ORNL-4621
UC-80 -- Reactor Technology

HFIR CORE NUCLEAR DESIGN

R. D. Cheverton
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OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

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REACTOR DIVISION

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ACKNOWLEDGMENTS

The studies reported herein extended over a period of about eight years, during which time many people were involved in varying degrees in the design and analysis of the HFIR and thus to some extent in the nuclear design of the core. Many of the contributions are referenced throughout the text. In addition the authors would like to express their appreciation to A. L. Boch, T. E. Cole, P. R. Kasten, J. A. Lane, A. M. Perry, A. M. Weinberg, and C. E. Winters for their many helpful suggestions and guidance.

ABSTRACT

The High-Flux Isotope Reactor is a flux-trap reactor containing aluminum-clad fully enriched fuel plates and light-water coolant and moderator. At its maximum steady-state power level of 100 Mw the peak thermal-neutron flux in the flux trap is 5.5×10^{15} neutrons/cm^2·sec. It is in the trap region that ^{242}Pu and heavier recycle material is irradiated to produce ^{252}Cf and lighter transplutonium isotopes. Numerous other experimental facilities are available and are presently being used for experiments requiring strong beam currents and high nonthermal fluxes. The peak total nonthermal flux in the reactor is 4.0×10^{15} neutrons/cm^2·sec.

In the process of designing the very high-performance HFIR core, several critical experiments and numerous other experiments pertaining to heat removal and structural integrity were conducted to insure satisfactory operation. Since the time that full power was first achieved (September 1966) 54 core loadings (as of October 1970) have been used with no fuel element damage or other serious problems. The fuel-cycle time at full power is 23 days (somewhat greater than was expected), and preliminary measurements indicate that the neutron fluxes over most of the core are essentially the same as predicted.

Modified core loadings for achieving longer fuel cycles have been investigated, and it appears that within the limitations imposed by fabrication and performance restrictions, 50% longer cycles could probably be obtained.

Keywords: HFIR, research reactors, isotope production, reactor core design, critical experiments

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R. D. Cheverton T. M. Sims

1. SUMMARY

The HFIR was designed primarily for producing transplutonium isotopes by using ^{242}Pu and eventually heavier recycle material as feed. The reactor has now been operating at full power for about four years and has performed essentially as expected, with one notable exception; the fuel-cycle time is about 40% longer than calculated.

In order to achieve economically the high thermal flux required for transplutonium production it was necessary to design a very high-performance core, and flux-trap geometry was selected because of its ability to produce a high ratio of thermal flux to power. Surrounding the flux trap are two concentric annular fuel elements containing highly enriched U_3O_8-Al, aluminum-clad, involute-geometry fuel plates. The side reflector is beryllium, and it is separated radially from the fuel region by a thin annular control region. All components are cooled with light water, which is also the primary moderator.

In the process of designing the HFIR core, several critical experiments were conducted. The first was a solution critical experiment, and this was followed by three experiments with actual HFIR-type fuel elements. The last of these latter three experiments was conducted in the actual HFIR facility, while all the others were conducted in a separate critical facility. Power-distribution data from these experiments were used in conjunction with one-dimensional fuel-cycle calculations to predict two-dimensional power distributions throughout a fuel cycle.

Because the core operates at very high power density the fast-neutron flux is also quite high, and on a small scale (because of space limitations) it is proving very useful for materials-irradiation-damage studies in conjunction with advanced power reactor programs. Even the horizontal beam tubes, which were added almost as an afterthought, are producing very high and very useful neutron currents.

A schematic representation of the core is depicted in Fig. 1.1, and typical radial flux distributions are shown in Fig. 1.2. Other pertinent core characteristics are given in Table 1.1.

The present HFIR design, although quite advanced in terms of neutron fluxes and heat-removal capability, does not necessarily represent an optimum or ultimate design within present technology or a small extrapolation thereof. One modification that is being pursued at the present time is an increase in fuel and burnable-poison loadings to achieve a longer fuel cycle. It appears at present that a 50% longer fuel cycle can be achieved before encountering power-distribution, mechanical-integrity, fabrication, and radiation-damage limitations.

Table 1.1. Summary of HFIR Characteristics

Reactor power levels, Mw	
Steady-state operating	100
Minimum steady-state incipient boiling	130
Neutron fluxes at 100-Mw operation, neutrons/$cm^2 \cdot sec$	
Thermal	
Maximum unperturbed in island	5.5×10^{15}
Average in typical 300-g ^{242}Pu island target	2.0×10^{15}
Maximum unperturbed in Be reflector	
Beginning of fuel cycle	1.1×10^{15}
End of fuel cycle	1.6×10^{15}
Maximum unperturbed at Be-H_2O reflector interface	
Beginning of fuel cycle	1.4×10^{14}
End of fuel cycle	1.7×10^{14}
Average in fuel region	
Beginning of cycle	3.3×10^{14}
End of fuel cycle	4.5×10^{14}
Total nonthermal	
Average in island target	2.4×10^{15}
Maximum in fuel region	4.0×10^{15}
Prompt-neutron lifetime, μsec	
Beginning of cycle	35
End of cycle	70
Effective delayed-neutron fraction	0.0071
Length of typical fuel cycle, days	23
Reactor materials	
Fuel plate	U_3O_8-Al cermet with Al cladding
Weight of ^{235}U per plate in inner fuel element, g	15.18 ± 1%
Weight of ^{235}U per plate in outer fuel element, g	18.44 ± 1%
^{235}U enrichment, %	~93
Total loading of ^{235}U, kg	9.40
Total burnable-poison loading (^{10}B in inner fuel-element plates only), g	2.8
Coolant	H_2O
Island moderator	H_2O
Side reflector	
Removable	Be + 5% H_2O
Permanent	Be + 2% H_2O
Shim, safety and regulating plates	
Black region	Eu_2O_3 + Al
Gray region	Ta + Al
White region	Al
Plutonium target rods	PuO_2-Al cermet with Al cladding
Core geometry	Cylindrical flux trap
Fuel-element geometry	Cylindrical annulus with involute-shaped fuel plates
Number of fuel elements per loading	2
Core dimensions	
Flux-trap diameter, in.	5.067
Inner fuel-element diameters, in.	
Side plates	
ID	5.067
OD	10.590
Active elements	
ID	5.623
OD	9.920
Outer fuel-element diameters, in.	
Side plates	
ID	11.250
OD	17.134

Table 1.1 (continued)

Active elements	
ID	11.913
OD	16.483
Fuel-region height (active), in.	20.0
Fuel-region volume (active), liters	50.59
Control-region diameters, in.	
ID	17.134
OD	18.872
Side-reflector dimensions, in.	
Height	24
Removable-reflector ID	18.872
Removable-reflector OD	23.756
Permanent-reflector OD	43.0
Pressure-vessel ID	94
Fuel-plate thickness, in.	0.050
Fuel-plate total length, in.	24.0
Fuel-plate heat transfer surface area (total), ft^2	428.8
Coolant-channel thickness, in.	0.050
Heat transfer data	
Fuel-plate heat load, Mw	97.5
Power density (av), Mw/liter	1.93
Heat flux (av), Btu/hr·ft^2	0.776×10^6
Heat flux (hot spot), Btu/hr·ft^2	1.97×10^6
Coolant velocity, ft/sec	51
Temperatures, °F	
Coolant inlet	120
Coolant outlet (nominal max)	196
Oxide-water interface (nominal max)	269
Metal-oxide interface (nominal max)	303
Fuel-plate center line (nominal max)	325
Experimental facilities (other than flux trap)	
1.584-in.-diam vertical facilities in permanent reflector	
Number	16
Location (radial distance), in.	
11 holes at	15.438
5 holes at	17.344
2.834-in.-diameter vertical facilities in permanent reflector	
Number	6
Location (radial distance), in.	18.219
0.500-in.-diameter vertical facilities in shim access plugs	8
0.500-in.-diameter vertical facilities[a] in outer ring of removable reflector	8
Horizontal beam tubes	
Number	3
Location	Horizontal midplane; terminate ~3 in. from fuel
Type	Radial, tangential, and through
Engineering facilities	
Number	4
Location	Approximately tangent to outer surface of beryllium reflector, 41° to vertical

[a]Diameters of four of these facilities were recently enlarged to 1.4 in.

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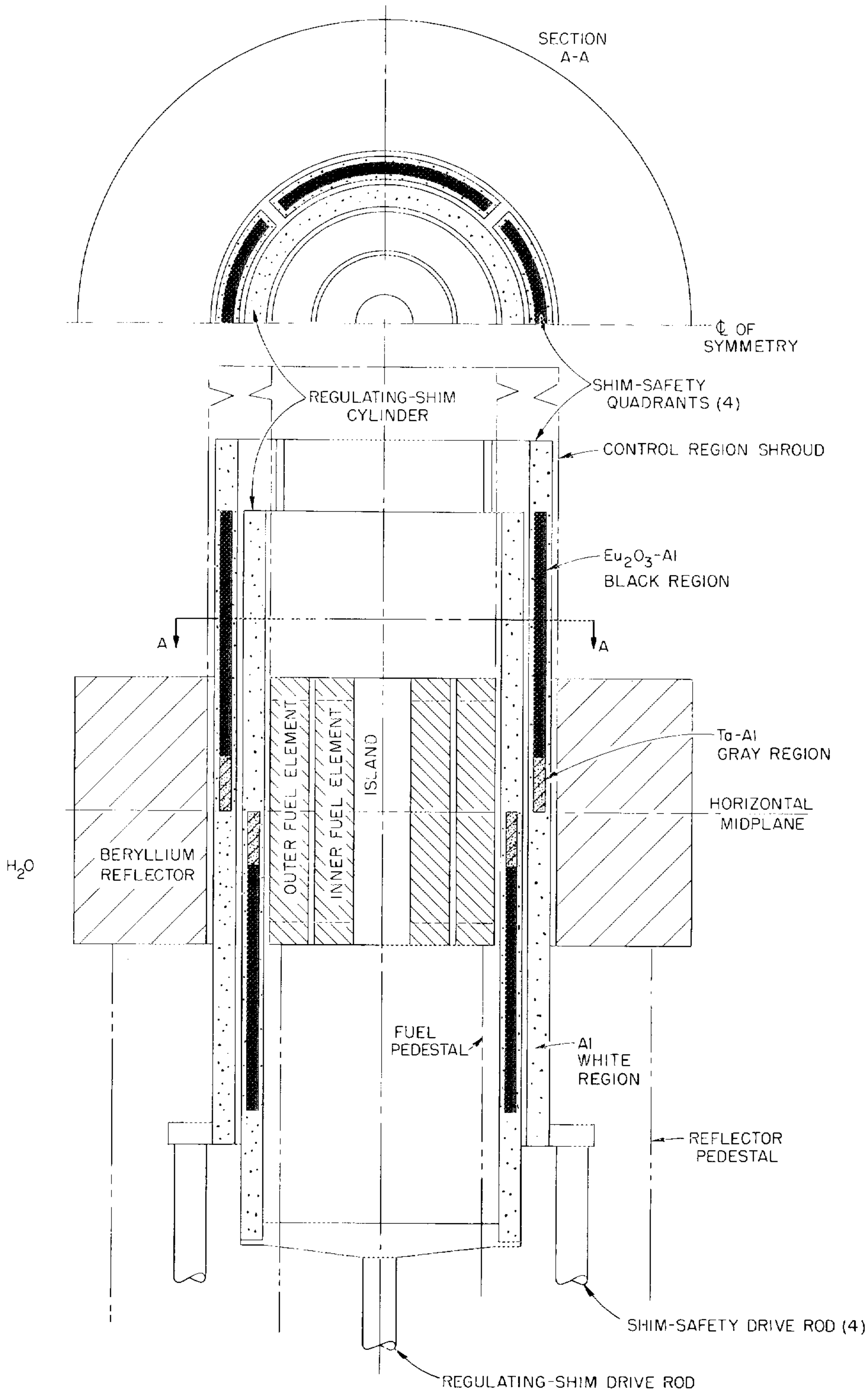

Fig. 1.1. Schematic Representation of HFIR Core.

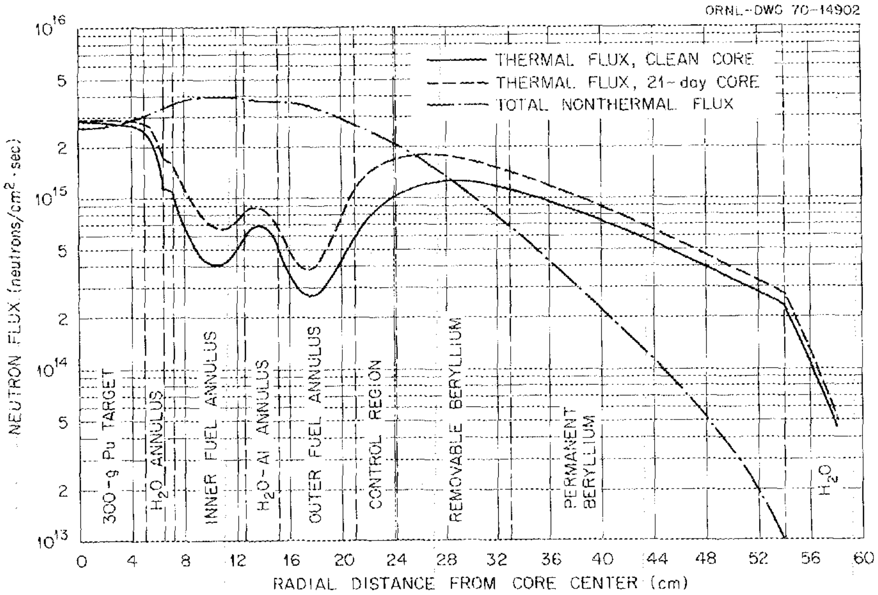

Fig. 1.2. Typical Thermal and Total Nonthermal Radial Flux Distributions at Horizontal Midplane of HFIR for 100-Mw Operation.

2. INTRODUCTION

The design of the High-Flux Isotope Reactor (HFIR) was undertaken with essentially a single purpose in mind – the production of transplutonium isotopes, such as ^{252}Cf, at a rate of milligrams per year. Feed material for the production of the heavy isotopes was to be ^{242}Pu and eventually recycle material, and the heaviest isotope to be considered for design optimization purposes was ^{252}Cf, since heavier isotopes have much lower production rates (very short half-lives).

A flux-trap type of reactor design was desired for the HFIR because of its relatively large ratio of peak thermal-neutron flux to total power (Φ/P). Survey studies of flux-trap reactors conducted during the period 1956 to 1958 not only disclosed the characteristically large value of Φ/P but also indicated that the desired quantities of the heavy isotopes could be produced at a reasonable power level (~100 Mw).[1-4]

Beginning in 1958, preliminary HFIR design studies were undertaken, and the first HFIR physics report[5] was issued in 1960. Solution critical experiments,[6-8] which generally validated the calculational methods, were conducted early in 1960 and were followed by two critical experiments employing prototype HFIR fuel elements and control rods.[9-13] These latter experiments, along with later calculations, were used to complete the core design and to provide operational data.

This report briefly discusses many of the factors involved in the optimization of the core design and provides detailed information on neutron fluxes, power distributions, fuel-core fission densities and temperatures, control-rod worths, reactivities associated with experimental facilities, various reactivity coefficients, and fuel-cycle characteristics. Since it appeared that it would be possible to significantly increase the fuel-cycle time over that of the present core, a brief discussion of methods by which this might be done is also included. Detailed analysis of flux-trap-void and material effects and of reactor fast transients are available in separate reports,[14,15] The core heat transfer analysis,[16] which of course was an important part of the optimization study, and specific reactor safety studies are also reported separately.[17] A functional description of the overall HFIR facility is presented in Ref. 18.

Construction of the reactor facility was completed in 1964, and criticality was first achieved August 25, 1965. For the next four months, numerous hydraulic and nuclear experiments were conducted without significant difficulties being discovered. Low-power operation began in January 1966, and full power (100 Mw) was achieved in September 1966. At the time of this writing (October 1970) approximately 126,000 Mwd of full-power operation has accumulated without nuclear difficulties. However, a discrepancy does exist between the calculated and actual fuel-cycle time. The actual time is 23 days, which is significantly longer than predicted.

3. BRIEF DESCRIPTION OF HFIR

The HFIR is a highly enriched (~93%) ^{235}U-fueled aluminum-clad system that is cooled and moderated with pressurized light water, which dissipates its heat through heat exchangers to a cooling tower. The core consists of two concentric fuel annuli with a cylindrical cavity (flux trap) at the center and a beryllium-water side reflector, which is separated radially from the cylindrical fuel region by a thin annular control region, as shown schematically in Fig. 1.1. The two fuel annuli constitute two fuel elements, each containing involute-shaped fuel plates that are held in place with two cylindrical side plates. In the annular control region are two concentric cylindrical control rods, with the inner constituting a continuous cylindrical surface and the outer being divided into quadrants, each with its own drive mechanism.

In addition to the central flux trap, which at present is used primarily for production of transplutonium isotopes, there are several other experimental facilities, all of which are located in the beryllium side reflector. As shown in Figs. 3.1 and 3.2, these facilities include three horizontal beam holes at the horizontal midplane of the core and numerous vertical facilities plus four slant facilities adjacent to the side of the beryllium reflector.

Dimensional, material, and functional characteristics of the reactor are listed in Table 1.1.

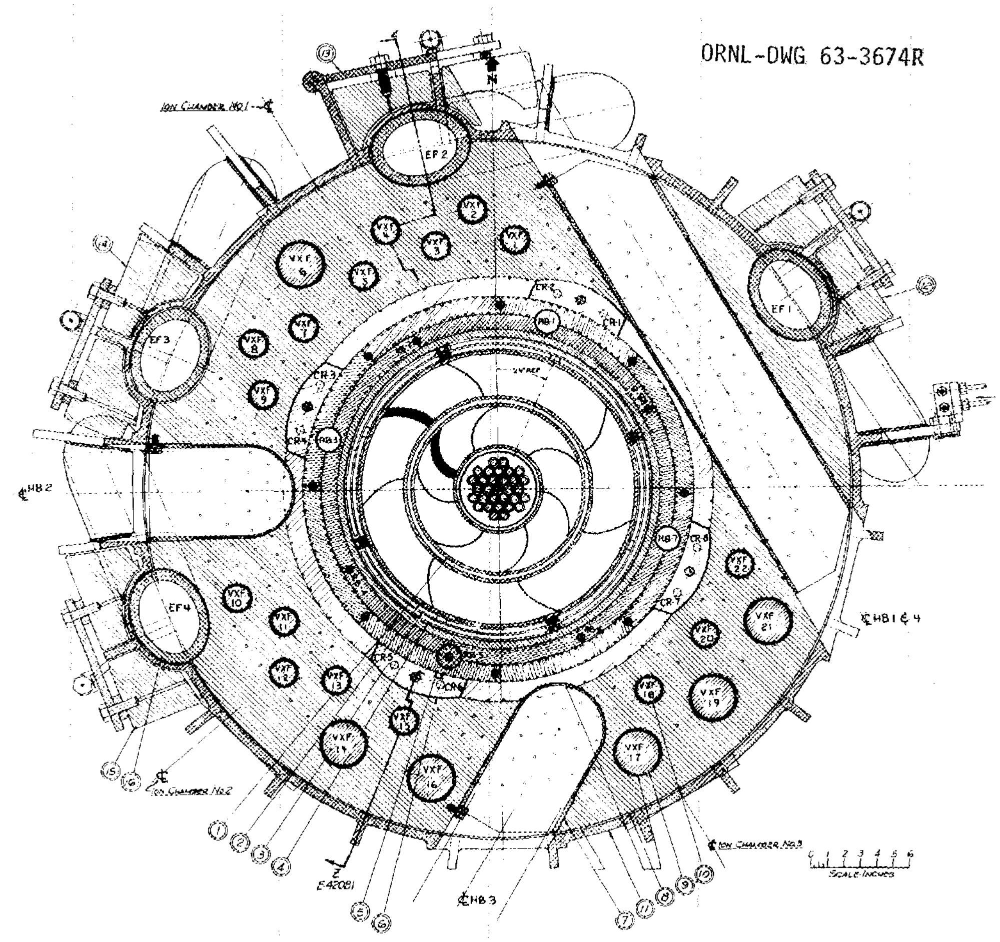

Fig. 3.1. HFIR Cross Section at Horizontal Midplane.

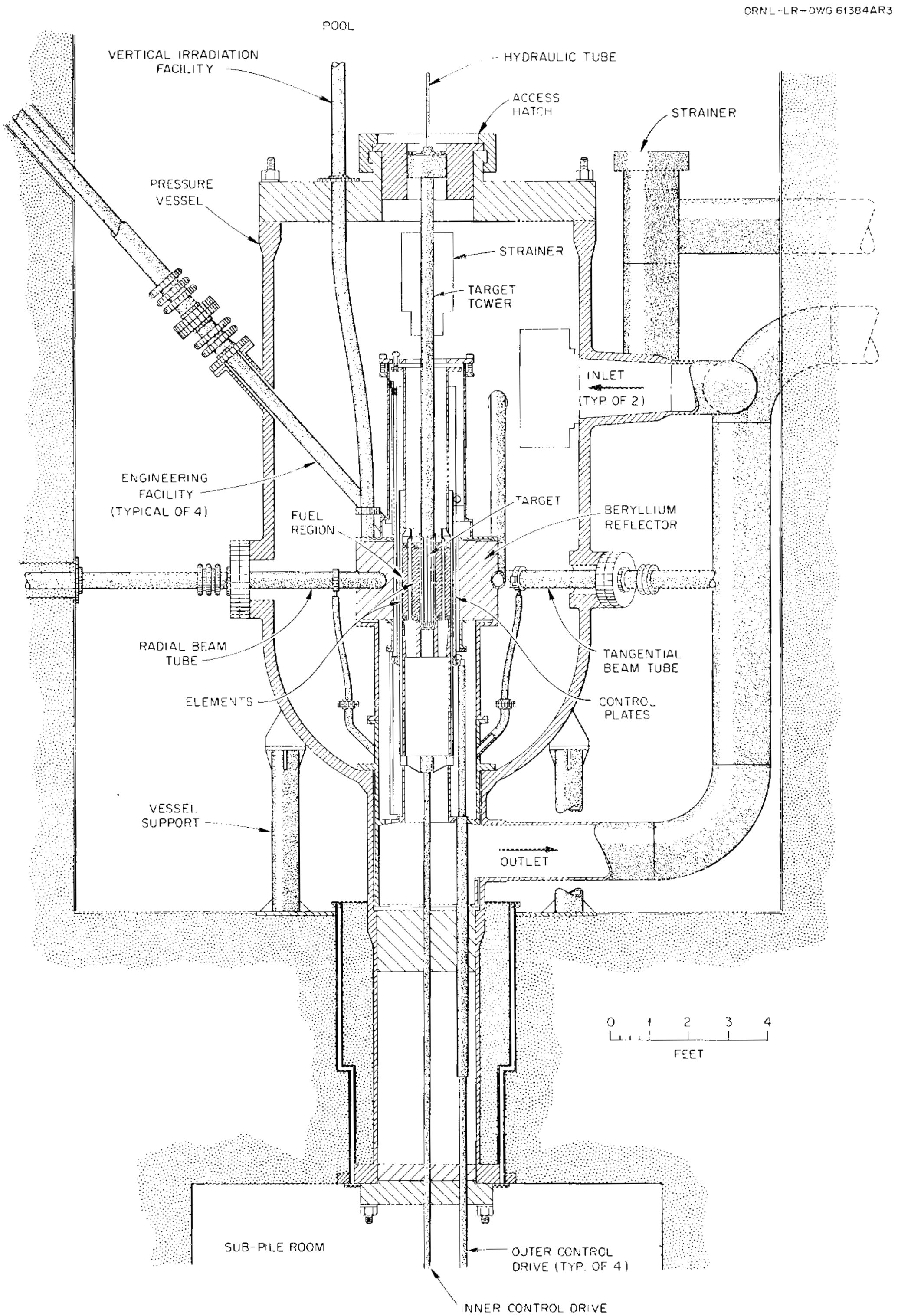

Fig. 3.2. Vertical Section of HFIR Vessel and Core.

4. REVIEW OF DESIGN CONSIDERATIONS

The design of the HFIR core represents an effort to achieve the maximum possible production rate of ^{252}Cf with a specified quantity of ^{242}Pu feed material and a reasonable power level. For expediency this had to be done within the framework of existing or slightly extrapolated technology and available information on transplutonium production constants. Even as the core was being designed and fabricated, new basic data became available that could have resulted in improvements but which arrived too late. Thus it cannot be said that the HFIR core represents an optimum design; for instance, the optimum flux-trap diameter for a 300-g ^{242}Pu target is probably somewhat greater than the present diameter. At the time the flux-trap diameter was established the amount of plutonium feed material available for irradiation in the flux trap was significantly less than at present, and significant variations in reported neutron cross sections for many of the heavy isotopes have occurred.

4.1 Selection of Reactor Type and Materials

Flux-trap geometry was selected for the HFIR because it results in a high value of thermal-neutron flux per unit of power, and the peak thermal flux exists in a region external to the fuel; that is, the central moderator region or flux trap. Cylindrical geometry and a symmetrical reflector control system were specified because they both helped to flatten the power distribution and thus contributed to higher average power density operation. In this regard a further significant improvement was achieved by varying the fuel concentration in the radial direction. Water was selected for the moderator in the flux trap because it results in a higher peak flux than can be achieved with other practical moderators.

The fuel region, which surrounds the flux trap, contains two annular fuel elements that contain involute-shaped aluminum-clad fuel plates. Water was specified as the coolant and moderator, even though heavy water would have provided somewhat better leakage characteristics, because of the greater simplicity in overall design and the lower cost. Aluminum was selected as the fuel cladding material because, compared with other cladding materials, such as stainless steel, nickel, and zirconium, it results in much lower fabrication and reprocessing costs. Furthermore, with the exception of the very expensive zirconium, aluminum results in significantly lower parasitic neutron absorption and thus lower fuel loading and smaller core size. It also appeared that the strength and corrosion resistance of aluminum were quite satisfactory for the intended service.

Because of the expected requirement for high fuel concentration in the fuel plate a dispersion of U_3O_8 in aluminum powder was selected, instead of a uranium-aluminum alloy, to prevent excessive fuel segregation. Furthermore, more uniform burnable-poison loadings are achieved with cermets than with alloys. Fuel plates, rather than wires and tubes, were selected for the heat transfer surface configuration, because for practical plate and wire dimensions, the plate provides significantly more heat transfer area per unit volume; furthermore, a plate provides more surface area per individual unit, and thus fewer units are required per total fuel loading. Involute geometry for the fuel plate was specified for several reasons: it provided a uniform metal-to-water ratio; the fuel elements could be made in the shape of circular annuli with only two annuli being required; only two slightly different types of fuel plates were required; it provided a means for varying the fuel concentration in the radial direction (variable-thickness fuel and poison core along the involute arc); and it permitted the use of a plate that was not significantly different in size and shape than those already being satisfactorily produced for other reactors. In addition the curved shape, in contrast to a flat plate, tends to minimize mechanical instability problems.

Surrounding the fuel region is an annular control region containing two thin-walled ($^1/_4$-in.) concentric cylindrical control elements. The inner cylinder, which is used for both shim and regulation and which is referred to as the shim-regulating rod, has a single drive rod with a duplex drive mechanism that superimposes the regulating motion on the shim motion. This rod moves upward to insert poison. The outer control cylinder is divided into quadrants, each having its own drive and safety release mechanism. These rods, referred to as the shim-safety rods, are used for both shim and safety and are moved downward into the core to add poison. Normally the shim-safety rods are moved as if ganged together, and this gang and the shim-regulating rod are maintained symmetrical about the horizontal midplane of the core to maintain symmetry in the power distribution.

Each control rod contains three longitudinal regions: a black region containing europium, a gray region containing tantalum, and a white region containing aluminum. The europium (Eu_2O_3) and tantalum are dispersed in and are clad with aluminum so that a control rod is essentially an aluminum plate or cylinder containing black and gray cores. Aluminum was selected because of its relatively low material density (which results in low heat-generation rates and low acceleration forces), good thermal conductivity, low neutron-scattering cross section (important in the black and gray regions), low neutron-absorption cross section (important in the white region), and the relative simplicity with which a sufficiently strong aluminum-base rod can be fabricated to very close dimensional tolerances.

Europium was selected as the black absorber primarily because of the deficiencies of other more widely used absorbers. For instance, boron suffers excessive radiation damage; cadmium has too low a melting temperature and epithermal cross section; hafnium and silver have excessively low cross sections for inclusion as dispersions and create severe design problems if included as discrete sections of the rod; gadolinium has too low an epithermal cross section; and dysprosium has a rather low absorption cross section and a high scattering cross section. Europium, on the other hand, has adequately high thermal and epithermal cross sections, is metallurgically compatible with aluminum (in the oxide form), and because of its high-cross-section daughter products has a relatively long cross-section lifetime.

Tantalum was selected as the gray-region material because of its appropriate absorption cross section and its compatibility with aluminum. Also ORNL had had some successful fabrication experience with it. A later requirement for the gray material was that it should have good corrosion resistance in reactor water when coupled with aluminum; tantalum also satisfied this requirement.

Surrounding the control region is the beryllium reflector. The materials considered for the reflector were beryllium, heavy water, a mixture of heavy and light water, and graphite. Graphite would have required canning, and this appeared to be impractical for a reflector containing many experimental facilities. Heavy water or mixtures of heavy and light water had several advantages relative to the control concept and reflector experimental facilities; however, the disadvantages associated with maintaining separation of the light- and heavy-water regions of the core and with the maintenance of a heavy-water cleanup system outweighed the advantages. Thus, beryllium was selected. To accommodate the radiation-damage problem in beryllium, the reflector was divided into radial regions so that the innermost regions could be replaced periodically.

The entire core is surrounded by enough water to prevent significant radiation damage and heating in the pressure vessel and to provide adequate shielding for component handling.

4.2 Calculational Parameter Study

The thermal flux in the flux trap results primarily from leakage of nonthermal neutrons from the fuel region into the flux trap and from their subsequent moderation therein. Thus, the flux that can be achieved is a function of the leakage characteristics of the fuel region, the moderating characteristics of the flux trap, and the power.

An optimum flux-trap diameter exists because total leakage into the trap is essentially independent of trap diameter (for the diameter range of interest), moderation increases and becomes asymptotic to a maximum as the diameter increases, and neutron density per neutron increases as the diameter (volume) decreases. The optimum diameter is smaller for moderators having small values of neutron age, and thus water results in the smallest trap diameter and the highest thermal flux. The relatively small high-flux volume obtained with water appeared to be quite adequate for the originally anticipated amount of plutonium feed material (100 to 200 g ^{242}Pu). Calculations made to determine the optimum trap diameter indicated a negligible difference between optimum diameters with and without the target.

Since the time that the target diameter was specified the available feed material and the amount of target structural and heat-removal material has increased. Recent calculations indicate that a 10% increase in thermal flux could be achieved by increasing the trap diameter from 14 to 18 cm, while maintaining the same core cross-sectional area and power level.

Total neutron leakage from the fuel region to the flux trap is influenced by the following fuel-region parameters: metal-to-water ratio, length-to-diameter ratio, neutron cross section, power distribution, and power density. Increasing the metal-to-water ratio, power, and power density and decreasing the neutron cross section tends to increase leakage, while an optimum length-to-diameter ratio exists. A further increase in leakage (for a given power level) can be achieved by peaking the power density next to the flux trap. Other parameters that enter the picture because of their influence on the fuel-region parameters are heat transfer, mechanical considerations, and fuel loading (fuel-cycle time). The result of considering all these parameters simultaneously was that the metal-to-water ratio was determined primarily by the need to achieve the maximum practical heat transfer surface area per unit volume, and this was limited by mechanical and fabrication considerations. The power distribution, instead of being peaked, was made nearly flat (by varying the fuel distribution in the radial direction) in order to raise the average power density as much as possible. This reduced the island flux per unit power by a few percent but increased the permissible average power density and thus the total leakage by nearly a factor of 2. The power level was established in a very early conceptual design on the basis of satisfying the desired transplutonium-production rates and on the basis of available capital funds. In order to arrive at the minimum permissible active core volume, existing correlations for burnout heat flux and preliminary data on power distribution, tolerances, and uncertainties were used to estimate a permissible average power density. Finally, a fuel loading was specified primarily on the basis of providing a reasonable fuel-cycle time, although limitations were imposed by reactivity, metallurgical properties, radiation damage, and corrosion; fortunately the criteria and limitations were compatible.

It should be apparent from the above description of how the design was pieced together that it does not necessarily represent an optimum design; in fact much of the valid experimental data was obtained after the design was established. This left room for improvement, but the HFIR is satisfying the original objectives.

4.3 Experimental Programs

Since the conceptual design of the HFIR called for a very high performance advanced core and required extrapolation of existing technology in some areas, many of the design parameters were investigated experimentally. Some early nuclear experiments with flux-trap cores were conducted in Russia and were reported at the Second United Nations International Conference on the Peaceful Uses of Atomic Energy.[4] The data indicated that the optimum trap diameter with nothing but water in the trap was about 12 cm, which agreed quite well with ORNL calculations. Therefore no further experimental optimization of the trap diameter was proposed. However, many other nuclear parameters were investigated at ORNL in critical experiments conducted specifically for the HFIR (see Appendix A).

Shortly after establishing the HFIR conceptual design, a solution critical experiment (HFIRCE-1) was proposed for establishing the accuracy with which critical mass, power distribution, and flux levels could be calculated. These data were then used to help firm up the design so that a critical experiment (HFIRCE-2) could be conducted with actual fuel elements, control rods, and a beryllium reflector.

The HFIRCE-2 core was essentially identical to the present design except that the fuel elements contained only 8.01 kg ^{235}U and 1.7 g ^{10}B, and the distributions of these materials were different. Furthermore, two sets of control rods, each different from the present design, were used. The first set had a silver-copper black region, a nickel gray region, and an aluminum white region, with each region about 20 in. long. This set simulated a proposed nickel-clad silver, nickel, aluminum design, which was finally rejected because of fabrication and design difficulties and because of the detrimental effects of the rather large scattering cross section of the nickel. The second set of rods simulated the present rod design with a silver-copper black region, a 5-in.-long silver-aluminum gray region, and an aluminum white region.

Results from the HFIRCE-2 experiments and new information on reactivity tolerances and control-rod and fuel-element fabrication problems indicated that the fuel loading should be increased from 8.0 to 9.4 kg ^{235}U, the burnable-poison loading should be increased from 1.7 to 2.12 g ^{10}B, and the distribution of both fuel and burnable poison should be changed. Thus a third critical experiment was planned.

Experiments conducted in the HFIRCE-3 series were essentially the same as in the HFIRCE-2 series. The control rods used for the initial HFIRCE-3 experiments were those that simulated the present Eu_2O_3-Ta-Al rods; that is, the silver-copper-aluminum rods. Results from these experiments and still further information on reactivity tolerances indicated that the ^{10}B loading should be increased from 2.12 g to 3.60 g. (Because of the lead time required for fuel-element fabrication the larger loading was specified for the first set of HFIR production fuel elements.) When the first set of actual Eu_2O_3-Ta-Al rods finally became available and were used in the experiments, it was determined that these rods were worth considerably more than the silver-copper-aluminum rods. Therefore, the ^{10}B loading for subsequent cores was reduced; the new loading is 2.80 g.

After the HFIR facility became available, a number of experiments were performed in it with the HFIRCE-3 core and the HFIRCE-3 Eu_2O_3-Ta-Al control rods. These experiments, referred to as the HFIRCE-4 experiments, were performed to (1) investigate small differences in the HFIRCE-3 and HFIR overall core assemblies, (2) obtain more detailed power-distribution data, (3) calibrate the control rods, and (4) investigate more thoroughly the question of reproducibility.

