MASTER

74213

ATOMICS INTERNATIONAL
A Division of North American Aviation, Inc.

Do not remove this sheet

CLASSIFICATION CANCELLED
DATE 9-7-61
For The Atomic Energy Commission
H. F. Carroll
Chief, Declassification Branch

NAA-SR-MEMO 865 Rev.

This document contains 4 pages

This is copy 3 of 5 series B

~~RESTRICTED DATA~~

~~THIS DOCUMENT CONTAINS RESTRICTED DATA AS DEFINED IN THE ATOMIC ENERGY ACT OF 1954. ITS TRANSMITTAL OR THE DISCLOSURE OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED.~~

~~SECRET~~

Security Classification

NAA–SR–MEMOs are working papers and may be expanded, modified, or withdrawn at any time, and are intended for internal use only.

This report may not be published without the approval of the Patent Branch, AEC.

730-V-33 (REV 6/59)

0RO 11369 1-1

DISCLAIMER

DISCLAIMER

FLUX DISTRIBUTIONS AND LEAKAGE CURRENTS FOR SRE, P-16

BY
R. BALENT

A. TWO-GROUP FLUX DISTRIBUTION

USING THE LATTICE CONSTANTS GIVEN IN NAA-SR-MEMO-700, P. 22, TWO-GROUP, TWO-REGION CRITICALITY CALCULATIONS WERE MADE FOR 10 FT. AND 11 FT. DIAMETER TANKS. THE CONSTANTS USED IN THESE CALCULATIONS ARE AS FOLLOWS:

CORE CONSTANTS

k_∞ = 1.264

τ = 353 cm^2

L^2 = 212 cm^2

FAST DIFFUSION COEFFICIENT = D_F = 1.113 CM

THERMAL DIFFUSION COEFFICIENT = D_{TH} = 0.901 CM

p = 0.82

REFLECTOR CONSTANTS

τ = 350 cm^2

L^2 = 4177 cm^2

D_F = 1.113

D_{TH} = 0.901

p = 1

A 40 CENTIMETER AXIAL REFLECTOR SAVINGS WAS ASSUMED SO THE UNREFLECTED HEIGHT WAS TAKEN TO BE 263 CM. THE AXIAL BUCKLING TERM, $(\pi/H)^2 = 1.43 \times 10^{-4}$ cm^{-2}, WAS ACCOUNTED FOR IN THE RADIAL COMPONENTS OF THE TWO-GROUP EQUATIONS. THE 10 FT. TANK REQUIRED A CORE RADIUS OF 102 CM FOR CRITICALITY (I.E., DIAMETER = 6.7 FT), WHICH CORRESPONDS TO A 1.65 FT. RADIAL REFLECTOR AND A REFLECTOR SAVINGS OF 42 CM. THE 11 FT. TANK REQUIRED A CORE RADIUS OF 95 CM FOR CRITICALITY (I.E, DIAMETER = 6.2 FT), WHICH CORRESPONDS TO A 2.4 FT. RADIAL REFLECTOR AND A REFLECTOR SAVINGS OF 49 CM.

IN THE TWO-GROUP, TWO-REGION CRITICALITY CALCULATIONS THE FLUXES ARE ASSUMED TO GO TO ZERO AT THE EDGE OF THE GRAPHITE REFLECTOR. REFERENCE TO FIG. SRDP-9-20033 DATED DECEMBER 18, 1953 SHOWS THAT THE GRAPHITE HAS AN EQUIVALENT DIAMETER ONLY SLIGHTLY GREATER THAN 10 FEET. HOWEVER, SINCE THE

CORE TANK, THERMAL AND CONCRETE SHIELDS WILL HAVE SOME REFLECTING PROPERTIES, CALCULATIONS OF THE NEUTRON LEAKAGES ARE BASED ON THE 11 FOOT DIAMETER CASE, ALSO, THE CALCULATIONS ARE FOR A FULLY LOADED CORE. SINCE A HIGHER U^{235} ENRICHMENT THAN USED IN THESE CALCULATIONS WILL BE LOADED INTO THE CORE, THE REACTOR SHOULD GO CRITICAL BEFORE REACHING THE FULLY LOADED CONDITION AND THUS THE RESULTING NEUTRON LEAKAGE WILL BE REDUCED SOMEWHAT FROM THE CALCULATED VALUES.

