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A Division of North American Aviation Inc.

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TECHNICAL DATA RECORD

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PAGE 1 OF 14

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TITLE
Weight Scaling Factors for SNAP Reactor Shields

PROGRAM
SRIP

SUBACCOUNT TITLE
Design Integration

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STATEMENT OF PROBLEM

The problem was to develop data which would be useful in estimating the shield weights for future SNAP reactor nuclear power systems.

ABSTRACT

A series of weight scaling factor graphs are presented for the following basic shield configurations:

1. Instrument-rated shadow shields
2. Man-rated shadow shields
3. Man-rated four-pi shields.

Each graph shows the weight ratio of a new shield design with respect to a Base Case design as a function of one parameter. The parameters for which the weight ratios are given include reactor power, dose rates, and the principal overall dimensions. Each parameter is considered to be essentially independent of the other parameters; thus the total weight ratio for a new design is the product of the weight ratios for the individual parameters. Shield weights for each of the Base Case designs are given.

The mathematical models used in calculating the shield weights and weight ratios are shown in Figures 1, 2, & 3, pages 3, 4, & 5. The shield thicknesses were calculated by F. Ridolphi and J. A. Belcher, 731-145, using the OPEX code for the man-rated cases and hand calculations for the instrument-rated case. For the instrument-rated case the gamma dose comprises 64% and the neutron dose 36% of the total dose based on the conversion relationship that 1 rad = 1.8×10^6 nvt equiv. For the man-rated cases a neutron RBE of 5 was used.

Shield weights were calculated using Deck No. 4W099 and the shield thicknesses previously calculated; they were normalized to the Base Case conditions listed below to give the shield weight scaling factors shown in the graphs which follow. The total neutron shield weight was taken equal to 1.39 times the weight of the lithium hydride neutron shield material alone to allow for the weight of structural members.

The Base Case conditions for the three shield configurations are:

INSTRUMENT-RATED SHADOW SHIELD	
Base Case weight	844 lb.
Parameter values	
A = Reactor power	600 kw.
B = Shadow cone diam. at reactor midplane	20 in.
C = Fuel element length	20 in.
D = Separation distance	50 ft.
E = Dose plane diameter	25 ft.
F = Core diameter	10 in.
G = Dose rate at dose plane	2.8×10^{12} nvt equiv.
MAN-RATED SHADOW SHIELD	
Base Case weight	4588 lb.
Parameter values	
A = Reactor power	600 kw.
B = Shadow cone diam. at reactor midplane	20 in.
C = Fuel element length	20 in.
D = Separation distance	150 ft.
E = Dose plane diameter	60 ft.
F = Core diameter	10 in.
G = Dose rate at dose plane	1.5 mrem/hr.
H = Gallery height	24 in.
MAN-RATED FOUR PI SHIELD	
Base Case weight	15383 lb.
Parameter values	
A = Reactor power	600 kw.
B = Shadow cone diam. at reactor midplane	20 in.
C = Fuel element length	20 in.
D = Separation distance	150 ft.
E = Dose plane diameter	60 ft.
F = Core diameter	10 in.
G = Dose rate at dose plane	1.5 mrem/hr.
H = Gallery height	12 in.
I = Dose rate at reactor midplane	100 r/hr.@ 100 ft.

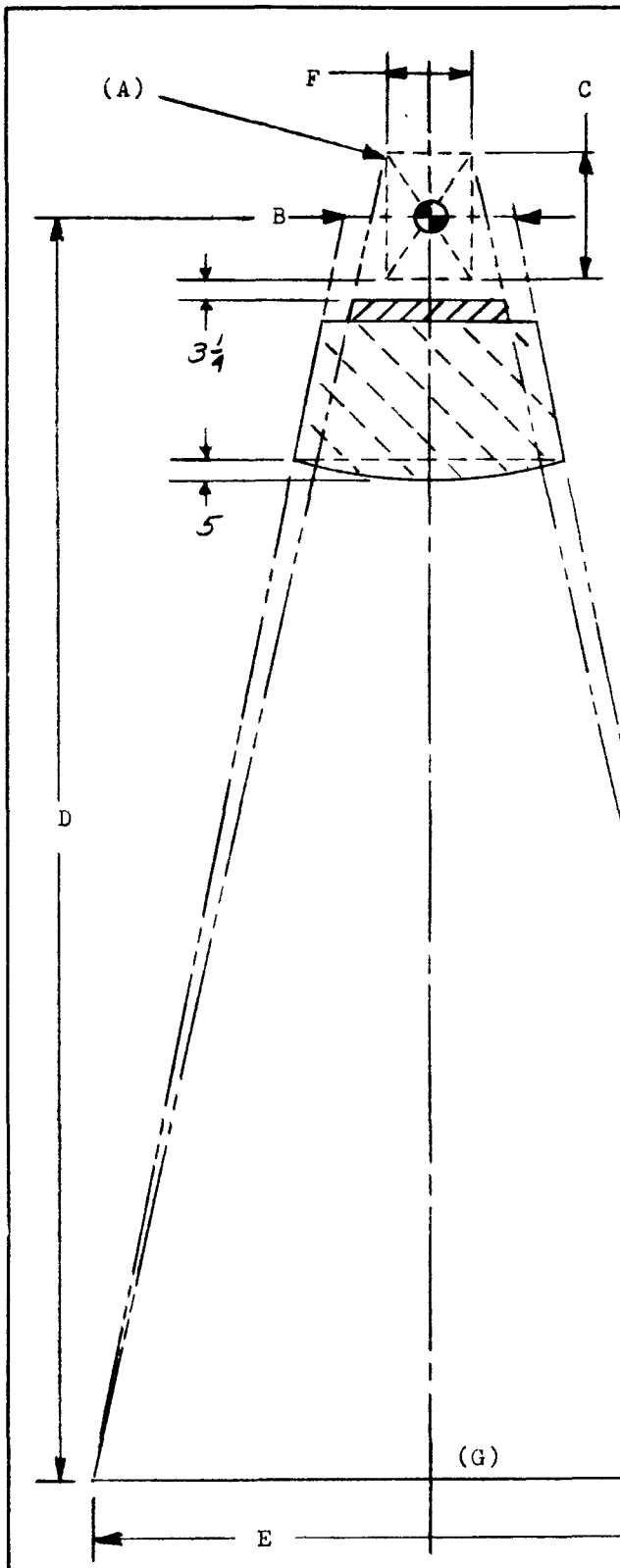

Figure 1.
Instrument-rated shadow shield

Parameters
A = Reactor power
B = Shadow cone diameter at reactor midplane
C = Fuel element length
D = Separation distance
E = Dose plane diameter
F = Core diameter
G = Dose rate at dose plane

