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DATE: December 13, 1960

SUBJECT: Homogeneous Molten Salt Reactors

TO: Distribution

FROM: C. W. Nestor, Jr.

SUMMARY

Multigroup one-dimensional calculations were done recently to obtain estimates of critical masses, power density distributions and fissioning spectra for some homogeneous molten salt reactors having outer reflectors and central "islands," placed inside the currently proposed MSRE vessel. For a 5-inch-thick outer reflector and a 1-ft-diameter island, both beryllium, the calculated critical mass is 108 kg; 40 percent of the fissions occur at thermal, and the maximum power density of 3.9 times the core mean power density occurs at the island-salt interface. If the reflector thickness is increased to 10 inches, the critical mass is reduced to 34 kg; 67 percent of the fissions occur at thermal, and the peak power density of twice the core mean again occurs at the core island-salt interface.

HOMOGENEOUS MOLTEN SALT REACTORS

C. W. Nestor, Jr.

Multigroup one-dimensional calculations were done recently to obtain estimates of critical masses, power density distributions and fissioning spectra for some homogeneous molten salt reactors having outer reflectors and central "islands," placed inside the currently proposed MSRE vessel as shown in Fig. 1. The salt composition, listed in Table 1, is that of the current MSRE mixture.[1]

Results of these calculations are given in Table 2, with earlier results for the current MSRE and some results for bare homogeneous molten salt reactors,[2] included for comparison. Power density shapes for the reflected reactors are plotted in Figs. 2, 3, 4, and 5.

Table 1. Salt Composition

Compound	Mole %
LiF	70
BeF_2	23
ZrF_4	5
ThF_4	1
UF_4	~1 (as required for criticality)

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1 W. R. Grimes, letter of Aug. 23, 1960.

2 J. A. Lane, H. G. MacPherson and F. Maslan, eds., Fluid Fuel Reactors, Addison-Wesley, 1958.

Table 2

5" reflector thickness, 1 ft island diameter

Island and reflector material	Mole % uranium	Core critical mass, kg	Percent thermal fissions	Median fissioning energy, ev
C	0.90	206	13.2	100-150
Be	0.47	108	40.2	7.5- 10
BeO	0.54	124	32.8	20 - 25

10" reflector thickness, 1 ft island diameter

Island and reflector material	Mole % uranium	Core critical mass, kg	Percent thermal fissions	Median fissioning energy, ev
C	0.67	93	33.2	20 - 25
Be	0.25	34	67.3	thermal
BeO	0.28	39	62.0	thermal

5" reflector thickness, no island

Reflector material	Mole % uranium	Core critical mass, kg	Percent thermal fissions	Median fissioning energy, ev
C	1.04	250	4.6	150-400
Be	0.72	175	20.9	50- 65
BeO	0.76	186	16.0	80- 90

10" reflector thickness, no island

Reflector material	Mole % uranium	Core critical mass, kg	Percent thermal fissions	Median fissioning energy, ev
C	0.85	130	20.6	65-80
Be	0.43	65	46.5	0.8-1.4
BeO	0.46	71	41.5	7.5-10

Current MSRE (12 volume percent fuel salt, 88 volume percent graphite)

Mole % uranium	Core critical mass, kg	Percent thermal fissions	Median fissioning energy, ev
0.27	13	91.4	thermal

Bare molten salt reactor

(5 ft diameter sphere, 30 mole % BeF_2 + 68 mole % LiF + 1 mole % ThF_4 + ~1 mole % UF_4)

Mole % uranium	Core critical mass, kg	Percent thermal fissions	Median fissioning energy, ev
0.94	239	0.040	425

