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SUBJECT: Responds to questions raised at 850604 meeting re criticality safety analysis.Calculations & graphs prepared by Pickard,Lowe & Garrick,Inc encl.

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SUBJECT: Responds to questions raised at [illegible] meeting re criticality safety analysis. Calculations & graphs prepared by Pickard, Lowe & Garrick, Inc. encl.

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ROGER W. KOBER
VICE PRESIDENT
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June 26, 1985

Director of Nuclear Reactor Regulation
Attention: Mr. John A. Zwolinski, Chief
Operating Reactors Branch No. 5
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Response to NRC Staff Questions
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Mr. Zwolinski:

On February 27, 1985, Rochester Gas and Electric Corporation submitted an Application for Amendment to Operating License to allow the storage of consolidated fuel at Ginna.

At our meeting of June 4, 1985, the NRC Staff raised several questions concerning the criticality safety analysis. Attached, in response, are some additional calculations performed by Pickard, Lowe and Garrick.

Very truly yours,

Roger W. Kober

Roger W. Kober

A001
1/1

Question: Please discuss the effects on criticality of the storage of fewer than 179 rods per half canister such as in a failed fuel configuration.

Response: The discussion below summarizes the results of calculations performed to determine at the optimum pitch the k_∞ for fuel rod storage in a failed fuel configuration. In addition, results are presented to show the effect of burnup on the k_∞ of both an infinite lattice of fuel rods and the fuel storage rack containing these fuel rods as a function of the number of fuel rods present in a consolidated fuel rod storage canister (results for zero burnup were previously presented in Figure 7 of the criticality analysis in the February 27, 1985 submittal).

The calculations were performed for an Exxon fuel assembly design with an initial enrichment of 3.13 w/o and for a burnup of 21 MWD/KGU. This fuel type was selected because all of the burnup dependent input data required for the current calculations were readily available from the results of previous calculations. However, good estimates of the corresponding results for the fuel stored at West Valley were obtained by comparing the k_∞ burnup dependence of the Exxon fuel assembly with that of a W Core 1 fuel assembly with an initial enrichment of 2.78 w/o.

The stainless steel tubes which are intended to contain failed fuel rods for storage in consolidated fuel canisters have a 0.75 inch outer diameter with a wall thickness of 0.035 inch. Based on these tube dimensions and the dimensions of the consolidated fuel storage canister, geometric considerations limit the number of tubes that can be accommodated in one-half of a canister to 55 when the rods are arranged on a triangular or hexagonal pitch. If the tubes could be constrained to a square pitch, the limiting number of tubes would be reduced to 50 per half canister. Using these two cases as a lower limit on the water-to-nonwater volume ratio, this ratio was then increased by increasing the pitch on a square lattice, and the resulting k is shown in Figure 1 for an infinite lattice of stainless steel tubes containing Exxon type fuel rods at 3.13 w/o initial and with a burnup of 21 MWD/KGU.

Due to the presence of the stainless steel tubes, the maximum k_∞ of about 0.83 is obtained for the dryest lattices, and increasing the water volume (by increasing the pitch) results in a uniform reduction in k_∞ due to increased neutron absorption in the stainless steel tubes and/or the water. Based on the low k_∞'s obtained for an infinite lattice of these fuel rods, there is no need to evaluate the reduction in k_∞ which

would occur if these rods were placed in canisters and stored in the Region 2 racks.

A similar set of calculations were performed using the same fuel rods but without the presence of the stainless steel tubes. In this case the maximum number of fuel rods per half canister is 179. The results are shown in Figure 2 for both the k_∞ of an infinite lattice and the k_∞ of the storage rack containing the canisters. In this case, the maximum lattice k_∞ is about 1.16, but the maximum rack k_∞ is only about 0.87.

