for

Rochester Gas and Electric Corporation

- GINNA PLANT -

Criticality Safety Analysis for the New Fuel Storage Racks

by

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Pickard, Lowe and Garrick, Inc.

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Introduction

The new fuel storage racks for the Ginna Plant accommodate 44 fuel assemblies in 4 rows of 11 assemblies. Although new fuel assemblies are always stored in a dry condition in these racks, the condition of optimum moderation is considered in this analysis, even though it is inconceivable that such a condition could be achieved in these racks.

Description of the Analysis

A plan view of the new fuel storage racks is shown in Figure 1. Although the center to center spacing between all fuel assembly storage locations is not uniform in the East-West Direction, a minimum uniform spacing was conservatively assumed in the analysis. Figure 1 also shows the conservative symmetric geometry model chosen to calculate the effects of radial neutron leakage from the racks in the North-South direction. Symmetry boundary conditions (i.e., zero neutron current) are imposed on the North, East, and West boundaries of the model, and a zero neutron flux boundary condition is imposed at the outer edge of the assumed water reflector on the South boundary. The detailed dimensions and geometry of this model are shown in Figure 2.

The fuel assembly characteristics utilized for the analysis are shown in Table 1. A uniform axial enrichment distribution of 4.25 w/o U-235 was assumed for each fuel rod in the assembly.

The k_∞ of the fuel pin cell used to generate cross sections for the rack criticality analysis is shown as a function of water density in Figure 3. For the normal dry storage condition, the fuel assembly k_∞ will be essentially the same as or lower than the fuel pin cell k_∞, and therefore an upper limit for the k_{eff} of the rack for dry conditions may be obtained by extrapolation of the fuel pin cell k_∞ to zero water density. The resulting k_∞ is about 0.72, and the k_{eff} of the finite rack will be substantially less than that value.

If it is assumed the entire rack area is surrounded by a full density water reflector, then the water density in the resulting enclosed area can be varied, and the k of the rack can be determined from edits which combine the void-water and fuel assembly regions of the model shown in Figure 2. The resulting fuel rack k is also shown in Figure 3. At water densities below 0.1 gm/cc, an optimum moderation condition is approached. The apparent optimum moderator density is quite low because of the large volume fraction of the void-water region (0.994) as compared to that of the fuel region (.006). However, these large k 's at low water densities are not of concern as shown by the k_{eff} values from the same calculations.

The neutron multiplication factor, which includes neutron leakage effects in the North-South direction only, is shown as a function of water density in Figure 4. The maximum neutron multiplication factor is seen to be about 0.94 at an optimum water density of about .045 gm/cc. However, these calculations assumed zero neutron leakage in both the East-West radial direction and the axial direction.

To determine the effect of axial neutron leakage on the multiplication factor, flux weighted cross sections representing the fuel assembly and void-water regions of the radial model were used in one-dimensional axial calculations, and the results are also shown in Figure 4. The maximum neutron multiplication factor is now seen to be about 0.70 at a water density of about .075 gm/cc. This low multiplication factor even at optimum moderation conditions makes it unnecessary to evaluate the neutron leakage effects in the East-West radial direction which would result in some further small but significant reduction in the neutron multiplication factor.

In addition to the other conservatisms in the calculations, no credit was taken for neutron streaming effects at low water densities. Considering the large distances separating fuel assemblies in the rack, such effects would be expected to significantly increase neutron leakage from the racks and thereby further reduce the neutron multiplication factor.

Figure 4 also demonstrates the acceptability of the new fuel storage racks in the flooded condition which corresponds to a water density of 1.0 gm/cc. As shown, the neutron multiplication factor is somewhat less than 0.88 for the fully flooded condition and therefore clearly acceptable.

Because of the conservative techniques and assumptions used to evaluate the maximum possible neutron multiplication factor, there is more than reasonable assurance that no significant hazards based on criticality safety are involved in storing fuel assemblies of up to 4.25 w/o U-235 in the Ginna new fuel storage racks.

