.6-44
CE 14x14 Class Damaged Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9282	0.0007	0.9296
Internal Moderator Density = 060 %	0.9341	0.0008	0.9357
Internal Moderator Density = 070 %	0.9317	0.0007	0.9331
Internal Moderator Density = 080 %	0.9244	0.0007	0.9258
Internal Moderator Density = 090 %	0.9118	0.0006	0.9130
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9325	0.0007	0.9339
Internal Moderator Density = 070 %	0.9343	0.0008	0.9359
Internal Moderator Density = 080 %	0.9287	0.0007	0.9301
Internal Moderator Density = 090 %	0.9194	0.0008	0.9210
Internal Moderator Density = 100 %	0.9079	0.0006	0.9091
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9309	0.0006	0.9321
Internal Moderator Density = 070 %	0.9349	0.0007	0.9363
Internal Moderator Density = 080 %	0.9332	0.0007	0.9346
Internal Moderator Density = 090 %	0.9239	0.0007	0.9253
Internal Moderator Density = 100 %	0.9155	0.0006	0.9167
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9270	0.0008	0.9286
Internal Moderator Density = 070 %	0.9361	0.0007	0.9375
Internal Moderator Density = 080 %	0.9349	0.0007	0.9363
Internal Moderator Density = 090 %	0.9305	0.0008	0.9321
Internal Moderator Density = 100 %	0.9220	0.0007	0.9234
Enrichment = 4.85 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9213	0.0007	0.9227
Internal Moderator Density = 070 %	0.9307	0.0007	0.9321
Internal Moderator Density = 080 %	0.9329	0.0008	0.9345
Internal Moderator Density = 090 %	0.9303	0.0007	0.9317
Internal Moderator Density = 100 %	0.9223	0.0008	0.9239

Table U.6-44
CE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9300	0.0007	0.9314
Internal Moderator Density = 060 %	0.9341	0.0007	0.9355
Internal Moderator Density = 070 %	0.9297	0.0007	0.9311
Internal Moderator Density = 080 %	0.9204	0.0007	0.9218
Internal Moderator Density = 090 %	0.9054	0.0007	0.9068
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9333	0.0007	0.9347
Internal Moderator Density = 070 %	0.9338	0.0006	0.9350
Internal Moderator Density = 080 %	0.9264	0.0007	0.9278
Internal Moderator Density = 090 %	0.9156	0.0008	0.9172
Internal Moderator Density = 100 %	0.9010	0.0007	0.9024
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9318	0.0007	0.9332
Internal Moderator Density = 070 %	0.9343	0.0007	0.9357
Internal Moderator Density = 080 %	0.9281	0.0007	0.9295
Internal Moderator Density = 090 %	0.9176	0.0007	0.9190
Internal Moderator Density = 100 %	0.9079	0.0007	0.9093
Enrichment = 4.95 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9308	0.0007	0.9322
Internal Moderator Density = 070 %	0.9362	0.0007	0.9376
Internal Moderator Density = 080 %	0.9321	0.0007	0.9335
Internal Moderator Density = 090 %	0.9275	0.0007	0.9289
Internal Moderator Density = 100 %	0.9155	0.0007	0.9169
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9109	0.0007	0.9123
Internal Moderator Density = 070 %	0.9194	0.0007	0.9208
Internal Moderator Density = 080 %	0.9193	0.0007	0.9207
Internal Moderator Density = 090 %	0.9134	0.0007	0.9148
Internal Moderator Density = 100 %	0.9041	0.0007	0.9055

Table U.6-44
CE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9326	0.0006	0.9338
Internal Moderator Density = 060 %	0.9354	0.0007	0.9368
Internal Moderator Density = 070 %	0.9323	0.0007	0.9337
Internal Moderator Density = 080 %	0.9196	0.0009	0.9214
Internal Moderator Density = 090 %	0.9031	0.0006	0.9043
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9324	0.0007	0.9338
Internal Moderator Density = 070 %	0.9318	0.0007	0.9332
Internal Moderator Density = 080 %	0.9245	0.0007	0.9259
Internal Moderator Density = 090 %	0.9128	0.0007	0.9142
Internal Moderator Density = 100 %	0.9010	0.0007	0.9024
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9327	0.0007	0.9341
Internal Moderator Density = 070 %	0.9336	0.0006	0.9348
Internal Moderator Density = 080 %	0.9288	0.0007	0.9302
Internal Moderator Density = 090 %	0.9183	0.0008	0.9199
Internal Moderator Density = 100 %	0.9042	0.0006	0.9054
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9282	0.0007	0.9296
Internal Moderator Density = 070 %	0.9329	0.0007	0.9343
Internal Moderator Density = 080 %	0.9291	0.0008	0.9307
Internal Moderator Density = 090 %	0.9204	0.0007	0.9218
Internal Moderator Density = 100 %	0.9091	0.0007	0.9105
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9084	0.0007	0.9098
Internal Moderator Density = 070 %	0.9130	0.0007	0.9144
Internal Moderator Density = 080 %	0.9113	0.0007	0.9127
Internal Moderator Density = 090 %	0.9057	0.0007	0.9071
Internal Moderator Density = 100 %	0.8956	0.0006	0.8968

Table U.6-44
CE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9355	0.0007	0.9369
Internal Moderator Density = 060 %	0.9374	0.0006	0.9386
Internal Moderator Density = 070 %	0.9308	0.0007	0.9322
Internal Moderator Density = 080 %	0.9191	0.0007	0.9205
Internal Moderator Density = 090 %	0.9035	0.0007	0.9049
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9344	0.0007	0.9358
Internal Moderator Density = 070 %	0.9325	0.0007	0.9339
Internal Moderator Density = 080 %	0.9233	0.0007	0.9247
Internal Moderator Density = 090 %	0.9121	0.0007	0.9135
Internal Moderator Density = 100 %	0.8967	0.0006	0.8979
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9329	0.0007	0.9343
Internal Moderator Density = 070 %	0.9324	0.0007	0.9338
Internal Moderator Density = 080 %	0.9271	0.0007	0.9285
Internal Moderator Density = 090 %	0.9166	0.0006	0.9178
Internal Moderator Density = 100 %	0.9029	0.0008	0.9045
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9224	0.0006	0.9236
Internal Moderator Density = 070 %	0.9253	0.0008	0.9269
Internal Moderator Density = 080 %	0.9221	0.0007	0.9235
Internal Moderator Density = 090 %	0.9125	0.0008	0.9141
Internal Moderator Density = 100 %	0.8996	0.0007	0.9010
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9010	0.0008	0.9026
Internal Moderator Density = 070 %	0.9060	0.0007	0.9074
Internal Moderator Density = 080 %	0.9057	0.0007	0.9071
Internal Moderator Density = 090 %	0.8969	0.0007	0.8983
Internal Moderator Density = 100 %	0.8872	0.0007	0.8886

Table U.6-44
CE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 040 %	0.9257	0.0007	0.9271
Internal Moderator Density = 050 %	0.9361	0.0007	0.9375
Internal Moderator Density = 060 %	0.9357	0.0006	0.9369
Internal Moderator Density = 070 %	0.9283	0.0007	0.9297
Internal Moderator Density = 080 %	0.9153	0.0007	0.9167
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 050 %	0.9322	0.0007	0.9336
Internal Moderator Density = 060 %	0.9362	0.0006	0.9374
Internal Moderator Density = 070 %	0.9305	0.0007	0.9319
Internal Moderator Density = 080 %	0.9220	0.0006	0.9232
Internal Moderator Density = 090 %	0.9074	0.0007	0.9088
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 050 %	0.9201	0.0007	0.9215
Internal Moderator Density = 060 %	0.9285	0.0007	0.9299
Internal Moderator Density = 070 %	0.9272	0.0007	0.9286
Internal Moderator Density = 080 %	0.9174	0.0008	0.9190
Internal Moderator Density = 090 %	0.9071	0.0007	0.9085

Table U.6-44
CE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.55 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 040 %	0.9271	0.0007	0.9285
Internal Moderator Density = 050 %	0.9366	0.0007	0.9380
Internal Moderator Density = 060 %	0.9357	0.0006	0.9369
Internal Moderator Density = 070 %	0.9248	0.0006	0.9260
Internal Moderator Density = 080 %	0.9115	0.0007	0.9129
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 050 %	0.9276	0.0007	0.9290
Internal Moderator Density = 060 %	0.9306	0.0008	0.9322
Internal Moderator Density = 070 %	0.9258	0.0006	0.9270
Internal Moderator Density = 080 %	0.9144	0.0006	0.9156
Internal Moderator Density = 090 %	0.8996	0.0006	0.9008
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 050 %	0.9130	0.0007	0.9144
Internal Moderator Density = 060 %	0.9182	0.0007	0.9196
Internal Moderator Density = 070 %	0.9140	0.0007	0.9154
Internal Moderator Density = 080 %	0.9038	0.0006	0.9050
Internal Moderator Density = 090 %	0.8906	0.0007	0.8920

Table U.6-45
CE 14x14 Class Damaged Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.55 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9307	0.0007	0.9321
Internal Moderator Density = 070 %	0.9348	0.0007	0.9362
Internal Moderator Density = 080 %	0.9328	0.0006	0.9340
Internal Moderator Density = 090 %	0.9265	0.0007	0.9279
Internal Moderator Density = 100 %	0.9167	0.0006	0.9179
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9265	0.0007	0.9279
Internal Moderator Density = 070 %	0.9348	0.0007	0.9362
Internal Moderator Density = 080 %	0.9364	0.0007	0.9378
Internal Moderator Density = 090 %	0.9335	0.0007	0.9349
Internal Moderator Density = 100 %	0.9265	0.0006	0.9277
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9221	0.0008	0.9237
Internal Moderator Density = 070 %	0.9335	0.0007	0.9349
Internal Moderator Density = 080 %	0.9361	0.0007	0.9375
Internal Moderator Density = 090 %	0.9350	0.0007	0.9364
Internal Moderator Density = 100 %	0.9298	0.0007	0.9312
Enrichment = 4.35 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9144	0.0007	0.9158
Internal Moderator Density = 070 %	0.9286	0.0007	0.9300
Internal Moderator Density = 080 %	0.9341	0.0007	0.9355
Internal Moderator Density = 090 %	0.9357	0.0007	0.9371
Internal Moderator Density = 100 %	0.9324	0.0007	0.9338
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9076	0.0007	0.9090
Internal Moderator Density = 070 %	0.9251	0.0007	0.9265
Internal Moderator Density = 080 %	0.9332	0.0007	0.9346
Internal Moderator Density = 090 %	0.9354	0.0007	0.9368
Internal Moderator Density = 100 %	0.9339	0.0007	0.9353

Table U.6-45
CE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.80 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9334	0.0007	0.9348
Internal Moderator Density = 070 %	0.9343	0.0006	0.9355
Internal Moderator Density = 080 %	0.9316	0.0006	0.9328
Internal Moderator Density = 090 %	0.9223	0.0006	0.9235
Internal Moderator Density = 100 %	0.9108	0.0007	0.9122
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9260	0.0007	0.9274
Internal Moderator Density = 070 %	0.9332	0.0007	0.9346
Internal Moderator Density = 080 %	0.9323	0.0007	0.9337
Internal Moderator Density = 090 %	0.9280	0.0007	0.9294
Internal Moderator Density = 100 %	0.9195	0.0007	0.9209
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9263	0.0008	0.9279
Internal Moderator Density = 070 %	0.9346	0.0007	0.9360
Internal Moderator Density = 080 %	0.9356	0.0007	0.9370
Internal Moderator Density = 090 %	0.9317	0.0007	0.9331
Internal Moderator Density = 100 %	0.9259	0.0006	0.9271
Enrichment = 4.70 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9210	0.0007	0.9224
Internal Moderator Density = 070 %	0.9322	0.0007	0.9336
Internal Moderator Density = 080 %	0.9348	0.0008	0.9364
Internal Moderator Density = 090 %	0.9351	0.0007	0.9365
Internal Moderator Density = 100 %	0.9314	0.0007	0.9328
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9092	0.0007	0.9106
Internal Moderator Density = 070 %	0.9235	0.0007	0.9249
Internal Moderator Density = 080 %	0.9309	0.0007	0.9323
Internal Moderator Density = 090 %	0.9312	0.0007	0.9326
Internal Moderator Density = 100 %	0.9280	0.0009	0.9298

Table U.6-45
CE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9356	0.0007	0.9370
Internal Moderator Density = 070 %	0.9368	0.0007	0.9382
Internal Moderator Density = 080 %	0.9314	0.0008	0.9330
Internal Moderator Density = 090 %	0.9236	0.0007	0.9250
Internal Moderator Density = 100 %	0.9094	0.0008	0.9110
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9282	0.0007	0.9296
Internal Moderator Density = 070 %	0.9348	0.0006	0.9360
Internal Moderator Density = 080 %	0.9339	0.0007	0.9353
Internal Moderator Density = 090 %	0.9276	0.0007	0.9290
Internal Moderator Density = 100 %	0.9183	0.0008	0.9199
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9279	0.0007	0.9293
Internal Moderator Density = 070 %	0.9358	0.0007	0.9372
Internal Moderator Density = 080 %	0.9371	0.0008	0.9387
Internal Moderator Density = 090 %	0.9318	0.0007	0.9332
Internal Moderator Density = 100 %	0.9239	0.0007	0.9253
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9226	0.0007	0.9240
Internal Moderator Density = 070 %	0.9324	0.0007	0.9338
Internal Moderator Density = 080 %	0.9366	0.0007	0.9380
Internal Moderator Density = 090 %	0.9338	0.0007	0.9352
Internal Moderator Density = 100 %	0.9287	0.0007	0.9301
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9093	0.0007	0.9107
Internal Moderator Density = 070 %	0.9238	0.0008	0.9254
Internal Moderator Density = 080 %	0.9296	0.0007	0.9310
Internal Moderator Density = 090 %	0.9291	0.0007	0.9305
Internal Moderator Density = 100 %	0.9256	0.0008	0.9272

Table U.6-45
CE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9375	0.0007	0.9389
Internal Moderator Density = 070 %	**0.9380**	**0.0007**	**0.9394**
Internal Moderator Density = 080 %	0.9326	0.0006	0.9338
Internal Moderator Density = 090 %	0.9223	0.0007	0.9237
Internal Moderator Density = 100 %	0.9109	0.0007	0.9123
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9311	0.0007	0.9325
Internal Moderator Density = 070 %	0.9366	0.0006	0.9378
Internal Moderator Density = 080 %	0.9327	0.0007	0.9341
Internal Moderator Density = 090 %	0.9268	0.0006	0.9280
Internal Moderator Density = 100 %	0.9168	0.0007	0.9182
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9283	0.0007	0.9297
Internal Moderator Density = 070 %	0.9355	0.0007	0.9369
Internal Moderator Density = 080 %	0.9350	0.0007	0.9364
Internal Moderator Density = 090 %	0.9314	0.0006	0.9326
Internal Moderator Density = 100 %	0.9232	0.0007	0.9246
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9212	0.0007	0.9226
Internal Moderator Density = 070 %	0.9335	0.0007	0.9349
Internal Moderator Density = 080 %	0.9356	0.0007	0.9370
Internal Moderator Density = 090 %	0.9326	0.0008	0.9342
Internal Moderator Density = 100 %	0.9267	0.0007	0.9281
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9052	0.0009	0.9070
Internal Moderator Density = 070 %	0.9185	0.0007	0.9199
Internal Moderator Density = 080 %	0.9235	0.0007	0.9249
Internal Moderator Density = 090 %	0.9226	0.0008	0.9242
Internal Moderator Density = 100 %	0.9189	0.0007	0.9203

Table U.6-45
CE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	Iσ	k_{eff}
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9273	0.0007	0.9287
Internal Moderator Density = 060 %	0.9358	0.0007	0.9372
Internal Moderator Density = 070 %	0.9342	0.0006	0.9354
Internal Moderator Density = 080 %	0.9261	0.0007	0.9275
Internal Moderator Density = 090 %	0.9148	0.0007	0.9162
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9311	0.0007	0.9325
Internal Moderator Density = 070 %	0.9350	0.0006	0.9362
Internal Moderator Density = 080 %	0.9306	0.0007	0.9320
Internal Moderator Density = 090 %	0.9226	0.0007	0.9240
Internal Moderator Density = 100 %	0.9116	0.0006	0.9128
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9331	0.0007	0.9345
Internal Moderator Density = 070 %	0.9359	0.0008	0.9375
Internal Moderator Density = 080 %	0.9346	0.0007	0.9360
Internal Moderator Density = 090 %	0.9289	0.0008	0.9305
Internal Moderator Density = 100 %	0.9182	0.0007	0.9196

Table U.6-45
CE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.35 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9308	0.0006	0.9320
Internal Moderator Density = 060 %	0.9365	0.0009	0.9383
Internal Moderator Density = 070 %	0.9340	0.0006	0.9352
Internal Moderator Density = 080 %	0.9246	0.0006	0.9258
Internal Moderator Density = 090 %	0.9131	0.0007	0.9145
Enrichment = 4.85 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9330	0.0007	0.9344
Internal Moderator Density = 070 %	0.9363	0.0006	0.9375
Internal Moderator Density = 080 %	0.9289	0.0007	0.9303
Internal Moderator Density = 090 %	0.9222	0.0006	0.9234
Internal Moderator Density = 100 %	0.9069	0.0007	0.9083
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9290	0.0007	0.9304
Internal Moderator Density = 070 %	0.9323	0.0007	0.9337
Internal Moderator Density = 080 %	0.9287	0.0007	0.9301
Internal Moderator Density = 090 %	0.9207	0.0008	0.9223
Internal Moderator Density = 100 %	0.9099	0.0006	0.9111

Table U.6-46
WE 14x14 Class Damaged Fuel Assembly without CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.75 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9309	0.0007	0.9323
Internal Moderator Density = 060 %	0.9369	0.0007	0.9383
Internal Moderator Density = 070 %	0.9368	0.0006	0.9380
Internal Moderator Density = 080 %	0.9298	0.0007	0.9312
Internal Moderator Density = 090 %	0.9186	0.0006	0.9198
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9329	0.0007	0.9343
Internal Moderator Density = 070 %	0.9378	0.0007	0.9392
Internal Moderator Density = 080 %	0.9350	0.0007	0.9364
Internal Moderator Density = 090 %	0.9277	0.0007	0.9291
Internal Moderator Density = 100 %	0.9159	0.0006	0.9171
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9317	0.0008	0.9333
Internal Moderator Density = 070 %	0.9370	0.0007	0.9384
Internal Moderator Density = 080 %	0.9351	0.0007	0.9365
Internal Moderator Density = 090 %	0.9301	0.0007	0.9315
Internal Moderator Density = 100 %	0.9187	0.0007	0.9201
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9272	0.0008	0.9288
Internal Moderator Density = 070 %	0.9356	0.0006	0.9368
Internal Moderator Density = 080 %	0.9378	0.0008	0.9394
Internal Moderator Density = 090 %	0.9334	0.0007	0.9348
Internal Moderator Density = 100 %	0.9260	0.0008	0.9276
Enrichment = 4.85 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9202	0.0008	0.9218
Internal Moderator Density = 070 %	0.9322	0.0008	0.9338
Internal Moderator Density = 080 %	0.9353	0.0007	0.9367
Internal Moderator Density = 090 %	0.9336	0.0007	0.9350
Internal Moderator Density = 100 %	0.9282	0.0008	0.9298

Table U.6-46
WE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.95 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9298	0.0007	0.9312
Internal Moderator Density = 060 %	0.9334	0.0007	0.9348
Internal Moderator Density = 070 %	0.9299	0.0006	0.9311
Internal Moderator Density = 080 %	0.9206	0.0007	0.9220
Internal Moderator Density = 090 %	0.9082	0.0007	0.9096
Enrichment = 4.45 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9351	0.0007	0.9365
Internal Moderator Density = 070 %	0.9367	0.0008	0.9383
Internal Moderator Density = 080 %	0.9312	0.0006	0.9324
Internal Moderator Density = 090 %	0.9210	0.0007	0.9224
Internal Moderator Density = 100 %	0.9088	0.0007	0.9102
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9308	0.0006	0.9320
Internal Moderator Density = 070 %	0.9357	0.0007	0.9371
Internal Moderator Density = 080 %	0.9304	0.0008	0.9320
Internal Moderator Density = 090 %	0.9237	0.0008	0.9253
Internal Moderator Density = 100 %	0.9112	0.0006	0.9124
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9336	0.0007	0.9350
Internal Moderator Density = 070 %	**0.9383**	**0.0007**	**0.9397**
Internal Moderator Density = 080 %	0.9376	0.0007	0.9390
Internal Moderator Density = 090 %	0.9331	0.0007	0.9345
Internal Moderator Density = 100 %	0.9231	0.0007	0.9245
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9097	0.0007	0.9111
Internal Moderator Density = 070 %	0.9193	0.0007	0.9207
Internal Moderator Density = 080 %	0.9205	0.0007	0.9219
Internal Moderator Density = 090 %	0.9185	0.0007	0.9199
Internal Moderator Density = 100 %	0.9098	0.0008	0.9114

Table U.6-46
WE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.05 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9314	0.0007	0.9328
Internal Moderator Density = 060 %	0.9338	0.0007	0.9352
Internal Moderator Density = 070 %	0.9287	0.0007	0.9301
Internal Moderator Density = 080 %	0.9201	0.0008	0.9217
Internal Moderator Density = 090 %	0.9060	0.0007	0.9074
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9366	0.0007	0.9380
Internal Moderator Density = 070 %	0.9363	0.0007	0.9377
Internal Moderator Density = 080 %	0.9309	0.0007	0.9323
Internal Moderator Density = 090 %	0.9207	0.0007	0.9221
Internal Moderator Density = 100 %	0.9063	0.0007	0.9077
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9350	0.0007	0.9364
Internal Moderator Density = 070 %	0.9366	0.0007	0.9380
Internal Moderator Density = 080 %	0.9330	0.0007	0.9344
Internal Moderator Density = 090 %	0.9246	0.0007	0.9260
Internal Moderator Density = 100 %	0.9126	0.0007	0.9140
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9263	0.0007	0.9277
Internal Moderator Density = 070 %	0.9321	0.0007	0.9335
Internal Moderator Density = 080 %	0.9298	0.0007	0.9312
Internal Moderator Density = 090 %	0.9254	0.0007	0.9268
Internal Moderator Density = 100 %	0.9138	0.0007	0.9152
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9052	0.0007	0.9066
Internal Moderator Density = 070 %	0.9126	0.0009	0.9144
Internal Moderator Density = 080 %	0.9150	0.0007	0.9164
Internal Moderator Density = 090 %	0.9087	0.0007	0.9101
Internal Moderator Density = 100 %	0.9016	0.0007	0.9030

Table U.6-46
WE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.15 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9327	0.0007	0.9341
Internal Moderator Density = 060 %	0.9363	0.0007	0.9377
Internal Moderator Density = 070 %	0.9294	0.0007	0.9308
Internal Moderator Density = 080 %	0.9196	0.0008	0.9212
Internal Moderator Density = 090 %	0.9051	0.0006	0.9063
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9369	0.0007	0.9383
Internal Moderator Density = 070 %	0.9365	0.0007	0.9379
Internal Moderator Density = 080 %	0.9303	0.0006	0.9315
Internal Moderator Density = 090 %	0.9187	0.0007	0.9201
Internal Moderator Density = 100 %	0.9067	0.0007	0.9081
Enrichment = 4.85 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9358	0.0008	0.9374
Internal Moderator Density = 070 %	0.9372	0.0007	0.9386
Internal Moderator Density = 080 %	0.9314	0.0006	0.9326
Internal Moderator Density = 090 %	0.9225	0.0007	0.9239
Internal Moderator Density = 100 %	0.9106	0.0008	0.9122
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9216	0.0007	0.9230
Internal Moderator Density = 070 %	0.9267	0.0007	0.9281
Internal Moderator Density = 080 %	0.9235	0.0007	0.9249
Internal Moderator Density = 090 %	0.9157	0.0007	0.9171
Internal Moderator Density = 100 %	0.9058	0.0007	0.9072
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8997	0.0008	0.9013
Internal Moderator Density = 070 %	0.9065	0.0008	0.9081
Internal Moderator Density = 080 %	0.9080	0.0007	0.9094
Internal Moderator Density = 090 %	0.9002	0.0007	0.9016
Internal Moderator Density = 100 %	0.8909	0.0008	0.8925

Table U.6-46
WE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 040 %	0.9219	0.0007	0.9233
Internal Moderator Density = 050 %	0.9350	0.0007	0.9364
Internal Moderator Density = 060 %	0.9351	0.0007	0.9365
Internal Moderator Density = 070 %	0.9271	0.0007	0.9285
Internal Moderator Density = 080 %	0.9147	0.0006	0.9159
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 050 %	0.9271	0.0008	0.9287
Internal Moderator Density = 060 %	0.9344	0.0007	0.9358
Internal Moderator Density = 070 %	0.9328	0.0007	0.9342
Internal Moderator Density = 080 %	0.9250	0.0006	0.9262
Internal Moderator Density = 090 %	0.9117	0.0007	0.9131
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9255	0.0008	0.9271
Internal Moderator Density = 070 %	0.9258	0.0007	0.9272
Internal Moderator Density = 080 %	0.9184	0.0007	0.9198
Internal Moderator Density = 090 %	0.9087	0.0006	0.9099
Internal Moderator Density = 100 %	0.8941	0.0007	0.8955

Table U.6-46
WE 14x14 Class Damaged Fuel Assembly without CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.60 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 040 %	0.9268	0.0006	0.9280
Internal Moderator Density = 050 %	0.9380	0.0008	0.9396
Internal Moderator Density = 060 %	0.9367	0.0007	0.9381
Internal Moderator Density = 070 %	0.9288	0.0007	0.9302
Internal Moderator Density = 080 %	0.9158	0.0007	0.9172
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 050 %	0.9246	0.0007	0.9260
Internal Moderator Density = 060 %	0.9291	0.0007	0.9305
Internal Moderator Density = 070 %	0.9263	0.0006	0.9275
Internal Moderator Density = 080 %	0.9166	0.0007	0.9180
Internal Moderator Density = 090 %	0.9025	0.0007	0.9039

Table U.6-47
WE 14x14 Class Damaged Fuel Assembly with CCs Final Results

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.70 wt. % U-235, Soluble Boron = 2000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9353	0.0006	0.9365
Internal Moderator Density = 070 %	0.9377	0.0007	0.9391
Internal Moderator Density = 080 %	0.9342	0.0007	0.9356
Internal Moderator Density = 090 %	0.9274	0.0006	0.9286
Internal Moderator Density = 100 %	0.9165	0.0008	0.9181
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9304	0.0006	0.9316
Internal Moderator Density = 070 %	0.9364	0.0007	0.9378
Internal Moderator Density = 080 %	0.9377	0.0007	0.9391
Internal Moderator Density = 090 %	0.9345	0.0007	0.9359
Internal Moderator Density = 100 %	0.9274	0.0007	0.9288
Enrichment = 4.20 wt. % U-235, Soluble Boron = 2000 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9213	0.0008	0.9229
Internal Moderator Density = 070 %	0.9322	0.0008	0.9338
Internal Moderator Density = 080 %	0.9338	0.0006	0.9350
Internal Moderator Density = 090 %	0.9313	0.0007	0.9327
Internal Moderator Density = 100 %	0.9255	0.0006	0.9267
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2000 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9180	0.0007	0.9194
Internal Moderator Density = 070 %	0.9284	0.0007	0.9298
Internal Moderator Density = 080 %	0.9354	0.0007	0.9368
Internal Moderator Density = 090 %	0.9356	0.0007	0.9370
Internal Moderator Density = 100 %	0.9317	0.0007	0.9331
Enrichment = 4.75 wt. % U-235, Soluble Boron = 2000 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9089	0.0007	0.9103
Internal Moderator Density = 070 %	0.9250	0.0008	0.9266
Internal Moderator Density = 080 %	0.9331	0.0007	0.9345
Internal Moderator Density = 090 %	0.9358	0.0008	0.9374
Internal Moderator Density = 100 %	0.9327	0.0008	0.9343

Table U.6-47
WE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 3.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9316	0.0008	0.9332
Internal Moderator Density = 070 %	0.9320	0.0007	0.9334
Internal Moderator Density = 080 %	0.9265	0.0007	0.9279
Internal Moderator Density = 090 %	0.9169	0.0008	0.9185
Internal Moderator Density = 100 %	0.9045	0.0007	0.9059
Enrichment = 4.40 wt. % U-235, Soluble Boron = 2300 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9325	0.0007	0.9339
Internal Moderator Density = 070 %	0.9379	0.0007	0.9393
Internal Moderator Density = 080 %	0.9365	0.0007	0.9379
Internal Moderator Density = 090 %	0.9301	0.0006	0.9313
Internal Moderator Density = 100 %	0.9197	0.0007	0.9211
Enrichment = 4.60 wt. % U-235, Soluble Boron = 2300 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9319	0.0007	0.9333
Internal Moderator Density = 070 %	0.9382	0.0007	0.9396
Internal Moderator Density = 080 %	0.9384	0.0006	0.9396
Internal Moderator Density = 090 %	0.9348	0.0008	0.9364
Internal Moderator Density = 100 %	0.9269	0.0006	0.9281
Enrichment = 4.90 wt. % U-235, Soluble Boron = 2300 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9252	0.0007	0.9266
Internal Moderator Density = 070 %	0.9349	0.0007	0.9363
Internal Moderator Density = 080 %	0.9382	0.0007	0.9396
Internal Moderator Density = 090 %	0.9374	0.0007	0.9388
Internal Moderator Density = 100 %	0.9302	0.0006	0.9314
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2300 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9071	0.0007	0.9085
Internal Moderator Density = 070 %	0.9197	0.0008	0.9213
Internal Moderator Density = 080 %	0.9255	0.0008	0.9271
Internal Moderator Density = 090 %	0.9258	0.0007	0.9272
Internal Moderator Density = 100 %	0.9239	0.0007	0.9253

Table U.6-47
WE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9337	0.0007	0.9351
Internal Moderator Density = 070 %	0.9338	0.0007	0.9352
Internal Moderator Density = 080 %	0.9257	0.0006	0.9269
Internal Moderator Density = 090 %	0.9183	0.0006	0.9195
Internal Moderator Density = 100 %	0.9034	0.0006	0.9046
Enrichment = 4.50 wt. % U-235, Soluble Boron = 2400 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9324	0.0007	0.9338
Internal Moderator Density = 070 %	0.9378	0.0008	0.9394
Internal Moderator Density = 080 %	0.9358	0.0007	0.9372
Internal Moderator Density = 090 %	0.9295	0.0006	0.9307
Internal Moderator Density = 100 %	0.9189	0.0007	0.9203
Enrichment = 4.65 wt. % U-235, Soluble Boron = 2400 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9290	0.0006	0.9302
Internal Moderator Density = 070 %	0.9361	0.0007	0.9375
Internal Moderator Density = 080 %	0.9345	0.0006	0.9357
Internal Moderator Density = 090 %	0.9301	0.0006	0.9313
Internal Moderator Density = 100 %	0.9210	0.0007	0.9224
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9244	0.0007	0.9258
Internal Moderator Density = 070 %	0.9365	0.0007	0.9379
Internal Moderator Density = 080 %	0.9381	0.0008	0.9397
Internal Moderator Density = 090 %	0.9351	0.0007	0.9365
Internal Moderator Density = 100 %	0.9284	0.0007	0.9298
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2400 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.9022	0.0008	0.9038
Internal Moderator Density = 070 %	0.9138	0.0008	0.9154
Internal Moderator Density = 080 %	0.9198	0.0006	0.9210
Internal Moderator Density = 090 %	0.9203	0.0008	0.9219
Internal Moderator Density = 100 %	0.9143	0.0008	0.9159

Table U.6-47
WE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.10 wt. % U-235, Soluble Boron = 2500 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 060 %	0.9345	0.0007	0.9359
Internal Moderator Density = 070 %	0.9349	0.0007	0.9363
Internal Moderator Density = 080 %	0.9274	0.0007	0.9288
Internal Moderator Density = 090 %	0.9175	0.0007	0.9189
Internal Moderator Density = 100 %	0.9026	0.0007	0.9040
Enrichment = 4.55 wt. % U-235, Soluble Boron = 2500 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9307	0.0008	0.9323
Internal Moderator Density = 070 %	0.9341	0.0007	0.9355
Internal Moderator Density = 080 %	0.9319	0.0007	0.9333
Internal Moderator Density = 090 %	0.9242	0.0007	0.9256
Internal Moderator Density = 100 %	0.9148	0.0007	0.9162
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2500 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9313	0.0008	0.9329
Internal Moderator Density = 070 %	0.9372	0.0007	0.9386
Internal Moderator Density = 080 %	0.9363	0.0007	0.9377
Internal Moderator Density = 090 %	0.9320	0.0007	0.9334
Internal Moderator Density = 100 %	0.9222	0.0006	0.9234
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1D or 2D Basket			
Internal Moderator Density = 060 %	0.9197	0.0007	0.9211
Internal Moderator Density = 070 %	0.9285	0.0007	0.9299
Internal Moderator Density = 080 %	0.9298	0.0007	0.9312
Internal Moderator Density = 090 %	0.9269	0.0007	0.9283
Internal Moderator Density = 100 %	0.9209	0.0007	0.9223
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2500 ppm, Type 1E or 2E Basket			
Internal Moderator Density = 060 %	0.8964	0.0007	0.8978
Internal Moderator Density = 070 %	0.9098	0.0007	0.9112
Internal Moderator Density = 080 %	0.9147	0.0007	0.9161
Internal Moderator Density = 090 %	0.9124	0.0007	0.9138
Internal Moderator Density = 100 %	0.9067	0.0008	0.9083

Table U.6-47
WE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Continued)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.30 wt. % U-235, Soluble Boron = 2800 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9295	0.0007	0.9309
Internal Moderator Density = 060 %	0.9320	0.0008	0.9336
Internal Moderator Density = 070 %	0.9302	0.0009	0.9320
Internal Moderator Density = 080 %	0.9212	0.0007	0.9226
Internal Moderator Density = 090 %	0.9077	0.0006	0.9089
Enrichment = 4.80 wt. % U-235, Soluble Boron = 2800 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9302	0.0007	0.9316
Internal Moderator Density = 070 %	0.9334	0.0007	0.9348
Internal Moderator Density = 080 %	0.9294	0.0007	0.9308
Internal Moderator Density = 090 %	0.9182	0.0008	0.9198
Internal Moderator Density = 100 %	0.9069	0.0006	0.9081
Enrichment = 5.00 wt. % U-235, Soluble Boron = 2800 ppm, Type 1C or 2C Basket			
Internal Moderator Density = 060 %	0.9296	0.0007	0.9310
Internal Moderator Density = 070 %	0.9323	0.0007	0.9337
Internal Moderator Density = 080 %	0.9298	0.0008	0.9314
Internal Moderator Density = 090 %	0.9211	0.0007	0.9225
Internal Moderator Density = 100 %	0.9110	0.0007	0.9124

Table U.6-47
WE 14x14 Class Damaged Fuel Assembly with CCs Final Results

(Concluded)

Model Description	k_{KENO}	1σ	k_{eff}
Enrichment = 4.50 wt. % U-235, Soluble Boron = 3000 ppm, Type 1A or 2A Basket			
Internal Moderator Density = 050 %	0.9333	0.0006	0.9345
Internal Moderator Density = 060 %	0.9352	0.0007	0.9366
Internal Moderator Density = 070 %	0.9311	0.0007	0.9325
Internal Moderator Density = 080 %	0.9215	0.0007	0.9229
Internal Moderator Density = 090 %	0.9085	0.0007	0.9099
Enrichment = 5.00 wt. % U-235, Soluble Boron = 3000 ppm, Type 1B or 2B Basket			
Internal Moderator Density = 060 %	0.9328	0.0008	0.9344
Internal Moderator Density = 070 %	0.9337	0.0007	0.9351
Internal Moderator Density = 080 %	0.9282	0.0007	0.9296
Internal Moderator Density = 090 %	0.9160	0.0007	0.9174
Internal Moderator Density = 100 %	0.9046	0.0006	0.9058