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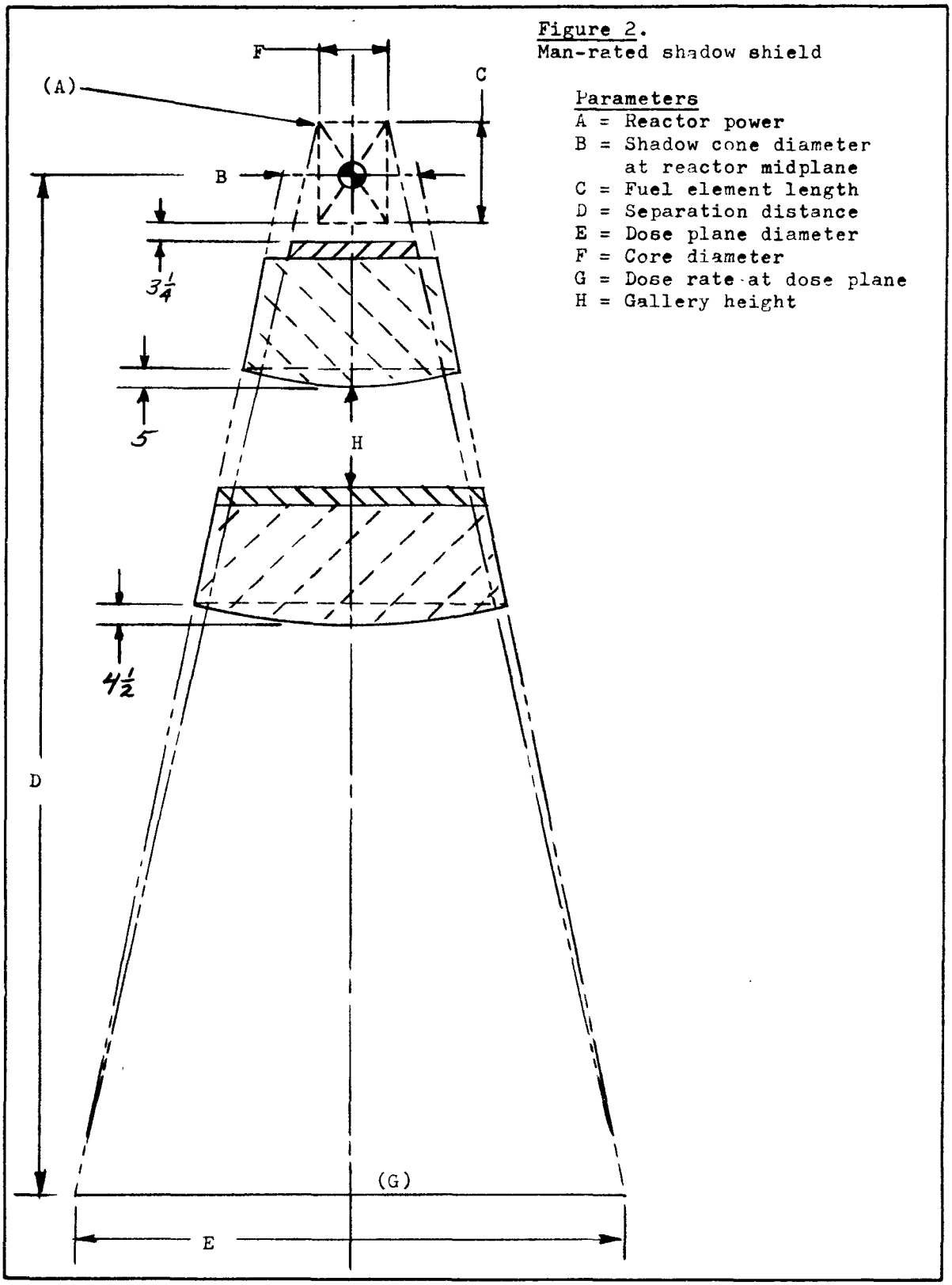

Figure 2.
Man-rated shadow shield

Parameters
A = Reactor power
B = Shadow cone diameter at reactor midplane
C = Fuel element length
D = Separation distance
E = Dose plane diameter
F = Core diameter
G = Dose rate at dose plane
H = Gallery height