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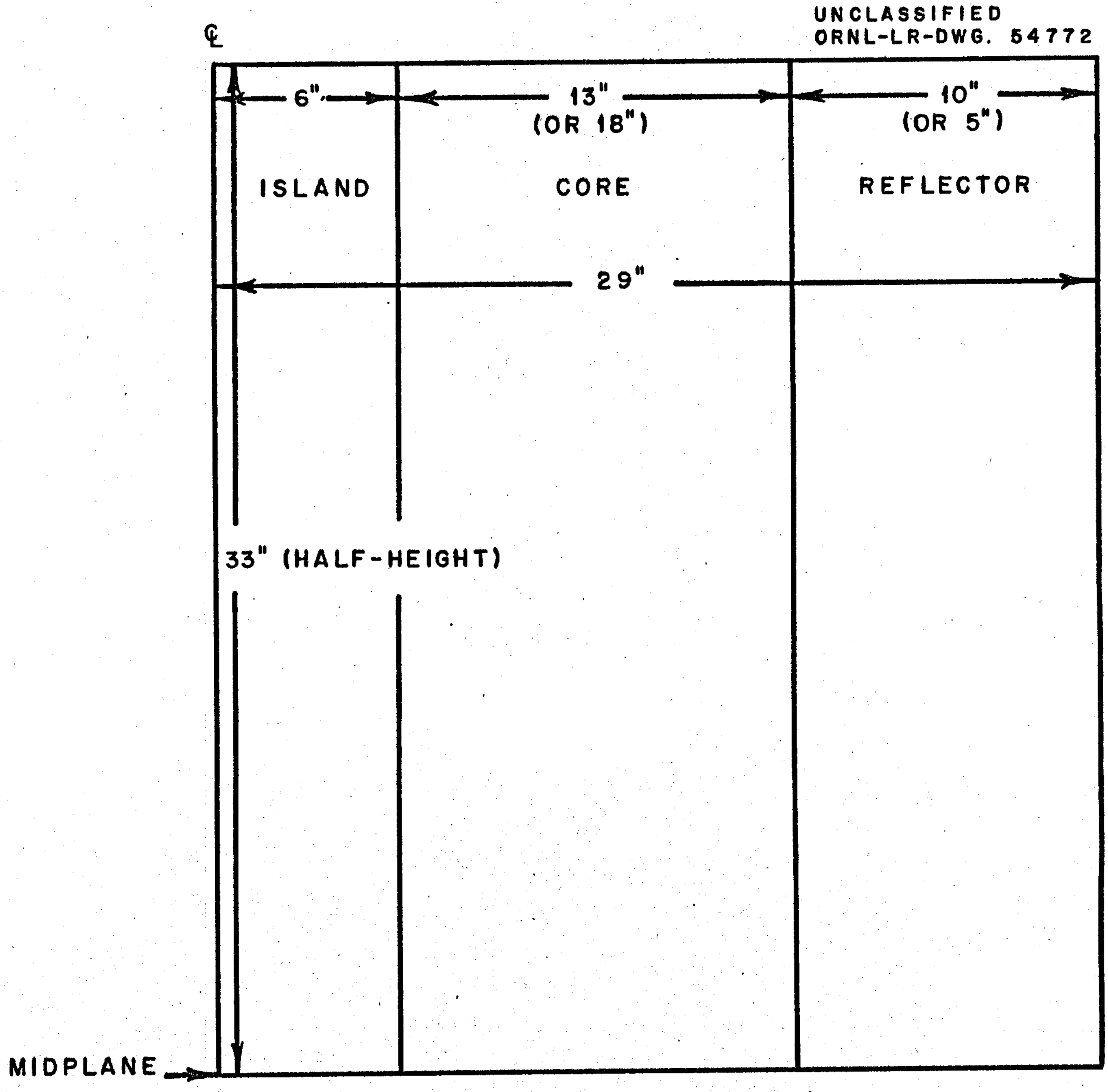

Fig. 1. Reactor Model.

