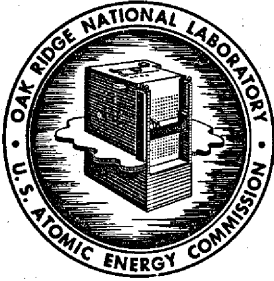


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DATE: December 13, 1960
SUBJECT: Homogeneous Molten Salt Reactors
TO: Distribution
FROM: C. W. Nestor, Jr.

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.

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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

| <u>Compound</u> | <u>Mole %</u> |
|------------------|-------------------------------------|
| LiF | 70 |
| BeF ₂ | 23 |
| ZrF ₄ | 5 |
| ThF ₄ | 1 |
| UF ₄ | ~1 (as required for criticality) |

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.

| <u>Island and reflector material</u> | <u>Mole % uranium</u> | <u>Core critical mass, kg</u> | <u>Percent thermal fissions</u> | <u>Median fissioning energy, ev</u> |
|--------------------------------------|-----------------------|-------------------------------|---------------------------------|-------------------------------------|
| 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

| <u>Island and reflector material</u> | <u>Mole % uranium</u> | <u>Core critical mass, kg</u> | <u>Percent thermal fissions</u> | <u>Median fissioning energy, ev</u> |
|--------------------------------------|-----------------------|-------------------------------|---------------------------------|-------------------------------------|
| 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

| <u>Reflector material</u> | <u>Mole % uranium</u> | <u>Core critical mass, kg</u> | <u>Percent thermal fissions</u> | <u>Median fissioning energy, ev</u> |
|---------------------------|-----------------------|-------------------------------|---------------------------------|-------------------------------------|
| 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

| <u>Reflector material</u> | <u>Mole % uranium</u> | <u>Core critical mass, kg</u> | <u>Percent thermal fissions</u> | <u>Median fissioning energy, ev</u> |
|---------------------------|-----------------------|-------------------------------|---------------------------------|-------------------------------------|
| 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)

| <u>Mole % uranium</u> | <u>Core critical mass, kg</u> | <u>Percent thermal fissions</u> | <u>Median fissioning energy, ev</u> |
|-----------------------|-------------------------------|---------------------------------|-------------------------------------|
| 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)

| <u>Mole % uranium</u> | <u>Core critical mass, kg</u> | <u>Percent thermal fissions</u> | <u>Median fissioning energy, ev</u> |
|-----------------------|-------------------------------|---------------------------------|-------------------------------------|
| 0.94 | 239 | 0.040 | 425 |