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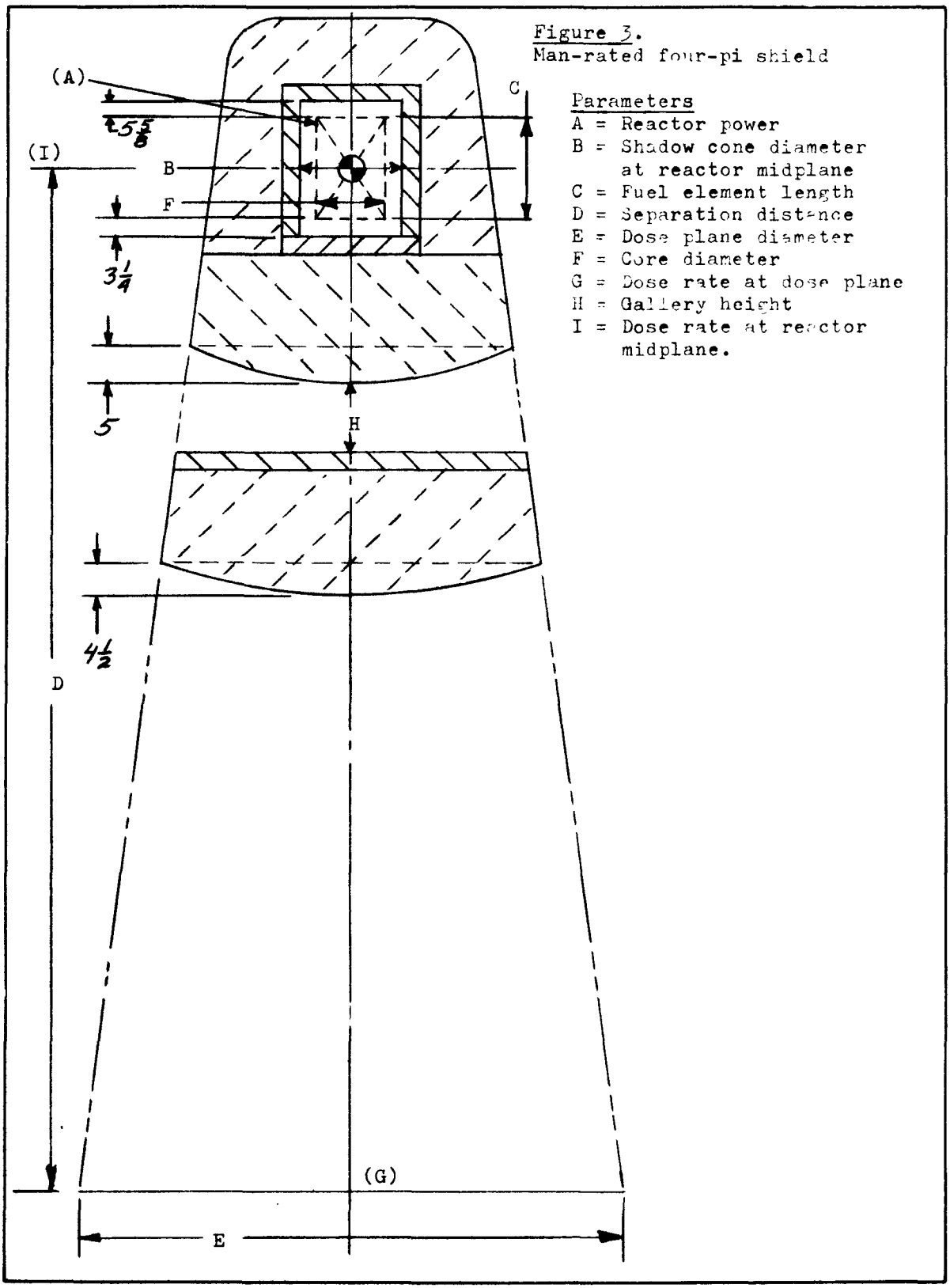

Figure 3.
Man-rated four-pi shield

Parameters
A = Reactor power
B = Shadow cone diameter at reactor midplane
C = Fuel element length
D = Separation distance
E = Dose plane diameter
F = Core diameter
G = Dose rate at dose plane
H = Gallery height
I = Dose rate at reactor midplane.

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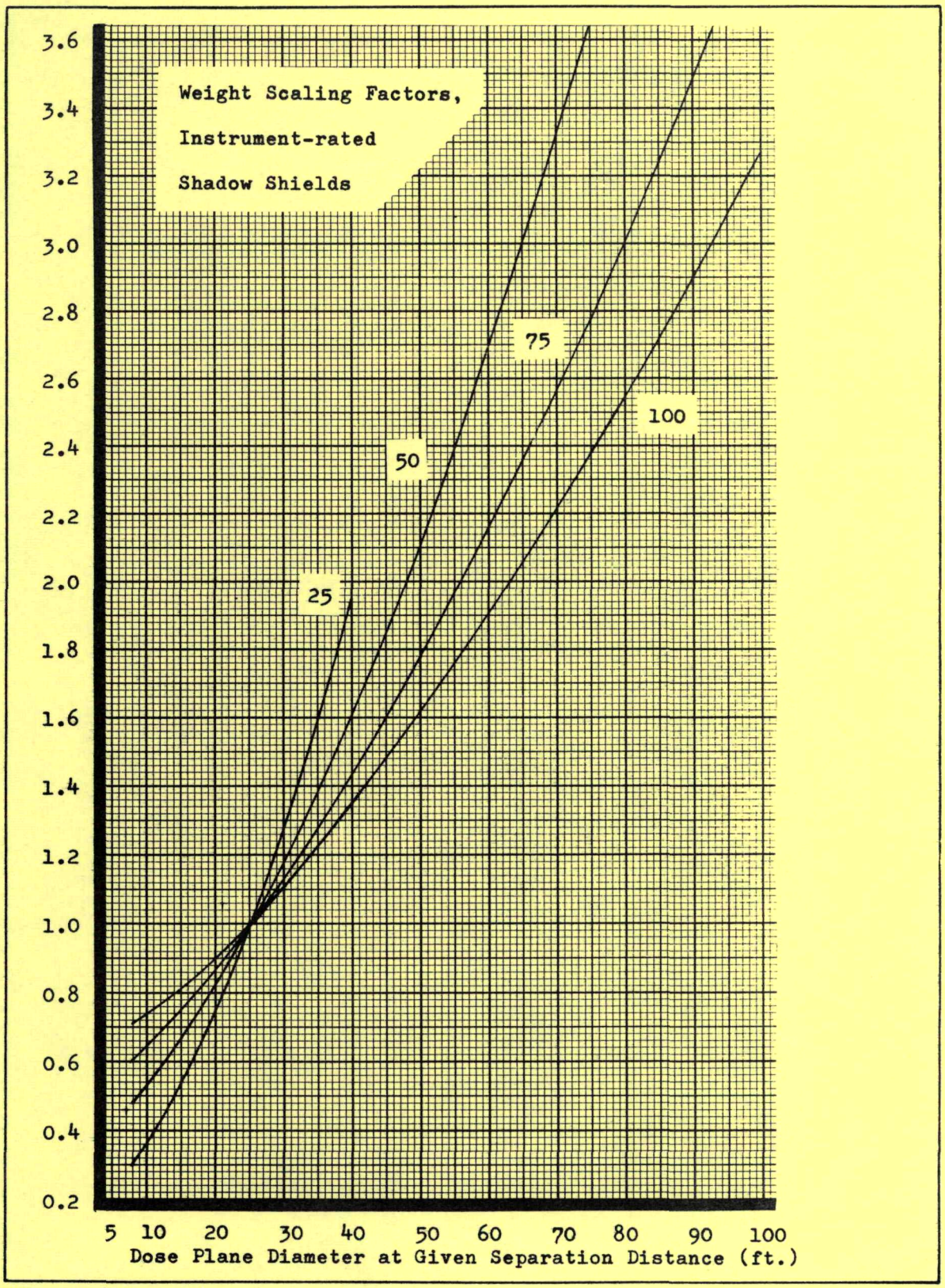