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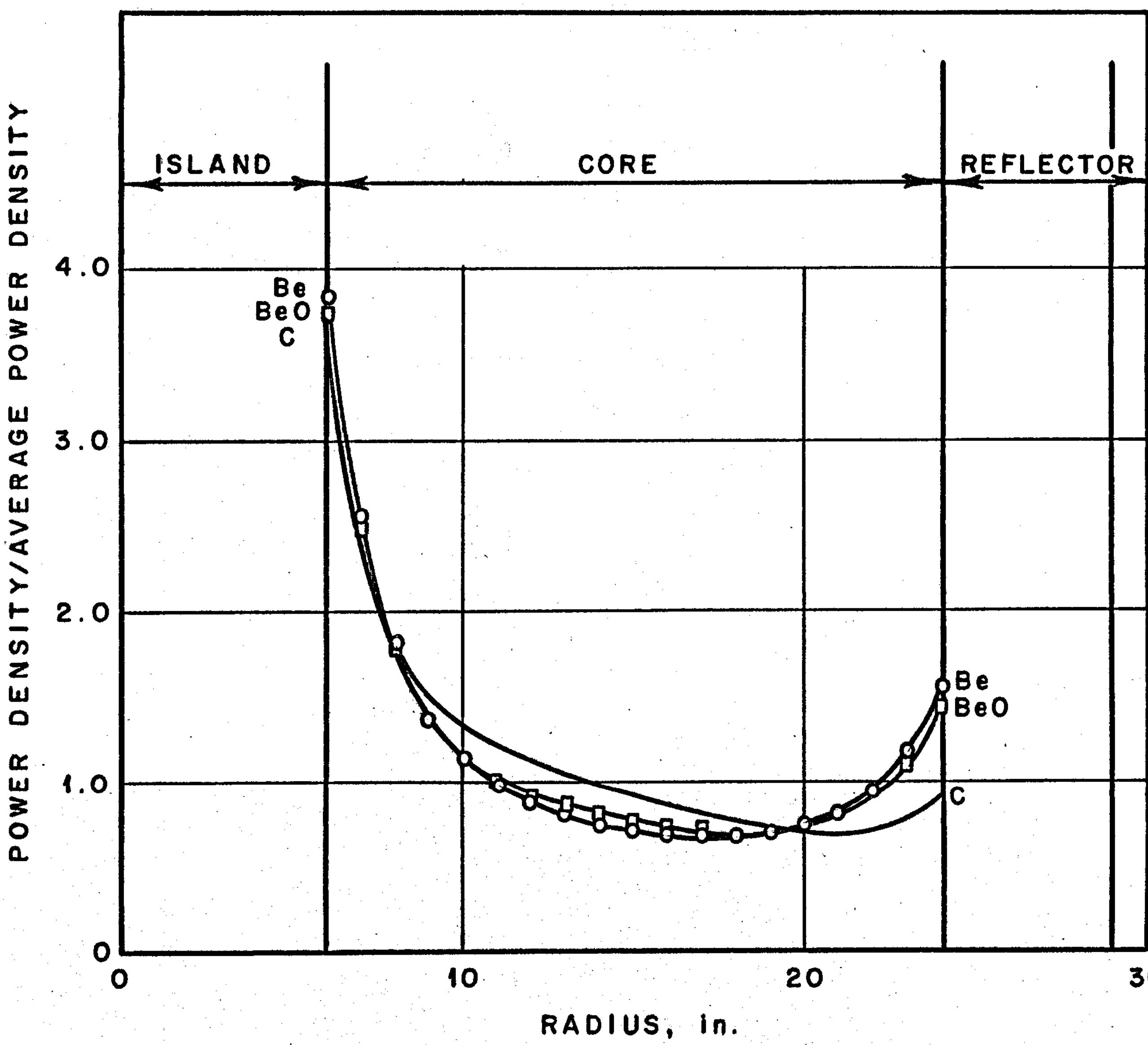

Fig. 2. Power Density Distributions Associated with a 6" Island and a 5" Reflector.

