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402/536-4000

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Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

References:
(1) Docket No. 50-285
(2) Letter OPPD (W. C. Jones) to NRC (J. R. Miller) dated March 12, 1982 and supplementary letters of April 26, June 23, November 23, 1982 and April 29, June 6, August 1 and August 23, 1983
(3) Amendment 75 and SER to OL DPR-40, NRC (J. R. Miller) to OPPD (W. C. Jones) dated September 9, 1983

Gentlemen:

SUBJECT: Ultrasonic Fuel Inspection in the Spent Fuel Pool

The Safety Evaluation Report for Amendment 75 (Reference 3) prescribes, on page 6, the Fort Calhoun Station refueling machine be interlocked to prevent movement into Region 2 of the spent fuel pool during refueling operations. During the 1987 Refueling outage, OPPD plans to perform ultrasonic inspection of fuel assemblies which currently reside in the reactor core. This inspection program is part of our fuel integrity program to enhance the Fort Calhoun Station's fuel reliability and performance. However, it is necessary to conduct the inspection in the cask loading area (Region 2) of the spent fuel pool due to test equipment requirements.

A supplementary criticality analysis of the Fort Calhoun Station spent fuel pool was prepared for OPPD by Pickard, Lowe and Garrick, as was the original analysis submitted in Reference (2) in order to support the movement into Region 2 during refueling operations. Attached for your review, this report investigates the use of an ultrasonic fuel test rig in the cask laydown area of the spent fuel pool during a refueling outage assuming a 1,800 ppm boron concentration is maintained in the pool. A minimum separation of one foot, five inches was also analyzed for the test rig.

The analysis was also bounded with a 1,700 ppm boron concentration and the minimum separation was also identified to bound a generic test rig for future fuel inspection programs. The results of the analysis indicate that a maximum k_{eff} in Region 2 with 1,800 ppm boron is calculated at 0.7860 and 0.8020 for 1,700 ppm for the test rig.

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Rec'd w/check $150.00

Due to the extremely conservative nature of the analysis in Reference 2 and the supplementary analysis, it is concluded that the use of the ultrasonic test rig poses no problem from the standpoint of criticality safety. Thus, it is requested that the revision listed below be issued to Reference (3) to allow the temporary transfer of fuel assemblies in and out of Region 2 of the Fort Calhoun Station spent fuel pool during refueling outages for the purpose of inspection of spent fuel assemblies:

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"...region during refueling operations." [Add] The interlock may be bypassed during refueling operations when the following conditions have been met:

(1) The independent burnup calculations have been completed, as required above.

(2) CEA assemblies only are to be moved into Region 2.

(3) To allow ultrasonic fuel inspection or sipping programs to be implemented, the inspection stand must provide a minimum separation of one foot, five inches (center-to-center) between the fuel assemblies during testing, as specified in the supplementary criticality analysis submitted (letter reference).

It is anticipated that assemblies being permanently discharged, for which the required burnup verification has been completed, could remain in Region 2 racks after inspection.

As prescribed in 10 CFR 170.12, enclosed please find our check for $150.00. If you have any questions, please contact us.

Sincerely,

R. L. Andrews
Division Manager
Nuclear Production

RLA/bjb

c: LeBoeuf, Lamb, Leiby & MacRae
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Mr. A. C. Thadani, Project Director
Mr. W. A. Paulson, NRC Project Manager
Mr. P. H. Harrell, NRC Senior Resident Inspector

ATTACHMENT

1. INTRODUCTION

A criticality analysis of the Fort Calhoun spent fuel storage pool with the proposed ultrasonic test rig located in the cask laydown area has been performed. An analysis of the pool and spent fuel storage rack in the absence of the test rig had been completed previously. Reference 1

2. ANALYTICAL METHOD

The analytical methods used are the same as those used to perform the original analysis as described in Reference 1. Both Exxon and Combustion Engineering (CE) fuel are stored in the pool. Analysis using LEOPARD (Reference 2) indicated that the Exxon fuel design is marginally more reactive than the CE fuel design for fresh fuel at the limiting enrichment of 4.0 w/o. The Exxon fuel, with the design parameters given in Table 1 is, therefore, used throughout this analysis.