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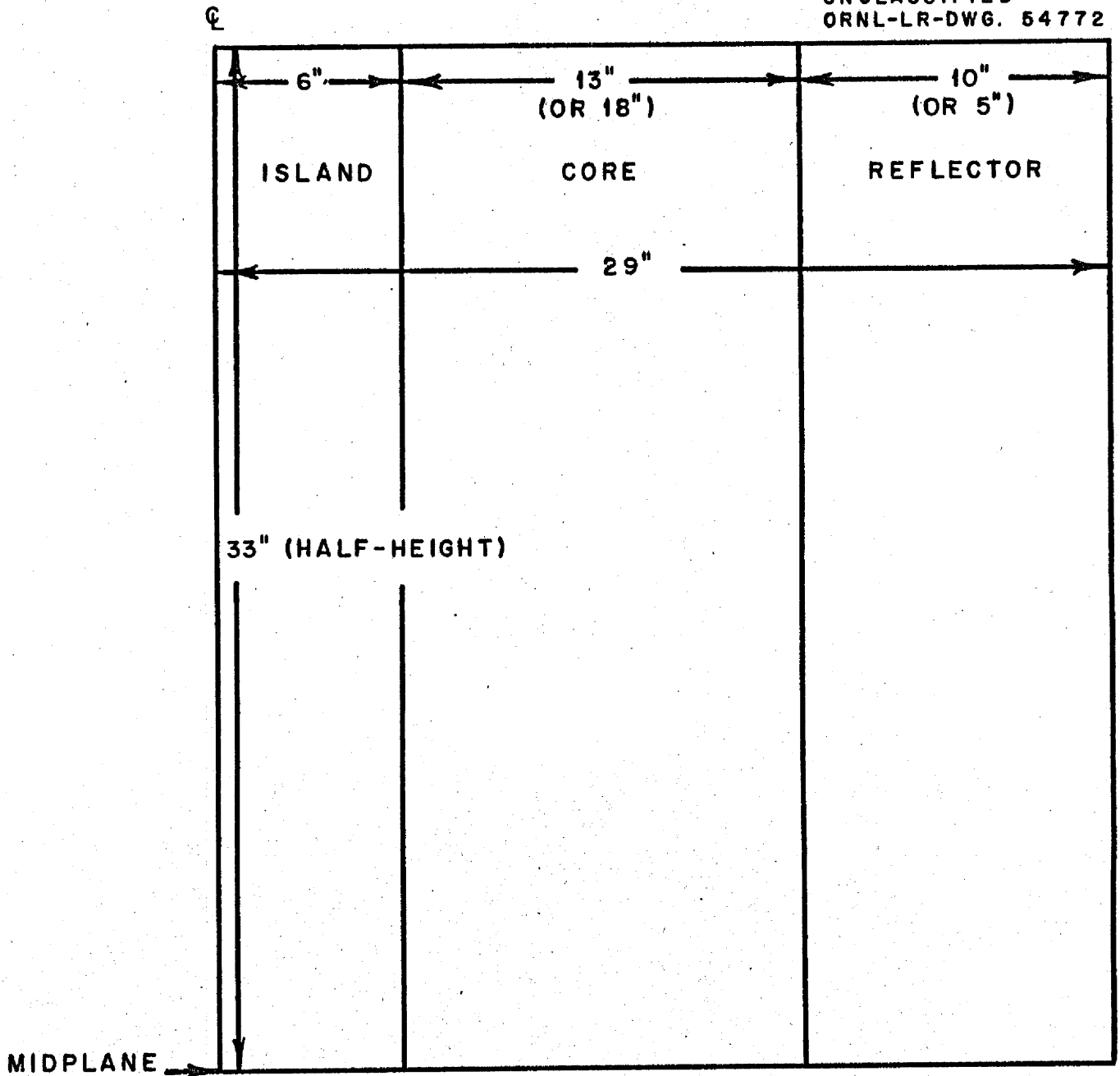


Fig. 1. Reactor Model.