Thermal, hydraulic, and mechanical design features were also analyzed with the aid of experimental programs. Heat transfer tests were conducted with electrically heated, simulated fuel-plate assemblies to determine burnout and incipient-boiling heat fluxes, fluid-film heat transfer coefficients, and friction factors specifically for HFIR operating conditions.[19] Corrosion experiments were conducted with similar equipment to investigate and to obtain correlations for the rate of oxide growth, which is important in the calculation of the very significant temperature drop across the low-thermal-conductivity oxide.[20] Much development effort was required to perfect the techniques for making contoured fuel-plate and burnable-poison cores (method for varying fuel concentration in radial direction) and to determine the expected distribution tolerances.[21] Assembly dimensional tolerances were also important in the design analysis and thus had to be studied by fabricating entire fuel elements. A study of the compatibility of control rod materials was also quite important. Early in the design effort there were indications that Eu_2O_3 and tantalum were not stable in aluminum. Because of this and the high cost of Eu_2O_3 it was decided to switch to the less desirable silver-nickel-aluminum combination. Unsuccessful attempts to clad silver with nickel and to obtain a satisfactory union of the gray and white regions, and continued efforts to achieve compatibility between the more desirable control-rod materials, finally resulted in a decision to revert to the Eu_2O_3-Ta-Al rods.

Experiments were also conducted to investigate the mechanical stability and deflection characteristics of the fuel plates when subjected to thermal differential expansion and hydraulic loads[22] and to obtain information on fuel-plate and control-rod radiation damage. The fuel-plate radiation-damage studies were conducted at the ETR in conjunction with the ATR and HFIR programs.[23] Information from these experiments was not really incorporated in the design because the data were only recently made available. However, the data indicated that there would be no radiation-damage problems with HFIR fuel plates, and actual HFIR operation has proved this to be the case.

4.4 Design Limitations

There are a number of design features in the fuel elements that relate to limitations that are not as obvious as those associated with heat transfer, radiation damage, dimensional tolerances, strength, etc. One of these concerns the increase in fuel segregation as the contour of the fuel distribution is made steeper. Because of this effect it was necessary to add a water region between the two fuel elements to flatten the thermal flux and thus the fuel distribution; unfortunately this was done at the expense of decreasing neutron leakage to the flux trap by a few percent.

Fuel-cycle time can of course be limited by radiation damage, but perhaps some not so apparent limitations are those associated with the limited worth of a reflector control system, the detrimental effects of increased burnable-poison loading on power distribution and the flux-trap flux, and the effect of increased fuel loading on fuel segregation. These limitations are a function of type of materials, location of specific materials within the core, and method of fabrication. For the present HFIR design it was believed that these limits had been nearly reached. However, as discussed in Chapter 11, recent developments might permit a significant extension of fuel-cycle time.

Since an attempt was being made to achieve the highest possible performance in the HFIR fuel element, it was necessary to consider individual tolerances and uncertainties, and of course it was important that none be overlooked. The list included categories such as reactor-instrumentation and recorder inaccuracies, fabrication tolerances, uncertainties associated with calculational models, and inaccuracies in experimental data and resultant correlations. In the case of the HFIR these factors are very important in achieving not only adequate heat transfer but also adequate reactivity shutdown margins. Since an arbitrarily "large" safety factor does not exist, it is important that specified tolerances be adhered to. In at least one case it is probably not reasonable to entirely trust the usual inspection techniques; this involves the reactivity worth of the fuel elements. Since the addition of only one element to the core could make the core supercritical, if for instance the burnable poison had accidentally been left out, and a few other things were out of specification, it was decided to devise a technique for checking the reactivity of a fuel element assembly under conditions that provided considerably more reactivity control than available in the reactor facility. Such a check is applied to each new pair of fuel elements in a special critical facility.

4.5 Design Philosophy Regarding Core Performance Capability

A review of the designs and operating histories of pre-HFIR era research and testing reactors indicates that these reactors were *initially* designed with what is now considered to be very large margins of safety insofar as heat removal is concerned. At least in some of these cases the "necessity" for the large margin was associated with a lack of reliable design data in relatively new scientific fields. Following initial operation, and as more information became available, the power levels of these reactors were gradually increased by substantial amounts.

The situation for the HFIR was intended to be different; that is, no arbitrary safety factors were included, and no additional operating capacity was designed into any significant component of the heat-removal system. One reason for this approach was that it was desired to achieve the highest neutron fluxes possible with the funds that were available. Of course even with HFIR there were some final data that did not become available until after the design was frozen. However, the most recent analysis of permissible power level based on the certified design criteria and the most recent data, as of October 1970, indicates that the permissible maximum nominal steady-state power level for the present fuel element capabilities is 100 Mw. This is consistent with the advertised power level capability but is somewhat lower than the previously published value.[16]

Since the time HFIR first operated for a complete fuel cycle at full power, there has been the inevitable desire to either raise the power level or degrade the specifications, either of which would in principle reduce the cost of a neutron (the going rate is about 1×10^{-18} dollars per neutron absorbed in the plutonium feed material). Of course simply because the fuel elements perform satisfactorily at design conditions is no reason to suspect that they are "overdesigned." In fact in most cases if any degradations are permitted with the present core design, the best estimate of the permissible power level will drop below 100 Mw. On the other hand there are areas in which further research and development work could lead to a new core design that would permit somewhat higher power levels. In view of this situation and in defense of what was considered to be a reasonable design approach, the design criteria, methods of analysis, and possible areas for improvement are briefly reviewed here.

Early in the HFIR project it was necessary to establish a maximum nominal steady-state power level and a nominal peak power level at which the ultimate scram would be set. Proper selection of the latter power level is very important for two reasons: if set too low the reactor will scram on "noise," and if set too high the performance capability will be jeopardized (reduced normal operating power level). After much consideration of these two factors, 130% of normal full power was selected for the ultimate scram point. The possibility of lowering this limit can probably be investigated during reactor operation.

It is possible, though not very probable, that the power level could wander up to nearly 130 Mw for a brief period of time, and of course it is possible that a relatively fast transient could also result in 130 Mw being achieved. It was decided that the probability of such occurrences during the reactor facility's lifetime was high enough that core damage should not be permitted during brief periods of time (a few hours) at 130 Mw.

In the process of designing the core it was necessary to create an analytical model for considering all the fabrication and operational adversities and technical uncertainties insofar as their effects on heat-removal capacity and radiation damage are concerned. After examining the various probabilities associated with frequency of occurrence and considering the various methods of inspection that might be used, it was concluded that a satisfactory model would permit all adversities and uncertainties to occur simultaneously, consistent with physically realizable situations. This approach has been viewed by some as overly conservative; however, continuing surveillance of inspection techniques and records and of operational methods indicates to the designers that the model is still justified. If, on the other hand, more sophisticated inspection techniques were used, such as digital rather than analog retrieval and analysis of fuel-distribution data, it would probably be possible to upgrade the power rating on at least some of the fuel elements.[24] Of course other core and heat-removal components were designed for the same limiting power level as the fuel elements; that is, 100 Mw.

Another design approach that might be changed as a result of additional experimentation is that of using the incipient boiling point rather than burnout as a limiting condition at 130% nominal power. Because of possible parallel-channel hydraulic instabilities (boiling disease) and narrow-channel effects (channel dimension approaches bubble size) the burnout power level tends to approach the incipient-boiling power level. The experimental program did not provide all the data desired in these areas, and until appropriate experiments are conducted, there is no choice other than to select incipient boiling as the limiting condition.

Successful operation of the HFIR core at 100 Mw does not necessarily imply that the core is adequately designed. The reason for this is that the actual degree of perversity of a particular core loading is not known (with current inspection techniques), and the core is not necessarily subjected to limiting operational conditions. Thus unless a "maximum permissible preversity" core is purposely fabricated, the degree of perversity is established, and that core is subjected to the appropriate limiting abnormal operating conditions to establish its adequacy, it is necessary to rely on the calculations. It is important that this be understood because it effectively negates the possibility of simply raising the power level of a typical fuel loading to determine its upper steady-state limit. This same reasoning also applies to degrading of the fuel-element specifications while holding the power level constant.

Because of the strong dependence on calculations and laboratory experimental data it is important that the criteria, methods of analysis, and application of experimental data be thoroughly understood before attempting to reduce fabrication and operating costs at the expense of a reduced margin of safety. The relatively large margins associated with previous research reactors do not exist in the HFIR.

5. NEUTRON FLUXES

An attempt is made in this chapter to provide neutron flux information that will be of use to prospective HFIR users. Most of the flux values were obtained from calculations; however, there are some experimental data available that can be used for estimating the accuracy of the calculated values and normalizing them. Regarding the accuracy of the calculated values, it can be generally stated that in regions away from the control rods and the ends of the fuel elements, the calculated unperturbed thermal fluxes are within about ±10% of the actual values. Calculated thermal fluxes for the "standard" flux-trap targets should also have an accuracy of about ±10%.

Recently there has been increased interest in epithermal and fast-flux irradiations in the HFIR. Thus some nonthermal flux information, both calculated and measured, is included. It is of interest to note that the maximum fast fluxes available for experiments also occur in the flux trap, and thus thermal- and fast-flux experiments must compete for the peak flux space.

Much experimental flux-related information was obtained from the fuel regions in connection with the power-distribution measurements. Such information has been useful in predicting the accuracy with which power distributions can be calculated, but no further reduction of the data has been attempted. However, there is little likelihood that experiments will be placed within the bounds of the fuel regions.

The methods used for calculating the fluxes are described in Appendix B. It is sufficient to say here that one-dimensional 33-group diffusion-theory methods were used most extensively, with a sprinkling of two-dimensional few-group diffusion calculations. Typical radial flux distributions from the one-dimensional calculations are shown in Fig. 5.1. Two-dimensional results for the HFIRCE-4 core in the clean condition with a 300-g plutonium target are shown in Figs. 5.2 through 5.5. For the fully poisoned condition (rods out and soluble poison in the moderator) with no target, the results are shown in Figs. 5.6 through 5.9. The fully poisoned condition is not really typical of an operating core, but the curves do show to some extent

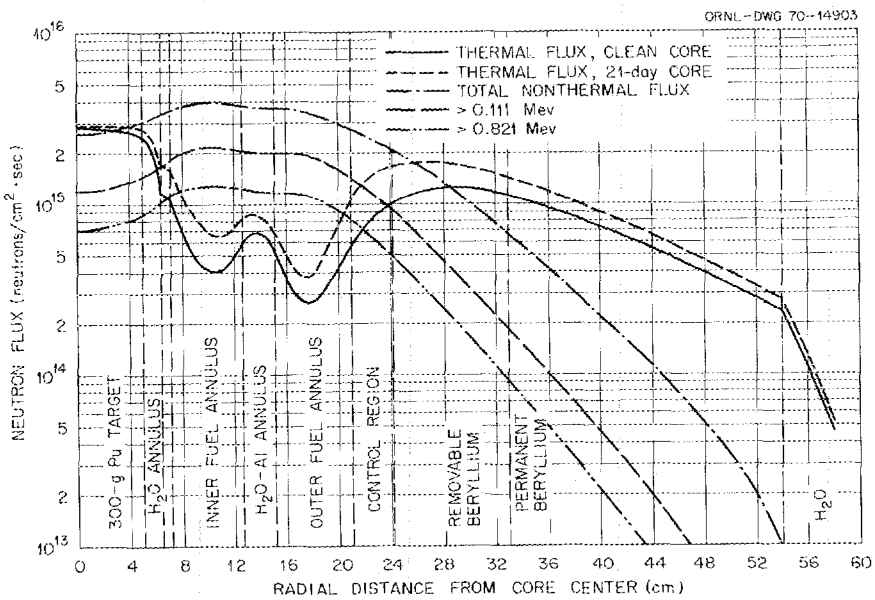

Fig. 5.1. Typical Radial Neutron Flux Distributions at Core Horizontal Midplane with Reactor Operating at 100 Mw.

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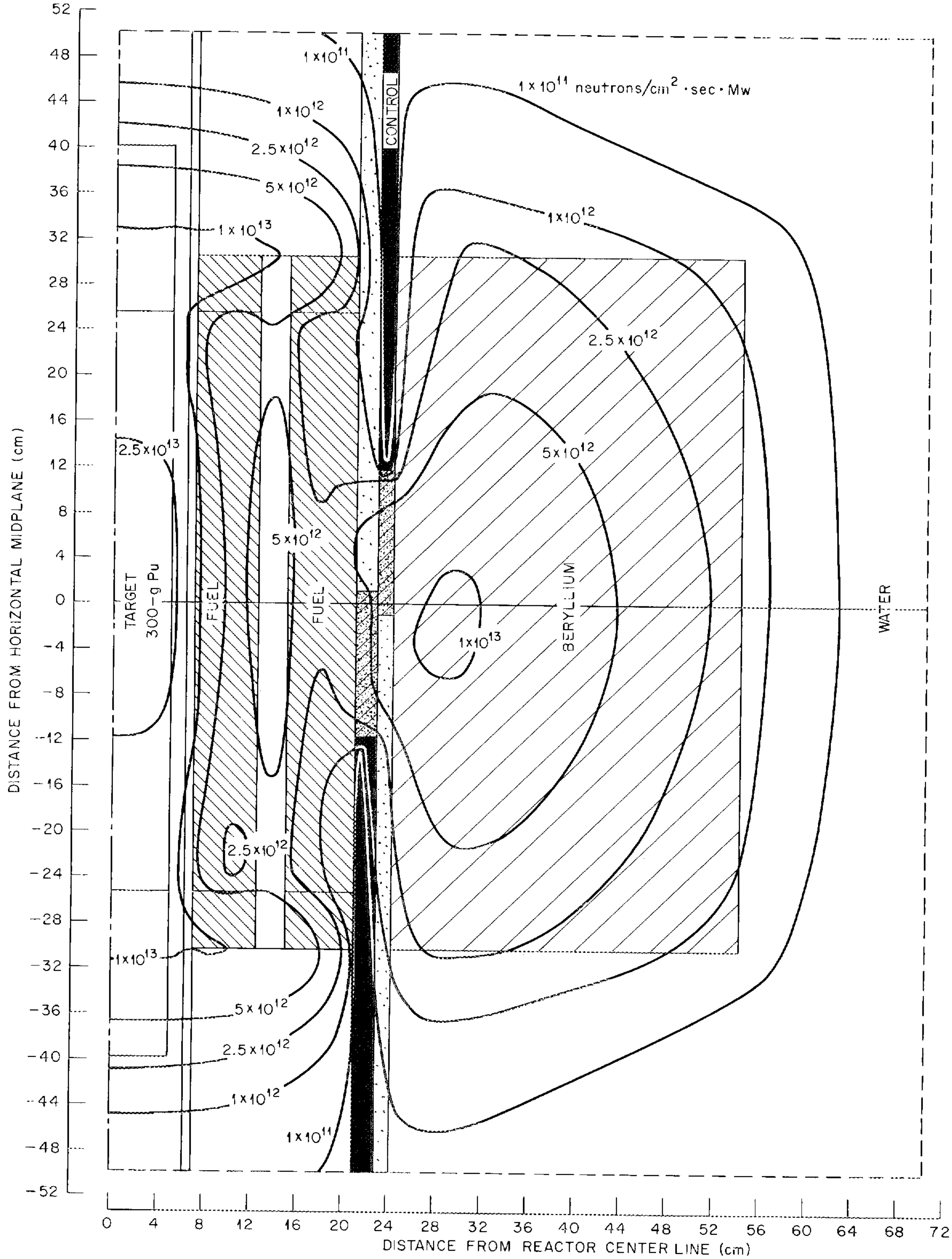

Fig. 5.2. Thermal Flux Per Unit Power in HFIRCE-4 Core in Clean Condition.

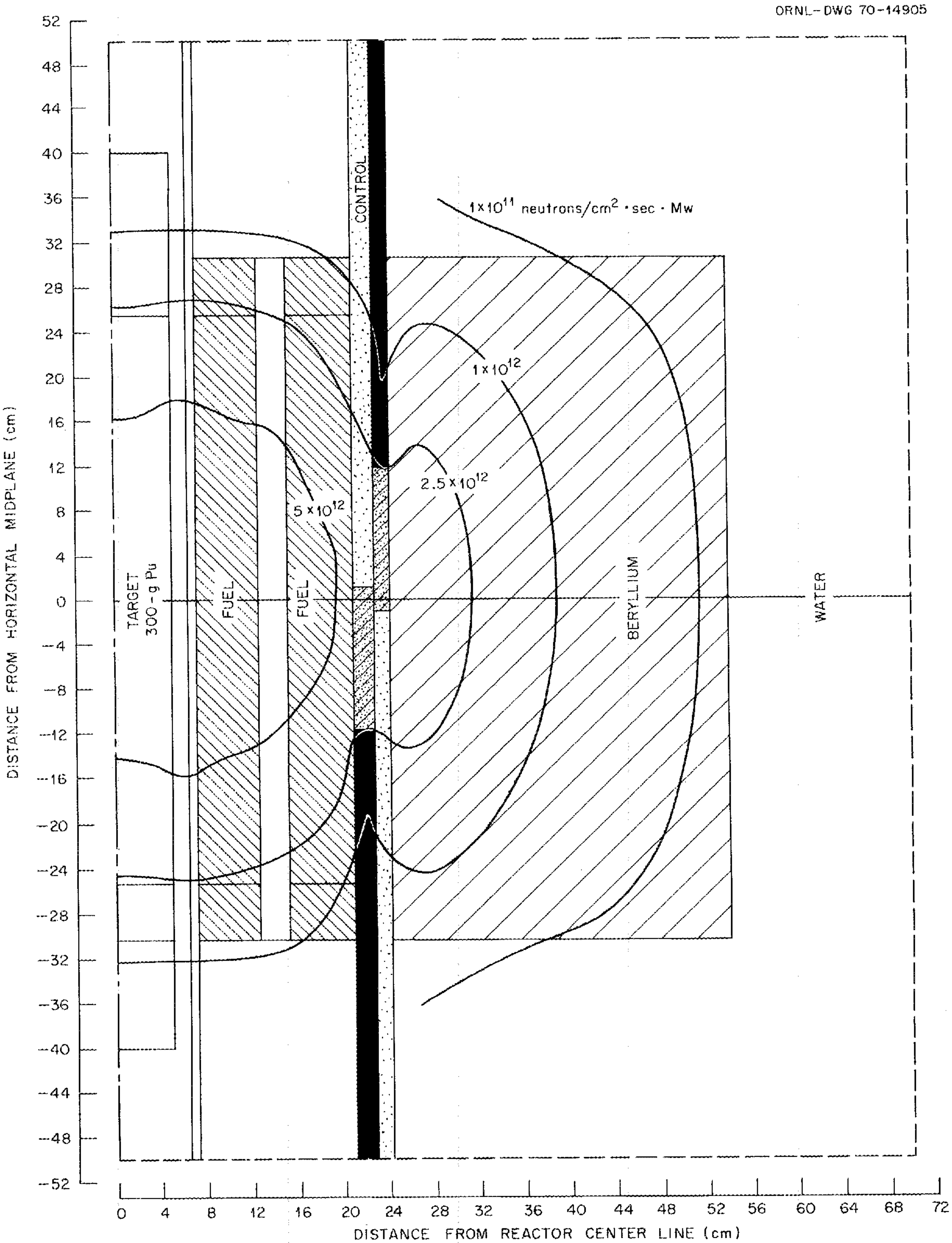

Fig. 5.3. Flux from 0.414 to 101 ev Per Unit Power in HFIRCE-4 Core in Clean Condition.

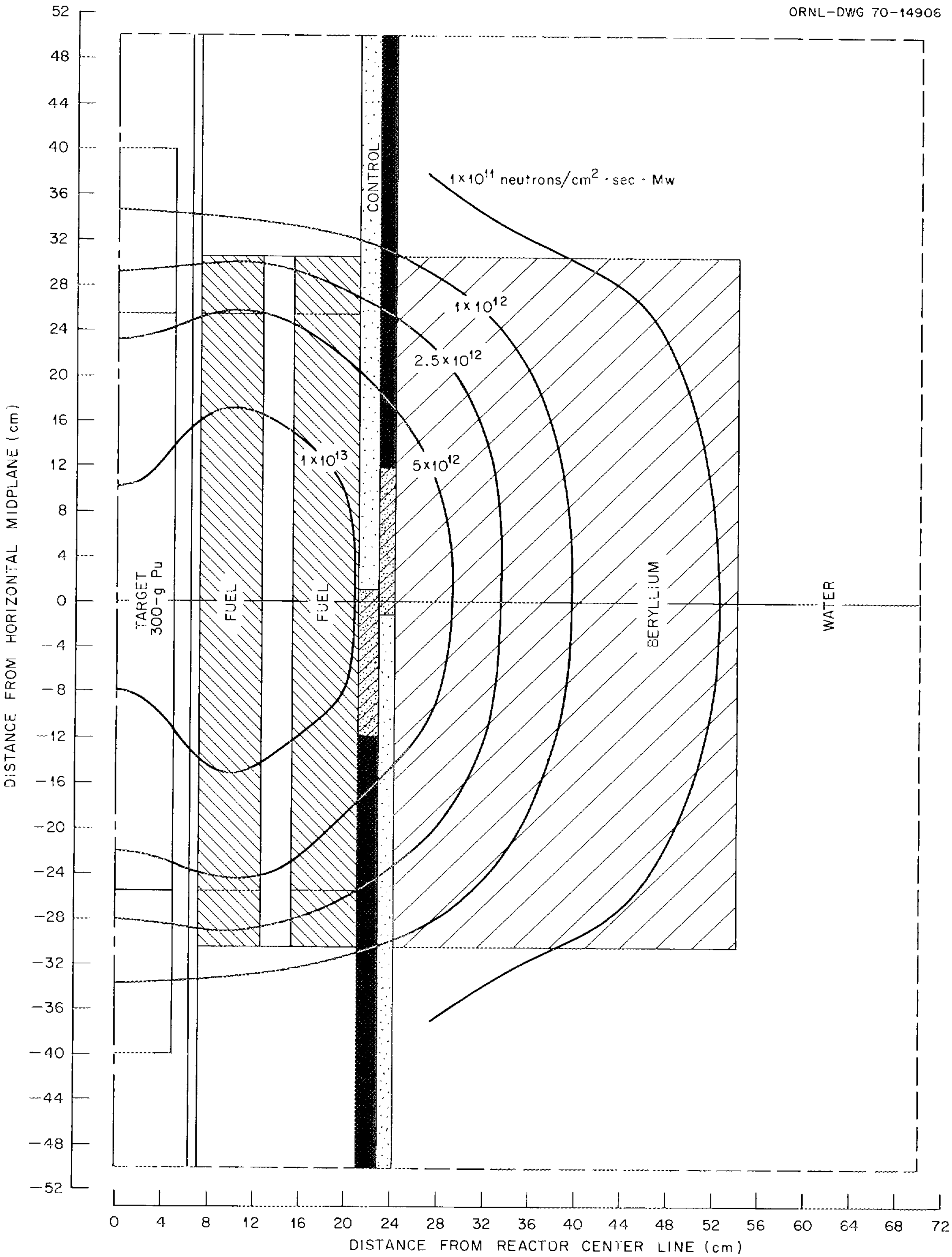

Fig. 5.4. Flux from 101 ev to 0.183 Mev Per Unit Power in HFIRCE-4 Core in Clean Condition.

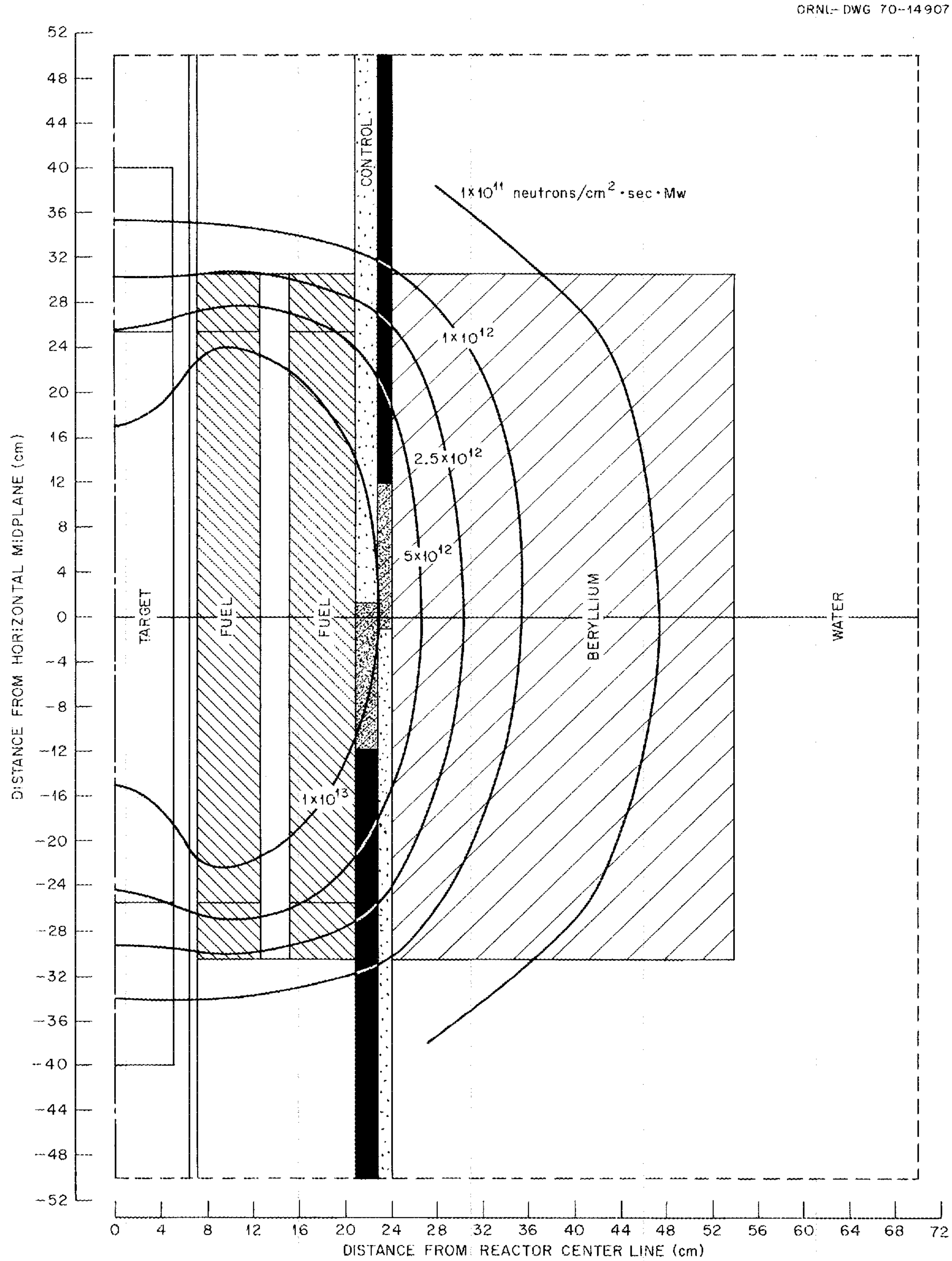

Fig. 5.5. Flux Above 0.183 Mev Per Unit Power in HFIRCE-4 Core in Clean Condition.

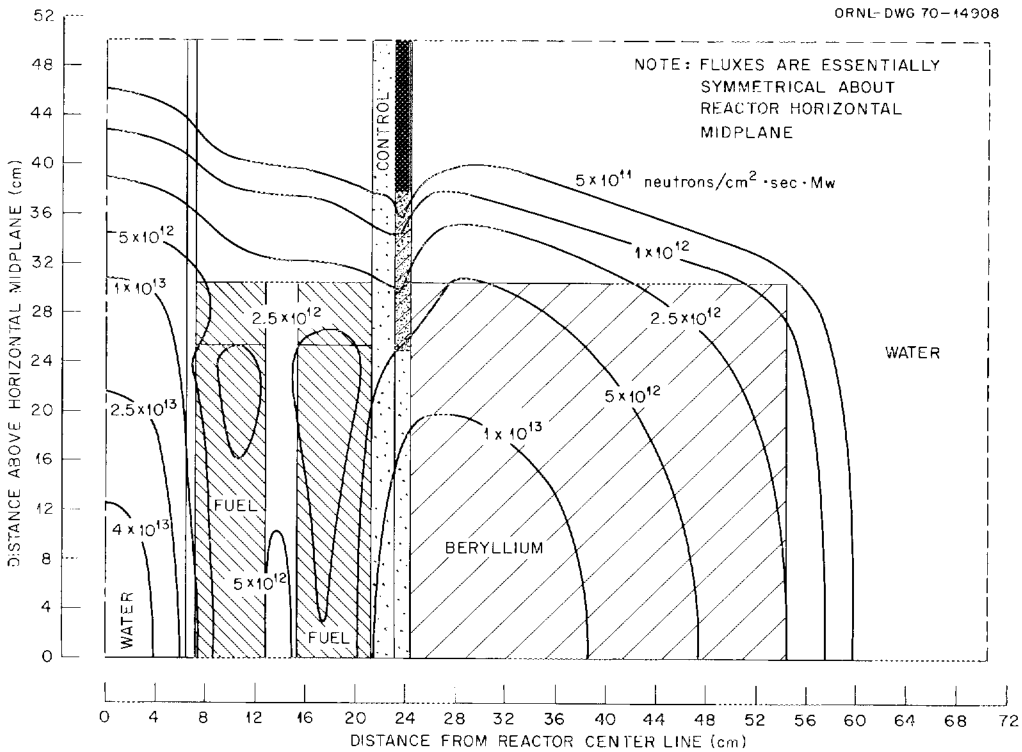

Fig. 5.6. Thermal Flux Per Unit Power in HFIRCE-4 Core with Rods Out, 1.35 g B/liter in Moderator, and No Target.

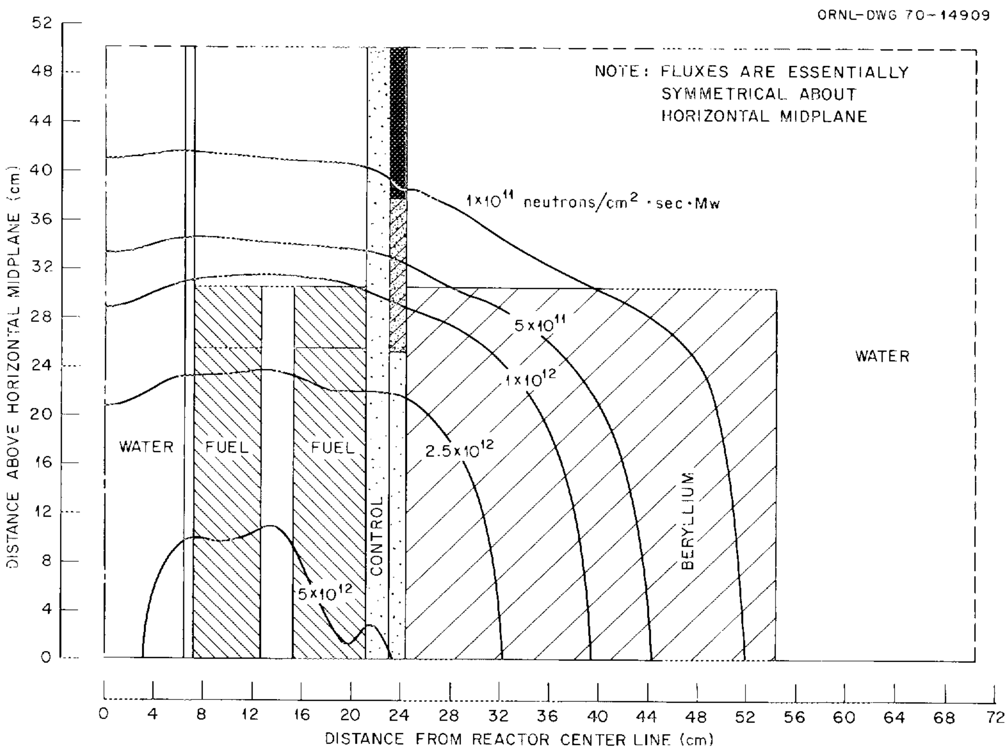

Fig. 5.7. Flux from 0.414 to 101 ev Per Unit Power in HFIRCE-4 Core with Rods Out, 1.35 g B/liter in Moderator, and No Target.

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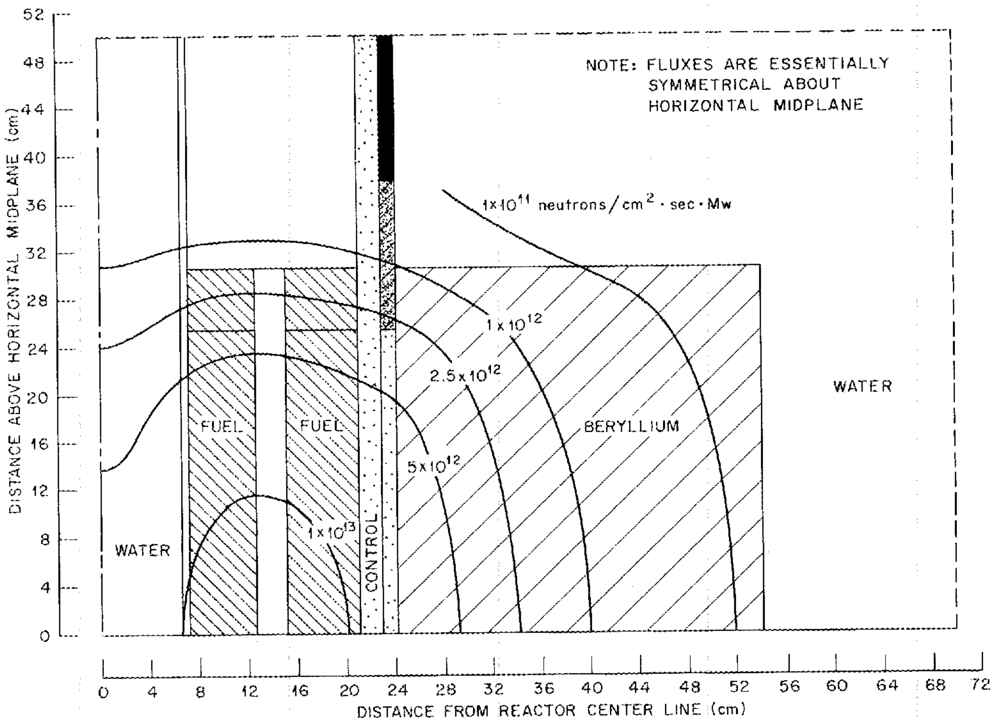

Fig. 5.8. Flux from 101 ev to 0.183 MeV Per Unit Power in HFIRCE-4 Core with Rods Out, 1.35 g B/liter in Moderator, and No Target.