The test rig design and the PDQ (Reference 3) model geometry are shown in Figures 1 and 2, respectively. The PDQ geometry assumes an infinite lattice of cells at the spacing mandated by the test rig, and thus is conservative relative to the actual design. In all cases, credit is taken for the presence of the minimum concentration of 1,800 ppm boron in the pool water and axial leakage. However, bounding cases were also run with a soluble boron concentration of 1700 ppm boron. No credit is taken for structural materials in the test rig. It has been confirmed that the assemblies are physically constrained to maintain a minimum separation which is not less than that shown in Figure 1 (Reference 4).

3. RESULTS

The geometry of Figure 2 was used to model cases with temperatures of 68°F, 100°F, 150°F, and 200°F at unit water density, and at reduced water densities of 0.05, 0.10, 0.15, 0.30, 0.60, and 0.80 of the nominal density at 68°F. The results are shown in Figures 3 and 4. The peak value of k_{eff} is 0.7747, which occurs at a water density of 0.10 of the nominal density. At 1700 ppm boron this peak K_{eff} increases to 0.7905. The $\Delta k/k$ for the maximum pool temperature is 0.0001. The other uncertainties are assumed comparable to those given in Table 3 of Reference 1, which total to 0.0145 $\Delta k/k$. Thus, the maximum value of k_{eff} for the infinite test rig array at 1800 ppm boron is 0.7860 and at 1700 ppm boron is 0.8020. The case where the assembly test rig produced a larger separation between fuel assemblies was also modeled and resulted in a lower k_{eff}.

Using the data in Table 9 for an assembly with a 4.0 w/o assay and Figure 17 of Reference 1, the maximum value of k_{eff} in Region 2 with 1,800 ppm boron is 0.6692 and at 1700 ppm boron is 0.6739.

Since the reactivity of an infinite lattice will not be increased by replacing a part of the lattice with a region of lower reactivity, the pool reactivity will not exceed the conservatively calculated k_{eff} for the infinite test rig array of 0.7860 at 1800 ppm or 0.8020 at 1700 ppm boron.

4. CONCLUSIONS

Due to the extremely conservative nature of this analysis, it is clear that the use of the ultrasonic test rig poses no problem from the standpoint of criticality safety.

REFERENCES

1. Pickard, Lowe and Garrick, Inc., "Criticality Analysis for the Fort Calhoun Nuclear Station Modified Maximum Density Spent Fuel Storage Racks," October 15, 1982.

2. Barry, R. F., "LEOPARD - A Spectrum Department Non-Spactial Depletion Code for the IBM-7094," WCAP-3269, September 1963.

3. Caldwell, W. R., "PDQ-7 Reference Manual," WAPD-TM-678, January 1967.

4. Ultratest Fuel Inspection Stand - General Arrangement Drawing XN-NF-305, 761 from Exxon Nuclear Company, Inc.

TABLE 1. FUEL ASSEMBLY TECHNICAL INFORMATION FOR FORT CALHOUN NUCLEAR PLANT

Rod Array	14 x 14
Rods Per Assembly	176
Rod Pitch, In.	0.580
Overall Dimensions, In.	8.13 x 8.13
Assembly Overall Length, In.	146.33
Active Fuel Height, In.	128.0
Clad Thickness, In.	0.028
Fuel Rod O.D., In.	0.440
Pellet Diameter, In.	0.3815
Diametral Gap, In.	0.00425
Pellet Density (% theoretical)	94.75
Control Rod Guide Tubes	
Outer Diameter, In.	1.115
Wall Thickness, In.	0.080
Center Guide Tube	
Outer Diameter, In.	1.115
Wall Thickness, In.	0.080

