The Light company
Houston Lighting & Power South Texas Project Electric Generating Station P. O. Box 289 Wadsworth, Texas 77483

June 3, 1992
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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

South Texas Project Electric Generating Station
Units 1 & 2
Docket No. STN 50-498, STN 50-499
Clarification to the Proposed Amendment to the
Unit 1 and Unit 2 Technical Specifications Regarding the
Spent Fuel Storage Pool Rack Criticality Analyses

Reference: 1. ST-HL-AE-4093, Letter from W.H. Kinsey, HL&P, to USNRC, Document Control Desk, "South Texas Project Electric Generating Station Units 1 & 2, Docket Nos. STN 50-498, STN 50-499, Proposed Amendment to the Unit 1 and Unit 2 Technical Specifications", May 26, 1988.

A telephone conversation between Messrs. G. Dick and L. Kopp of the USNRC and Messrs. S. Phillips and D.E. Gore of HL&P was held on May 28, 1992, to discuss some comments which Mr. Kopp had on the licensing submittal on the South Texas spent fuel storage pool racks (Reference 1). Mr. Kopp requested that the origination of the K_{inf} values used in various discussions be clarified. Per his request, a sentence has been added to the applicable sections of the submittal for clarification purposes. Please note that the sentence inserted in the discussions of K_{inf} is paraphrased from Section 3.3.2 of the Westinghouse criticality report (Attachment 2 of Reference 1).

The attached pages reflect the requested changes (marked with change bars) and editorial changes to figures 1, 2, 7, 9, and 11 of the Westinghouse criticality report.

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Please replace the affected pages in the Reference 1 submittal with the attached pages.

If you should have any questions on this matter, please contact Mr. S. D. Phillips at (512) 972-8472 or me at (512) 972-7205.

Warren H. Kinsey, Jr.
Vice President
Nuclear Generation

SDP/

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter	)	
	)	
Houston Lighting & Power Company, et al.,	)	Docket Nos. 50-498
	)	50-499
	)	
South Texas Project	)	
Units 1 and 2	)	

AFFIDAVIT

Warren H. Kinsey, Jr. being duly sworn, hereby deposes and says that he is Vice President, Nuclear Generation, of Houston Lighting & Power Company; that he is duly authorized to sign and file with the Nuclear Regulatory Commission the proposed amendment to the Unit 1 and Unit 2 Technical Specifications; is familiar with the content thereof; and that the matters set forth therein are true and correct to the best of his knowledge and belief.

Warren H. Kinsey, Jr.
Vice President, Nuclear Generation

STATE OF TEXAS)
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)

Subscribed and sworn to before me, a Notary Public in and for The State of Texas this 3rd day of June, 1992.

CONNIE MONTGOMERY
Notary Public, State of Texas
My Commission Expires 08-20-95

Connie Montgomery
Notary Public in and for the
State of Texas

cc:

Regional Administrator, Region IV
Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

George Dick, Project Manager
U.S. Nuclear Regulatory Commission
Washington, DC 20555

. I. Tapia
Senior Resident Inspector
c/o U. S. Nuclear Regulatory
Commission
P. O. Box 910
Bay City, TX 77414

J. R. Newman, Esquire
Newman & Holtzinger, P.C.
1615 L Street, N.W.
Washington, DC 20036

D. E. Ward/T. M. Puckett
Central Power and Light Company
P. O. Box 2121
Corpus Christi, TX 78403

J. C. Lanier/M. B. Lee
City of Austin
Electric Utility Department
P.O. Box 1088
Austin, TX 78767

K. J. Fiedler/M. T. Hardt
City Public Service Board
P. O. Box 1771
San Antonio, TX 78296

Rufus S. Scott
Associate General Counsel
Houston Lighting & Power Company
P. O. Box 61867
Houston, TX 77208

INPO
Records Center
1100 Circle 75 Parkway
Atlanta, GA 30339-3064

Dr. Joseph M. Hendrie
50 Bellport Lane
Bellport, NY 11713

D. K. Lacker
Bureau of Radiation Control
Texas Department of Health
1100 West 49th Street
Austin, TX 78756-3189

Revised 10/11/91

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Safety Evaluation and No Significant Hazards Evaluation for the Spent Fuel Storage Pool Rack Criticality Analyses

analyses on the maximum fuel assembly enrichments for each type of storage rack.

To decide the most appropriate storage location for each fuel assembly, each fuel assembly will either be categorized, prior to insertion into the spent fuel storage racks, by reactivity or designated as a Category 1 assembly (the default). The reactivity categories are:

<u>CATEGORY 1:</u>
Fuel in Category 1 shall have an initial nominal enrichment of less than or equal to 5.0 w/o.