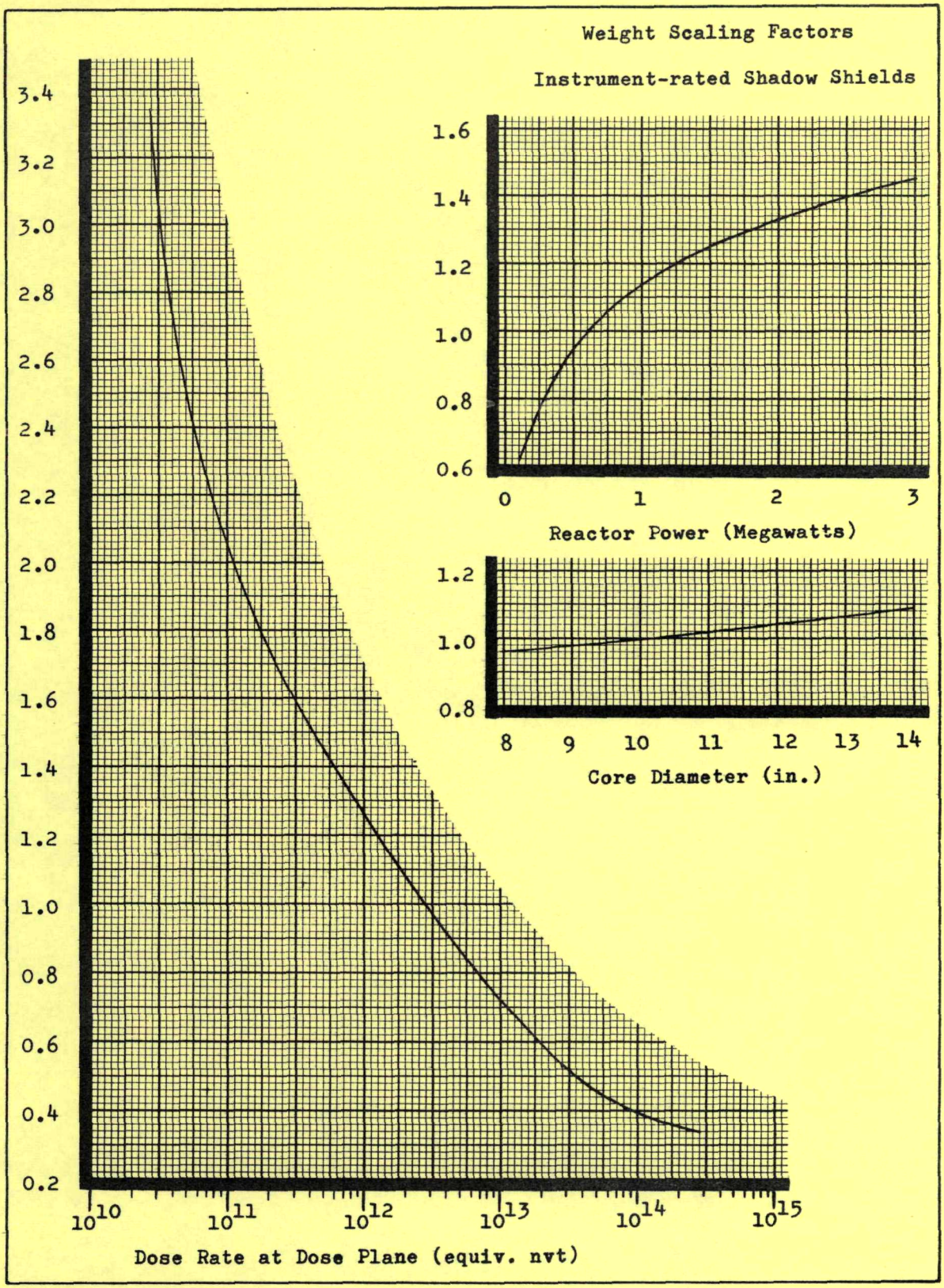
Weight Scaling Factors
Instrument-rated Shadow Shields
1.6
1.4
1.2
1.0
0.8
0.6
0
1
2
3
Reactor Power (Megawatts)
1.2
1.0
0.8
8
9
10
11
12
13
14
Core Diameter (in.)
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
10^10
10^11
10^12
10^13
10^14
10^15
Dose Rate at Dose Plane (equiv. nvt)