Table U.6-48
Summary of Criticality Results for Intact Fuel Assemblies

Model Description	k_{KENO}	1σ	k_{eff}
Regulatory Requirements			
Dry Storage - Bounded by infinite array of dry casks	0.5519	0.0005	0.5529
Normal Conditions - Wet Loading	0.9397	0.0007	0.9411
Accident Conditions - damaged transfer cask while fuel still wet	0.9397	0.0007	0.9411

Table U.6-49
Summary of Criticality Results for Damaged Fuel Assemblies

Model Description	k_{KENO}	1σ	k_{eff}
Regulatory Requirements			
Dry Storage - Bounded by infinite array of dry casks	0.6127	0.0004	0.6135
Normal Conditions - Wet Loading	0.9379	0.0008	0.9395
Accident Conditions - damaged transfer cask while fuel still wet	0.9386	0.0006	0.9399

Table U.6-50
Benchmarking Results

Run ID	U Enrich. Wt%	Pitch (cm)	H_2O/fuel Volume	Separation of Assemblies (cm)	AEG	k_{eff}	1σ
B1645SO1	2.46	1.41	1.015	1.78	32.8118	0.9965	0.0008
B1645SO2	2.46	1.41	1.015	1.78	32.7528	1.0006	0.0008
BW1231B1	4.02	1.511	1.139		31.1429	0.9966	0.0009
BW1231B2	4.02	1.511	1.139		29.8872	0.9990	0.0007
BW1273M	2.46	1.511	1.376		32.2213	0.9961	0.0007
BW1484A1	2.46	1.636	1.841	1.636	34.5373	0.9975	0.0008
BW1484A2	2.46	1.636	1.841	4.908	35.1630	0.9934	0.0008
BW1484B1	2.46	1.636	1.841		33.9415	0.9984	0.0008
BW1484B2	2.46	1.636	1.841	1.636	34.5780	0.9961	0.0009
BW1484B3	2.46	1.636	1.841	4.908	35.2638	0.9978	0.0008
BW1484C1	2.46	1.636	1.841	1.636	34.6547	0.9936	0.0009
BW1484C2	2.46	1.636	1.841	1.636	35.2469	0.9944	0.0010
BW1484S1	2.46	1.636	1.841	1.636	34.5159	1.0002	0.0008
BW1484S2	2.46	1.636	1.841	1.636	34.5530	0.9990	0.0008
BW1484SL	2.46	1.636	1.841	6.544	35.4203	0.9944	0.0009
BW1645S1	2.46	1.209	0.383	1.778	30.1060	0.9987	0.0008
BW1645S2	2.46	1.209	0.383	1.778	29.9920	1.0049	0.0008
BW1810A	2.46	1.636	1.841		33.9524	0.9987	0.0006
BW1810B	2.46	1.636	1.841		33.9711	0.9995	0.0006
BW1810CR	2.46	1.636	1.841		33.1556	0.9995	0.0008
BW1810D	2.46	1.636	1.841		33.0876	0.9981	0.0010
BW1810E	2.46	1.636	1.841		33.1520	0.9991	0.0007
BW1810F	2.46	1.636	1.841		33.9581	1.0029	0.0007
BW1810GR	2.46	1.636	1.841		32.9478	0.9986	0.0007
BW1810H	2.46	1.636	1.841		32.9370	0.9981	0.0008
BW1810I	2.46	1.636	1.841		33.9613	1.0028	0.0007
BW1810J	2.46	1.636	1.841		33.1379	0.9995	0.0008
EPRU65	2.35	1.562	1.196		33.9138	0.9959	0.0008
EPRU65B	2.35	1.562	1.196		33.4073	1.0000	0.0009
EPRU75	2.35	1.905	2.408		35.8676	0.9968	0.0009
EPRU75B	2.35	1.905	2.408		35.3074	1.0002	0.0008
EPRU87	2.35	2.21	3.687		36.6120	1.0011	0.0009
EPRU87B	2.35	2.21	3.687		36.3460	1.0003	0.0008
NSE71SQ	4.74	1.26	1.823		33.7627	0.9978	0.0009
NSE71W1	4.74	1.26	1.823		34.0088	0.9981	0.0010
NSE71W2	4.74	1.26	1.823		34.3856	0.9995	0.0010

Table U.6-50
Benchmarking Results

(Continued)

Run ID	U Enrich. Wt%	Pitch (cm)	H_2O/fuel Volume	Separation of Assemblies (cm)	AEG	k_{eff}	1σ
P2438BA	2.35	2.032	2.918	5.05	36.2244	0.9973	0.0009
P2438SLG	2.35	2.032	2.918	8.39	36.2906	0.9985	0.0009
P2438SS	2.35	2.032	2.918	6.88	36.2690	0.9979	0.0009
P2438ZR	2.35	2.032	2.918	8.79	36.2891	0.9976	0.0009
P2615BA	4.31	2.54	3.883	6.72	35.7276	1.0005	0.0011
P2615SS	4.31	2.54	3.883	8.58	35.7456	0.9959	0.0011
P2615ZR	4.31	2.54	3.883	10.92	35.7709	0.9980	0.0010
P2827L1	2.35	2.032	2.918	13.72	36.2491	1.0051	0.0008
P2827L2	2.35	2.032	2.918	11.25	36.2939	1.0005	0.0010
P2827L3	4.31	2.54	3.883	20.78	35.6740	1.0095	0.0009
P2827L4	4.31	2.54	3.883	19.04	35.7173	1.0066	0.0010
P2827SLG	2.35	2.032	2.918	8.31	36.3010	0.9957	0.0008
P3314BA	4.31	1.892	1.6	2.83	33.1874	1.0000	0.0009
P3314BC	4.31	1.892	1.6	2.83	33.2334	0.9992	0.0009
P3314BF1	4.31	1.892	1.6	2.83	33.2422	1.0024	0.0009
P3314BF2	4.31	1.892	1.6	2.83	33.2121	1.0001	0.0010
P3314BS1	2.35	1.684	1.6	3.86	34.8545	0.9957	0.0010
P3314BS2	2.35	1.684	1.6	3.46	34.8324	0.9940	0.0008
P3314BS3	4.31	1.892	1.6	7.23	33.4328	0.9996	0.0009
P3314BS4	4.31	1.892	1.6	6.63	33.4152	1.0000	0.0008
P3314SLG	4.31	1.892	1.6	2.83	34.0109	0.9971	0.0010
P3314SS1	4.31	1.892	1.6	2.83	33.9613	0.9984	0.0010
P3314SS2	4.31	1.892	1.6	2.83	33.7719	1.0014	0.0009
P3314SS3	4.31	1.892	1.6	2.83	33.8956	0.9995	0.0010
P3314SS4	4.31	1.892	1.6	2.83	33.7604	0.9962	0.0009
P3314SS5	2.35	1.684	1.6	7.8	34.9476	0.9947	0.0010
P3314SS6	4.31	1.892	1.6	10.52	33.5406	1.0010	0.0008
P3314W1	4.31	1.892	1.6		34.3962	1.0009	0.0010
P3314W2	2.35	1.684	1.6		35.2153	0.9972	0.0008
P3314ZR	4.31	1.892	1.6	2.83	33.9897	0.9977	0.0010
P3602BB	4.31	1.892	1.6	8.3	33.3198	1.0031	0.0010
P3602BS1	2.35	1.684	1.6	4.8	34.7746	1.0034	0.0009
P3602BS2	4.31	1.892	1.6	9.83	33.3649	1.0047	0.0010
P3602N11	2.35	1.684	1.6	8.98	34.7410	1.0025	0.0008
P3602N12	2.35	1.684	1.6	9.58	34.8378	1.0048	0.0009

Table U.6-50
Benchmarking Results

(Continued)

Run ID	U Enrich. Wt%	Pitch (cm)	H_2O/fuel Volume	Separation of Assemblies (cm)	AEG	k_{eff}	1σ
P3602N13	2.35	1.684	1.6	9.66	34.9334	1.0006	0.0009
P3602N14	2.35	1.684	1.6	8.54	35.0287	0.9969	0.0010
P3602N21	2.35	2.032	2.918	10.36	36.2787	0.9999	0.0009
P3602N22	2.35	2.032	2.918	11.2	36.1963	1.0014	0.0008
P3602N31	4.31	1.892	1.6	14.87	33.2015	1.0063	0.0010
P3602N32	4.31	1.892	1.6	15.74	33.3085	1.0072	0.0010
P3602N33	4.31	1.892	1.6	15.87	33.4168	1.0084	0.0010
P3602N34	4.31	1.892	1.6	15.84	33.4653	1.0028	0.0010
P3602N35	4.31	1.892	1.6	15.45	33.5169	1.0030	0.0009
P3602N36	4.31	1.892	1.6	13.82	33.5832	1.0003	0.0010
P3602N41	4.31	2.54	3.883	12.89	35.5269	1.0127	0.0010
P3602N42	4.31	2.54	3.883	14.12	35.6711	1.0068	0.0009
P3602N43	4.31	2.54	3.883	12.44	35.7505	1.0049	0.0009
P3602SS1	2.35	1.684	1.6	8.28	34.8708	1.0007	0.0009
P3602SS2	4.31	1.892	1.6	13.75	33.4133	1.0026	0.0010
P3926L1	2.35	1.684	1.6	10.06	34.8569	1.0003	0.0009
P3926L2	2.35	1.684	1.6	10.11	34.9374	1.0020	0.0008
P3926L3	2.35	1.684	1.6	8.5	35.0657	0.9967	0.0010
P3926L4	4.31	1.892	1.6	17.74	33.3262	1.0066	0.0009
P3926L5	4.31	1.892	1.6	18.18	33.4035	1.0054	0.0010
P3926L6	4.31	1.892	1.6	17.43	33.5141	1.0038	0.0009
P3926SL1	2.35	1.684	1.6	6.59	35.0674	0.9950	0.0009
P3926SL2	4.31	1.892	1.6	12.79	33.5810	0.9998	0.0009
P4267B1	4.31	1.89	1.59		31.7989	0.9992	0.0008
P4267B2	4.31	1.89	1.59		31.5288	1.0027	0.0007
P4267B3	4.31	1.715	1.09		30.9907	1.0057	0.0009
P4267B4	4.31	1.715	1.09		30.5098	0.9993	0.0008
P4267B5	4.31	1.715	1.09		30.1008	1.0009	0.0008
P4267SL1	4.31	1.89	1.59		33.4692	0.9987	0.0011
P4267SL2	4.31	1.715	1.09		31.9346	0.9995	0.0011
P62FT231	4.31	1.891	1.6	5.67	32.9228	1.0020	0.0009
P71F14F3	4.31	1.891	1.6	5.19	32.8227	1.0009	0.0010
P71F14V3	4.31	1.891	1.6	5.19	32.8587	0.9977	0.0010
P71F14V5	4.31	1.891	1.6	5.19	32.8662	0.9980	0.0010
P71F214R	4.31	1.891	1.6	5.19	32.8669	0.9976	0.0009

Table U.6-50
Benchmarking Results

(Concluded)

Run ID	U Enrich. Wt%	Pitch (cm)	H_2O/fuel Volume	Separation of Assemblies (cm)	AEG	k_{eff}	1σ
PAT80L1	4.74	1.6	3.807	2	35.0276	1.0014	0.0009
PAT80L2	4.74	1.6	3.807	2	35.1079	0.9986	0.0011
PAT80SS1	4.74	1.6	3.807	2	35.0125	0.9998	0.0009
PAT80SS2	4.74	1.6	3.807	2	35.1128	0.9967	0.0010
W3269A	5.7	1.422	1.93		33.1383	0.9976	0.0009
W3269B1	3.7	1.105	1.432		32.4010	0.9962	0.0008
W3269B2	3.7	1.105	1.432		32.3940	0.9965	0.0008
W3269B3	3.7	1.105	1.432		32.2464	0.9945	0.0008
W3269C	2.72	1.524	1.494		33.7731	0.9979	0.0009
W3269SL1	2.72	1.524	1.494		33.3854	0.9973	0.0010
W3269SL2	5.7	1.422	1.93		33.1006	1.0024	0.0010
W3269W1	2.72	1.524	1.494		33.5160	0.9972	0.0012
W3269W2	5.7	1.422	1.93		33.1786	1.0015	0.0010
W3385S11	5.74	1.422	1.932		33.2320	1.0004	0.0009
W3385S12	5.74	2.012	5.067		35.8876	1.0014	0.0010
Correlation	**0.32**	**0.41**	**0.19**	**0.66**	**-0.04**	**N/A**	**N/A**

Table U.6-51
USL-1 Results

Parameter	Range of Applicability	Formula for USL-1 (0.05 Δk_{eff} Margin)
U Enrichment (wt% U-235)	2.35 – 5.74	0.9404 + (1.0545E-03)*X (X < 3.5906) 0.9442 (X > = 3.5906)
Fuel Rod Pitch (cm)	1.105 – 2.540	0.9357 + (4.7885E-03)*X (X < 1.7997) 0.9443 (X > = 1.7997)
Water/Fuel Volume Ratio	0.383 – 5.067	0.9421 + (7.5929E-04)*X (X < 2.1362) 0.9438 (X >= 2.1362)
Assembly Separation (cm)	1.636 – 20.78	0.9409 + (5.0511E-04)*X (X < 7.1170) 0.9442 (X >= 7.1170)
Average Energy Group Causing Fission (AEG)	29.9 – 36.6	0.9438 (X < 32.694) 0.9467 + (-8.8965E-05)*X (X >= 32.694)

Table U.6-52
USL Determination for Criticality Analysis

Parameter	Value from Limiting Analysis	Bounding USL-1
U Enrichment (wt. % U-235)	3.3	0.9438
Fuel Rod Pitch (cm)	1.25984	**0.9417**
Water/Fuel Ratio	1.619	0.9433
Assembly Separation (cm)	2.2225	0.9420
Average Energy Group Causing Fission (AEG)	30.12	0.9438

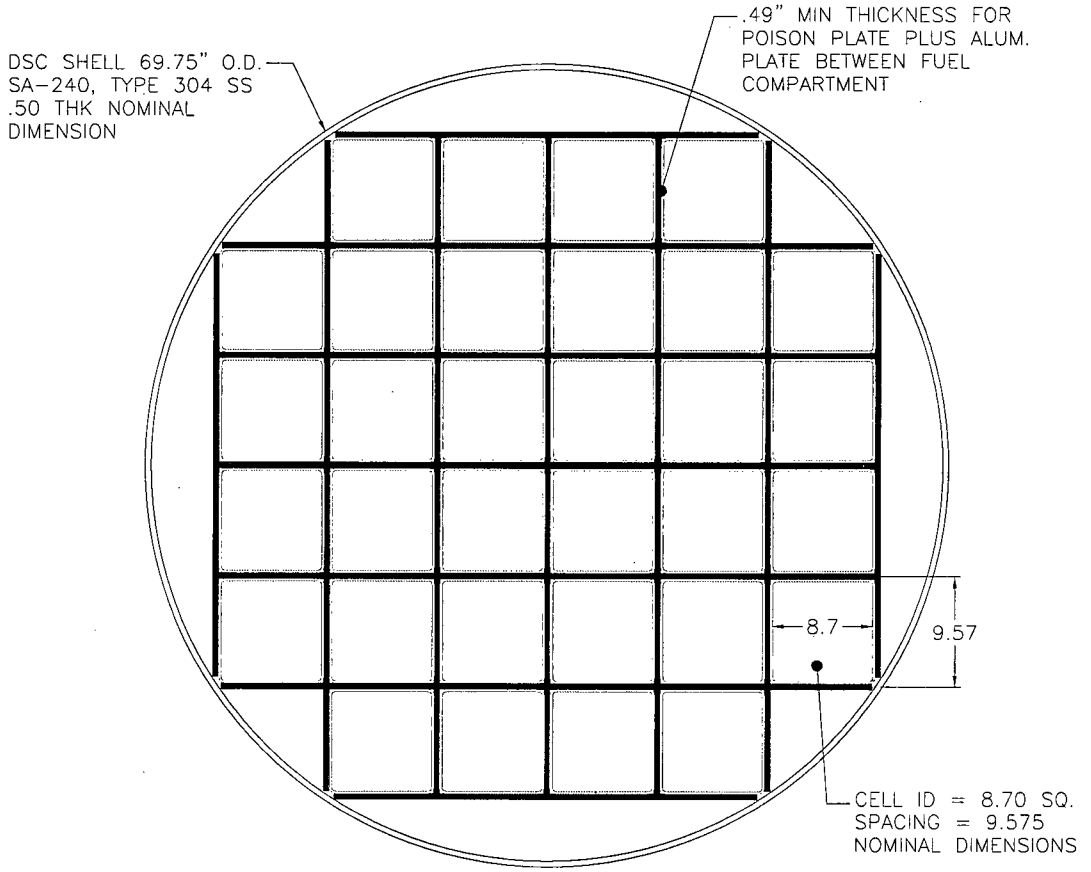

Figure U.6-1
NUHOMS® 32PTH1 DSC Cross Section

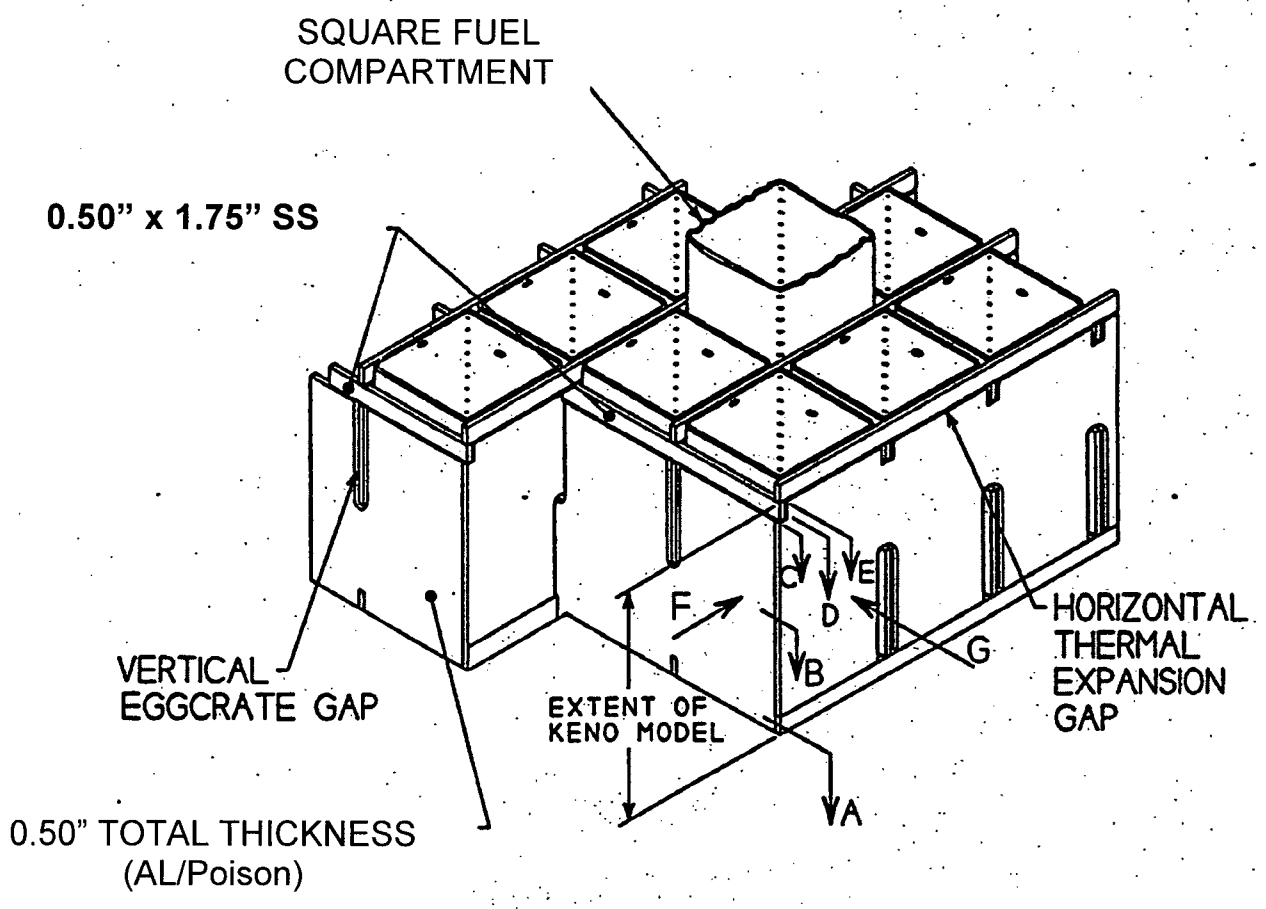

Figure U.6-2
Basket Views and Dimensions

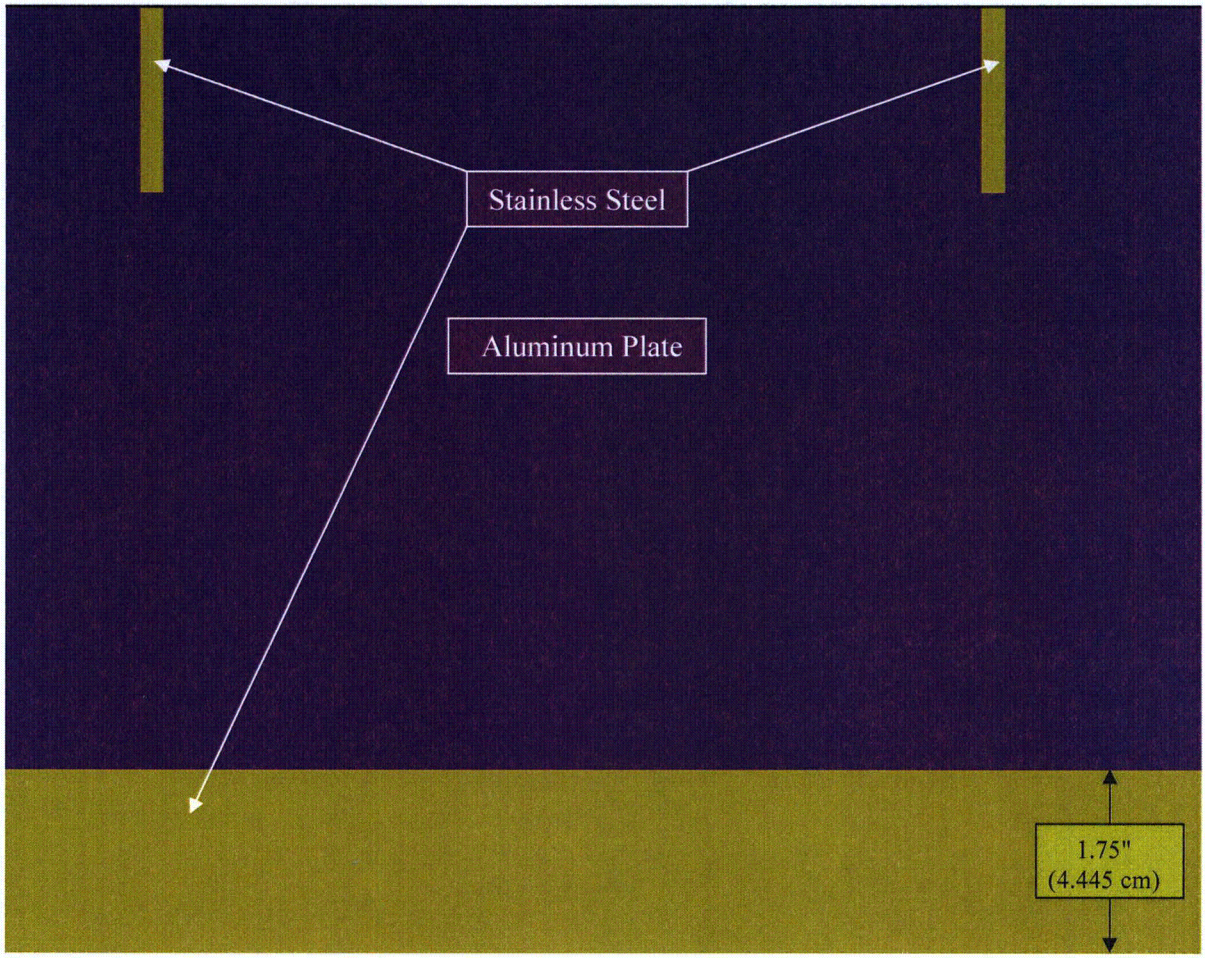

Figure U.6-3
Basket Model Compartment Wall (View G)

(Not to Scale)

Periodic Boundary at the Top of Model

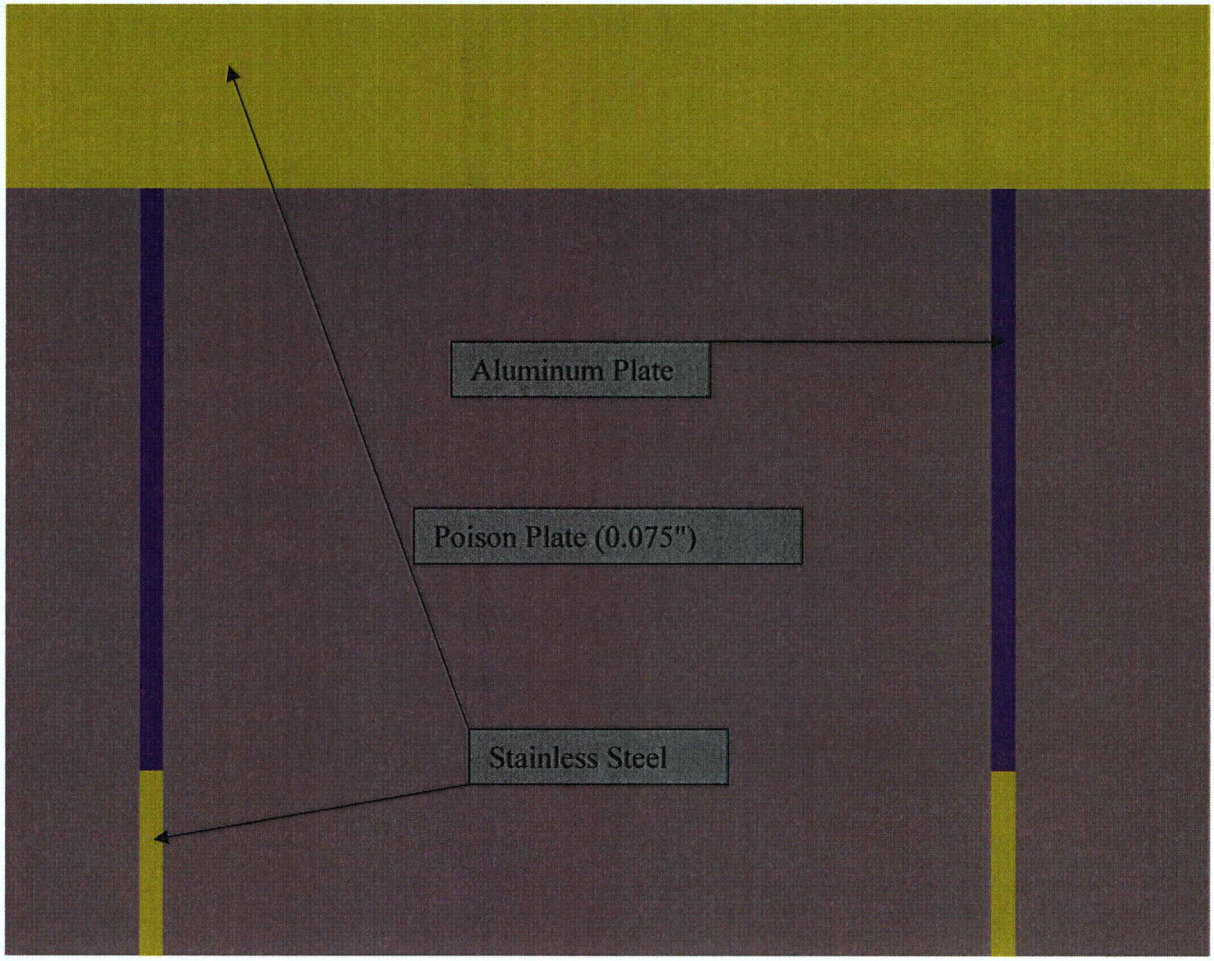

Figure U.6-4
Basket Model Compartment Wall (View F)

(Not to Scale)

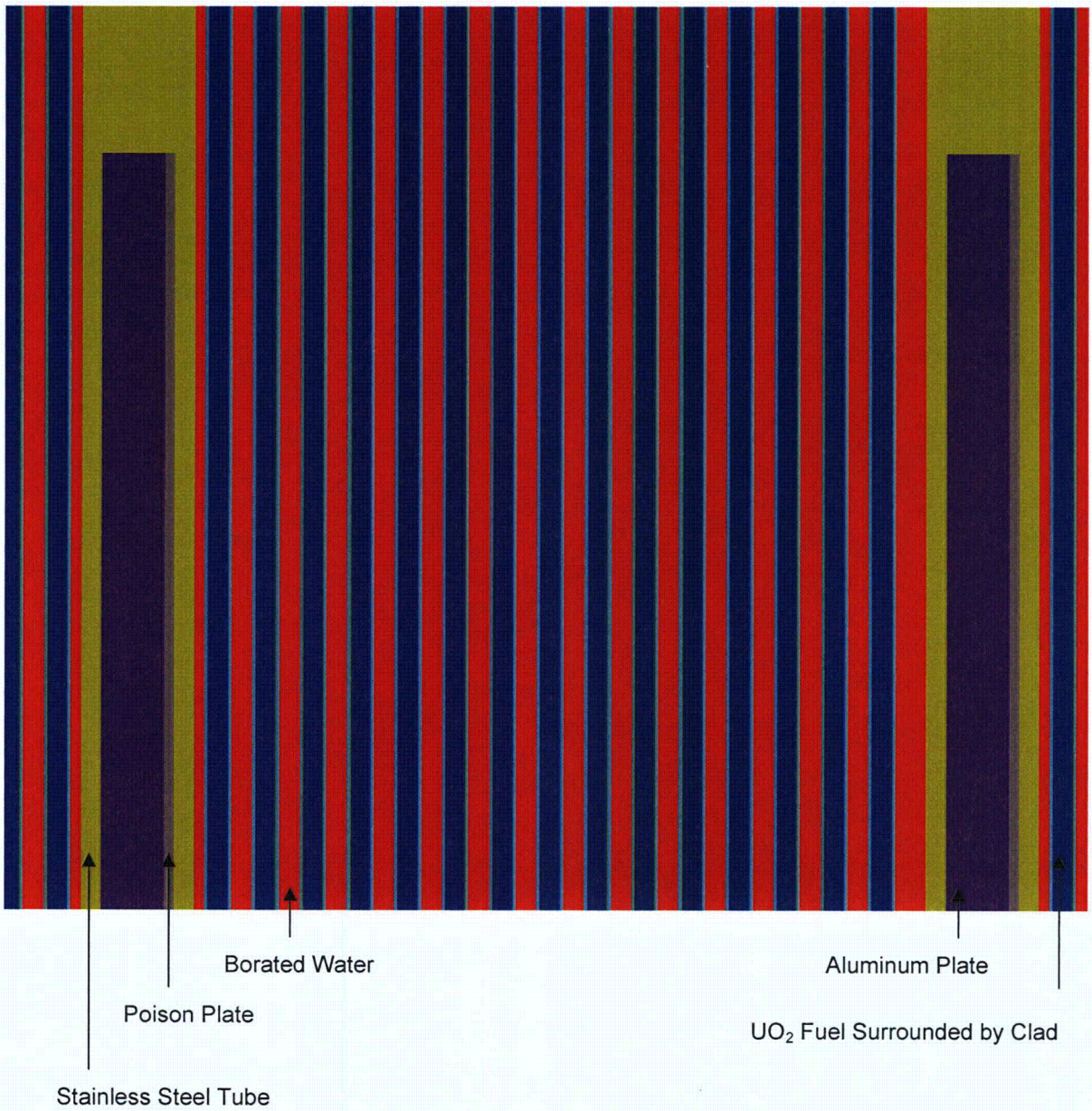

Figure U.6-5
Basket Model Compartment Wall with Fuel Assembly (View G)

(Not to Scale)

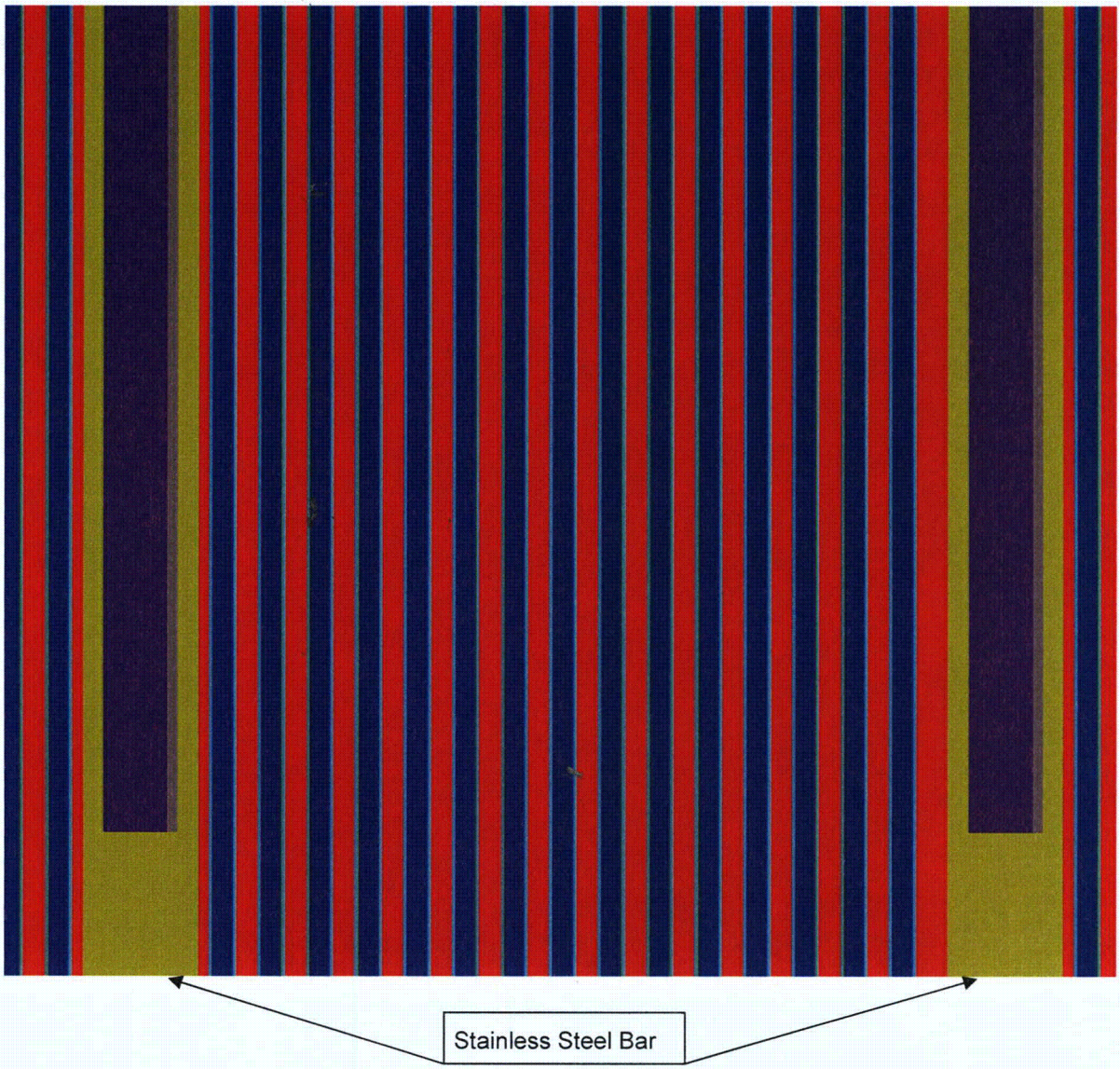

Figure U.6-6
Basket Model Compartment Wall with Fuel Assembly (View F)