<u>CATEGORY 2:</u>
Fuel in Category 2 shall meet at least one of the following criteria:

1) a maximum initial nominal enrichment of 4.0 w/o; or,
2) a minimum burnup as shown on Figure 1; or,
3) a minimum number of Westinghouse Integral Fuel Burnable Absorber pins, as shown on Figure 2, or a K_{inf} of less than or equal to 1.445. The fuel assembly K_{inf} shall be based on a unit assembly configuration (infinite in the lateral and axial extent) in the reactor core geometry, assuming unborated water at 68°F.

<u>CATEGORY 3:</u>
Fuel in Category 3 shall have the minimum assembly burnup shown on Figure 3.

<u>CATEGORY 4:</u>
Fuel in Category 4 shall have the minimum assembly burnup shown on Figure 4.

Region 1 racks may be used to store Category 1, 2, 3, and 4 fuel. Category 1 fuel shall be stored in a checkerboard pattern configuration with Category 3 or 4 fuel, alternating fuel assemblies as shown in Figure 5. Category 2, 3, and 4 fuel may be stored in a close packed arrangement. Empty water cells may be substituted for fuel assemblies in all cases.

Region 2 racks may be used to store Category 1, 2, 3, and 4 fuel. Fuel in Categories 1, 2, and 3 shall be stored in a checkerboard pattern configuration alternating fuel assemblies with empty water cells in a 2 out of 4 pattern, as shown in Figure 6. Category 4 fuel may be stored in a close packed arrangement or in the checkerboard pattern described above. Empty water cells may be substituted for fuel assemblies in all cases.

neutron absorbing material is a non-removable or integral part of the fuel assembly once it is manufactured.

In this case, the concept of reactivity equivalencing is based upon the reactivity decrease associated with the presence of IFBA's. A series of reactivity calculations, to calculate a fuel assembly reference K_{inf}, is performed using PHOENIX. The fuel assembly reference K_{inf} is based on a unit assembly configuration (infinite in the lateral and axial extent) in the reactor core geometry, assuming unborated water at 68°F. The fuel assembly containing the IFBA's is depleted to determine the maximum assembly reactivity. These results are then used to generate a set of enrichment-fuel assembly IFBA content ordered pairs which yield the equivalent K_{eff} when the fuel is stored in the racks. IFBA credit is only used for Region 1 racks.

The fuel burnup used in the reactivity calculation is that burnup which yields the highest equivalent K_{eff} when the fuel is stored in the spent fuel racks. Fuel assembly depletions performed in PHOENIX show that for the number of IFBA pins per assembly considered in this analysis, the maximum reactivity for the rack geometry occurs at zero burnup. Although the boron concentration in the IFBA pins decreases with fuel depletion, the fuel assembly reactivity decreases more rapidly, resulting in a maximum fuel rack reactivity at zero burnup.

Uncertainties associated with the IFBA dependent reactivities computed with PHOENIX are accounted for in the development of the individual reactivity equivalence limits. For IFBA credit applications, an uncertainty of approximately 10% of the total number of IFBA pins is accounted for in the development of the IFBA requirements.

The following equation is used to develop the maximum K_{eff} for the spent fuel storage racks:

$$K_{eff} = K_{worst} + B_{method} + B_{part} + \sqrt{[(ks)^2_{worst} + (ks)^2_{method}]}$$

where:

- K_{worst} = worst case KENO K_{eff} that includes material, mechanical, and enrichment tolerances
- B_{method} = method bias determined from benchmark critical comparisons
- B_{part} = method bias to account for Boraflex poison particle self-shielding
- ks_{worst} = 95/95 uncertainty in the worst case KENO K_{eff}

ks_{method} = 95/95 uncertainty in the method bias.

4.2 Region 1 Rack Design

The Region 1 racks have a 10.95 inch-nominal center-to-center spacing with locked removable poison assemblies between the cells. This region is conservatively designed to accommodate close packed storage of unirradiated fuel enriched to 4.0 weight percent uranium-235. Substituting calculated values for the worst case K_{eff} and uncertainties and biases in the order listed previously, the result is:

$$K_{eff} = 0.9221 + 0.0074 + 0.0014 + \sqrt{[(0.0041)^2 + (0.0029)^2]} = 0.9359$$

Since K_{eff} is less than 0.95 including uncertainties at a 95/95 probability/confidence level, the acceptance criteria for criticality is met for Region 1 close packed storage of fuel assemblies enriched to a nominal 4.0 w/o uranium-235.

Storage of close packed fuel with nominal enrichment of greater than 4.0 w/o is achievable by the use of reactivity equivalencing for burnup credit and the presence of IFBA pins, as discussed in Section 4.0.