Figure 3 shows a comparison of k_∞ vs. burnup behavior for an Exxon fuel assembly at 3.13 w/o and a 2.78 w/o fuel assembly stored at West Valley. The k_∞ of the two types of fuel assemblies is the same for a burnup of 21 MWD/KGU; so the data shown in Figures 1 and 2 should also be applicable to West Valley fuel assemblies with a burnup of 21 MWD/KGU. However, the minimum burnup of the fuel assemblies stored at West Valley is about 15.5 MWD/KGU for an initial enrichment of 2.795 w/o. The k_∞ of the 2.78 w/o fuel assemblies at a burnup of 15.0 MWD/KGU was selected as being representative of the minimum burnup - maximum k_∞ fuel stored at West Valley, and based on the data shown in Figure 3, the difference in k_∞ for this fuel at burnups of 21 and 15 MWD/KGU is .0535 Δk_∞. This reactivity difference has been applied to the data generated for the Exxon fuel and the results are shown in Figures 4 and 5. These figures show that for the minimum burnup maximum k_∞ fuel stored at West Valley, the maximum infinite lattice k_∞ for the fuel rods in stainless steel tubes is about 0.88, and for the fuel rods stored in canisters in the storage rack, the maximum k_∞ is about 0.93. However, a situation in which between 75 and 100 fuel rods per half canister are uniformly spaced in more than one storage rack position would have to be considered a low probability accident situation. In that case, credit should be allowed for the presence of 2000 ppm boron which would further reduce the k_∞ of the rack by more than .20 Δk_∞.

In conclusion there appears to be no criticality safety concerns for storage of failed or nonfailed fuel.

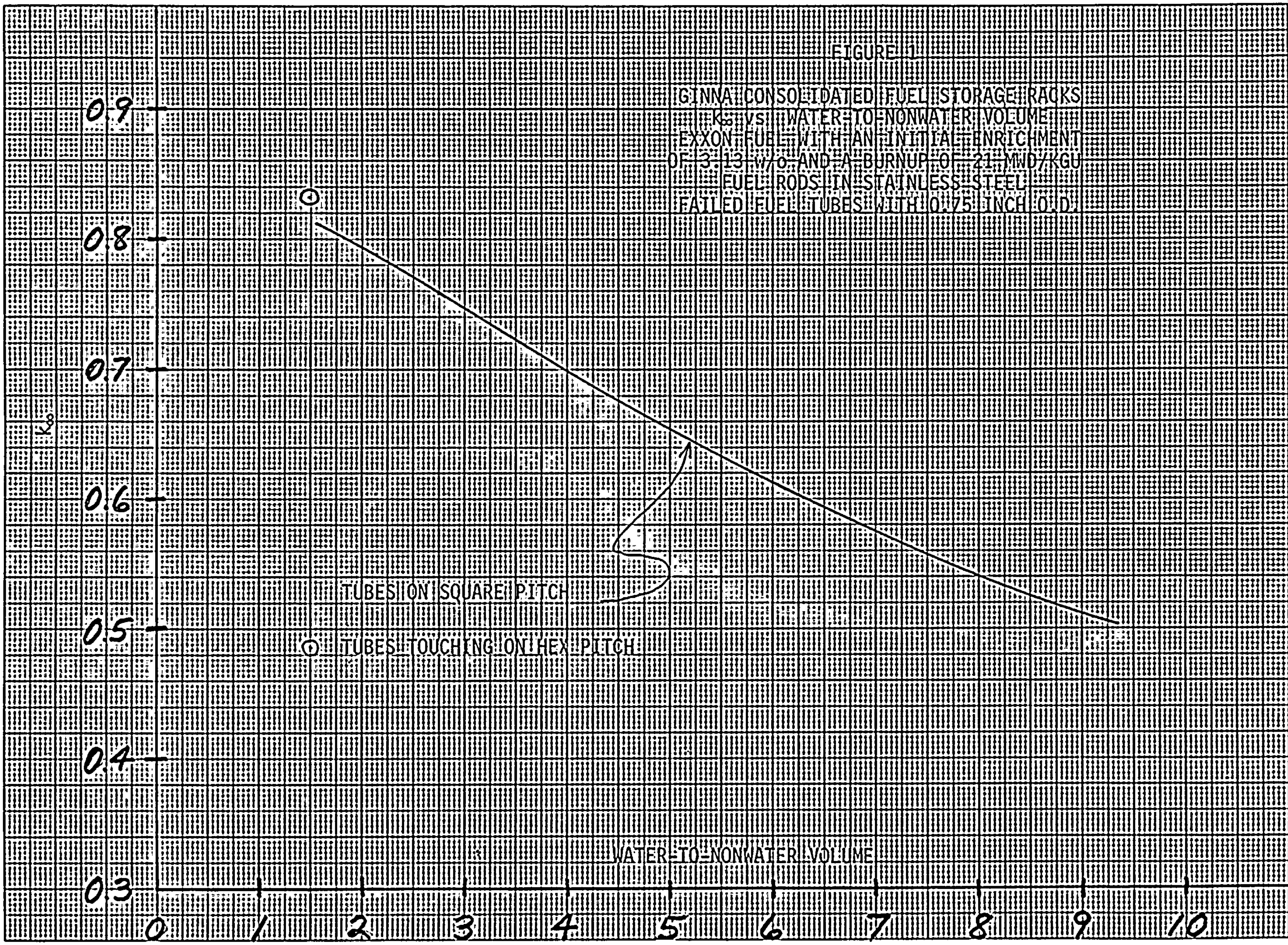
FIGURE 1
GINNA CONSOLIDATED FUEL STORAGE RACKS
K∞ vs WATER-TO-NONWATER VOLUME
EXXON FUEL WITH AN INITIAL ENRICHMENT
OF 3.13 w/o AND A BURNUP OF 21 MWD/KGU
FUEL RODS IN STAINLESS STEEL
FAILED FUEL TUBES WITH 0.75 INCH O.D.
TUBES ON SQUARE PITCH
TUBES TOUCHING ON HEX PITCH
WATER-TO-NONWATER VOLUME
K∞
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
1
2
3
4
5
6
7
8
9
10