Table 1

FUEL ASSEMBLY CHARACTERISTICS

Number of rods containing UO_2	179	
Rod pitch (in)	0.5560	
Overall envelope dimensions (in)	7.763	
Weight of U (Kg U)	350.5	
Active fuel length (in)	141.4	
Enriched uranium region		
Length (in)	128.98	
Enrichment (w/o)	4.25	
Natural uranium blanket region		
Length (in)	12.42	
Enrichment (w/o)	0.711	
Instrument tube		
Material	Zr-4	
O.D. (in)	0.4015	
I.D. (in)	0.3499	
Guide tubes		
Material	Zr-4	
O.D. (in), above dashpot	0.5280	
O.D. (in), in dashpot	0.4825	
I.D. (in), above dashpot	0.4900	
I.D. (in), in dashpot	0.4425	
Fuel pellet		
Material	UO_2	
Density (% theoretical)	$95^{+1.0}_{-1.5}$	
O.D. (in)	0.3444	0.0019
Cladding		
O.D. (in)	.400	
I.D. (in)	.3514	
Spacer Grids		
Number	9	
Weights of materials*		
Inconel grids (2), lbs total	3.00	
Zircaloy grids (7), lbs total	19.46	

*Does not include weight of the stainless steel sleeves or inserts.

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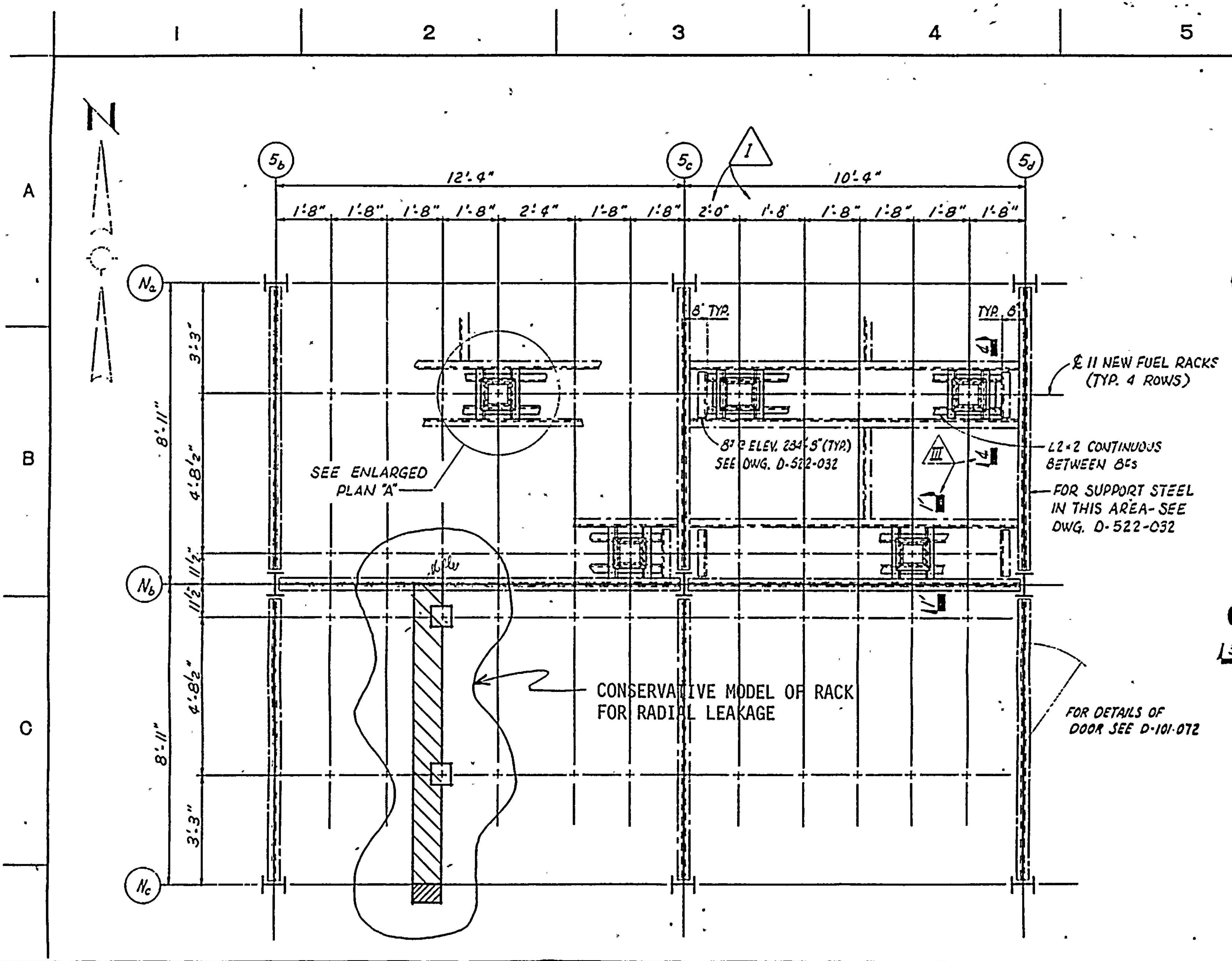