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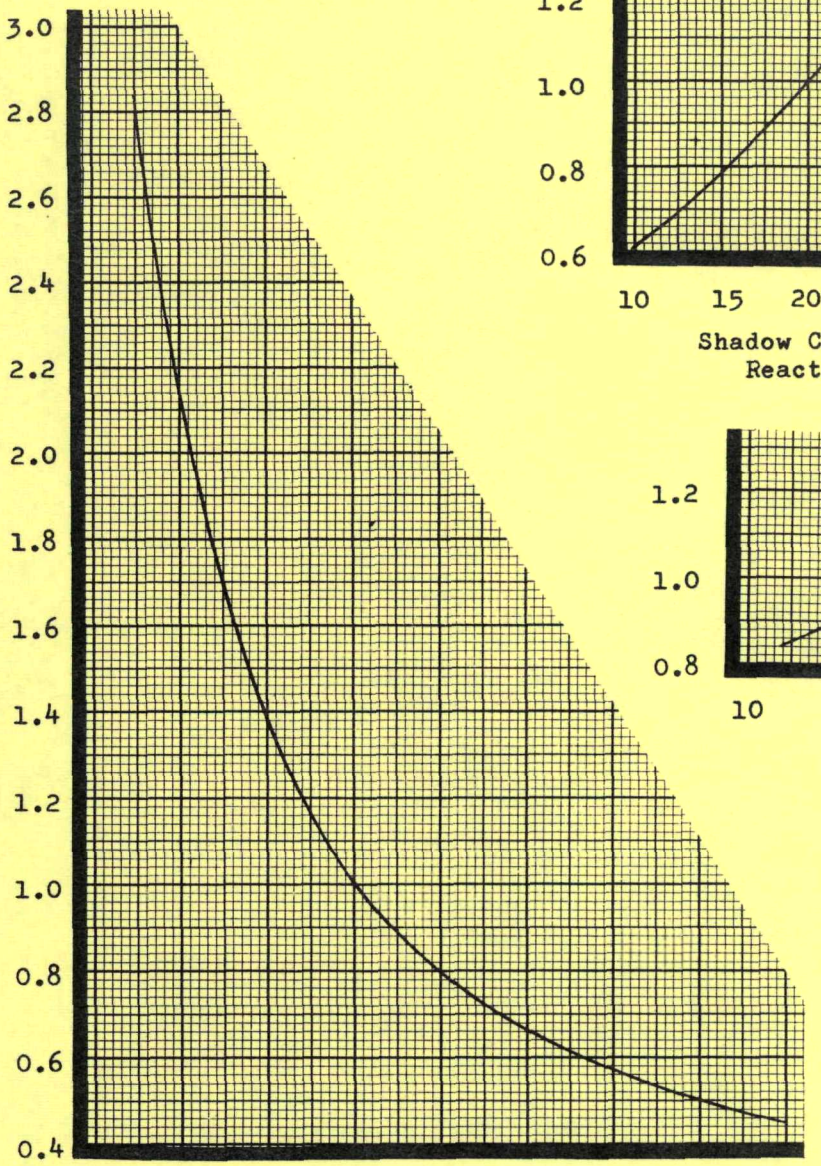
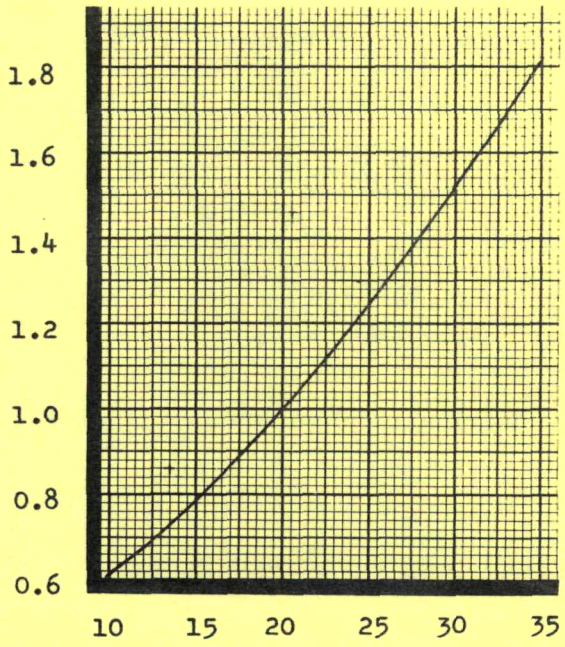
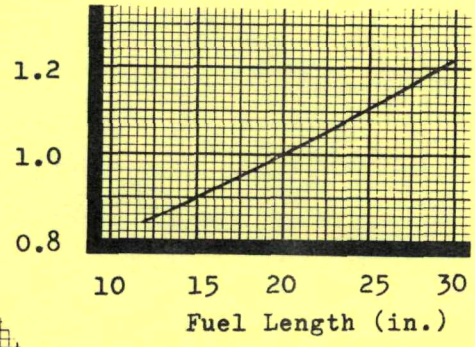
Weight Scaling Factors -