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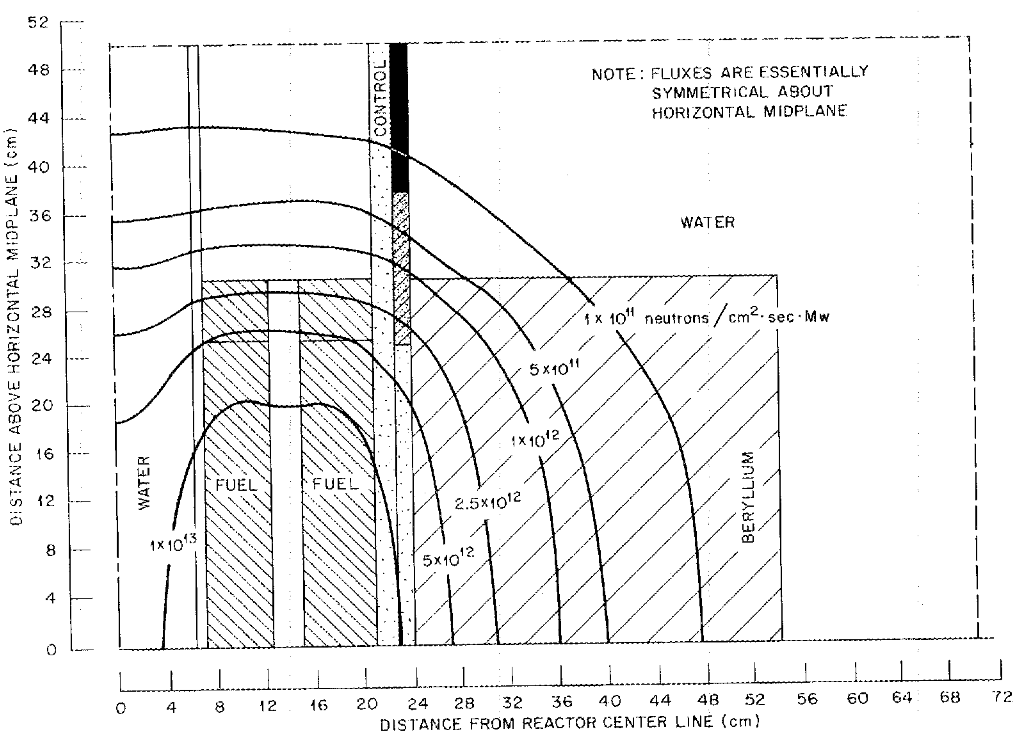

Fig. 5.9. Flux Above 0.183 Mev Per Unit Power in HFIRCE-4 Core with Rods Out, 1.35 g B/liter in Moderator, and No Target.

the effect of withdrawing the rods and also show flux distributions in the flux trap without a target.

As indicated in Fig. 5.1 the thermal flux in the flux trap changes very little with time in the fuel cycle, whereas the peak thermal flux in the beryllium reflector increases (according to this calculation) by about 80% from beginning to end of cycle. The big change is the result of control rod withdrawal.

Typical 33-group fluxes from a one-dimensional calculation are tabulated in Appendix C, along with factors for normalizing the computer output. In the following paragraphs flux characteristics in specific regions are discussed.

5.1 Flux-Trap Region

The thermal flux in the flux trap results primarily from the moderation in the trap of high-energy neutrons that leak out of the fuel region. Because of the large absorption cross section in the fuel region, relatively few low-energy neutrons leak from the fuel region to the flux trap. Thus, the thermal flux in the trap is reasonably independent of changes in the fuel region during a fuel cycle. Of greater importance are the number of neutrons produced (power density), the diameter of the trap (slowing-down distance and volume), and the moderating and absorption characteristics of the trap contents. Selection of trap size and moderator are discussed elsewhere in the report, but it is important to understand what changes in flux will occur as a result of changes in the target. It is also of interest to note the change in flux in the trap that is associated with a change in power distribution and absorption cross section in the fuel region. Such changes are shown in Fig. 5.10.

Curve 1 in Fig. 5.10 is a typical thermal-flux radial distribution in the flux trap without a target and with the core in the clean condition. If enough poison is uniformly added to the fuel region so that the reactor is critical with the rods fully withdrawn (curve 2), the increased fuel-region absorption and the change in power distribution decrease the peak thermal flux by only 10%. The insertion into the trap of an aluminum target without the feed material (curve 3) reduces the peak thermal flux by 27%, and the addition of the feed material (curve 4) subtracts another 21% (total of 48%).

The displacement of water by the target reduces moderation in the trap and thus reduces the thermal flux and increases the nonthermal flux. Curve 5 in Fig. 5.10 indicates what happens when the aluminum-to-water ratio in the trap is increased to 4.0 (the present target design has a metal-to-water ratio of 0.75). The decrease in peak thermal flux, compared with no target, is 78%; and the increase in total nonthermal flux is about 30%. Figures 5.11 and 5.12 show in greater detail the effect that increasing the aluminum-to-water ratio has on increasing the nonthermal fluxes.

With the 300-g plutonium target installed there is not much space left in the flux trap for other experimental assemblies. However, the "optimum-diameter" target does leave a narrow water annulus between the target and the inner fuel element that is being considered for materials irradiation. The effect of uniformly distributed void and absorber in this region on the average thermal flux in the plutonium target is shown in Fig. 5.13. Figure 5.14 shows how six experimental assemblies might actually be added to the narrow annulus. The numbers in the symmetrical segment indicate the thermal-flux perturbations resulting from the addition of the six materials-irradiation rods.

As indicated in Fig. 5.1, the variation in flux levels in the flux trap during a fuel cycle is not very large. Figure 5.15 shows in greater detail the variations in the peak thermal and total nonthermal fluxes as a function of time. The initial drop in fluxes reflects the buildup of xenon and the resultant shift in power distribution, both of which tend to reduce the flux trap thermal flux. The subsequent increase in thermal flux reflects the increase in fuel-region flux with fuel burnup. As explained in Chapter 8 the 23-day fuel-cycle calculations did not include long-lived fission-product buildup, and thus the calculated increase in flux-trap thermal flux is somewhat greater than would probably actually exist. Further details of the time dependence of neutron fluxes in the flux trap are given in Tables 5.1 through 5.5.

Table 5.1. Horizontal Midplane Thermal Neutron Fluxes at 100 Mw in the HFIR Flux Trap with Standard 300-g Plutonium Target Installed

Radial Distance from Reactor Longitudinal Center Line (cm)	Neutron Fluxes as a Function of Time in Fuel Cycle (neutrons/cm^2·sec)			
	0 Days	1 Day	11 Days	21 Days
	$\times 10^{15}$	$\times 10^{15}$	$\times 10^{15}$	$\times 10^{15}$
0	2.82	2.75	2.89	2.91
1	2.81	2.74	2.88	2.91
2	2.78	2.71	2.86	2.90
3	2.72	2.66	2.82	2.87
4	2.63	2.57	2.76	2.83
5	2.49	2.43	2.63	2.75
5.7	2.07	2.04	2.28	2.43
6.4	1.27	1.25	1.53	1.75

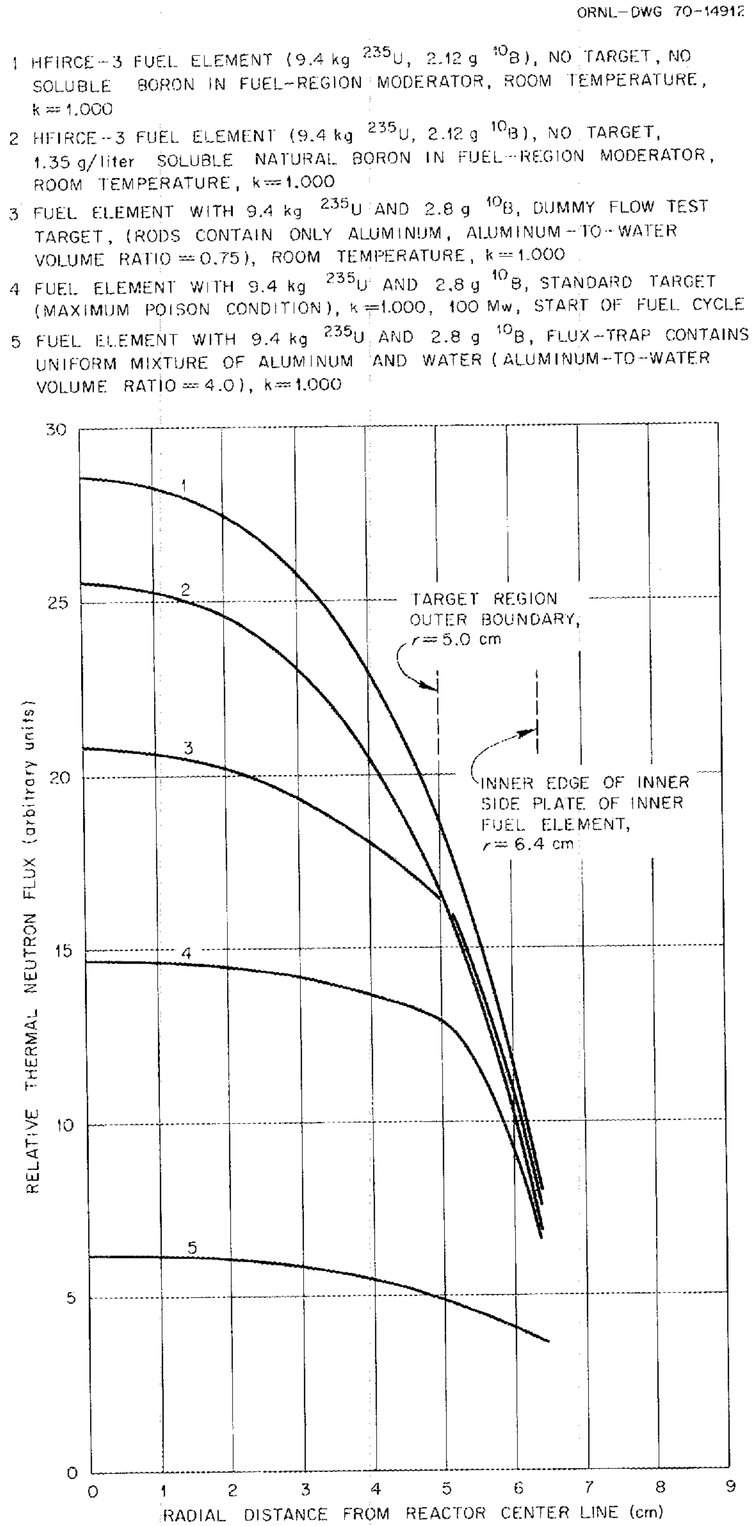

Fig. 5.10. Relative Thermal-Neutron Flux in HFIR Flux Trap for Various Flux Trap Conditions. All curves from one-dimensional 33-group diffusion-theory calculations.

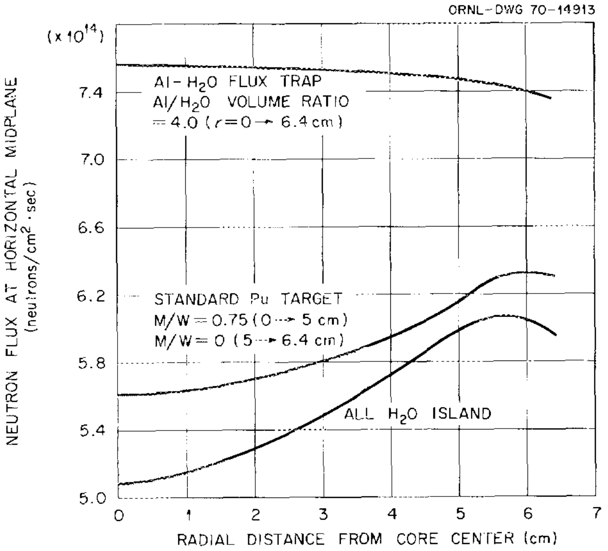

Fig. 5.11. Epithermal Flux (0.414 ev < E > 101 ev) in Flux Trap at Horizontal Midplane with Reactor Operating at 100 Mw.

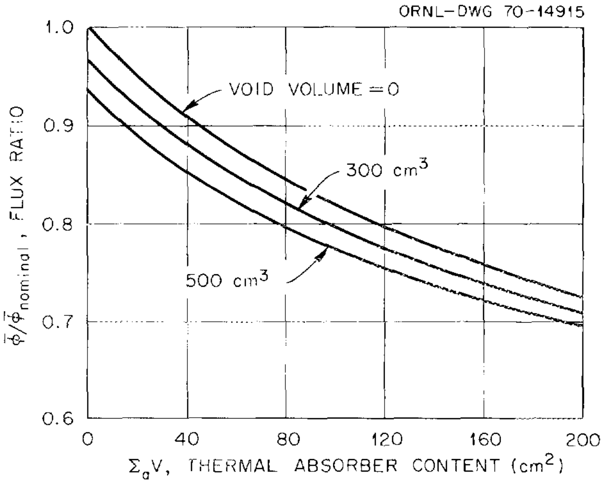

Fig. 5.13. Volume-Averaged Thermal-Neutron Flux in 300-g Plutonium Target Versus 1/v Absorber Content and Void Volume in Surrounding Water Region (r = 5.0 → 6.4 cm).

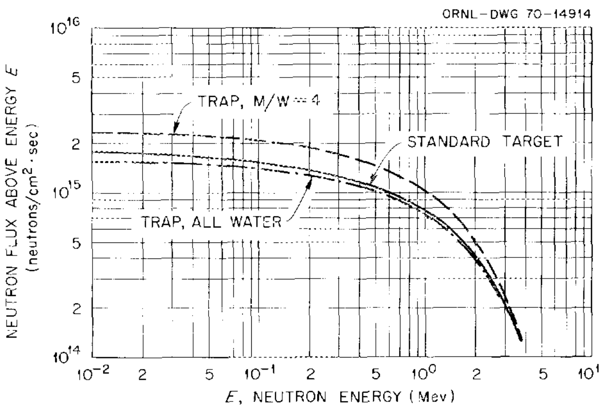

Fig. 5.12. Integral Fluxes in Flux Trap (r = 5 cm) at Horizontal Midplane with Reactor Operating at 100 Mw.

Table 5.2. Horizontal Midplane Flux of Neutrons Having Energies Between 0.414 and 101 ev at 100 Mw in the HFIR Flux Trap with Standard 300-g Plutonium Target Installed

Radial Distance from Reactor Longitudinal Center Line (cm)	Neutron Fluxes as a Function of Time in Fuel Cycle (neutrons/cm²·sec)			
	0 Days	1 Day	11 Days	21 Days
	$\times 10^{14}$	$\times 10^{14}$	$\times 10^{14}$	$\times 10^{14}$
0	5.61	5.46	5.55	5.40
1	5.63	5.48	5.57	5.42
2	5.69	5.54	5.63	5.49
3	5.79	5.64	5.74	5.60
4	5.94	5.79	5.90	5.77
5	6.16	6.01	6.14	6.02
5.7	6.32	6.17	6.32	6.23
6.4	6.30	6.17	6.35	6.30

Calculated axial thermal-flux shapes in the flux-trap region are shown in Figs. 5.16 and 5.17 for two critical experiment conditions: a clean core with the simulated 300-g plutonium target, and the fully poisoned core (rods out) with no target. Nonthermal axial distributions for the clean core condition are shown in Fig. 5.18.

Several experiments were performed for the purpose of measuring the fluxes in the flux trap. During some of the early critical experiments, ^{235}U and gold foils were irradiated in the flux trap without a target. Agreement between calculated and measured values was good, but those values have not been recalculated with the most recent methods. Measurements were made more recently in the HFIR facility, in which case the ability to go to elevated power improved the experimental accuracy. In one particular experiment[25] the flux trap contained a target consisting of 30 rods and the nuclear equivalent of 240 g of ^{242}Pu. Cobalt flux wires were inserted and removed by means of the hydraulic rabbit,

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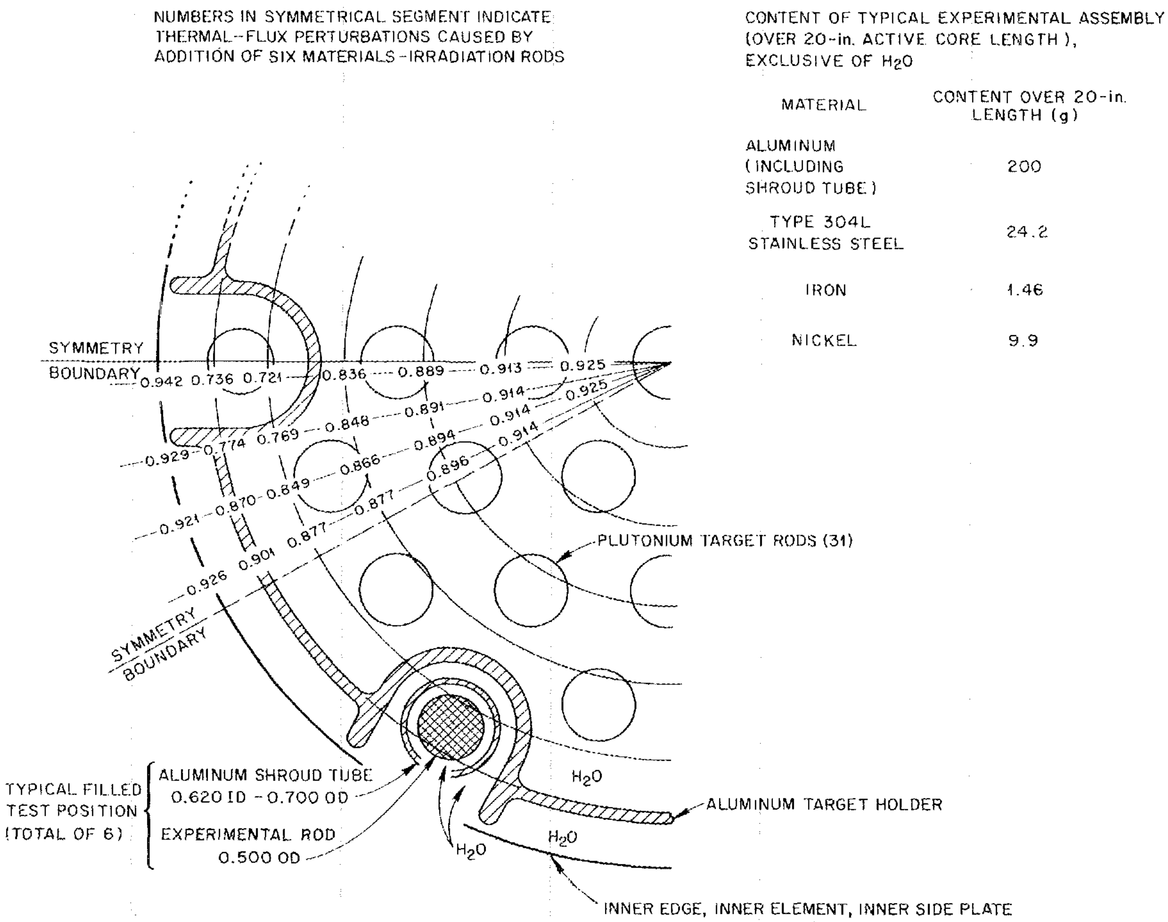

Fig. 5.14. Ratio of Thermal Flux in Plutonium Target with Six Materials-Testing Rods to That in the Standard Plutonium Target.

Table 5.3. Horizontal Midplane Flux of Neutrons Having Energies Between 101 ev and 0.183 Mev at 100 Mw in the HFIR Flux Trap with Standard 300-g Plutonium Target Installed

Radial Distance from Reactor Longitudinal Center Line (cm)	Neutron Fluxes as a Function of Time in Fuel Cycle (neutrons/cm^2·sec)			
	0 Days	1 Day	11 Days	21 Days
	$\times 10^{14}$	$\times 10^{14}$	$\times 10^{14}$	$\times 10^{14}$
0	9.08	8.81	8.95	8.64
1	9.13	8.87	9.00	8.70
2	9.31	9.02	9.16	8.85
3	9.56	9.27	9.43	9.10
4	9.93	9.64	9.77	9.47
5	10.3	10.1	10.2	9.89
5.7	10.8	10.5	10.7	10.4
6.4	11.4	11.1	11.3	11.0

Table 5.4. Horizontal Midplane Flux of Neutrons Having Energies Between 0.183 and 0.821 Mev at 100 Mw in the HFIR Flux Trap with Standard 300-g Plutonium Target Installed

Radial Distance from Reactor Longitudinal Center Line (cm)	Initial Neutron Flux (neutrons/cm^2·sec)
	$\times 10^{14}$
0	4.10
1	4.14
2	4.23
3	4.25
4	4.43
5	4.68
5.7	5.40
6.4	5.94

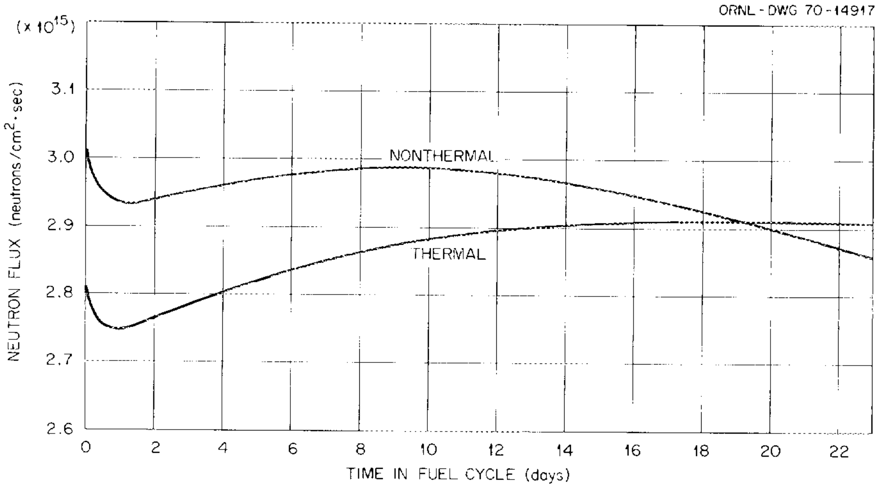

Fig. 5.15. Calculated Peak Neutron Fluxes in HFIR Target Versus Time in Fuel Cycle for 100-Mw Operation with Maximum Poison Target.

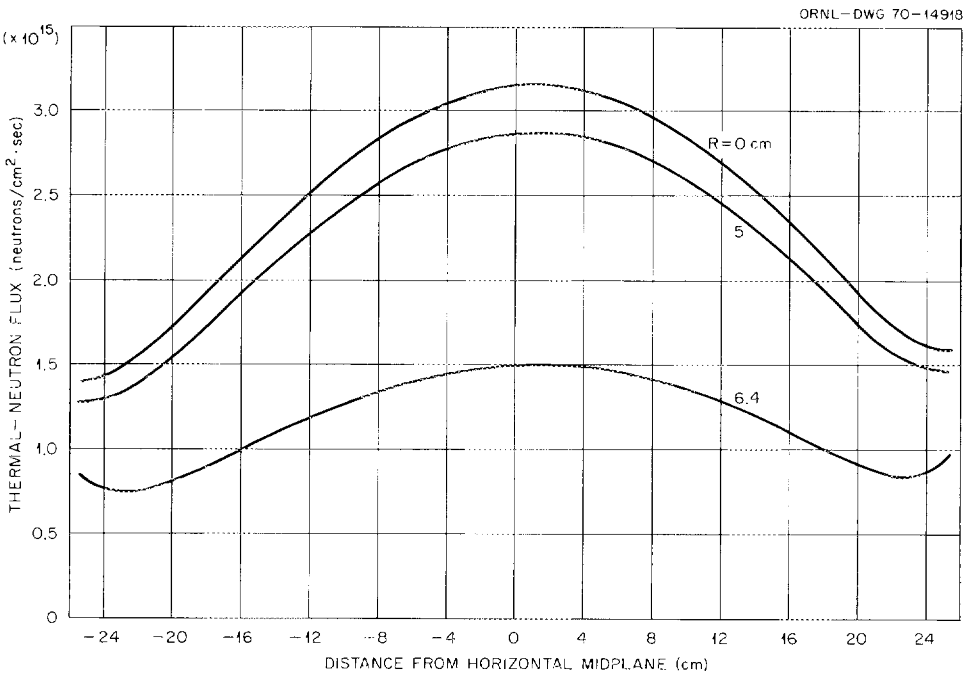

Fig. 5.16. Thermal-Flux Axial Profile in Flux Trap with 300-g Plutonium Target and Clean Core Condition, HFIRCE-4.

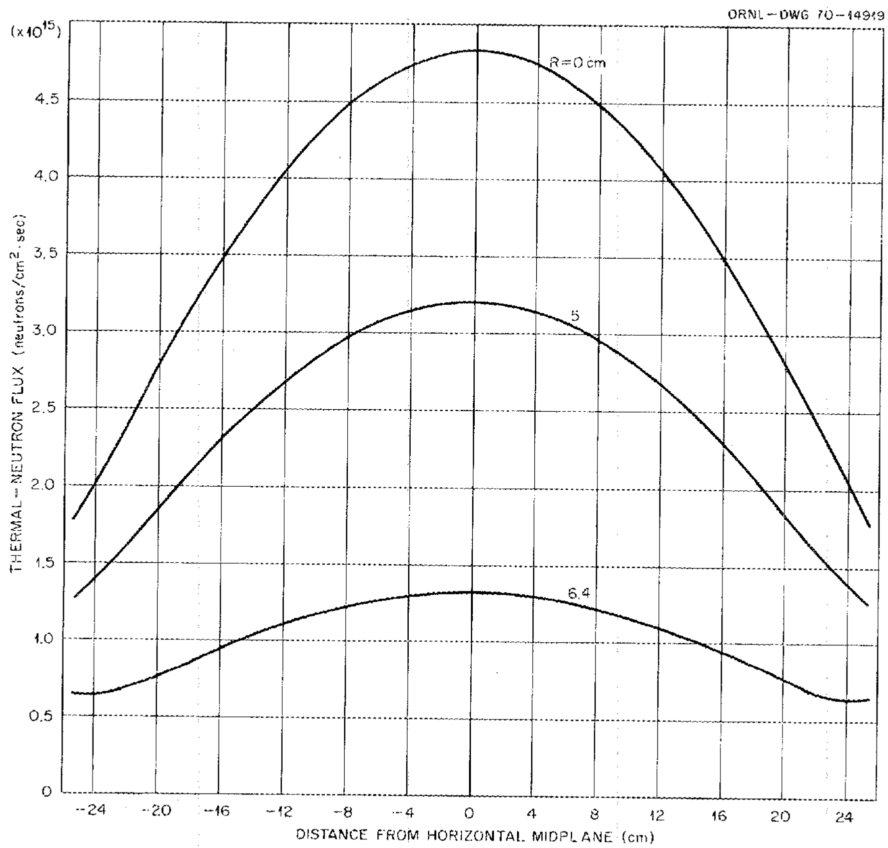

Fig. 5.17. Thermal-Flux Axial Profile in Flux Trap Without Target, Rods Out, and 1.35 g B/liter in Moderator, HFIRCE-4.

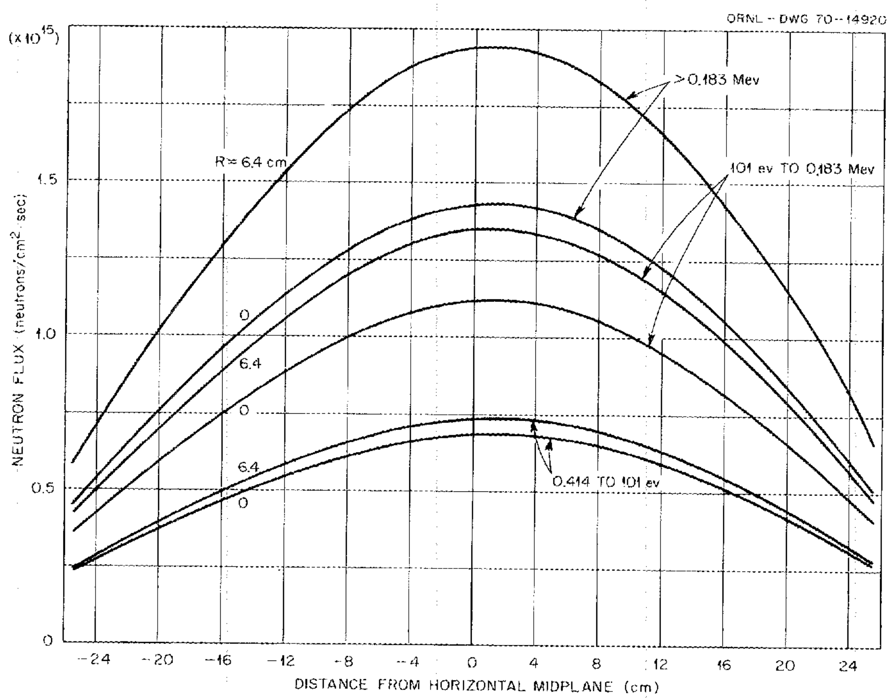

Fig. 5.18. Nonthermal-Flux Axial Profiles in Flux Trap with 300-g Plutonium Target and Clean Core Condition, HFIRCE-4.

Table 5.5. Horizontal Midplane Flux of Neutrons Having Energies Greater than 0.821 Mev at 100 Mw in the HFIR Flux Trap with Standard 300-g Plutonium Target Installed

Radial Distance from Reactor Longitudinal Center Line (cm)	Initial Neutron Flux (neutrons/cm^2·sec)
	$\times 10^{14}$
0	7.05
1	7.11
2	7.30
3	7.62
4	8.08
5	8.69
5.7	9.38
6.4	10.30

which is on the core vertical center line. The peak thermal flux at 100 Mw was determined to be 3.5 X 10^{15} neutrons cm^2·sec ±10%; the corresponding calculated value was 3.1 X 10^{15} neutrons/cm^2·sec.

Several other measurements were made to obtain axial profiles, in which case both thermal and some higher energy fluxes were determined. Comparisons between calculated and measured axial flux shapes are shown in Figs. 5.19 through 5.22.

5.2 Beryllium-Reflector Region

Thermal fluxes in the beryllium reflector have about the same intrinsic sensitivity to core variations as do the flux-trap thermal fluxes. However, there is an additional and relatively large effect that results from movement of the control rods. The calculated effect for typical HFIR conditions is shown in Fig. 5.1 and also in Tables 5.6 through 5.10, which list thermal and nonthermal fluxes at the centers of the vertical experimental facilities (VXF) at different times in a fuel cycle. Calculated axial flux plots are shown in Figs. 5.23 through 5.29, and horizontal midplane (HMP) integral nonthermal fluxes are shown in Fig. 5.30. These latter fluxes correspond to typical HFIR operating conditions, while the data in Figs. 5.23 through 5.29 correspond to HFIRCE-4 conditions, with the exceptions that full-power temperatures and densities were used. The beginning-of-cycle core included a typical flux-trap target, and the end-of-cycle core had soluble poison in the fuel region and no target in the flux trap. Actually, reasonable variations in flux-trap content and fuel-region soluble-poison content have little effect on reflector fluxes.

The exact locations of the experimental facilities are shown in Figs. 3.1 and 3.2, and pertinent dimensions and other related information are given in Table 5.11.

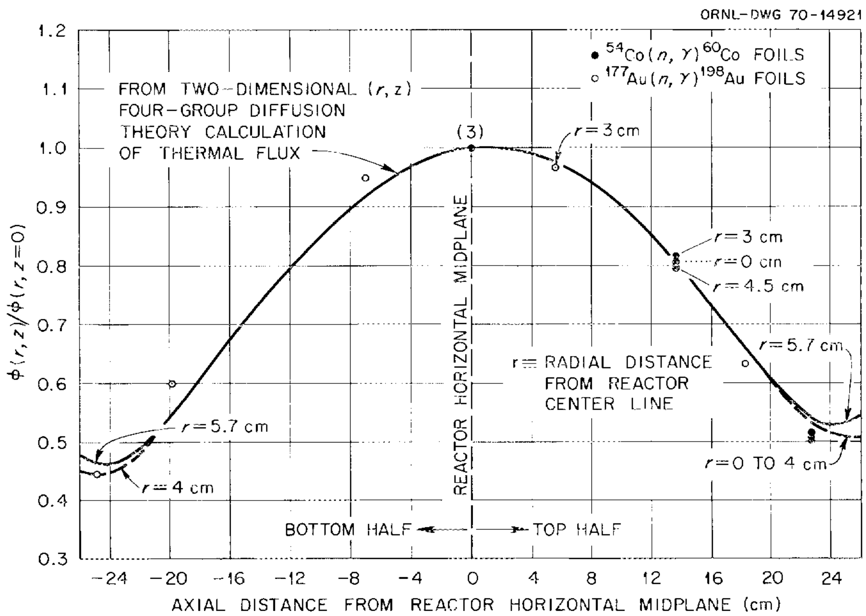

Fig. 5.19. Comparison of Cobalt and Gold Foil Data with Calculated Axial Distribution of Thermal Flux in HFIR Target Region.

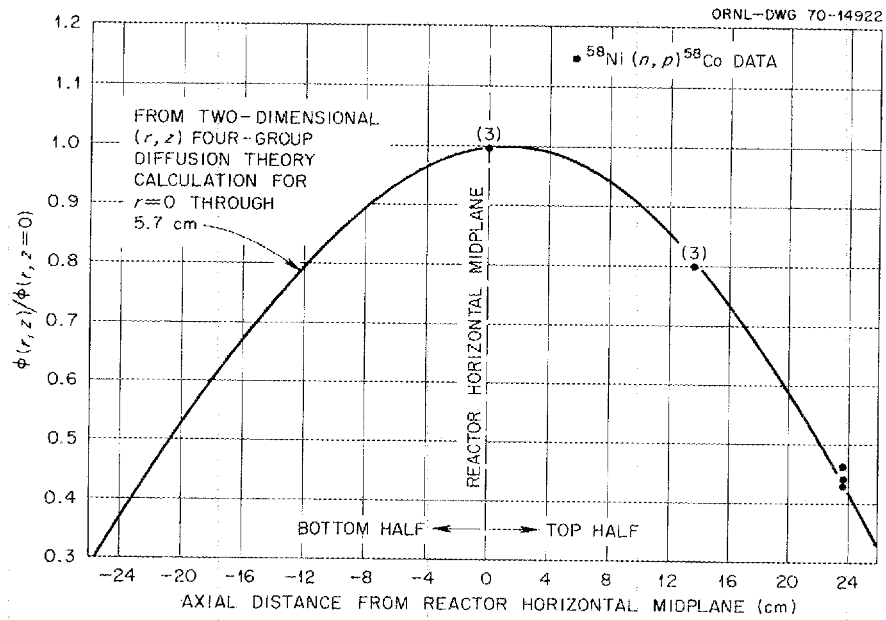

Fig. 5.20. Comparison of ^{58}Ni(n,p)^{58}Co Data with Calculated Axial Distribution of Flux Having Energies Greater Than 0.183 Mev in HFIR Flux Trap.

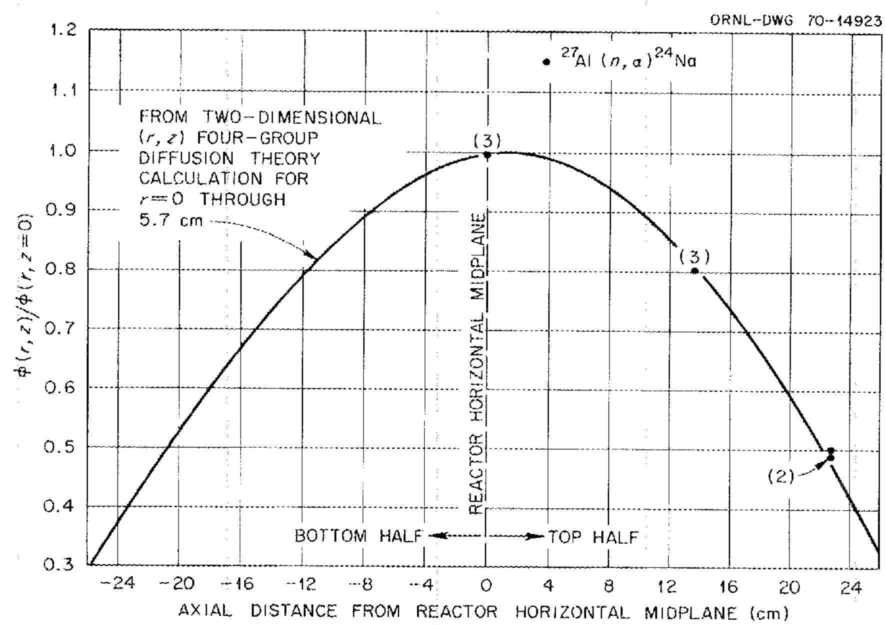

Fig. 5.21. Comparison of ^{27}Al(n,α)^{24}Na Data with Calculated Axial Distribution of Flux of Neutrons Having Energies Greater Than 0.183 Mev in HFIR Flux Trap.