(Not to Scale)

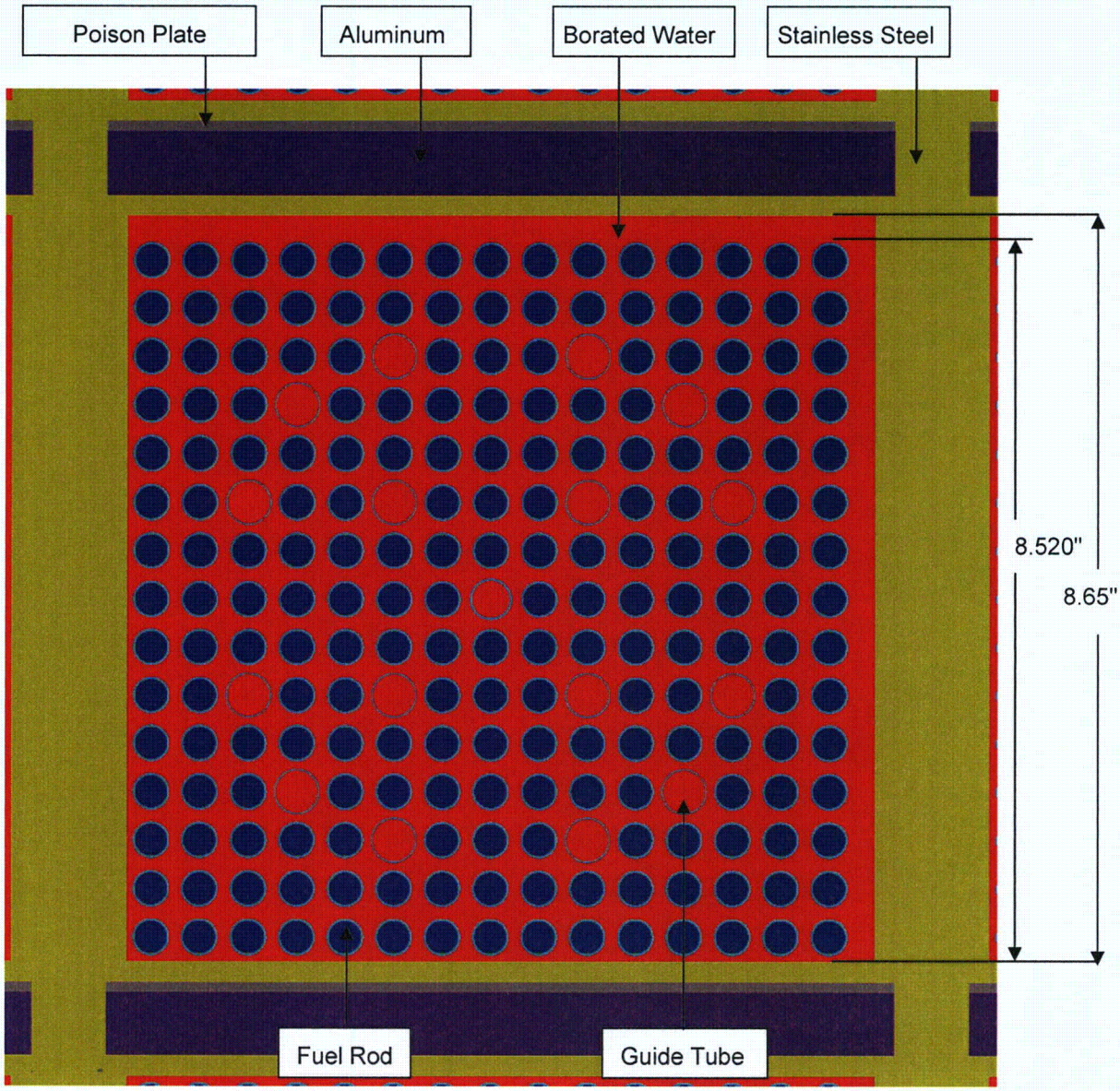

Figure U.6-7
Basket Compartment with B&W 15x15 Fuel Assembly (Section A)

(Not to Scale)

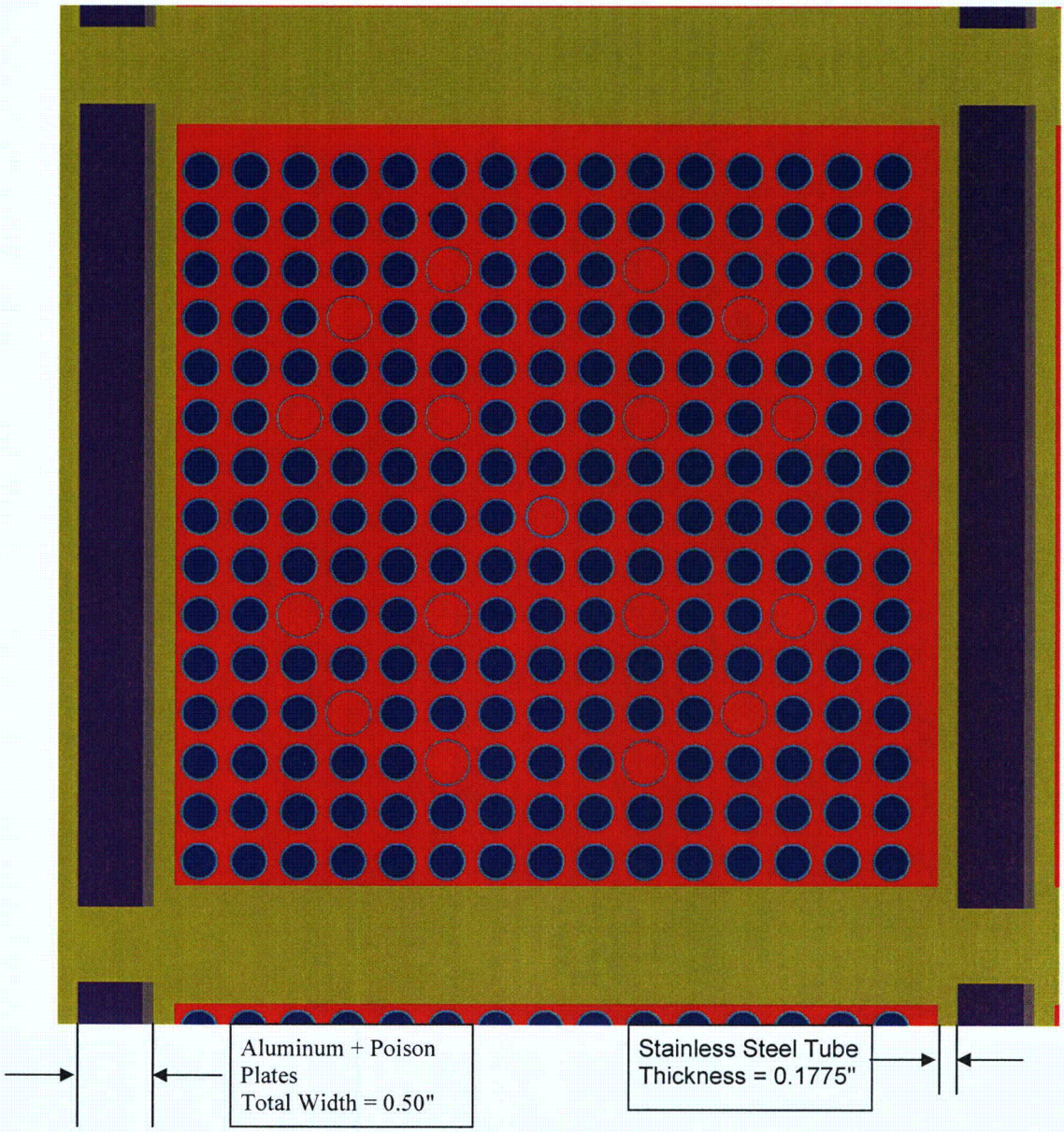

Figure U.6-8
Basket Compartment with Fuel Assembly (Section B)

(Not to Scale)

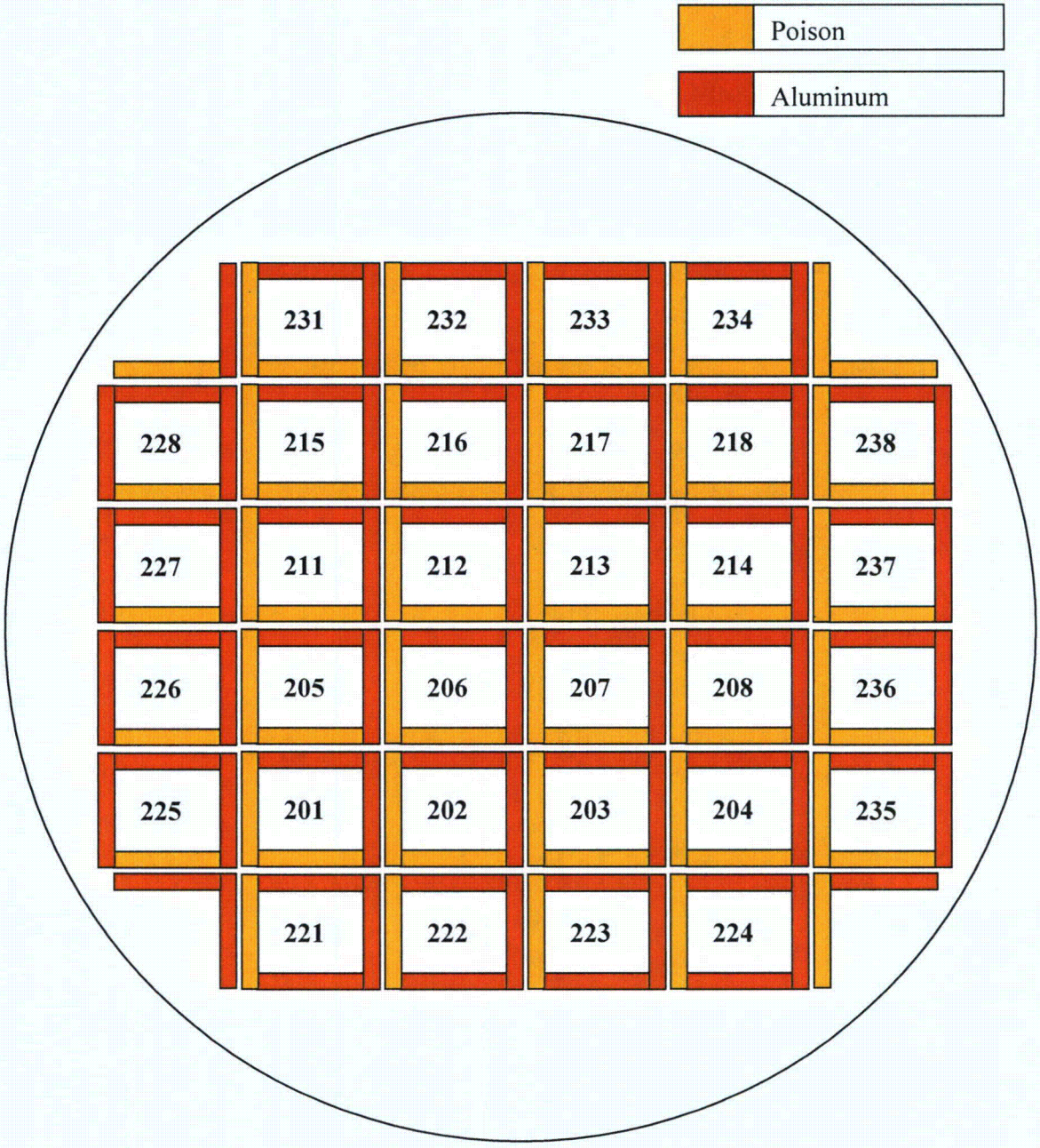

Figure U.6-9
Fuel Position and Poison Plate Location in the 32PTH1 DSC Design

(Not to Scale)

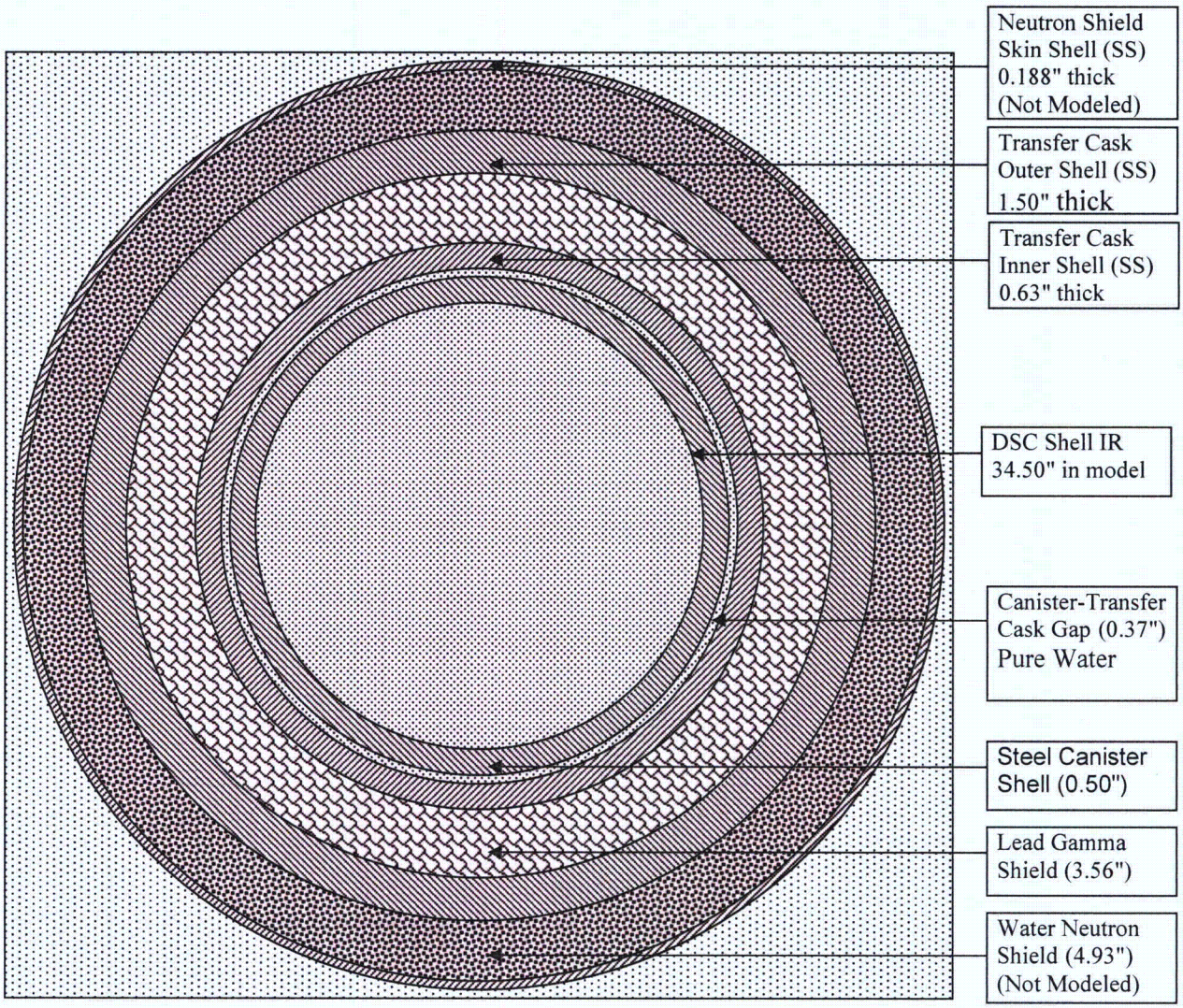

Figure U.6-10
Canister and Transfer Cask Description in the KENO Model

(Not to Scale)