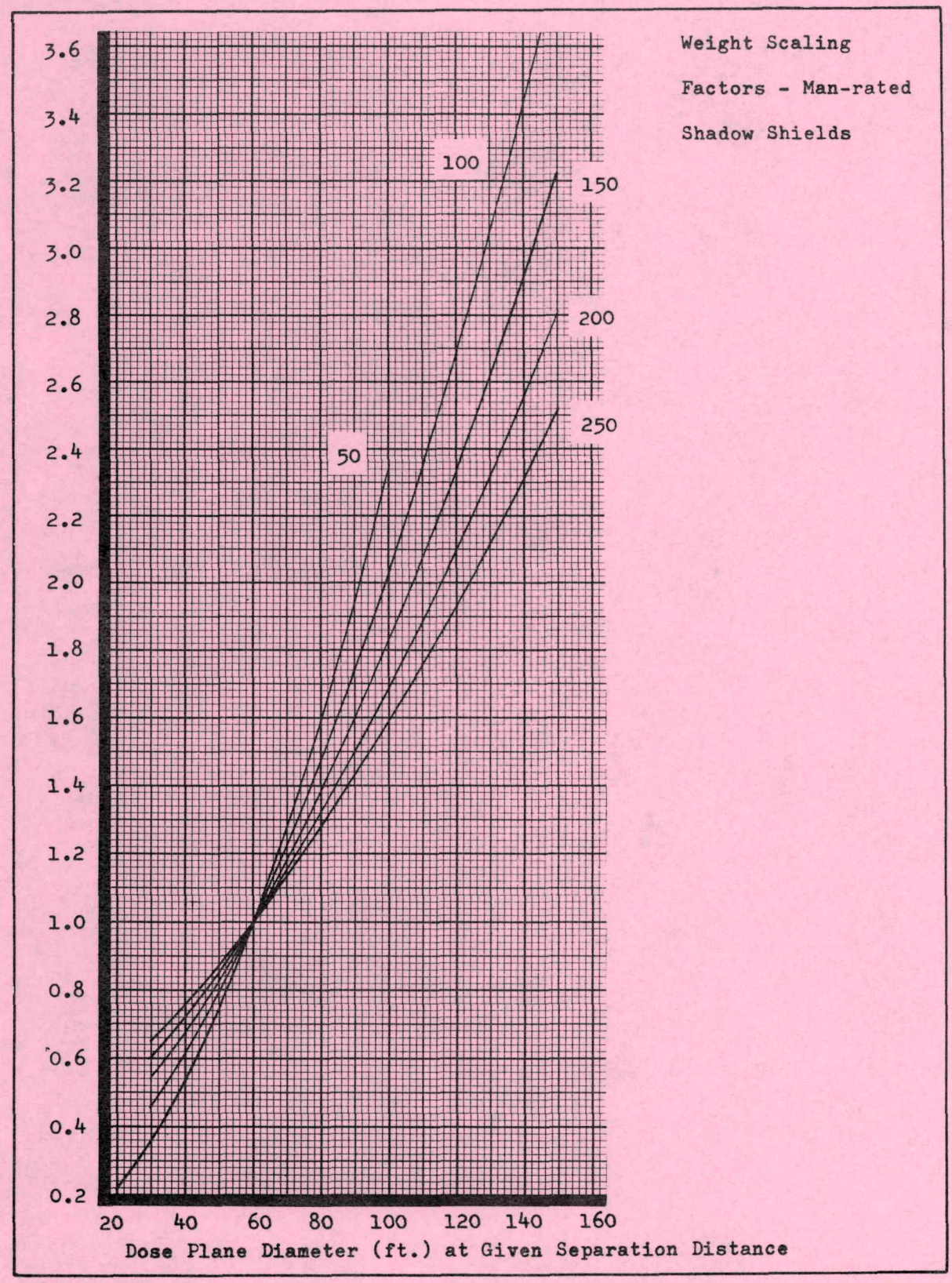
Instrument-rated

Shadow Shields

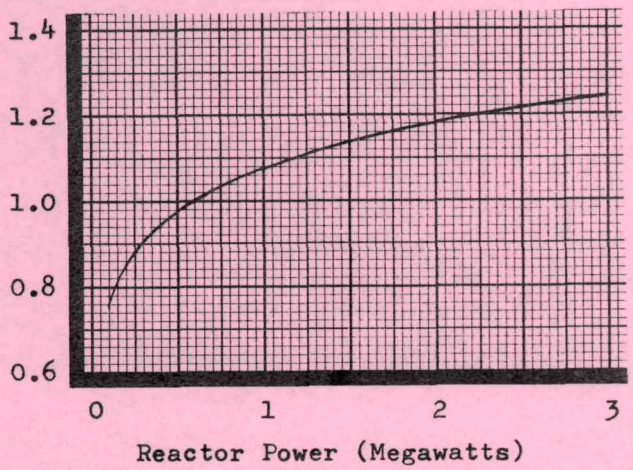


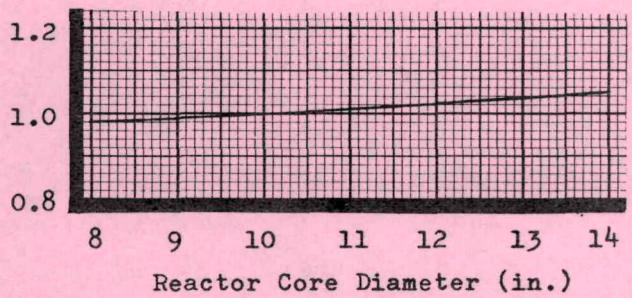


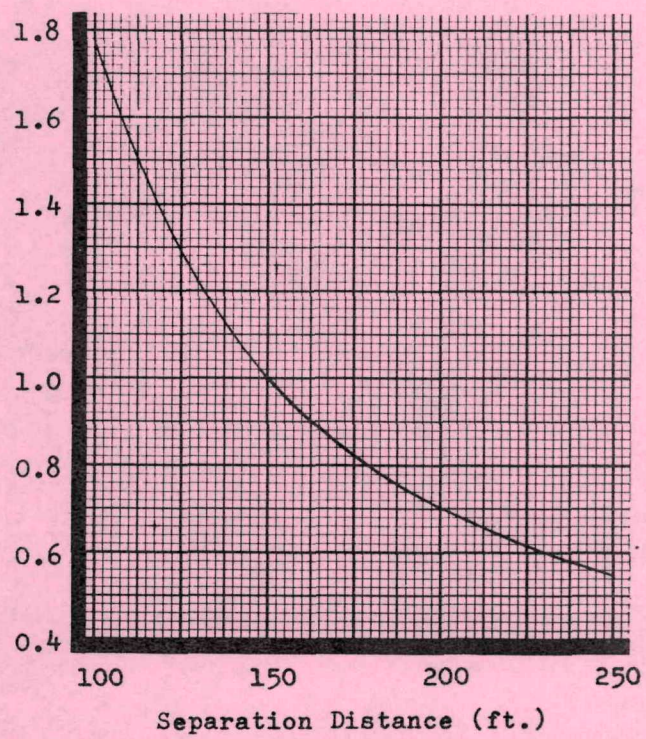



Weight Scaling
Factors - Man-rated
Shadow Shields
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
100
150
200
250
50
20
40
60
80
100
120
140
160
Dose Plane Diameter (ft.) at Given Separation Distance

Weight Scaling Factors - Man-rated Shadow Shields.