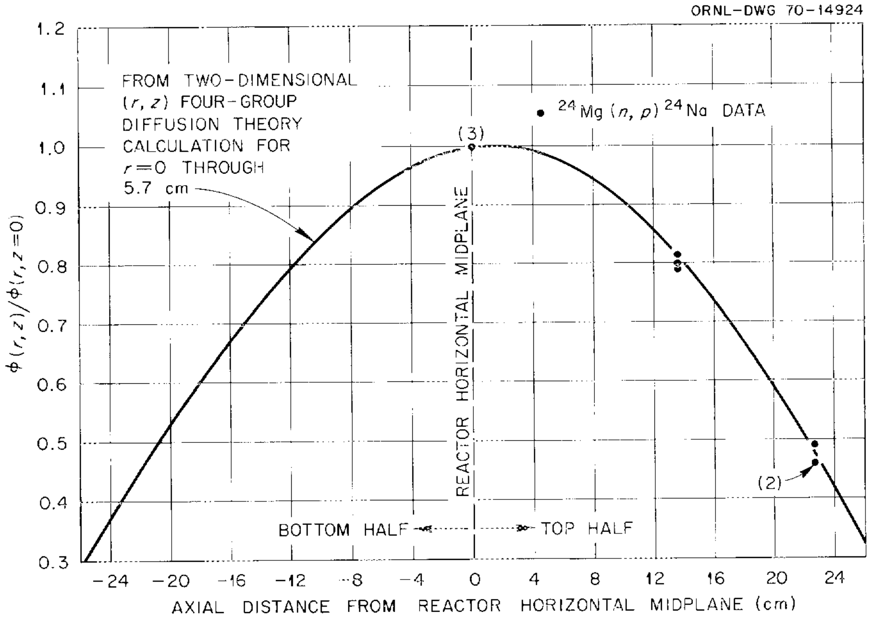

Fig. 5.22. Comparison of $^{24}Mg(n,p)^{24}Na$ Data with Calculated Axial Distribution of Flux of Neutrons Having Energies Greater Than 0.183 Mev in HFIR Flux Trap.

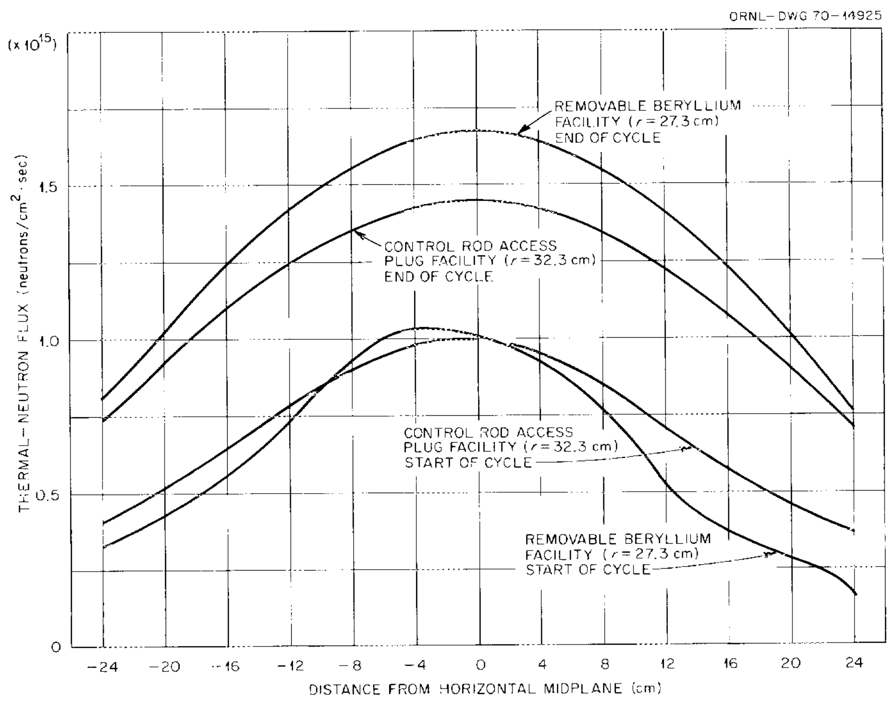

Fig. 5.23. Thermal-Flux Axial Profiles in Removable Beryllium Reflector Experiment Facilities at 100 Mw.

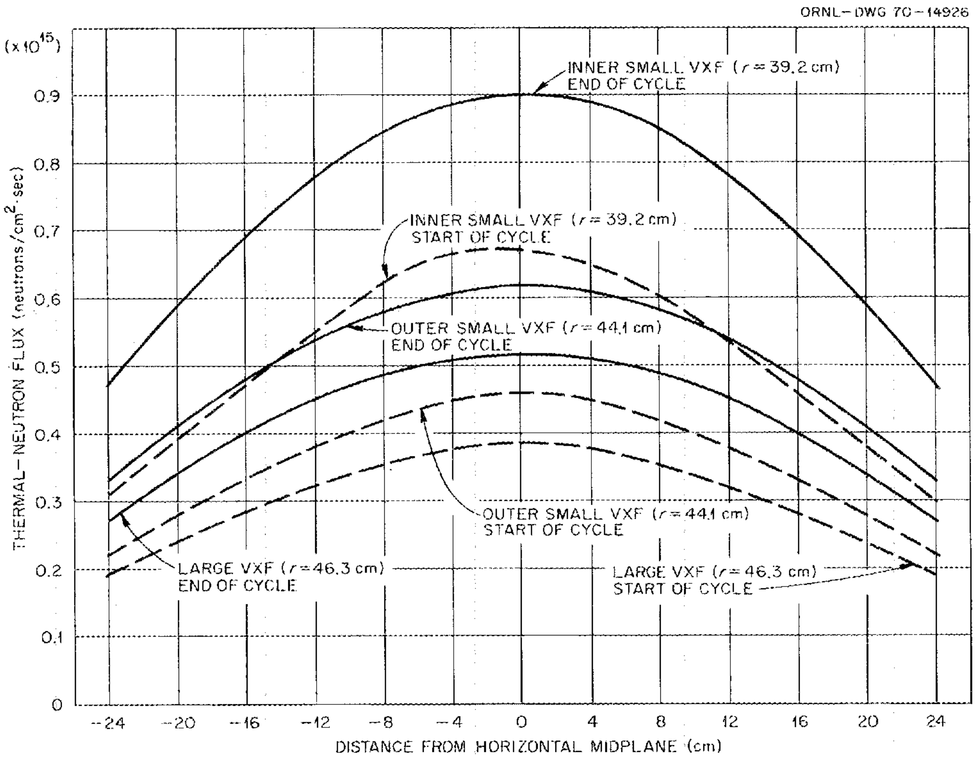

Fig. 5.24. Thermal-Flux Axial Profiles in Permanent Beryllium Reflector Vertical Experiment Facilities (VXF) at 100 Mw.

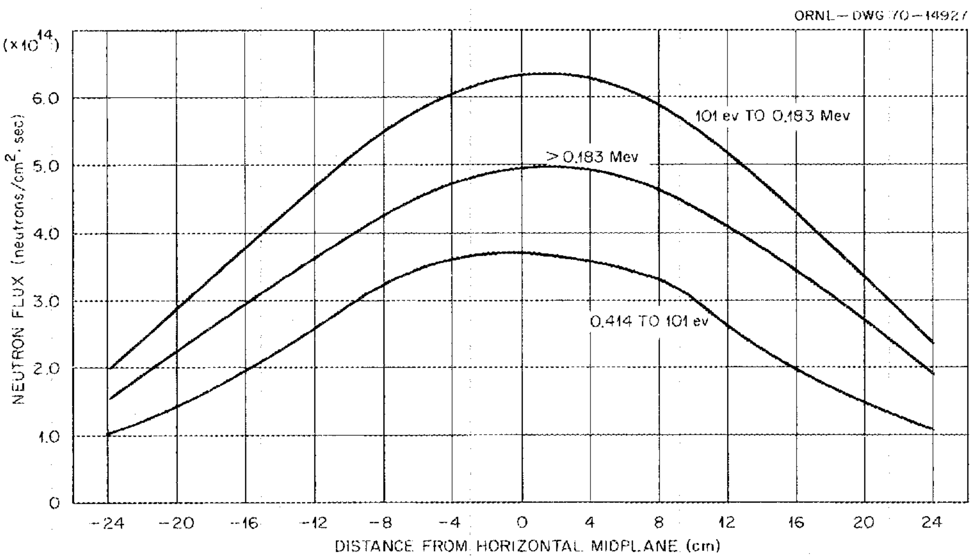

Fig. 5.25. Nonthermal-Flux Axial Profiles in Removable Beryllium Experiment Facilities (r = 27.3 cm) at 100 Mw.

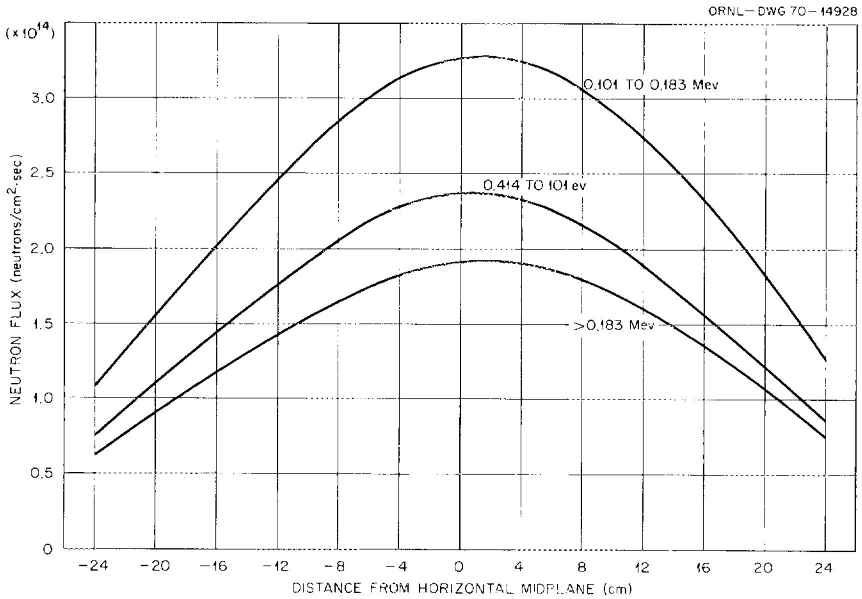

Fig. 5.26. Nonthermal-Flux Axial Profiles in Control Rod Access Plug Experiment Facilities (r = 32.3 cm) at 100 Mw.

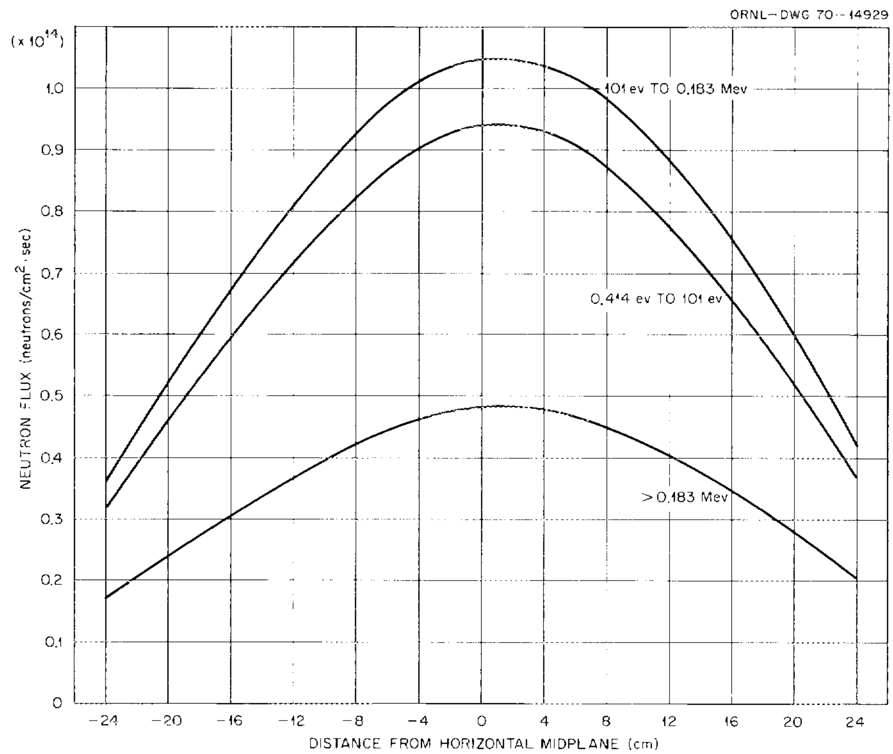

Fig. 5.27. Nonthermal-Flux Axial Profiles in Inner Small Vertical Experiment Facilities (r = 39.2 cm) at 100 Mw.

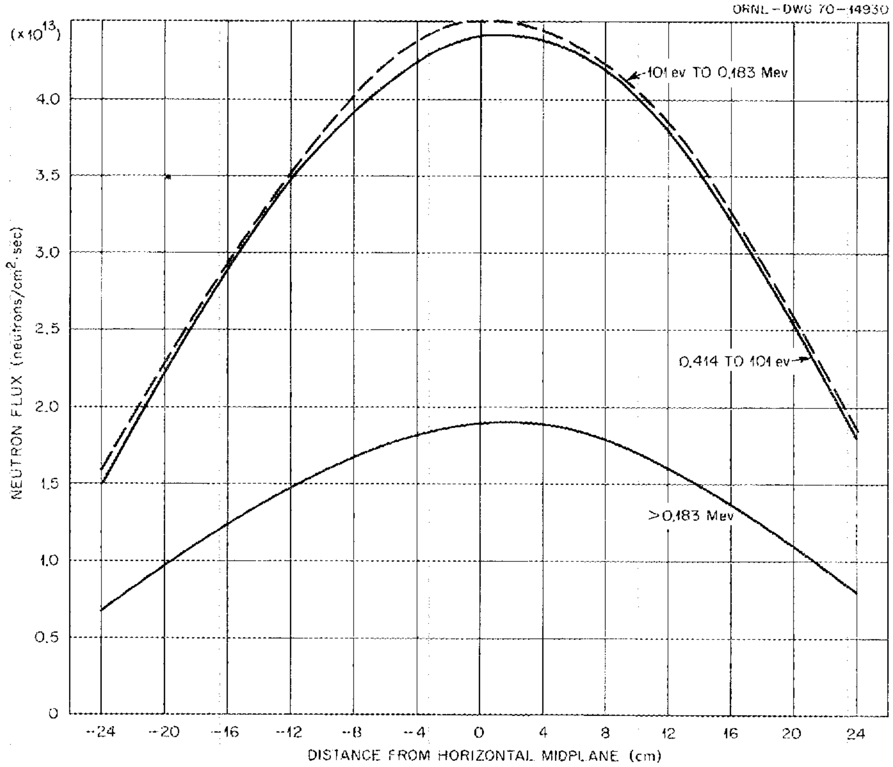

Fig. 5.28. Nonthermal-Flux Axial Profiles in Outer Small Vertical Experiment Facilities (r = 44.1 cm) at 100 Mw.

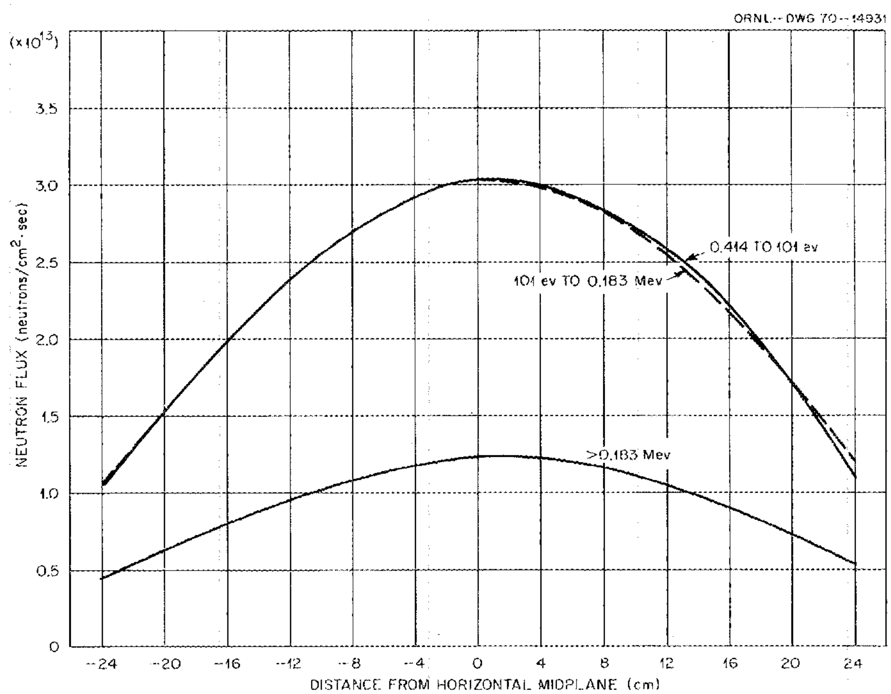

Fig. 5.29. Nonthermal-Flux Axial Profiles in Large Vertical Experiment Facilities (r = 46.3 cm) at 100 Mw.

Table 5.6. Time-Dependent Horizontal Midplane Thermal-Neutron Fluxes at 100 Mw at the Center Line of the Vertical Experimental Facilities (VXF) in the Beryllium Reflector

Facility	Radial Distance Between Reactor Center Line and Facility Center Line (cm)	Neutron Fluxes as a Function of Time in Fuel Cycle (neutrons/cm^2·sec)			
		0 Days	1 Day	11 Days	21 Days
		$\times 10^{15}$	$\times 10^{15}$	$\times 10^{15}$	$\times 10^{15}$
Large and small removable-beryllium facilities	27.3	1.22	1.42	1.51	1.74
Control-rod access-plug facilities	32.3	1.15	1.28	1.33	1.47
Inner small VXF	39.2	0.79	0.87	0.89	0.97
Outer small VXF	44.1	0.55	0.60	0.62	0.66
Large VXF	46.3	0.47	0.51	0.52	0.56

Table 5.7. Time-Dependent Horizontal Midplane Flux of Neutrons Having Energies Between 0.414 and 101 ev at 100 Mw at the Center Lines of the Vertical Experimental Facilities (VXF) in the Beryllium Reflector

Facility	Radial Distance Between Reactor Center Line and Facility Center Line (cm)	Neutron Fluxes as a Function of Time in Fuel Cycle (neutrons/cm^2·sec)			
		0 Days	1 Day	11 Days	21 Days
		$\times 10^{14}$	$\times 10^{14}$	$\times 10^{14}$	$\times 10^{14}$
Large and small removable-beryllium facilities	27.3	3.96	4.01	4.03	4.14
Control-rod access-plug facilities	32.3	2.38	2.46	2.44	2.48
Inner small VXF	39.2	1.02	1.04	1.03	1.05
Outer small VXF	44.1	0.47	0.48	0.48	0.48
Large VXF	46.3	0.33	0.34	0.34	0.34

Table 5.8. Time-Dependent Horizontal Midplane Flux of Neutrons Having Energies Between 101 ev and 0.183 Mev at 100 Mw at the Center Lines of the Vertical Experimental Facilities (VXF) in the Beryllium Reflector

Facility	Radial Distance Between Reactor Center Line and Facility Center Line (cm)	Neutron Fluxes as a Function of Time in Fuel Cycle (neutrons/cm^2·sec)			
		0 Days	1 Day	11 Days	21 Days
		$\times 10^{14}$	$\times 10^{14}$	$\times 10^{14}$	$\times 10^{14}$
Large and small removable-beryllium facilities	27.3	6.34	6.59	6.53	6.62
Control-rod access-plug facilities	32.3	3.23	3.32	3.28	3.34
Inner small VXF	39.2	1.12	1.15	1.14	1.16
Outer small VXF	44.1	0.45	0.47	0.46	0.47
Large VXF	46.3	0.31	0.32	0.31	0.32

Table 5.9. Horizontal Midplane Flux for Neutrons Having Energies Between 0.183 and 0.821 Mev at 100 Mw at the Center Lines of the Vertical Experimental Facilities (VXF) in the Beryllium Reflector

Facility	Radial Distance Between Reactor Center Line and Facility Center Line (cm)	Initial Neutron Flux (neutrons/cm^2·sec)
		$\times 10^{14}$
Large and small removable-beryllium facilities	27.3	2.16
Control-rod access-plug facilities	32.3	0.801
Inner small VXF	39.2	0.227
Outer small VXF	44.1	0.0858
Large VXF	46.3	0.0578

Table 5.10. Horizontal Midplane Flux for Neutrons Having Energies Between 0.821 and 10 Mev at 100 Mw at the Center Lines of the Vertical Experimental Facilities (VXF) in the Beryllium Reflector

Facility	Radial Distance Between Reactor Center Line and Facility Center Line (cm)	Initial Neutron Flux (neutrons/cm^2·sec)
		$\times 10^{14}$
Large and small removable-beryllium facilities	27.3	2.82
Control-rod access-plug facilities	32.3	1.01
Inner small VXF	39.2	0.280
Outer small VXF	44.1	0.105
Large VXF	46.3	0.0704

Table 5.11. Location of Vertical Experiment Facilities (VXF) in HFIR Beryllium Reflector

Facility	Facility Designations (see Fig. 3.1)	Total Number of Facilities of This Type	Radial Distance Between Reactor Center Line and Facility Center Line (cm)
Large removable-beryllium facilities	RB-1, -3, -5, -7	4	27.3
Small removable-beryllium facilities	RB-2, -4, -6, -8	4	27.3
Control-rod access-plug facilities	CR-1 through -8	8	32.3
Inner small VXF	VXF-1, -3, -5, -7, -9, -11, -13, -15, -18, -20, -22	11	39.2
Outer small VXF	VXF-2, -4, -8, -10, -12	5	44.1
Large VXF	VXF-6, -14, -16, -17, -19, -21	6	46.3

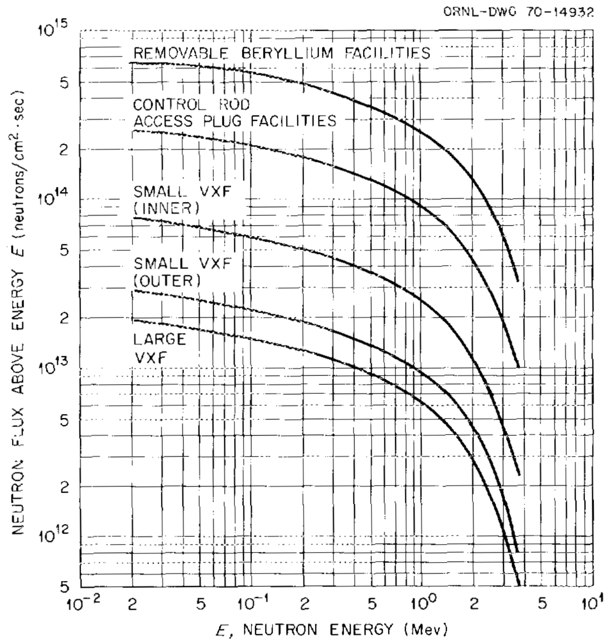

Fig. 5.30. Integral Fluxes in Beryllium Experimental Facilities in Horizontal Midplane at 100 Mw.

The accuracy of calculated flux values in the beryllium reflector is not expected to be so good as that in the flux trap, particularly when the facilities contain experiments. Some experimental data from early critical experiments indicated that with the control rods out the agreement between experimental and calculated fluxes at the outer beryllium-water interface was good (±10%). However, based on comparisons of calculated and measured power densities next to the control regions, it is expected that with the rods partially inserted the calculated fluxes in the reflector close to the control region would be less accurate. At the present time there are not enough good measurements with which to make a meaningful comparison of absolute values.

The variation in reflector peak thermal flux shown in Fig. 5.1 is probably greater than actually exists. The reason for this is that the one-dimensional calculation does not account for the window peaking effect* when the control rods are partially withdrawn, such as at the beginning of a cycle. This effect tends to boost the thermal-flux peak at the horizontal midplane at the beginning of the cycle. (This is important from the standpoint of achieving nearly constant currents in the horizontal beam tubes.) To check on this, axial traverses of reflector thermal fluxes were obtained with a self-powered rhodium detector in one of the VXF facilities (see Fig. 3.1). The results of these experiments are shown in Fig. 5.31. As indicated the maximum change in horizontal midplane thermal flux was only about 5%. In this particular case the first traverse was made just after achieving equilibrium xenon; therefore the complete change was not recorded. However, a comparison with the one-dimensional calculation of flux versus time (see Table 5.6) indicates the actual change to be much less than that calculated.

*As indicated in Fig. 1.1, withdrawal of the control rods creates a neutron window in the control region at the horizontal midplane.

5.3 Beam-Hole Fluxes

During the early operational phases of the HFIR, preliminary exploratory neutron-flux and neutron and gamma-ray spectra measurements were made in beam holes HB-2 (radial beam tube) and HB-3 (tangential beam tube). The results have been reported in detail by Blosser and Thomas[26] and are briefly summarized here.

Figure 5.32 shows the orientation of the beam tubes with respect to the reactor core at the horizontal midplane. The shutter and collimator arrangement used in the experiments is shown in Fig. 5.33. The collimators were designed so that they would fit either beam tube, which allowed a given collimator-shutter opening arrangement to be used as the experiment required. For the high-intensity beam, which was used in measuring the emergent neutron fluxes, the shutter opening was 3.5 in. in diameter; the length of the beam tube from the shutter to the detector position was 6 ft, and an air gap of 6 in. existed between the shutter and the leading edge of the beam.

Results of the thermal-flux measurements are summarized in Table 5.12. The experimenters estimated the total accumulated error for both the thermal- and nonthermal-flux measurements to be approximately ±14%. The results of the epithermal flux measurements are given in Table 5.13 in terms of flux per unit lethargy per unit power and flux per unit energy per unit power versus energy in the epithermal region.

The results of fast-flux measurements made with ^{32}S, ^{24}Mg, and ^{27}Al detectors are summarized in Table 5.14.

The above measurements were made at a specific time in a fuel cycle (about midway) and thus do not reflect the variation of beam current with time. A time-

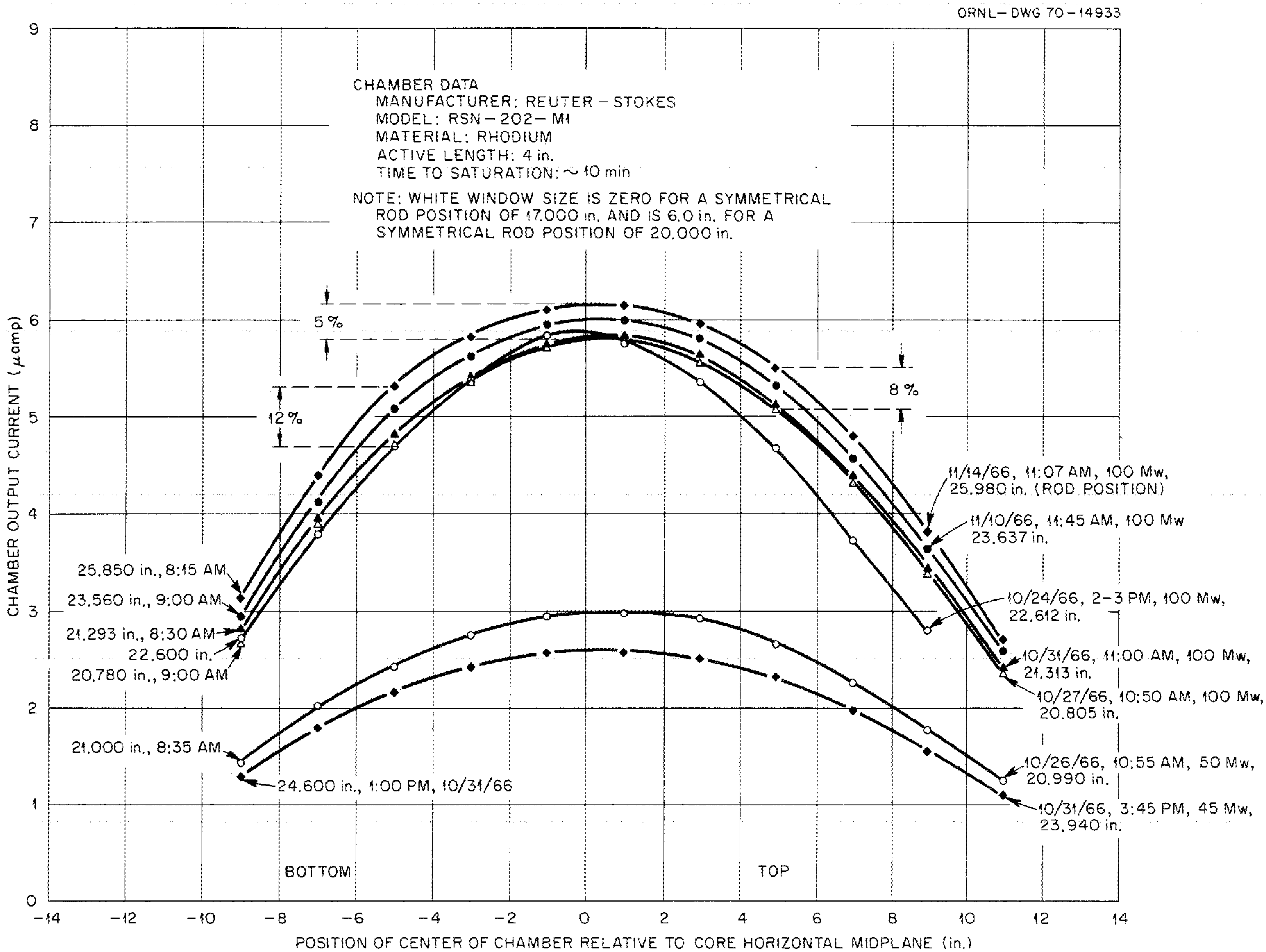

Fig. 5.31. Axial Thermal Flux Shapes at r = 44.1 cm for Various Symmetrical Rod Positions. Fluxes measured with self-energizing chamber.

Table 5.12. Thermal Flux Per Unit Power and Cadmium Ratios of the Various Detectors Used in Beam Tubes HB-2 and HB-3

Beam Tube	Foil	Cross Section Used (b)	Thermal Flux Per Unit Power (neutrons/cm^2·sec)	Cadmium Ratio
			$\times 10^7$	
HB-2	^{197}Au	96.0	7.633	3.0846
	^{63}Cu	4.3	7.779	2273.7
	^{115}In	155.0	7.765	2.983
	^{59}Co	37.0	7.487	18.63
	^{24}Na	0.536	7.6	31.87
HB-3	^{197}Au	96.0	6.912[a]	3.050[a]
	^{63}Cu	4.3	6.890	3119.0
	^{115}In	155.0	6.489	3.025
	^{59}Co	37.0	6.987	19.98
	^{24}Na	0.536	6.938	41.59

[a]Average of two measurements.

Table 5.13. Flux Per Unit Lethargy Per Unit Power and Flux Per Unit Energy Per Unit Power Emerging from HB-2 and HB-3 as a Function of Energy in the Epithermal Region

Energy (ev)	Detector	E ϕ(E)/P, Flux Per Unit Lethargy Per Unit Power (neutrons/cm^2·ln E·Mw)		ϕ(E)/P, Flux Per Unit Energy Per Unit Power (neutrons/cm^2·ln E·Mw)	
		HB-2	HB-3	HB-2	HB-3
1.46	^{115}In	2.534×10^6	2.072×10^6	1.735×10^6	1.42×10^6
4.9	^{197}Au	2.485×10^6	2.258×10^6	5.07×10^5	4.61×10^5
132	^{59}Co	2.583×10^6	2.256×10^6	1.92×10^4	1.67×10^4
2850	^{23}Na	2.949×10^6	2.049×10^6	1.04×10^3	7.19×10^2

Table 5.14. Emergent Integral Flux Above Energy E Per Unit Power for HB-2 and HB-3

Threshold Energy (Mev)	Reaction	$\frac{1}{P}\int_{E_{th}}^{\infty} \phi(E)\, dE$ (neutrons/cm^2·sec·Mw)		Ratio of HB-2 to HB-3 Fluxes
		HB-2	HB-3	
2.9	^{32}S(n,p)^{32}P	3.72×10^6	7.93×10^5	4.70
6.3	^{24}Mg(n,p)^{24}Na	1.25×10^6	1.23×10^5	10.22
8.1	^{27}Al(n,α)^{24}Na	2.04×10^5	2.62×10^4	7.66

dependent measurement was later made at HB-1 for average neutron energies of 0.07 and 0.14 ev. The results are shown in Fig. 5.34. As indicated the flux increases about 7% during the first day, while the rods are being withdrawn to compensate for xenon. For several days thereafter the flux is nearly constant and then steadily rises to a total increase of approximately 20% by the end of the cycle.

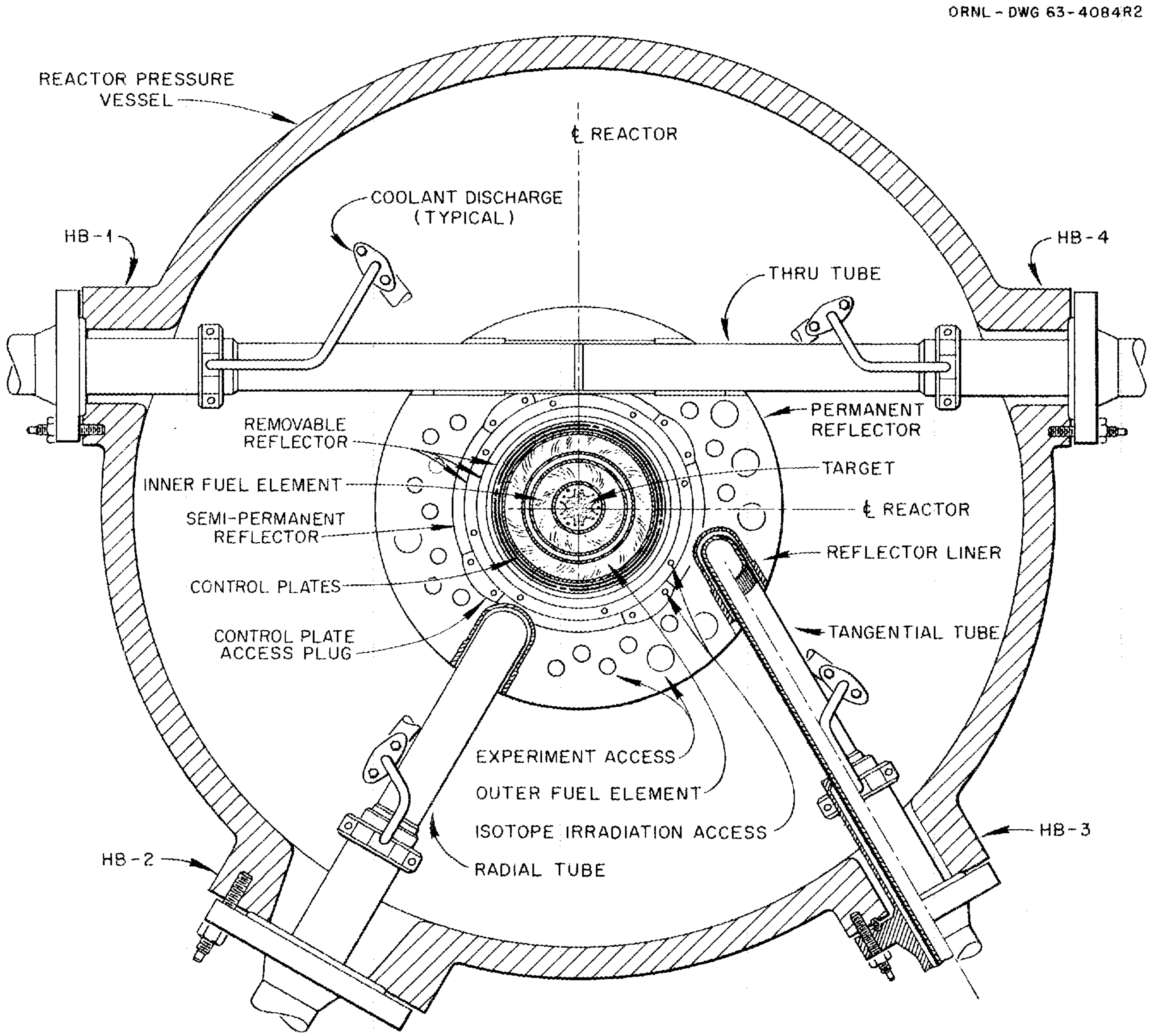

Fig. 5.32. Cross Section of Reactor Core at Horizontal Midplane Showing Orientation of Beam Tubes in Reactor Core.