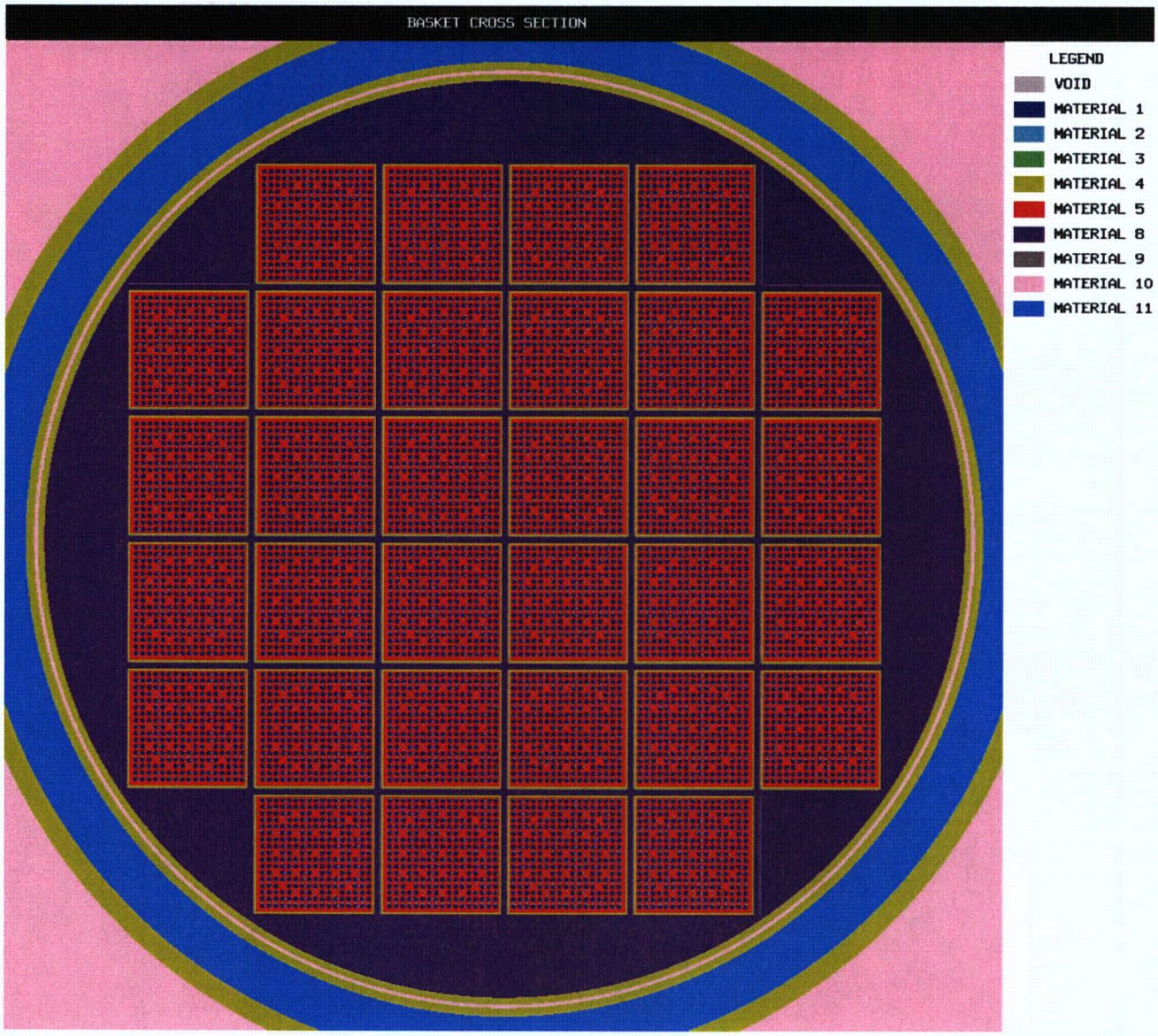

Figure U.6-11
WE 17x17 Class Assembly KENO Model

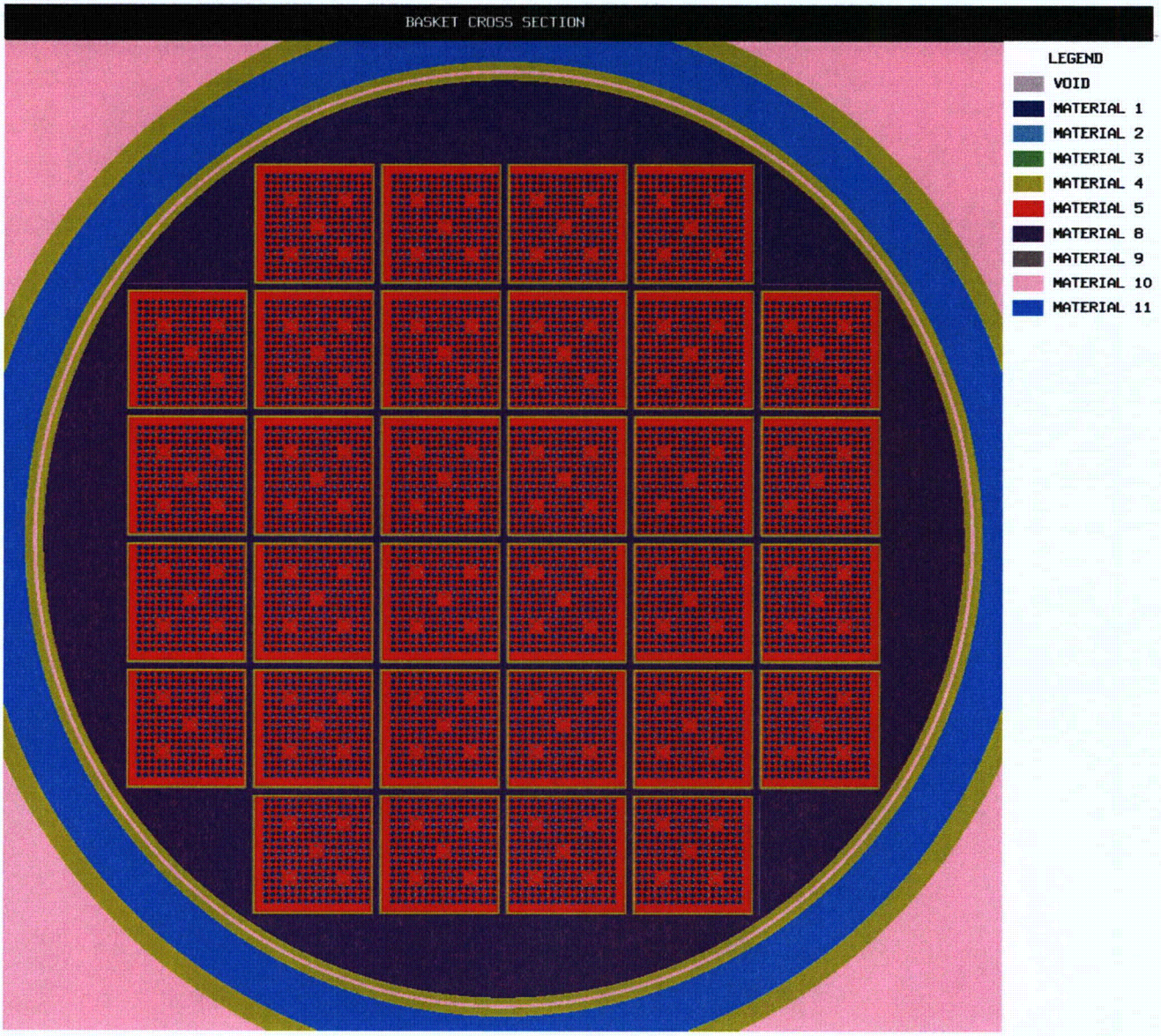

Figure U.6-12
CE 16x16 Class Assembly KENO Model

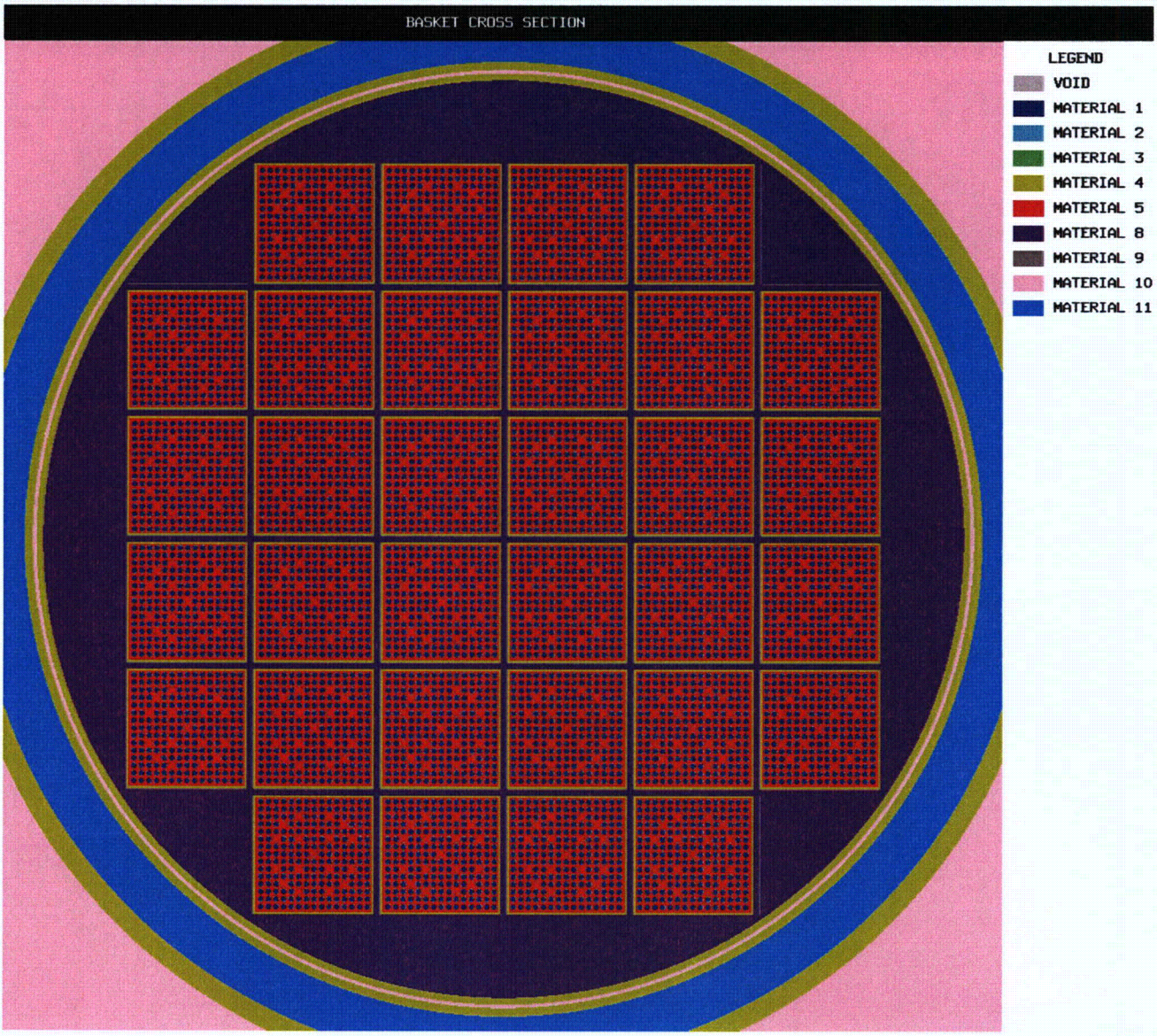

Figure U.6-13
BW 15x15 Class Assembly KENO Model

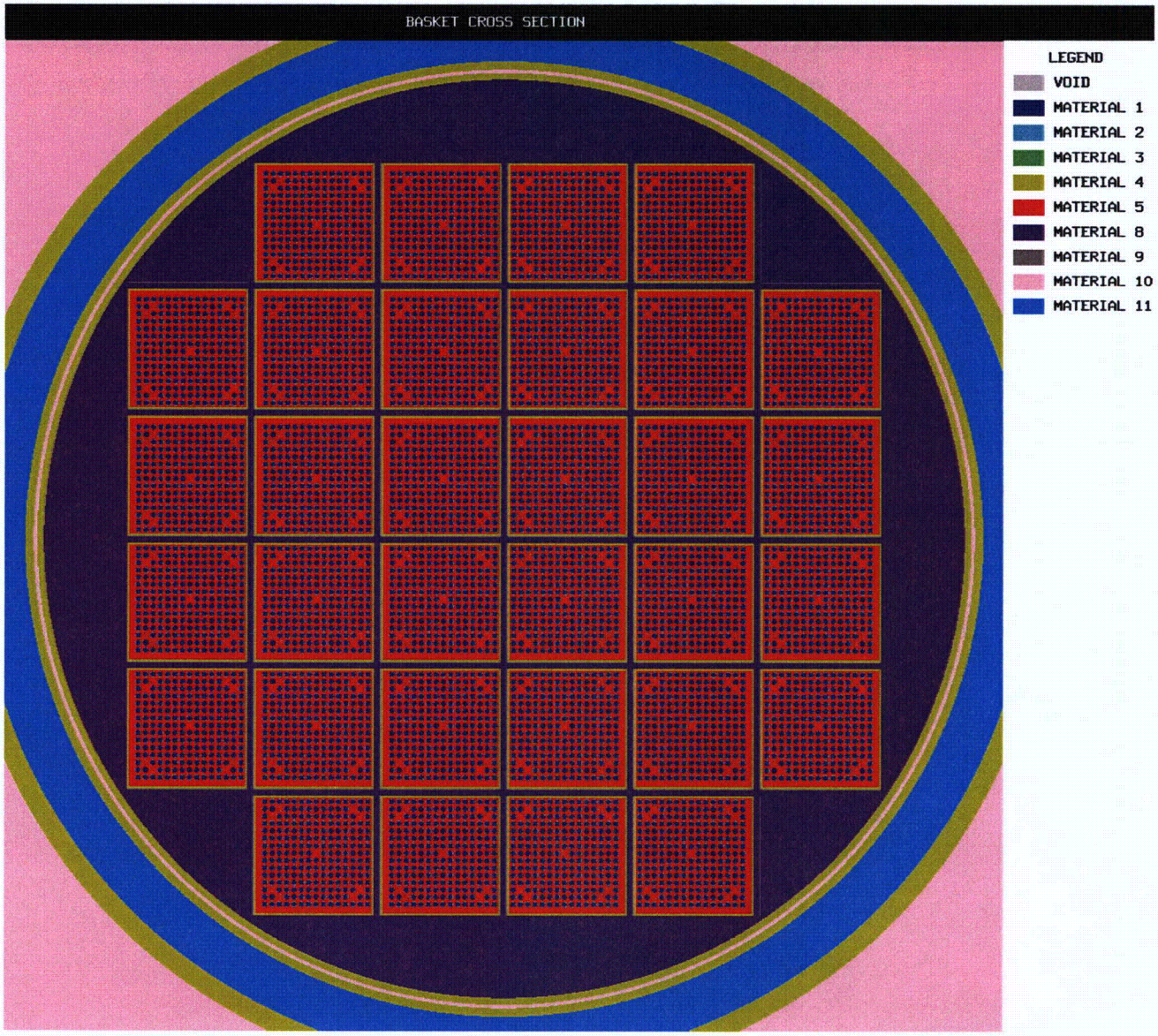

Figure U.6-14
CE 15x15 Class Assembly KENO Model

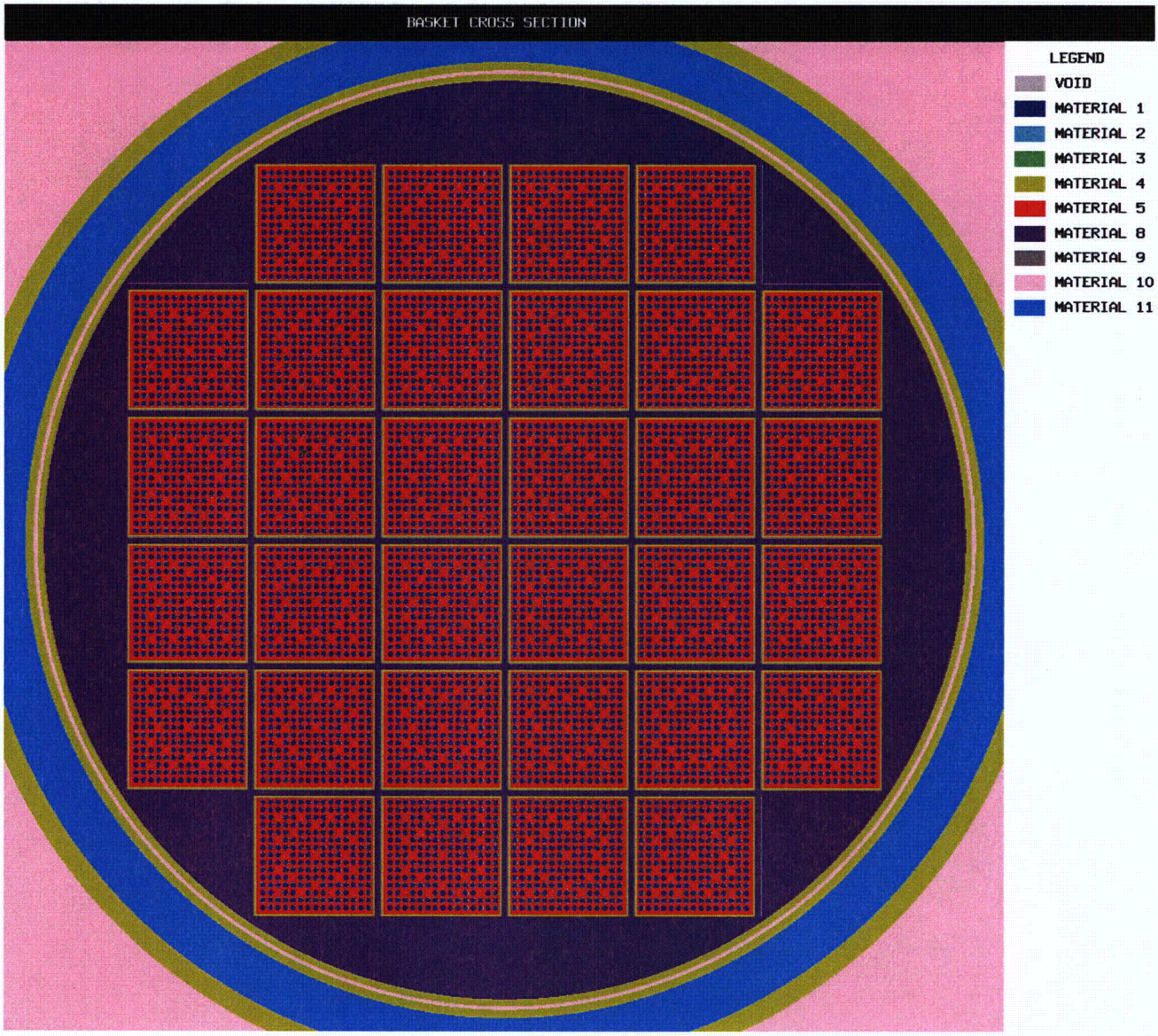

Figure U.6-15
WE 15x15 Class Assembly KENO Model

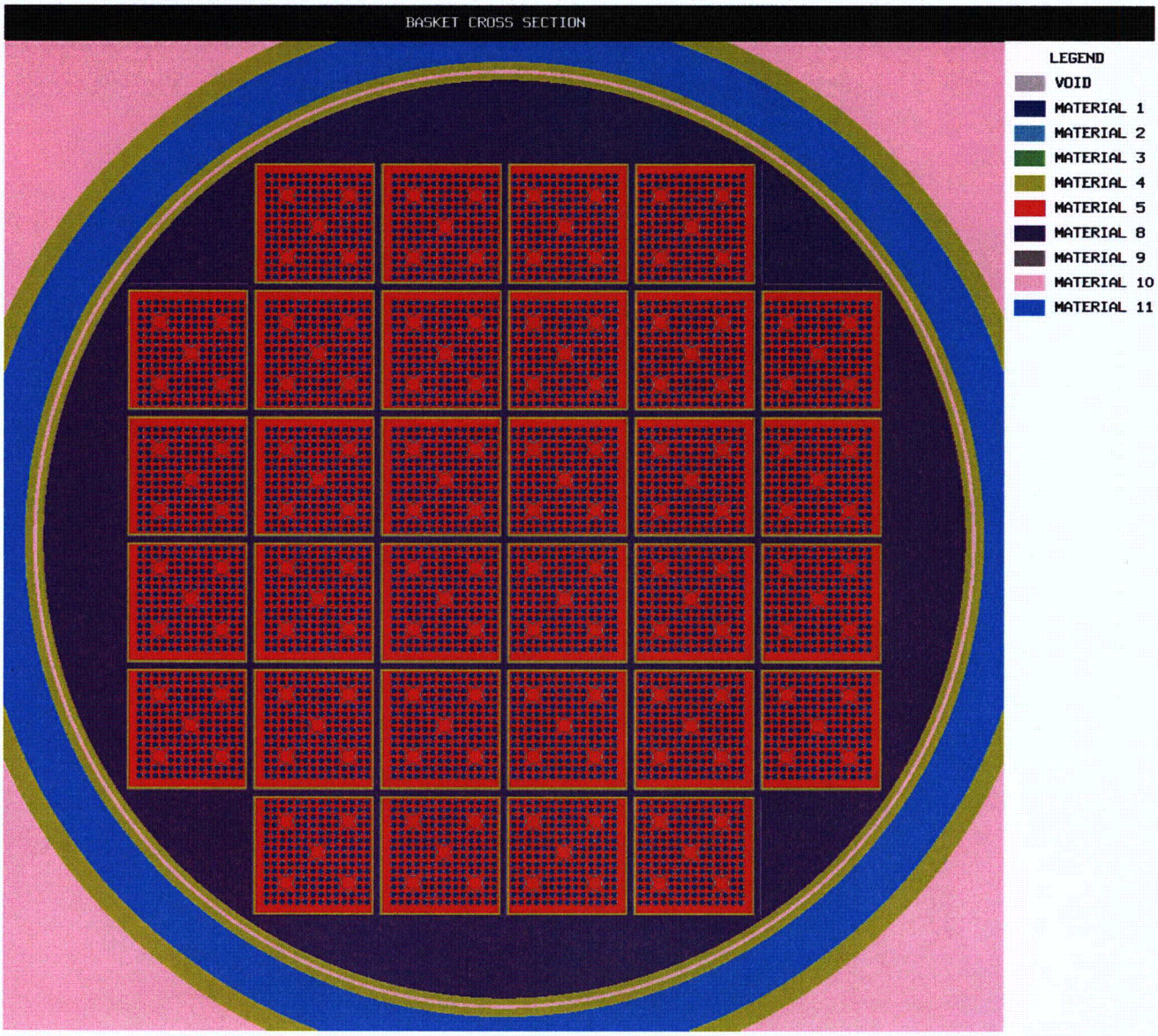

Figure U.6-16
CE 14x14 Class Assembly KENO Model

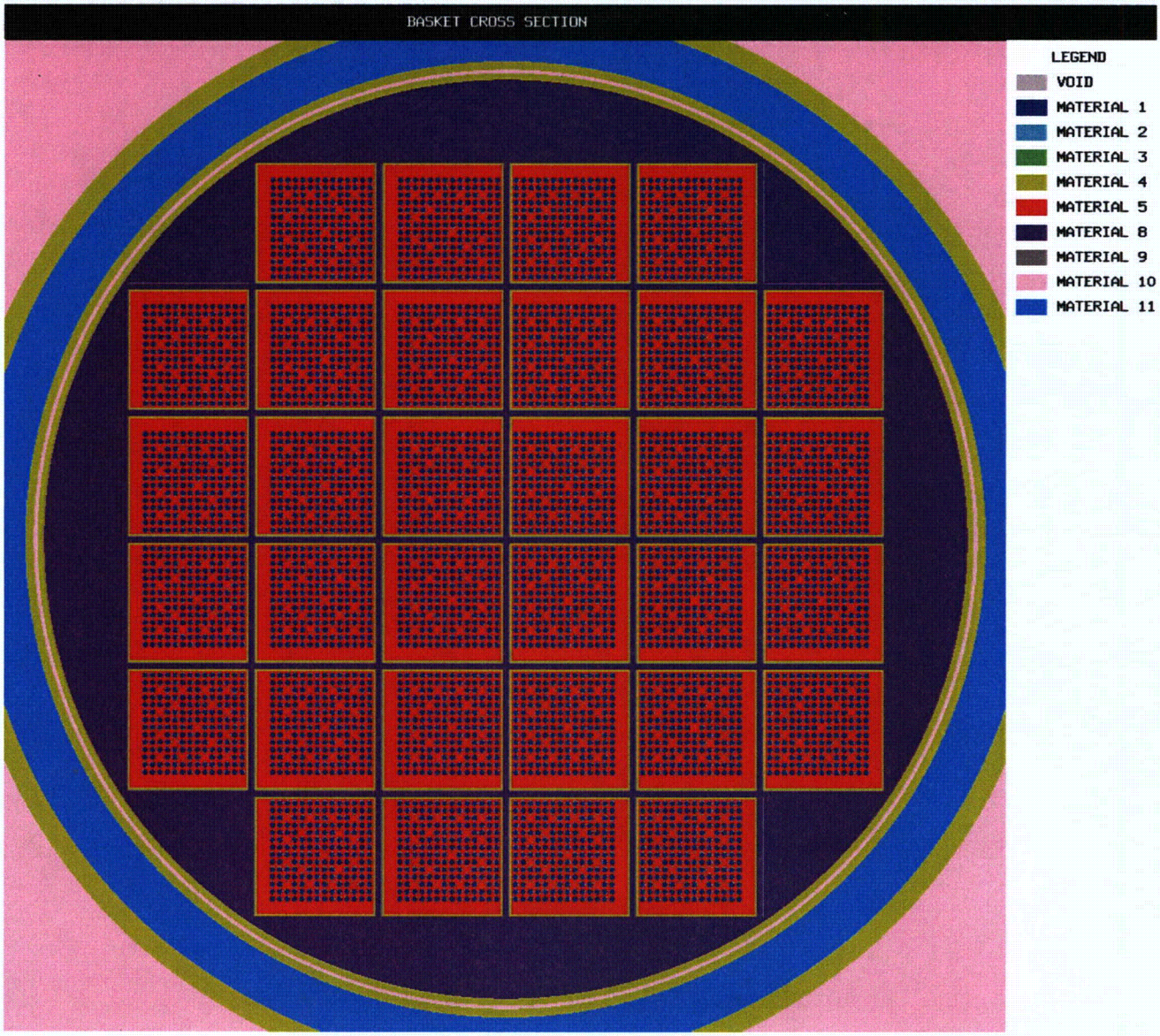

Figure U.6-17
WE 14x14 Class Assembly KENO Model

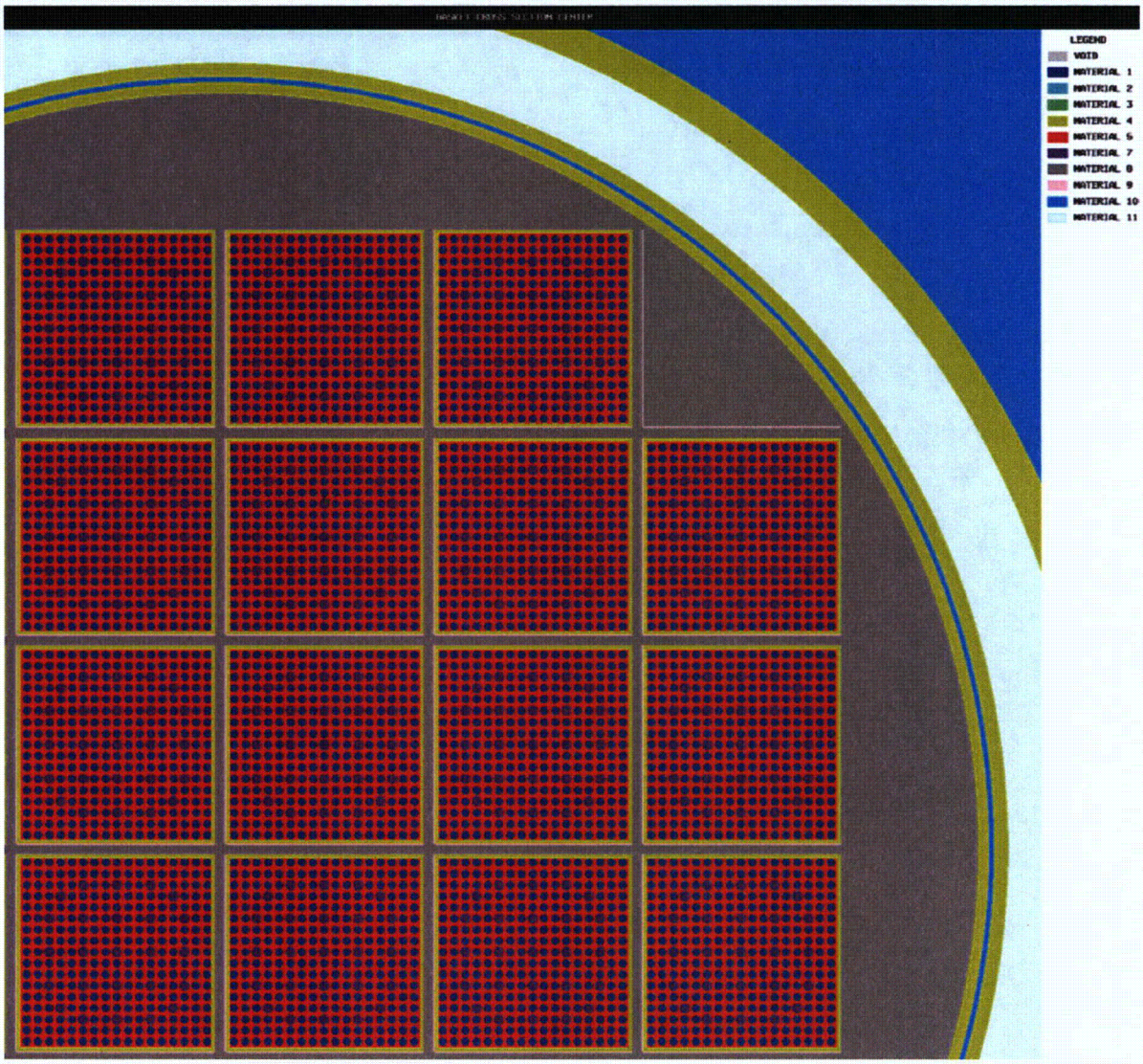

Figure U.6-18
WE 17x17 Class Assembly – Optimum Pitch KENO Model with CC

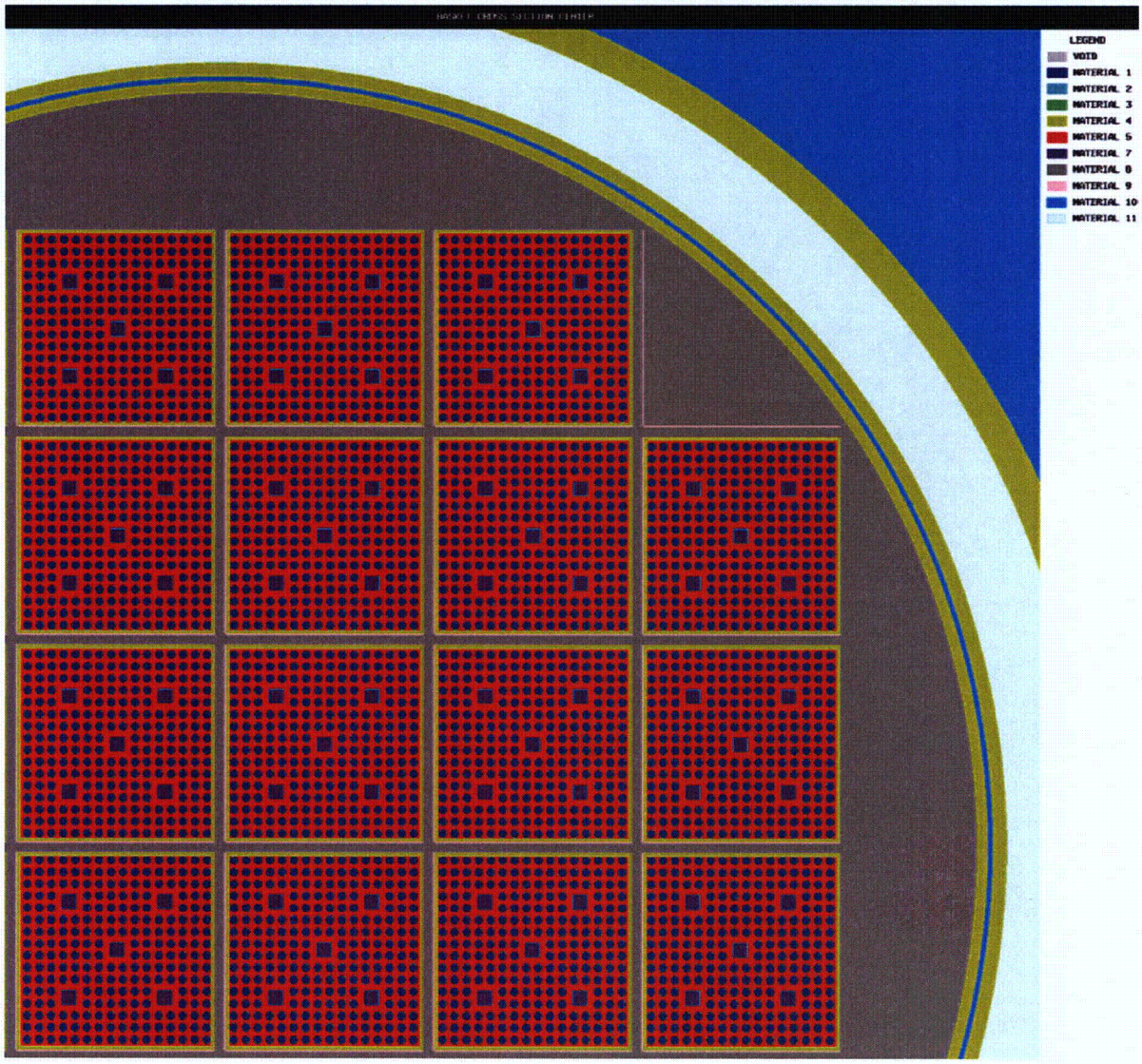

Figure U.6-19
CE 16x16 Class Assembly – Optimum Pitch KENO Model with CCs

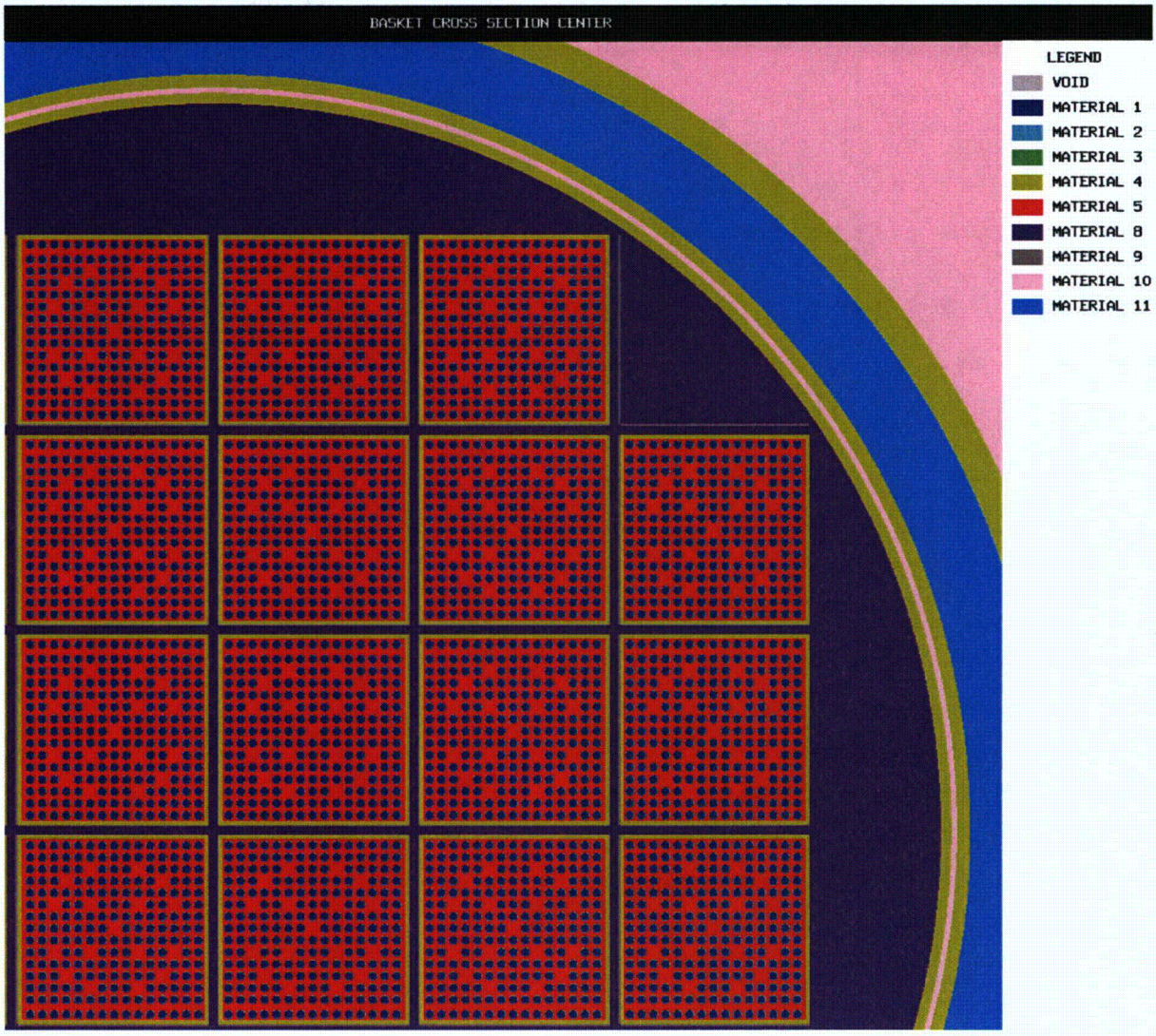

Figure U.6-20
BW 15x15 Class Assembly – Single Shear KENO Model

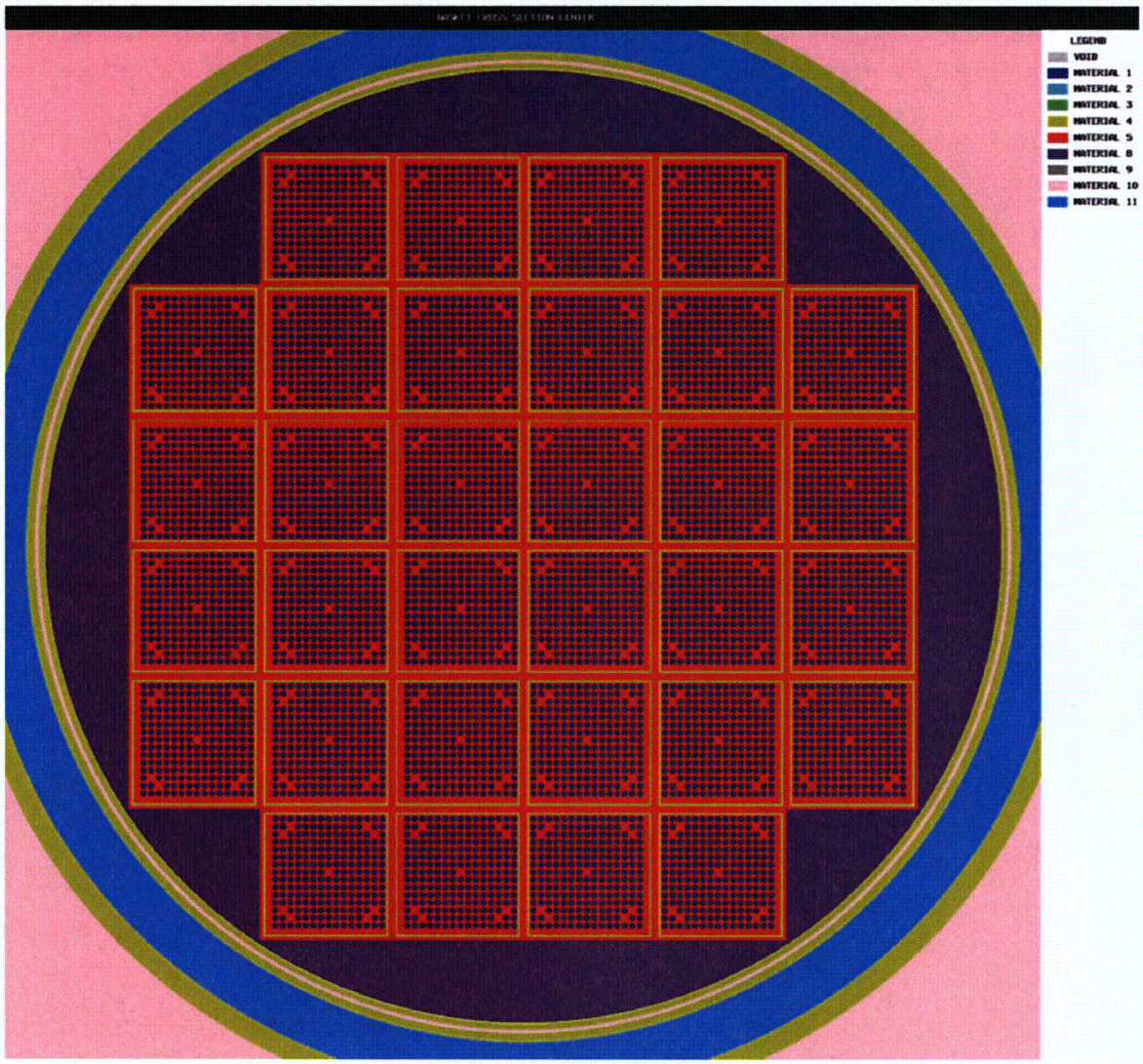

Figure U.6-21
CE 15x15 Class Assembly – 4″ Fuel Shift KENO Model

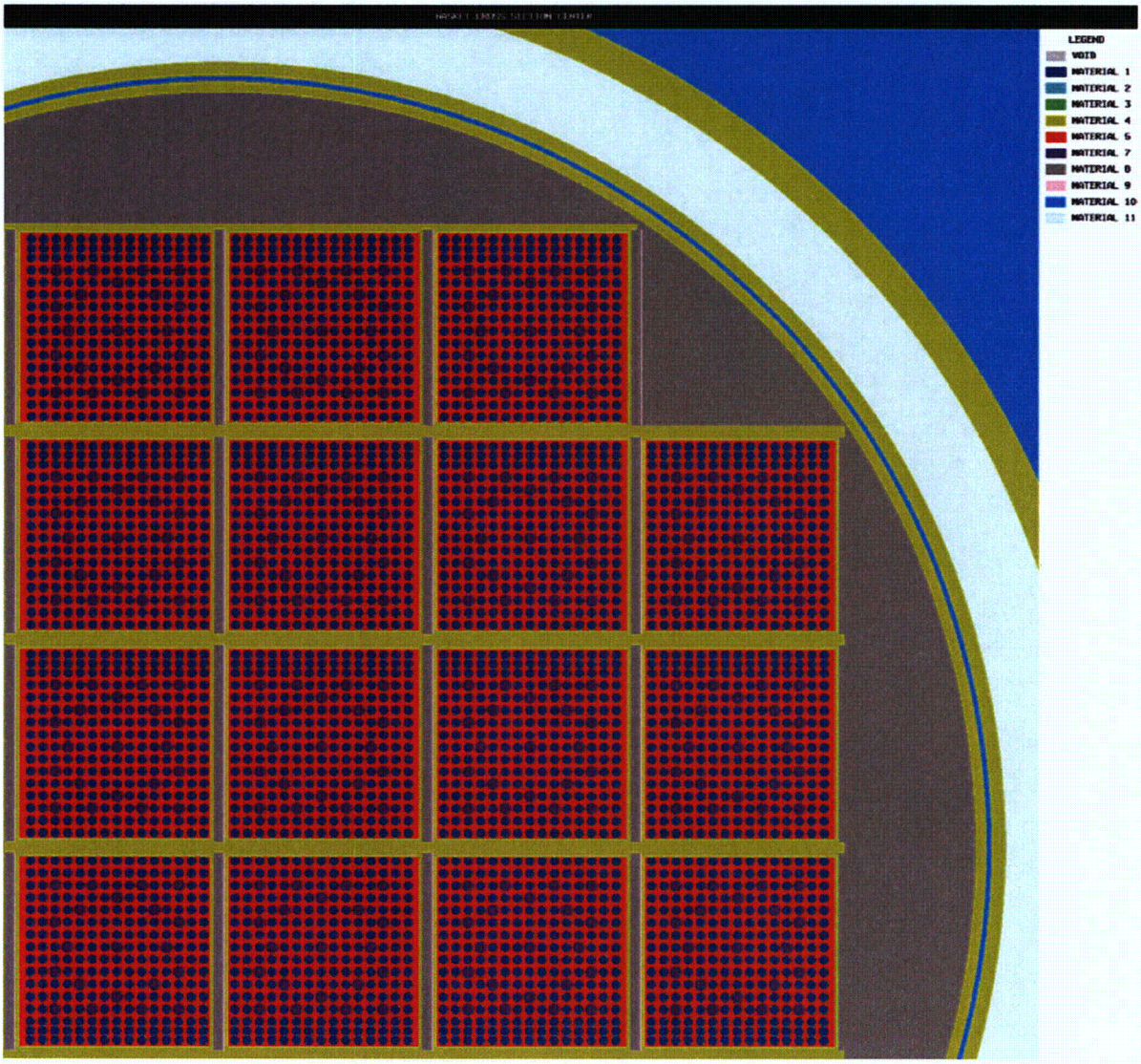

Figure U.6-22
WE 15x15 Class Assembly – Double Shear KENO Model

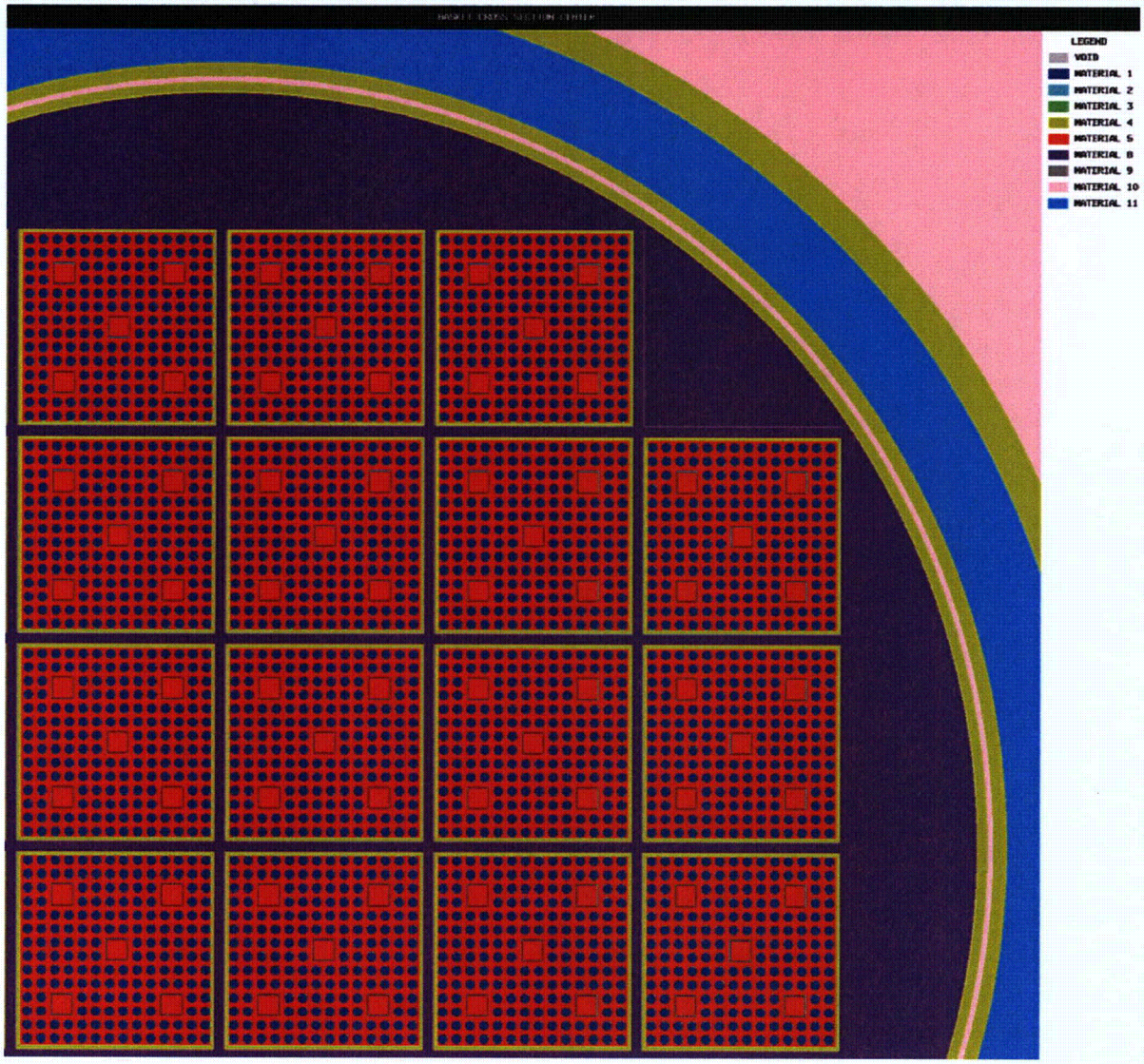

Figure U.6-23
CE 14x14 Class Assembly – Optimum Pitch KENO Model

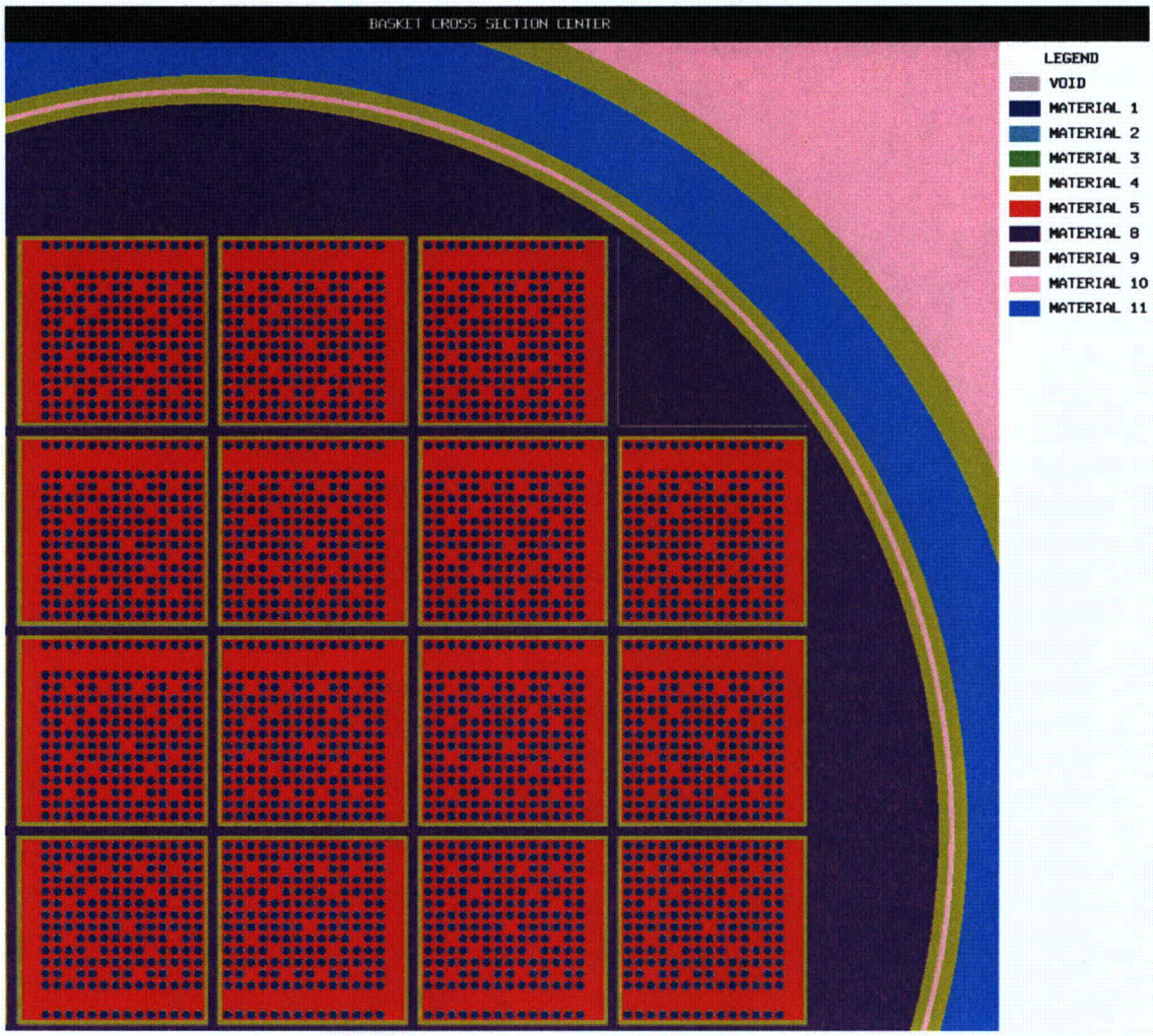

Figure U.6-24
WE 14x14 Class Assembly – Single Shear KENO Model

U.7 Confinement

Confinement of all radioactive materials in the NUHOMS®-32PTH1 system is provided by the NUHOMS®-32PTH1 DSC which is designed and tested to meet the leak tight criteria of ANSI N14.5-1997 [7.1].

As discussed in Section 7.2.2 of the UFSAR, the release of airborne radioactive material is addressed for three phases of system operation: Fuel handling in the spent fuel pool, drying and sealing of the DSC, and DSC transfer and storage. Potential airborne releases from irradiated or spent fuel assemblies (SFAs) in the spent fuel pool are discussed in the plant's existing 10CFR50 license.

DSC drying and sealing operations are performed using procedures which prohibit airborne leakage. During these operations, all vent lines are routed to the existing radwaste systems of the plant. Once the DSC is dried and sealed, there are no design basis accidents which could result in a breach of the DSC and the airborne release of radioactivity. Design provisions to preclude the release of gaseous fission products as a result of accident conditions are discussed in Section 8.2.9 of the UFSAR.

During transfer of the sealed DSC and subsequent storage in the HSM, the only postulated mechanism for the release of airborne radioactive material is the dispersion of non-fixed surface contamination on the DSC exterior. By filling the TC/DSC annulus with demineralized water, placing an inflatable seal over the annulus, and utilizing procedures which require examination of the annulus surfaces for smearable contamination, the contamination limits on the DSC can be maintained below the permissible level for off-site shipments of fuel. Therefore, there is no possibility of significant radionuclide release from the DSC exterior surface during transfer or storage.

U.7.1 Confinement Boundary

Once inside the DSC, the SFAs are confined by the DSC shell and by multiple barriers at each end of the DSC. For intact fuel, the fuel cladding is the first barrier for confinement of radioactive materials. The fuel cladding is protected by maintaining the cladding temperatures during storage below those levels which may cause degradation of the cladding. In addition, the SFAs are stored in an inert atmosphere to prevent degradation of the fuel, specifically cladding rupture due to oxidation and its resulting volumetric expansion of the fuel. Thus, a helium atmosphere for the DSC is incorporated into the design to protect the fuel cladding integrity by inhibiting the ingress of oxygen into the DSC cavity.

