UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 16 TO FACILITY OPERATING LICENSE NO. NPF-42

KANSAS GAS & ELECTRIC COMPANY

KANSAS CITY POWER AND LIGHT COMPANY

KANSAS ELECTRIC POWER COOPERATIVE, INC.

WOLF CREEK GENERATING STATION

DOCKET NO. 50-482

1.0 INTRODUCTION

By letter dated February 26, 1988, Wolf Creek Nuclear Operating Corporation requested changes to Wolf Creek Generating Station Technical Specification Sections 5.3.1 and 5.6.1.1 and Figures 3.9-1 and 5.6-1. These specifications relate to the design of the Wolf Creek fuel assemblies and the fuel storage facilities. In particular these changes would permit the storage of fuel assemblies with enrichments up to 4.5 weight percent U-235 in the Wolf Creek spent fuel storage pool. Storage has previously been approved for enrichments up to 3.5 weight percent U-235. The staff has reviewed the request and prepared the following evaluation.

The spent fuel storage facility is located within the fuel building and provides onsite storage for up to 200 fresh or low burnup fuel assemblies and 1140 irradiated or high burnup fuel assemblies. The spent fuel pool is a reinforced concrete structure with a stainless steel liner. The pool contains 413,400 gallons of water which contains 2000 parts per million dissolved boron as a neutron poison. The water serves as shielding and coolant for the irradiated fuel assemblies. The fuel storage pool is separated into two fuel storage regions. Region 1 provides a low density storage regime for the storage of approximately one full core (200 fuel assemblies) of fresh or low burnup fuel assemblies and Region 2 provides a higher density storage arrangement that can accommodate up to 7 full cores (1140 fuel assemblies) of high burnup fuel assemblies.

Both regions utilize an array of stainless steel fuel storage boxes welded together to create fuel storage racks. In Region 1 the fuel assemblies are loaded into the racks in a checkerboard array with every other storage location physically blocked off so that fuel can be stored only in alternating locations. In Region 2 the less reactive, highly burned up fuel assemblies are stored in three out of every four storage locations to achieve a 75% storage density.

The criticality safety analyses for the Wolf Creek operating license assumed the storage of Westinghouse Standard Fuel Assemblies (SFA) with a maximum enrichment of 3.5 weight percent U-235. Those analyses were reviewed and found acceptable by the staff in NUREG-0881 "Safety Evaluation Report Related to Operation of the Wolf Creek Generating Station Unit No. 1".

The analyses supporting the proposed increase to 4.5 weight percent U-235 use the same methods and assumptions used to analyze the initial Wolf Creek spent fuel pool storage limits.

2.0 EVALUATION

This proposed change does not involve a physical modification to the fuel storage racks at the Wolf Creek Generating Station. It involves the recalculation of the reactivity calculations used to show compliance with the NRC staff guidelines regarding fuel storage facilities. These new calculations take into consideration an increase in the storage rack wall thickness from 0.090 inches to 0.120 inches that was made during the rack construction.

The increase in wall thickness increases the distance between stored fuel assemblies and results in a reduction of the calculated effective multiplication factor (K_{eff}).

The reduction in K_{eff} resulting from the increased spacing between fuel assemblies was not recalculated for previous cycles because the calculations were acceptably conservative for the 3.5 weight percent U-235 fuel assemblies in use at that time. However, the licensee has decided to utilize higher enrichments of up to 4.5 weight percent U-235 during the upcoming Cycle 4 and has recalculated the effective mutiplication factor of the fuel storage racks for enrichments up to 4.5 weight percent U-235.

Region 1 Design

The Region 1 racks consist of a honeycomb structure of stainless steel boxes of 0.12-in. wall thickness. Each box has a 9.236-in. outside dimension and is welded to its neighbors to form storage locations on a 9.236-in. center-to-center spacing. Fuel assemblies are located in every other storage location. The criticality analysis of the racks is performed with the state-of-the-art LEOPARD/PDQ-7 code package. These codes have been benchmarked against critical experiments in the range of pellet diameters, water-to-fuel ratios and enrichments that encompass the Wolf Creek design. This benchmarking led to the conclusion that the calculational model is capable of determining the multiplication factor of the Region 1 racks to within 1-percent reactivity change with a 95-percent probability at the 95-percent confidence level.

The effects of various mechanical and thermal uncertainties have been analyzed. These include pool-water temperature, placement of assemblies in storage boxes, stainless steel thickness variation, and UO_2 pellet density. Combining these uncertainties with the calculational uncertainty yields a value of 0.9472 for the multiplication factor of the Region 1 racks when loaded with fuel assemblies of 4.5 weight percent U-235 enrichment, including all uncertainties. This meets the staff acceptance criterion of less than or equal to 0.95 for this quantity, thus meeting the requirements of GDC 62, "Prevention of Criticality in Fuel Storage and Handling." The staff, therefore, concludes that fuel assemblies of the Westinghouse 17x17 standard design having enrichments no greater than 4.5 weight percent U-235 may be stored in Region 1 of the racks.