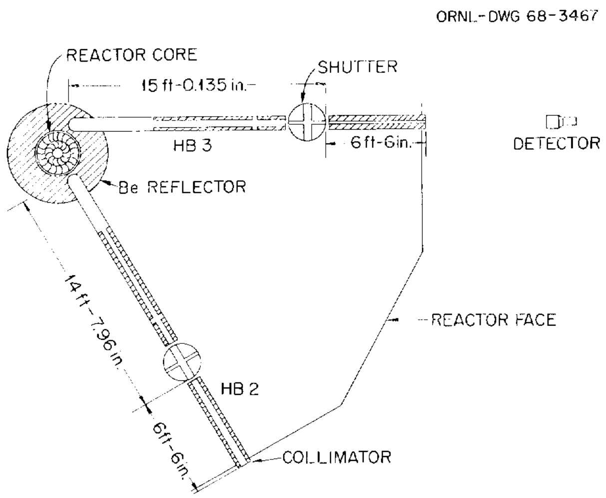

Fig. 5.33. Schematic Diagram of Collimator and Shutter Arrangement in HB-2 and HB-3.

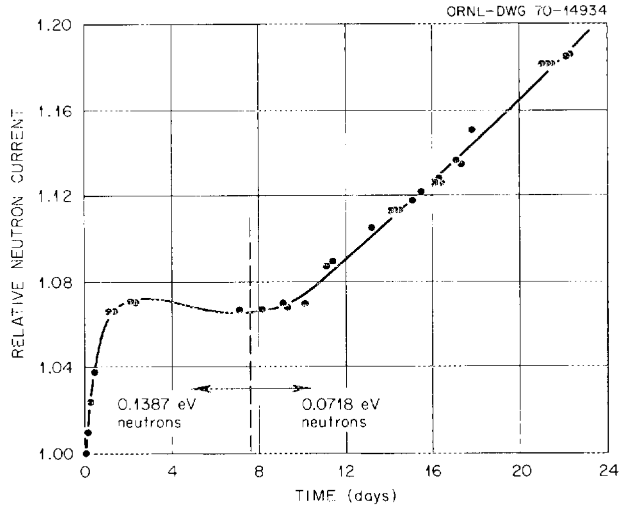

Fig. 5.34. Relative Neutron Current ($\bar{E}$ = 0.14 ev) from HB-3 Versus Time in Cycle.

6. REACTIVITY CONTROL

An effort was made during the design of the HFIR to discover all the significant reactivity perturbations so that a large, arbitrary control margin would not be required. This was an important feature because, generally speaking, the greater the control requirement the lower the reactor performance in terms of available thermal-neutron fluxes. (The maximum-to-average power-density ratio increases with increasing control and thus requires a reduction in average power density.) An analysis of both transient and steady-state reactivity control requirements is presented in a separate report.[15] However, more recent data on reactivity accountability make it desirable to include a discussion on steady-state requirements here.

6.1 Reactivity Accountability

A summary of reactivity accountability for a core loading built to the second production core specifications* is given in Table 6.1. The target referred to in Table 6.1 is the target that was used in the HFIR critical experiments. It contains 8.35 g ^{235}U, 127.9 g ^{238}U, and 107.6 g Ag; the metal-to-water ratio (by volume) is 0.75 over the active length of the target. Based on a recent set of heavy-element cross sections, this target corresponds to an initial ^{242}Pu loading of 300 to 480 g, with the largest value being the most probable, and the smaller value being the most conservative insofar as positive reactivity and heat removal are concerned. At about 0.4 year of irradiation,† the plutonium target will have its maximum concentration of ^{245}Cm and thus its maximum positive reactivity effect on the core. If the initial target loading contains 3 g ^{239}Pu and 3 g ^{241}Pu in addition to the ^{242}Pu (anticipated feed material composition for 300-g plutonium loading), the reactivity effect of the clean target will be the same as that of the above 0.4-year target.

Another time-dependent variable that will affect reactivity and which was investigated is the concentration of the high-cross-section nuclides ^6Li and ^3He in the beryllium reflector. The reaction paths for the production of these poisons are

$$^9\text{Be} + n(>1\ \text{Mev}) \rightarrow {}^4\text{He} + {}^6\text{He}$$

$$^6\text{He} \xrightarrow{0.8\ \text{sec}} {}^6\text{Li} + \beta^-$$

$$^6\text{Li} + n(\text{thermal}) \rightarrow {}^4\text{He} + {}^3\text{H}$$

$$^3\text{H} \xrightarrow{12.3\ \text{y}} {}^3\text{He} + \beta^-$$

Early in the HFIR program, Claiborne,[27] using preliminary HFIR design data, calculated a decrease in reactivity, attributed to ^6Li and ^3He, of 1.3% $\Delta k/k$ in 0.2 yr and 1.7% $\Delta k/k$ in five years, both of which apply to end-of-fuel-cycle conditions. However, recent calculations have shown the reactivity effect to be more like 0.4% $\Delta k/k$, and about 80% of this was achieved within the first fuel cycle. The calculations also showed that for clean core conditions the worth of equilibrium ^6Li was only 0.2% $\Delta k/k$, with the reduced worth being a result of the reduced contribution of the beryllium reflector with the rods partially inserted. This amount of reactivity is about equal to the normal variation in fuel loading and target worth, and thus it is difficult to differentiate between them at the time when new fuel elements are loaded. Operation of the reactor for about 20 fuel cycles has given no clear indication of a change in reactivity due to buildup of ^6Li in the beryllium. However, no concentrated effort has been made to accurately separate the various reactivities. Based on what has been done to date, it appears that the poisoning effect is small enough not to warrant changing the removable beryllium for this reason alone. Of course, if the poison nearly saturates within a single fuel cycle, there would be no advantage in changing the beryllium.

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*These specifications are consistent with the fuel element design presently being used.

†Based on early calculations and cross-section sets.

Table 6.1. Summary of Reactivity Accountability for the Second Production Core

Parameter	Reactivity (Δk) as a Function of Time in Cycle		
	0 Days	2 Days	14 Days
Fuel worth with following core conditions: No boron burnable poison; no target; no beryllium poisoning; zero power at 70°F	0.135[a]		
Boron burnable poison	−0.050[a]	−0.037	−0.009
Temperature deficit (evaluated with the HFIRCE-3 target[b] zero power at 70°F to 100 Mw)	−0.004		
Simulated plutonium target, based on HFIRCE-3 target[b]			
Maximum (time zero and again at 0.4 year)	+0.007[a]		
Minimum (0.1 year)	−0.002		
$^{135}Xe + {}^{149}Sm$ (at power)	0	−0.049	−0.053
All fission products	0	−0.053	−0.086
Beryllium poison ($^{6}Li + {}^{3}He$)			
Time zero	0[a]		
23 days	−0.003		
1 year	−0.004		
Beam-tube flooding	~0		
Fuel-loading tolerance (±1%)	±0.0015		
Boron-loading tolerance (±10%)	±0.0038		
Fuel-distribution tolerance (±10%)	±0.0054		
Boron-distribution tolerance (±35%)	±0.0023		
Metal-to-water ratio tolerance (±0.001 in.)[c]	±0.005		
Minimum $k_{eff} - 1$ (clean core, 100 Mw)[d]	0.057		
Typical nominal $k_{eff} - 1$ (clean core, 70°F)	0.092		
Maximum $k_{eff} - 1$ (clean core, 70°F)	0.110		

[a]These reactivities used for typical nominal case.
[b]See text for description of target.
[c]Tolerance on fuel-plate thickness.
[d]One-year-old beryllium reflector.

6.2 Shutdown Margin

The term "shutdown margin" refers here to the amount of reactivity that exists for a specified core condition, regardless of whether the particular condition is considered normal or otherwise. Thus for all credible core conditions the shutdown margin must be negative. In the design and analysis of the HFIR, the worst (most reactive) credible core conditions were specified. Therefore the absolute value of the shutdown margin is not important insofar as steady-state reactivity control is concerned; the margin must simply be less than zero. This approach is in a sense different than that used in the design of several other reactors, including the ORR, for which a somewhat arbitrary shutdown margin was specified on the basis of the normal clean core condition.* Such an approach has been satisfactory for many relatively low-performance reactors that have several dollars in reactivity associated with the worth of the fuel. However, this simplified system for arriving at desired control-rod worth can break down for two extreme conditions: (1) when the worth of the fuel is very small, and (2) when excessive shutdown margin is obtained at the expense of a reduced fuel-cycle time or reduced reactor performance

*In its practical application the specification amounts to a requirement that the rods be at least one-half withdrawn when criticality is achieved. In its literal sense the specification amounts to a requirement that the rods be worth twice the worth of the fuel for normal clean core conditions.

(increases in maximum-to-average power density, perturbation of experimental fluxes, etc.) or both. The HFIR falls into the latter category.

The HFIR control region was located outside the fuel region in order to have the least effect on the flux in the target region and on the fuel-region power distribution. Since the worth of the HFIR rods is largely dependent on reflected neutrons, it has definite limitations; in fact, the worth of the rods must be supplemented by a burnable poison. The limitations on the burnable-poison (^{10}B) content are associated with power distribution, core lifetime, flux-trap neutron flux, and radiation damage. From an operating economy point of view the fuel-cycle time should be as long as possible; however, there are metallurgical limitations on the amount of fuel that can be included in the fuel plates. Thus the conclusion is that the shutdown margin must be minimized in order to achieve the desired high thermal flux in the flux trap and also an economically feasible fuel-cycle time.*

In order to minimize the shutdown margin it was necessary to consider all credible reactivity variations. These included tolerances on fuel and burnable-poison loading and distribution, reactivity variations associated with experiments (primarily the plutonium target in the flux trap), the beryllium reflector, unusual control-rod positions (run-away rods and rod testing), and reactivity variations associated with moderator density changes (primarily flux-trap voids). Burnup of the black region of the rods falls into a somewhat different category because considerable burnup can be tolerated before a significant change in worth is observed; the same reasoning also applies to control-rod poison-loading tolerances. Thus, no allowance has been made for variations in the worth of the rods, which are calibrated periodically to insure adequate worth.

Another point to be considered is that the HFIR contains only two fuel elements, and there are no provisions for inserting more than this. Furthermore, these two elements are subjected to a reactivity check under safe conditions to assure that the reactivity is within the specified tolerances. Thus, it is not necessary to provide sufficient control-rod worth to accommodate unexpected fuel and poison loadings outside the allowable variations cited in Table 6.1.

6.2.1 Combinations of Reactivity Variations Considered Credible. In all cases the most reactive combinations of fuel and burnable-poison loading and distributions within specified manufacturing tolerances were considered; the plutonium target was assumed to be in its most reactive state; and the beryllium was considered to be clean. However, it was assumed that the simultaneous occurrence of two "accidental" reactivity additions was incredible. The accidental reactivity additions considered are listed below:

1. optimum void in the flux trap without a target – worth about 0.032 $\Delta k/k$;
2. optimum void in the flux trap with the target – worth about 0.015 $\Delta k/k$;
3. runaway control rods –
   a. one shim-safety rod fully withdrawn; the other three safety rods scrammed; shim-regulating rod motion stopped;
   b. Shim-regulating rod rully withdrawn; all four safety rods scrammed.

Another postulate is that in the event of a scram only one of the five rods (or its equivalent in terms of reactivity) will fail to insert, in which case the termination of the shim-regulating rod motion during a runaway-rod accident is considered to be a scram or safety device.

In addition, provisions were made for withdrawing any one rod completely with all other rods fully inserted. This facilitates the testing of rod motion prior to operation.

From the above list of events, four reactor conditions can be derived for which the reactor must be shut down. They are listed in Table 6.2.

Case I provides for refueling, at which time the target must be removed with the fuel elements in place; case II provides for rod testing; case III corresponds to a scram resulting from void insertions; and case IV corresponds to the runaway-rod accident.

Another case of interest involves a fully withdrawn rod, as in cases II, III, and IV, which cannot be inserted before removing the fuel. In order to remove the fuel it is first necessary to remove the target, and therefore this case is similar to case I, except that one rod, presumably the shim-regulating rod, is fully withdrawn. If necessary, additional shutdown margin for this fifth case could be achieved by other poisoning techniques (poison strips, soluble poison, etc.), and therefore it has

*The above discussion is not intended to imply that the present core design (9.4 kg ^{235}U, 2.8 g ^{10}B) represents the ultimate that can be achieved in terms of core life consistent with desired performance; it simply represents the best that could be achieved with the existing technology and a reasonable schedule. A longer life fuel loading is presently being designed. A combination of two burnable poisons (boron and cadmium) is being considered for use in such a way that performance will not be sacrificed.

Table 6.2. Cases for Which Core Must Be Subcritical

Case	Control-Rod Positions	Flux-Trap Condition
I	All rods fully inserted	Optimum void; no target
II	Four rods inserted; one rod fully withdrawn	Optimum void; with target
III	Three-out-of-four rods scrammed from symmetrical, critical condition	Optimum void; with target
IV	Three-out-of-four rods scrammed; one shim-safety fully withdrawn	No void; with target

Table 6.3. Shutdown Margins for Various Cores and Conditions

Case	Shutdown Margin ($-\Delta k/k$)			
	Critical Experiment HFIRCE-3	HFIRCE-3 Core in HFIR	First Production Core (3.6 g ^{10}B) in HFIR	Second Production Core (2.8 g ^{10}B) in HFIR
I	0.0513	0.0513	0.0538	0.0408
II	0.0363	0.0226	0.0251	0.0121
III	0.0235	0.0167	0.0192	0.0062
IV	0.0167	0.0099	0.0124	−0.0006
V	0.0260	0.0123	0.0148	0.0018

not been listed as a required case in Table 6.2. However, shutdown margins for this case without "additional" poisons have been listed in Table 6.3 (case V).

6.2.2 Determination of Shutdown Margin. Control-rod worths and shutdown margins for the HFIR were initially extrapolated for design purposes from a series of critical experiments (HFIRCE-2 and -3) performed at a critical facility. In the most recent of these experiments the control rods were identical with those proposed for the reactor, and the only difference in the fuel element was in the burnable-poison loading, which was slightly less in the HFIRCE-3 core than finally specified for the production cores. In these experiments pulsed-neutron techniques were used for measuring the shutdown margins for the four cases specified in Table 6.2.

When the HFIR facility became available, the shutdown margin for case IV was checked with the HFIRCE-3 core and the HFIRCE-3 Eu_2O_3-Ta-Al control rods. In these experiments negative reactivities were determined with a Rhoette.*

*Analog computer for calculating reactivity from flux versus time input.

When applying the above data it was assumed that the HFIRCE-3 core was in the least reactive state consistent with permissible tolerances and with the few inspections that could be made during fabrication. For purposes of extrapolating to an actual production core, it was assumed that the latter core would at some time be in its most reactive condition, consistent with permissible tolerances. After determining the reactivities associated with the core tolerances and measuring the shutdown margins for the HFIRCE-3 core with the Eu_2O_3-Ta-Al control rods, it was possible to determine the necessary final burnable-poison loading for the production cores.

Once a production core was available it was possible to measure the shutdown margin for case IV. However, it is never entirely clear what actual concentrations, distributions, etc., exist in a particular core. Thus it is not possible to make a general check on the adequacy of the nominal specifications. It is possible, however, to check each individual core when installed in the reactor if variable reactivities associated with experiments are either understood or small.

A useful precaution to prevent installation of abnormally reactive cores is to compare the reactivity of each new core against a standard. If the standard were the HFIRCE-3 core, in principle the only remaining unknown would be the reactivity status of experiment fixtures and materials, control rods, and reflector. At the present time each new core loading is being checked indirectly against the HFIRCE-3 core in a special critical facility.

Based on the shutdown measurements made in the critical experiments and in the HFIR facility with the HFIRCE-3 core and with the HFIRCE-3 Eu_2O_3-Ta-Al control rods, the shutdown margins for the four specified cases (plus one additional case) under the maximum reactivity conditions (as defined in Table 6.2 and the preceding paragraphs) were estimated to be as shown in Table 6.3. The "first production core" referred to in this table contained 3.6 g ^{10}B burnable poison and the "second production core" and subsequent cores contained 2.8 g ^{10}B. Further details of the actual experiments are discussed in Appendix A.

6.3 Differential Rod Worth

Differential rod worths were determined experimentally for the ganged safety rods and the shim-regulating rod using the rod bump technique. Two different core conditions were considered: (1) criticality maintained with the rods and (2) criticality maintained with soluble poison in the moderator and the rods maintained symmetrical. Curves of differential worth versus rod position are shown in Figs. 6.1 and 6.2.

In Fig. 6.2 the abrupt change in differential worth is a result of the gray sections of the rods overlapping. The boron concentration shown in Fig. 6.2 is for boron in the moderator that is contained only in the two fuel annuli and the annular gap between the two annuli.

The significance of these differential rod worths in connection with transients is discussed in Ref. 15.

6.4 Transmutation of Control-Rod Poisons

The poison content of the Eu_2O_3 section of the control rods was designed to provide essentially unchanged shutdown margin (with rods fully inserted) for at least six months of full-power operation. The rods are not actually black to neutrons because many of the neutrons reflected by the beryllium reflector return with epithermal and higher energies. Europium and some of its daughter products have reasonably good resonance cross sections that contribute significantly to the worth of the rods. However, these cross sections and the available volume are not large enough to provide significant self-shielding in the epithermal

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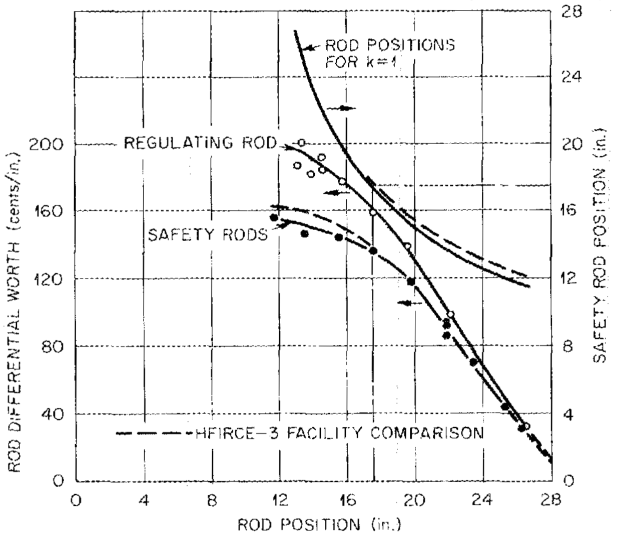

Fig. 6.1. HFIR Differential Rod-Worth Data for HFIRCE-3 Core and HFIRCE-3 Rods in HFIR Facility.

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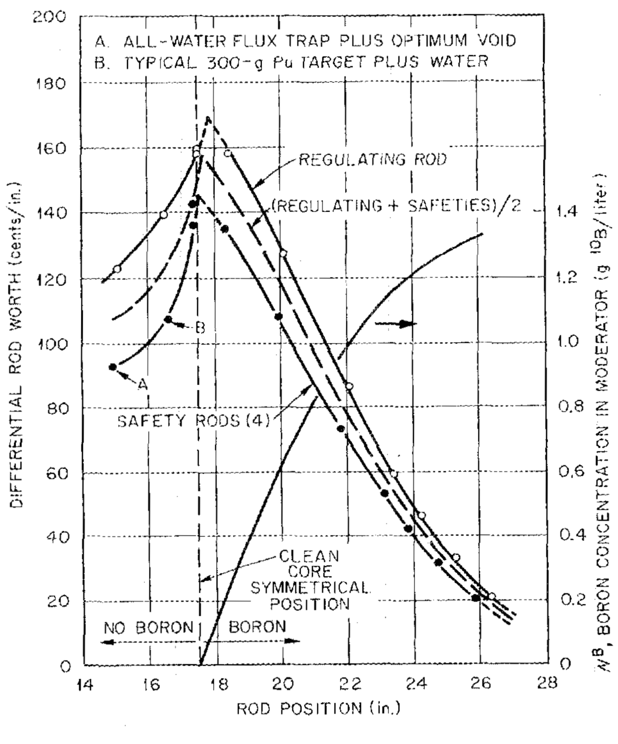

Fig. 6.2. Differential Worth of HFIRCE-3 Rods in HFIR Facility with HFIRCE-3 Core. Except as indicated otherwise, island contained all water. Boron in moderator used as auxiliary control; rods essentially symmetrical.

range. On the other hand, since only the tip of the Eu_2O_3 region sees the very high flux, and since the tips of the shim-regulating rod and the shim-safety rods, when inserted, are overlapped by relatively unburned portions of the black regions, it was expected that the change in worth in six months would be very small. Furthermore, a late change in design provided an additional 2 in. of safety-rod travel and black-region length that allowed the safety-rod black tips to be pushed out the end of the core. Thus it was expected that from the standpoint of shutdown margin the rods would last significantly in excess of six months.

In the gray region the situation is somewhat different, although the expected life was about the same as that for the black region. Tantalum tends to burn out steadily, but only after the daughter product, ^{182}Ta, which has an 8000-b cross section and a 115-d half-life, saturates. The effect of the ^{182}Ta is to increase the total cross section of the gray region by a factor of about 2 once equilibrium has been reached. At full-power fluxes the peak value of the macroscopic cross section is reached in a few days.

Burnout of the tantalum tends to reduce the shutdown margin for cases in which the gray region plugs an opening in the rods, such as when a safety rod fails to scram. Since it is assumed that only one rod will fail to scram, the effect of gray-region burnup on shutdown margin will be small. It is possible to check on the extent of the effect by periodically checking the shutdown margin for case III.

The life of the gray region, in terms of neutron-absorption requirements, will probably be determined by the gray-region effect on minimum differential rod worth rather than on shutdown margin. The minimum permissible differential worth is associated with transient behavior and is discussed in Ref 15.

7. POWER DISTRIBUTIONS

The HFIR core had to be designed for a very high average power density to achieve the desired high neutron fluxes. Since the average power density is limited by burnout at the hot spot, it was beneficial to reduce the maximum-to-average power density ratio (q_{max}/q_{avg}) as much as possible. Several design features were included specifically for this purpose: cylindrical geometry, bidirectional reflector control, flux suppressors at the ends of the core, restrictions on proximity of reflector experiments to fuel region, inclusion of a water channel between the two annular fuel elements, and nonuniform radial distribution of fuel and burnable poison. The resultant nominal value of (q_{max}/q_{avg}) is about 1.5, and it stays nearly constant all through a normal fuel cycle. Basic details associated with these features are discussed in Ref. 5 and are reviewed briefly here in light of the final design.

The current general radial shapes of the fuel and burnable-poison distributions are shown in Fig. 7.1, and the method by which the distributions are actually achieved is indicated in Fig. 7.2. Since the filler and fuel sections are separate, it is physically possible to achieve a wide range of burnable-poison distributions for a given fuel distribution and still maintain the overall rectangular shape of the composite fuel-plate core. However, by concentrating the burnable poison in the high-thermal-flux regions the flux was flattened somewhat, thus reducing the necessary fuel gradient. Of course a strong absorber close to the flux trap reduces the thermal flux in the flux trap, but there is a practical limit to the fuel gradient that can be achieved physically. The steeper the gradient the thinner the thin edge of the fuel core relative to fuel-particle size, and thus the greater the variation in local fuel density in the thin edge of the fuel core. This increases (q_{max}/q_{avg}).*

The appropriate fuel and burnable-poison distributions were determined by an iterative process in which the fuel concentration in each radial fuel region was adjusted to produce a prescribed radial power distribution by using the flux distribution from the previous iteration. Since the flux shapes were not very sensitive to fuel distribution, only a few iterations were required.

Having achieved the prescribed fuel distribution as described above, a fuel-cycle calculation was made to obtain power distribution as a function of burnup.

*This latter difficulty could be reduced by decreasing the size of the fuel particles, but then fission gas retention would be reduced.

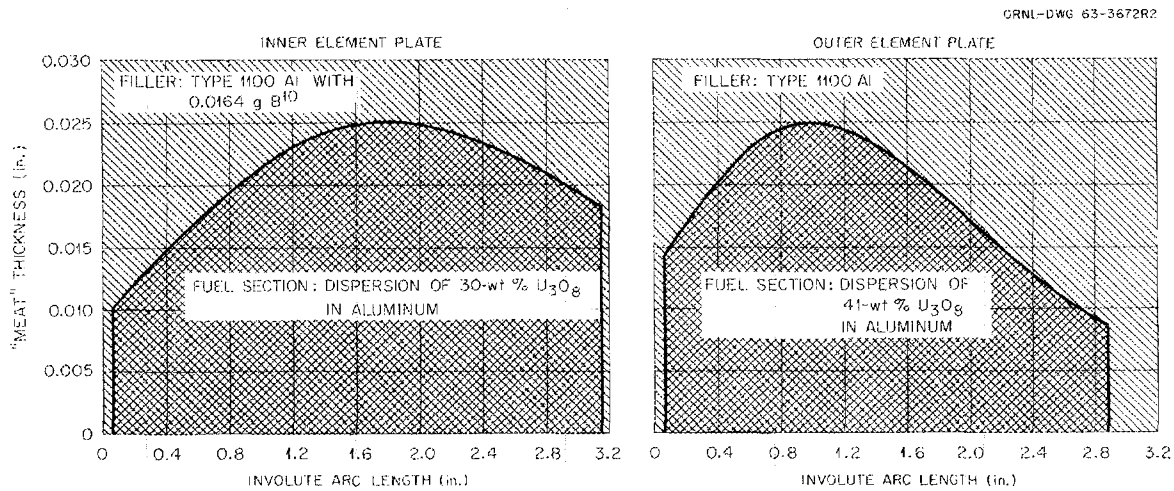

Fig. 7.1. Distribution of Fuel and Burnable Poison Across Width of Involute Fuel Plate.

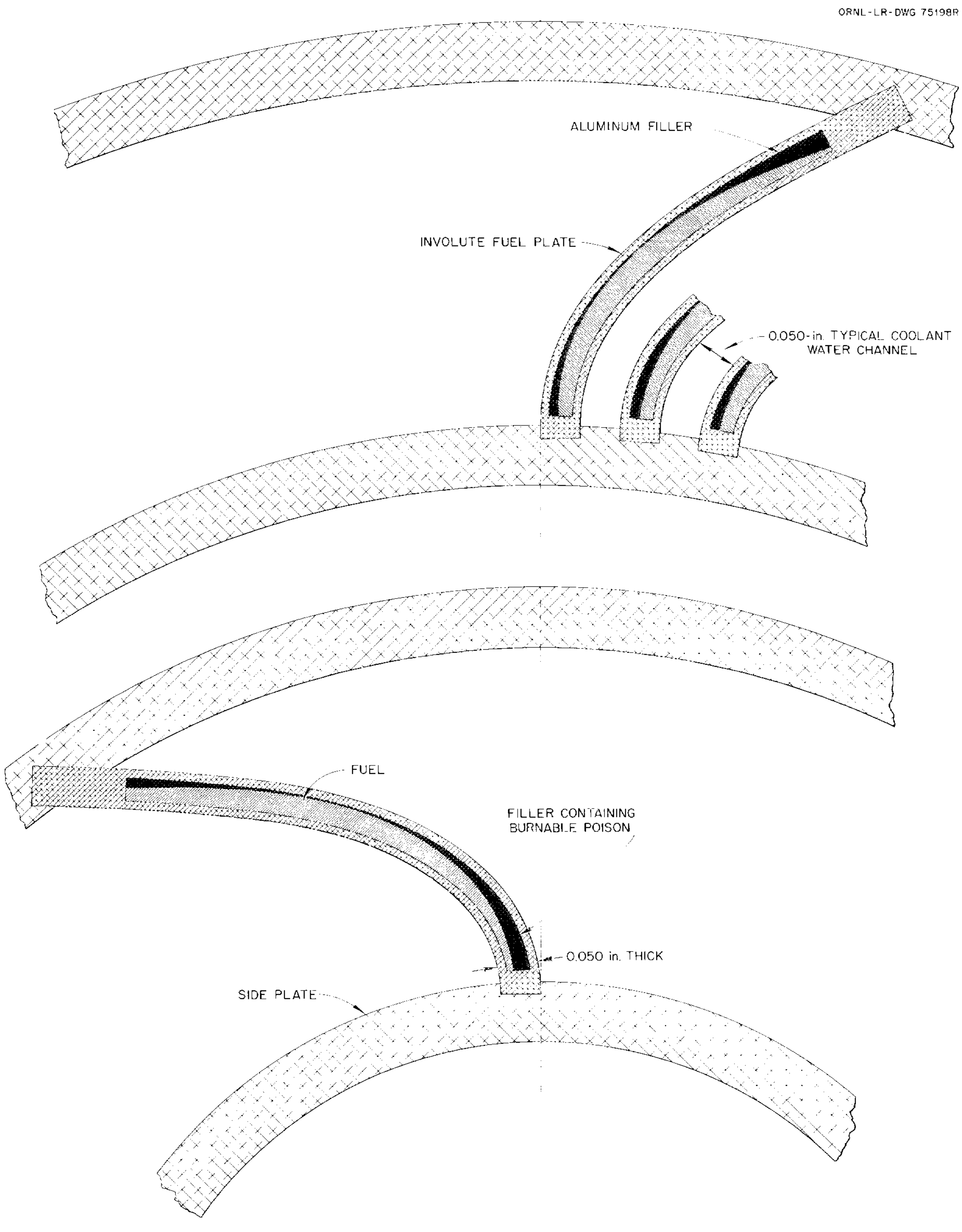

Fig. 7.2. Method of Achieving Radial Distribution of Fuel and Burnable Poison.

From this step a new prescribed initial power distribution could be obtained. By repeating this process, (q_{max}/q_{avg}) was minimized.

Most of these power-distribution calculations were one-dimensional, but a few two-dimensional calculations were made for specific cases to obtain axial values of (q_{max}/q_{avg}). Relatively large uncertainties in power distribution close to the control region were accommodated in the distribution of the fuel.

Early critical-experiment results (HFIRCE-2) were used to check on the general procedure for obtaining the initial power distribution, and using this procedure, with a few modifications, the second critical-experiment core (HFIRCE-3) was designed. This core had the same fuel loading and the same fuel and burnable-poison distributions as the present production cores. The poison loading was eventually changed in accordance with more recent reactivity control information.

The final distributions that were specified for the HFIR production cores are given in Figs. A.8 and A.9 (App. A). These were also the distributions used in the HFIRCE-3 fuel elements. The only difference between the HFIRCE-3 elements, the first production core elements, and the second production core elements was in the total loading of burnable poison. The loadings were 2.12, 3.60, and 2.80 g ^{10}B, respectively.

The HFIRCE-3 experiments, which indicated that the power distributions were satisfactory, were followed by a set of experiments (HFIRCE-4) conducted in the actual HFIR facility. Power distributions from these experiments were used to normalize the most recent calculated values for all times in the fuel cycle. This information, along with appropriate uncertainties, was used in a final heat transfer analysis[16] to determine the allowable steady-state power level for the fuel elements.

Experimentally determined power distributions are presented in Figs. 7.3 through 7.8 for various concentrations of soluble poison in the moderator. Figures 7.9 through 7.14 show comparisons between one-dimensional calculations and the axially averaged experimental results.

Figures 7.15 and 7.16 show the effect on power distribution of opening a white window between the gray regions of the shim-safety and shim-regulating rod banks. This effect, which is referred to as "window peaking," produces a maximum axial (q_{max}/q_{avg}) for an intermediate position of the control rods. With the rods fully withdrawn, $(q_{max}/q_{avg})_{axial}$ is essentially independent of radial position, having a value of about 1.3. With the rods partially inserted the window-peaking effect increases the axial power density adjacent to the control region to a maximum of about 1.86. However, during normal steady-state operation it does not contribute significantly to the limiting hot-spot condition because the corresponding total power density is less than 1.5.

The several sets of curves in Figs. 7.9 through 7.14 show that the agreement between the one-dimensional calculation and the axially averaged experimental values was quite good over the extreme range of control-rod positions, being within about 5%, except near the control region when the rods were partially inserted. The generally good agreement was an important feature of the analytical procedure, since a detailed knowledge of axial distributions (from experiments) for various rod positions, coupled with the one-dimensional fuel-cycle calculations, made it possible, through an appropriate normalization procedure, to obtain two-dimensional power distributions for various times in the fuel cycle. This method neglects the axial nonuniformity of fuel burnup, but the actual effect on power peaking was estimated to be quite small, and what effect there is tends to flatten the power distribution.

The effect of a flux-trap target on the power distribution can be determined from a comparison of Figs. 7.9 and 7.14. These results indicate that removal of the target would increase the peak horizontal midplane power density by about 11%. The particular target used in this comparison was the simulated 300-g ^{242}Pu maximum fission target. Since the total cross section and the metal-to-water ratio of the target are about the same for all practical targets, the above differences in power distribution are expected to apply for all presently proposed targets. If the target composition were changed radically, it would be necessary to consider the change in power density in a reevaluation of core heat removal.

At the present time an actual HFIR production core is slightly different than the HFIRCE-3 core in that the production core has 2.8 g ^{10}B burnable poison, as compared with 2.12 g ^{10}B for the critical experiment core. Correcting for this difference and the difference in temperatures between critical experiment conditions and full-power operating conditions reduced the nominal peak power density measured in the experiments from about 1.68 to 1.56. The complete predicted power-distribution maps for an HFIR production core at full power (100 Mw) are shown in Table 7.1.