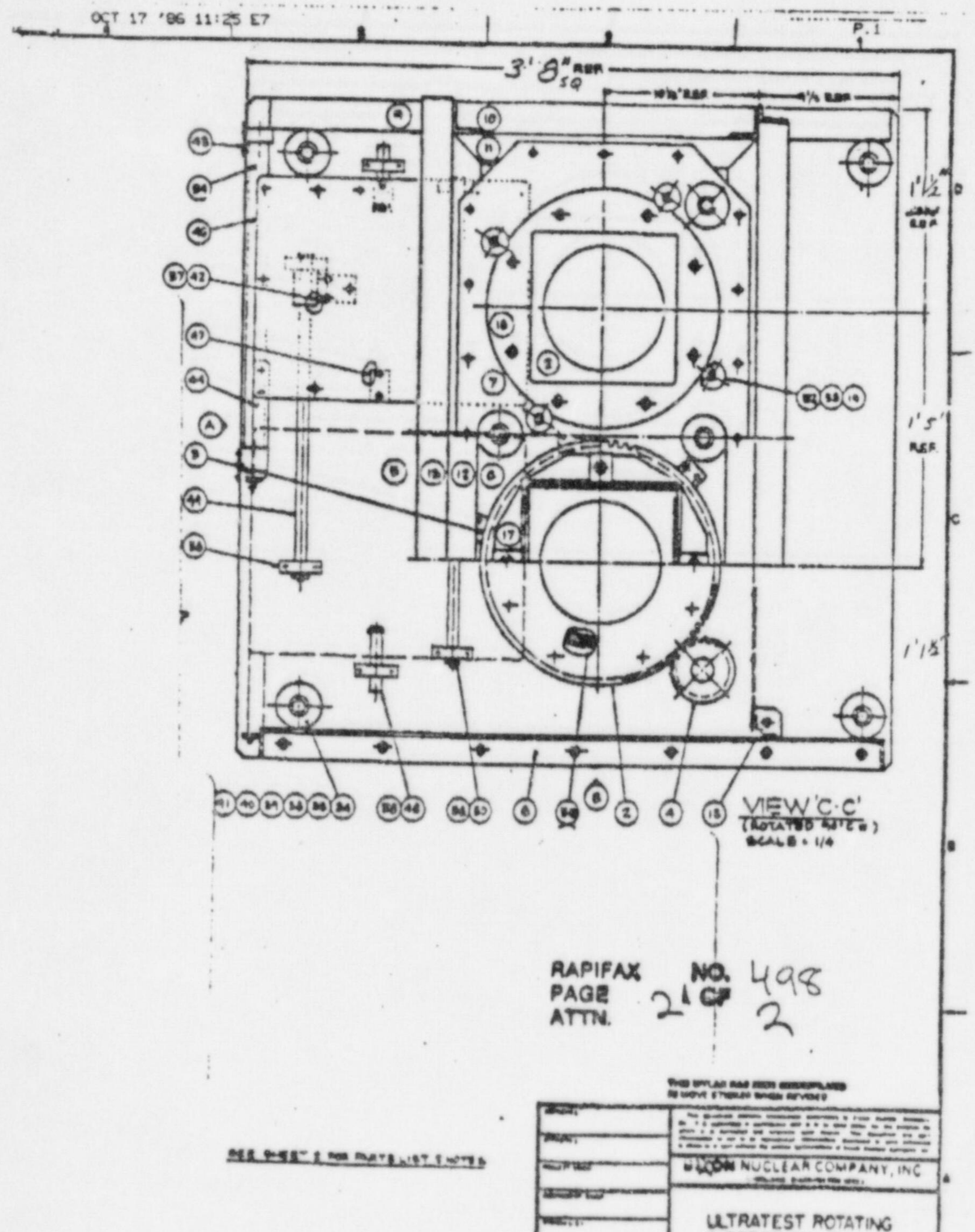

FIGURE 1. CROSS-SECTION OF ULTRASONIC TEST RIG

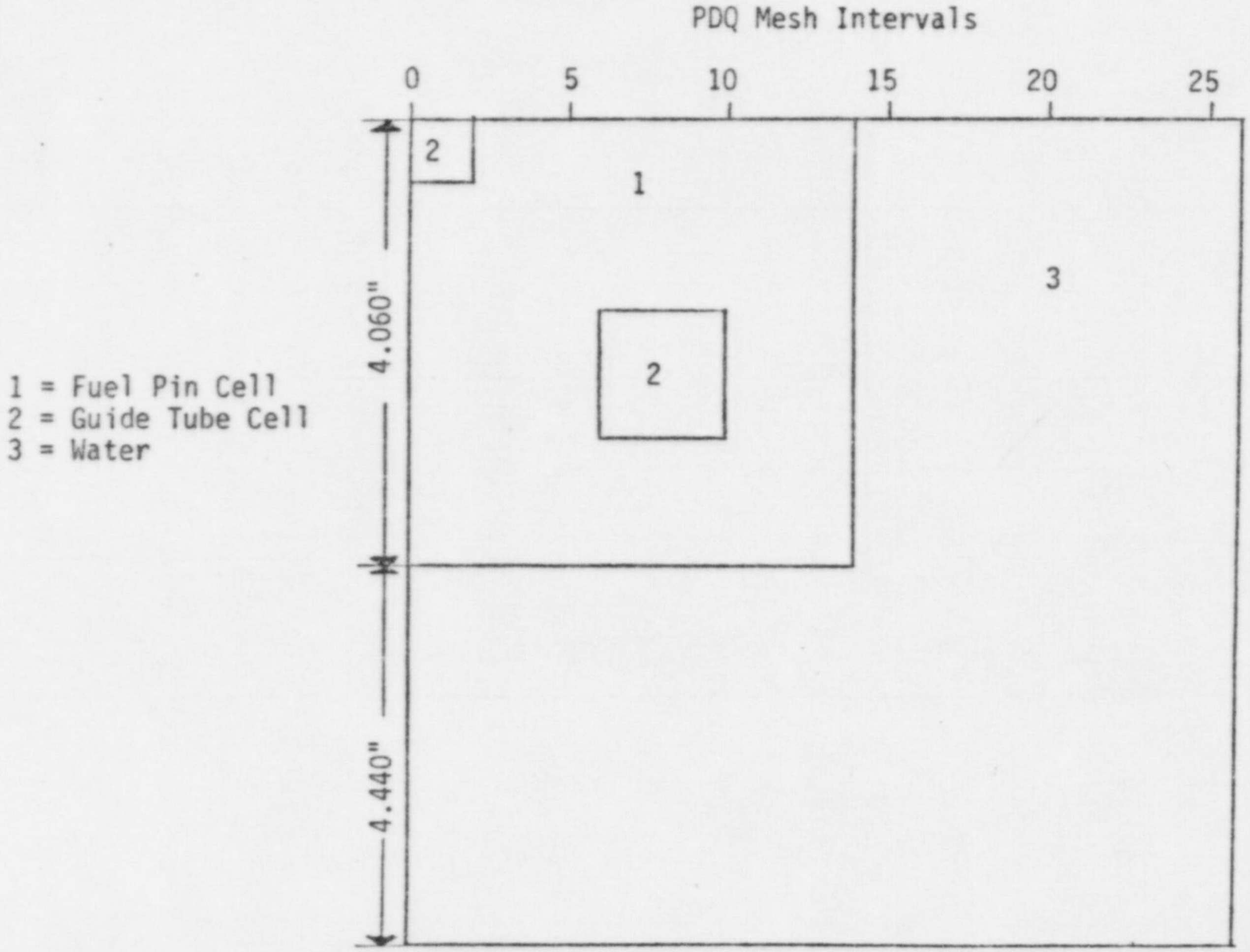