Reactivity equivalencing for burnup credit allows fuel with an initial nominal enrichment of greater than 4.0 w/o to be stored in a close packed array if the fuel assembly K_{eff} is less than the constant K_{eff} contour given in Figure 1. This minimum burnup curve starts at 4.0 w/o at 0 MWD/MTU and ends at 5.0 w/o at 5400 MWD/MTU. The curve includes a reactivity uncertainty of 0.0018 ΔK, consistent with the minimum burnup requirement of 5400 MWD/MTU at 5.0 w/o.

Reactivity equivalencing for IFBA credit allows fuel with an initial nominal enrichment of greater than 4.0 w/o to be stored in a close packed array if the fuel assembly reference K_{inf} is less than or equal to 1.445. The fuel assembly reference K_{inf} is based on a unit assembly configuration (infinite in the lateral and axial extent) in the reactor core geometry, assuming unborated water at 68°F. Figure 2 illustrates the minimum number of IFBA pins required in a fuel assembly, as a function of initial fuel assembly enrichment, for close packed storage in Region 1. This curve starts at 4.0 w/o and no IFBA pins and ends at 5.0 w/o and 80 IFBA pins.

computed with PHOENIX. An uncertainty which increases linearly with burnup, passing through 0.01 ΔK at 30,000 MWD/MTU is applied to the PHOENIX calculational results in the development of the burnup requirements. This uncertainty is considered to be very conservative and is based on consideration of the good agreement between PHOENIX predictions and measurements (Reference 4.3-37) and on conservative estimates of fuel assembly isotopic buildup variances.

Reactivity credit for the presence of Westinghouse Integral Fuel Burnable Absorbers (IFBA) (Reference 4.3-37) in fuel assemblies is also achieved by the use of reactivity equivalencing (Reference 4.3-37). IFBA's consist of neutron absorbing material applied as a thin ZrB_2 coating on the outside of the UO_2 fuel pellet. As a result, the neutron absorbing material is a non-removable or integral part of the fuel assembly once it is manufactured.

In this case, the concept of reactivity equivalencing is based upon the reactivity decrease associated with the presence of IFBA's. A series of reactivity calculations, to calculate a fuel assembly reference K_{inf}, is performed using PHOENIX. The fuel assembly reference K_{inf} is based on a unit assembly configuration (infinite in the lateral and axial extent) in the reactor core geometry, assuming unborated water at 68°F. The fuel assembly containing the IFBA's is depleted to determine the maximum assembly reactivity. These results are then used to generate a set of enrichment-fuel assembly IFBA content ordered pairs which yield the equivalent K_{inf} when the fuel is stored in the racks. IFBA credit is only used for Region 1 racks.

The fuel burnup used in the reactivity calculation is that burnup which yields the highest equivalent K_{eff} when the fuel is stored in the spent fuel racks. Fuel assembly depletions performed in PHOENIX show that for the number of IFBA pins per assembly considered in this analysis, the maximum reactivity for the rack geometry occurs at zero burnup. Although the boron concentration in the IFBA pins decreases with fuel depletion, the fuel assembly reactivity decreases more rapidly, resulting in a maximum fuel rack reactivity at zero burnup.

Uncertainties associated with the IFBA dependent reactivities computed with PHOENIX are accounted for in the development of the individual reactivity equivalence limits. For IFBA credit applications, an uncertainty of approximately 10% of the total number of IFBA pins is accounted for in the development of the IFBA requirements.

The following equation is used to develop the maximum K_{eff} for the spent fuel storage racks:

K_{worst} = worst case KENO K_{eff} that includes material, mechanical, and enrichment tolerances
B_{method} = method bias determined from benchmark critical comparisons
B_{part} = method bias to account for Boraflex poison particle self-shielding
ks_{worst} = 95/95 uncertainty in the worst case KENO K_{eff}
ks_{method} = 95/95 uncertainty in the method bias.

Substituting calculated values in the order listed above, the result is:

$$K_{eff} = 0.9221 + 0.0074 + 0.0014 + \sqrt{[(0.0041)^2 + (0.0029)^2]} = 0.9359$$

Since K_{eff} is less than 0.95 including uncertainties at a 95/95 probability/confidence level, the acceptance criteria for criticality is met for Region 1 close packed storage of fuel assemblies enriched to a nominal 4.0 w/o uranium-235.

Storage of close packed fuel with nominal enrichment of greater than 4.0 w/o is achievable by the use of reactivity equivalencing for burnup credit and the presence of IFBA pins, as discussed in Section 4.3.2.6.2.1.