Power distributions for other than clean core conditions were obtained by adjusting the one-dimensional

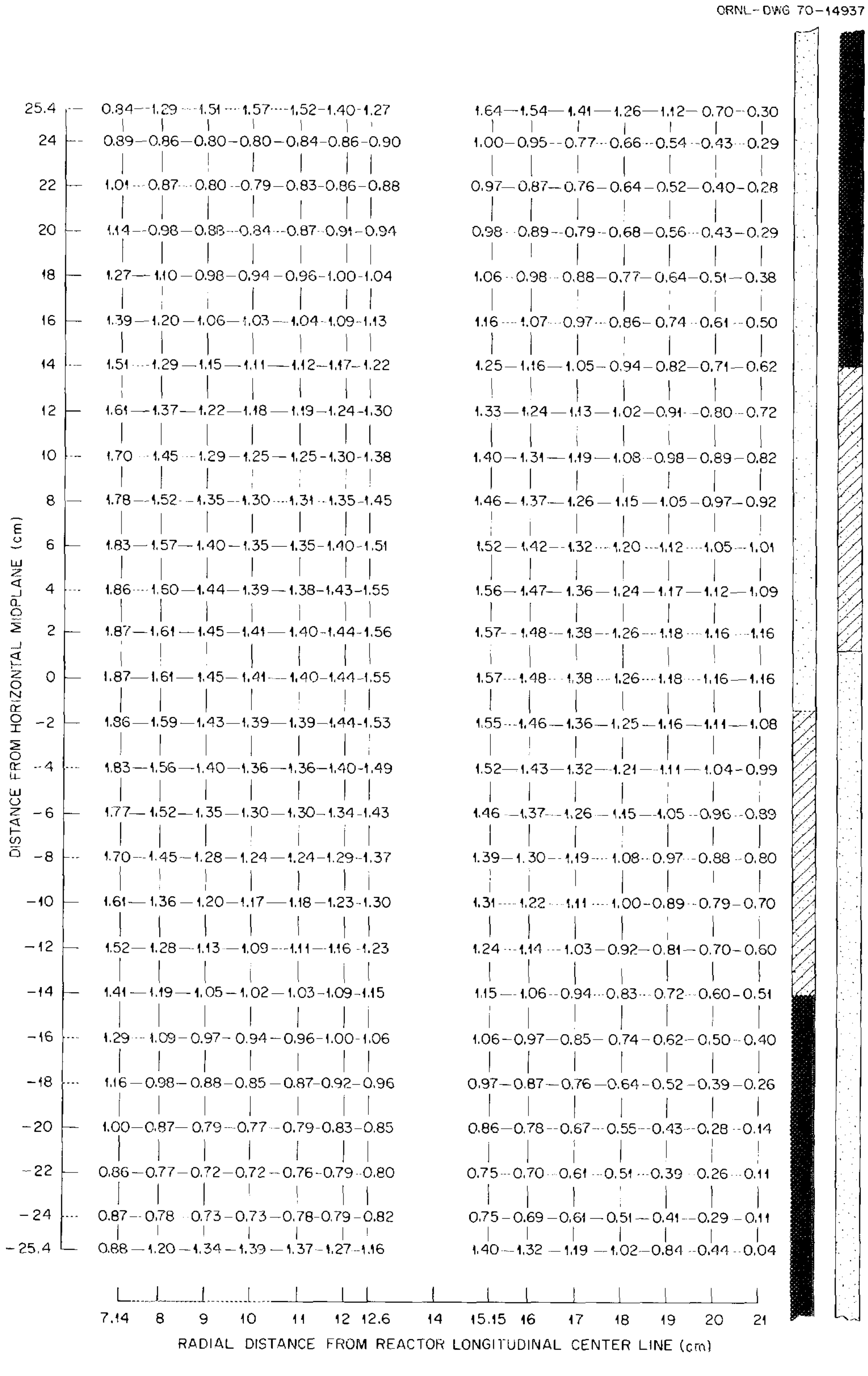

Fig. 7.3. Relative Power Distribution in HFIRCE-4 with a Clean Core and the Rods at 17.5 in.; No Target.

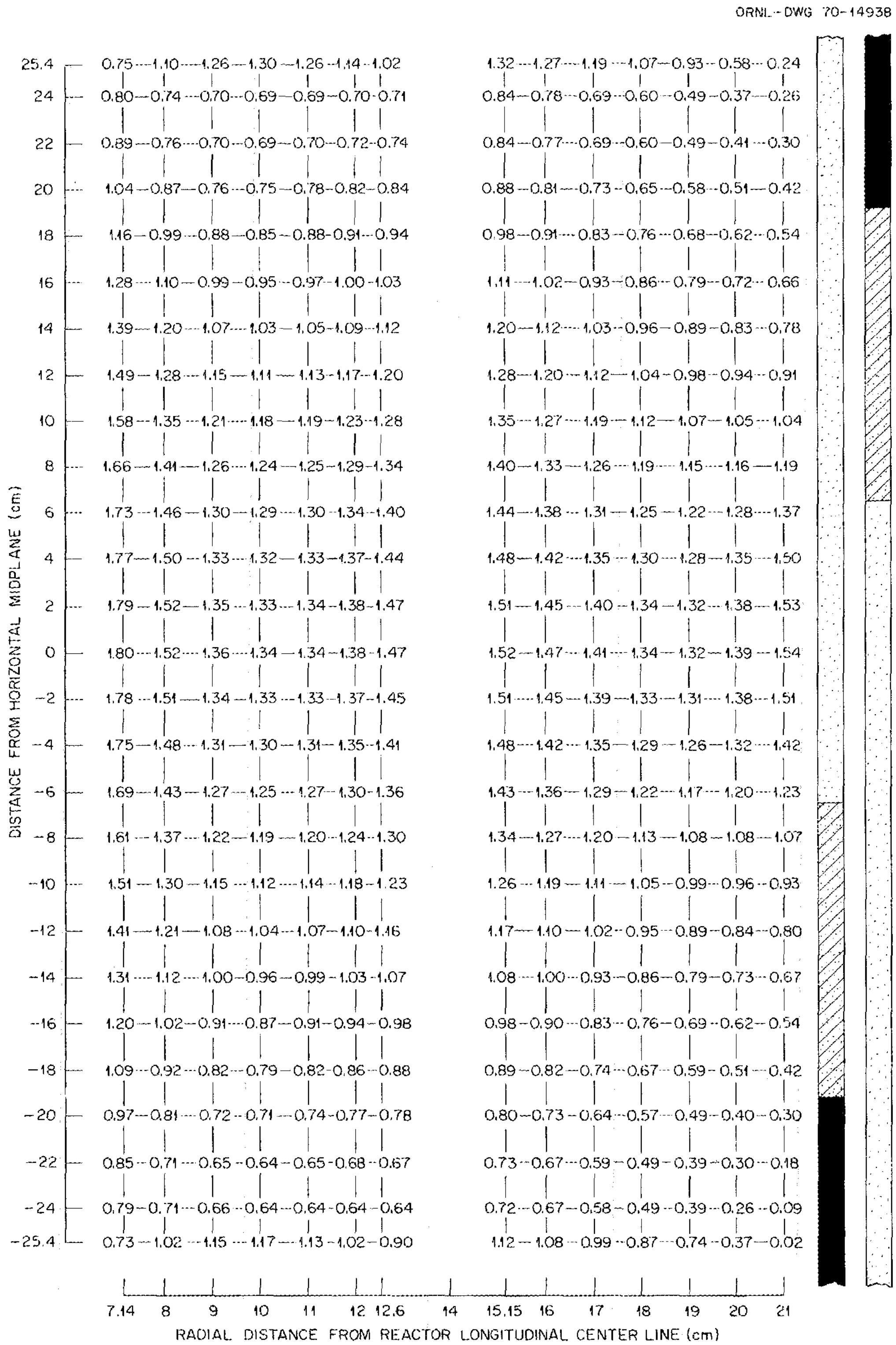

Fig. 7.4. Relative Power Distribution in HFIRCE-4 with 0.527 g B/liter in Moderator, No Target, and Rods at 19.4 in.

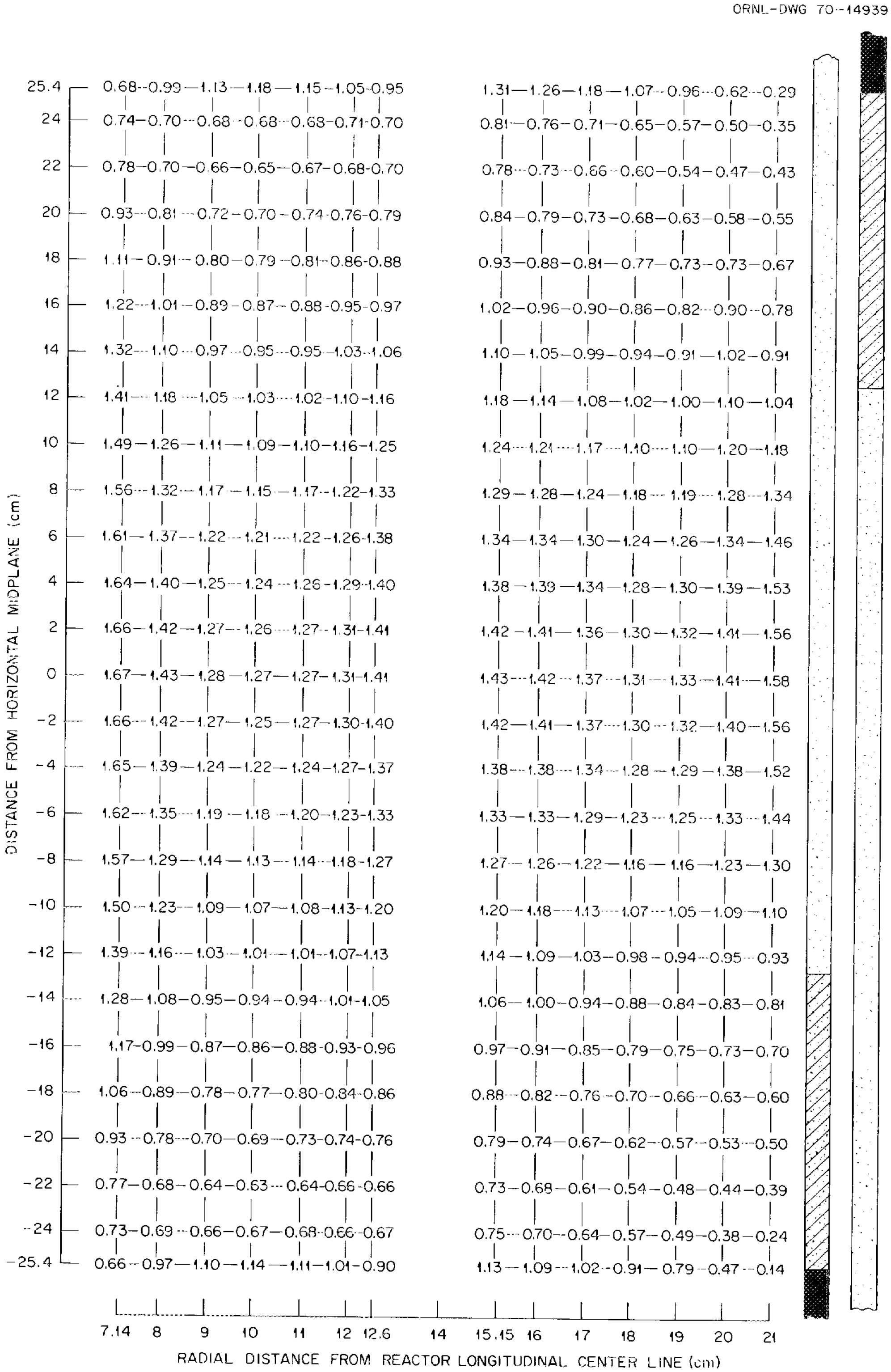

Fig. 7.5. Relative Power Distribution in HFIRCE-4 with 0.910 g B/liter in Moderator, No Target, and Rods at 21.295 in.

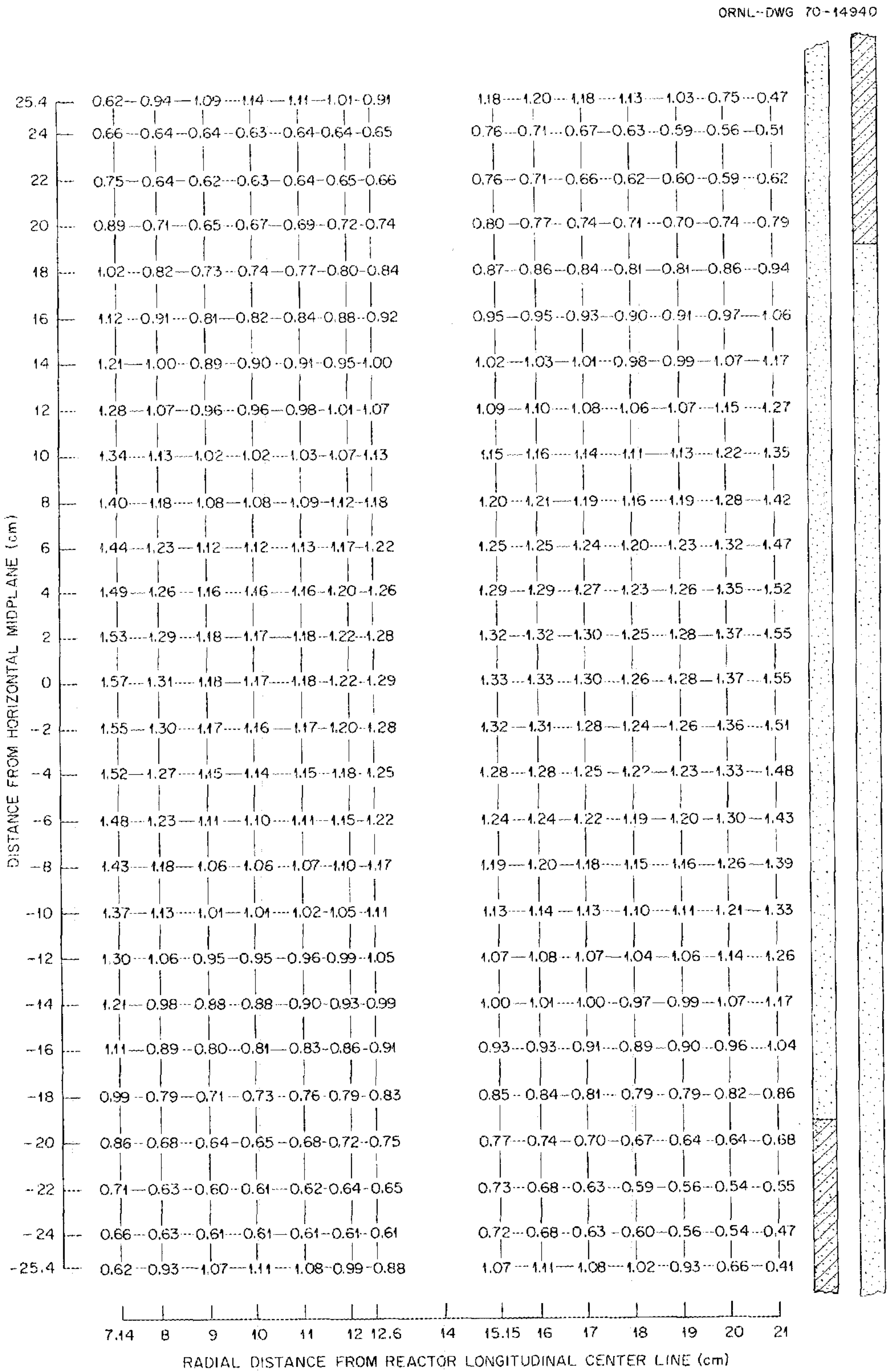

Fig. 7.6. Relative Power Distribution in HFIRCE-4 with 1.25 g B/liter in Moderator, No Target, and Rods at 24.3 in.

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Distance from horizontal midplane (cm)	7.14	8	9	10	11	12	12.6	15.15	16	17	18	19	20	21
25.4	0.61	0.93	1.07	1.12	1.08	0.97	0.87	1.20	1.24	1.24	1.19	1.12	0.85	0.64
24	0.62	0.61	0.58	0.58	0.60	0.61	0.62	0.79	0.73	0.70	0.68	0.68	0.68	0.68
22	0.72	0.63	0.58	0.58	0.60	0.63	0.64	0.76	0.73	0.69	0.68	0.69	0.73	0.76
20	0.85	0.71	0.63	0.64	0.66	0.69	0.72	0.79	0.77	0.76	0.75	0.77	0.84	0.91
18	0.97	0.81	0.71	0.71	0.74	0.78	0.80	0.86	0.86	0.85	0.84	0.85	0.93	1.03
16	1.08	0.89	0.78	0.78	0.81	0.85	0.88	0.94	0.94	0.93	0.92	0.92	1.01	1.13
14	1.17	0.97	0.85	0.84	0.88	0.92	0.96	1.01	1.01	1.00	0.99	0.99	1.09	1.22
12	1.25	1.04	0.91	0.91	0.94	0.98	1.02	1.08	1.08	1.07	1.06	1.06	1.15	1.29
10	1.31	1.10	0.97	0.97	0.99	1.03	1.08	1.13	1.13	1.13	1.11	1.11	1.21	1.36
8	1.37	1.15	1.03	1.02	1.04	1.07	1.12	1.18	1.18	1.17	1.16	1.16	1.26	1.42
6	1.41	1.20	1.07	1.07	1.08	1.11	1.16	1.22	1.22	1.21	1.20	1.20	1.30	1.47
4	1.45	1.23	1.11	1.10	1.11	1.14	1.20	1.25	1.24	1.23	1.22	1.21	1.32	1.49
2	1.48	1.25	1.12	1.12	1.12	1.15	1.22	1.26	1.26	1.24	1.23	1.22	1.32	1.49
0	1.50	1.26	1.13	1.12	1.13	1.16	1.23	1.27	1.26	1.25	1.23	1.22	1.32	1.49
−2	1.49	1.24	1.12	1.11	1.12	1.15	1.23	1.26	1.26	1.24	1.22	1.22	1.32	1.49
−4	1.46	1.22	1.11	1.10	1.10	1.14	1.22	1.25	1.24	1.24	1.23	1.21	1.32	1.49
−6	1.43	1.19	1.07	1.07	1.07	1.11	1.19	1.23	1.22	1.22	1.20	1.20	1.31	1.48
−8	1.38	1.15	1.03	1.03	1.04	1.08	1.15	1.19	1.19	1.18	1.16	1.16	1.27	1.44
−10	1.33	1.11	0.99	0.98	1.00	1.04	1.10	1.14	1.14	1.13	1.11	1.11	1.22	1.38
−12	1.27	1.05	0.93	0.93	0.95	0.99	1.04	1.09	1.08	1.07	1.06	1.06	1.16	1.31
−14	1.18	0.98	0.86	0.87	0.89	0.94	0.97	1.03	1.02	1.01	0.99	0.99	1.09	1.23
−16	1.08	0.89	0.79	0.80	0.83	0.87	0.90	0.95	0.94	0.93	0.92	0.92	1.01	1.14
−18	0.94	0.77	0.70	0.72	0.75	0.79	0.81	0.87	0.86	0.84	0.83	0.83	0.93	1.04
−20	0.77	0.65	0.62	0.65	0.67	0.70	0.72	0.80	0.78	0.75	0.73	0.74	0.83	0.93
−22	0.68	0.60	0.57	0.59	0.61	0.63	0.64	0.77	0.73	0.70	0.69	0.69	0.72	0.79
−24	0.67	0.61	0.58	0.59	0.60	0.62	0.62	0.79	0.73	0.70	0.69	0.69	0.69	0.64
−25.4	0.61	0.91	1.03	1.08	1.03	0.92	0.82	1.16	1.19	1.18	1.14	1.06	0.78	0.54

RADIAL DISTANCE FROM REACTOR LONGITUDINAL CENTER LINE (cm) (7.14, 8, 9, 10, 11, 12, 12.6, 14, 15.15, 16, 17, 18, 19, 20, 21)

Fig. 7.7. Relative Power Distribution in HFIRCE-4 with 1.35 g B/liter in Moderator, No Target, and Rods Out.

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DISTANCE FROM HORIZONTAL MIDPLANE (cm)	7.14	8	9	10	11	12	12.6	15.15	16	17	18	19	20	21
25.4	0.85	1.29	1.52	1.60	1.57	1.46	1.34	1.64	1.56	1.44	1.28	1.12	0.71	0.24
24	0.89	0.89	0.89	0.89	0.89	0.90	0.95	1.05	0.93	0.80	0.69	0.56	0.52	0.29
22	0.88	0.86	0.85	0.84	0.86	0.90	0.93	1.02	0.91	0.77	0.63	0.51	0.40	0.27
20	1.02	0.93	0.89	0.88	0.89	0.94	0.98	1.04	0.92	0.79	0.67	0.54	0.42	0.30
18	1.15	1.05	0.98	0.95	0.97	1.04	1.10	1.12	1.01	0.87	0.75	0.62	0.49	0.34
16	1.27	1.15	1.07	1.04	1.06	1.13	1.20	1.22	1.10	0.96	0.84	0.71	0.56	0.40
14	1.37	1.24	1.16	1.13	1.14	1.21	1.29	1.31	1.19	1.04	0.92	0.79	0.64	0.48
12	1.46	1.32	1.24	1.21	1.22	1.29	1.38	1.39	1.26	1.12	1.00	0.87	0.74	0.58
10	1.53	1.39	1.31	1.29	1.30	1.36	1.45	1.45	1.33	1.19	1.07	0.96	0.83	0.70
8	1.59	1.46	1.39	1.36	1.37	1.42	1.51	1.50	1.39	1.25	1.14	1.03	0.93	0.81
6	1.63	1.51	1.44	1.42	1.43	1.48	1.56	1.55	1.43	1.31	1.20	1.09	1.01	0.93
4	1.66	1.54	1.46	1.44	1.46	1.51	1.60	1.59	1.47	1.35	1.22	1.10	1.01	0.92
2	1.68	1.55	1.47	1.45	1.46	1.52	1.62	1.63	1.51	1.37	1.23	1.10	1.00	0.91
0	1.68	1.55	1.46	1.44	1.45	1.52	1.62	1.66	1.52	1.37	1.23	1.10	1.00	0.91
−2	1.68	1.54	1.45	1.42	1.44	1.50	1.61	1.62	1.50	1.36	1.23	1.10	0.99	0.90
−4	1.66	1.52	1.43	1.39	1.41	1.47	1.58	1.58	1.46	1.34	1.22	1.09	0.98	0.91
−6	1.62	1.49	1.39	1.34	1.36	1.43	1.53	1.53	1.42	1.30	1.19	1.08	0.96	0.81
−8	1.56	1.43	1.33	1.29	1.30	1.37	1.45	1.48	1.36	1.22	1.11	0.99	0.85	0.66
−10	1.48	1.35	1.26	1.22	1.24	1.30	1.37	1.42	1.29	1.14	1.01	0.87	0.71	0.52
−12	1.40	1.28	1.19	1.15	1.17	1.23	1.29	1.34	1.21	1.05	0.90	0.74	0.58	0.39
−14	1.30	1.19	1.11	1.08	1.09	1.15	1.20	1.25	1.12	0.96	0.80	0.65	0.48	0.29
−16	1.19	1.09	1.02	0.99	1.01	1.06	1.11	1.14	1.02	0.87	0.72	0.57	0.41	0.23
−18	1.08	0.99	0.92	0.90	0.92	0.97	1.02	1.02	0.91	0.79	0.65	0.51	0.36	0.18
−20	0.95	0.87	0.81	0.81	0.82	0.87	0.92	0.93	0.83	0.71	0.59	0.45	0.31	0.16
−22	0.82	0.77	0.77	0.71	0.78	0.82	0.86	0.92	0.80	0.67	0.54	0.42	0.29	0.17
−24	0.72	0.76	0.76	0.77	0.80	0.82	0.87	0.93	0.81	0.68	0.55	0.42	0.32	0.18
−25.4	0.63	1.06	1.30	1.40	1.40	1.32	1.21	1.40	1.33	1.21	1.05	0.89	0.48	0.06

RADIAL DISTANCE FROM REACTOR LONGITUDINAL CENTER LINE (cm) (axis marks: 7.14, 8, 9, 10, 11, 12, 12.6, 14, 15.15, 16, 17, 18, 19, 20, 21)

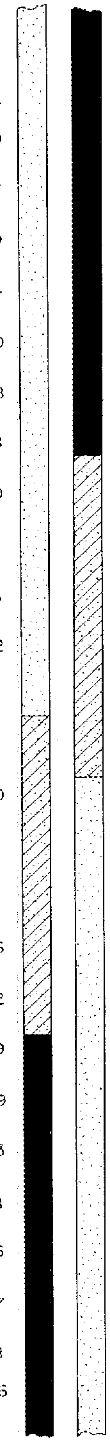

Fig. 7.8. Relative Power Distribution in HFIRCE-4 with Clean Core, 300-g Plutonium Target, and Rods at 16.6 in.

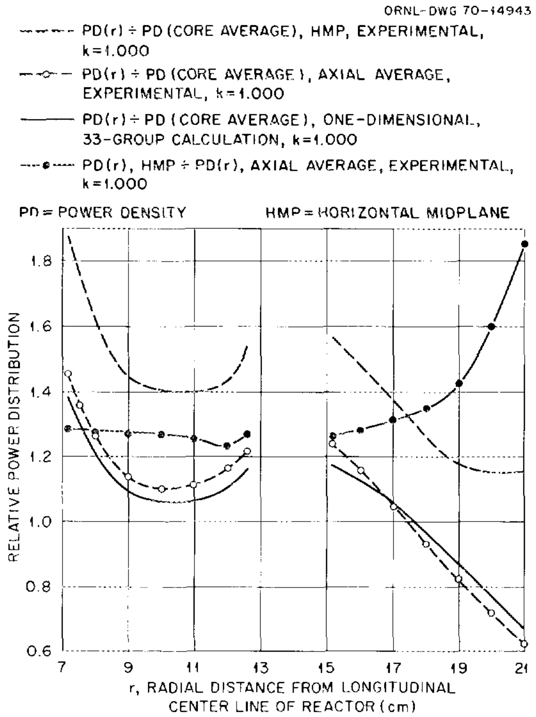

Fig. 7.9. Calculated and Measured Radial Power Distribution in HFIRCE-4 with Clean Core, No Target, and Rods at 17.5 in.

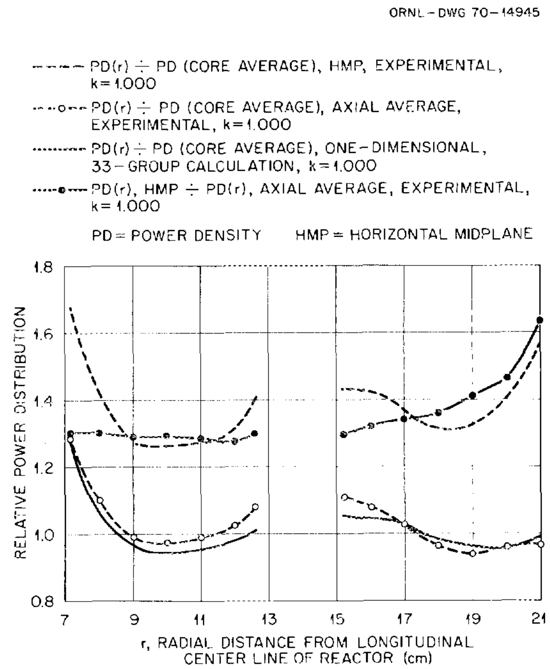

Fig. 7.11. Calculated and Measured Radial Power Distribution with 0.910 g B/liter in Moderator, No Target, and Rods at 21.3 in.

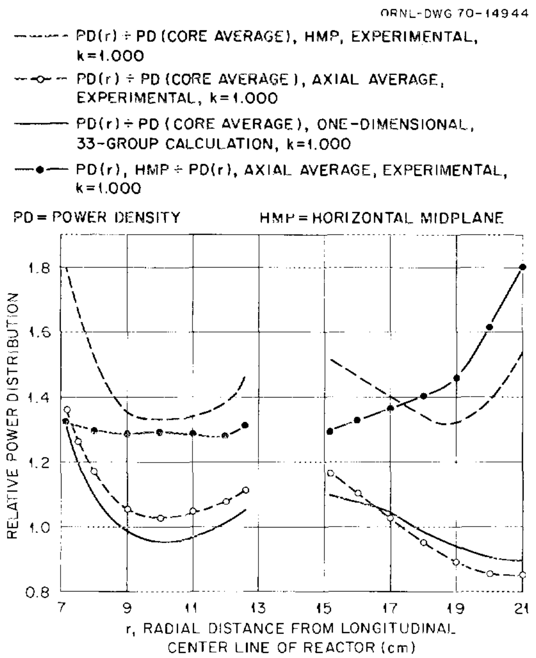

Fig. 7.10. Calculated and Measured Radial Power Distribution with 0.527 g B/liter in Moderator, No Target, and Rods at 19.4 in.

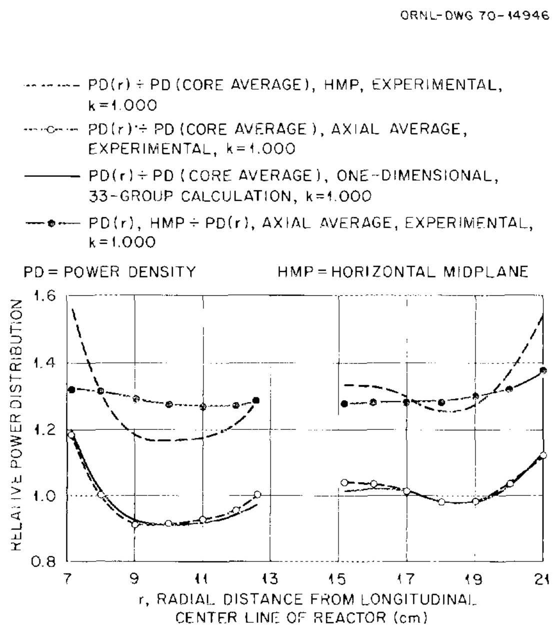

Fig. 7.12. Calculated and Measured Radial Power Distribution with 1.25 g B/liter in Moderator, No Target, and Rods at 24.3 in.

Table 7.1. Power Densities in the HFIR Fuel Elements

Reactor power level: 100 Mw
Core life: 2500 Mw-days

Distance from Core Midplane (cm)	Relative Power Density — Distance from Core Center Line (cm): Inner Fuel Element							Outer Fuel Element						
	7.14	8.00	9.00	10.00	11.00	12.00	12.60	15.15	16.00	17.00	18.00	19.00	20.00	21.00
						Time: 0 days = 0 hr								
25.4	0.678	1.109	1.379	1.515	1.470	1.344	1.186	1.580	1.512	1.394	1.254	1.119	0.719	0.298
24	0.722	0.741	0.738	0.771	0.809	0.830	0.837	0.970	0.934	0.770	0.660	0.542	0.442	0.293
22	0.815	0.753	0.738	0.767	0.802	0.830	0.824	0.943	0.860	0.758	0.650	0.533	0.425	0.291
20	0.924	0.848	0.810	0.821	0.850	0.889	0.893	0.961	0.885	0.796	0.691	0.578	0.467	0.323
18	1.031	0.952	0.904	0.917	0.939	0.980	0.988	1.043	0.978	0.881	0.781	0.669	0.562	0.429
16	1.130	1.043	0.990	1.007	1.027	1.067	1.077	1.146	1.075	0.977	0.878	0.769	0.669	0.552
14	1.227	1.126	1.068	1.089	1.107	1.146	1.162	1.239	1.165	1.064	0.964	0.864	0.775	0.670
12	1.312	1.198	1.137	1.163	1.179	1.217	1.241	1.320	1.247	1.143	1.045	0.946	0.875	0.787
10	1.387	1.264	1.200	1.233	1.241	1.280	1.316	1.388	1.319	1.214	1.117	1.027	0.973	0.898
8	1.447	1.322	1.255	1.285	1.294	1.334	1.383	1.448	1.382	1.279	1.180	1.101	1.073	1.019
6	1.493	1.372	1.306	1.332	1.339	1.380	1.445	1.499	1.437	1.337	1.239	1.168	1.169	1.127
4	1.520	1.398	1.338	1.369	1.372	1.410	1.478	1.539	1.480	1.382	1.284	1.222	1.246	1.224
2	1.532	1.408	1.350	1.386	1.388	1.422	1.490	1.558	1.500	1.404	1.306	1.242	1.285	1.308
0	1.533	1.403	1.349	1.386	1.388	1.420	1.485	1.559	1.500	1.405	1.306	1.242	1.285	1.308
−2	1.523	1.393	1.335	1.372	1.375	1.418	1.464	1.543	1.483	1.389	1.291	1.222	1.237	1.225
−4	1.494	1.368	1.305	1.342	1.345	1.380	1.425	1.510	1.448	1.353	1.255	1.174	1.150	1.117
−6	1.448	1.324	1.256	1.289	1.295	1.330	1.372	1.448	1.387	1.286	1.190	1.101	1.067	0.998
−8	1.384	1.264	1.193	1.221	1.235	1.283	1.312	1.379	1.311	1.209	1.112	1.021	0.968	0.882
−10	1.312	1.195	1.127	1.150	1.167	1.212	1.248	1.303	1.232	1.129	1.030	0.937	0.868	0.769
−12	1.235	1.120	1.057	1.077	1.097	1.144	1.177	1.222	1.149	1.045	0.944	0.846	0.767	0.661
−14	1.148	1.039	0.982	1.000	1.023	1.069	1.098	1.135	1.060	0.957	0.854	0.750	0.662	0.555
−16	1.050	0.952	0.903	0.920	0.945	0.988	1.011	1.044	0.969	0.865	0.760	0.649	0.552	0.438
−18	0.944	0.859	0.820	0.839	0.864	0.904	0.916	0.951	0.876	0.770	0.662	0.544	0.433	0.304
−20	0.819	0.762	0.735	0.755	0.783	0.816	0.812	0.845	0.783	0.675	0.567	0.449	0.321	0.174
−22	0.709	0.668	0.667	0.698	0.735	0.762	0.753	0.741	0.700	0.616	0.517	0.403	0.282	0.138
−24	0.706	0.678	0.680	0.713	0.749	0.760	0.762	0.744	0.695	0.613	0.521	0.420	0.296	0.112
−25.4	0.703	1.028	1.231	1.342	1.319	1.216	1.078	1.342	1.294	1.173	1.016	0.848	0.451	0.034
						Time: 1.014 days = 24.33 hr								
25.4	0.616	1.000	1.230	1.339	1.281	1.163	1.036	1.343	1.293	1.197	1.068	0.933	0.587	0.234
24	0.655	0.678	0.685	0.707	0.708	0.717	0.719	0.854	0.789	0.697	0.600	0.494	0.368	0.258
22	0.733	0.688	0.682	0.703	0.714	0.732	0.751	0.850	0.784	0.692	0.597	0.494	0.414	0.297
20	0.853	0.792	0.746	0.771	0.797	0.831	0.856	0.895	0.828	0.737	0.651	0.577	0.516	0.416
18	0.956	0.904	0.861	0.873	0.895	0.928	0.956	1.001	0.924	0.835	0.758	0.683	0.621	0.535
16	1.054	1.003	0.963	0.970	0.989	1.022	1.049	1.125	1.038	0.940	0.862	0.789	0.727	0.650
14	1.147	1.093	1.050	1.058	1.074	1.109	1.138	1.224	1.137	1.039	0.958	0.887	0.836	0.768
12	1.230	1.168	1.122	1.138	1.152	1.188	1.221	1.306	1.222	1.125	1.047	0.980	0.945	0.898
10	1.305	1.233	1.181	1.207	1.219	1.258	1.294	1.371	1.295	1.202	1.123	1.068	1.058	1.035
8	1.369	1.285	1.230	1.269	1.279	1.319	1.359	1.425	1.354	1.268	1.193	1.149	1.173	1.183
6	1.424	1.329	1.271	1.320	1.329	1.371	1.418	1.468	1.404	1.323	1.252	1.221	1.293	1.360
4	1.459	1.362	1.302	1.351	1.361	1.400	1.465	1.505	1.444	1.366	1.302	1.281	1.363	1.482
2	1.478	1.380	1.321	1.370	1.372	1.411	1.490	1.537	1.477	1.408	1.341	1.315	1.397	1.520
0	1.482	1.385	1.326	1.372	1.372	1.410	1.491	1.548	1.492	1.418	1.347	1.324	1.406	1.527
−2	1.469	1.373	1.313	1.360	1.358	1.399	1.471	1.538	1.480	1.403	1.334	1.309	1.389	1.501
−4	1.443	1.347	1.285	1.333	1.332	1.373	1.430	1.510	1.445	1.367	1.297	1.260	1.332	1.406
−6	1.395	1.302	1.242	1.286	1.292	1.329	1.380	1.451	1.380	1.297	1.221	1.174	1.209	1.221
−8	1.323	1.246	1.190	1.218	1.229	1.268	1.319	1.369	1.296	1.208	1.136	1.083	1.085	1.063
−10	1.246	1.180	1.128	1.147	1.160	1.199	1.251	1.281	1.208	1.120	1.048	0.988	0.967	0.922
−12	1.165	1.105	1.058	1.068	1.087	1.125	1.172	1.191	1.116	1.030	0.955	0.892	0.851	0.790
−14	1.077	1.023	0.978	0.987	1.008	1.045	1.085	1.095	1.017	0.935	0.860	0.792	0.737	0.661

Table 7.1 (continued)