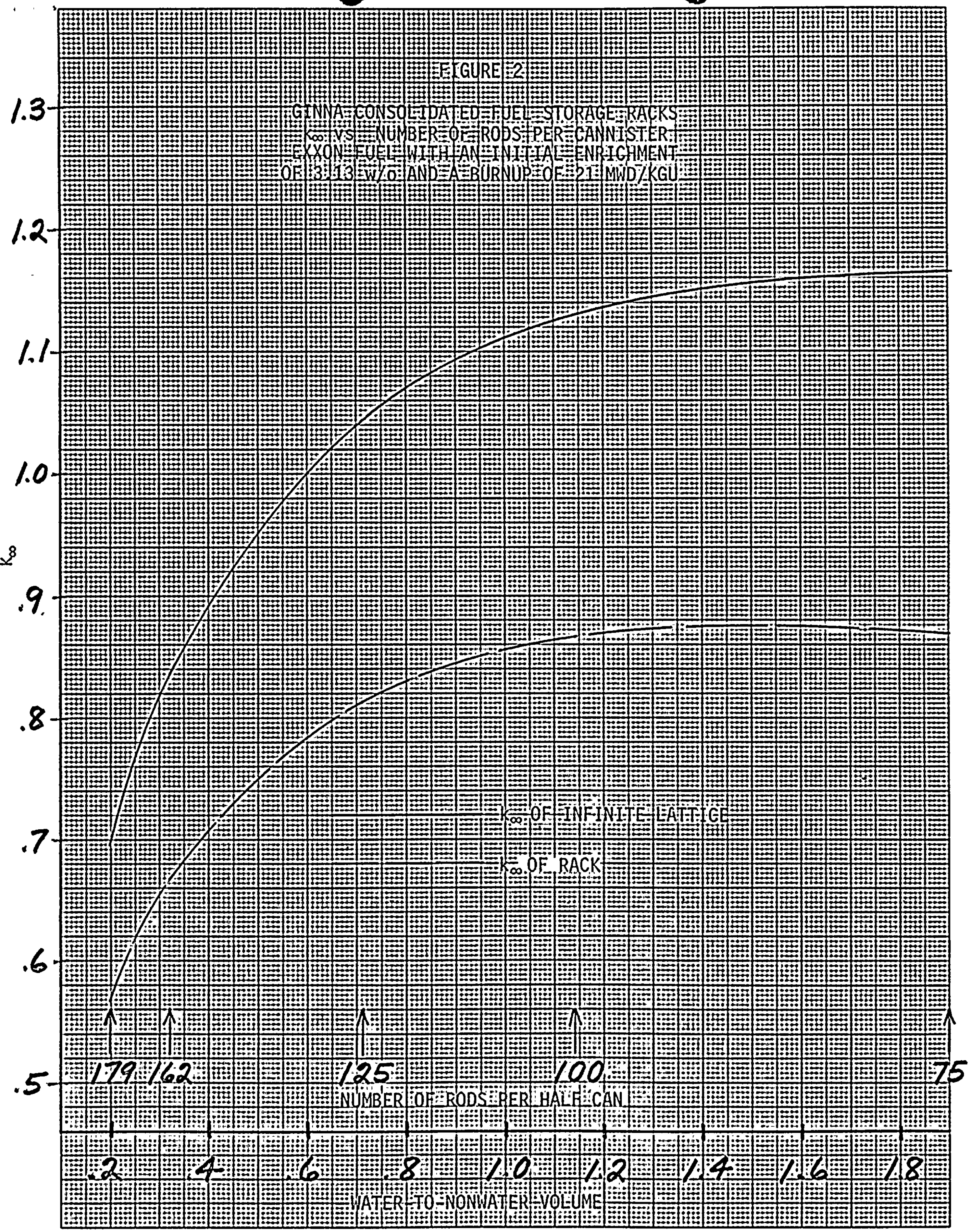

FIGURE 2

GINNA CONSOLIDATED FUEL STORAGE RACKS
k_∞ vs. NUMBER OF RODS PER CANNISTER
EXXON FUEL WITH AN INITIAL ENRICHMENT
OF 3.13 w/o AND A BURNUP OF 21 MWD/KGU