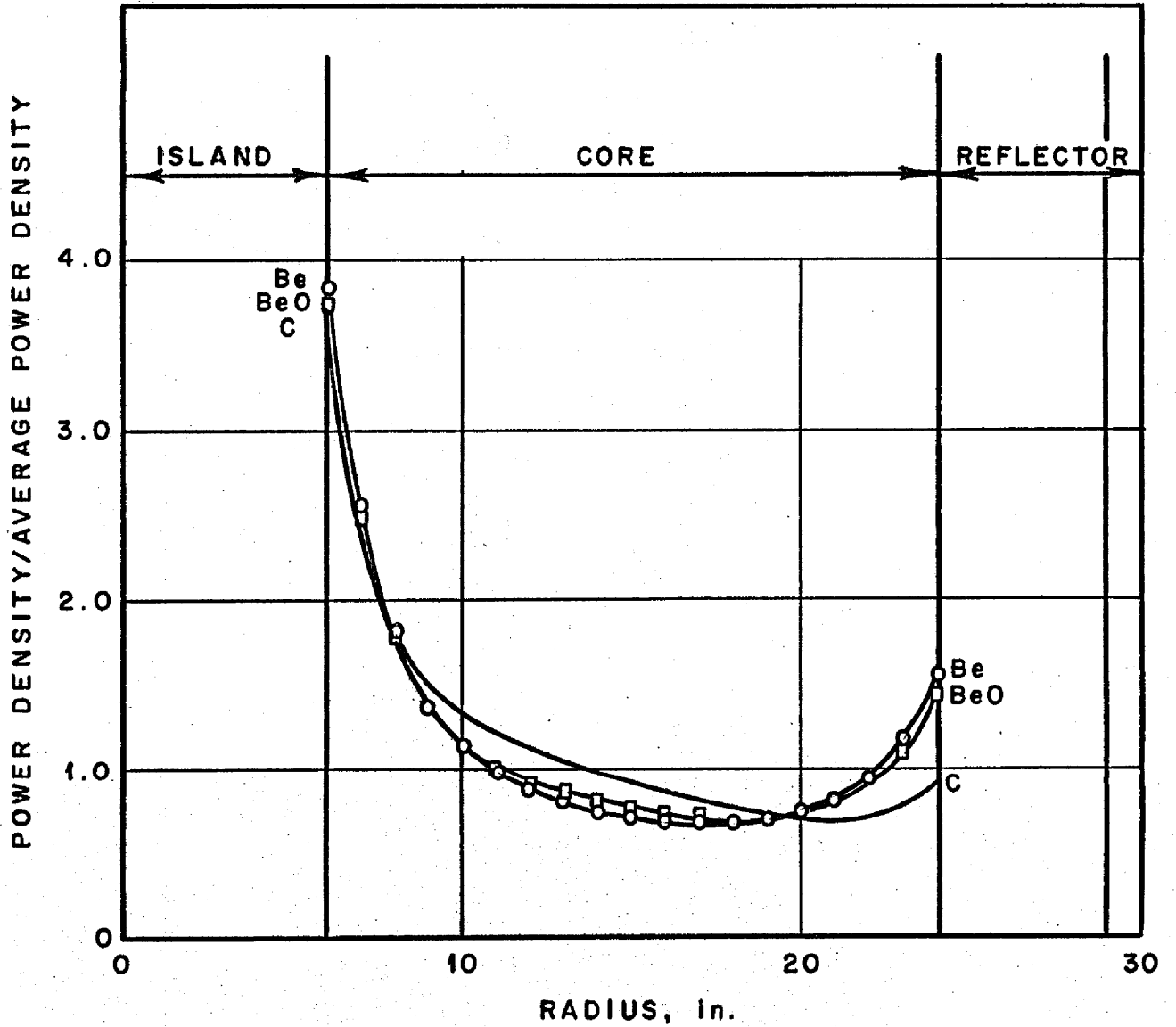


Fig. 2. Power Density Distributions Associated with a 6" Island and a 5" Reflector.