Distance from Core Midplane (cm)	Relative Power Density													
	Distance from Core Center Line (cm)													
	Inner Fuel Element							Outer Fuel Element						
	7.14	8.00	9.00	10.00	11.00	12.00	12.60	15.15	16.00	17.00	18.00	19.00	20.00	21.00
−16	0.988	0.933	0.892	0.897	0.926	0.963	0.990	0.999	0.921	0.841	0.764	0.690	0.625	0.537
−18	0.894	0.837	0.799	0.813	0.841	0.874	0.893	0.906	0.830	0.746	0.667	0.589	0.515	0.416
−20	0.799	0.735	0.701	0.724	0.753	0.785	0.788	0.815	0.742	0.650	0.569	0.485	0.407	0.296
−22	0.700	0.649	0.638	0.655	0.666	0.691	0.681	0.744	0.677	0.590	0.491	0.390	0.303	0.178
−24	0.651	0.642	0.644	0.660	0.653	0.655	0.652	0.736	0.677	0.588	0.491	0.386	0.258	0.087
−25.4	0.598	0.929	1.119	1.205	1.149	1.036	0.915	1.136	1.095	1.001	0.872	0.737	0.378	0.024
							Time: 11.57 days = 277.7 hr							
25.4	0.504	0.947	1.181	1.258	1.211	1.090	0.950	1.289	1.281	1.199	1.082	0.950	0.607	0.253
24	0.545	0.669	0.709	0.723	0.718	0.731	0.700	0.802	0.777	0.720	0.652	0.569	0.482	0.310
22	0.575	0.669	0.688	0.689	0.707	0.705	0.694	0.768	0.743	0.670	0.608	0.540	0.459	0.376
20	0.685	0.769	0.751	0.751	0.785	0.785	0.791	0.825	0.806	0.741	0.689	0.631	0.560	0.486
18	0.818	0.872	0.836	0.839	0.860	0.893	0.881	0.917	0.892	0.824	0.772	0.722	0.715	0.585
16	0.903	0.965	0.928	0.932	0.932	0.981	0.967	1.007	0.981	0.912	0.863	0.814	0.880	0.685
14	0.979	1.052	1.016	1.019	1.004	1.063	1.061	1.088	1.069	1.004	0.951	0.906	0.989	0.794
12	1.045	1.130	1.096	1.098	1.078	1.137	1.159	1.162	1.155	1.097	1.033	0.999	1.079	0.908
10	1.105	1.200	1.169	1.169	1.157	1.203	1.252	1.225	1.234	1.186	1.112	1.095	1.165	1.035
8	1.155	1.259	1.230	1.232	1.232	1.262	1.329	1.276	1.306	1.260	1.189	1.185	1.243	1.176
6	1.191	1.306	1.281	1.288	1.293	1.305	1.376	1.325	1.366	1.315	1.252	1.251	1.308	1.281
4	1.214	1.339	1.314	1.329	1.331	1.334	1.399	1.366	1.412	1.355	1.292	1.291	1.352	1.341
2	1.228	1.359	1.336	1.350	1.346	1.351	1.405	1.400	1.438	1.379	1.316	1.313	1.370	1.373
0	1.239	1.365	1.342	1.352	1.346	1.358	1.405	1.415	1.449	1.391	1.325	1.322	1.370	1.386
−2	1.230	1.354	1.329	1.334	1.339	1.345	1.397	1.400	1.435	1.385	1.314	1.310	1.364	1.372
−4	1.219	1.329	1.299	1.300	1.310	1.315	1.370	1.362	1.405	1.358	1.287	1.284	1.342	1.331
−6	1.197	1.289	1.249	1.256	1.265	1.274	1.326	1.312	1.355	1.305	1.244	1.239	1.291	1.259
−8	1.161	1.237	1.198	1.206	1.202	1.223	1.264	1.254	1.286	1.235	1.171	1.156	1.194	1.141
−10	1.108	1.176	1.140	1.146	1.136	1.170	1.196	1.189	1.204	1.146	1.077	1.045	1.062	0.965
−12	1.032	1.106	1.079	1.079	1.065	1.110	1.125	1.122	1.113	1.049	0.984	0.933	0.925	0.812
−14	0.948	1.028	0.999	1.003	0.996	1.044	1.045	1.044	1.017	0.950	0.891	0.834	0.813	0.712
−16	0.863	0.943	0.911	0.918	0.928	0.965	0.956	0.960	0.921	0.858	0.798	0.743	0.709	0.617
−18	0.783	0.851	0.819	0.826	0.848	0.872	0.861	0.864	0.830	0.769	0.710	0.656	0.609	0.527
−20	0.689	0.745	0.736	0.738	0.766	0.760	0.762	0.775	0.748	0.681	0.624	0.567	0.517	0.439
−22	0.569	0.653	0.673	0.676	0.679	0.677	0.659	0.722	0.693	0.614	0.542	0.476	0.424	0.344
−24	0.540	0.661	0.694	0.716	0.720	0.684	0.669	0.742	0.713	0.644	0.578	0.489	0.369	0.211
−25.4	0.491	0.926	1.150	1.221	1.168	1.041	0.899	1.111	1.107	1.032	0.920	0.788	0.459	0.125
							Time: 22.72 days = 545.3 hr							
25.4	0.379	0.874	1.183	1.276	1.218	1.053	0.874	1.120	1.244	1.226	1.165	1.050	0.709	0.327
24	0.403	0.594	0.695	0.711	0.706	0.671	0.624	0.725	0.740	0.695	0.651	0.601	0.534	0.352
22	0.460	0.599	0.675	0.707	0.705	0.677	0.632	0.722	0.740	0.691	0.646	0.607	0.565	0.431
20	0.547	0.659	0.707	0.749	0.757	0.752	0.714	0.757	0.799	0.767	0.731	0.710	0.705	0.549
18	0.624	0.759	0.790	0.835	0.845	0.836	0.806	0.826	0.895	0.870	0.837	0.826	0.821	0.648
16	0.688	0.847	0.833	0.923	0.926	0.914	0.890	0.901	0.984	0.965	0.934	0.925	0.923	0.735
14	0.742	0.927	0.969	1.006	1.003	0.987	0.966	0.970	1.067	1.049	1.018	1.013	1.015	0.813
12	0.788	0.998	1.046	1.081	1.074	1.054	1.034	1.034	1.139	1.123	1.092	1.088	1.094	0.880
10	0.824	1.055	1.115	1.150	1.139	1.116	1.091	1.090	1.202	1.187	1.150	1.154	1.160	0.936
8	0.857	1.103	1.176	1.209	1.197	1.171	1.139	1.141	1.256	1.242	1.199	1.208	1.214	0.984
6	0.887	1.143	1.225	1.260	1.246	1.219	1.177	1.184	1.300	1.285	1.240	1.251	1.259	1.021
4	0.914	1.177	1.261	1.298	1.282	1.251	1.210	1.219	1.338	1.323	1.272	1.286	1.289	1.052
2	0.940	1.203	1.281	1.315	1.296	1.266	1.233	1.250	1.367	1.349	1.297	1.300	1.302	1.072
0	0.962	1.224	1.286	1.315	1.297	1.268	1.243	1.264	1.377	1.349	1.301	1.299	1.303	1.072
−2	0.951	1.210	1.275	1.304	1.284	1.254	1.234	1.249	1.359	1.330	1.284	1.280	1.292	1.048
−4	0.934	1.182	1.248	1.276	1.256	1.232	1.207	1.214	1.328	1.304	1.260	1.253	1.269	1.023

Table 7.1 (continued)

Distance from Core Midplane (cm)	Relative Power Density — Distance from Core Center Line (cm) — Inner Fuel Element							Outer Fuel Element						
	7.14	8.00	9.00	10.00	11.00	12.00	12.60	15.15	16.00	17.00	18.00	19.00	20.00	21.00
−6	0.911	1.145	1.207	1.236	1.218	1.193	1.172	1.172	1.288	1.269	1.228	1.221	1.237	0.993
−8	0.880	1.102	1.159	1.189	1.174	1.147	1.127	1.125	1.242	1.225	1.189	1.181	1.196	0.961
−10	0.844	1.050	1.100	1.131	1.120	1.094	1.074	1.072	1.187	1.175	1.139	1.133	1.148	0.922
−12	0.798	0.988	1.031	1.066	1.059	1.035	1.015	1.011	1.121	1.113	1.080	1.076	1.089	0.875
−14	0.744	0.916	0.954	0.990	0.990	0.969	0.950	0.947	1.045	1.038	1.008	1.007	1.014	0.808
−16	0.680	0.832	0.869	0.910	0.915	0.900	0.879	0.877	0.961	0.949	0.919	0.917	0.914	0.718
−18	0.607	0.737	0.776	0.822	0.833	0.825	0.804	0.804	0.867	0.847	0.813	0.802	0.783	0.599
−20	0.526	0.637	0.694	0.728	0.748	0.746	0.722	0.729	0.764	0.731	0.692	0.653	0.612	0.468
−22	0.437	0.589	0.656	0.680	0.678	0.664	0.627	0.688	0.704	0.657	0.614	0.575	0.514	0.381
−24	0.407	0.589	0.663	0.682	0.674	0.638	0.590	0.686	0.703	0.659	0.618	0.572	0.510	0.324
−25.4	0.379	0.866	1.165	1.251	1.191	1.027	0.849	1.016	1.150	1.120	1.054	0.950	0.627	0.281
Time: 25.00 days = 600.00 hr														
25.4	0.358	0.850	1.170	1.265	1.198	1.019	0.824	1.131	1.294	1.284	1.243	1.141	0.805	0.415
24	0.363	0.558	0.634	0.654	0.662	0.645	0.592	0.746	0.757	0.723	0.704	0.690	0.643	0.439
22	0.422	0.571	0.633	0.657	0.665	0.657	0.609	0.718	0.759	0.722	0.709	0.702	0.693	0.495
20	0.497	0.648	0.688	0.725	0.733	0.727	0.685	0.739	0.808	0.794	0.785	0.786	0.791	0.586
18	0.568	0.735	0.772	0.808	0.821	0.815	0.766	0.808	0.896	0.884	0.877	0.867	0.879	0.664
16	0.629	0.814	0.853	0.885	0.898	0.894	0.842	0.883	0.980	0.967	0.959	0.943	0.957	0.729
14	0.684	0.886	0.929	0.955	0.973	0.966	0.909	0.951	1.057	1.043	1.034	1.015	1.026	0.787
12	0.730	0.950	0.999	1.032	1.041	1.029	0.970	1.011	1.124	1.111	1.101	1.078	1.087	0.838
10	0.768	1.006	1.065	1.099	1.100	1.083	1.024	1.064	1.183	1.170	1.159	1.136	1.142	0.883
8	0.801	1.054	1.124	1.160	1.152	1.129	1.069	1.110	1.236	1.220	1.208	1.185	1.191	0.923
6	0.826	1.094	1.176	1.215	1.198	1.166	1.108	1.147	1.275	1.259	1.249	1.224	1.232	0.951
4	0.848	1.126	1.213	1.246	1.228	1.195	1.139	1.172	1.299	1.283	1.270	1.241	1.243	0.963
2	0.866	1.145	1.231	1.263	1.243	1.211	1.159	1.185	1.312	1.294	1.277	1.243	1.243	0.965
0	0.877	1.147	1.234	1.269	1.248	1.215	1.168	1.189	1.316	1.295	1.278	1.243	1.243	0.966
−2	0.868	1.134	1.229	1.261	1.242	1.210	1.168	1.186	1.312	1.294	1.277	1.243	1.243	0.965
−4	0.854	1.114	1.210	1.242	1.222	1.193	1.159	1.173	1.299	1.284	1.268	1.240	1.243	0.965
−6	0.833	1.087	1.176	1.208	1.190	1.167	1.134	1.152	1.276	1.264	1.246	1.222	1.236	0.956
−8	0.809	1.054	1.132	1.166	1.153	1.133	1.093	1.117	1.239	1.223	1.210	1.186	1.200	0.930
−10	0.778	1.012	1.079	1.112	1.108	1.092	1.044	1.075	1.190	1.174	1.162	1.139	1.152	0.891
−12	0.741	0.960	1.014	1.052	1.053	1.043	0.987	1.024	1.131	1.114	1.102	1.081	1.095	0.846
−14	0.692	0.895	0.943	0.983	0.991	0.983	0.924	0.965	1.062	1.092	1.033	1.014	1.030	0.796
−16	0.631	0.813	0.861	0.906	0.918	0.913	0.852	0.896	0.986	0.965	0.954	0.938	0.958	0.741
−18	0.552	0.707	0.770	0.821	0.836	0.831	0.774	0.818	0.896	0.875	0.862	0.849	0.874	0.677
−20	0.452	0.595	0.677	0.731	0.746	0.738	0.689	0.750	0.811	0.778	0.764	0.752	0.786	0.603
−22	0.395	0.552	0.626	0.671	0.676	0.662	0.610	0.724	0.767	0.728	0.714	0.702	0.686	0.513
−24	0.392	0.557	0.635	0.665	0.668	0.647	0.593	0.738	0.766	0.732	0.724	0.700	0.653	0.414
−25.4	0.356	0.829	1.129	1.217	1.145	0.971	0.780	1.090	1.245	1.231	1.189	1.086	0.739	0.350

fuel-cycle calculation results with the critical-experiment data to obtain a normalized two-dimensional power distribution. In order to match a calculated partially depleted core with a partially poisoned (moderator soluble poison) critical-experiment core, an appropriate relationship between control-rod position and control-region smeared-poison concentration was obtained from one-dimensional calculations of the experimental cores. A curve representing the relationship used is shown in Fig. 7.17. This technique does not consider the different relationship that would be obtained if calculations were made for actual partially burned cores containing nonuniformly distributed fission products and nonuniformly depleted

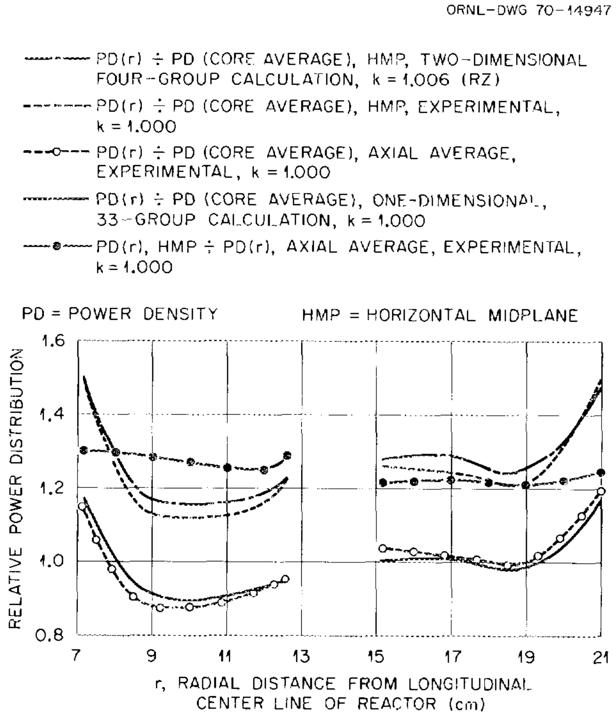

Fig. 7.13. Calculated and Measured Radial Power Distribution with 1.35 g B/liter in Moderator, No Target, and Rods Out.

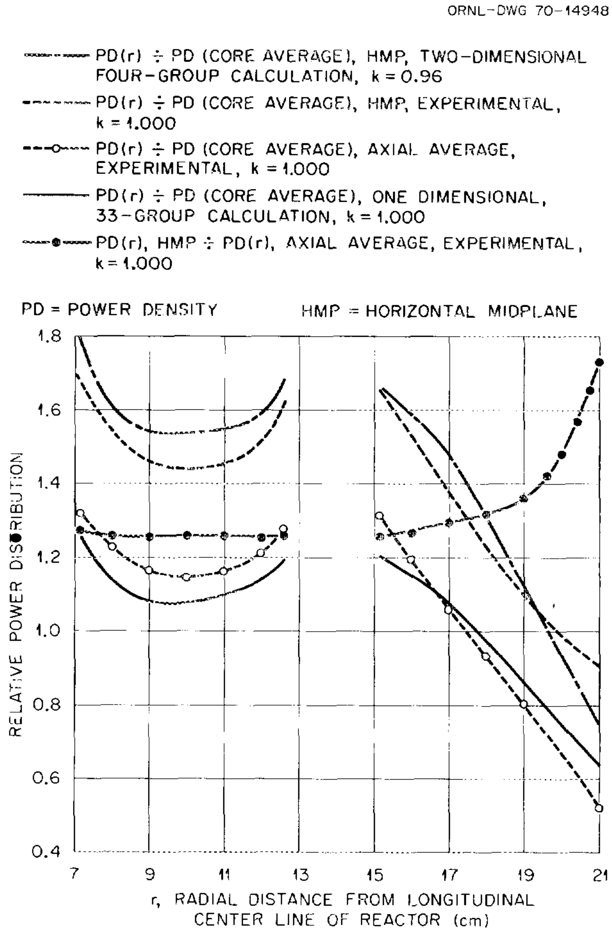

Fig. 7.14. Calculated and Measured Radial Power Distribution in Clean Core with 300-g Plutonium Target and Rods at 16.6 in.

fuel. In an effort to determine the magnitude of the error involved, reactivity perturbations were introduced in the critical experiments in at least two different ways to achieve the same control-rod positions. Calculations of these cases indicated that the calculated control-region smeared-poison concentration was sufficiently insensitive to the associated redistribution of neutron flux to warrant the above procedure for determining rod position.

Two-dimensional calculations were not relied upon for predicting power distributions. However, a few such calculations were made to determine how well the power distribution could be estimated in this manner. Differences between the calculated and measured values are shown in Tables 7.2 and 7.3 for the "end" and beginning-of-cycle conditions. Referring to the rods-out case (Table 7.3), it is observed that the agreement is very good except near the ends of the core. In these areas the calculation tends to underestimate the end peaking, although near the flux trap it overestimates the end peaking. It is also observed that the calculated neutron multiplication factor is within 0.6% $\Delta k/k$ of unity.

For the clean core condition the two-dimensional calculation is less accurate because of difficulties in establishing appropriate self-shielding factors for the control rods. In this particular calculation no self-shielding factors were used. It may be observed in Table 7.3 that the calculation overestimated the worth of the rods (k = 0.96) and underestimated the power densities adjacent to the control region. Next to and near the ends of the flux trap, the discrepancy is also greater than for the rods-withdrawn case; this is probably due to the fact that the latter core flux trap did not contain a target and the clean core flux trap did.

The above power distributions apply to steady-state operation only. Calculations were also made for specific transient cases. During a xenon transient in the early part of a fuel cycle, power densities adjacent to the

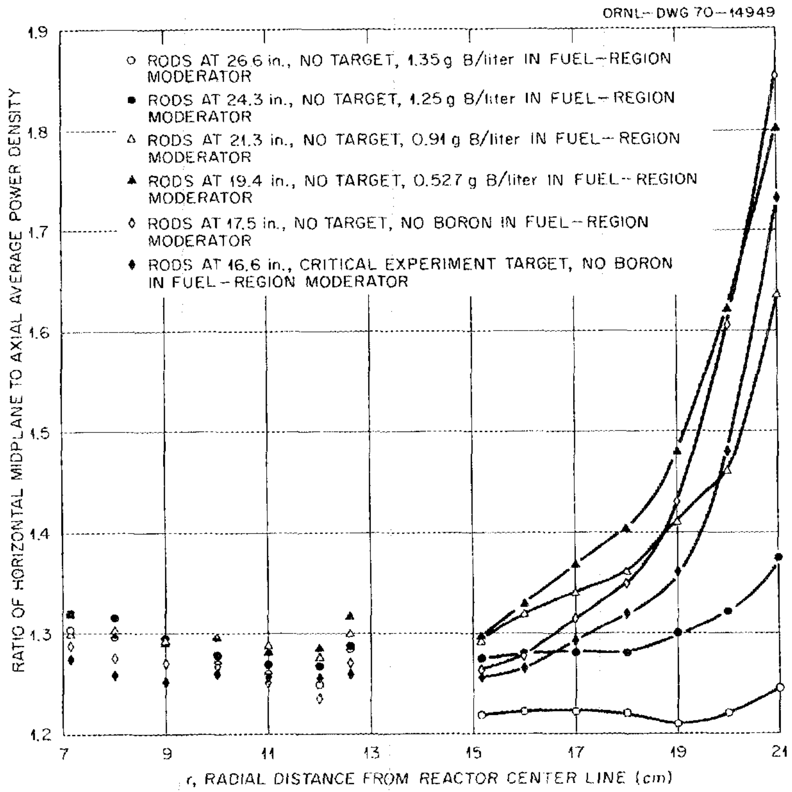

Fig. 7.15. Ratio of Horizontal Midplane to Axial Average Power Density Versus Radial Distance from Reactor Center Line for Various Symmetrical Critical Control Rod Positions. Experimental Data obtained from HFIRCE-4 core.

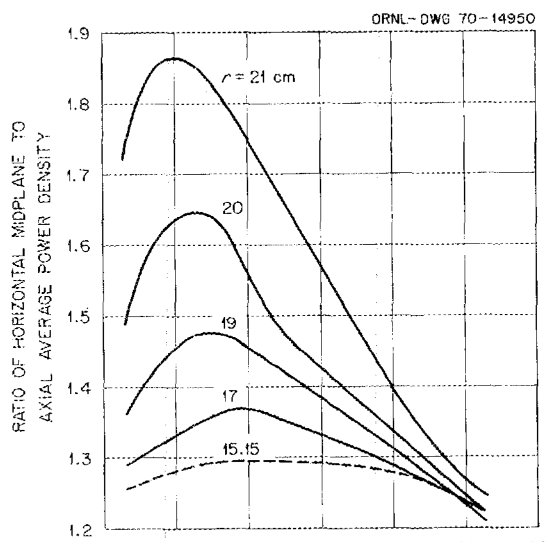

Fig. 7.16. Ratio of Horizontal Midplane to Axial Average Power Density for Several Radii as a Function of Critical Control Rod Position. Data from HFIRCE-4 experiments.

control region can be higher than the peak power density at any time during a normal steady-state fuel cycle. This results from the window-peaking effect associated with withdrawal of the control rods (refer to Fig. 7.16) and with the lack of nonuniform burnup of the fuel early in the cycle. The maximum window-peaking effect occurs for an intermediate position of the control rods, and the associated peak power density is at the horizontal midplane. Compared with the normal steady-state hot-spot condition the transient hot spot is less severe because the former is at the outlet (high bulk water temperature) and the latter is upstream from that point. Also the transient hot spot does not have as large an accumulation of aluminum oxide and thus does not experience as much plate warpage and loss of strength. Thus it is concluded that the most serious hot-spot condition occurs during normal steady-state conditions.

All the power distributions discussed thus far apply to the nominal core condition. It is necessary, of course, to consider the effects of variations in fuel and

Table 7.2. Difference D(r,z) Between Measured and Two-Dimensional Four-Group Calculated Power Distributions for HFIRCE-4 Core with 1.35 g B/liter in Moderator, No Target, and Rods Out

Experimental $k_{eff} = 1.000$
Calculated $k_{eff} = 1.006$

Distance from Core Midplane (cm)	$D(r,z) = \frac{PD_{expt} - PD_{calc}}{PD_{expt}} \times 100$													
	Distance from Core Center Line (cm)													
	7.14	8	9	10	11	12	12.6	15.15	16	17	18	19	20	21
25.4	−26	17	27	28	26	22	16	35	30	26	26	30	18	5
24	−15	−5	−2	−2	2	2	0	18	11	9	9	12	10	6
22	−8	−6	−3	−3	0	2	2	12	10	4	3	7	8	1
20	−5	−6	−8	−5	−2	0	1	6	4	3	4	5	8	4
18	−2	−4	−7	−7	−1	1	0	3	3	2	4	4	6	5
16	0	−4	−8	−6	−2	0	0	3	2	1	2	1	4	5
14	−1	−4	−7	−7	−3	−1	0	1	1	0	1	0	4	4
12	−1	−4	−8	−7	−3	−1	−1	1	0	−1	1	0	3	3
10	−2	−5	−7	−5	−4	−2	−1	0	−1	−1	0	−1	2	3
8	−2	−4	−5	−5	−3	−3	−2	0	−1	−2	0	−1	2	3
6	−3	−3	−5	−4	−3	−3	−2	−1	−1	−2	0	−1	2	3
4	−2	−3	−4	−3	−3	−3	0	0	−2	−2	−1	−2	1	2
2	−1	−3	−4	−3	−3	−3	0	−1	−1	−3	−2	−2	−1	1
0	−1	−2	−4	−4	−3	−3	0	−1	−2	−3	−2	−3	−1	1
−2	−1	−4	−4	−4	−3	−3	1	−1	−2	−3	−2	−2	−1	1
−4	−1	−4	−4	−3	−4	−3	2	0	−2	−2	0	−2	1	2
−6	−1	−4	−5	−4	−4	−3	1	0	−1	−1	0	−1	2	3
−8	−1	−4	−6	−4	−4	−2	1	1	0	−1	0	−1	2	4
−10	−1	−4	−5	−4	−3	−1	1	1	0	−1	0	−1	3	4
−12	1	−3	−5	−4	−2	0	1	2	0	−1	1	0	3	5
−14	0	−3	−7	−3	−2	1	1	3	2	0	1	0	4	5
−16	0	−4	−6	−4	0	2	2	4	2	0	2	1	4	5
−18	−5	−9	−9	−4	0	3	1	5	3	0	1	1	6	5
−20	−16	−15	−10	−3	0	1	1	8	5	1	1	1	6	5
−22	−15	−12	−7	−2	2	2	2	13	10	6	7	7	6	4
−24	−9	−5	−3	0	2	3	0	18	11	9	12	13	13	0
−25.4	−26	15	24	27	22	17	11	33	28	22	25	38	15	−4

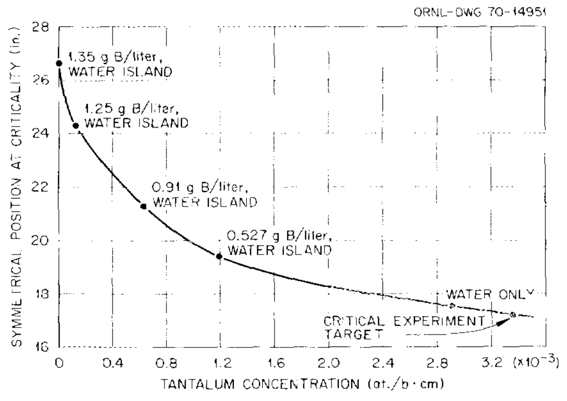

Fig. 7.17. Symmetrical Control Rod Position Versus Tantalum Concentration in Control Region of One-Dimensional Calculation for HFIRCE-3.

burnable-poison loadings and distributions and in metal-to-water ratio within the specified fabrication tolerances. Minimum and maximum reactivity cores were defined within these tolerances, and appropriate one-dimensional calculations were made. Radial power distributions obtained from such calculations are shown in Figs. 7.18, 7.19, and 7.20 for the nominal, minimum, and maximum* reactivity cores at various times in the fuel cycle. As may be observed the maximum reactivity core produces a peak power density about 20% greater than nominal, and the minimum reactivity core produces a 10% increase over nominal.

*The power-distribution discontinuities shown in Figs. 7.19 and 7.20 result from assumed discontinuities in radial fuel distributions that are consistent with permissible tolerances.

Table 7.3. Difference D(r,z) Between Measured and Two-Dimensional Four-Group Calculated Power Distributions for HFIRCE-4 Core in Clean Condition with 300-g Pu Target

Experimental $k_{eff} = 1.00$
Calculated $k_{eff} = 0.96$

Distance from Core Midplane (cm)	$D(r,z) = \frac{PD_{expt} - PD_{calc}}{PD_{expt}} \times 100$													
	Distance from Core Center Line (cm)													
	7.14	8	9	10	11	12	12.6	15.15	16	17	18	19	20	21
25.4	−41	0	8	8	6	5	1	21	13	10	17	32	35	8
24	−17	−7	−4	−4	−4	−7	−5	8	3	1	7	13	37	41
22	−16	−6	0	0	1	2	1	12	9	5	5	8	20	33
20	−8	−5	−4	−5	−4	−1	−1	7	2	−2	0	4	14	33
18	−5	−4	−5	−7	−5	−1	1	4	1	−3	−1	5	16	32
16	−5	−3	−5	−8	−6	−2	0	3	−1	−4	0	7	16	35
14	−4	−4	−6	−8	−7	−3	−1	2	−3	−6	−2	6	17	38
12	−3	−5	−6	−8	−7	−5	−1	0	−5	−7	−3	3	16	33
10	−7	−5	−6	−7	−7	−5	−3	−2	−6	−9	−6	0	6	14
8	−7	−4	−4	−7	−6	−6	−4	−4	−6	−10	−7	−3	3	7
6	−7	−4	−4	−6	−5	−5	−4	−5	−8	−8	−7	−4	4	12
4	−8	−4	−5	−6	−5	−5	−4	−4	−7	−9	−7	−5	1	7
2	−7	−4	−5	−6	−6	−5	−4	−2	−5	−8	−7	−5	1	9
0	−7	−4	−5	−7	−7	−5	−4	0	−5	−7	−7	−3	5	19
−2	−6	−4	−5	−7	−6	−5	−3	−1	−4	−7	−5	−1	6	18
−4	−5	−3	−3	−7	−6	−5	−2	−1	−4	−5	−2	0	6	19
−6	−4	−1	−4	−7	−6	−3	−1	−1	−3	−4	−1	4	9	12
−8	−3	−1	−3	−6	−5	−3	−1	1	−1	−4	−1	3	7	3
−10	−3	−1	−3	−6	−4	−2	−1	4	0	−3	0	5	10	12
−12	−1	0	−2	−4	−3	0	1	6	2	−1	3	11	31	69
−14	−2	1	−1	−3	−1	2	3	8	4	1	4	14	33	76
−16	−2	1	0	−2	1	4	5	9	6	2	6	16	34	70
−18	0	2	0	−1	2	5	7	9	5	5	8	18	33	72
−20	−2	0	−1	0	2	6	8	11	8	7	12	16	32	69
−22	−10	−4	3	−3	6	9	9	17	14	12	15	21	38	76
−24	−25	−9	−5	−4	1	1	3	13	10	9	13	21	44	83
−25.4	−65	−6	8	9	11	12	8	24	18	17	26	44	50	50

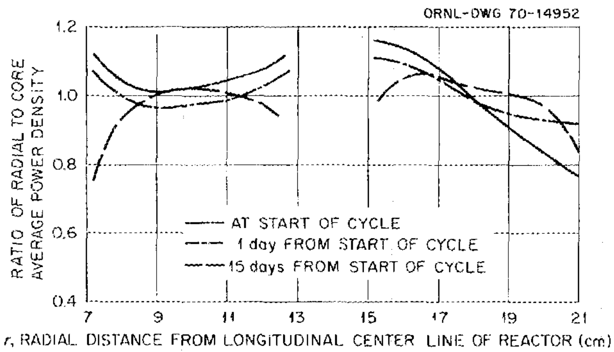

Fig. 7.18. Calculated Radial Power Distributions for Production Core with Nominal Core Conditions and Maximum Poison Target (16-Day Cycle).

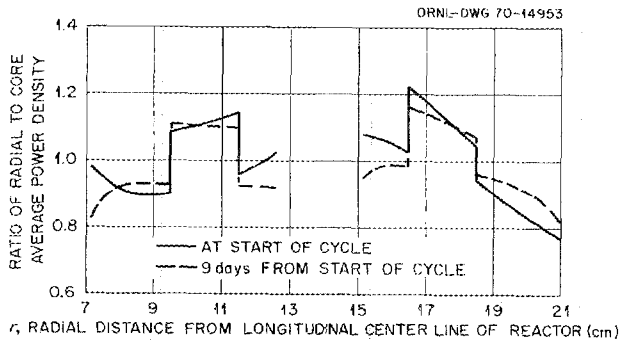

Fig. 7.19. Calculated Radial Power Distributions for Production Core with Minimum Reactivity Core Conditions and Maximum Poison Target (10.5-Day Cycle).

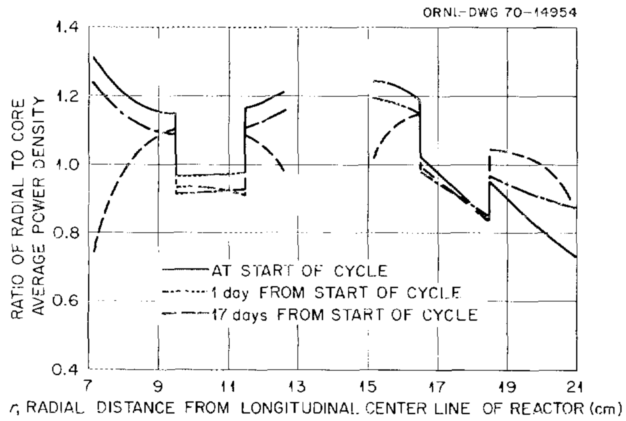

Fig. 7.20. Calculated Radial Power Distributions for Production Core with Maximum Reactivity Core Conditions and Maximum Reactivity Target (18.5-Day Cycle).

Another fabrication tolerance that must be considered is the dimensional tolerance at the ends and edges of the fuel plate fuel core. It is possible for a single fuel core to extend radially and axially beyond the others and thus expose its protruding edges to higher neutron fluxes than the rest of fuel cores are exposed to. The calculated radial power density gradients for the inner and outer edges of the inner and outer elements are 60, 40, 50, and 35%/cm, respectively, with the latter value applicable only within the gray and white window regions. Axial gradients at the ends of the fuel cores were determined experimentally and are shown in Fig. 7.21 as a function of radial position. These measurements were made for the beginning-of-cycle conditions. Gradients at later times are somewhat less.

The present dimensional tolerances on the relative positions of fuel cores permit radial protrusions of about 0.20, 0.10, 0.16, and 0.12 cm (going from inner to outer edges) and axial protrusions of about 1.34 cm. Thus the possible increases in local power densities associated with fuel-core edge-position tolerances are 12, 4, 8, and 4% for the radial edges and as much as 50% for the ends.

As will be discussed in Chapter 8 the calculated length of the fuel cycle for a nominal core was about 16 days, whereas the actual fuel-cycle time for the HFIR has consistently been 23 days. Since the discrepancy is too large to be explained by fabrication tolerances and inaccuracies in measuring power level, it was desirable to manipulate the calculation in such a way as to produce a calculated cycle of 23 days for the purpose of examining the power distribution. The details of how this was done are explained in Chapter 8, but the power-distribution results are shown in Fig. 7.22. A comparison of this figure with Fig. 7.18 shows that the extended fuel cycle increases the peak-to-average power density ratio about 5%.

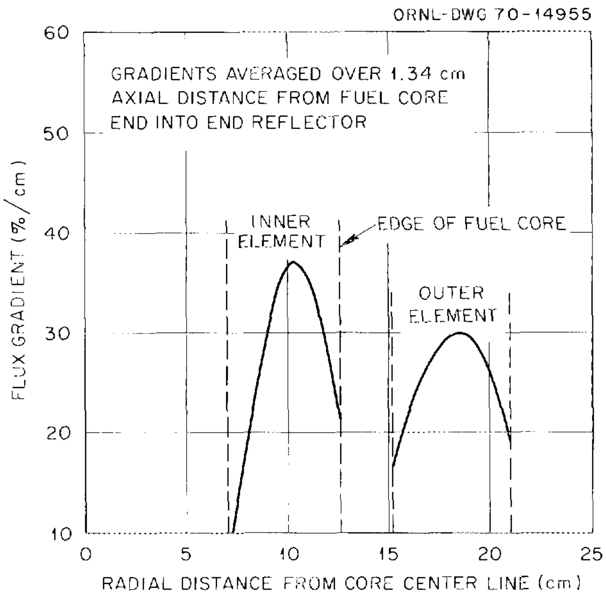

Fig. 7.21. Fission Flux Axial Gradients at End of Fuel Cores for Clean Core Conditions.