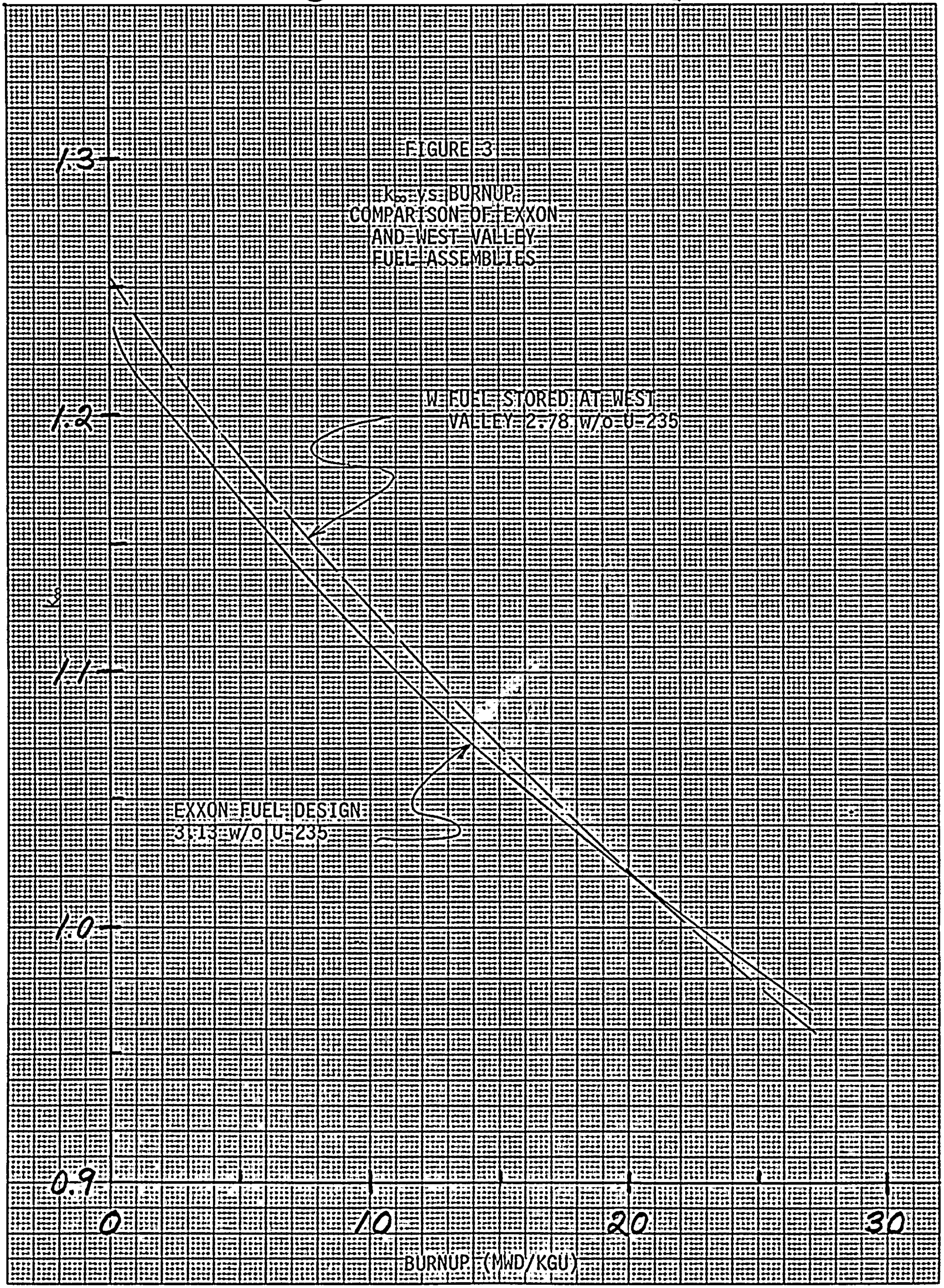

FIGURE 3
k∞ vs BURNUP
COMPARISON OF EXXON
AND WEST VALLEY
FUEL ASSEMBLIES
W FUEL STORED AT WEST
VALLEY 2.78 w/o U-235
EXXON FUEL DESIGN
3.13 w/o U-235
1.3
1.2
1.1
1.0
0.9
0
10
20
30
BURNUP (MWD/KGU)

