5.3 REACTOR

5.3.1 REACTOR CORE

5.3.1.1 The reactor core contains approximately 68 metric tons of uranium in the form of natural or slightly enriched uranium dioxide pellets. The pellets are encapsulated in Zircaloy-4 tubing to form fuel rods which are all pre-pressurized. The reactor core is made up of 157 fuel assemblies. Each fuel assembly contains 204 fuel rod locations occupied by rods consisting of natural or slightly enriched uranium pellets, solid inert materials, or a combination of the aforementioned.(1)

5.3.1.2 Deleted

5.3.1.3 Reload fuel will be similar in physical design to the initial core. The enrichment of reload fuel will be no more than 4.2 + 0.05 (nominal 4.2) weight percent of U-235.

5.3.1.4 Deleted

5.3.1.5 There are 45 full-length RCC assemblies in the reactor core. The full-length RCC assemblies contain 144-inch segments of silver-indium-cadmium alloy clad with stainless steel.(2)

5.3.1.6 Deleted

5.3.2 REACTOR COOLANT SYSTEM

5.3.2.1 The design of the Reactor Coolant System complies with the code requirements.(3)

5.4 FUEL STORAGE

5.4.1 SPENT FUEL PIT

The new and spent fuel pit structures are designed to withstand the anticipated earthquake loadings as Class I structures. The spent fuel pit has a stainless steel liner to ensure against loss of water.[1]

5.4.2 CRITICALITY

5.4.2.1 NEW FUEL STORAGE RACKS

Due to the new fuel storage rack design, a nominal 21-inch center-to-center distance is maintained between fuel assemblies. To permit storage of fuel with a maximum assembly axial plane enrichment of 4.2 + 0.05 (nominal 4.2) weight percent U-235, additional separation is maintained by use of any of the storage rack location options below[2][4] in order to establish a geometry which ensures that k_{eff} is less than 0.95 assuming the new fuel storage racks are flooded with unborated water and which assures that k_{eff} is less than 0.98 in an optimum moderation event.

The four listed options provide fuel storage locations which are secured to prevent fuel storage in those locations.

OPTION A: B4,6,8,10 / C3,5,7,9 / D4,6,8,10 / E3,5,7,9 / F4,6,8,10 / G3,5,7,9
H4,6,8,10 / J3,5,7,9

OPTION B: C4,5,6,7,8,9 / D4,5,6,7,8,9 / E4,5,6,7,8,9 / F4,5,6,7,8,9
G4,5,6,7,8,9 / H4,5,6,7,8,9

OPTION C: C4,5,6,7,8,9 / D4,5,6,7,8,9 / E4,5,8,9 / F4,5,8,9 / G4,5,6,7,8,9
H4,5,6,7,8,9

OPTION D: C4,5,6,7,8,9 / D4,5,8,9 / E4,5,8,9 / F1,4,5,8,9 / G1,4,5,8,9
H1,4,5,6,7,8,9 / J1 / K1

5.4.2.2 SPENT FUEL STORAGE PIT

A combination of nominal assembly spacing and neutron absorbent material between stored assemblies is maintained to ensure that k_{eff} is less than 0.95 when flooded with unborated water based on a maximum assembly axial plane enrichment of 4.2 + 0.05 (nominal 4.2) weight percent U-235.[4]

5.4.3 BORON CONCENTRATION - SPENT FUEL STORAGE PIT

The spent fuel storage pit is filled with borated water at a concentration of greater than or equal to 1500 ppm during refueling operations or new fuel movement in the spent fuel storage pit. This minimum boron concentration ensures subcriticality under worst case design events.

5.4.4 STORAGE CAPACITY - SPENT FUEL STORAGE PIT

The spent fuel storage pit provides a storage location for 544 fuel assemblies.

Reference

(1) FSAR Section 9.1

(2) XN-NF-86-100, "Final Report, Criticality Safety Analysis, H. B. Robinson New Fuel Storage Vault with 4.2 Percent Enriched 15 x 15 Fuel Assemblies, September, 1986 and Addendum 1 to XN-NF-86-100, January 1"

(3) XN-NF-86-107, "Final Report, Criticality Safety Analysis, H. B. Robinson Spent Fuel Storage Racks (Unpoisoned, Low Density) with 4.2% Enriched 15 x 15 Fuel Assemblies," September 1986

(4) ANF-89-017, "Criticality Safety Analysis of the H. B. Robinson Spent Fuel Pool with 4.2% Nominal Enrichment Fuel Assemblies, January 1989."

H. B. Robinson New Fuel Storage Vault with 4.2% Nominal Enriched Fuel Assemblies

INTRODUCTION

The subject report addresses 4.2% enriched 15x15 assemblies in the H. B. Robinson New Fuel Storage Vault. Using data from that report with additional calculation results presented here, it is shown that 4.2% nominal fuel designs are acceptable with the same administrative controls as in the reference report.

The vault was designed to store up to 100 bundles in a 10x10 array with five additional bundles in an eleventh row. All bundles are on 21-inch nominal centers; bundle-bundle interactions are negligible at flooded conditions. Peak reactivity occurs with low density water (as fog, foam, mist) within and between the bundles in the rack. Because the k-eff of the fully-loaded rack could exceed 0.98 with optimum moderation, four optional loading arrangements (designated as Options A - D) were modeled and demonstrated as acceptable with 69-73 bundles. Amendment No. 112 to the H. B. Robinson Operating License (dated January 20, 1987) approved these four loading arrangements.

CASMO-3 RESULTS

The k-inf for an infinite array of infinite length bundles on 21-inch centers was calculated with low density moderation at both 4.20% and 4.25% enrichments. The results are in Table 1.

TABLE 1 K-INF RESULTS WITH LOW DENSITY MODERATION

Water Density (vol%)	4.20% Fuel k-inf	4.25% Fuel k-inf	Δk
2	1.25223	1.25426	0.00203
3	1.33596	1.33797	0.00201
4	1.37064	1.37271	0.00207
5	1.37641	1.37855	0.00214
6	1.36470	1.36691	0.00221
7	1.34178	1.34402	0.00224
8	1.31176	1.31403	0.00227
10	1.24071	1.24297	0.00226
15	1.05852	1.06063	0.00211

The effect of the 0.05% enrichment tolerance is about 0.0023 or less. Based on typical Monte Carlo (KENO) results with an uncertainty of 0.003 to 0.006, the results with 4.25% enrichments would be expected to be not significantly different from the results at 4.20% enrichments. That is why CASMO was used to estimate the enrichment tolerance effect.

The effect of enrichment tolerance (taken as 0.0023) for each of the four optional loading arrangements at peak reactivity is as follows.

Option A

Peak k-eff = 0.961 ± 0.0051. The enrichment tolerance increases the 0.0051 value to 0.0056.

Option B

Peak k-eff = 0.914 ± 0.0047. The 0.0047 value is increased to 0.0052.

Option C

Peak k-eff = 0.913 ± 0.0052. The 0.0052 value is increased to 0.0057.

Option D

Peak k-eff = 0.897 ± 0.0048. The 0.0048 value is increased to 0.0053.

Therefore with 4.2% nominal fuel in the vault, the peak k-eff is less than 0.98 with at least 95% confidence. At flooded conditions, the 0.917 ± 0.005 result becomes 0.917 ± 0.0055, which is less than 0.95 with at least 95% confidence.

All applicable criticality safety criteria are met with 4.2% nominal fuel in the vault.