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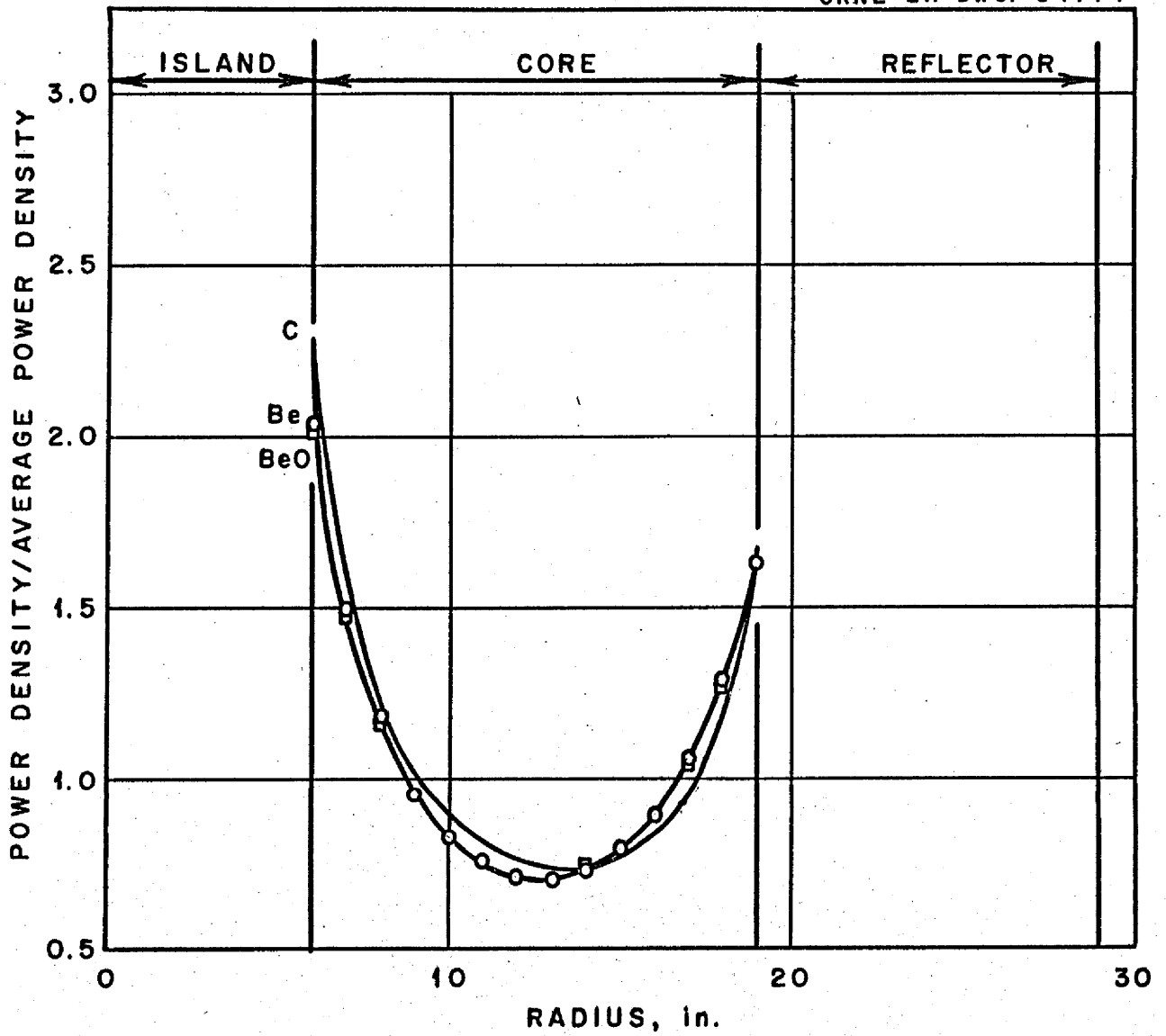


Fig. 3. Power Density Distributions Associated With a 6" Island and a 10" Outer Reflector.