Reactivity equivalencing for burnup credit allows fuel with an initial nominal enrichment of greater than 4.0 w/o to be stored in a close packed array if the fuel assembly K_{eff} is less than the constant K_{eff} contour given in Section 5.6 of the Technical Specifications. This minimum burnup curve starts at 4.0 w/o at 0 MWD/MTU and ends at 5.0 w/o at 5400 MWD/MTU. The curve includes a reactivity uncertainty of 0.0018 ΔK, consistent with the minimum burnup requirement of 5400 MWD/MTU at 5.0 w/o.

Reactivity equivalencing for IFBA credit allows fuel with an initial nominal enrichment of greater than 4.0 w/o to be stored in a close packed array if the fuel assembly reference K_{inf} is less than or equal to 1.445. The fuel assembly reference K_{inf} is based on a unit assembly configuration (infinite in the lateral and axial extent) in the reactor core geometry, assuming unborated water at 68°F. A figure reflecting this constant K_{inf} is given in Section 5.6 of the Technical Specifications. This curve reflects the minimum number of IFBA pins required in an assembly for close packed storage. The curve starts at 4.0 w/o and no IFBA pins and ends at 5.0 w/o and 80 IFBA pins.

The IFBA absorber material is a zirconium diboride (ZrB_2) coating on the outside of the fuel pellet (Reference 4.3-37). Each IFBA pin has a nominal poison material loading of 1.57 milligrams B^{10} per inch, which is the minimum standard loading offered by Westinghouse for 17x17XL/STD fuel assemblies. The IFBA B^{10} loading is reduced

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5.6.1.2 Prior to insertion into the spent fuel storage racks, each fuel assembly shall be categorized by reactivity, as discussed below, or be designated as a Category 1 fuel assembly. All fuel enrichment values are initial nominal uranium-235 enrichments. The reactivity categories are:

CATEGORY 1:
Fuel in Category 1 shall have an initial nominal enrichment of less than or equal to 5.0 w/o.

CATEGORY 2:
Fuel in Category 2 shall meet at least one of the following criteria:

1) a maximum initial nominal enrichment of 4.0 w/o; or,
2) a minimum burnup as shown on Figure 5.6-1; or,
3) a minimum number of Westinghouse Integral Fuel Burnable Absorber pins, as shown on Figure 5.6-2, or a K_{inf} of less than or equal to 1.445. The fuel assembly K_{inf} shall be based on a unit assembly configuration (infinite in the lateral and axial extent) in the reactor core geometry, assuming unborated water at 68°F.

The IFBA rod requirements shown in Figure 5.6-2 are based on an IFBA linear B^{10} loading of 1.57 mg-B^{10}/inch. For higher IFBA linear B^{10} loadings, the required number of IFBA rods per assembly may be reduced by the ratio of the increased B^{10} loading to the nominal 1.57 mg-B^{10}/inch loading.

CATEGORY 3:
Fuel in Category 3 shall have the minimum assembly burnup shown on Figure 5.6-3.

CATEGORY 4:
Fuel in Category 4 shall have the minimum assembly burnup shown on Figure 5.6-4.

Data points for the curves presented in Figures 5.6-1 through 5.6-4 are presented in tables on the respective figures. Linear interpolation between table values may be used for intermediate points.

5.6.1.3 Region 1 racks may be used to store Category 1, 2, 3, and 4 fuel. Category 1 fuel shall be stored in a checkerboard pattern configuration with Category 3 or 4 fuel, alternating fuel assemblies as shown in Figure 5.6-5.