Helium is known to leak through valves, mechanical seals, and escape through very small passages because of its small atomic diameter and because it is an inert element and exists in a monatomic species. Negligible leakage rates can be achieved with careful design of vessel closures. Helium will not, to any practical extent, diffuse through stainless steel. For this reason, the DSC has been designed as a redundant weld-sealed containment pressure vessel with no mechanical or electrical penetrations.

For damaged fuel assemblies, top and bottom caps are provided to contain any potential fuel debris such as broken rods, loose pellets and/or pieces of cladding in the fuel compartment. The end caps fit snugly into the top and bottom of the fuel compartment. They are held in place by the fuel compartments and the inner bottom cover plate and the top shield plug during transfer and storage. The end caps have multiple through holes to permit unrestricted flooding and draining of the fuel cells.

U.7.1.1 Confinement Vessel

The confinement vessel is provided by the NUHOMS®-32PTH1 DSC. The DSC is designed to provide confinement of all radionuclides under normal and accident conditions. The DSC is designed, fabricated and tested in accordance with the applicable requirements of the ASME Boiler and Pressure Vessel Code, Division 1, Section III, Subsection NB [7.2] with alternatives to the code as discussed in Chapter U.3, Section U.3.1.2.3. The DSC shell and inner and outer bottom cover plates are delivered to the site as an assembly. The shell and the inner bottom cover plate, which provide the confinement boundary as shown in Chapter U.3, Figure U.3.1-1, are pressure tested in accordance with the ASME code, Section III, NB-6300 and leak tested to meet the ANSI N14.5 [7.1] leak-tight criteria. The pneumatic pressure test and leak test are performed on the finished shell and the inner bottom cover plate during fabrication. The outer bottom cover plate root and final layer closure welds are inspected using dye penetrant inspection methods in accordance with requirements of the ASME code [7.2].

Once the fuel assemblies are loaded into the DSC, the heavy shield plug is installed to provide radiation shielding to minimize radiation exposure to workers during DSC closure operations. The inner top cover plate is welded into place along with the vent and siphon port cover plates. These welds and associated components define the confinement boundary at the top end of the DSC as shown in Chapter U.3, Figure U.3.1-1. These welds are applied using a multiple layer technique with multi-level PT in accordance with the alternative to the ASME code as specified in Chapter U.3, Section U.3.1.2.3 and ISG-15 [7.4]. Finally, the outer top cover plate is welded

into place to provide redundant sealing. The outer top cover plate is a structural attachment to the DSC confinement boundary. The welds of inner top cover plate are tested using an optional test port in the outer top cover plate or other alternate means (e.g., test head) to meet the leak tight criteria [7.1]. A test port plug (if used) is then threaded into the outer top cover plate and seal welded in place. The root, mid and final layer closure welds are inspected using dye penetrant inspection methods in accordance with requirements of the ASME code [7.2].

U.7.1.2 Confinement Penetrations

The DSC confinement boundary contains two penetrations (vent and siphon ports) for draining, vacuum drying and backfilling the DSC cavity. The vent and siphon ports are closed with welded cover plates and the DSC outer top cover plate provides the redundant closure. The DSC outer top cover plate has an optional single penetration used for leak testing the closure welds. A test port plug (if used) is threaded into the outer top cover plate and seal welded in place after testing to complete the redundant closure. The DSC has no bolted closures or mechanical seals.

U.7.1.3 Seals and Welds

The welds made during fabrication of the 32PTH1 DSC that affect the confinement boundary include the weld applied to the shell bottom and the circumferential and longitudinal seam welds applied to the cylindrical shell. These welds are inspected (radiographic or ultrasonic inspection, and liquid penetrant inspection) according to the requirements of Subsection NB of the ASME code.

The welds applied to the vent and siphon port covers and the inner top cover plate during closure operations, define the confinement boundary at the top end of the 32PTH1 DSC. These welds are applied using a multiple-layer technique with multi-level PT in accordance with alternatives to the ASME code as specified in Chapter U.3, Section U.3.1.2.3 and ISG-15 [7.4]. This effectively eliminates any pinhole leak which might occur in a single-pass weld, since the chance of pinholes being in alignment on successive weld passes is negligibly small. Chapter U.3, Figure U.3.1-1 provides a graphic representation of the confinement boundaries and welds.

U.7.1.4 Closure

All top end closure welds are multiple-layer welds. This effectively eliminates a pinhole leak which might occur in a single pass weld, since the chance of pinholes being in alignment on successive weld passes is not credible. Furthermore, the DSC cover plates are sealed by separate, redundant closure welds. Finally, the inner closure welds are tested to the leak tight criteria [7.1]. There are no bolted closures or mechanical seals.

U.7.2 Requirements for Normal Conditions of Storage

U.7.2.1 Release of Radioactive Material

The NUHOMS®-32PTH1 DSC is designed, fabricated and tested to meet the leak tight criteria of ANSI N14.5-1997 [7.1]. Therefore, there is no release of radioactive material under normal conditions of storage. As noted in acceptance criteria IV-4 of ISG-5, Revision 1, [7.3], a closure monitoring system is not required. The confinement boundary ensures that the inert fill gas does not leak or diffuse through the weld or parent material of the DSC. The continued effectiveness of the confinement boundary is demonstrated by (a) either a daily visual inspection of the HSM inlets and outlets or a daily monitoring of the HSM thermal performance, and (b) the use of radiation monitors (typically TLDs) on the ISFSI boundary fence. A breach of the confinement boundary would result in an increase in the measured dose at the ISFSI fence. If an increase were detected, steps would be initiated to enable the licensee to take corrective actions to maintain safe storage conditions.

U.7.2.2 Pressurization of Confinement Vessel

The maximum internal pressures in the NUHOMS®-32PTH1 DSC during normal operations are reported in Chapter U.4, Section U.4.6.6.4 to be 7.3 psig for the Type 1 DSC and 7.6 psig for the Type 2 DSC. The maximum internal pressures during off-normal conditions are 10.9 psig and 12.1 psig for the Type 1 and Type 2 DSCs, respectively. These pressures are below the design pressures of the DSC as shown in Chapter U.4, Section U.4.1.

U.7.3 Confinement Requirements for Hypothetical Accident Conditions

U.7.3.1 Fission Gas Products

The analysis presented in Chapter U.3 demonstrates that the confinement boundary (pressure boundary) is not compromised following hypothetical accident conditions. Therefore, there is no need to calculate the fission gas products available for release.

U.7.3.2 Release of Contents

The NUHOMS®-32PTH1 DSC is designed and tested to meet the leak tight criteria of ANSI N14.5-1997 [7.1]. The analysis presented in Chapter U.3 demonstrates that the confinement boundary (pressure boundary) is not compromised following hypothetical accident conditions. Therefore, there is no release of radioactive material under hypothetical accident conditions of storage.

U.7.4 References

7.1 "American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment," ANSI N14.5-1997, American National Standards Institute, Inc., New York, New York, 1997.

7.2 ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NB, 1998, including 2000 addenda.

7.3 U.S. Nuclear Regulatory Commission, Interim Staff Guidance (ISG)-5, "Confinement Evaluation," Revision 1.

7.4 U.S. Nuclear Regulatory Commission, Interim Staff Guidance (ISG)-15, "Materials Evaluation."

U.8 Operating Systems

This Chapter presents the operating procedures for the standardized NUHOMS®-32PTH1 system described in previous chapters and shown on the drawings in Chapter U.1, Section U.1.5. The procedures include preparation of the DSC and fuel loading, closure of the DSC, transfer to the ISFSI using the TC, DSC transfer into the HSM-H, monitoring operations, and DSC retrieval from the HSM-H. The standardized NUHOMS® transfer equipment, and the existing plant systems and equipment are used to accomplish these operations. Procedures are delineated here to describe how these operations are to be performed and are not intended to be limiting. Standard fuel and cask handling operations performed under the plant's 10CFR50 operating license are described in less detail. Existing operational procedures may be revised by the licensee and new ones may be developed according to the requirements of the plant, provided that the limiting conditions of operation specified in Technical Specifications and the Functional and Operating Limits of the NUHOMS® CoC are not exceeded.

The following sections outline the typical operating procedures for the standardized NUHOMS® System. These generic NUHOMS® procedures have been developed to minimize the amount of time required to complete the subject operations, to minimize personnel exposure, and to assure that all operations required for DSC loading, closure, transfer, and storage are performed safely. Plant specific ISFSI procedures are to be developed by each licensee in accordance with the requirements of 10CFR72.212 (b) and the guidance of Regulatory Guide 3.61 [8.1]. The generic procedures presented here are provided as a guide for the preparation of plant specific procedures and serve to point out how the NUHOMS® System operations are to be accomplished. They are not intended to be limiting, in that the licensee may evaluate that alternate acceptable means are available to accomplish the same operational objective.

Process flow diagrams for the NUHOMS® System operations are presented Figure U.8-1 and Figure U.8-2. The location of the various operations may vary with individual plant requirements. The following steps describe the recommended generic operating procedures for the standardized NUHOMS® System.

Note: The generic terms used throughout this Section are as follows. See Chapter U.1 for description of components.

- TC or OS200 TC or transfer cask or cask is used for a NUHOMS® OS200 transfer cask,
- DSC may be 32PTH1-S or 32PTH1-L or 32PTH1-M DSC, and
- HSM or HSM-H is used to indicate a NUHOMS® HSM-H.

U.8.1 Procedures for Loading the Cask

U.8.1.1 Preparation of the TC and DSC

1. Prior to placement in dry storage, the candidate intact and damaged fuel assemblies shall be evaluated (by plant records or other means) to verify that they meet the physical, thermal and radiological criteria specified in Technical Specification 1.2.1.

2. Prior to being placed in service, the TC is to be cleaned or decontaminated as necessary to insure a surface contamination level of less than those specified in Technical Specification 1.2.12.

3. Place the TC in the vertical position in the cask decon area using the cask handling crane and the TC lifting yoke.

4. Place scaffolding around the cask so that the transfer cask top cover plate and surface of the cask are easily accessible to personnel.

5. Remove the TC top cover plate and examine the cask cavity for any physical damage and ready the cask for service.

6. Examine the DSC for any physical damage which might have occurred since the receipt inspection was performed. The DSC is to be cleaned and any loose debris removed.

7. Record the DSC serial number which is located on the grapple ring. Verify the correct DSC type, basket type and poison material types against the DSC serial number. Verify that the DSC is appropriate for the specific fuel loading campaign per the criteria specified in Technical Specification 1.2.1.

8. Using a crane, lower the DSC into the cask cavity by the internal lifting lugs and rotate the DSC to match the cask and DSC alignment marks.

9. If damaged fuel assemblies are included in a specific loading campaign, place the required number of bottom end caps provided (up to a maximum of 16) into the cell locations per Technical Specification 1.2.1. Optionally, this step may be performed at any prior time.

10. Fill the cask/DSC annulus with clean, demineralized water. Place the inflatable seal into the upper cask liner recess and seal the cask-DSC annulus by pressurizing the seal with compressed air.

11. Fill the DSC cavity with water from the fuel pool or an equivalent source which meets the requirements of Technical Specification 1.2.15d.

NOTE: A TC/DSC annulus pressurization tank filled with demineralized water as described above is connected to the top vent port of the TC via a hose to provide a positive head above the level of water in the TC/DSC annulus. This is an optional arrangement, which provides

additional assurance that contaminated water from the fuel pool will not enter the TC/DSC annulus, provided a positive head is maintained at all times.

12. Place the top shield plug onto the DSC. Examine the top shield plug to ensure a proper fit. Optionally, the top shield plug once fitted, may be removed and disconnected from the yoke. It may be installed later once the DSC is loaded and prior to removing it from the pool.

13. Position the cask lifting yoke above the transfer cask and engage the cask lifting trunnions and the rigging cables to the DSC top shield plug. Adjust the rigging cables as necessary to obtain even cable tension.

14. Visually inspect the yoke lifting hooks to insure that they are properly positioned and engaged on the cask lifting trunnions.

15. Provide for later connection to the vacuum drying system (VDS) or an optional water draining/pumping device to the siphon port of the DSC and position any connecting hose such that the hose will not interfere with loading (yoke, fuel, shield plug, rigging, etc.). A flowmeter or other suitable means for measuring the amount of water removed must be installed at a suitable location as part of this connection.

16. Move the scaffolding away from the cask as necessary.

17. Lift the cask just far enough to allow the weight of the cask to be distributed onto the yoke lifting hooks. Reinspect the lifting hooks to insure that they are properly positioned on the cask trunnions.

18. a. Optionally, secure a sheet of suitable material to the bottom of the TC to minimize the potential for ground-in contamination. This may also be done prior to initial placement of the cask in the decon area.

    b. Fill the TC liquid neutron shield as required by licensee ALARA requirements and crane capacity limits. This step may be completed at any time prior to immersion of the TC/DSC into the pool.

19. Prior to the cask being lowered into the fuel pool, the water level in the pool should be adjusted as necessary to accommodate the cask/DSC volume. If the water placed in the DSC cavity was obtained from the fuel pool, a level adjustment may not be necessary.

U.8.1.2 <u>DSC Fuel Loading</u>

1. Lift the cask/DSC and position it over the cask loading area of the spent fuel pool in accordance with the plant's 10CFR50 cask handling procedures.

2. Lower the cask into the fuel pool until the bottom of the cask is at the height of the fuel pool surface. As the cask is lowered into the pool, spray the exterior surface of the cask with demineralized water.

3. Place the cask in the designated location of the fuel pool.

4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask. Spray the lifting yoke with clean demineralized water if it is raised out of the fuel pool.

5. The potential for fuel misloading is essentially eliminated through the implementation of procedural and administrative controls. The controls instituted to ensure that damaged and/or intact fuel assemblies and control components (CCs), if applicable, are placed into a known cell location within a DSC, will typically consist of the following:

   - A cask/DSC loading plan is developed to verify that the damaged and/or intact fuel assemblies, and CCs, if applicable, meet the burnup, enrichment and cooling time parameters of Technical Specification 1.2.1.

   - The loading plan is independently verified and approved before the fuel load.

   - A fuel movement schedule is then written, verified and approved based upon the loading plan. All fuel movements from any rack location are performed under strict compliance of the fuel movement schedule.

   - If loading damaged fuel assemblies, verify that the required number of bottom end caps are installed in appropriate fuel compartment tube locations before fuel load.

6. Prior to loading of a spent fuel assembly (and CCs, if applicable) into the DSC, the identity of the assembly (and CCs, if applicable) is to be verified by two individuals using an underwater video camera or other means. Verification of CC identification is optional if the CC has not been moved from the host fuel assembly since it's last verification. Read and record the identification number from the fuel assembly (and CCs, if applicable) and check this identification number against the DSC loading plan which indicates which fuel assemblies (and CCs, if applicable) are acceptable for dry storage.

7. Position the fuel assembly for insertion into the selected DSC storage cell and load the fuel assembly. Repeat Step 5 through 7 for each SFA loaded into the DSC. If loading damaged fuel assemblies, place top end caps over each damaged fuel assembly placed into the basket. A maximum of 16 damaged fuel assemblies may be loaded into the basket per Technical Specification 1.2.1. After the DSC has been fully loaded, check and record the identity and location of each fuel assembly and CCs, if applicable, in the DSC.

8. After all the SFAs and CCs, if applicable, have been placed into the DSC and their identities verified, position the lifting yoke and the top shield plug and lower the shield plug onto the DSC. Note that separate rigging may be used to install the shield plug prior to engaging the trunnions with the lifting yoke.

   CAUTION: Verify that all the lifting height restrictions as a function of temperature specified in Technical Specification 1.2.13 can be met in the following steps which involve lifting of the TC.

9. Visually verify that the top shield plug is properly seated onto the DSC.

10. Position the lifting yoke with the TC trunnions and verify that it is properly engaged.

11. Raise the TC to the pool surface. Prior to raising the top of the cask above the water surface, stop vertical movement.

12. Inspect the top shield plug to verify that it is properly seated onto the DSC. If not, lower the cask and reposition the top shield plug. Repeat Steps 8 through 12 as necessary.

13. Continue to raise the TC from the pool and spray the exposed portion of the cask with water until the top region of the cask is accessible.

14. Drain any excess water from the top of the DSC shield plug back to the fuel pool.

15. Check the radiation levels at the center of the top shield plug and around the perimeter of the cask. Disconnect the top shield plug rigging.

16. Drain a minimum of 50 gallons of water from the DSC cavity. Optionally, approximately 900 gallons of water (as indicated by the flowmeter) may be drained from the DSC back into the pool or other suitable location to meet the weight limit on the crane. Use 1 to 3 psig of helium to backfill the DSC with helium per ISG-22 [8.2] guidance as water is being removed from the DSC cavity.

17. Lift the TC from the fuel pool. As the cask is raised from the pool, continue to spray the cask with water and decon as directed.

18. Move the TC with loaded DSC to the cask decon area.

19. If applicable to keep the occupational exposure ALARA, temporary shielding may be installed as necessary to minimize personnel exposure. Install cask seismic restraints if required by Technical Specification 1.2.16 (required only on plant specific basis).

U.8.1.3 DSC Drying and Backfilling

CAUTION: During performance of steps listed in Section U.8.1.3, monitor the TC/DSC annulus water level and replenish if necessary until drained.

1. Check the radiation levels along the perimeter of the cask. The cask exterior surface should be decontaminated as necessary in accordance with the limits specified in Technical Specification 1.2.12. Temporary shielding may be installed as necessary to minimize personnel exposure.

2. Place scaffolding around the cask so that any point on the surface of the cask is easily accessible to personnel.

3. Disengage the rigging cables from the top shield plug and remove the eyebolts. Disengage the lifting yoke from the trunnions and position it clear of the cask.

4. Decontaminate the exposed surfaces of the DSC shell perimeter and remove the inflatable TC/DSC annulus seal.

5. Connect the cask drain line to the cask, open the cask cavity drain port and allow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the DSC shell. Take swipes around the outer surface of the DSC shell and check for smearable contamination in accordance with the Technical Specification 1.2.12 limits.

   CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Drain approximately 900 gallons of water (as indicated on a flowmeter) from the DSC back into the fuel pool or other suitable location If not drained in Step 8.1.2.16. Consistent with ISG-22 [8.5] guidance, helium at 1-3 psig is used to backfill the DSC with an inert gas (helium) as water is being removed from the DSC. Only helium may be used to assist in the removal of water.

7. Monitor TC/DSC annular water level and replenish as necessary until drained.

8. Install the automatic welding machine onto the inner top cover plate and place the inner top cover plate with the automatic welding machine onto the DSC. Optionally, the inner top cover plate and the automatic welding machine can be placed separately. Verify proper fit-up of the inner top cover plate with the DSC shell.

9. Check radiation levels along surface of the inner top cover plate. Temporary shielding may be installed as necessary to minimize personnel exposure. Verify that the transfer cask dose rates are compliant with limits specified in Technical Specification 1.2.11e.

10. Insert a 1/4-inch tubing of sufficient length and adequate temperature resistance through the vent port such that it terminates just below the DSC shield plug. Connect the flexible tubing to a hydrogen monitor to allow continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner cover plate. Optionally, other methods may be used for continuous monitoring of the hydrogen atmosphere in the DSC cavity during welding of the inner top cover plate.

11. Cover the cask/DSC annulus to prevent debris and weld splatter from entering the annulus.

12. Ready the automatic welding machine and tack weld the inner top cover plate to the DSC shell. Install the inner top cover plate weldment and remove the automatic welding machine.

    CAUTION: Continuously monitor the hydrogen concentration in the DSC cavity using the arrangement or other alternate methods described in Step 10 during the inner top cover plate cutting/welding operations. Verify that the measured hydrogen concentration does not exceed a safety limit of 2.4% [8.2 and 8.3]. If this limit is exceeded, stop all welding operations and purge the DSC cavity with approximately 2-3 psig helium via the tubing to reduce the hydrogen concentration safely below the 2.4% limit.

13. Perform dye penetrant weld examination of the inner top cover plate weld in accordance with the Technical Specification 1.2.5 requirements.

14. Remove purge lines and connect the VDS to the DSC siphon and vent ports.

15. Install temporary shielding to minimize personnel exposure throughout the subsequent welding operations as required.

16. a. If using blowdown method to remove water, engage helium supply (up to 15 psig) and open the valve on the vent port and allow helium to force the water from the DSC cavity through the siphon port.

    b. If using water pumps to remove water without blowdown, pump water from DSC.

17. Once the water stops flowing from the DSC, close the DSC siphon port and disengage the helium source or turn off the section pump, as applicable.

18. Connect the hose from the vent port and the siphon port to the intake of the vacuum pump. Connect a hose from the discharge side of the VDS to the plant's radioactive waste system or spent fuel pool. Connect the VDS to a helium source.

    Note: Proceed cautiously when evacuating the DSC to avoid freezing consequences.

19. Open the valve on the suction side of the pump, start the VDS and draw a vacuum on the DSC cavity. The cavity pressure should be reduced in steps of approximately 100 mm Hg, 50 mm Hg, 25 mm Hg, 15 mm Hg, 10 mm Hg, 5 mm Hg, and 3 mm Hg. After pumping down to each level (these levels are optional), the pump is valved off and the cavity pressure monitored. The cavity pressure will rise as water and other volatiles in the cavity evaporate. When the cavity pressure stabilizes, the pump is valved in to complete the vacuum drying process. It may be necessary to repeat some steps, depending on the rate and extent of the pressure increase. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less as specified in Technical Specification 1.2.2.

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

20. Open the valve to the vent port and allow the helium to flow into the DSC cavity.

21. Pressurize the DSC with helium up to 15 psig.

22. Helium leak test the inner top cover plate weld for a leak rate of 1×10^{-4} atm cm^3 /sec. This test is optional.

23. If a leak is found, repair the weld, repressurize the DSC and repeat the helium leak test.

24. Once no leaks are detected, depressurize the DSC cavity by releasing the helium through the VDS to the plant's spent fuel pool or radioactive waste system.

25. Re-evacuate the DSC cavity using the VDS. The cavity pressure should be reduced in steps of approximately 10 mm Hg, 5 mm Hg, and 3 mm Hg. After pumping down to each level, the pump is valved off and the cavity pressure is monitored level (these levels are optional). When the cavity pressure stabilizes, the pump is valved in to continue the vacuum drying process. Vacuum drying is complete when the pressure stabilizes for a minimum of 30 minutes at 3 mm Hg or less in accordance with Technical Specification 1.2.2 limits.

26. Open the valve on the vent port and allow helium to flow into the DSC cavity to pressurize the DSC to about 22.5-23.5 psig and hold for 10 min. Depressurize the DSC cavity by releasing the helium through the VDS to the plant spent fuel pool or radioactive waste system to about 2.5 psig in accordance with Technical Specification 1.2.3a limits.

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

27. Close the valves on the helium source.

U.8.1.4 DSC Sealing Operations

CAUTION: During performance of steps listed in Section U.8.1.4, monitor the Cask/DSC annulus water level and replenish as necessary to maintain cooling.

1. Disconnect the VDS from the DSC. Seal weld the prefabricated plugs over the vent and siphon ports. Inject helium into blind space just prior to completing welding, and perform a dye penetrant weld examination in accordance with the Technical Specification 1.2.5 requirements.

2. Temporary shielding may be installed as necessary to minimize personnel exposure. Install the automatic welding machine onto the outer top cover plate and place the outer top cover plate with the automatic welding system onto the DSC. Optionally, outer top cover plate may be installed separately from the welding machine. Verify proper fit up of the outer top cover plate with the DSC shell.

3. Tack weld the outer top cover plate to the DSC shell. Place the outer top cover plate weld root pass.

4. Helium leak test the inner top cover plate and vent/siphon port plate welds using the leak test port in the outer top cover plate in accordance with Technical Specification 1.2.4a limits. Verify that the personnel performing the leak test are qualified in accordance with SNT-TC-1A [8.4]. Alternatively this can be done with a test head in step 1 of Section U.8.1.4.

5. If a leak is found, remove the outer cover plate root pass (if not using test head), the vent and siphon port plugs and repair the inner cover plate welds. Repeat procedure steps from U.8.1.3 Step 19.

6. Perform dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the DSC shell and perform dye penetrant examination on the weld surface in accordance with the Technical Specification 1.2.5 requirements.

7. Install and seal weld the prefabricated plug, if applicable, over the outer cover plate test port and perform dye penetrant weld examinations in accordance with Technical Specification 1.2.5 requirement.

8. Remove the automatic welding machine from the DSC.

9. Open the cask drain port valve and drain the water from the cask/DSC annulus.

10. Rig the cask top cover plate and lower the cover plate onto the TC.

11. Bolt the cask cover plate into place, tightening the bolts to the required torque in a star pattern.

    CAUTION: Monitor the applicable time limits of Technical Specification 1.2.18b until the completion of DSC transfer Step 6 of Section U.8.1.6.

12. Verify that the transfer cask dose rates are compliant with limits specified in Technical Specification 1.2.11e.

U.8.1.5 TC Downending and Transfer to ISFSI

Note: Alternate Procedure for Downending of Transfer Cask: Some plants have limited floor hatch openings above the cask/trailer/skid, which limit crane travel (within the hatch opening) that would be needed in order to downend the TC with the trailer/skid in a stationary position. For these situations, alternate procedures are to be developed on a plant-specific basis, with detailed steps for downending.

1. Re-attach the TC lifting yoke to the crane hook, as necessary. Ready the transport trailer and cask support skid for service.

2. Move the scaffolding away from the cask as necessary. Engage the lifting yoke and lift the cask over the cask support skid on the transport trailer.

3. The transport trailer should be positioned so that cask support skid is accessible to the crane with the trailer supported on the vertical jacks.

4. Position the cask lower trunnions onto the transfer trailer support skid pillow blocks.

5. Move the crane forward while simultaneously lowering the cask until the cask upper trunnions are just above the support skid upper trunnion pillow blocks.

6. Inspect the positioning of the cask to insure that the cask and trunnion pillow blocks are properly aligned.

7. Lower the cask onto the skid until the weight of the cask is distributed to the trunnion pillow blocks.

8. Inspect the trunnions to ensure that they are properly seated onto the skid and install the trunnion tower closure plates, if required.

9. Remove the bottom ram access cover plate from the cask if integral rem/trailer is not used. Install the two-piece temporary neutron/gamma shield plug to cover the bottom ram access. Install the ram trunnion support frame on the bottom of the TC. (The temporary shield plug and ram trunnion support frame are not required with integral ram/trailer.)

U.8.1.6 DSC Transfer to the HSM

1. Prior to transporting the cask to the ISFSI or prior to positioning the transfer cask at the HSM designated for storage, remove the HSM door using a porta-crane, inspect the cavity of the HSM, removing any debris and ready the HSM to receive a DSC. The doors on adjacent HSMs should remain in place.

   CAUTION: Very high dose rates in the empty HSM are expected if adjacent to a loaded HSM due to high heat loads in 32PTH1 DSC. Proper ALARA practices should be followed during these operations.

2. Inspect the HSM air inlet and outlets to ensure that they are clear of debris. Inspect the screens on the air inlet and outlets for damage.

   CAUTION: Verify that the requirements of Technical Specification 1.2.14a "TC/DSC Transfer Operations at High Ambient Temperatures (32PTH1 DSC only)" are met prior to next step.

3. Using a suitable vehicle, transport the cask from the plant's fuel/reactor building to the ISFSI along the designated transfer route.

4. Once at the ISFSI, position the transport trailer to within several inches of the HSM.

5. Check the position of the trailer to ensure the centerline of the HSM and cask approximately coincide. If the trailer is not properly oriented, reposition the trailer, as necessary.

6. Using crane, unbolt and remove the cask top cover plate.

   CAUTION: Verify that the applicable time limits of Technical Specification 1.2.18b are met.

7. Back the cask to within a few inches of the HSM, set the trailer brakes and disengage the tractor. Drive the tractor clear of the trailer. Extend the transfer trailer vertical jacks.

8. Connect the skid positioning system hydraulic power unit to the positioning system via the hose connector panel on the trailer, and power it up. Remove the skid tie-down bracket

fasteners and use the skid positioning system to bring the cask into approximate vertical and horizontal alignment with the HSM. Using optical survey equipment and the alignment marks on the cask and the HSM, adjust the position of the cask until it is properly aligned with the HSM.

9. Using the skid positioning system, fully insert the cask into the HSM access opening docking collar.

10. Secure the cask trunnions to the front wall embedments of the HSM using the cask restraints.

11. After the cask is docked with the HSM, verify the alignment of the TC using the optical survey equipment.

12. Position the hydraulic ram behind the cask in approximate horizontal alignment with the cask and level the ram. Remove either the bottom ram access cover plate or the outer plug of the two-piece temporary shield plug if installed. Power up the ram hydraulic power supply and extend the ram through the bottom cask opening into the DSC grapple ring.

13. Activate the hydraulic cylinder on the ram grapple and engage the grapple arms with the DSC grapple ring.

14. Recheck all alignment marks in accordance with the Technical Specification 1.2.9 limits and ready all systems for DSC transfer.

15. Activate the hydraulic ram to initiate insertion of the DSC into the HSM. Stop the ram when the DSC reaches the support rail stops at the back of the module.

16. Disengage the ram grapple mechanism so that the grapple is retracted away from the DSC grapple ring.

17. Retract and disengage the hydraulic ram system from the cask and move it clear of the cask. Remove the cask restraints from the HSM.

18. Using the skid positioning system, disengage the cask from the HSM access opening.

19. Install the DSC axial in retainer through the HSM door opening.

20. Install the HSM door using a portable crane and secure it in place. Door may be welded for security. Verify that the HSM dose rates are compliant with the limits specified in Technical Specification 1.2.7g.

21. Replace the TC top cover plate. Secure the skid to the trailer, retract the vertical jacks and disconnect the skid positioning system.

22. Tow the trailer and cask to the designated equipment storage area. Return the remaining transfer equipment to the storage area.

23. Close and lock the ISFSI access gate and activate the ISFSI security measures.

U.8.1.7 Monitoring Operations

1. Perform routine security surveillance in accordance with the licensee's ISFSI security plan.

2. Perform one of the two alternate daily surveillance activities listed below:

   a. A daily visual surveillance of the HSM air inlets and outlets to insure that no debris is obstructing the HSM vents in accordance with Technical Specification 1.3.1 requirements.

   b. A temperature measurement of the thermal performance, for each HSM, on a daily basis in accordance with Technical Specification 1.3.2 requirements.

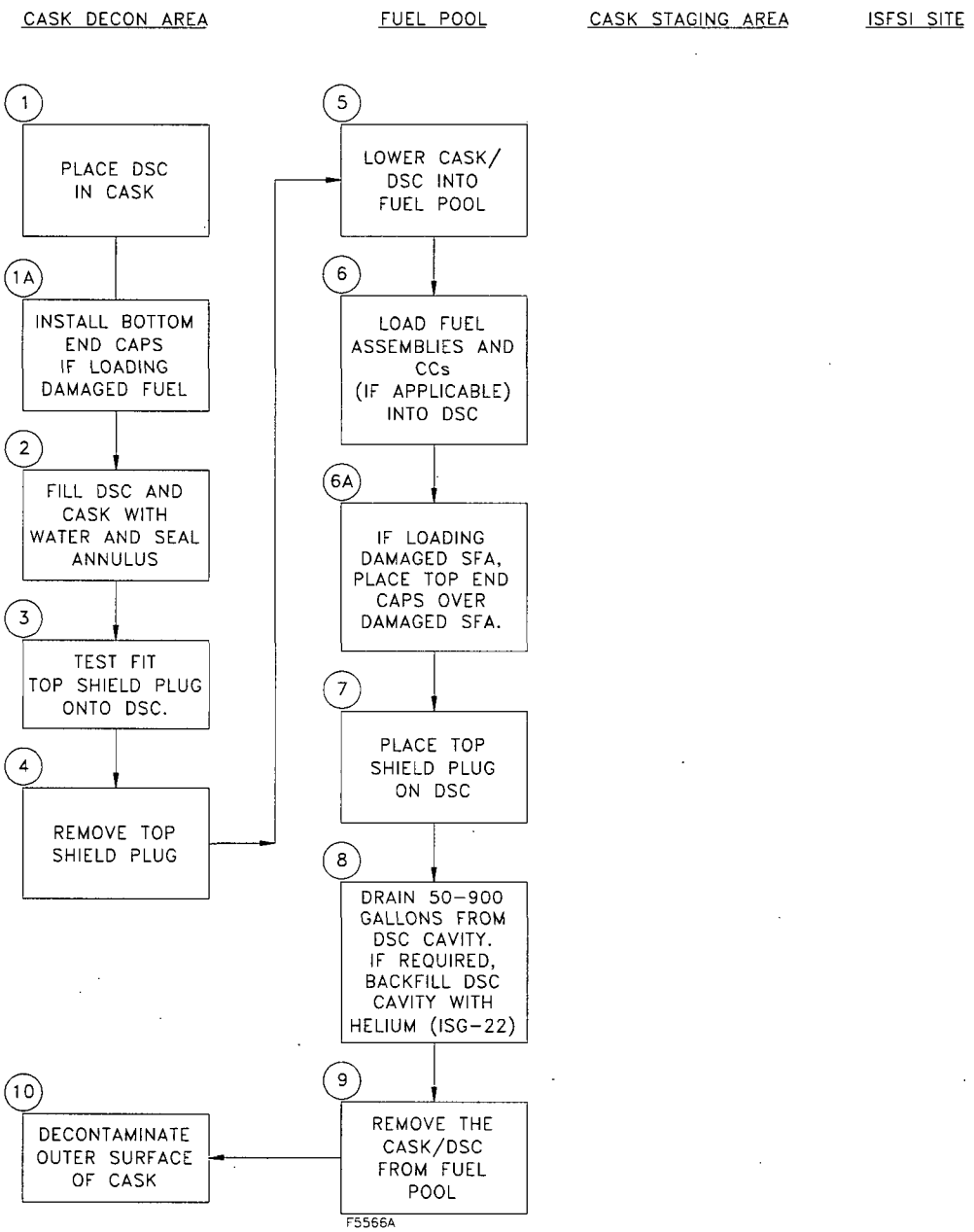

Figure U.8-1
NUHOMS® System Loading Operations Flow Chart

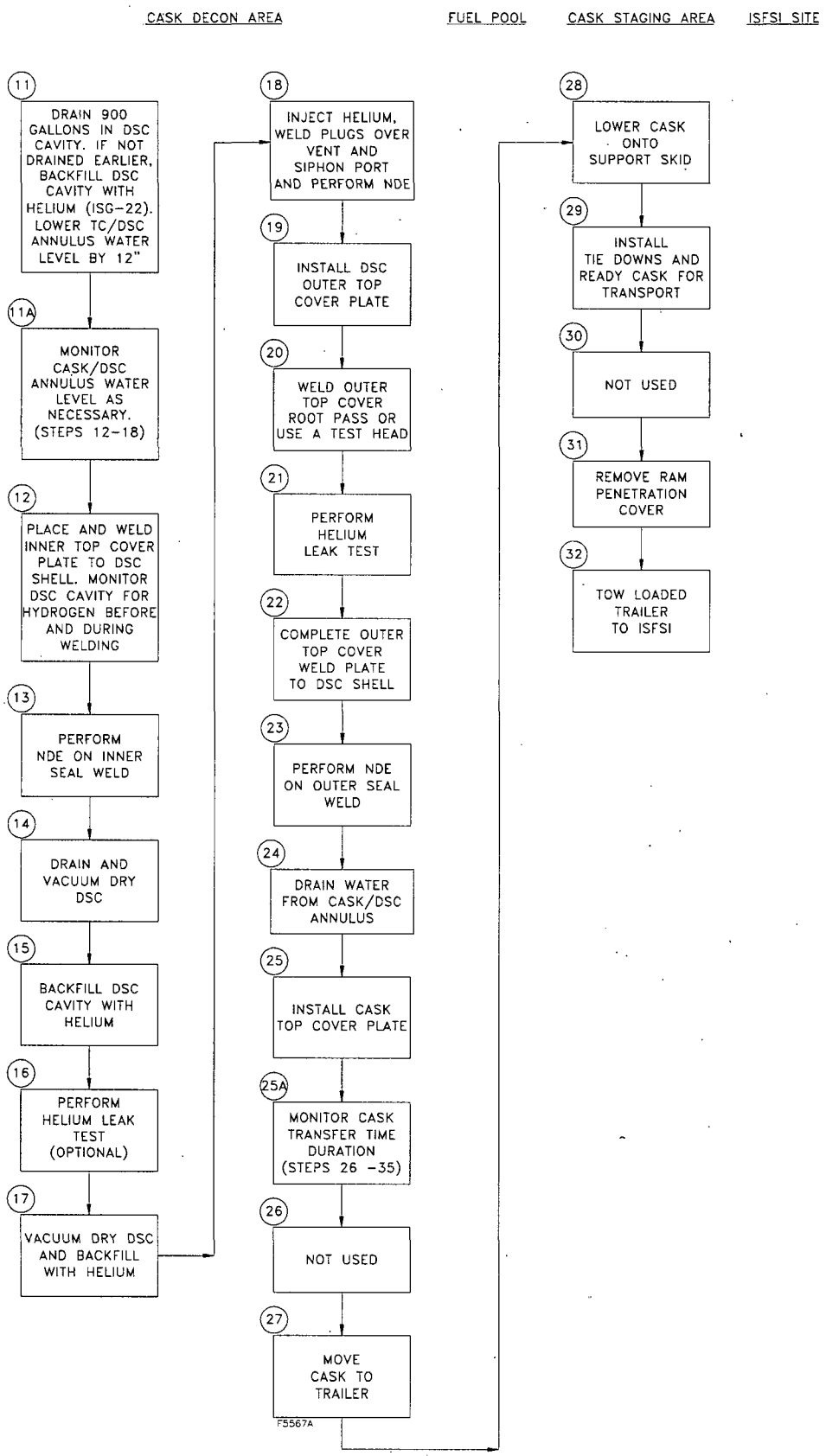

Figure U.8-1
NUHOMS® System Loading Operations Flow Chart

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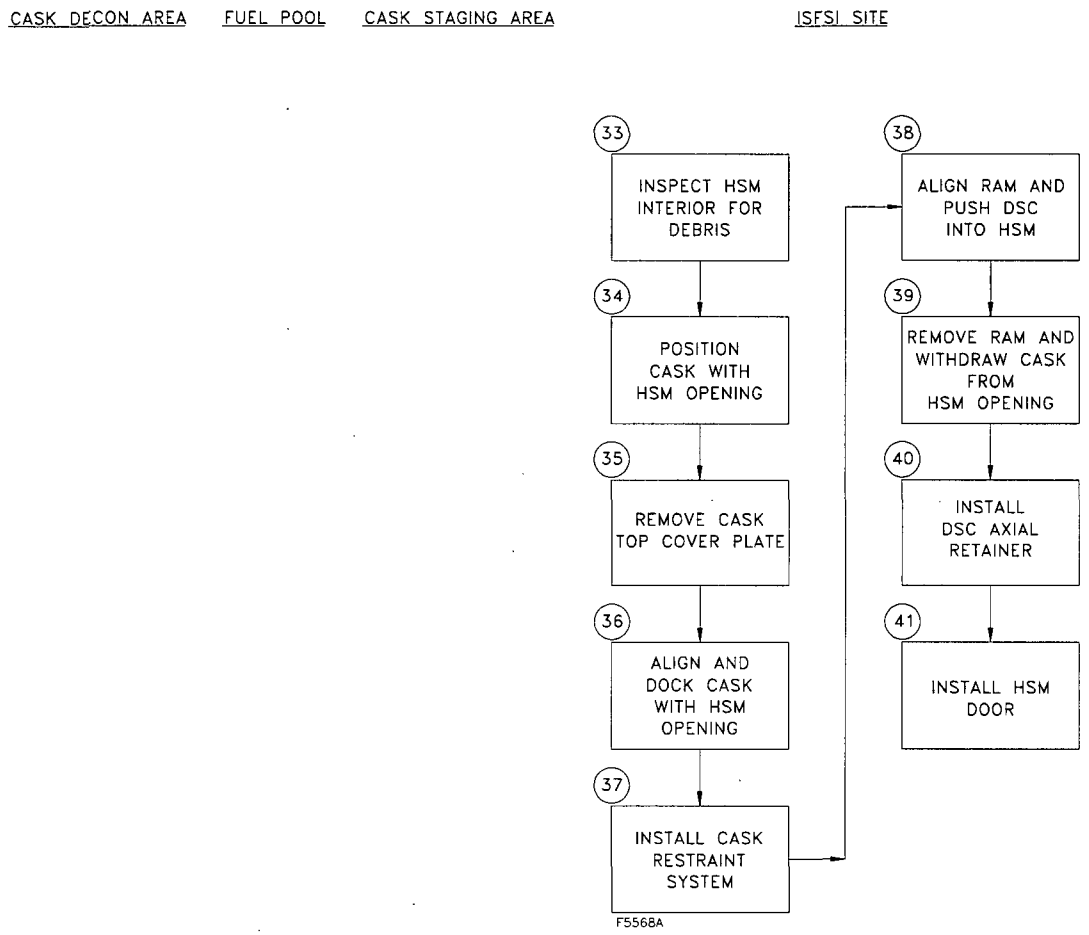