THE EQUATIONS GIVING THE FLUX DISTRIBUTIONS ARE AS FOLLOWS:

IN CORE:

$$Nv(\text{FAST}) = A J_0 (\alpha R) + C I_0 (\beta R)$$

$$nv(\text{THERMAL} = S_1 A J_0 (\alpha R) + S_2 C I_0 (\beta R)$$

IN REFLECTOR:

$$nv(\text{FAST}) = F Z(\alpha_{1R}, R)$$

$$nv(\text{THERMAL} = G Z(\alpha_{2R}, R) + S_3 F Z(\alpha_{1R}, R)$$

WHERE

$$Z = I_0 (\alpha R) - \frac{I_0 (\alpha R_0)}{K_0 (\alpha R_0)} K_0 (\alpha R)$$

THE NUMERICAL VALUES FOR THE 11' TANK ARE

$\alpha = 0.0164$	$\alpha_{1R} = 0.0548$	$A = 1$
$\beta = 0.0900$	$\alpha_{2R} = 0.0195$	$C = -0.193 \times 10^{-3}$
$S_1 = 0.5594$		$F = -0.362 \times 10^{-5}$
$S_2 = -0.8841$	$R_0 = 168$ CM	$G = -0.0267$
$S_3 = -1.313$		

B. FOUR-GROUP FLUX DISTRIBUTION

THE FAST GROUP OF THE TWO-GROUP CALCULATION WAS BROKEN DOWN INTO 3 FAST GROUPS AS SHOWN IN THE FOLLOWING TABLE ALONG WITH THE SLOWING DOWN AREA (AGE) AND SLOWING DOWN CROSS SECTION FOR EACH GROUP:

(THIS IS A COPY)

Group	Energy Range (electron volts)	τ = slowing down area (cm^2)	Σ (cm^{-1})
1	2×10^6 to 3×10^4	85 cm^2	1.312×10^{-2}
2	3×10^4 to 10^4	22.4 cm^2	4.9×10^{-2}
3	10^4 to 0.058	245 cm^2	0.455×10^{-2}

The flux for each of the three fast groups can be taken as a simple ratio of the slowing down area of that group to the total age times the fast flux of the two-group solution. Thus:

$$nv_1 = \frac{\tau_1}{\tau} \, nv_F$$

(similarly for nv_2 and nv_3)

It is assumed that all resonance capture takes place between the 3rd and thermal groups.

C. Leakage

The leakage out of the core and reflector for the 4 energy groups is given in following table. The first column gives the leadage for the case where the thermal flux has been normalized to unity at r = 0. E. Weisner has estimated the maximum thermal flux in the graphite for a power level of 20 MW to be 6×10^{13}; thus, the second column gives the leakage for this power level.

Energy Group	Leakage out of core (i.e., r = 95 cm) neutrons/cm^2/sec. 1	2	Leakage out of reflector (i.e., r = 168 cm) neutrons/cm^2/sec. 1	2
1[2×10^6 to 3×10^4 ev]	-9.85×10^{-3}	-5.9×10^{11}	-2.74×10^{-4}	-1.65×10^{10}
2[3×10^4 to 10^4 ev]	-2.6×10^{-3}	-1.56×10^{11}	$-.721 \times 10^{-4}$	$-.433 \times 10^{10}$
3[10^4 to 0.058 ev]	-28.4×10^{-3}	-1.71×10^{12}	-7.9×10^{-4}	-4.75×10^{10}
Thermal Group	$+12.5 \times 10^{-3}$	$+7.53 \times 10^{11}$	-9.1×10^{-3}	-5.45×10^{11}

It is hoped the above will be useful in shielding calculations.

(This is a copy)

Distribution:

Abbott
Bowman
Cohen
Eggen
Faris
Fillmore
Hallett
Heisler
Howe
Inman
Laubenstein
Loftness
Martin, A.
Motta
Olson
Parkins
Pearlman
Richter
Siegel
Starr
Syrovy
Weisner
Woolsey

(This is a copy)