Region 2 Design

The Region 2 racks are constructed in the same manner as those of Region 1 and have the same dimensions. However, Region 2 fuel is stored in three boxes out of every group of four. The same code package was used for the multiplication factor calculations as was used in the Region 1 analysis. However, direct verification of the codes was not possible because no critical experiments have been done with assemblies having large burnups. Rather, verification of various aspects of the calculation was undertaken. For example, the ability to calculate the isotopic composition of burned fuel was verified by comparing the LEOPARD/CINDER calculation to the measured results of irradiations performed on UO_2 fuel in the Yankee-Rowe reactor and on mixed oxide fuel in Saxton.

Similar evidence was used to assess the fission product buildup uncertainty and its reactivity effect and the reactivity effect of the transuranium isotopes. The various uncertainties are summed to obtain a total calculational bias 0.46-percent reactivity change. In addition, sensitivity studies were performed to obtain the thermal and mechanical uncertainties. A value of 2.21-percent reactivity change was obtained which, when conservatively added to the calculational biases, produces a total uncertainty of 2.67-percent reactivity change and results in a K_{eff} for the basic cell of 0.9265 in Region 2.

A criterion of 0.915, not including uncertainties, is used by the licensee for the multiplication factor for Region 2. This is equivalent to 0.942, including uncertainties, and meets the staff's acceptance criterion of 0.95, thereby meeting the requirements of GDC 62.

To establish minimum burnup criteria that will assure that the infinite multiplication ($K\infty$) factor for various enrichment fuel assemblies is always less than or equal to 0.915, $K\infty$ has been calculated for fuel enrichments of 2.10, 2.60, 3.10, 3.80, and 4.50 weight percent U-235 as a function of fuel burnup. The burnup value that results in a $K\infty$ of 0.915 has been plotted as a function of initial fuel enrichment. This curve is approximately linear and yields required burnups of 9,830 megawatt days per metric ton (MWD/MT) for an initial enrichment of 2.10 weight percent (w/o) U-235; 24,200 MWD/MT for 3.10 w/o U-235, and 42,210 MWD/MT for 4.5 w/o U-235.

This curve, proposed technical specification Figure 5.6-1, drawn through the points which represent the minimum burnup for K_∞ equal to 0.915, as a function of initial burn up, establishes the storage acceptance criterion for Region 2 of the spent fuel pool.

Based on this review, as summarized above, the staff concludes that any number of Westinghouse-design standard 17x17 fuel assemblies with burnups in the acceptable region of proposed technical specification Figure 5.6-1 may be stored in Region 2 of the Wolf Creek spent fuel storage racks. The staff conclusion is based on the following:

(1) The criticality calculations were performed with state-of-the-art models and methods.

(2) Uncertainties have been accounted for.

(3) The multiplication factor, including uncertainties, meets the staff acceptance criterion for this quantity.

The decision as to whether a particular assembly is to be placed in Region 2 of the pool is proposed to be made under administrative control. After the assemblies to be discharged have been transferred to Region 1 from the core and the reactor is operating, an analysis of the burnup of each assembly will be made. This analysis will make use of (1) the records that show the location of each assembly at all times since its arrival on site and (2) core operating histories and power distributions while the assembly was in the reactor. The records of fuel assembly location are generated by following written, previously approved procedures. The burnup history of each assembly is integrated to arrive at its total burnup. The burnup value is then compared with the storage acceptance criterion (Figure 5.6-1 of the Technical Specifications) in order to permit or deny storage in Region 2.

The staff requires (via Technical Specifications) that the procedures include (a) an independent check of the analysis which permits storage in Region 2, and (b) the requirement that the records of the analysis be kept for as long as the assemblies remain in the pool.

With the above requirements, the staff finds the use of the administrative control to select assemblies for storage in Region 2 of the racks acceptable.

Accident conditions have been examined for both Region 1 and Region 2. Most accident conditions result in a reduction in pool multiplication factor. Those that have a potential for increasing K-effective include not maintaining the proper arrangement (checkerboard or 3 out of 4) and dropping an assembly adjacent to a rack. For these accident conditions credit may be taken for the presence of boron in the pool water. The 2000 parts per million of boron reduces the K-effective value by an amount sufficient to overcome any increase due to accident conditions. The staff concludes that the consideration of accidents in Region 1 and Region 2 is adequate, therefore, and acceptable.

Based on the review described above, the staff concludes that the proposed increase in the enrichment of fuel assemblies stored in the spent fuel racks at Wolf Creek is acceptable. The staff further concludes that the proposed Technical Specifications including surveillance requirements provide assurance that the use of higher enrichment fuel is acceptable.

3.0 ENVIRONMENTAL CONSIDERATION

The amendment involves a change in the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposures. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration and there has been no public comment on such finding. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR Section 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

4.0 CONCLUSION

The staff has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (2) such activities will be conducted in compliance with the Commission's regulations, and the issuance of the amendment will not be inimical to the common defense and security or the the health and safety of the public.

Dated: June 17, 1988

Principal Contributor: Paul W. O'Connor