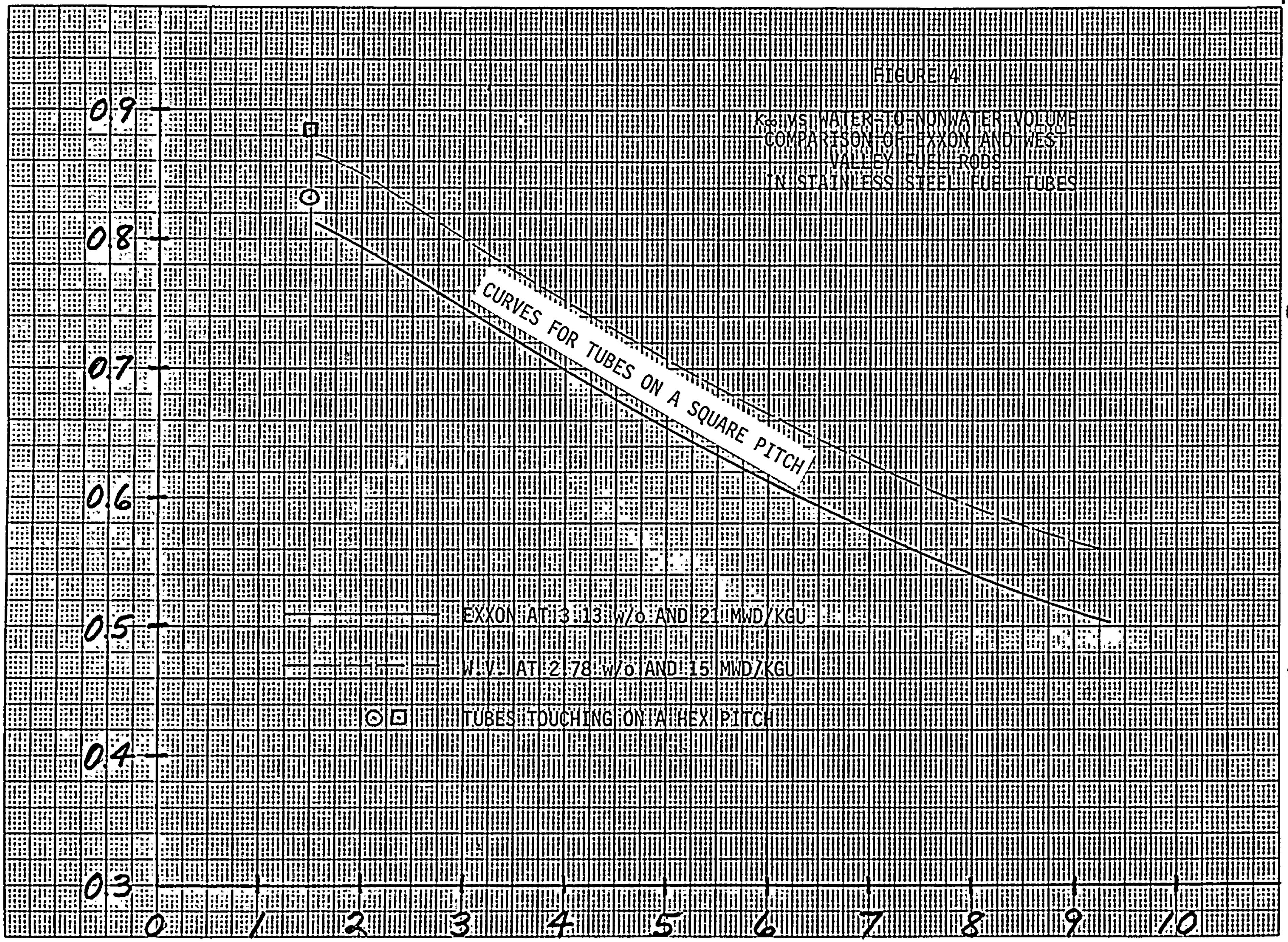
FIGURE 4
K∞ vs WATER-TO-NONWATER VOLUME
COMPARISON OF EXXON AND WEST
VALLEY FUEL RODS
IN STAINLESS STEEL FUEL TUBES
CURVES FOR TUBES ON A SQUARE PITCH
EXXON AT 3.13 w/o AND 21 MWD/KGU
W.V. AT 2.78 w/o AND 15 MWD/KGU
TUBES TOUCHING ON A HEX PITCH
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
1
2
3
4
5
6
7
8
9
10