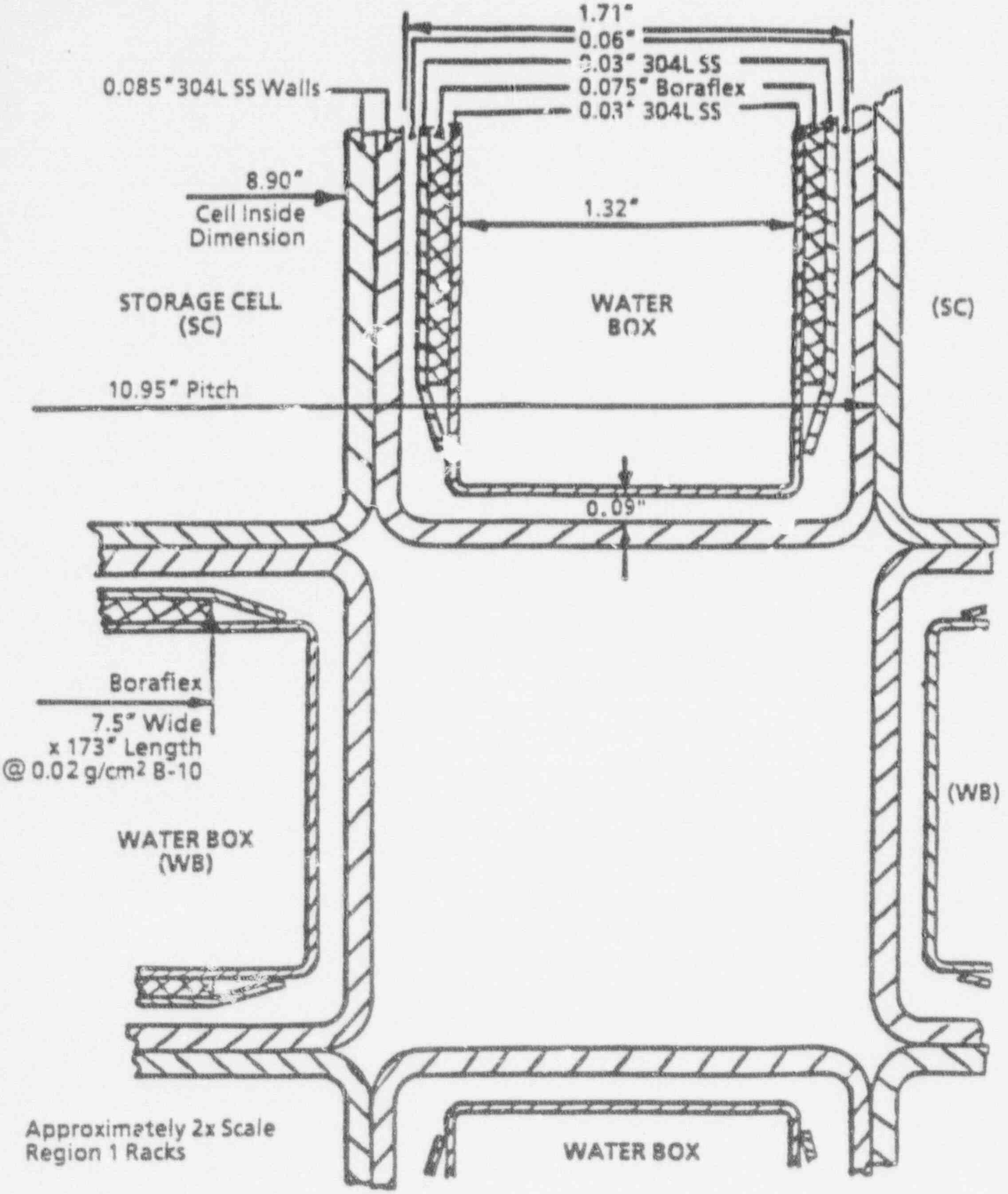