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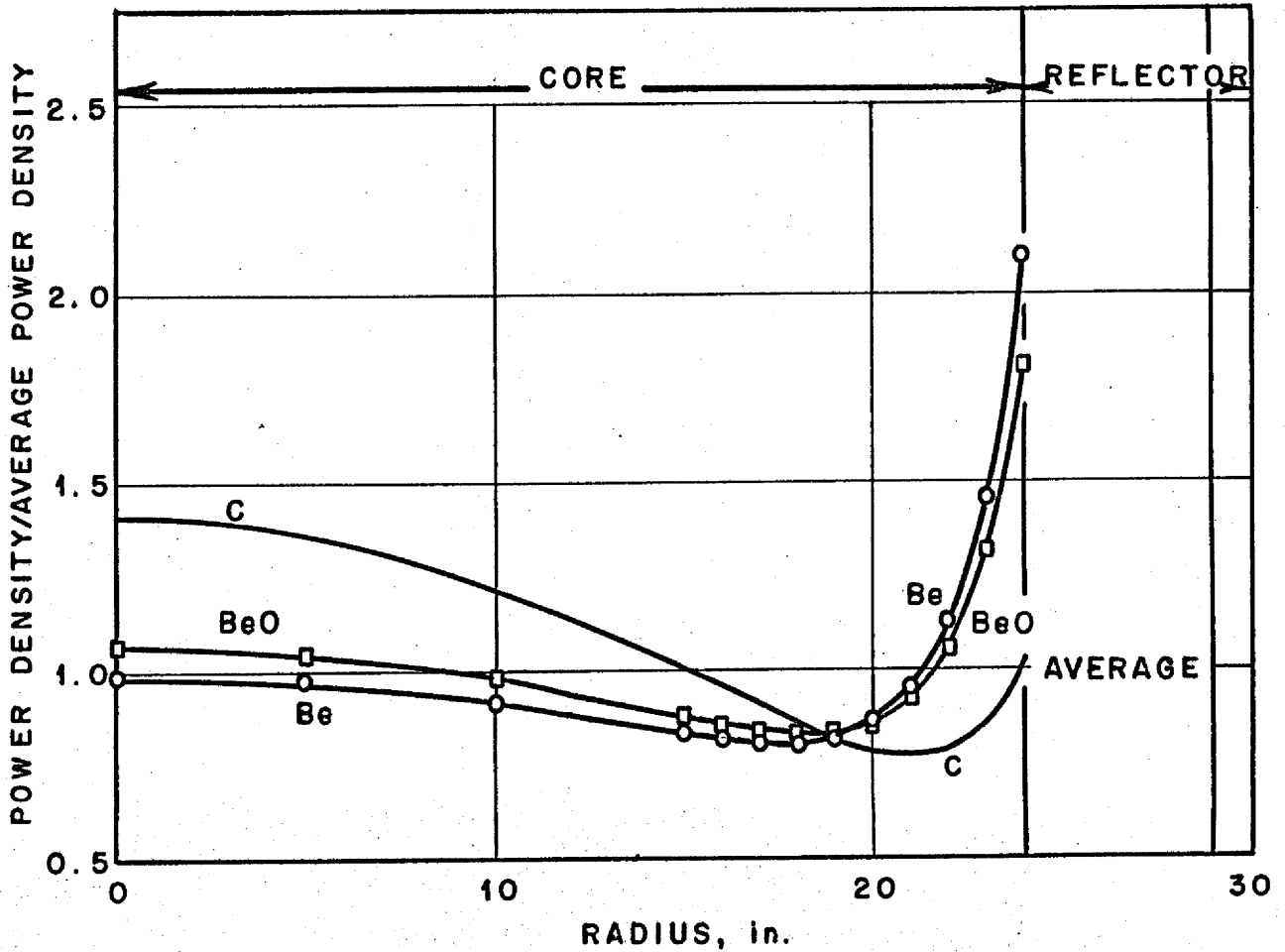


Fig. 4. Power Density Distributions Associated With a 24" Core and a 5" Reflector.