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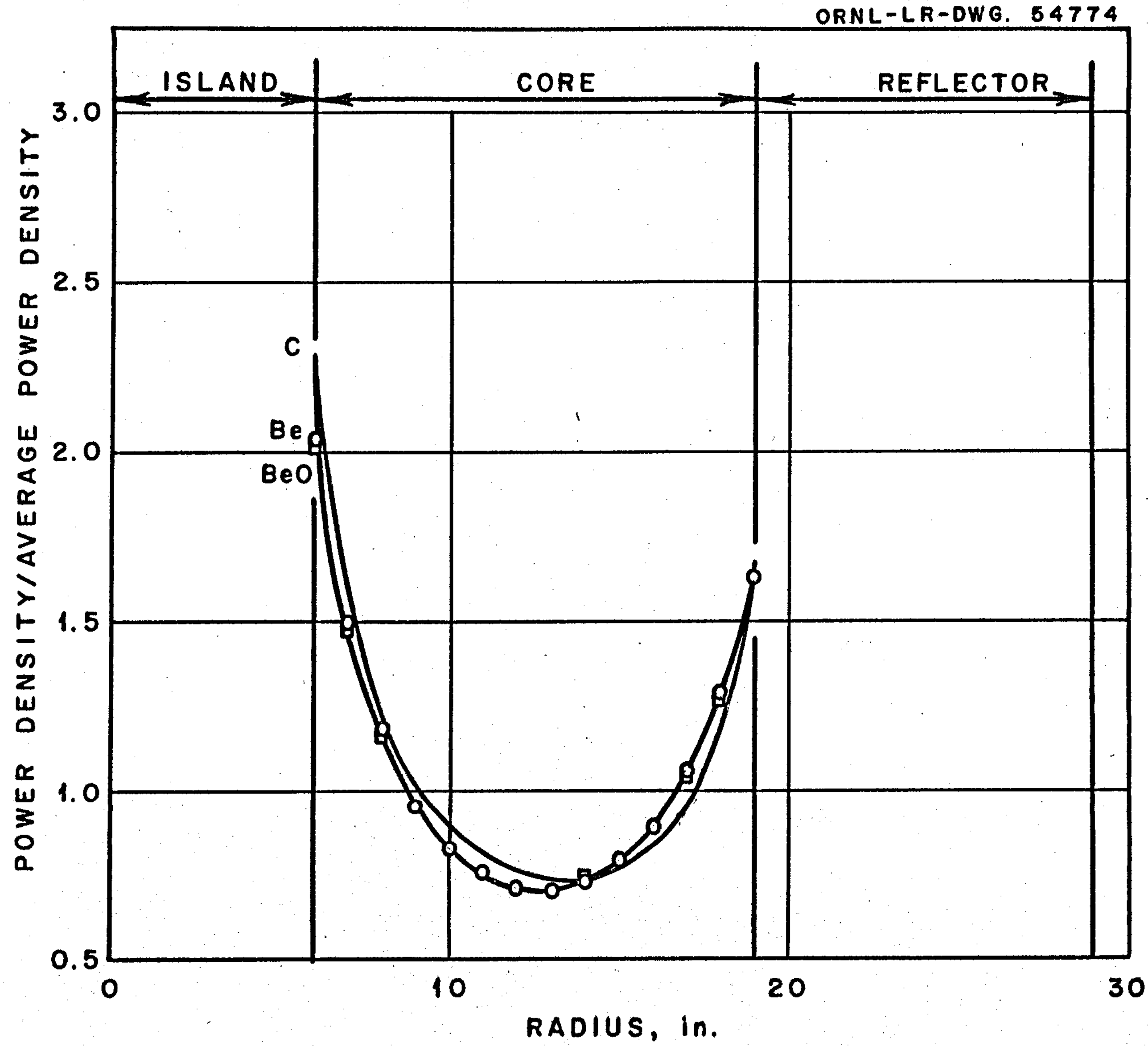

Fig. 3. Power Density Distributions Associated With a 6" Island and a 10" Outer Reflector.