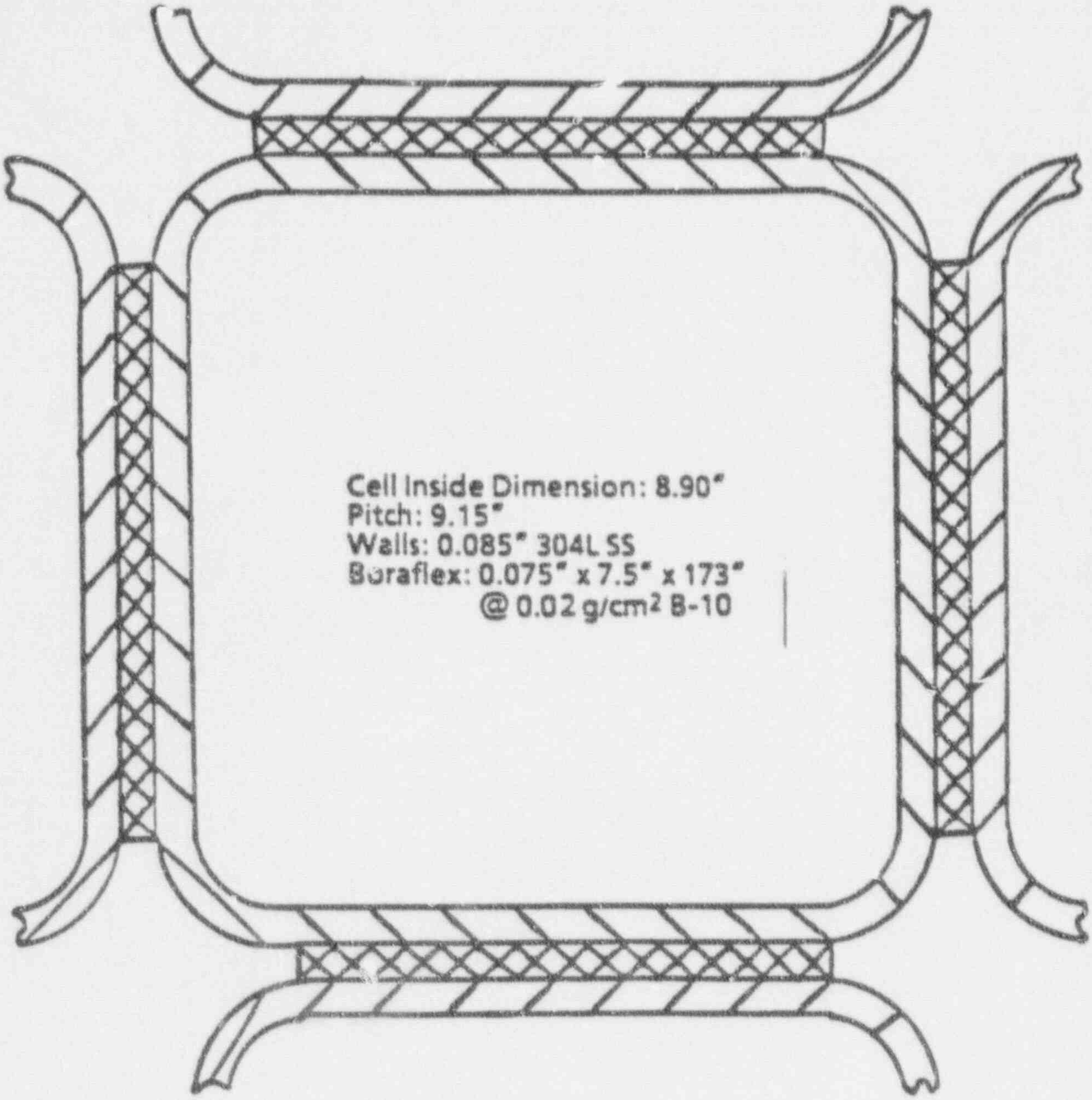