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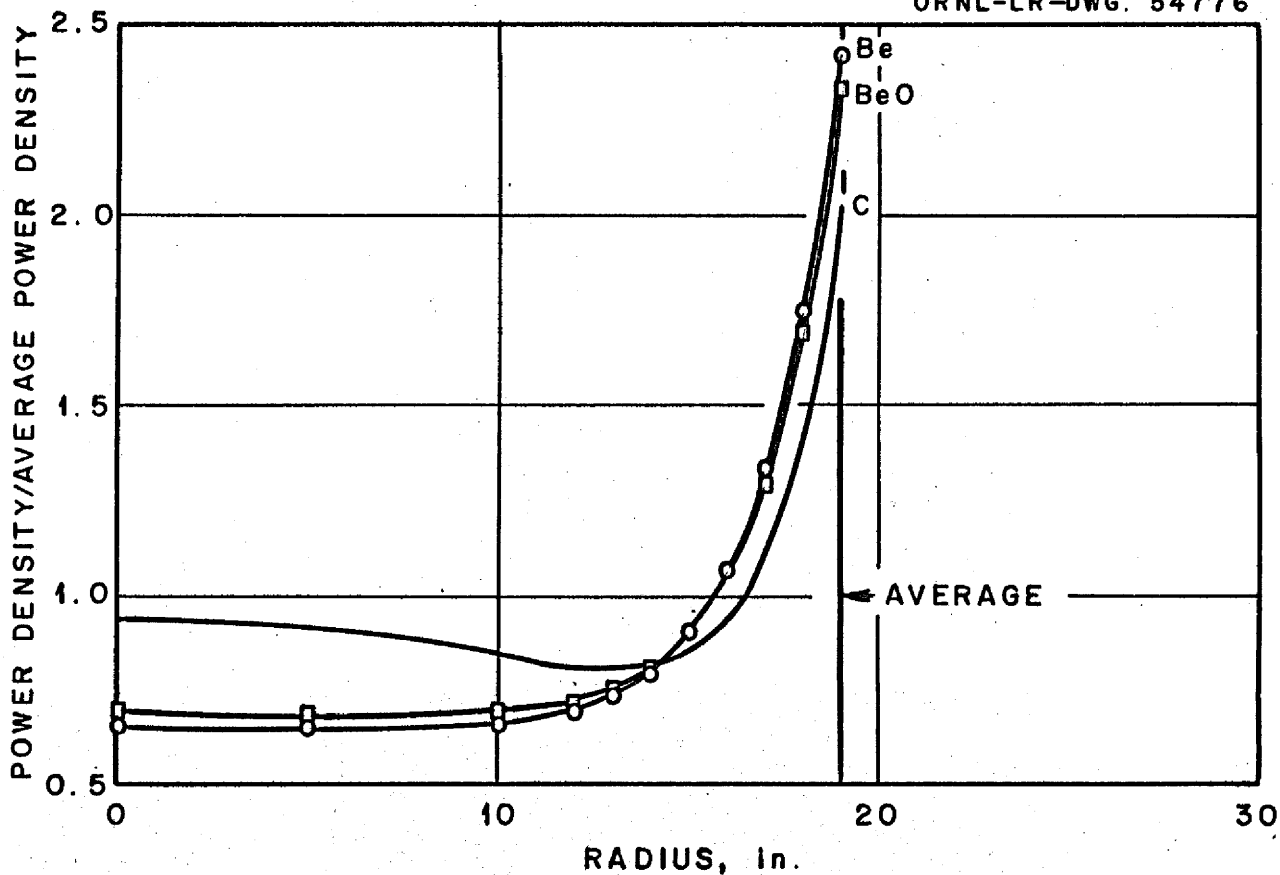


Fig. 5. Power Density Distributions Associated With a 19" Core and a 10" Reflector.

Distribution

1. L. G. Alexander
2. S. E. Beall
3. A. L. Benson
4. C. E. Bettis
5. E. S. Bettis
6. F. F. Blankenship
7. A. L. Boch
8. S. E. Bolt
9. R. B. Briggs
10. F. R. Bruce
11. O. W. Burke
12. D. O. Campbell
13. W. R. Chambers
14. R. A. Charpie
15. W. G. Cobb
16. J. A. Conlin
17. W. H. Cook
18. G. A. Cristy
19. J. L. Crowley
20. D. A. Douglas
21. W. K. Ergen
22. A. P. Fraas
23. J. H. Frye
24. C. H. Gabbard
25. W. R. Gall
26. W. R. Grimes
27. E. C. Hise
28. L. N. Howell
29. W. H. Jordan
30. P. R. Kasten
31. R. J. Kedl
32. B. W. Kinyon
33. M. I. Lundin
34. H. G. MacPherson
35. W. D. Manly
36. E. R. Mann
37. W. B. McDonald
38. C. K. McGlothlan
39. R. L. Moore
40. J. C. Moyers
41. D. J. Murphy
42. C. W. Nestor
43. T. E. Northup
44. L. F. Parsly
45. P. Patriarca
46. H. R. Payne
47. R. C. Robertson
48. H. W. Savage
49. D. Scott
50. F. P. Self
51. A. N. Smith
52. I. Spiewak
53. J. A. Swartout
54. A. Taboada
55. W. G. Ulrich
56. D. C. Watkin
57. D. C. Watkin
58. A. M. Weinberg
59. J. H. Westsik
60. C. H. Wodtke
61. L. L. Bennett
62. R. D. Cheverton
63. H. C. Claiborne
64. T. B. Fowler
65. M. P. Lietzke
66. B. E. Prince
67. M. Tobias
68. D. R. Vondy
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