Figure U.8-1
NUHOMS® System Loading Operations Flow Chart
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U.8.2 Procedures for Unloading the Cask

U.8.2.1 DSC Retrieval from the HSM

1. Ready the TC, transport trailer, and support skid for service and tow the trailer to the HSM.

2. Back the trailer to within a few inches of the HSM and remove the cask top cover plate.

   CAUTION: High dose rates are expected in the HSM cavity after removal of HSM door. Proper ALARA practices should be followed.

3. Remove the HSM door using a crane. Remove the DSC axial retainer.

4. Using the skid positioning system align the cask with the HSM and position the skid until the cask is docked with the HSM access opening.

5. Using optical survey equipment, verify alignment of the cask with respect to the HSM. Install the cask restraints.

6. Install (if required) and align the hydraulic ram with the cask.

7. Extend the ram through the cask into the HSM until it is inserted in the DSC grapple ring.

8. Activate the arms on the ram grapple mechanism with the DSC grapple ring.

9. Retract ram and pull the DSC into the cask.

10. Retract the ram grapple arms.

11. Disengage the ram from the cask. Install the ram access penetration cover plate.

12. Remove the cask restraints.

13. Using the skid positioning system, disengage the cask from the HSM.

14. Install the cask top cover plate and ready the trailer for transport.

15. Replace the door on the HSM.

U.8.2.2 Removal of Fuel from the DSC

When the DSC has been removed from the HSM, there are several potential options for off-site shipment of the fuel. It is preferred to ship the DSC intact to a reprocessing facility, monitored retrievable storage facility or permanent geologic repository in a compatible shipping cask licensed under 10CFR71.

If it becomes necessary to remove fuel from the DSC prior to off-site shipment, there are two basic options available at the ISFSI or reactor site. The fuel assemblies could be removed and reloaded

into a shipping cask using dry transfer techniques, or if the applicant so desires, the initial fuel loading sequence could be reversed and the plant's spent fuel pool utilized. Procedures for unloading the DSC in a fuel pool are presented here. However, wet or dry unloading procedures are essentially identical to those of DSC loading through the DSC weld removal (beginning of preparation to placement of the cask in the fuel pool). Prior to opening the DSC, the following operations are to be performed.

CAUTION: Verify that the applicable time limits of Technical Specification 1.2.18b are met until the completion of Step U.8.2.2.14.

1. The TC may now be transported to the cask handling area inside the plant's fuel/reactor building.

2. Position and ready the trailer for access by the crane.

3. Attach the lifting yoke to the crane hook.

4. Engage the lifting yoke with the trunnions of the TC.

5. Visually inspect the yoke lifting hooks to insure that they are properly aligned and engaged onto the TC trunnions.

6. Lift the TC approximately one inch off the trunnion supports.

7. Move the crane backward in a horizontal motion while simultaneously raising the crane hook vertically and lift the TC off the trailer. Move the TC to the cask decon area.

8. Lower the TC into the cask decon area in the vertical position.

9. Wash the TC to remove any dirt which may have accumulated on the TC during the DSC loading and transfer operations.

10. Place scaffolding around the TC so that any point on the surface of the TC is easily accessible to personnel.

11. Unbolt the TC top cover plate.

12. Connect the rigging cables to the TC top cover plate and lift the cover plate from the TC. Set the TC cover plate aside and disconnect the lid lifting cables.

13. Install temporary shielding to reduce personnel exposure as required. Fill the TC/DSC annulus with clean demineralized water and seal the annulus.

The process of DSC unloading is similar to that used for DSC loading. DSC opening operations described below are to be carefully controlled in accordance with plant procedures. This operation is to be performed under the site's standard health physics guidelines for welding, grinding, and handling of potentially highly contaminated equipment. These are to include the

use of prudent housekeeping measures and monitoring of airborne particulates. Procedures may require personnel to perform the work using respirators or supplied air.

If fuel needs to be removed from the DSC, either at the end of service life or for inspection after an accident, precautions must be taken against the potential for the presence of damaged or oxidized fuel and to prevent radiological exposure to personnel during this operation. A sampling of the atmosphere within the DSC will be taken prior to inspection or removal of fuel.

If the work is performed outside the fuel/reactor building, a tent may be constructed over the work area, which may be kept under a negative pressure to control airborne particulates. Any radioactive gas release will be Kr-85, which is not readily captured. Whether the krypton is vented through the plant stack or allowed to be released directly depends on the plant operating requirements.

Following opening of the DSC, the cask and DSC are filled with water prior to lowering the top of cask below the surface of the fuel pool to prevent a sudden inrush of pool water. Cask placement into the pool is performed in the usual manner. Fuel unloading procedures will be governed by the plant operating license under 10CFR50. The generic procedures for these operations are as follows:

14. Locate the DSC siphon and vent port using the indications on the top cover plate. Place a portable drill press on the top of the DSC. Position the drill with the siphon port.

15. Place an exhaust hood or tent over the DSC, if necessary. The exhaust should be filtered or routed to the site radwaste system.

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port location. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

16. Drill a hole through the DSC top cover plate to expose the siphon port quick connect.

17. Drill a second hole through the top cover plate to expose the vent port quick connect.

18. Obtain a sample of the DSC atmosphere. Fill the DSC with water from the fuel pool through the siphon port with the vent port open and routed to the plant's off-gas system.

    CAUTION:

    (a) The water fill rate must be regulated during this reflooding operation to ensure that the DSC vent pressure does not exceed 20.0 psig.

    (b) Provide for continuous hydrogen monitoring of the DSC cavity atmosphere during all subsequent cutting operations to ensure that a safety limit of 2.4% is not exceeded [8.2 and 8.3]. Purge with 2-3 psig helium as necessary to maintain the hydrogen concentration safely below this limit.

19. Place welding blankets around the cask and scaffolding to keep dose rates ALARA.

20. Using plasma arc-gouging, a mechanical cutting system or other suitable means, remove the seal weld from the outer top cover plate and DSC shell. A fire watch should be placed on the scaffolding with the welder, as appropriate. The exhaust system should be operating at all times.

21. The material or waste from the cutting or grinding process should be treated and handled in accordance with the plant's low level waste procedures unless determined otherwise.

22. Remove the top of the tent, if necessary.

23. Remove the exhaust hood, if necessary.

24. Remove the DSC outer top cover plate.

25. Reinstall tent and temporary shielding, as required. Remove the seal weld from the inner top cover plate to the DSC shell in the same manner as the top cover plate. Remove the inner top cover plate. Remove any remaining excess material on the inside shell surface by grinding.

26. Clean the cask surface of dirt and any debris which may be on the cask surface as a result of the weld removal operation. Any other procedures which are required for the operation of the cask should take place at this point as necessary.

27. Engage the yoke onto the trunnions, install eyebolts into the top shield plug and connect the rigging cables to the eyebolts.

28. Visually inspect the lifting hooks or the yoke to insure that they are properly positioned on the trunnions.

29. The cask should be lifted just far enough to allow the weight of the TC to be distributed onto the yoke lifting hooks. Inspect the lifting hooks to insure that they are properly positioned on the trunnions.

30. Install suitable protective material onto the bottom of the TC to minimize cask contamination. Move the cask to the fuel pool.

31. Prior to lowering the cask into the pool, adjust the pool water level, if necessary, to accommodate the volume of water which will be displaced by the cask during the operation.

32. Lower the cask into the fuel pool leaving the top surface of the cask approximately one foot above the surface of the pool water.

33. Lower the TC into the pool. As the TC is lowered, the exterior surface of the cask should be sprayed with clean demineralized water.

34. Position the cask over the designated area in the fuel pool.

35. Not used.

36. Disengage the lifting yoke from the cask and lift the top shield plug from the DSC.

37. If the DSC contains damaged fuel assemblies, remove the top end caps. Remove the fuel from the DSC and place the fuel into the spent fuel racks.

38. Lower the top shield plug onto the DSC.

39. Visually verify that the top shield plug is properly positioned onto the DSC.

40. Engage the lifting yoke onto the cask trunnions.

41. Visually verify that the yoke lifting hooks are properly engaged with the cask trunnions.

42. Lift the cask by a small amount and verify that the lifting hooks are properly engaged with the trunnions.

43. Lift the cask to the pool surface. Prior to raising the top of the cask to the water surface, stop vertical movement and inspect the top shield plug to ensure that it is properly positioned.

44. Spray the exposed portion of the cask with demineralized water.

45. Visually inspect the top shield plug of the DSC to insure that it is properly seated within the cask. If the top shield plug is not properly seated, lower the cask back to the fuel pool and reposition the plug.

46. Drain any excess water from the top of the top shield plug into the fuel pool.

47. Lift the cask from the pool. As the cask is rising out of the pool, spray the cask with demineralized water.

48. Move the cask to the cask decon area.

49. Check radiation levels around the perimeter of the cask. The cask exterior surface should be decontaminated if necessary.

50. Place scaffolding around the cask so that any point along the surface of the cask is easily accessible to personnel.

51. Connect a water draining/pumping device to the siphon port of the DSC and remove water from DSC cavity.

52. The top cover plates may be welded into place as required.

53. Decontaminate the DSC, as necessary, and handle in accordance with low-level waste procedures. Alternatively, the DSC may be repaired for reuse.

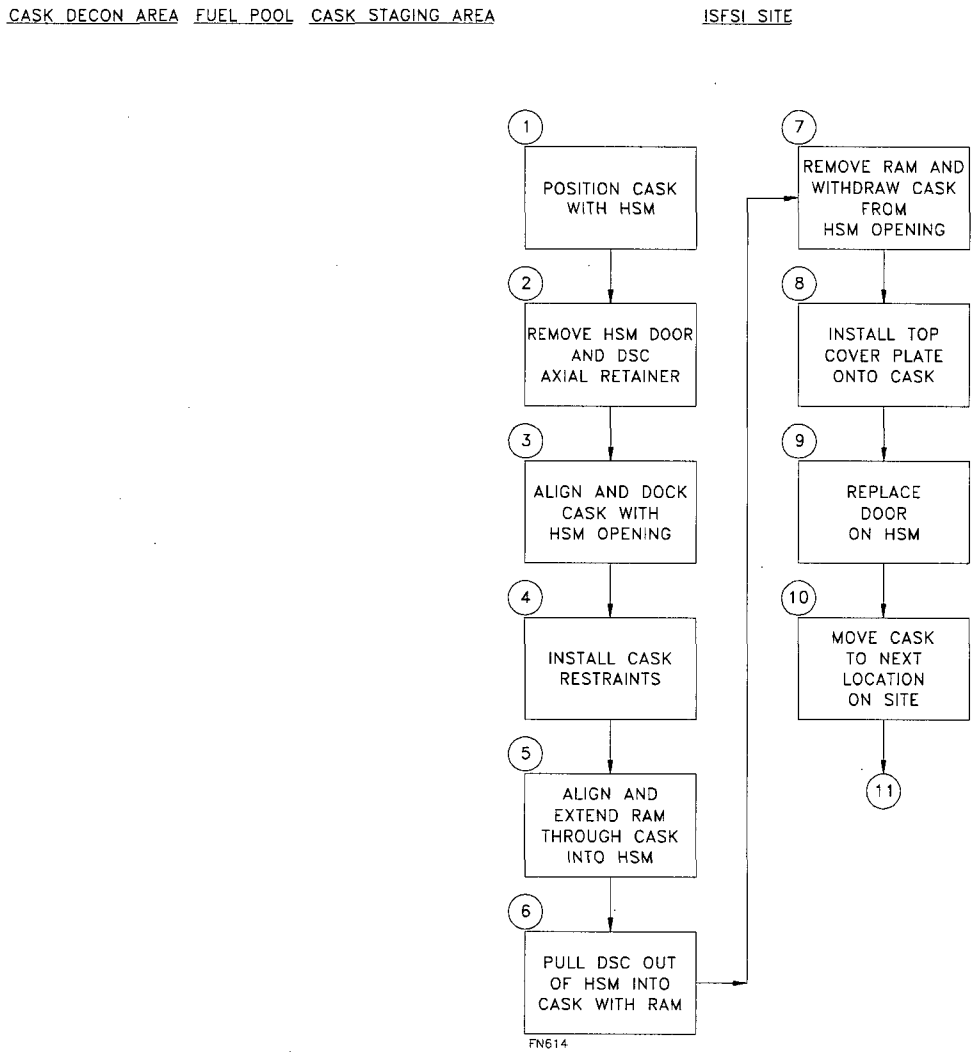

Figure U.8-2
NUHOMS® System Retrieval Operations Flow Chart

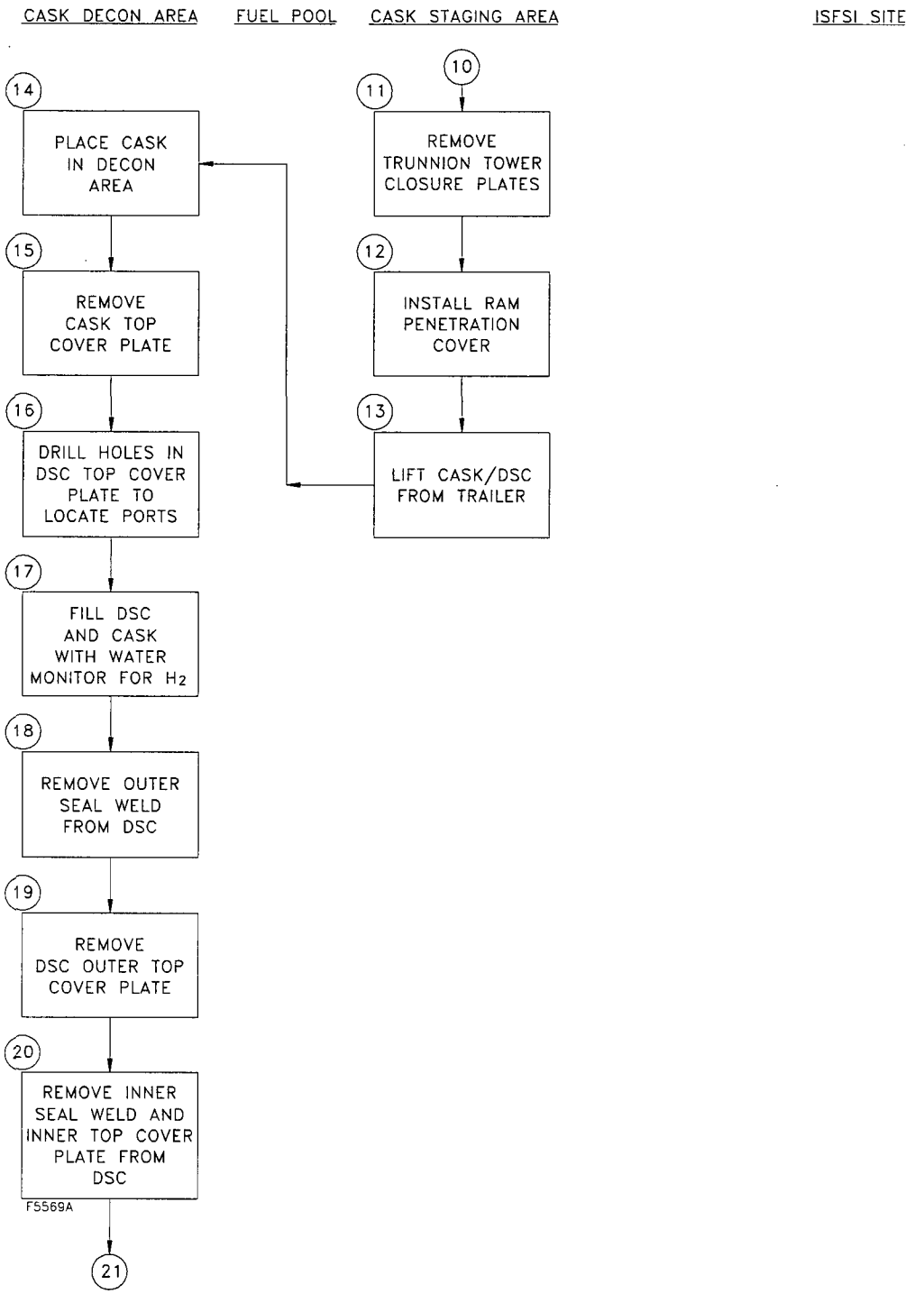

Figure U.8-2
NUHOMS® System Retrieval Operations Flow Chart
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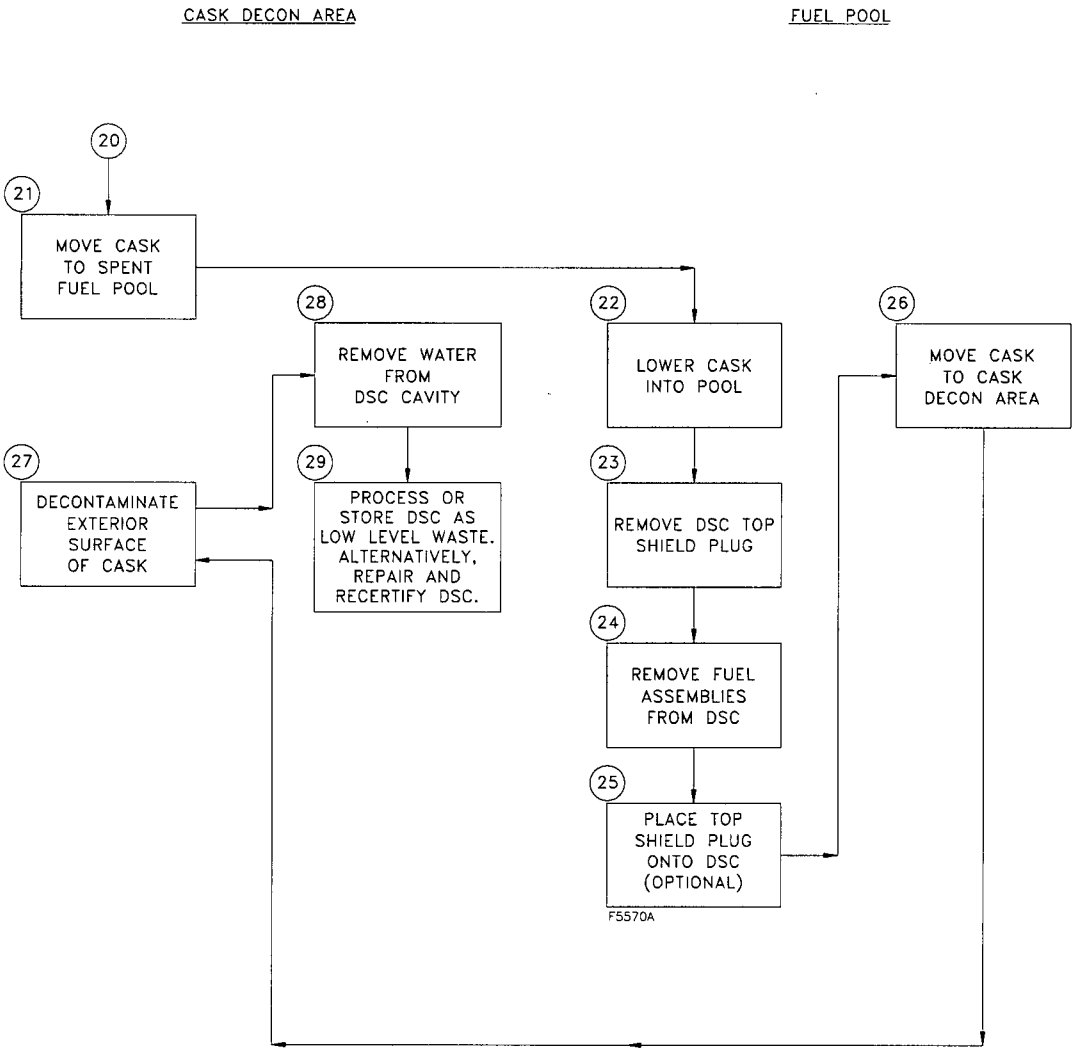

Figure U.8-2
NUHOMS® System Retrieval Operations Flow Chart
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U.8.3 Identification of Subjects for Safety Analysis

No Change.

U.8.4 Fuel Handling Systems

No Change.

U.8.5 Other Operating Systems

No Change.

U.8.6 Operation Support System

No Change.

U.8.7 Control Room and/or Control Areas

No Change.

U.8.8 Analytical Sampling

No Change.

U.8.9 References

8.1 U.S. Nuclear Regulatory Commission, "Standard Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Container," Regulatory Guide 3.61 (February 1989).

8.2 U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 For the NUHOMS®-24P and NUHOMS®–7P.

8.3 U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.

8.4 SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing," 1992.

8.5 U.S. Nuclear Regulatory Commission , Interim Staff Guidance (ISG-22), "Potential Rod Splitting due to Exposures to an Oxidizing Atmosphere during Short-term Cask Loading Operations in LWR of Other Uranium Oxide Based Fuel."

U.9 Acceptance Tests and Maintenance Program

U.9.1 Acceptance Tests

The pre-operational testing requirements for the NUHOMS® system are given in Chapter 9.0, with the exceptions described in the following sections. The NUHOMS®-32PTH1 DSC has been enhanced to provide leaktight confinement and the basket includes an updated poison plate design. Additional acceptance testing of the NUHOMS®-32PTH1 DSC welds and of the poison plates are described.

U.9.1.1 Visual Inspection

Visual inspections are performed at the fabricator's facility to ensure that the DSC, the Transfer Cask and the HSM conform to the drawings and specifications. The visual inspections include weld, dimensional, surface finish, and cleanliness inspections. Visual inspections specified by codes applicable to a component are performed in accordance with the requirements and acceptance criteria of those codes.

All weld inspection is performed using qualified processes and qualified personnel according to the applicable code requirements, e.g., ASME or AWS. Non-destructive examination (NDE) requirements for welds are specified on the drawings provided in Chapter U.1; acceptance criteria are as specified by the governing code. NDE personnel are qualified in accordance with SNT-TC-1A [9.2].

The confinement welds on the DSC are inspected in accordance with ASME B&PV Code Subsection NB [9.1] including alternatives to ASME Code specified in Section U.3.1.2.3.

DSC non-confinement welds are inspected to the NDE acceptance criteria of ASME B&PV Code Subsection NG or NF, based on the applicable code for the components welded.

U.9.1.2 Structural

The DSC confinement boundary except the inner top cover/shield plug to the DSC shell weld is pressure tested at the fabricator's shop in accordance with ASME Article NB-6300. The test pressure is set between 22.5 to 24.0 psig for 32PTH1 DSC for future 10CFR71 application. This bounds the 1.1xDSC design pressure of 15 psig.

The inner top cover/shield plug to the DSC shell weld is also pressure tested between 22.5 to 24.0 psig for 32PTH1 DSC at the field after the fuel assemblies are loaded in the DSC. This test is in accordance with the alternatives to the ASME Code specified in Section U.3.1.2.3.

HSM-H reinforcement and concrete are tested as described in Section U.3.4.2.

U.9.1.3 Leak Tests

DSC confinement welds in the DSC shell and bottom are leak tested at the fabricator's shop to an acceptance criterion of 1×10^{-7} ref cm^3/s, i.e., "leaktight" as defined in ANSI N14.5 [9.4]. Personnel performing the leak test are qualified in accordance with SNT-TC-1A [9.2].

The weld between the DSC shell and inner top cover/shield plug and siphon/vent cover welds are also leak tested to an acceptance criteria of 1×10^{-7} ref cm^3/s at the field after the fuel assemblies are loaded in the canister.

U.9.1.4 Components

The NUHOMS® System does not include any components such as valves, rupture discs, pumps, or blowers. The gaskets in the Transfer Cask do not require acceptance testing other than the leak testing cited above. No other components of the NUHOMS® System require testing, except as discussed in this chapter.

U.9.1.5 Shielding Integrity

The Transfer Cask poured lead shielding integrity will be confirmed via gamma scanning prior to first use. The detector and examination grid will be matched to provide coverage of the entire lead-shielded surface area. For example, for a 6" × 6" grid, the detector will encompass a 6" × 6" square. The acceptance criterion is attenuation greater than or equal to that of a test block matching the cask through-wall configuration with lead and steel thicknesses equal to the design minima less 5%.

The radial neutron shielding is provided by filling the neutron shield shell with water during operations. No testing is necessary. The neutron shield material in the lid and bottom end is a proprietary polymer resin. The shielding performance of the resin will be assured by written procedures controlling temperature, measuring, and mixing of the components, degassing of the resin, and verification of the mass or volume of resin installed.

The gamma and neutron shielding materials of the storage system itself are limited to concrete HSM components and steel shield plugs in the DSC. The integrity of these shielding materials is ensured by the control of their fabrication in accordance with the appropriate ASME, ASTM or ACI criteria. No additional acceptance testing is required.

U.9.1.6 Thermal Acceptance

No thermal acceptance testing is required to verify the performance of each storage unit other than that specified in the Technical Specifications for initial loading.

The heat transfer analysis for the basket includes credit for the thermal conductivity of neutron-absorbing materials, as specified in Section U.4.3. Because these materials (with the exception of Boral®) do not have publicly documented values for thermal conductivity, testing of such materials will be performed in accordance with Section U.9.1.7.4.

U.9.1.7 Poison Acceptance

> ***CAUTION***
>
> *Sections U.9.1.7.1 through U.9.1.7.3 below are incorporated by reference into the NUHOMS® CoC 1004 Technical Specifications (paragraph 1.2.1) and shall not be deleted or altered in any way without a CoC amendment approval from the NRC. The text of these sections is shown in bold type to distinguish it from other sections.*

The neutron absorber used for criticality control in the DSC basket may consist any of the following types of material:

(a) Boron-aluminum alloy (borated aluminum)

(b) Boron carbide-aluminum metal matrix composite (MMC)

(c) Boral®

The 32PTH1 DSC safety analyses do not rely upon the tensile strength of these materials. The radiation and temperature environment in the cask is not sufficiently severe to damage these metallic/ceramic materials. To assure performance of the neutron absorber's design function only the presence of B10 and the uniformity of its distribution need to be verified, with testing requirements specific to each material. The boron content for these materials is given in Table U.9-1.

U.9.1.7.1 **Boron Aluminum Alloy (Borated Aluminum)**

See the Caution in Section U.9.1.7 before deletion or modification to this section.

The material is produced by direct chill (DC) or permanent mold casting with boron precipitating as a uniform fine dispersion of discrete AlB_2 or TiB_2 particles in the matrix of aluminum or aluminum alloy. For extruded products, the TiB_2 form of the alloy shall be used. For rolled products, either the AlB_2, the TiB_2, or a hybrid may be used.

Boron is added to the aluminum in the quantity necessary to provide the specified minimum B10 areal density in the final product, with sufficient margin to minimize rejection, typically 10 % excess. The amount required to achieve the specified minimum B10 areal density will depend on whether boron with the natural isotopic distribution of the isotopes B10 and B11, or boron enriched in B10 is used. In no case shall the boron content in the aluminum or aluminum alloy exceed 5% by weight.

The criticality calculations take credit for 90% of the minimum specified B10 areal density of borated aluminum. The basis for this credit is the B10 areal density acceptance testing, which shall be as specified in Section U.9.1.7.5. The specified acceptance testing assures that at any location in the material, the minimum specified areal density of B10 will be found with 95% probability and 95% confidence.

Visual inspections shall follow the recommendations in Aluminum Standards and Data, Chapter 4 "Quality Control, Visual Inspection of Aluminum Mill Products and

Castings"[9.5]. Local or cosmetic conditions such as scratches, nicks, die lines, inclusions, abrasion, isolated pores, or discoloration are acceptable. Widespread blisters, rough surface, or cracking shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.

U.9.1.7.2 **Boron Carbide / Aluminum Metal Matrix Composites (MMC)**

See the Caution in Section U.9.1.7 before deletion or modification to this section.

The material is a composite of fine boron carbide particles in an aluminum or aluminum alloy matrix. The material shall be produced by either direct chill casting, permanent mold casting, powder metallurgy, or thermal spray techniques. It is a low-porosity product, with a metallurgically bonded matrix. The boron carbide content shall not exceed 40% by volume. The boron carbide content for MMCs with an integral aluminum cladding shall not exceed 50% by volume.

Prior to use in the 32PTH1 DSC, MMCs shall pass the qualification testing specified in Section U.9.1.7.6, and shall subsequently be subject to the process controls specified in Section U.9.1.7.7.

The criticality calculations take credit for 90% of the minimum specified B10 areal density of MMCs. The basis for this credit is the B10 areal density acceptance testing, which is specified in Section U.9.1.7.5. The specified acceptance testing assures that at any location in the final product, the minimum specified areal density of B10 will be found with 95% probability and 95% confidence.

Visual inspections shall follow the recommendations in Aluminum Standards and Data, Chapter 4 "Quality Control, Visual Inspection of Aluminum Mill Products and Castings" [9.5]. Local or cosmetic conditions such as scratches, nicks, die lines, inclusions, abrasion, isolated pores, or discoloration are acceptable. Widespread blisters, rough surfaces, or cracking shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.

References to metal matrix composites throughout this chapter are not intended to refer to Boral®, which is described in the following section.

U.9.1.7.3 **Boral®**

See the Caution in Section U.9.1.7 before deletion or modification to this section.

This material consists of a core of aluminum and boron carbide powders between two outer layers of aluminum, mechanically bonded by hot-rolling an "ingot" consisting of an aluminum box filled with blended boron carbide and aluminum powders. The core, which is exposed at the edges of the sheet, is slightly porous. The average size of the boron carbide particles in the finished product is approximately 85 microns after rolling. The nominal boron carbide content shall be limited to 65% (+ 2% tolerance limit) of the core by weight.

The criticality calculations take credit for 75% of the minimum specified B10 areal density of Boral®. B10 areal density will be verified by chemical analysis and by certification of the

B10 isotopic fraction for the boron carbide powder, or by neutron transmission testing. Areal density testing is performed on an approximately 1 cm^2 area of a coupon taken near one of the corners of the sheet produced from each ingot. If the measured areal density is below that specified, all the material produced from that ingot will be either rejected, or accepted only on the basis of alternate verification of B10 areal density for each of the final pieces produced from that ingot.

Visual inspections shall verify that the Boral® core is not exposed through the face of the sheet at any location.

U.9.1.7.4 Thermal Conductivity Testing

All poison plate materials except Boral® will be qualification tested to verify that the thermal conductivity equals or exceeds the values listed in Section U.4.3. Testing of Boral® is not required since the thermal conductivity values utilized in Section U.4.3 were conservatively derived from References [9.7] and [9.8].

Testing shall conform to ASTM E1225 [9.9], ASTM E1461 [9.10], or equivalent method, performed at room temperature on coupons taken from the rolled or extruded production material. Previous testing of borated aluminum and metal matrix composite, shows that thermal conductivity increases slightly with temperature. Initial sampling shall be one test per lot, defined by the heat or ingot, and may be reduced if the first five tests meet the specified minimum thermal conductivity.