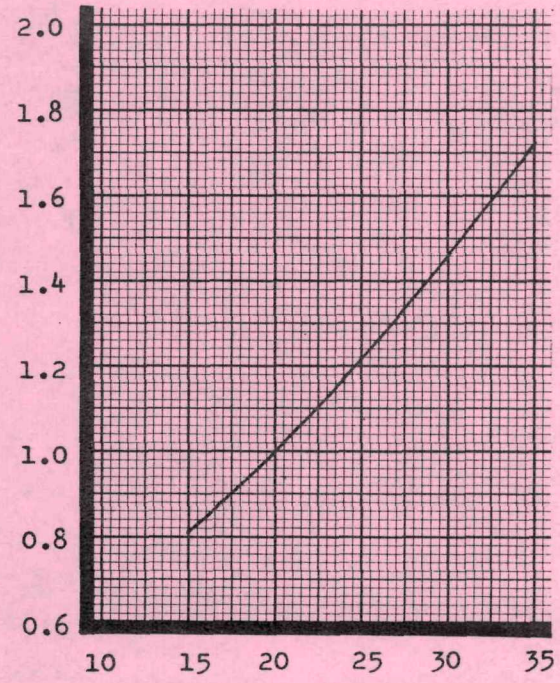


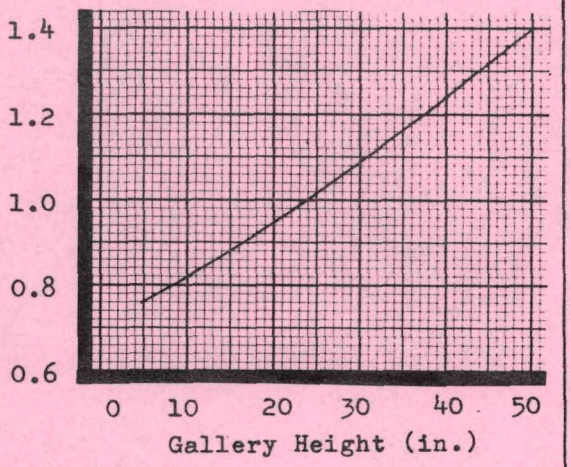


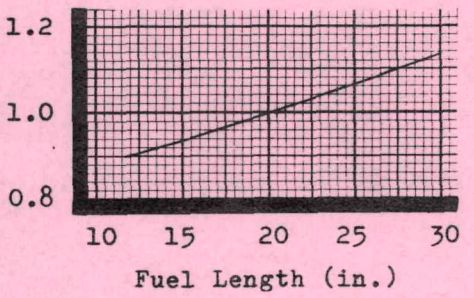


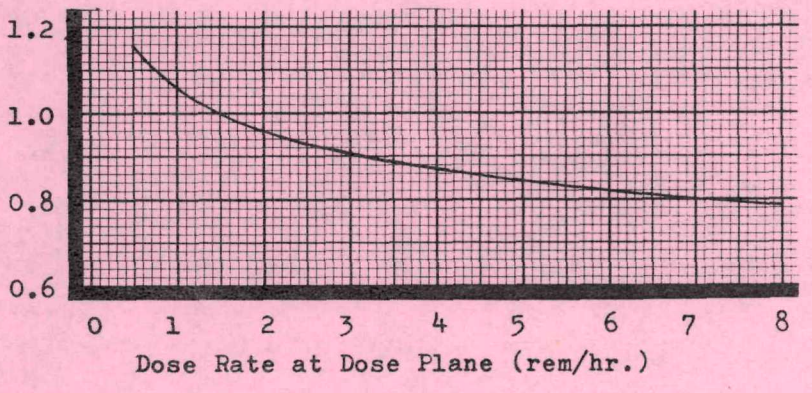
Weight Scaling Factors

Man-rated Shadow Shields









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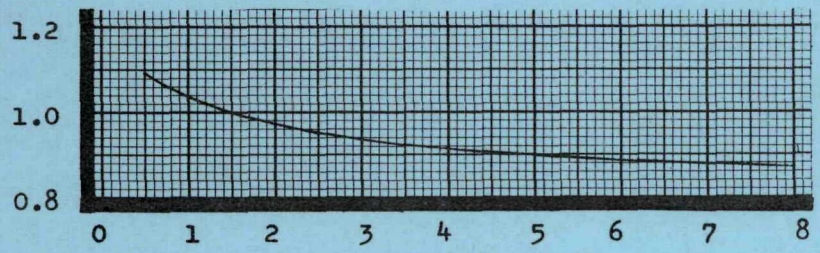
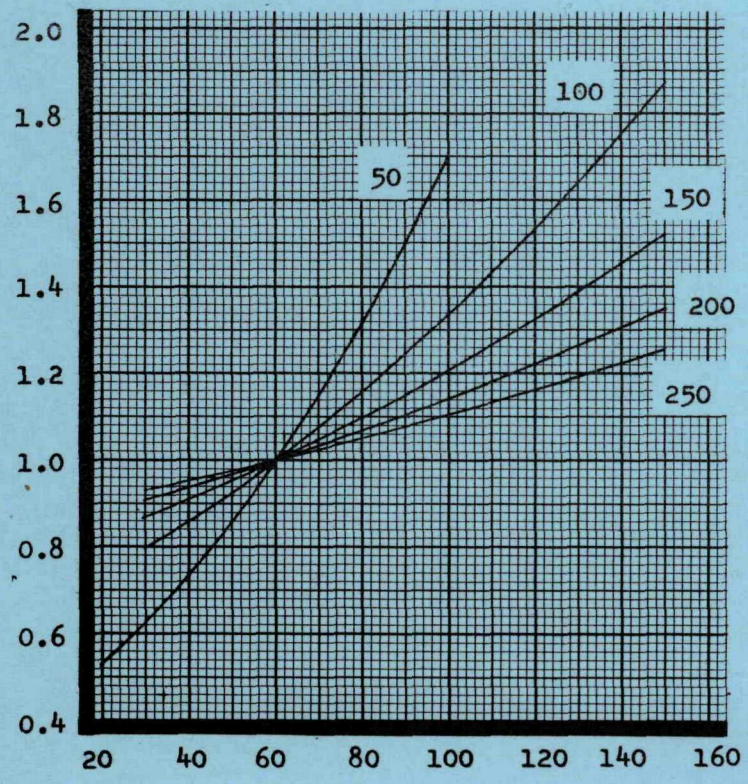
Weight Scaling Factors

Man-rated 4π Shields

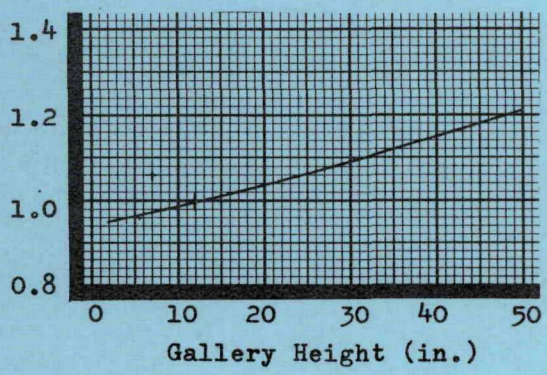


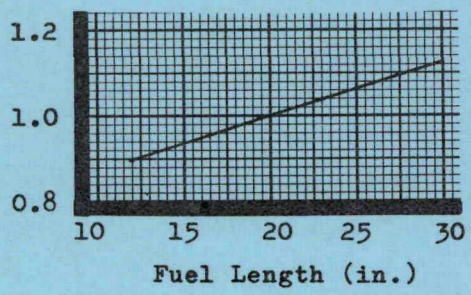
Dose Rate at Dose Plane (rem/hr.)