Figure 1 South Texas Region 1 Spent Fuel Storage Cell Nominal Dimensions



Not to Scale
Region 2 Rack - South Texas Project

Figure 2 South Texas Region 2 Spent Fuel Storage Cell Nominal Dimensions

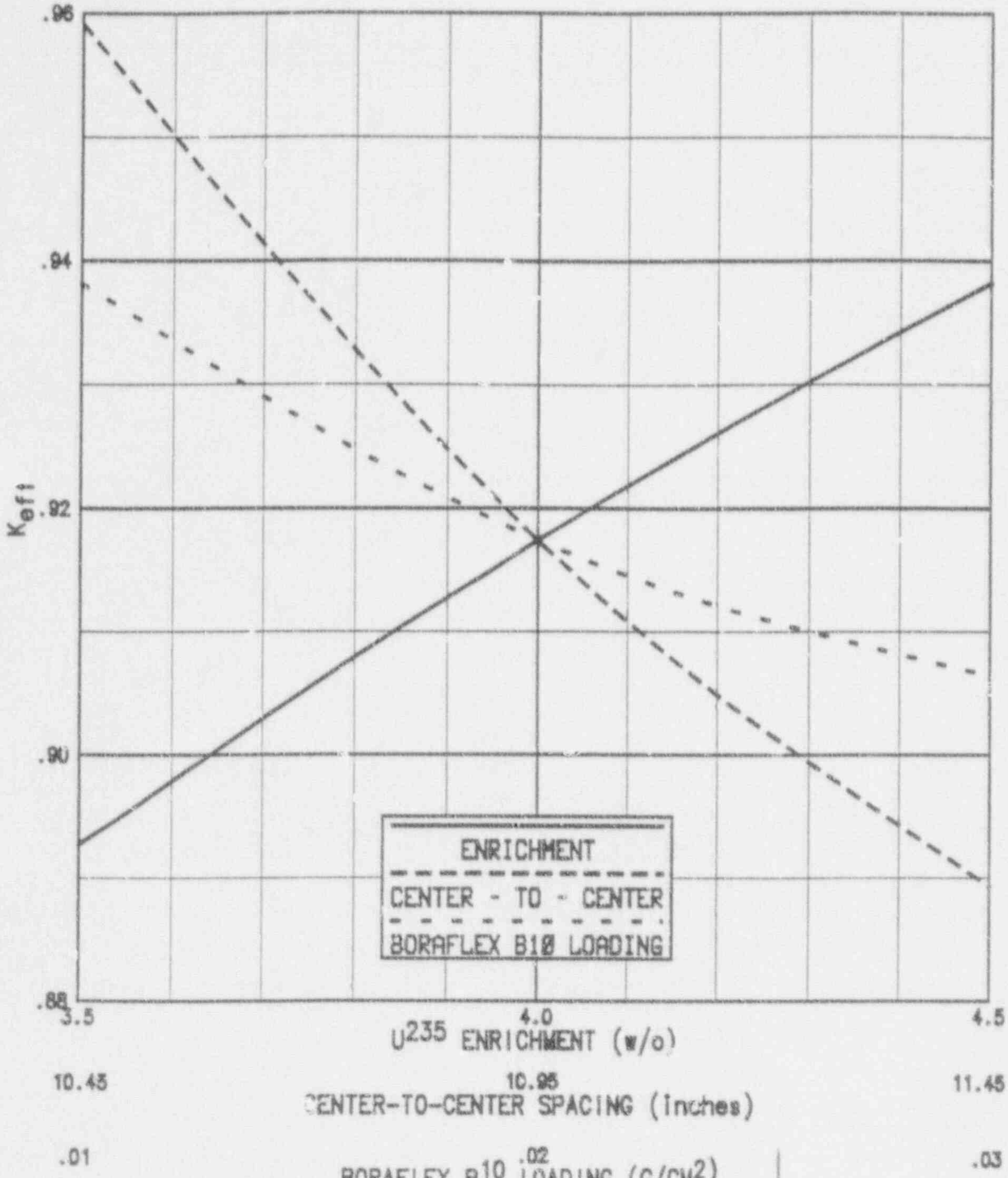