If a thermal conductivity test result is below the specified minimum, additional tests may be performed on the material from that lot. If the mean value of those tests falls below the specified minimum, the associated lot shall be rejected.

After twenty five tests of a single type of material, with the same aluminum alloy matrix, the same boron content, and the boron appearing in the same phase, e.g., B_4C, TiB_2, or AlB_2, if the mean value of all the test results less two standard deviations meets the specified thermal conductivity, no further testing of that material is required. This exemption may also be applied to the same type of material if the matrix of the material changes to a more thermally conductive alloy (e.g., from 6000 to 1000 series aluminum), or if the boron content is reduced without changing the boron phase.

The thermal analysis in Chapter U.4 assumes the neutron absorber can be made from a single piece or can be paired with aluminum 1100 plate. The minimum thermal conductivity of the neutron absorber plate shall be equal to or greater than that assumed in the analysis, as shown in Section U.4.3 for the borated aluminum and MMC poison materials.

The aluminum 1100 plate does not need to be tested for thermal conductivity; the material may be credited with the values published in the ASME Code Section II part D.

U.9.1.7.5 Specification for Acceptance Testing of Neutron Absorbers by Neutron Transmission

CAUTION

Section U.9.1.7.5 is incorporated by reference into the NUHOMS® CoC 1004 Technical Specifications (paragraph 1.2.1) and shall not be deleted or altered in any way without a CoC amendment approval from the NRC. The text of this section is shown in bold type to distinguish it from other sections.

Neutron Transmission acceptance testing procedures shall be subject to approval by the Certificate Holder. Test coupons shall be removed from the rolled or extruded production material at locations that are systematically or probabilistically distributed throughout the lot. Test coupons shall not exhibit physical defects that would not be acceptable in the finished product, or that would preclude an accurate measurement of the coupon's physical thickness.

A lot is defined as all the pieces produced from a single ingot or heat. If this definition results in lot size too small to provide a meaningful statistical analysis of results, an alternate larger lot definition may be used, so long as it results in accumulating material that is uniform for sampling purposes.

The sampling rate for neutron transmission measurements shall be such that there is at least one neutron transmission measurement for each 2000 square inches of final product in each lot.

The B10 areal density is measured using a collimated thermal neutron beam of up to 1.2 centimeter diameter. A beam size greater than 1.2 centimeter diameter but no larger than 1.7 centimeter diameter may be used if computations are performed to demonstrate that the calculated $k_{effective}$ of the system is still below the calculated Upper Subcritical Limit (USL) of the system assuming defect areas the same area as the beam. Alternatively, the confidence and probability levels can be increased such that it will result in equivalent acceptance rates for the material as the 1.2 centimeter diameter beam size.

The neutron transmission through the test coupons is converted to B10 areal density by comparison with transmission through calibrated standards. These standards are composed of a homogeneous boron compound without other significant neutron absorbers. For example, boron carbide, zirconium diboride or titanium diboride sheets are acceptable standards. These standards are paired with aluminum shims sized to match the effect of neutron scattering by aluminum in the test coupons. Uniform but non-homogeneous materials such as metal matrix composites may be used for standards, provided that testing shows them to provide neutron attenuation equivalent to a homogeneous standard.

Alternatively, digital image analysis may be used to compare neutron radioscopic images of the test coupon to images of the standards. The area of image analysis shall be up to 1.1 cm^2.

The minimum areal density specified shall be verified for each lot at the 95% probability, 95% confidence level or better. The following illustrates one acceptable method.

The acceptance criterion for individual plates is determined from a statistical analysis of the test results for their lot. The minimum B10 areal densities determined by neutron transmission are converted to volume density, i.e., the minimum B10 areal density is divided by the thickness at the location of the neutron transmission measurement or the maximum thickness of the coupon. The lower tolerance limit of B10 volume density is then determined, defined as the mean value of B10 volume density for the sample, less K times the standard deviation, where K is the one-sided tolerance limit factor for a normal distribution with 95% probability and 95% confidence [9.6].

Finally, the minimum specified value of B10 areal density is divided by the lower tolerance limit of B10 volume density to arrive at the minimum plate thickness which provides the specified B10 areal density.

Any plate which is thinner than this minimum or the minimum design thickness, whichever is greater, shall be treated as non-conforming, with the following exception. Local depressions are acceptable, so long as they total no more than 0.5% of the area on any given plate, and the thickness at their location is not less than 90% of the minimum design thickness.

Non-conforming material shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.

U.9.1.7.6 Specification for Qualification Testing of Metal Matrix Composites

U.9.1.7.6.1 Applicability and Scope

Metal matrix composites (MMCs) shall consist of fine boron carbide particles in an aluminum or aluminum alloy matrix. The ingot shall be produced by either powder metallurgy (PM), thermal spray techniques, or by direct chill (DC) or permanent mold casting. In any case, the final MMC product shall have density greater than 98% of theoretical, a metallurgically bonded matrix, and boron carbide content no greater than 40% by volume. (For MMCs with an integral aluminum cladding, the maximum boron carbide content shall be no greater than 50% by volume and the density shall be greater than 97% of theoretical density.) Boron carbide particles for the products considered here typically have an average size in the range 10-40 microns, although the actual specification may be by mesh size, rather than by average particle size. No more than 10% of the particles shall be over 60 microns. The material shall have negligible interconnected porosity exposed at the surface or edges.

Prior to initial use in a spent fuel dry storage or transport system, such MMCs shall be subjected to qualification testing that will verify that the product satisfies the design function. Key process controls shall be identified per Section U.9.1.7.7 so that the production material is equivalent to or better than the qualification test material. Changes to key processes shall be subject to qualification before use of such material in a spent fuel dry storage or transport system.

ASTM test methods and practices are referenced below for guidance. Alternative methods may

be used with the approval of the certificate holder.

U.9.1.7.6.2 Design Requirements

In order to perform its design functions the product must have at a minimum sufficient strength and ductility for manufacturing and for the normal and accident conditions of the storage/ transport system. This is demonstrated by the tests in Section U.9.1.7.6.4. It must have a uniform distribution of boron carbide. This is demonstrated by the tests in Section U.9.1.7.6.5.

U.9.1.7.6.3 Durability

There is no need to include accelerated radiation damage testing in the qualification. Such testing has already been performed on MMCs, and the results confirm what would be expected of materials that fall within the limits of applicability cited above. Metals and ceramics do not experience measurable changes in mechanical properties due to fast neutron fluences typical over the lifetime of spent fuel storage, about 10^{15} neutrons/cm^2.

The need for thermal damage and corrosion (hydrogen generation) testing shall be evaluated case-by-case based on comparison of the material composition and environmental conditions with previous thermal or corrosion testing of MMCs.

Thermal damage testing is not required for MMCs consisting only of boron carbide in an aluminum 1100 matrix, because there is no reaction between aluminum and boron carbide below 842°F, well above the basket temperature under normal conditions of storage or transport[1].

Corrosion testing is not required for full density MMCs consisting only of boron carbide in an aluminum 1100 matrix, because testing on one such material has already been performed by Transnuclear[2].

U.9.1.7.6.4 Required Qualification Tests and Examinations to Demonstrate Mechanical Integrity

At least three samples, one each from the two ends and middle of the test material production run shall be subject to:

a) room temperature tensile testing (ASTM- B557[3]) demonstrating that the material has the following tensile properties:
   - Minimum yield strength, 0.2% offset: 1.5 ksi
   - Minimum ultimate strength: 5 ksi
   - Minimum elongation in 2 inches: 0.5%

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1 **Sung, C., "Microstructural Observation of Thermally Aged and Irradiated Aluminum/Boron Carbide (B_4C) Metal Matrix Composite by Transmission and Scanning Electron Microscope," 1998.**

2 **Boralyn testing submitted to the NRC under docket 71-1027, 1998.**

3 **ASTM B557 Standard Test Methods of Tension Testing Wrought and Cast Aluminum and Magnesium-Alloy Products.**

(Alternatively show that the material fails in a ductile manner, e.g., by scanning electron microscopy of the fracture surface or by bend testing.)

and

b) testing (ASTM-B311[4]) to verify more than 98% (or 97% for MMCs with integral aluminum cladding) of theoretical density. Testing or examination for exposed interconnected porosity shall be performed by a means to be approved by the Certificate Holder.

U.9.1.7.6.5 Required Tests and Examinations to Demonstrate B10 Uniformity

CAUTION

Section U.9.1.7.6.5 is incorporated by reference into the NUHOMS® CoC 1004 Technical Specifications (paragraph 1.2.1) and shall not be deleted or altered in any way without a CoC amendment approval from the NRC. The text of this section is shown in bold type to distinguish it from other sections.

Uniformity of the boron distribution shall be verified either by:

a) Neutron radioscopy or radiography (ASTM E94[5], E142[6], and E545[7]) of material from the ends and middle of the test material production run, verifying no more than 10% difference between the minimum and maximum B10 areal density, or

b) Quantitative testing for the B10 areal density, B10 density, or the boron carbide weight fraction, on locations distributed over the test material production run, verifying that one standard deviation in the sample is less than 10% of the sample mean. Testing may be performed by a neutron transmission method similar to that specified in Section U.9.1.7.5, or by chemical analysis for boron carbide content in the composite.

U.9.1.7.6.6 Approval of Procedures

Qualification procedures shall be subject to approval by the Certificate Holder.

U.9.1.7.7 Specification for Process Controls for Metal Matrix Composites

U.9.1.7.7.1 Applicability and Scope

The applicability of this section is the same as that of Section U.9.1.7.6. It addresses the process controls to ensure that the material delivered for use is equivalent to the qualification test material.

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4 **ASTM B311, Test Method for Density Determination for Powder Metallurgy (P/M) Materials Containing Less than Two Percent Porosity**

5 **ASTM E94, Recommended Practice for Radiographic Testing**

6 **ASTM E142, Controlling Quality of Radiographic Testing**

7 **ASTM E545, Standard Method for Determining Image Quality in Thermal Neutron Radiographic Testing**

Key processing changes shall be subject to qualification prior to use of the material produced by the revised process. The Certificate Holder shall determine whether a complete or partial re-qualification program per Section U.9.1.7.7 is required, depending on the characteristics of the material that could be affected by the process change.

U.9.1.7.7.2 Definition of Key Process Changes

Key process changes are those which could adversely affect the uniform distribution of the boron carbide in the aluminum, reduce density, or reduce the mechanical strength or ductility of the MMC.

U.9.1.7.7.3 Identification and Control of Key Process Changes

CAUTION

Section U.9.1.7.7.3 is incorporated by reference into the NUHOMS® CoC 1004 Technical Specifications (paragraph 1.2.1) and shall not be deleted or altered in any way without a CoC amendment approval from the NRC. The text of this section is shown in bold type to distinguish it from other sections.

The manufacturer shall provide the Certificate Holder with a description of materials and process controls used in producing the MMC. The Certificate Holder and manufacturer shall identify key process changes as defined in Section U.9.1.7.7.2.

An increase in nominal boron carbide content over that previously qualified shall always be regarded as a key process change. The following are examples of other changes that may be established as key process changes, as determined by the Certificate Holder's review of the specific applications and production processes:

a) Changes in the boron carbide particle size specification that increase the average particle size by more than 5 microns or that increase the amount of particles larger than 60 microns from the previously qualified material by more than 5% of the total distribution but less than the 10% limit,

b) Change of the billet production process, e.g., from vacuum hot pressing to cold isostatic pressing followed by vacuum sintering,

c) Change in the nominal matrix alloy,

d) Changes in mechanical processing that could result in reduced density of the final product, e.g., for PM or thermal spray MMCs that were qualified with extruded material, a change to direct rolling from the billet,

e) For MMCs using a 6000 series aluminum matrix, changes in the billet formation process that could increase the likelihood of magnesium reaction with the boron carbide, such as an increase in the maximum temperature or time at maximum temperature, and

f) **Changes in powder blending or melt stirring processes that could result in less uniform distribution of boron carbide, e.g., change in duration of powder blending.**

In no case shall process changes be accepted if they result in a product outside the limits in Sections U.9.1.7.6.1 and U.9.1.7.6.4.

U.9.2 Maintenance Program

The NUHOMS®-32PTH1 system is a totally passive system and therefore will require little, if any, maintenance over the lifetime of the ISFSI. Typical NUHOMS®-32PTH1 system maintenance tasks will be performed in accordance with the UFSAR.

U.9.3 References

9.1 ASME Boiler and Pressure Vessel Code, Section III, 1998 Edition with 2000 Addenda.

9.2 SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing," 1992.

9.3 ANSI N14.6, "American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds or More for Nuclear Materials," New York, 1996.

9.4 ANSI N14.5-1997, "American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials", February 1998.

9.5 "Aluminum Standards and Data, 2003" The Aluminum Association.

9.6 Natrella, "Experimental Statistics," Dover, 2005.

9.7 AAR Advanced Structures, "Boral®, The Proven Neutron Absorber."

9.8 AAR Advanced Structures, Boral® Product Performance Report 624."

9.9 ASTM E1225, "Thermal Conductivity of Solids by Means of the Guarded-Comparative-Longitudinal Heat Flow Technique."

9.10 ASTM E1461, "Thermal Diffusivity of Solids by the Flash Method."

Table U.9-1
B10 Specification for the NUHOMS® 32PTH1 Poison Plates

Poison Type	32PTH1 Basket Type	Minimum Poison Loading (B10 mg/cm^2)	% Credit Used in Criticality Analysis
Borated Aluminum Alloy/MMC	1A or 2A	7	90
	1B or 2B	15	
	1C or 2C	20	
	1D or 2D	32	
	1E or 2E	50	
Boral®	1A or 2A	9	75
	1B or 2B	19	
	1C or 2C	25	
	1D or 2D	N/A	
	1E or 2E	N/A	

U.10 Radiation Protection

Section 7.4.1 discusses the anticipated cumulative dose exposure to site personnel during the fuel handling and transfer activities associated with utilizing one NUHOMS® HSM for storage of one DSC. Chapter U.8 describes in detail the NUHOMS® operational procedures, several of which involve potential exposure to personnel. This section of the Appendix provides occupational exposure and off-site dose rates from NUHOMS® 32PTH1 DSCs to be stored in NUHOMS® HSM-H.

U.10.1 Occupational Exposure

The expected occupational dose for placing a canister of spent fuel into dry storage is based on the operational steps outlined in Table 7.4-1 of the UFSAR. The total exposure for the occupational dose due to placing a single NUHOMS® 32PTH1 DSC loaded with design basis fuel assemblies into storage is conservatively estimated to be 2 person-rem as summarized in Table U.10-1. This is a very conservative estimate because the dose rates on and around 32PTH1 DSCs used in these calculations are based on very conservative assumptions for the design-basis source terms and analyses models. The calculated exposures are due mainly to the expected gamma dose rate during preparation for welding.

The NUHOMS® 32PTH1 system loading operations, the number of workers required for each operation, and the amount of time required for each operation are presented in Table U.10-1. This information is used as the basis for estimating the total occupational exposure associated with one fuel load. The dose rates applicable for each operation are based on the results presented in Section U.5.4 for loading operations. Engineering judgment and operational experience are used to estimate dose rates that were not explicitly evaluated. This evaluation assumes that a transfer trailer/skid with an integral ram is used for the DSC transfer operations. Licensees may elect to use different equipment and/or different procedures. Each Licensee must evaluate any such changes in accordance with its ALARA program.

Unique steps are sometimes necessary at the individual site to load the canister, complete closure operations and place the canister in the HSM-H. Specifically, the licensee may choose to modify the sequence of operations in order to achieve reduced dose rates for a larger number of steps, with the end result of reduced total exposure. The only requirement is that the licensee practice ALARA with respect to the total exposure received for a loading campaign. These estimated durations, manloading and dose rates are not limits.

The amount of time required to complete some operations as identified in Table U.10-1 may be greater than the actual amount of time spent in a radiation field. The process of vacuum drying the DSC includes setting up the vacuum drying system (VDS), verifying that the VDS is operating correctly, evacuating the DSC cavity, monitoring the DSC pressure, and disconnecting the VDS from the DSC. Of these tasks, only setup and removal of the VDS require a worker to spend time near the DSC. The most time consuming task, evacuating the DSC, does not require anyone to be present near DSC at all. The total exposure calculated for each task is therefore not necessarily equal to the number of workers multiplied by the total time required, multiplied by a dose rate. The exposure estimation for each task correctly accounts for cases such as vacuum drying and assumes that good ALARA practices are followed.

Localized regions of elevated dose rates should be anticipated and minimized with good ALARA practices. Such regions exist due primarily to radiation streaming, including for example, streaming through the cask/DSC annulus, the ventilation paths in OS200 lid and the DSC vent/siphon ports.

The results of the evaluations of the NUHOMS® 32PTH1 are presented in Table U.10-1.

The potential for streaming due to gaps associated with the alternate top closure have been evaluated using standard hand calculation methods. In this configuration streaming paths around

the lifting posts may occur. These streaming paths form annular ducts through the thick shield plug used in the alternate top closure. The following equations are used to evaluate the streaming due to annular ducts:

for gamma radiation,

$$\frac{\phi}{\phi_0} = \frac{1}{\pi L^2}\left[\left(\cos^{-1}\frac{r}{R}\right)\left(2R^2 - r^2\right) - r\sqrt{R^2 - r^2}\right], \text{ and}$$

for neutron radiation,

$$\frac{\phi}{\phi_0} = \frac{10}{L^2}\left[\left(\cos^{-1}\frac{r}{R}\right)\left(2R^2 - r^2\right) - r\sqrt{R^2 - r^2}\right],$$

for,

$$\frac{1}{R(R-r)} \ll R^2 - r^2 \ll L^2,$$

where, L is the length of the duct, r and R are inner and outer radius of the annular duct, respectively.

Using the above formulations, the increase in dose rates on the top of the DSC are estimated to be no more than twice the results presented in Chapter U.5 for radial gaps (R-r) less than 0.25" over the center of the cask. This localized increase in dose rates are an operational concern and should be mitigated through good ALARA practices.

U.10.2 Off-Site Dose Calculations

Calculated dose rates in the immediate vicinity of the NUHOMS® 32PTH1 system are presented in Chapter U.5, which provides a detailed description of source term configuration, analysis models and bounding dose rates. The bounding dose rates are based upon contributions from the design basis fuel including control components. Off-site dose rates and annual doses are presented in this section. This evaluation determines the neutron and gamma-ray off-site dose rates (including skyshine) in the vicinity of two generic ISFSI layouts containing design-basis fuel in the NUHOMS® 32PTH1 DSCs.

The first generic ISFSI evaluated is a 2x10 back-to-back array of HSM-Hs loaded with design-basis fuel in NUHOMS® 32PTH1 DSCs. The second generic layout evaluated is two 1x10 front-to-front arrays of HSM-Hs loaded with design-basis fuel in NUHOMS® 32PTH1 DSCs. This evaluation provides results for distances ranging from 6.1 to 600 meters from each face of the two arrays of HSMs.

The total annual exposure for each ISFSI layout as a function of distance from each face is given in Table U.10-2 for the HSM-H. These data are also plotted in Figure U.10-1 The total annual exposure estimates assume 100% occupancy for 365 days.

Dose rates are calculated for 32PTH1 system by scaling the results from Monte Carlo computer code MCNP (MCNP5 version 1.2) [10.4] calculations performed for the NUHOMS® 61BTH system and presented in Appendix T, Chapter T.10. The results of these calculations provide an example of how to demonstrate compliance with the relevant radiological requirements of 10CFR20 [10.1], 10CFR72 [10.2], and 40CFR190 [10.3] for a specific site. Each site must perform specific site calculations to account for the actual layout of the HSMs and fuel source.

The assumptions in Appendix T, Section T.10.2 are also applicable to the off-site dose calculations performed for the NUHOMS® 32PTH1 system.

U.10.2.1 Activity Calculations

Gamma-ray spectrum calculations for the HSM-H are shown in Table U.10-3. The group- wise fluxes on the HSM-H roof are taken from the MCNP results from Chapter U.5. The dose rate contribution from each group is computed by taking the product of the flux and the flux-to-dose factor. The "Input Current" column in Table U.10-3 is simply half the roof flux in each group, divided by the total dose rate and represents the roof current normalized to one mrem per hour. Similar calculations for neutrons are shown in Table U.10-4.

Activity calculations are performed for the HSM-H, as the activity is required in the MCNP input. Because no new MCNP calculations are performed these activity calculations are provided for comparison to other NUHOMS® systems. The total activity of each face of the ISFSI is calculated by multiplying the current (in particles/cm^2/sec per mrem/hr) by the average dose rate of the face and by the area of the face.

2x10 Back-to-Back Array

A box that envelops the HSM-H array and shield walls, as modeled in MCNP, approximates the 2x10 back-to-back array of HSMs. The dimensions of the box also include the width of the

HSM-H end shield walls. As discussed above, the total activity of each face of the box is calculated by multiplying the current by the average dose rate of the face and by the area of the face.

Two 1x10 Front-to-Front Arrays

A box that envelopes the HSM-H array and shield walls, as modeled in MCNP, approximates the two 1x10 arrays of HSM-Hs. The dimensions of the box also include the width of the HSM-H end and back shield walls. As discussed above, the total activity of each face of the box is calculated by multiplying the current by the average dose rate of the face and by the area of the face.

The surface activities are summarized in Table U.10-6 for the HSM-H.

U.10.2.2 Dose Rates

Dose rates are calculated for distances of 6.1 meters (20 feet) to 600 meters from the edges of the two ISFSI designs by scaling NUHOMS® 61BTH dose rates presented in Appendix T, Section T.10.2.

Conservative scaling factors are determined that are applied to each surface dose rate calculated for the NUHOMS® 61BTH system. The scaling factor is determined by taking a ratio of the NUHOMS® 32PTH1 and NUHOMS® 61BTH dose rates for each surface. The scaling factor is increased to account for spectral differences between the NUHOMS® 32PTH1 and NUHOMS® 61BTH. This scaling factor methodology is similar to the methodology employed to calculate the dose rates for the NUHOMS® 61BTH HSM Model 80 described in Appendix T, Section T.10.2.

Comparison of the gamma-ray spectrum shown in Table U.10-3 to the NUHOMS® 61BTH HSM-H spectrum in Chapter T.10.2 reveals the 32PTH1 spectrum is harder. To account for this the gamma scaling factors described above are doubled. The neutron spectrum shown in Table U.10-4 is essentially the same as the NUHOMS® 61BTH HSM-H.

The neutron and gamma dose rates from each ISFSI surface for the NUHOMS® 61BTH are scaled by the factors shown in Table U.10-5. The adjusted dose rates are combined and used to calculate the annual exposure.

The HSM-H MCNP site dose rate results are summarized in Table U.10-7 through Table U.10-9. The front dose rates for the 2x10 configuration are provided in Table U.10-7, the back dose rates for the 2-1x10 configuration are provided in Table U.10-8, and the side dose rates for both ISFSI configurations are provided in Table U.10-9.

The preceding analyses and the results provided in Figure U.10-1 are intended to provide typical dose rates for the generic ISFSI layouts described in Section U.10.2. They may not be applicable to an actual ISFSI. The written evaluations performed by a licensee for an actual ISFSI must consider the type and number of storage units, layout, characteristics of the irradiated fuel to be stored, site characteristics (e.g., berms, distance to the controlled area boundary, etc.), and reactor operations at the site in order to demonstrate compliance with 10CFR72.104.

U.10.3 References

10.1 Title 10, "Energy," Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation."

10.2 Title 10, "Energy," Code of Federal Regulations, Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste."

10.3 Title 40, "Protection of Environment," Code of Federal Regulations, Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations."

10.4 "MCNP – A General Monte Carlo N-Particle Transport Code," Version 5, Volume II: User's Guide, LA-CP-03-0245, 2003.

Table U.10-1
Occupational Exposure Summary, 32PTH1 System

Location	Task Description	# of workers	Duration (hr)	Area Dose Rate (mrem/hr)	Total Exposure (person-mrem)
Auxiliary Building and Fuel Pool	Place the DSC into the Transfer Cask	2	2	2	8
	Fill the Cask/DSC Annulus with Clean Water and Install the Inflatable Seal	3	1	2	6
	Fill the DSC Cavity with Water	1	6	2	12
	Place the Cask Containing the DSC in the Fuel Pool	5	0.5	2	5
	Verify and Load the Candidate Fuel Assemblies into the DSC	3	5	2	30
	Place the Top Shield Plug on the DSC	2	1	2	4
	Remove the Cask/DSC from the Fuel Pool and Place them in the Decon Area	5	0.5	2	5
		1	0.033	199	7
		1	0.667	146	98
Cask Decontamination Area	Decontaminate the Outer Surface of the Cask	1	1.75	146	256
		1	1	2	2
	Decontaminate the Top Region of the Cask and DSC	1	0.5	195	97
		1	0.5	64	32
	Drain Water from the DSC	1	0.083	199	17
	Remove Cask/DSC Annulus Seal and Set-Up Welding Machine	1	0.167	337	56
		1	0.75	87	65
		1	0.5	72	36
	Weld the Inner Top Cover to the DSC Shell and Perform NDE (PT)	2	6	2	24
		1	0.33	169	56
	Drain the Cask/DSC Annulus and the DSC Cavity	1	0.25	87	22
		1	0.017	169	3
		1	0.5	2	1
	Vacuum Dry and Backfill the DSC with Helium	1	0.5	72	36
		2	30	2	120
	Helium Leak Test the Shield Plug Weld	2	1	2	4
	Seal Weld the Prefabricated Plugs to the Vent and Siphon Ports and Perform NDE (PT)	1	0.5	87	44
	Fit-Up the DSC Outer Top Cover Plate	1	0.25	169	42
		1	0.5	87	44
	Weld the Outer Top Cover Plate to DSC Shell and Perform NDE (PT)	1	1	72	72
		1	0.167	169	28
		2	14	2	56
		1	0.333	169	56
	Install the Cask Lid	2	0.667	93	124
Reactor/ Fuel Building Bay	Ready the Cask Support Skid and Transport Trailer for Service	2	2	2	8
	Place the Cask onto the Skid and Trailer	2	0.25	136	68
	Secure the Cask to the Skid	1	0.25	136	34
ISFSI Site	Ready the Cask Support Skid and Transport Trailer for Service	2	2	negligible	0
	Transport the Cask to ISFSI	6	1	negligible	0
	Position the Cask in Close Proximity with the HSM	3	1	negligible	0
	Remove the Cask Lid	2	0.67	42	56
	Align and Dock the Cask with the HSM	2	0.25	108	54
	Position and Align Ram with Cask	2	0.5	174	174
	Remove Ram Access Cover Plate	1	0.083	562	47
	Transfer the DSC from the Cask to the HSM	3	0.5	negligible	0
	Lift the Ram Back onto the Trailer and Un-Dock the Cask from the HSM	2	0.083	56	9
	Install HSM Access Door	2	0.5	15	15
	Totals	**N/A**	**87**	**N/A**	**1934**

Total estimated dose is 2 person-rem per 32PTH1 canister load.

Table U.10-2
Total Annual Exposure, 32PTH1 Within HSM-H

2x10 Back To Back Array

Distance (meters)	Front Total Dose (mrem)	1σ Uncertainty (mrem)	1σ Relative Uncertainty
6.1	77,067	66	0.001
10	46,869	49	0.001
20	18,004	31	0.002
30	9,048	18	0.002
40	5,327	14	0.003
50	3,465	13	0.004
60	2,389	11	0.005
70	1,727	8	0.004
80	1,284	6	0.005
90	995	6	0.007
100	766	5	0.007
200	109	2	0.015
300	21.9	0.5	0.022
400	5.5	0.2	0.029
500	1.60	0.09	0.059
600	0.48	0.01	0.025

Distance (meters)	Side Total Dose (mrem)	1σ Uncertainty (mrem)	1σ Relative Uncertainty
6.1	6,880	17	0.002
10	5,130	15	0.003
20	3,017	12	0.004
30	2,041	11	0.005
40	1,481	7	0.005
50	1,117	6	0.006
60	866	7	0.008
70	676	5	0.008
80	541	5	0.009
90	432	4	0.008
100	358	4	0.012
200	58	1	0.018
300	12.0	0.3	0.026
400	3.0	0.1	0.039
500	0.75	0.02	0.032
600	0.23	0.02	0.070

Two 1x10 Front To Front Array

Distance (meters)	Back Total Dose (mrem)	1σ Uncertainty (mrem)	1σ Relative Uncertainty
6.1	5,344	15	0.003
10	4,588	17	0.004
20	3,069	14	0.005
30	2,186	12	0.006
40	1,593	10	0.006
50	1,225	12	0.010
60	966	8	0.009
70	753	8	0.011
80	602	9	0.014
90	491	7	0.014
100	396	3	0.009
200	71	3	0.041
300	14.1	0.4	0.027
400	3.8	0.2	0.055
500	0.99	0.04	0.041
600	0.39	0.10	0.244

Distance (meters)	Side Total Dose (mrem)	1σ Uncertainty (mrem)	1σ Relative Uncertainty
6.1	27,553	53	0.002
10	14,933	44	0.003
20	5,480	25	0.005
30	2,989	18	0.006
40	1,947	15	0.008
50	1,369	11	0.008
60	1,015	10	0.010
70	777	7	0.010
80	612	8	0.013
90	479	5	0.011
100	398	11	0.027
200	61	1	0.023
300	12.7	0.5	0.038
400	3.1	0.2	0.052
500	1.0	0.1	0.113
600	0.26	0.01	0.055

Table U.10-3
HSM-H Gamma-Ray Spectrum Calculation Results

E_{upper} (MeV)	E_{mean} (MeV)	Flux-Dose ANSI/ANS-6.1.1-1977 (mR/hr)/(γ/cm^2-sec)	Roof Flux (γ/cm^2-sec)	Dose Rate (mR/hr)	Input Current (γ/cm^2-sec per mrem/hr)
3.5	3	4.191E-03	7.09E+00	0.03	3.232E-01
2.5	2.25	3.469E-03	5.28E+01	0.18	2.405E+00
2	1.83	3.019E-03	4.98E+01	0.15	2.271E+00
1.66	1.495	2.628E-03	1.04E+02	0.27	4.726E+00
1.33	1.165	2.205E-03	2.01E+02	0.44	9.179E+00
1	0.9	1.833E-03	2.04E+02	0.37	9.289E+00
0.8	0.7	1.523E-03	3.62E+02	0.55	1.650E+01
0.6	0.5	1.173E-03	9.20E+02	1.08	4.192E+01
0.4	0.35	8.759E-04	1.14E+03	1.00	5.204E+01
0.3	0.25	6.306E-04	2.23E+03	1.41	1.016E+02
0.2	0.15	3.834E-04	7.16E+03	2.74	3.260E+02
0.1	0.08	2.669E-04	8.75E+03	2.33	3.984E+02
0.05	0.03	9.348E-04	4.34E+02	0.41	1.976E+01
		Totals	2.16E+04	10.98	9.845E+02

Table U.10-4
HSM-H Neutron Spectrum Calculation Results

E_{upper} (MeV)	E_{mean} (MeV)	Flux-Dose ANSI/ANS-6.1.1-1977 (mR/hr)/(n/cm^2-sec)	Roof Flux (n/cm^2-sec)	Dose Rate (mR/hr)	Input Current (n/cm^2-sec per mrem/hr)
20.0	17.5	2.200E-01	2.10E-07	4.62E-08	1.529E-07
15.0	12.5	1.853E-01	1.90E-04	3.53E-05	1.383E-04
10.0	8	1.471E-01	7.66E-03	1.13E-03	5.575E-03
6.0	5	1.562E-01	2.44E-02	3.81E-03	1.773E-02
4.0	3	1.326E-01	2.03E-01	2.68E-02	1.473E-01
2.0	1.75	1.275E-01	1.44E-01	1.84E-02	1.050E-01
1.5	1.25	1.299E-01	1.85E-01	2.41E-02	1.347E-01
1.0	0.75	1.137E-01	4.40E-01	5.00E-02	3.197E-01
0.5	0.375	7.146E-02	1.17E+00	8.40E-02	8.546E-01
0.25	0.175	3.598E-02	8.50E-01	3.06E-02	6.179E-01
0.1	0.055	1.360E-02	3.78E+00	5.14E-02	2.746E+00
0.01	0.005	3.575E-03	1.11E+02	3.97E-01	8.081E+01
		Totals	1.18E+02	6.9E-01	8.58E+01

Table U.10-5
ISFSI Surface Activity Scaling Factors, 32PTH1 Within HSM-H

HSM-H Surface	Gamma Scaling Factor	Neutron Scaling Factor
Front	2.09	0.57
Roof	0.77	0.58
Side	0.86	0.31
Back	0.38	0.44

Table U.10-6
Summary of ISFSI Surface Activities, 32PTH1 DSC Within HSM-H

2x10 Back-To-Back Array

Source	Area (cm^2)	Neutron Activity (neutrons/sec)	Gamma-Ray Activity (γ/sec)
Roof	3,942,392	2.11E+08	8.75E+10
Front 1	1,764,538	4.69E+07	5.17E+10
Front 2	1,764,538	4.69E+07	5.17E+10
Side 1	710,399	1.31E+06	5.03E+08
Side 2	710,399	1.31E+06	5.03E+08
Total	8,892,266	2.60E+08	1.40E+11

Two 1x10 Front-To-Front Arrays

Source	Area (cm^2)	Neutron Activity (neutrons/sec)	Gamma-Ray Activity (γ/sec)
Roof	2,257,337	1.21E+08	5.01E+10
Front	1,764,538	4.69E+07	5.17E+10
Back	1,764,538	6.72E+05	2.27E+08
Side 1	406,760	7.51E+05	2.88E+08
Side 2	406,760	7.51E+05	2.88E+08
Total	6,599,935	1.69E+08	1.02E+11

Table U.10-7
MCNP Front Detector Dose Rates for 2x10 Array, 32PTH1 DSC Within HSM-H

Distance (meters)	Gamma Dose Rate (mrem/hr)	Gamma MCNP 1σ Uncertainty	Neutron Dose Rate (mrem/hr)	Neutron MCNP 1σ Uncertainty	Total Dose Rate (mrem/hr)	Combined MCNP 1σ Uncertainty
6.1	8.63E+00	8.71E-04	1.66E-01	4.68E-03	8.80E+00	0.0009
10	5.24E+00	1.05E-03	1.11E-01	5.99E-03	5.35E+00	0.0010
20	2.00E+00	1.78E-03	5.36E-02	9.43E-03	2.06E+00	0.0017
30	1.00E+00	2.01E-03	3.21E-02	1.16E-02	1.03E+00	0.0020
40	5.87E-01	2.74E-03	2.15E-02	1.44E-02	6.08E-01	0.0027
50	3.80E-01	3.77E-03	1.55E-02	1.72E-02	3.96E-01	0.0037
60	2.61E-01	4.73E-03	1.14E-02	1.87E-02	2.73E-01	0.0046
70	1.88E-01	4.56E-03	9.15E-03	2.33E-02	1.97E-01	0.0045
80	1.39E-01	5.02E-03	7.12E-03	2.73E-02	1.47E-01	0.0050
90	1.08E-01	6.66E-03	5.53E-03	3.15E-02	1.14E-01	0.0065
100	8.32E-02	6.80E-03	4.28E-03	2.49E-02	8.75E-02	0.0066
200	1.17E-02	1.48E-02	7.56E-04	1.12E-01	1.24E-02	0.0155
300	2.38E-03	2.26E-02	1.28E-04	7.01E-02	2.50E-03	0.0217
400	5.92E-04	2.94E-02	3.84E-05	1.64E-01	6.30E-04	0.0293
500	1.75E-04	6.10E-02	8.28E-06	1.33E-01	1.83E-04	0.0585
600	5.16E-05	2.53E-02	3.08E-06	1.41E-01	5.47E-05	0.0251

Table U.10-8
MCNP MCNP Back Detector Dose Rates for Two 1x10 Arrays, 32PTH1 DSC Within HSM-H