1
2
3
4
5
A
B
C
N
5b
5c
5d
I
12'-4"
10'-4"
1'-8"
2'-4"
2'-0"
1'-8
Na
Nb
Nc
3'-3"
8'-11"
4'-8½"
11½"
8" TYP.
TYP. 8"
℄ 11 NEW FUEL RACKS
(TYP. 4 ROWS)
L2×2 CONTINUOUS
BETWEEN 8"s
FOR SUPPORT STEEL
IN THIS AREA - SEE
DWG. D-522-032
SEE ENLARGED
PLAN "A"
III
CONSERVATIVE MODEL OF RACK
FOR RADIAL LEAKAGE
FOR DETAILS OF
DOOR SEE D-101-072

Figure 1

Figure 2
SYMMETRIC MODEL TO CONSERVATIVELY REPRESENT RADIAL LEAKAGE OF THE GINNA NEW FUEL STORAGE RACKS

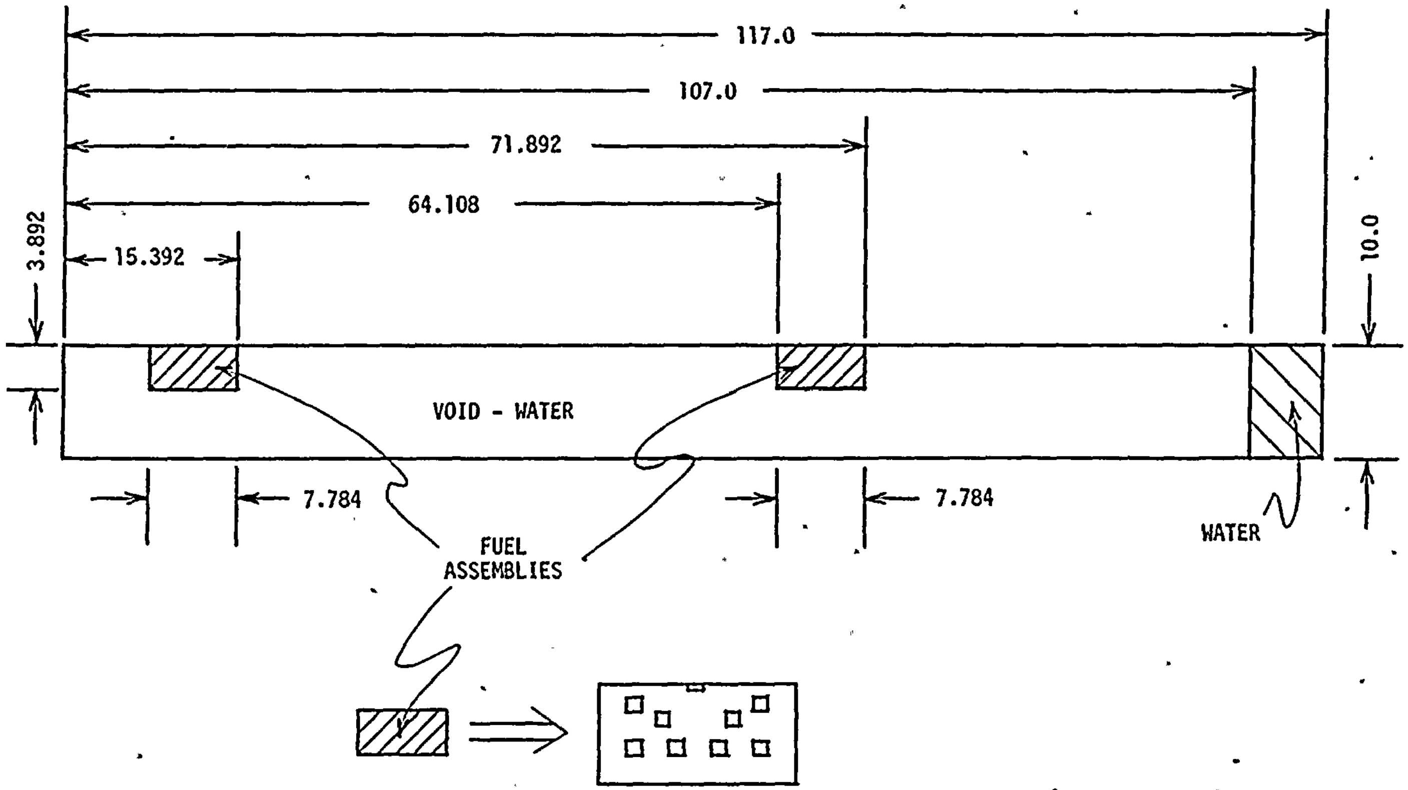


Figure 3

GINNA NEW FUEL RACK

WITH OFA AT 4.25 W/O U-235

INFINITE MULTIPLICATION FACTOR

VS

WATER DENSITY

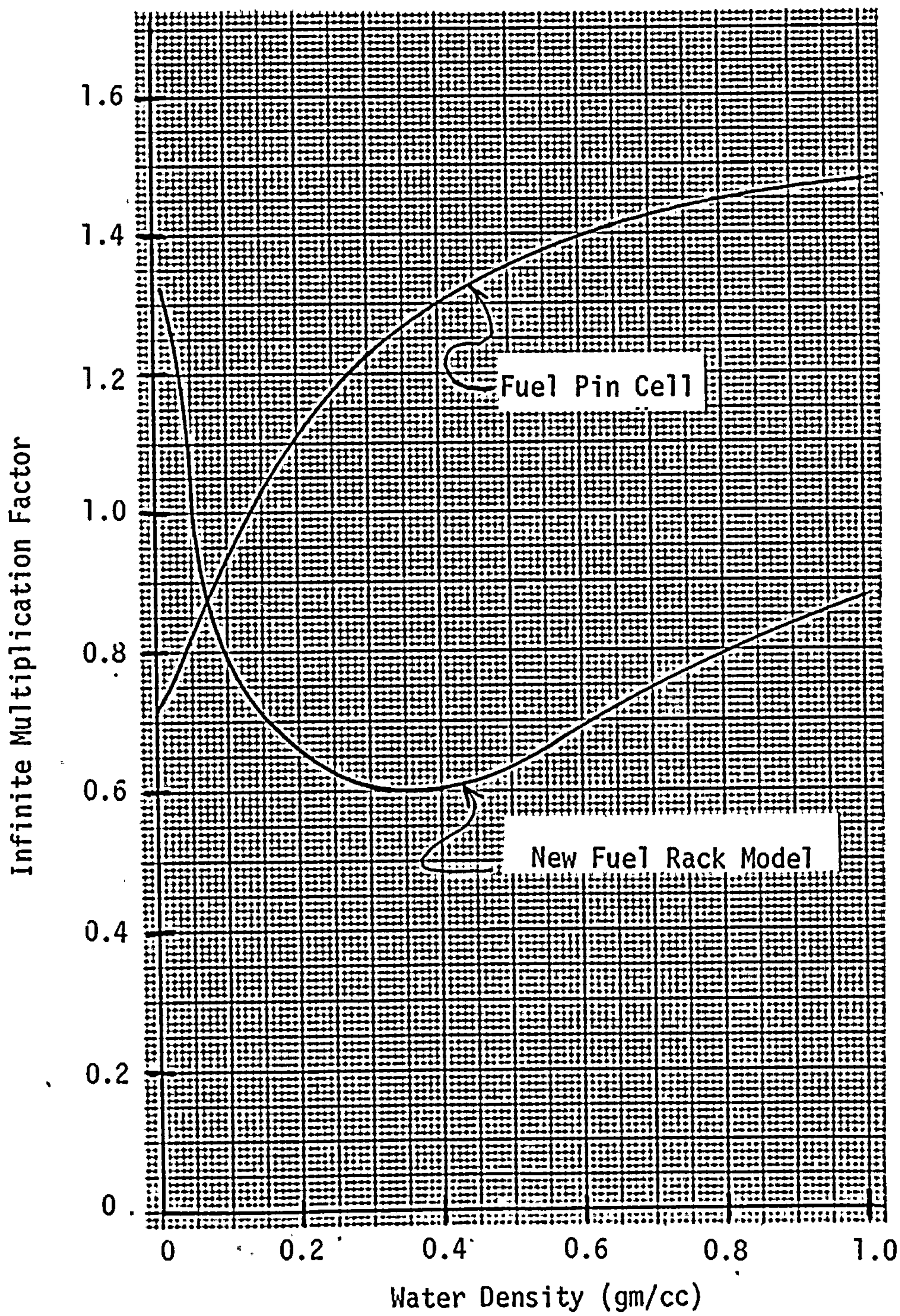
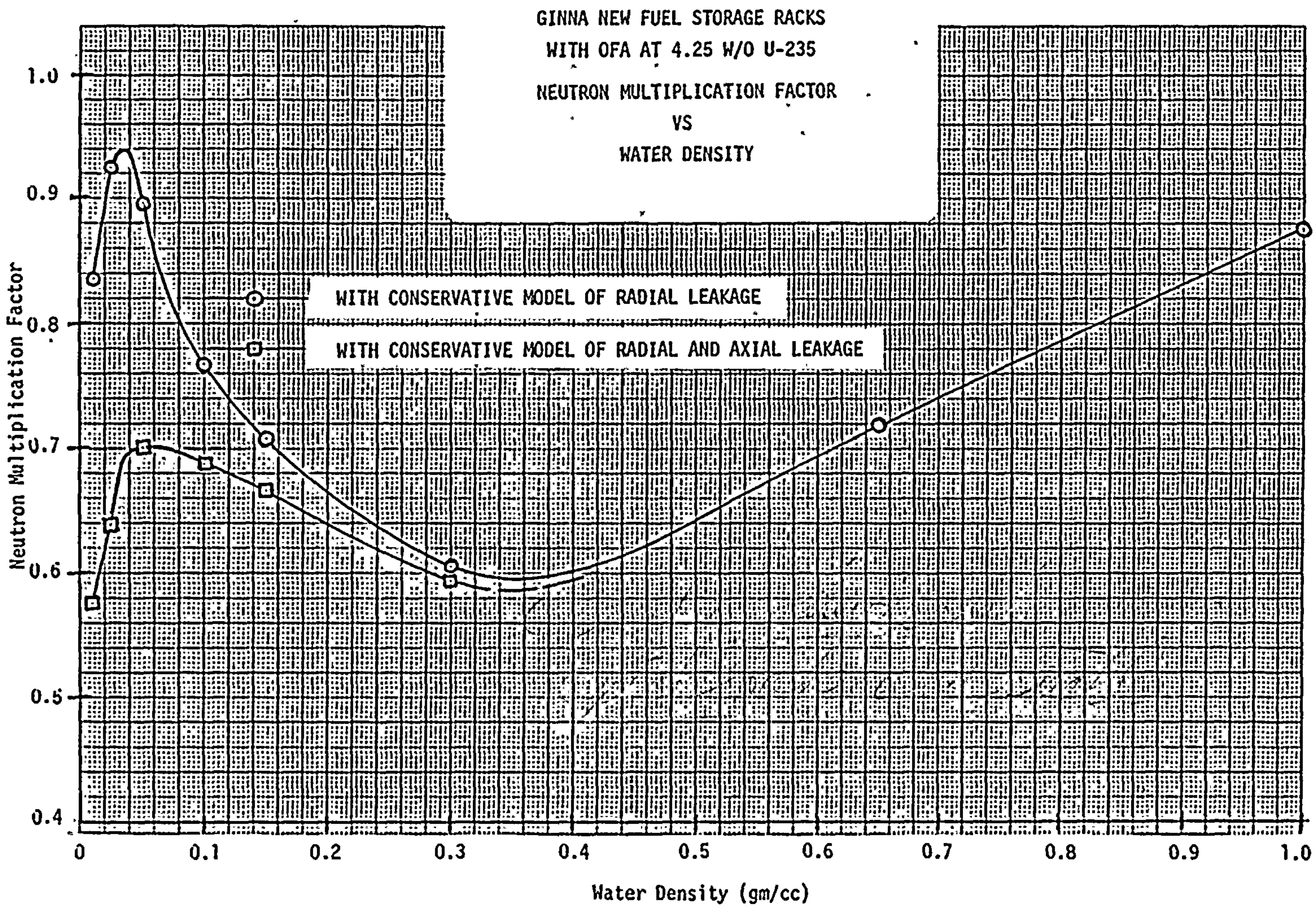