Figure 7 South Texas Region 1 Close Packed Reactivity Sensitivities

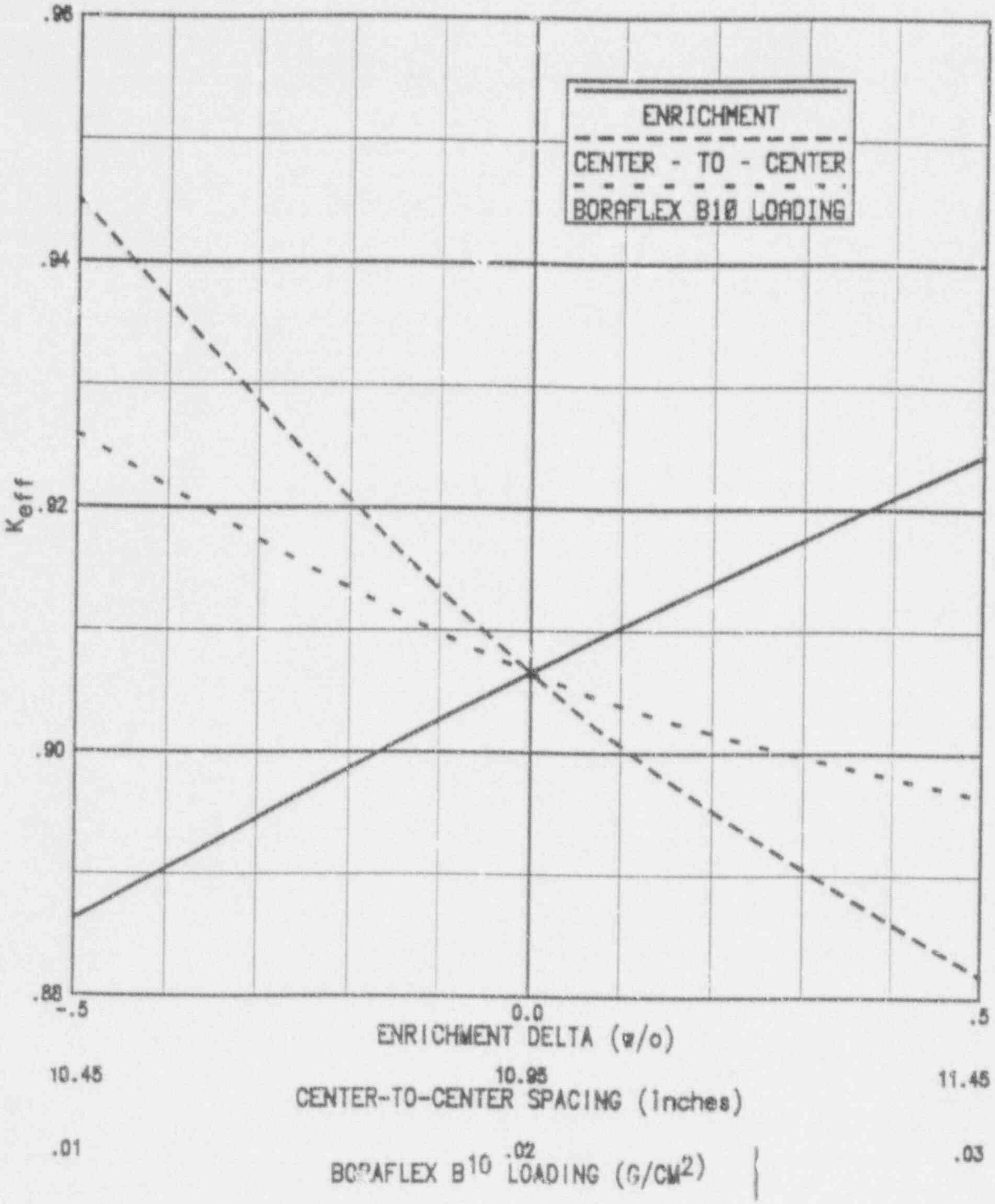


Figure 9 South Texas Region 1 Checkerboard Reactivity Sensitivities

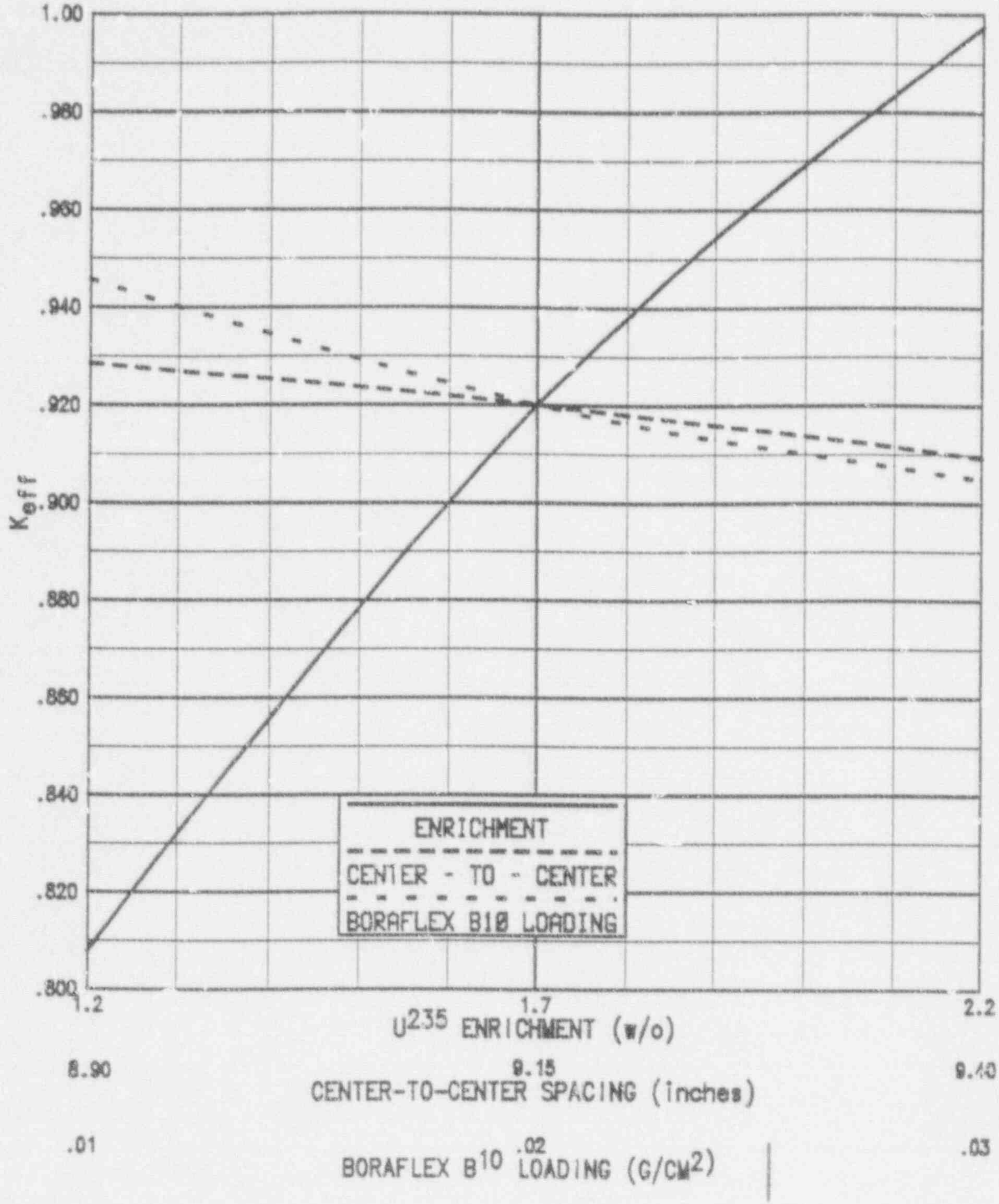


Figure 11 South Texas Region 2 Close Packed Reactivity Sensitivities