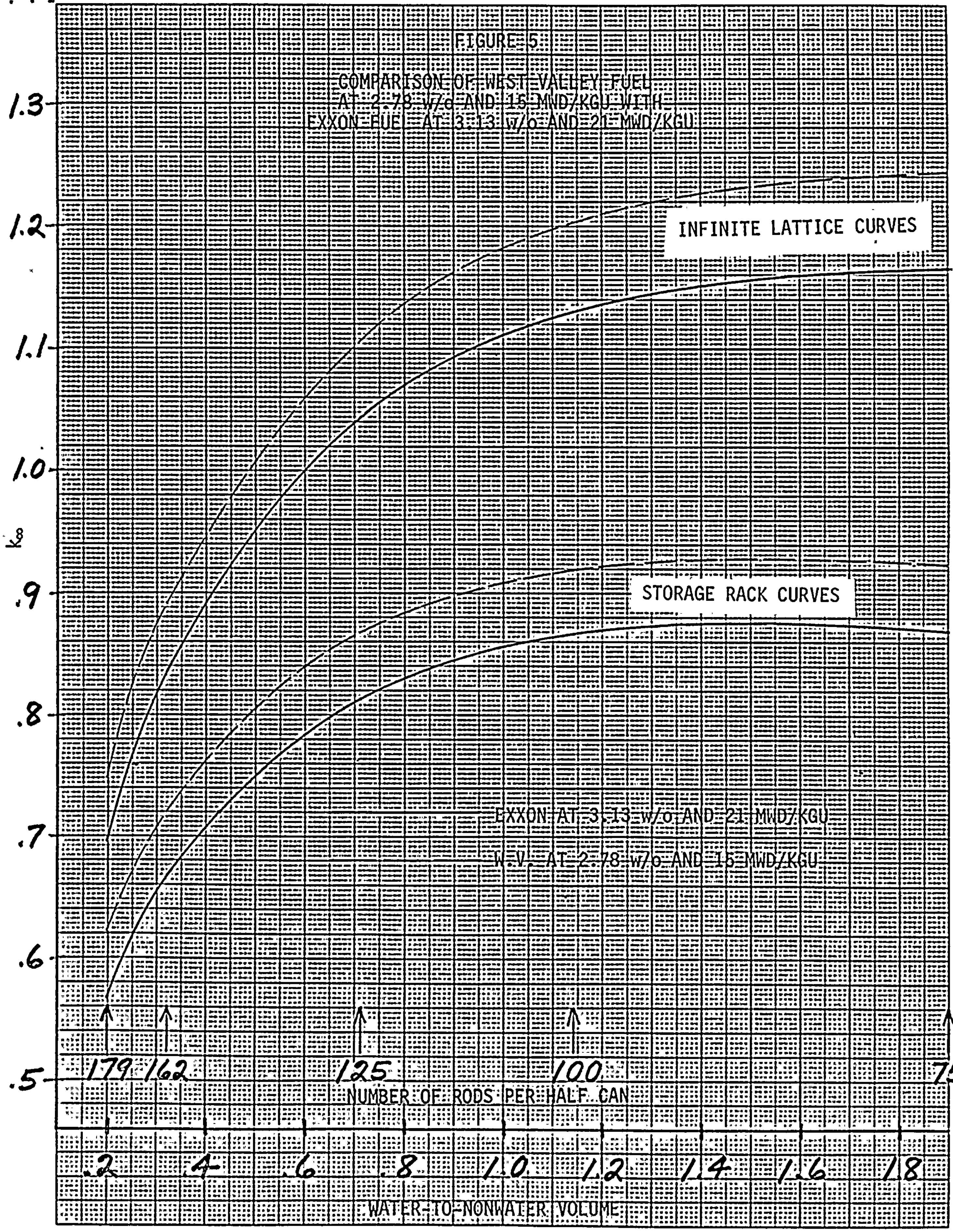
FIGURE 5
COMPARISON OF WEST VALLEY FUEL
AT 2.78 w/o AND 15 MWD/KGU WITH
EXXON FUEL AT 3.13 w/o AND 21 MWD/KGU
INFINITE LATTICE CURVES
STORAGE RACK CURVES
EXXON AT 3.13 w/o AND 21 MWD/KGU
W.V. AT 2.78 w/o AND 15 MWD/KGU
k∞
1.3
1.2
1.1
1.0
.9
.8
.7
.6
.5
179
162
125
100
75
NUMBER OF RODS PER HALF CAN
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
WATER-TO-NONWATER VOLUME
461510
10 X 10 TO THE CENTIMETER 18 X 25 CM.
KEUFFEL & ESSER CO. MADE IN U.S.A.