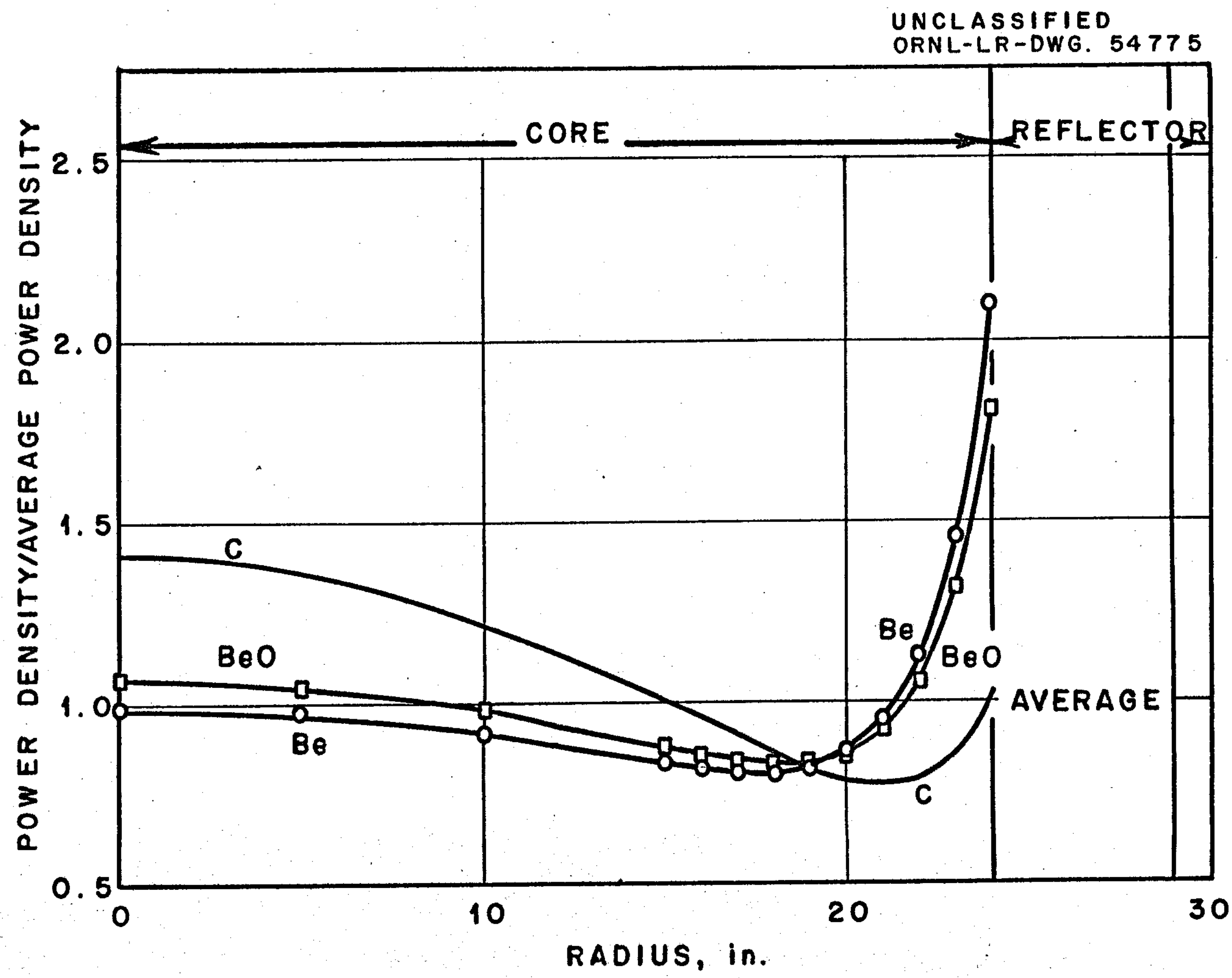

Fig. 4. Power Density Distributions Associated With a 24" Core and a 5" Reflector.