Distance (meters)	Gamma Dose Rate (mrem/hr)	Gamma MCNP 1σ Uncertainty	Neutron Dose Rate (mrem/hr)	Neutron MCNP 1σ Uncertainty	Total Dose Rate (mrem/hr)	Combined MCNP 1σ Uncertainty
6.1	5.58E-01	0.0030	5.19E-02	0.0104	6.10E-01	0.0029
10	4.79E-01	0.0038	4.50E-02	0.0127	5.24E-01	0.0036
20	3.20E-01	0.0047	3.03E-02	0.0148	3.50E-01	0.0045
30	2.28E-01	0.0059	2.17E-02	0.0180	2.50E-01	0.0056
40	1.66E-01	0.0064	1.55E-02	0.0175	1.82E-01	0.0060
50	1.28E-01	0.0109	1.23E-02	0.0197	1.40E-01	0.0101
60	1.01E-01	0.0091	9.41E-03	0.0225	1.10E-01	0.0086
70	7.83E-02	0.0113	7.64E-03	0.0294	8.59E-02	0.0106
80	6.24E-02	0.0154	6.38E-03	0.0370	6.88E-02	0.0144
90	5.10E-02	0.0147	5.06E-03	0.0418	5.60E-02	0.0139
100	4.11E-02	0.0088	4.04E-03	0.0383	4.52E-02	0.0087
200	7.46E-03	0.0431	6.69E-04	0.1090	8.13E-03	0.0406
300	1.48E-03	0.0282	1.31E-04	0.0937	1.62E-03	0.0270
400	4.08E-04	0.0584	2.67E-05	0.0787	4.34E-04	0.0550
500	1.05E-04	0.0426	7.86E-06	0.1514	1.13E-04	0.0410
600	4.17E-05	0.2624	3.22E-06	0.2143	4.49E-05	0.2441

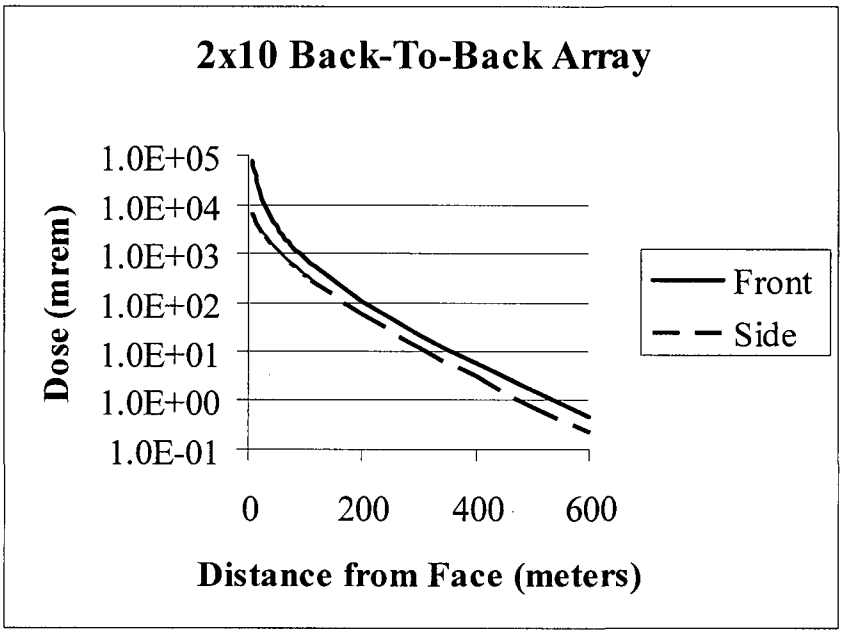
Table U.10-9
MCNP Side Detector Dose Rates, 32PTH1 DSC Within HSM-H

2x10 Back-to-Back Array

Distance (meters)	Gamma Dose Rate (mrem/hr)	Gamma MCNP 1σ Uncertainty	Neutron Dose Rate (mrem/hr)	Neutron MCNP 1σ Uncertainty	Total Dose Rate (mrem/hr)	Combined MCNP 1σ Uncertainty
6.1	7.31E-01	2.45E-03	5.41E-02	1.21E-02	7.85E-01	0.0024
10	5.43E-01	3.02E-03	4.29E-02	1.16E-02	5.86E-01	0.0029
20	3.17E-01	4.26E-03	2.71E-02	1.35E-02	3.44E-01	0.0041
30	2.14E-01	5.32E-03	1.94E-02	1.99E-02	2.33E-01	0.0051
40	1.55E-01	5.11E-03	1.39E-02	1.89E-02	1.69E-01	0.0049
50	1.17E-01	5.91E-03	1.08E-02	2.37E-02	1.28E-01	0.0058
60	9.06E-02	8.83E-03	8.23E-03	2.99E-02	9.88E-02	0.0085
70	7.05E-02	7.72E-03	6.67E-03	3.34E-02	7.72E-02	0.0076
80	5.66E-02	8.95E-03	5.16E-03	3.79E-02	6.18E-02	0.0088
90	4.51E-02	8.23E-03	4.21E-03	3.61E-02	4.94E-02	0.0081
100	3.74E-02	1.18E-02	3.47E-03	4.85E-02	4.09E-02	0.0116
200	6.07E-03	1.85E-02	5.31E-04	5.44E-02	6.60E-03	0.0176
300	1.26E-03	2.66E-02	1.06E-04	1.03E-01	1.37E-03	0.0258
400	3.16E-04	4.14E-02	2.68E-05	1.04E-01	3.43E-04	0.0390
500	7.70E-05	3.07E-02	8.54E-06	1.64E-01	8.55E-05	0.0321
600	2.42E-05	7.57E-02	2.37E-06	1.08E-01	2.66E-05	0.0696

Two 1x10 Front-To-Front Arrays

Distance (meters)	Gamma Dose Rate (mrem/hr)	Gamma MCNP 1σ Uncertainty	Neutron Dose Rate (mrem/hr)	Neutron MCNP 1σ Uncertainty	Total Dose Rate (mrem/hr)	Combined MCNP 1σ Uncertainty
6.1	3.06E+00	1.95E-03	8.73E-02	1.08E-02	3.15E+00	0.0019
10	1.65E+00	3.02E-03	5.86E-02	1.19E-02	1.70E+00	0.0029
20	5.92E-01	4.64E-03	3.34E-02	1.99E-02	6.26E-01	0.0045
30	3.19E-01	6.37E-03	2.24E-02	2.44E-02	3.41E-01	0.0062
40	2.07E-01	7.97E-03	1.56E-02	2.79E-02	2.22E-01	0.0077
50	1.44E-01	7.79E-03	1.23E-02	4.53E-02	1.56E-01	0.0080
60	1.07E-01	1.00E-02	8.79E-03	3.40E-02	1.16E-01	0.0096
70	8.09E-02	8.67E-03	7.78E-03	6.24E-02	8.86E-02	0.0096
80	6.43E-02	1.31E-02	5.60E-03	4.45E-02	6.99E-02	0.0125
90	5.03E-02	1.14E-02	4.33E-03	4.25E-02	5.47E-02	0.0111
100	4.18E-02	2.92E-02	3.68E-03	5.42E-02	4.55E-02	0.0272
200	6.41E-03	2.38E-02	5.51E-04	7.15E-02	6.96E-03	0.0226
300	1.35E-03	4.00E-02	9.52E-05	6.69E-02	1.44E-03	0.0377
400	3.26E-04	5.41E-02	3.08E-05	1.82E-01	3.57E-04	0.0519
500	1.06E-04	1.20E-01	7.06E-06	1.43E-01	1.13E-04	0.1125
600	2.72E-05	5.79E-02	2.44E-06	1.64E-01	2.97E-05	0.0548



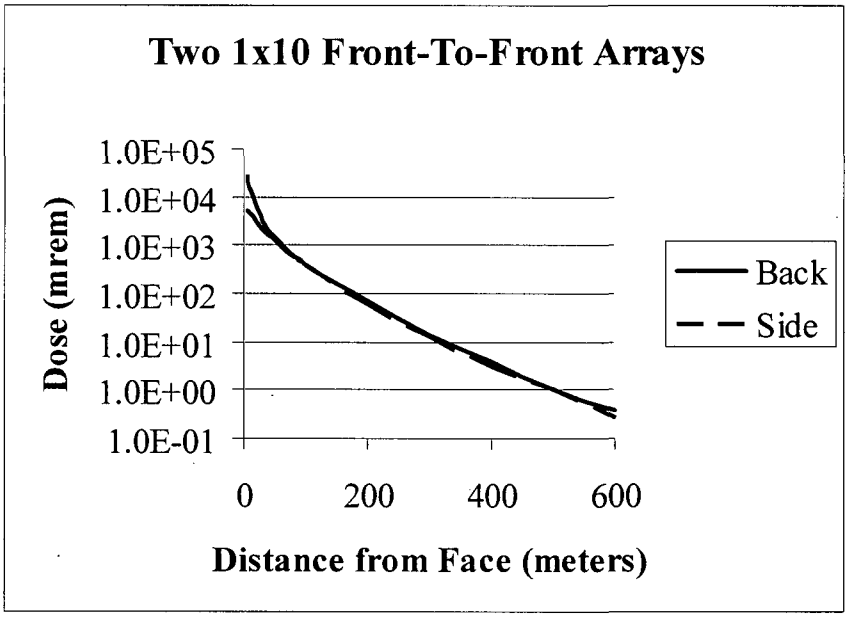


Figure U.10-1
Annual Exposure from the ISFSI as a Function of Distance, 32PTH1 DSC within HSM-H

U.11 Accident Analyses

This section describes the postulated off-normal and accident events that could occur during transfer and storage of the NUHOMS® 32PTH1 DSC. Sections which do not affect the evaluation presented in Chapter 8 are identified as "No change." Detailed analysis of the events are provided in other sections and referenced herein.

All the analyses provided in this section are applicable to both HSM-H or high seismic option of HSM-H (HSM-HS) unless specifically listed.

U.11.1 Off-Normal Operations

Off-normal operations are design events of the second type (Design Event II) as defined in ANSI/ANS 57.9 [11.1]. Off-normal conditions consist of that set of events that, although not occurring regularly, can be expected to occur with moderate frequency or on the order of once during a calendar year of ISFSI operation.

The off-normal conditions considered for the NUHOMS® 32PTH1 DSC are off-normal transfer loads, extreme temperatures and a postulated release of radionuclides.

U.11.1.1 Off-Normal Transfer Loads

No change. The limiting off-normal event is the jammed DSC during loading or unloading from the HSM. This event is described in UFSAR Section 8.1.2. Other off-normal events are bounded by the jammed DSC event.

U.11.1.1.1 Postulated Cause of Event

See UFSAR Section 8.1.2. The probability of a jammed DSC does not increase with the NUHOMS® 32PTH1 DSC since the interfacing design features and dimensions of the transfer cask top end and HSM access opening are not changed. The 32PTH1 DSC is provided with similar beveled lead-ins as the 24P/24PTH DSC. The maximum allowed misalignment of the sliding surfaces has not changed nor have any of the HSM insertion/retrieval procedures.

U.11.1.1.2 Detection of Event

No change. See UFSAR Section 8.1.2.

U.11.1.1.3 Analysis of Effects and Consequences

A detailed evaluation of this event is presented in Chapter U.3, Section U.3.6.2 for the 32PTH1 DSC and is summarized below. The NUHOMS® 32PTH1 DSC has a 0.5 inch shell wall thickness, while the NUHOMS® 24P has 0.625 inch thick shells. Therefore, the stresses in the canister shell are increased. The DSC shell stress due to the 3,836 in-kip moment due to axial sticking of the DSC is S_{mx} = 2.06 ksi. This magnitude of stress is negligible when compared to the allowable membrane stress of 17.5 ksi.

The DSC shell stress due to the 1,920-pound axial load during the binding of the DSC is 21.5 ksi. As stated in Chapter U.3, Section U.3.6.2.1, this stress is considered secondary and is enveloped by other handling stresses.

The evaluation of the basket due to normal and off-normal handling and transfer loads is presented in Chapter U.3, Section U.3.6.1.3.

U.11.1.1.4 Corrective Actions

No change. See UFSAR Section 8.1.2.

U.11.1.2 Extreme Temperatures

No change. The off-normal maximum ambient temperature of 125°F is used in UFSAR Section 8.1.2.2. For the NUHOMS® 32PTH1 system, a maximum ambient temperature of 117°F is used. Chapter U.3, Section U.3.4.4.3 summarizes the thermal analysis for the 32PTH1 DSC, HSM-H (HSM-HS) and OS200 TC.

U.11.1.2.1 Postulated Cause of Event

No change. See UFSAR Section 8.1.2.2.

U.11.1.2.2 Detection of Event

No change. See UFSAR Section 8.1.2.2.

U.11.1.2.3 Analysis of Effects and Consequences

The thermal evaluation of the NUHOMS® 32PTH1 system for off-normal conditions is presented in Chapter U.4. The 106°F normal condition with insolation bounds the 117°F case without insolation for the DSC in the TC. Therefore the normal condition maximum temperatures are bounding. The 117°F case with the DSC in the HSM-H is not bounded by the normal conditions and therefore evaluated in Chapter U.4.

The structural evaluation of the 32PTH1 DSC for off-normal temperature conditions is presented in Chapter U.3, Section U.3.6.2.2. The structural evaluation of the basket due to off-normal thermal conditions is presented in Chapter U.3, Section U.3.6.1.3. The structural evaluation of HSM-H and OS200 Transfer Cask for off-normal conditions with 32PTH1 DSC are presented in Chapter U.3, Section U.3.6.2.3 and Chapter U.3, Section U.3.6.2.4, respectively.

U.11.1.2.4 Corrective Actions

Restrictions for onsite handling of the TC with a loaded DSC under extreme temperature conditions are presented in Technical Specifications 1.2.13 and 1.2.14a.

U.11.1.3 Off-Normal Releases of Radionuclides

The NUHOMS® 32PTH1 DSC is designed and tested to the leak tight criteria of ANSI N14.5 [11.2]. Therefore the estimated quantity of radionuclides expected to be released annually to the environment due to normal or off-normal events is zero.

U.11.1.3.1 Postulated Cause of Event

In accordance with the Standard Review Plan, NUREG-1536 [11.3] and ISG-5 Rev. 1 [11.4] for off-normal conditions, it is conservatively assumed that 10% of the fuel rods fail.

U.11.1.3.2 Detection of Event

Failed fuel rods would go undetected, but are not a safety concern since the canister is designed and tested to the leak tight criteria of ANSI N14.5 [11.2].

U.11.1.3.3 Analysis of Effects and Consequences

The bounding off-normal pressure for the NUHOMS® 32PTH1 DSC is calculated with the DSC in either the HSM-H or in the TCs in Chapter U.4, Section U.4.6 as 18.65 psig. The NUHOMS® 32PTH1 DSC stresses were evaluated in Chapter U.3, Section U.3.6 assuming conservatively a 20 psig off-normal internal DSC pressure. The results show that the stresses due to these pressures are below the allowable stresses for off-normal conditions, as shown in Chapter U.3, Section U.3.6.

The NUHOMS® 32PTH1 DSC is designed and tested to the leak tight criteria of ANSI N14.5 [11.2]. Therefore the estimated quantity of radionuclides expected to be released annually to the environment due to normal or off-normal events is zero.

U.11.1.3.4 Corrective Actions

None required.

U.11.1.4 Radiological Impact from Off-Normal Operations

The NUHOMS® 32PTH1 DSC is designed and tested to the leak tight criteria of ANSI N14.5 [11.2]. The off-normal conditions have been evaluated in accordance with the ASME B&PV code [11.5]. The resulting stresses are below the allowable stresses. There will be no breach of the confinement boundary due to the off-normal conditions. Therefore, the estimated quantity of radionuclides expected to be released annually to the environment due to off-normal events is zero.

U.11.2 Postulated Accidents

U.11.2.1 Reduced HSM Air Inlet and Outlet Shielding

U.11.2.1.1 Cause of Accident

For HSM-H, this accident is not credible since the array of HSM-Hs is designed with the elimination of 6-inch gaps between the adjacent HSM-Hs. The HSM-Hs are placed next to each other and even in the unlikely event of large settlement of the ISFSI foundation, shifting of adjacent HSM-Hs occurring and causing the HSM-Hs to separate is not credible.

U.11.2.1.2 Accident Analysis

Not required.

U.11.2.1.3 Accident Dose Calculations

None

U.11.2.1.4 Corrective Actions

None

U.11.2.2 Earthquake

This event is described in UFSAR Section 8.2.3 and Chapter U.2, Section U.2.2.3.

U.11.2.2.1 Cause of Accident

As described in Chapter U.2, Section U.2.2.3, the loads due to the postulated seismic event are consistent with the criteria set forth in UFSAR Section 3.2.3, with the exception that the NRC Regulatory Guide 1.60 (R.G. 1.60) [11.9] response spectra is anchored to a maximum ground acceleration of 0.30g (instead of 0.25g) for the horizontal components and 0.25g (instead of 0.17g) for the vertical component (i.e., the site ZPA is 0.3g horizontal and 0.25g vertical). This earthquake is evaluated against Level C allowable criteria for those components evaluated in accordance with the ASME Code. The HSM-H is evaluated in accordance with ACI-349 Code [11.10].

In addition, an alternate higher seismic design loading is postulated. The alternate higher seismic loading consists of an "enhanced" NRC Regulatory Guide 1.60 response spectra anchored at 1.0g maximum horizontal accelerations and 1.0g maximum vertical acceleration. The enhanced R.G. 1.60 response spectra is enriched in the frequency range above 9 Hz as shown in Figure U.2-4. This earthquake level is evaluated against Level D allowable criteria for those components evaluated in accordance with the ASME Code. The HSM-HS is evaluated in accordance with ACI-349 Code [4.10].

U.11.2.2.2 Accident Analysis

Chapter U.3, Section U.3.7.2 describes the analysis performed to demonstrate the adequacy of the NUHOMS® 32PTH1 System components for the postulated seismic events defined in Section U.11.2.2.1.

Chapter U.3, Section U.3.7.2.1 and Section U.3.7.2.4.3 address the seismic stability of the 32PTH1 DSC resting on the steel support structure of the HSM-H and HSM-HS, respectively. Sections U.3.7.2.3.3 and U.3.7.2.3.4 address the seismic stability (overturning and sliding), response of the HSM-H, and Section U.3.7.2.4.3 addresses the sliding and rocking response of the HSM-HS. Seismic stability of the 32PTH1 DSC in the OS200 TC is addressed in Chapter U.3, Section U.3.7.2.5.

Chapter U.3, Section U.3.7.2.1.2 addresses the stress evaluation of the DSC shell assembly for the Level C and Level D postulated seismic loadings. Similarly, Section U.3.7.2.2 addresses the seismic basket evaluations. Section U.3.7.2.3.2 and Section U.3.7.2.4.2 address the seismic stress analysis of the HSM-H and HSM-HS, respectively. The OS200 seismic stresses for the Level C seismic loading are considered bounded by the transfer/handling load evaluation using a combined load of 2g applied simultaneously in all directions. The OS200 TC stresses due to the Level D seismic load are considered bounded by the 75g accident drop stresses and no explicit seismic evaluation is performed for this case.

The results of the analyses show that the seismic stresses of the DSC shell assembly are well within the allowable criteria limits and, thus, the leak-tight integrity of the canister is not compromised. Similarly, the stresses in the basket are well within Code allowable limits and do not result in deformation that would prevent fuel from being unloaded from the canister. The HSM-H / HSM-HS capacities computed in accordance with the ACI-349 Code exceed the computed seismic loads and, therefore, no damage to the HSM-H/HSM-HS is expected due to postulated seismic loads.

U.11.2.2.3 Accident Dose Calculations

The NUHOMS® 32PTH1 system is designed and analyzed to withstand the design basis earthquake accident. Hence, no radioactivity is released and there is no associated dose increase due to this event.

U.11.2.2.4 Corrective Actions

After a seismic event, the NUHOMS® HSM-H / HSM-HS and TC would be inspected for damage. Any debris would be removed. An evaluation would be performed to determine if the system components were still within the licensed design basis.

U.11.2.3 Extreme Winds and Tornado Missiles

This even is described in UFSAR Section 8.2.2.

U.11.2.3.1 Cause of Accident

No change to the description presented in UFSAR Section 8.2.2.1. No change to the determination of the tornado wind and tornado missile loads acting on the HSM-H / HSM-HS as detailed in Appendix P, Section P.2.2.1.

U.11.2.3.2 Accident Analysis

An evaluation that investigates the effect of the addition of the NUHOMS® 32PTH1 DSC, is presented in Chapter U.3, Section U.3.7.1. The evaluation of the HSM-H for the effect of DBT wind pressure loads is addressed in Section U.3.7.1.1. The tornado missile impact evaluation of the HSM-H / HSM-HS is presented in the following sections.

U.11.2.3.2.1 HSM-H/HSM-HS Missile Impact Analysis

No change to the missile impact evaluation presented in Appendix P, Section P.11.2.3.2.1.

To accommodate the longest 32PTH1 DSC inside the HSM-H / HSM-HS cavity, the concrete thickness of the shield door is reduced from 22.5 inches to 18.5 inches. The missile evaluations of the shielded composite door, described in Section P.11.2.3.2.1, do not take credit for the 22.5 inch concrete thickness that is structurally composite with the 7.875 inch total steel plate thickness. Therefore, the shielded door evaluations for missile loadings as presented in Section P.11.2.3.2.1 remain applicable for the shielded door with reduced concrete thickness.

In addition, as shown in the drawings for the HSM-H / HSM-HS in Section U.1.5, an optional door has been added to the HSM-H / HSM-HS design. The optional door has an additional 6.875 inches concrete thickness but the steel thickness is reduced to 3 inches.

As noted above, the evaluation of the shielded door includes an additional missile (8" diameter armor piercing artillery shell with a mass of 280 lbs and impact velocity of 508 fps). The controlling missile evaluations require a minimum steel thickness of 2.5 inches. Therefore, a door with 3 inch steel thickness is qualified for missile loads.

U.11.2.3.3 Accident Dose Calculations

The NUHOMS® 32PTH1 DSC is designed and tested as a leak-tight containment boundary according to the criteria of ANSI N14.5 [11.2]. As shown in Section U.11.2.3.2, the tornado wind and tornado missiles do not breach the containment boundary. Therefore, there is no increase in site boundary dose due to this accident event.

U.11.2.3.4 Corrective Actions

After excessive high winds or a tornado, the HSM-H/HSM-HS and OS200 TC would be inspected for damage. Any debris would be removed. Any damage resulting from impact with a missile would be evaluated to determine if the system was still within the licensed design basis.

U.11.2.4 Flood

This event is described in UFSAR Section 8.2.4.

U.11.2.4.1 Cause of Accident

No change. See UFSAR Section 8.2.4.1.

U.11.2.4.2 Accident Analysis

The HSM-H / HSM-HS and DSCs are evaluated for flooding in Section U.3.7.3. The DSC is designed and tested to be leak tight to the criteria of ANSI N14.5 [11.2]. The stresses in the DSC due to the design basis flood are well below the allowable stresses for Service Level C of the ASME Code Subsection NB [11.5]. Therefore, the NUHOMS® 32PTH1 DSC will withstand the design basis flood without breach of the confinement boundary.

U.11.2.4.3 Accident Dose Calculations

The radiation dose due to flooding of the HSM-H is negligible. The NUHOMS® 32PTH1 DSC is designed and tested as a leak-tight containment boundary. Flooding does not breach the containment boundary. Therefore radioactive material inside the DSC will remain sealed in the DSC and, therefore, will not contaminate the encroaching flood water.

U.11.2.4.4 Corrective Actions

No change. See UFSAR Section 8.2.4.4.

U.11.2.5 Accidental TC Drop

This event is described in UFSAR Section 8.2.5.

U.11.2.5.1 Cause of Accident

See Section U.3.7.4.

U.11.2.5.2 Accident Analysis

The evaluation of the NUHOMS® 32PTH1 DSC shell and basket assemblies due to an accidental drop is presented in Chapter U.3, Section U.3.7.4. As documented in Section U.3.3.7.4, the TC has been evaluated for the 32PTH1 DSC payload. As shown in Section U.3.7.4, the DSC shell and basket stress intensities and the OS200 TC are within the appropriate ASME Code Service Level D allowable limits and maintains their structural integrity.

For the TC, a complete loss of neutron shield was evaluated at the 117°F ambient condition with full solar load in Chapter U.4. It is conservatively assumed that the neutron shield jacket is still present but all the liquid is lost. The maximum DSC shell temperature is 651°F. The maximum cask inner liner, cask outer shell, and cask neutron shield jacket temperatures are 544°F, 518°F

and 308°F, respectively for 32PTH1 DSC with 40.8 kW decay heat load as shown in Chapter U.4, Table U.4-10. The fuel cladding temperatures are below their limit as shown in Chapter U.4, Table U.4-24. Accident thermal conditions, such as loss of the liquid neutron shield, need not be considered in the load combination evaluation. Rather the peak stresses resulting from the accident thermal conditions must be less than the allowable fatigue stress limit for 10 cycles from the appropriate fatigue design curves in Appendix I of the ASME Code. Similar analyses of other NUHOMS® TCs have shown that fatigue is not a concern. Therefore, these thermal stresses in a TC with a liquid neutron shield need not be evaluated for the accident condition.

U.11.2.5.3 Accident Dose Calculations for Loss of Neutron Shield

The postulated accident condition for the on-site TC assumes that after a drop event, the water in the neutron shield is lost. The loss of neutron shield is modeled using the normal operation models described in UFSAR Section 5.4 by replacing the neutron shield with air. Also, damaged fuel is modeled as fuel rubble that falls to the bottom of the cask. The dose rates due to the fuel rubble model are bounded by the results from assuming intact fuel in damaged fuel locations at far distances. The accident condition dose rates from Chapter U.5, are summarized in Table U.11-1 for the 32PTH1 DSC loaded with design basis fuel.

Table U.11-1 shows the accident condition dose rates at 1, 100 and 500 meters from the side of the OS200 TC. The dose received by a person located 100 meters away from the NUHOMS® 32PTH1 system installation for an assumed 8 hour duration would be less than 9 mrem with the OS200 TC. The dose to an off-site person located 600 meters away for the assumed 8 hour duration would be less than 0.03 mrem with the OS200 TC. These exposures are well within the limits of 10CFR72 for an accident condition.

U.11.2.5.4 Corrective Action

No change. See UFSAR Section 8.2.5.4.

U.11.2.6 Lightning

No change. The evaluation presented in UFSAR Section 8.2.6 is not affected by the addition of the NUHOMS® 32PTH1 DSC to the NUHOMS® System.

U.11.2.7 Blockage of Air Inlet and Outlet Openings

This accident conservatively postulates the complete blockage of the ventilation air inlet and outlet openings of the HSM-H.

U.11.2.7.1 Cause of Accident

No change. See UFSAR Section 8.2.7.1.

U.11.2.7.2 Accident Analysis

The thermal evaluation of this event is presented in Chapter U.4 for HSM-H and the 32PTH1 DSCs. The temperatures determined in Chapter U.4 are used in the structural evaluation of this event, which is presented in Chapter U.3, Sections U.3.7.6 and U.3.4.4.3.

The section below describes the additional analyses performed to demonstrate the acceptability of the system with the NUHOMS® 32PTH1 DSC.

U.11.2.7.3 Accident Dose Calculations

There are no off-site dose consequences as a result of this accident. The only significant dose increase is that related to the recovery operation. Based on the results presented in Chapter U.5, Table U.5-1, the bounding average dose on HSM front or roof is 12.5 mrem/hr.

It is conservatively estimated that the on-site workers will receive an additional dose of no more than 100 (=12.5x8) mrem during the eight hour period it is estimated may be required for removal of debris from the inlet and outlet vent openings. These exposures are well within the limits of 10CFR72.106 for an accident condition.

U.11.2.7.4 Corrective Action

No change. See UFSAR Section 8.2.7.4.

U.11.2.8 DSC Leakage

The NUHOMS® 32PTH1 DSC is designed as a pressure retaining containment boundary to prevent leakage of contaminated materials. The analyses of normal, off-normal, and accident conditions have shown that no credible conditions can breach the DSC shell or fail the double seal welds at each end of the DSC. The NUHOMS® 32PTH1 DSC is designed and tested to be leak tight. Therefore DSC leakage is not considered a credible accident scenario. See Chapter U.7 for additional details on the confinement evaluation.

U.11.2.9 Accident Pressurization of DSC

U.11.2.9.1 Cause of Accident

The bounding internal pressurization of the NUHOMS® 32PTH1 DSC is postulated to result from cladding failure of the spent fuel in combination with the transfer accident case with the loss of sunshield and liquid neutron shield in the transfer cask under extreme ambient temperature conditions of 117°F and maximum insolation, and the consequent release of spent fuel rod fill gas and free fission gas. The evaluation conservatively assumes that 100% of the fuel rods have failed.

U.11.2.9.2 Accident Analysis

The pressure due to this case is evaluated in Chapter U.4, Section U.4.6. The maximum accident condition pressure calculated is 126.34 psig for the 32PTH1 DSC. The accident design pressure is conservatively assumed to be 140 psig in the structural load combinations presented in Chapter U.2, Table U.2-15 for 32PTH1.

U.11.2.9.3 Accident Dose Calculations

There is no increase in dose rates as a result of this event.

U.11.2.9.4 Corrective Actions

This is a hypothetical event. Therefore no corrective actions are required. The canister is designed to withstand the pressure as a Level D condition. There will be no structural damage to the canister or leakage of radioactive material as a result of this event.

U.11.2.10 Fire and Explosion

U.11.2.10.1 Cause of the Accident

Combustible materials will not normally be stored at an ISFSI. Therefore, a credible fire would be very small and of short duration such as that due to a fire or explosion from a vehicle or portable crane.

However, a hypothetical fire accident is evaluated for the NUHOMS® 32PTH1 System based on a fuel fire. The source of fuel is postulated to be from a ruptured fuel tank of the TC transporter tow vehicle. The bounding capacity of the fuel tank is 300 gallons and the bounding hypothetical fire is an engulfing fire around the TC. Direct engulfment of the HSM-H is highly unlikely. Any fire within the ISFSI boundary while the DSC is in the HSM-H would be bounded by the fire during TC movement. The HSM-H concrete acts as a significant insulating fire wall to protect the 32PTH1-DSC from the high temperatures of the fire.

U.11.2.10.2 Accident Analysis

The evaluation of the hypothetical fire event is presented in Chapter U.4, Section U.4.5.4.2. The fire thermal evaluation is performed primarily to demonstrate the confinement integrity and fuel retrievability of the 32PTH1-DSC. This is assured by demonstrating that the DSC temperatures and internal pressures will not exceed those of the transfer cask drop accidents (see Section U.11.2.5) during the fire scenario. Peak temperatures for the NUHOMS® 32PTH1 System components are summarized in Chapter U.4, Table U.4-10.

U.11.2.10.3 Accident Dose Calculations

The 32PTH1-DSC confinement boundary will not be breached as a result of the postulated fire/explosion scenario. Accordingly, no 32PTH1-DSC damage or release of radioactivity is

postulated. Because no radioactivity is released, no resultant dose increase is associated with this event.

The fire scenario may result in the loss of TC neutron shielding should the fire occur while the 32PTH1-DSC is in the cask. The effect of loss of the neutron shielding due to a fire is bounded by that resulting from a cask drop scenario. See Section U.11.2.5.3 for evaluation of the dose consequences of a cask drop.

U.11.2.10.4 Corrective Actions

Evaluation of HSM-H or TC neutron shield damage as a result of a fire is to be performed to assess the need for temporary shielding (for HSM-H or cask, if fire occurs during transfer operations) and repairs to restore the TC and HSM-H to pre-fire design conditions.

U.11.2.11 Accident Temperatures

For this accident condition, very high ambient temperature of 133F is postulated.

U.11.2.11.1 Cause of Accident

At some locations, there is a possibility of very high ambient temperatures, higher than the off-normal conditions used in Section U.11.1. Therefore, to envelope these high temperatures, a 133F ambient temperature is selected for this accident evaluation.

U.11.2.12 Accident Analysis

The analysis of the 32PTH1 DSC in HSM-H with 133F ambient temperatures is bounded by the locked vent accident analysis documented in Section U.11.2.7 because the inlet and outlet vents are functioning normally for this accident. Similarly, the analysis of the 32PTH1 DSC in OS200 TC is bounded by the accidental cask drop analysis documented in Section U.11.2.5 because the neutron shield in the TC is functioning normally. The 32PTH1 DSC temperatures and internal pressures, HSM-H and TC temperatures and hence stresses are all bounded by the blocked vent analysis or the accidental cask drop analysis. Therefore, the NUHOMS® 32PTH1 system will withstand these very high ambient temperatures without breach of the confinement boundary.

U.11.2.13 Accident Dose Calculations

There are no radiation dose consequences for this accident. The NUHOMS® 32PTH1 DSC is designed and tested as a leak-tight containment boundary. Very high ambient temperature of 133F does not breach the containment boundary. Therefore radioactive material inside the DSC will remain sealed in the DSC and, therefore, will not contaminate the encroaching flood water.

U.11.2.14 Corrective Actions

None required.

U.11.3 References

11.1 American Nuclear Society, ANSI/ANS-57.9, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type), 1992.

11.2 ANSI N14.5-1997, "Leakage Tests on Packages for Shipment," February 1998.

11.3 NUREG-1536, "Standard Review Plan for dry Storage Casks, Final Report," US Nuclear Regulatory Commission, January 1997.

11.4 U.S. Nuclear Regulatory Commission, Interim Staff Guidance (ISG)-5, Rev. 1, Confinement Evaluation.

11.5 American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, 1998 including 2000 addenda.

11.6 American Concrete Institute, Code Requirements for Nuclear Safety Related Concrete Structures and Commentary, ACI 349-97 and ACI 349R-97, American Concrete Institute, Detroit, MI.

11.7 American Society of Civil Engineers, ASCE Manual No. 58, Structural Analysis and Design of Nuclear Plant Facilities, 1980.

11.8 "Design of Structures for Missile Impact", BC-TOP-9A, Revision 2, September 1974, Bechtel Power Corporation.

11.9 Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," U.S. Atomic Energy Commission, Revision 1, December 1973

11.10 "Code Requirements for Nuclear Safety Related Concrete Structures," ACI 349-97, American Concrete Institute, Detroit, MI.

Table U.11-1
Summary of NUHOMS® 32PTH1 DSC, OS200 TC Maximum Dose Rates during Transfer Operations

Dose Rate Location	Maximum Gamma (mrem/hr)	Gamma MCNP 1σ Error	Maximum Neutron (mrem/hr)	Neutron MCNP 1σ Error	Maximum Total(1) (mrem/hr)	Total MCNP 1σ Error
Cask 1 m (Radial) Accident Condition	1.74E+02	0.0280	3.58E+03	0.003	3.76E+03	0.0031
Cask 100 m (Radial) Accident Condition	9.38E-02	0.0175	1.00E+00	0.0029	1.10E+00	0.0030
Cask 500 m (Radial) Accident Condition	5.25E-04	0.0188	3.40E-03	0.0043	3.92E-03	0.0045

Note:

(1) Gamma and neutron dose rate peaks do not always occur at same location; therefore, the total dose rate is not always the sum of the gamma plus neutron dose rate.

U.12 Conditions for Cask Use - Operating Controls and Limits or Technical Specifications

The Technical Specifications changes, due to the addition of the 32PTH1 DSC to the NUHOMS® system, are included in the NUHOMS® CoC 1004 Amendment Number 10 application.

U.13 Quality Assurance

Chapter 11.0 provides a description of the Quality Assurance Program to be applied to the safety related and important to safety activities associated with the standardized NUHOMS® System. For the 32PTH1 DSC system, the following is added to clarify the contents of Section 11.2:

> "In lieu of the requirements listed in paragraphs A through H, Category A items may also be procured as commercial grade items and dedicated by in accordance with the guidelines of EPRI NP-5652."

U.14 Decommissioning

There is no change from the decommissioning evaluation presented in Section 9.6 due to the addition of 32PTH1 DSC to the NUHOMS® System.