FIGURE 2. PDQ REPRESENTATION OF ULTRASONIC TEST RIG UNIT CELL

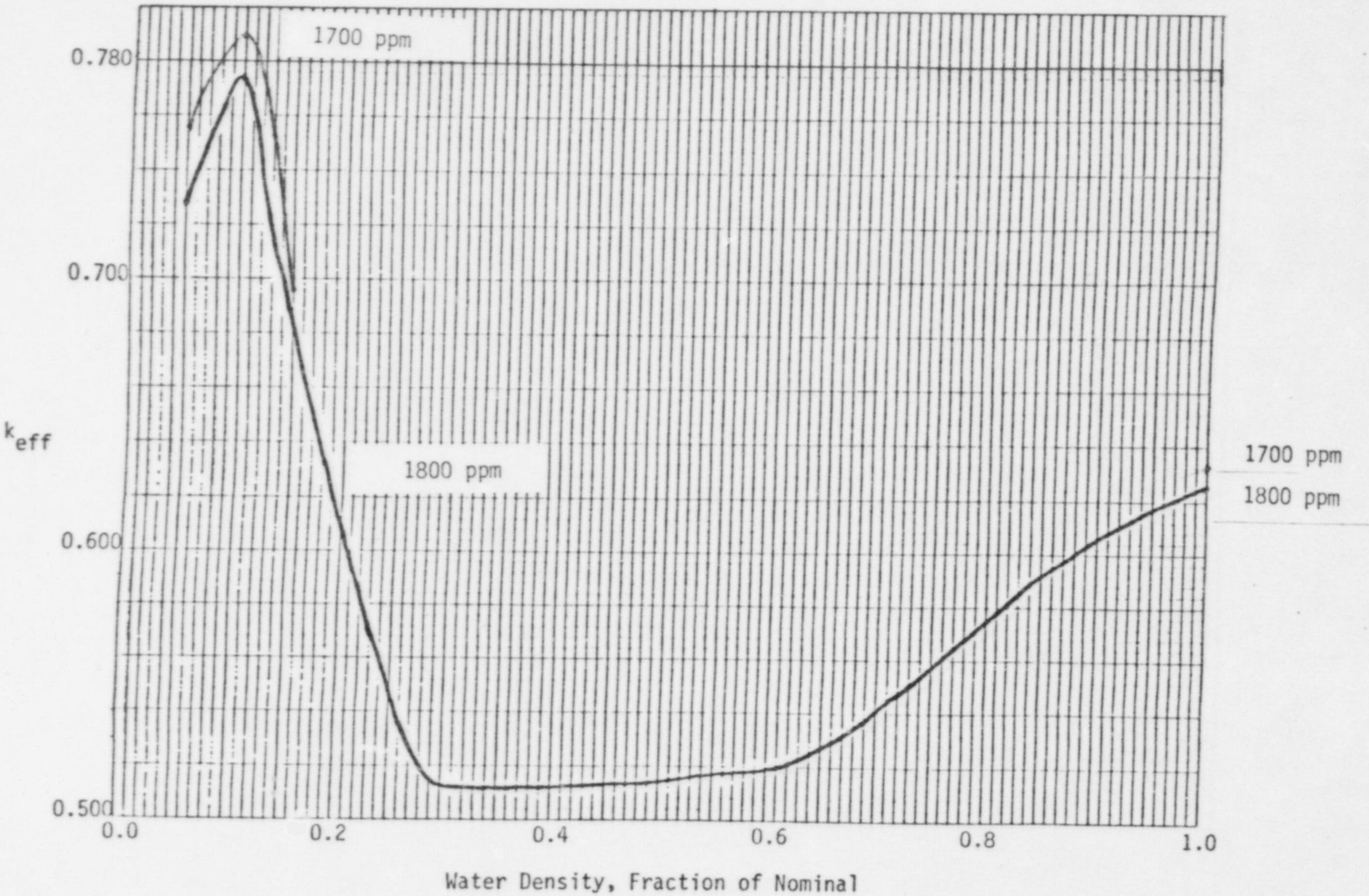