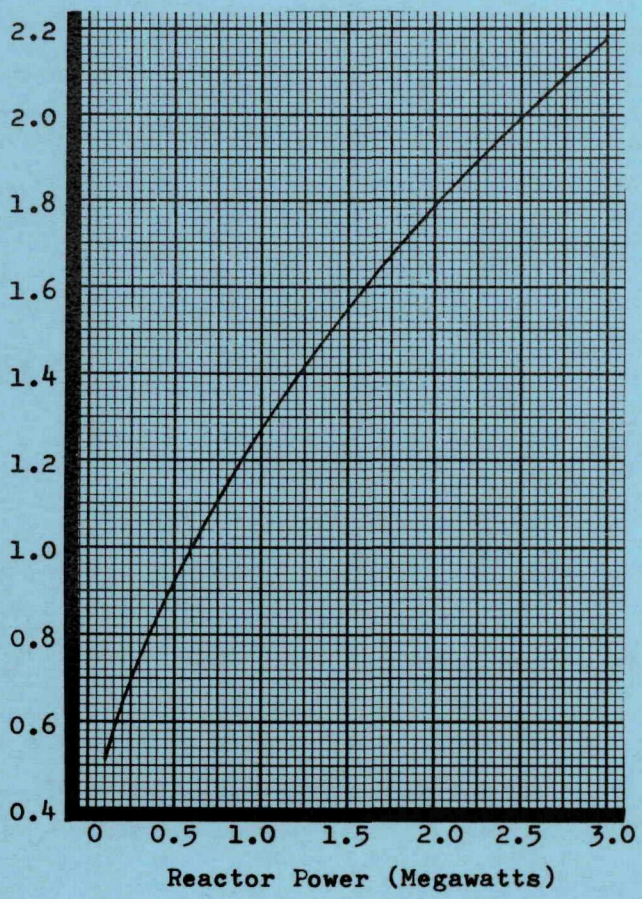


Weight Scaling Factors

Man-Rated 4π Shields

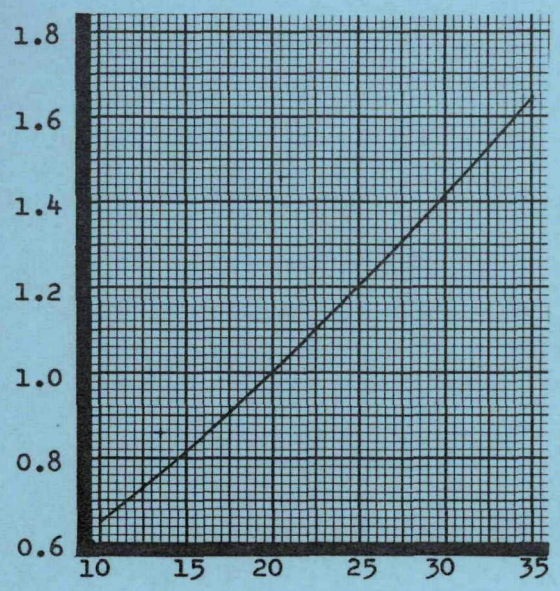




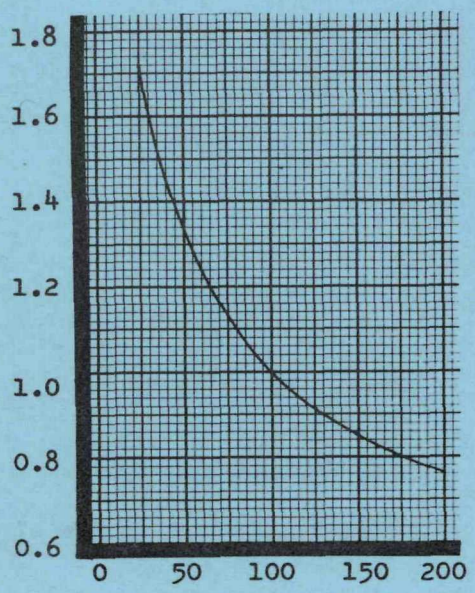


Weight Scaling Factors

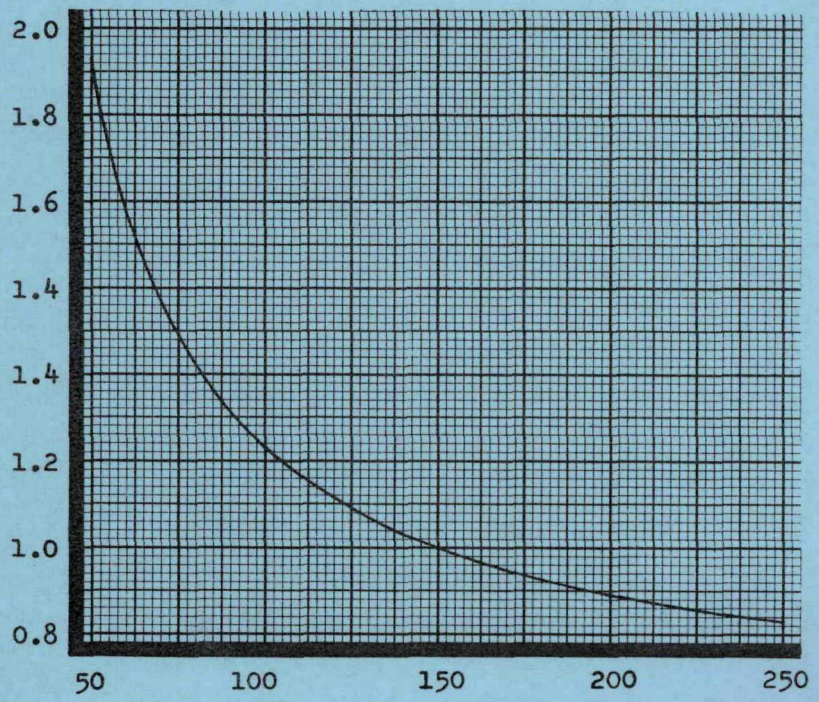
Man-rated 4π Shields



Shield I. D. at
Reactor Midplane (in.)



Rendezvous Zone Dose Rate
(rads/hr.)



Separation Distance (ft.)