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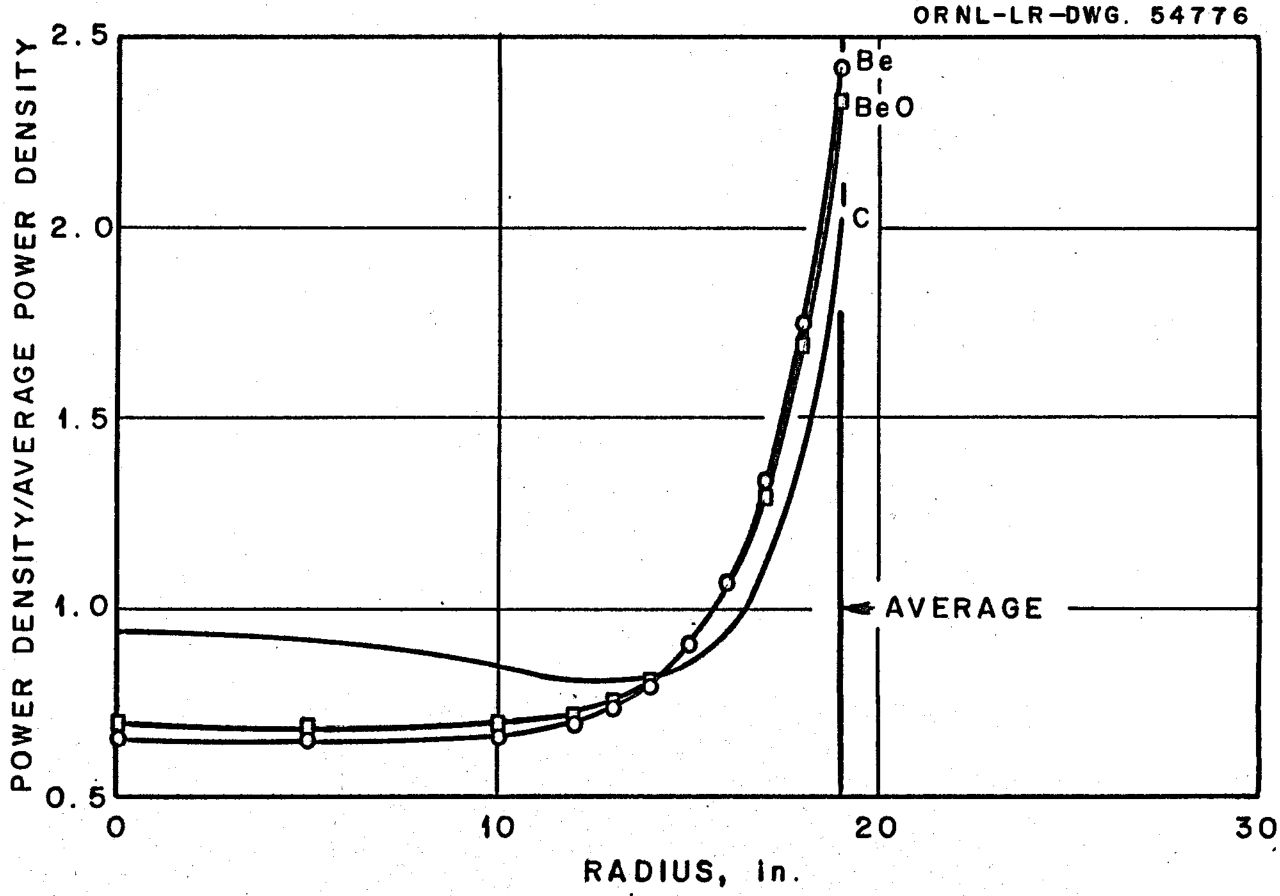

Fig. 5. Power Density Distributions Associated With a 19" Core and a 10" Reflector.

Distribution

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