FIGURE 4. TEST RIG k_{eff} AS A FUNCTION OF WATER DENSITY WHEN MODELED AS AN INFINITE LATTICE

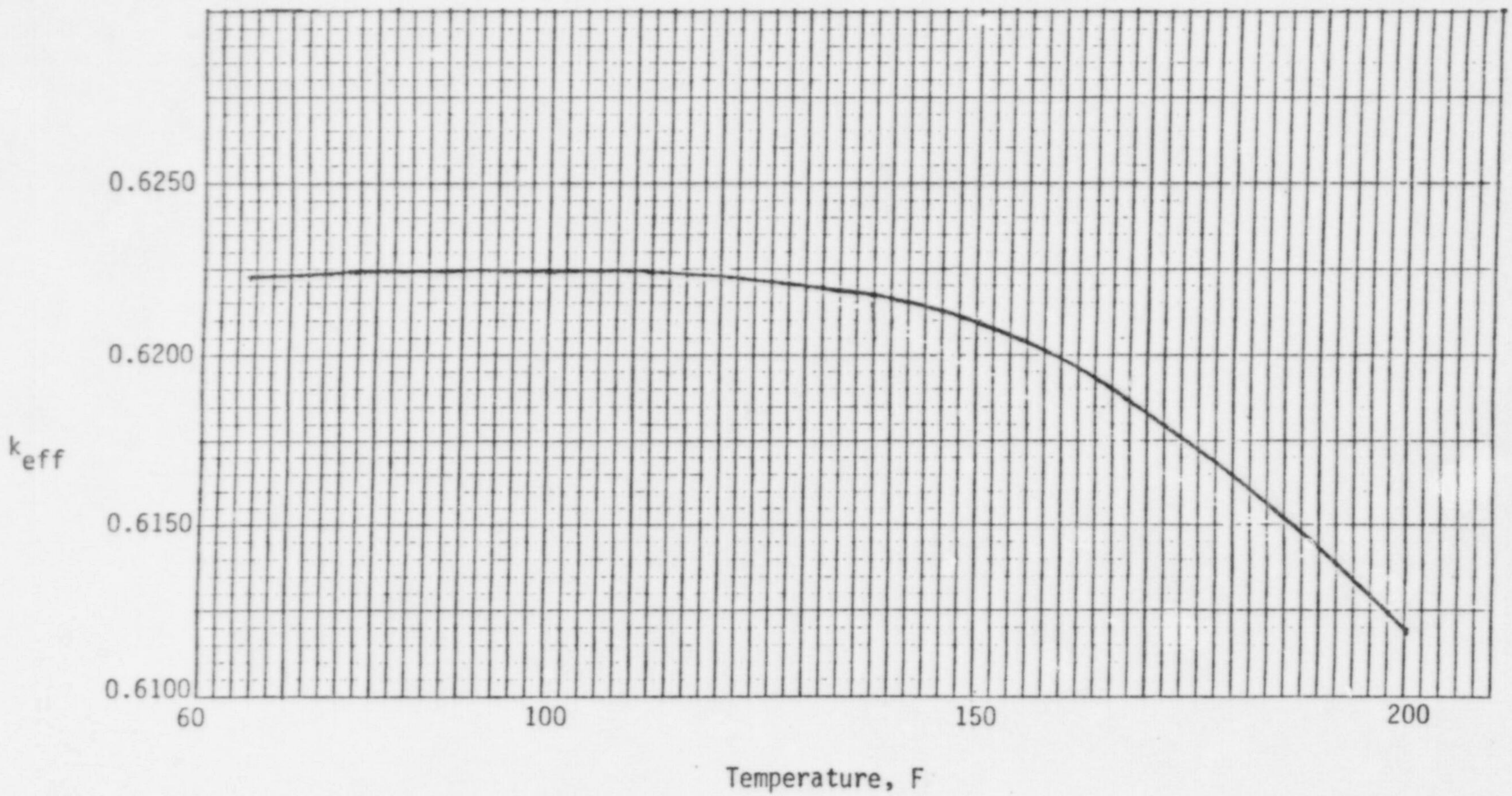

FIGURE 3. TEST RIG k_{eff} AS A FUNCTION OF WATER TEMPERATURE WHEN MODELED AS AN INFINITE LATTICE