Figure 4



GINNA NEW FUEL STORAGE RACKS
WITH OFA AT 4.25 W/O U-235
NEUTRON MULTIPLICATION FACTOR
VS
WATER DENSITY
WITH CONSERVATIVE MODEL OF RADIAL LEAKAGE
WITH CONSERVATIVE MODEL OF RADIAL AND AXIAL LEAKAGE
Neutron Multiplication Factor
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Water Density (gm/cc)

DISTRIB UTION
Docket
ORB Reading
GDick
HSmith
ELD attorney

September 2, 1983

DOCKET NO(S). 50-244

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SUBJECT: R.E. GINNA PLANT - OPPORTUNITY FOR HEARING (APPLICATIONS 11/24/81, SNUBBER REQUIREMENTS: 9/28/82, STAFF REORGANIZATION)

The following documents concerning our review of the subject facility are transmitted for your information.

- [ ] Notice of Receipt of Application.
- [ ] Draft/Final Environmental Statement, dated ____________.
- [ ] Notice of Availability of Draft/Final Environmental Statement, dated ____________.
- [ ] Safety Evaluation Report, or Supplement No. ________, dated ____________.
- [ ] Notice of Hearing on Application for Construction Permit.
- [ ] Notice of Consideration of Issuance of Facility Operating License.
- [ ] Application and Safety Analysis Report, Volume ____________.
- [ ] Amendment No. ________ to Application/SAR dated ____________.
- [ ] Construction Permit No. CPPR- ________, Amendment No. ________, dated ____________.
- [ ] Facility Operating License No. ________, Amendment No. ________, dated ____________.
- [ ] Order Extending Construction Completion Date, dated ____________.
- [x] Other *(Specify)* Commission's monthly publication of Federal Register notices, August 23, 1983 (see 48 FR 38421); the intervention period expires September 26, 1983.

Hazel Smith / cc
Office of Nuclear Reactor Regulation
Division of Licensing
Operating Reactors Branch #5

Enclosures:
As stated

cc: w/enclosures:
SeeSnext page

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NRC FORM 318 (10/80) NRCM 0240

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