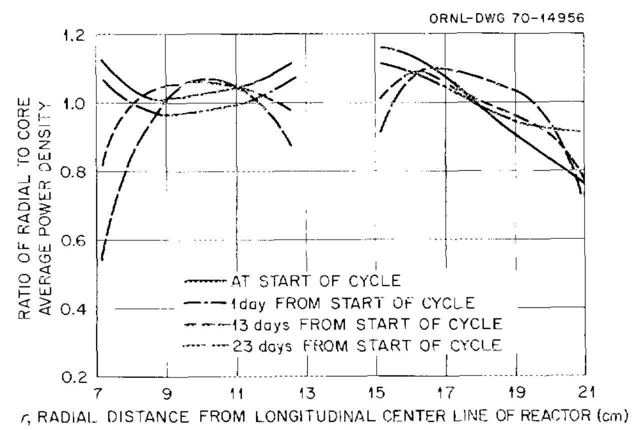

Fig. 7.22. Calculated Radial Power Distributions for Production Core with Nominal Core Conditions, Maximum Poison Target, and No Long-Life Fission Products (23-Day Cycle).

8. FUEL-CYCLE CALCULATIONS

Fuel-cycle calculations were made by using a one-dimensional 33-group 25-region diffusion code. As discussed in Appendix B the cross sections were obtained with THERMOS and GAM-I for a core that was about half depleted. This set of cross sections was used all through the fuel cycle without otherwise accounting for changes associated with burnup. In the THERMOS calculation the entire core was considered to be a unit cell, and thus it was possible to calculate thermal cross sections as a function of radial position.

The use of 25 radial regions, 16 of which were in the fuel region, permitted detailed consideration of nonuniform radial depletion and fission-product buildup. An estimate of nonuniformities in the axial direction indicated that the effect was small on both power distribution and reactivity and that the result was flattening of the power distribution and a decrease in reactivity.

The axial buckling was assumed to be independent of burnup, radial position, and neutron energy. A single value was obtained by performing a buckling search on the HFIRCE-3 core in the HFIR facility with the rods out and criticality maintained with boron in the moderator (fuel regions only). This value was used in all the fuel-cycle calculations.

As discussed in detail in Appendix B the fission products were divided into two categories: those with short half-lives or large cross sections or both and those with relatively long half-lives and small cross sections. The latter fission products were lumped into a single item, while the others were treated separately with their appropriate chains.

At each of the time steps in a fuel-cycle calculation, criticality was achieved by adjusting the poison concentration in the annular, homogenized control region. The adequacy of this procedure from the standpoint of predicting power distributions was discussed in Chapter 7.

A reasonable fuel-cycle time originally considered for the HFIR was about ten days. As the design progressed it became apparent that a 14-day cycle could probably be achieved without exceeding limitations associated with reactivity control, fuel-plate metallurgical considerations, and neutron fluxes in experimental facilities. Final fuel-cycle calculations for the HFIR indicated that the nominal fuel-cycle time for a core containing the maximum poison flux-trap target and having a clean beryllium reflector would be about 16 days.

Significant variations in fuel-cycle time can occur as a result of deviations from nominal in fuel and burnable-poison loadings and distributions, metal-to-water ratio in the fuel elements, flux-trap target contents, and beryllium-reflector impurity content. Of course experiments other than that in the flux trap can also have an effect, but the original intent was that they be located so as to have essentially no effect. Variations in fuel-cycle time associated with deviations of fuel and burnable-poison concentrations and of metal-to-water ratio from nominal values were intended to be limited by specified fabrication tolerances. This was also true to some extent for the beryllium reflector.

The reactivity span associated with extreme deviations within tolerance is about 0.04 $\Delta k/k$ if the flux-trap target initially contains 300 g ^{242}Pu. Fuel-cycle calculations for these cases indicated a range in fuel-cycle time from about 11 to about 19 days. Curves of k_{eff} versus time for the minimum, nominal, and maximum reactivity cases are shown in Fig. 8.1.

Reactivities associated with xenon, samarium, the lumped nonsaturating fission products and the boron burnable poison are shown in Fig. 8.2 as a function of

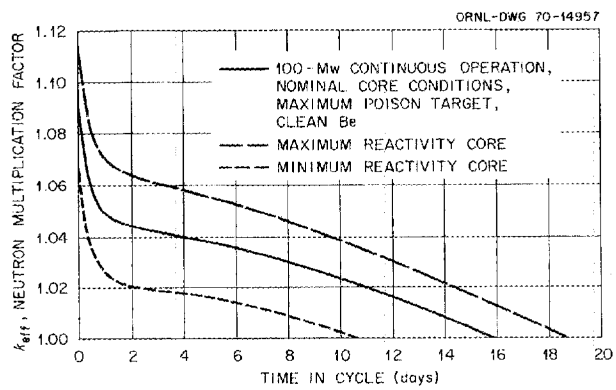

Fig. 8.1. Neutron Multiplication Factor During Fuel Cycle for Nominal, Maximum, and Minimum Reactivity Conditions.

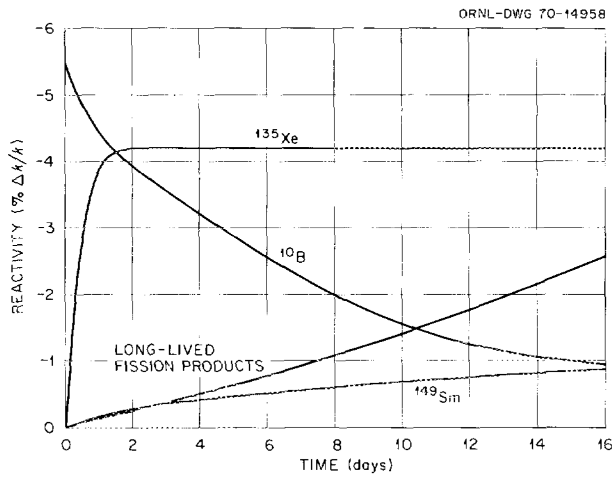

Fig. 8.2. Reactivity Variations with Time Associated with Xenon, Samarium, Long-Lived Fission Products, and Boron During Normal Fuel Cycle.

time for the nominal core under steady-state conditions. Of particular interest is the boron curve because it shows that at the end of the calculated fuel cycle the remaining boron is worth about 0.01 Δk/k, which is equivalent to about two days of core lifetime. The combined use of cadmium and boron was considered for the burnable poison because it could significantly reduce the loss in core lifetime. However, the preliminary investigations indicated that the much more rapidly burning cadmium introduced undesirable power distribution and reactivity characteristics in the early part of the cycle, and thus cadmium was dropped from further consideration for this particular core design.

The fuel-cycle analysis techniques were also used for looking at various slow transients. Figure 8.3 shows k_{eff}

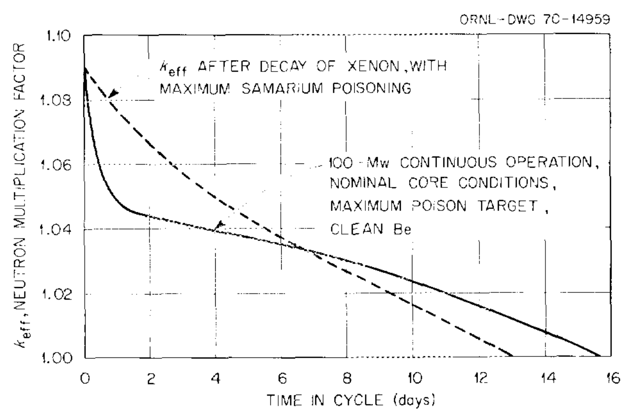

Fig. 8.3. Effect of Maximum Samarium Poisoning After Reactor Shutdown at Various Times in Cycle.

for a core assumed to be shut down from full power at time, t, and allowed to remain down long enough for essentially all the xenon to decay (~10 days). As indicated, a core less than seven days old gains reactivity relative to the steady-state conditions, but after seven days there is a loss. A 13-day-old core is the oldest core that could be "started" again without auxiliary reactivity. This permanent loss of reactivity is due to the decay of ^{149}Pm into stable ^{149}Sm.

Immediately following a shutdown the temporary buildup of xenon imposes a restriction on permissible short-term down time or reduced-power time or both. A family of curves reflecting this limitation is shown in Figs. 8.4 and 8.5. The reduced power levels shown on these curves are fission power rather than total power. Immediately following a large reduction in power (e.g., from 100 to 10 Mw) a large fraction of the total power is afterheat and does not contribute to the production or destruction of xenon. For the curves to be applicable the fission heat must be known.

After the xenon poisoning reaches a peak following a shutdown, there is a time when the combined poisoning effect of xenon, which is decaying, and samarium, which is building up, reaches a minimum between the peak xenon and the final samarium. As shown in Fig. 8.6 the minimum occurs at about four or five days after shutdown, and the difference in reactivity between this minimum point and an "infinite" decay time point for an 11-day-old core is about 0.01 Δk/k. Thus if a 13- to

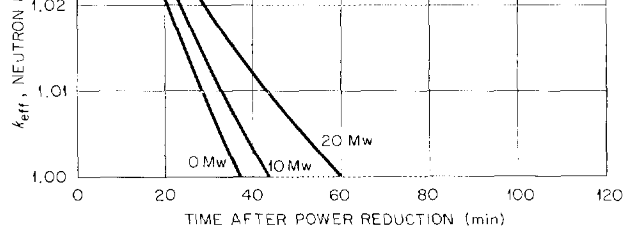

Fig. 8.4. Neutron Multiplication Factor Versus Time After Power Reduction for Nominal 9.4-kg ^{235}U and 2.8-g ^{10}B Core Following One Day of Operation at 100 Mw. Maximum poison target and clean beryllium reflector.

15-day-old core is shut down and caught by the relatively fast xenon buildup, the core could be saved by restarting after about four days but would be lost if delayed much longer than that.

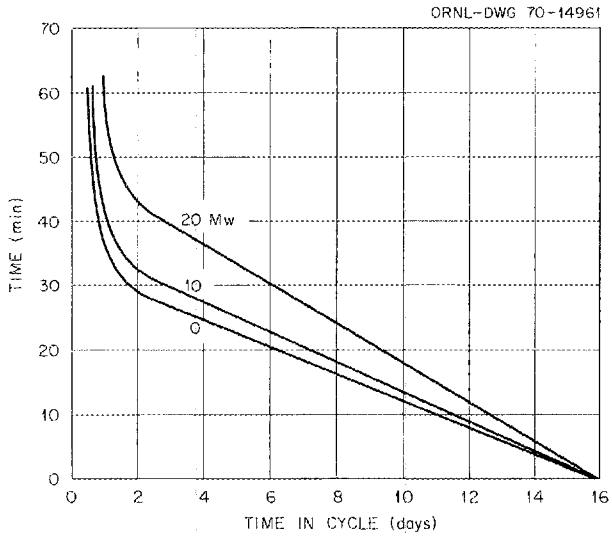

Fig. 8.5. Time Required to Reduce k_{eff} to 1.00 Following a Power Reduction from 100 Mw Versus Time in Cycle. Nominal 9.4-kg ^{235}U and 2.8-g ^{10}B core, maximum poison target, and clean beryllium reflector.

All the preceding discussion pertains quantitatively to the present production core, which contains 9.4 kg ^{235}U and 2.8 g ^{10}B. The very first production core contained the same fuel loading but had a burnable-poison loading of 3.6 instead of 2.8 g ^{10}B. [The larger boron loading was based on critical experiments employing a set of control rods (Ag black region, Ag-Al gray region) that proved to be worth less than the actual Eu_2O_3-Ta-Al rods, which were not available at the time.] This particular core had a calculated nominal lifetime of 14 days, a minimum of two days, and a maximum of 16 days. The very short minimum lifetime indicates the effect of not being able to burn out the burnable poison.

Since several HFIR cores have now been run to completion at full power, it is possible to make a comparison between calculated and observed fuel-cycle times and related performance characteristics. However, before making such comparisons it must be recognized that the actual detailed initial conditions of a fuel element in terms of fuel and poison loadings and distributions and metal-to-water ratio are not known, except that they are within the specified permissible limits. All elements are inspected to assure compliance with these limits, and a final reactivity check is made, but detailed information associated with a precise prediction of lifetime is not obtained.

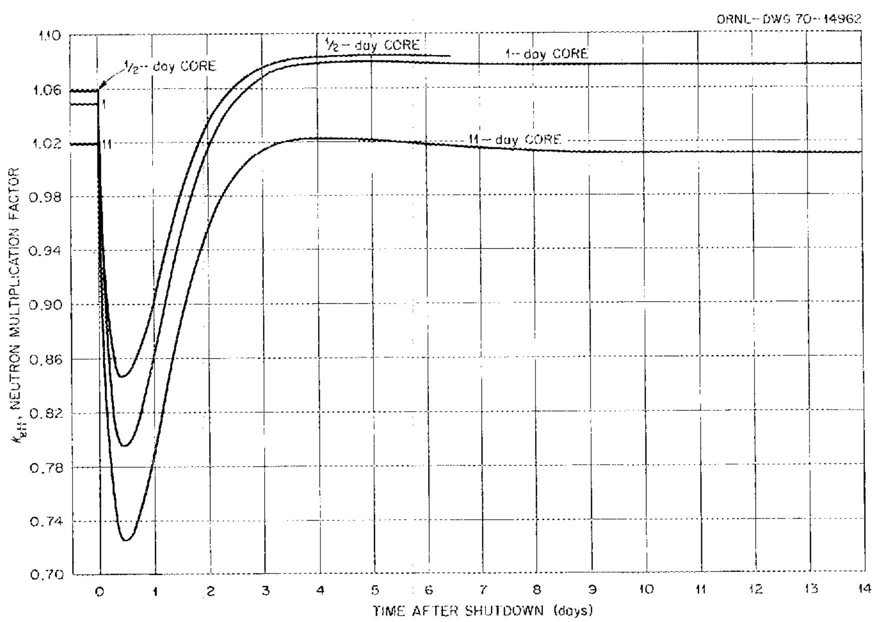

Fig. 8.6. Neutron Multiplication Factor Versus Time After Shutdown for Various Times in Cycle and Nominal Core Conditions.

The above uncertainties make it difficult to compare predicted and actual fuel-cycle times. However, it is not believed that the uncertainties are as great as the observed difference between the predicted nominal core fuel-cycle time and the apparent actual fuel-cycle time. For each of the cores operated so far, including the one containing 3.6 g ^{10}B, the actual fuel-cycle time has been very close to 2300 Mwd, as compared with a predicted range of 1100 to 1900 Mwd for the core containing 2.8 g ^{10}B.

A detailed analysis of fuel and boron loadings and distributions within typical HFIR fuel plates indicates a tendency toward low reactivity and thus short fuel cycle. Thus the discrepancy appears to be something basic in the model. One immediately suspected quantity was the lumped fission-product cross section, but complete removal of this fission product was required to achieve the actual fuel-cycle time. This certainly does not appear to be reasonable.

Present plans for investigating the fuel-cycle time discrepancy include a two-dimensional depletion calculation with several thermal groups. THERMOS- and GAM-calculated cross sections will be used, and some of these have been changed since the one-dimensional calculations were made. There is no clear indication, however, that this method will give better results.

In an effort to determine what effect the longer fuel cycle might have on power distribution and xenon transients, the lumped fission-product group was set equal to zero. No particular significance is attached to this other than it just happens to produce a nominal core fuel cycle of 2300 Mwd. The instantaneous effect of removing the lumped fission product in the computation is to increase the calculated peak power density. Thus this approach appeared to be conservative. Data on burnable-poison burnup and xenon-transient conditions for the longer fuel cycle are given in Figs. 8.7 through 8.10. Results from the steady-state portion of the calculation indicate that the residual poisoning due

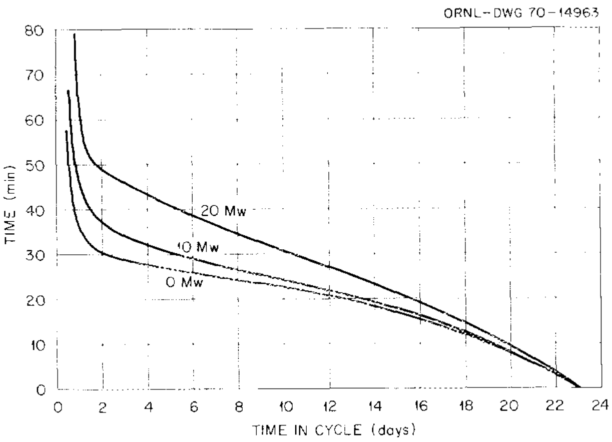

Fig. 8.7. Time Required to Reduce k_{eff} to 1.00 Versus Time in Cycle at 100 Mw Prior to Power Reduction. Nominal core conditions and 23-day cycle.

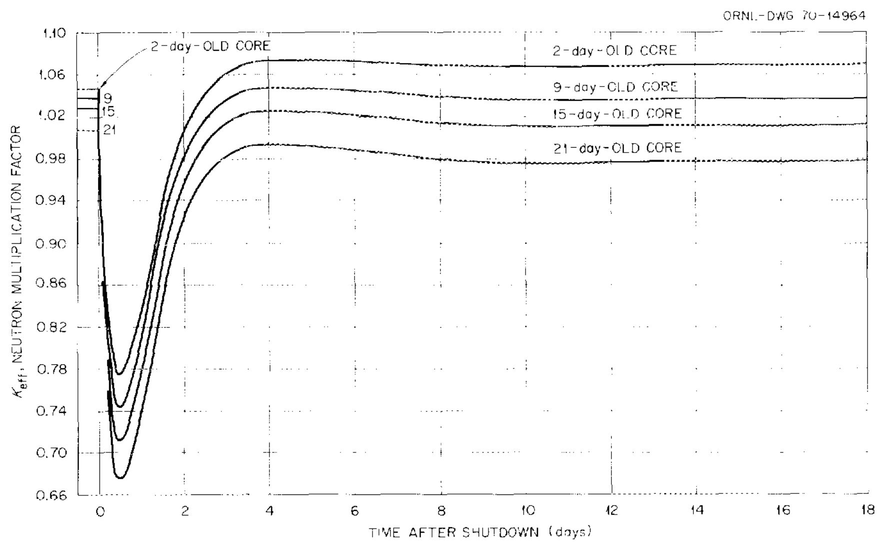

Fig. 8.8. Neutron Multiplication Factor Versus Time After Shutdown for Various Times in Fuel Cycle. Nominal core conditions and 23-day cycle.

to boron is essentially gone by the end of 2300 Mwd. This appears to be the explanation for the first production core (3.6 g ^{10}B) lasting as long as the subsequent cores (2.8 g ^{10}B).

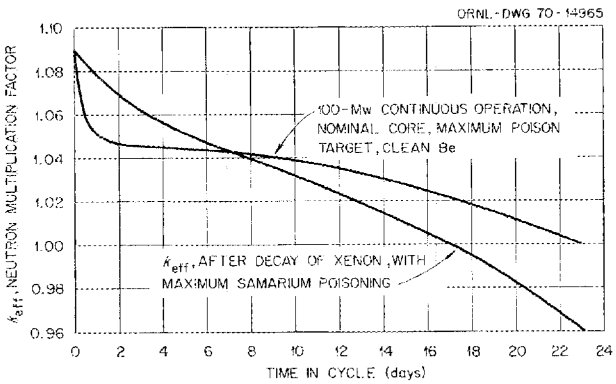

Fig. 8.9. Effect of Maximum Samarium Poisoning After Reactor Shutdown at Various Times in Cycle. Nominal core conditions and 23-day cycle.

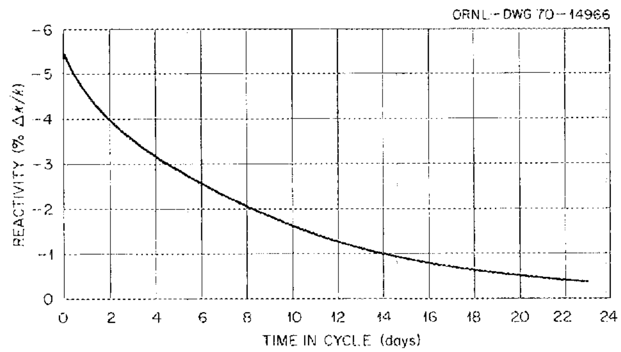

Fig. 8.10. Reactivity Variation with Time Associated with Boron During Normal Fuel Cycle. Nominal core conditions and 23-day cycle.

9. REACTIVITY COEFFICIENTS

Many of the reactivity coefficients were determined experimentally during the HFIR critical experiments. In some cases, however, it was necessary to rely on calculations because measurements were not practical. The results of both experiments and calculations are summarized here. More detail concerning the experimental work is included in Appendix A, and Ref. 14 presents a supplementary discussion on flux-trap void coefficients.

9.1 Temperature Coefficients

Overall core isothermal coefficients and fuel-region coefficients were measured in the HFIRCE-2 experiments. The flux-trap coefficients were determined by taking the difference between the overall and fuel-region coefficients and making a small calculated correction for the control- and beryllium-reflector-region coefficients. Changes in reactivity as a function of isothermal and fuel-region temperature are shown in Fig. 9.1, and the corresponding coefficients are shown in Fig. 9.2. These coefficients are strictly applicable to the clean core condition only. However, with the exception of the coefficient for the fuel region, they are also reasonably accurate for all stages of burnup. Calculations indicate that at the end of a fuel cycle the fuel-region coefficient, which is sensitive to control-rod position, should be one-half that for a clean core.

It may be observed in Fig. 9.2 that without the target in the flux trap the isothermal coefficient is positive up to about 110°F and negative for higher temperatures.

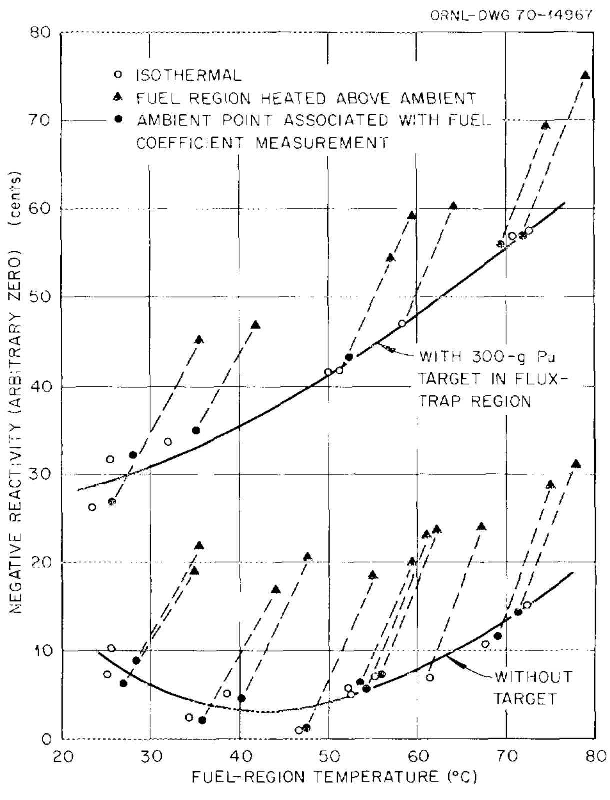

Fig. 9.1. Reactivity Versus Change in Fuel Region and Isothermal Temperatures.

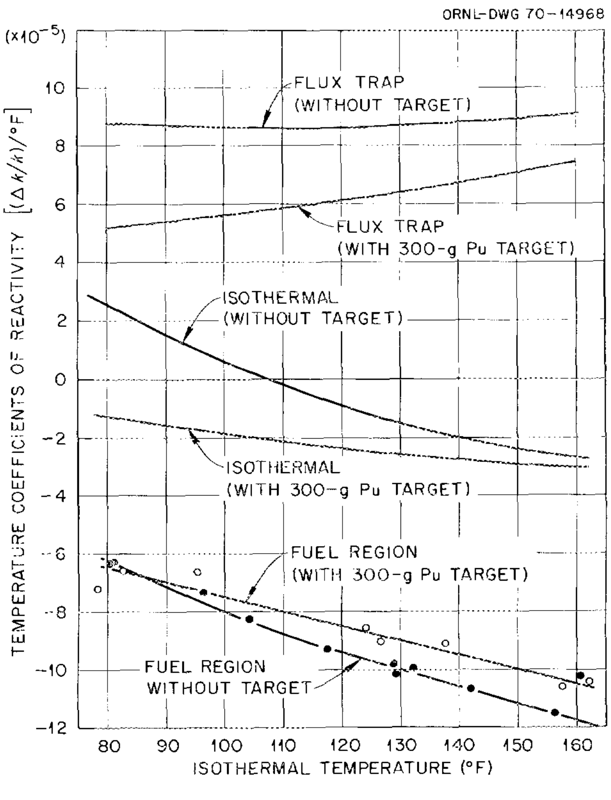

Fig. 9.2. Temperature Coefficients of Reactivity.

The positive value is of little consequence, since the maximum positive reactivity addition is only 0.0005 $\Delta k/k$, and the fuel-region coefficient, which is relatively prompt during a transient, is quite negative for all temperatures of interest.

The isothermal temperature coefficient measured in the actual reactor facility (with the target in the flux trap) was slightly positive in the temperature range 80 to 120°F, with the maximum reactivity addition being about 0.0007 $\Delta k/k$. The difference in the two measured isothermal coefficients is attributed primarily to a difference in the control-rod drive mechanisms in the HFIR facility and the critical-experiment facility. This difference resulted in somewhat different differential thermal expansion between the fuel elements, the control rods, and the control-rod position indicator.

9.2 Void Coefficients

Considerable emphasis was placed on investigation of the flux-trap void coefficient because displacement of water from this region can add significant amounts of positive reactivity. Void effects were investigated in detail in the HFIRCE-1 and -2 experiments, and checks on the worth of the optimum voids (i.e., the void fraction producing the maximum positive reactivity) were made in the HFIRCE-3 and -4 experiments.

The first HFIR critical experiments were performed with a solution fuel $[D_2O + H_2O + UO_2(NO_3)_2]$ and a D_2O outer reflector; the D_2O concentration in the fuel region was adjusted to produce about the same slowing-down and leakage characteristics as an $Al + H_2O + U$ system. In these experiments[6] $\frac{1}{2}$-in.-diam air-filled plastic tubes were added to an all-water flux trap to determine the void effect. The results of these experiments are shown in Fig. 9.3. Also shown in this figure is the reactivity effect of adding 1-in.-diam aluminum rods to the water-filled flux trap. It is of interest to note in the case of true voids that with the flux trap completely voided the critical moderator height was about the same as for no voids.

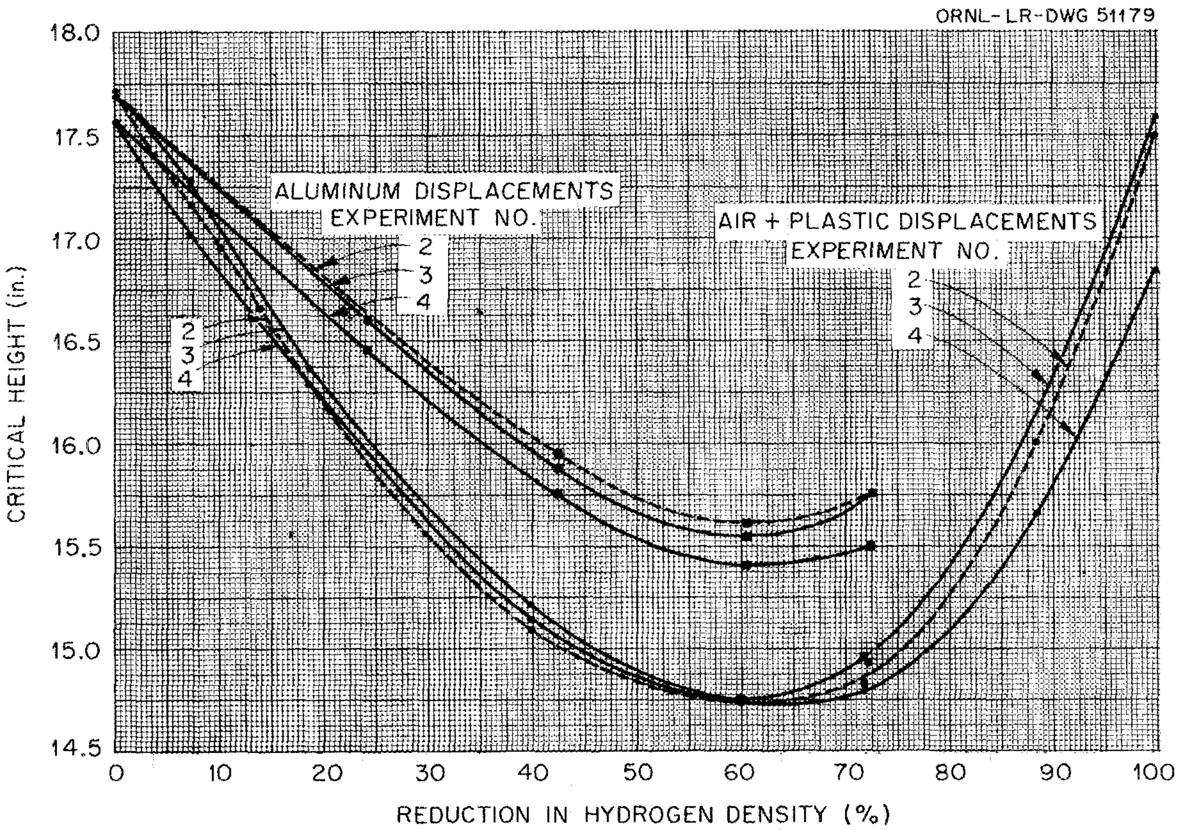

Fig. 9.3. Critical Height as a Function of Reduction in Hydrogen Density of Region I in HFIR Solution Critical Experiments

Reactivities associated with the optimum voids in Fig. 9.3 were somewhat greater than measured in later critical experiments with actual fuel elements. This is attributed to greater neutron leakage to the flux trap of the solution critical experiments and thus greater reactivity dependence on the flux trap. Even so, the results of these experiments should be of some interest in evaluating future modifications to flux-trap loadings, particularly since calculations have not predicted flux-trap void effects very accurately.

In the HFIRCE-2 experiments, styrofoam cylinders of increasing diameter were added to the center of the water-filled flux trap to obtain the curve of Δk versus reduction in average water density, as shown in Fig. 9.4. As indicated, the optimum void was 72% of the flux-trap volume, the corresponding positive reactivity addition was 3.2%, and the void coefficient for small void additions was about 0.06 (Δk/k)/(ΔV/V).

With the 300-g plutonium simulated target in the flux-trap, voids were added uniformly throughout the target volume to achieve the optimum void. These results are shown in Fig. 9.5. Since the aluminum target constitutes a near void, the optimum void fraction with the target in place is only 42%, and the corresponding positive reactivity addition is only 1.5% Δk/k. For small void additions the void coefficient is about 0.045 (Δk/k)/(ΔV/V).

For the HFIRCE-3 and -4 experiments, flux-trap plastic inserts were made that contained the optimum voids determined in the HFIRCE-2 experiments. The associated positive reactivity additions were found to be the same as measured in the HFIRCE-2 experiments.

Void coefficients for the fuel region were determined experimentally by replacing a few fuel plates with aluminum plates and then replacing the latter plates with water. By making a small correction for the absorption in the aluminum the aluminum coefficients were converted to void coefficients. Results from the HFIRCE-4 experiments are given below (the volumes refer to water):

Fuel Element	(Δk/k)/(ΔV/V)
Inner	−0.080
Outer	−0.170

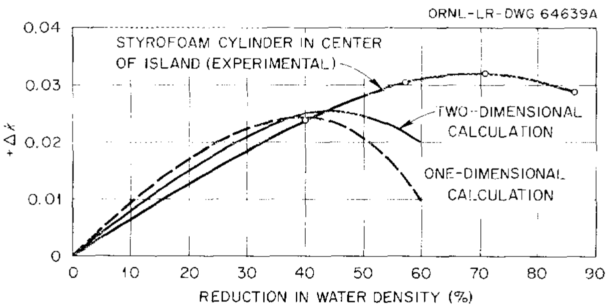

Fig. 9.4. Change in Neutron Multiplication Factor Attributed to Voids in Island (No Target).

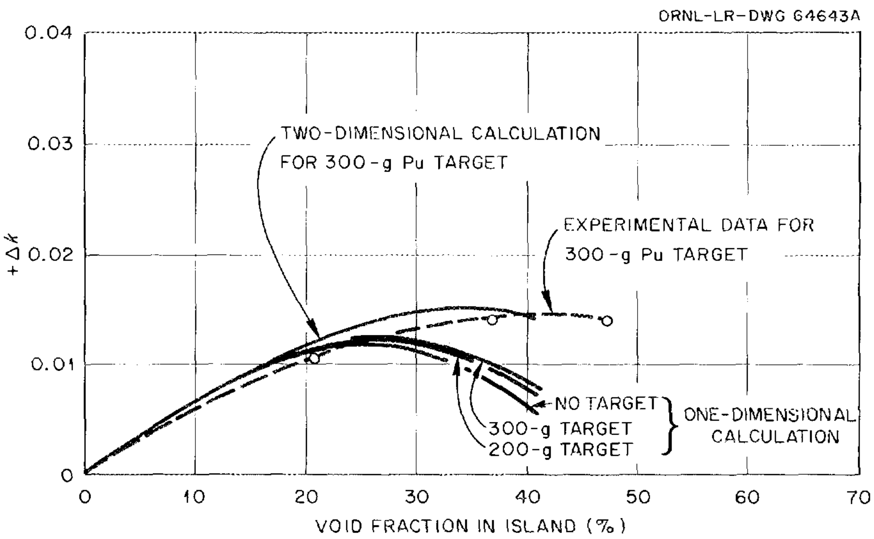

Fig. 9.5. Change in Neutron Multiplication Factor Attributed to Uniform Reduction in Water Density Over Entire Island, Including Plutonium Target.

The radial variation of void coefficient within the fuel region was estimated with a one-dimensional calculation and is shown in Fig. 9.6. Close to the inner and outer reflector regions the coefficients are very close to zero.

Void coefficients in the control and beryllium reflector regions were not determined experimentally, but calculations indicate that the average coefficient for the two regions combined is positive up to a water displacement of 60%. The positive reactivity addition associated with the optimum void is 0.005 $\Delta k/k$, and the coefficient for small void fractions is 0.02 $(\Delta k/k)/(\Delta V/V)$.

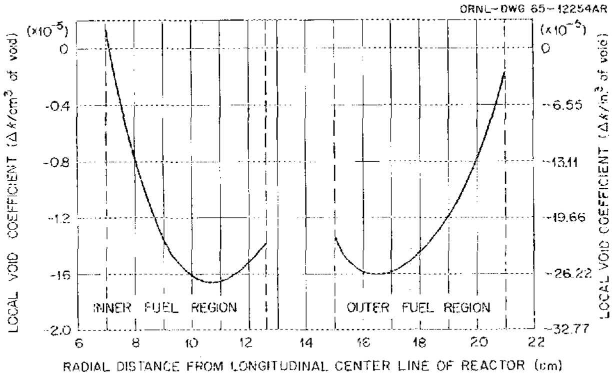

Fig. 9.6. Void Coefficient in HFIR for Uniform Local Void Distribution.

9.3 Fuel, Fuel-Plate, Aluminum, and Boron Coefficients for Fuel Region

Results from the HFIRCE-4 experiments pertaining to the fuel, fuel-plate, and aluminum-plate coefficients are given in Table 9.1. The coefficients were obtained by replacing as many as six fuel plates in each element with aluminum plates or water. It may be seen that replacement of a fuel plate with water adds positive reactivity. Calculations were made to determine at what point the coefficient would change from positive to negative. The results are shown in Fig. 9.7. As indicated, the coefficient becomes zero when about 30% of the fuel plates have been replaced (uniformly across the core) with water. The corresponding increase in reactivity is about 0.03 $\Delta k/k$.

The fuel-plate coefficients determined for the HFIRCE-3 core are slightly different than for a regular HFIR production core because of the different boron burnable-poison loading (2.12 g ^{10}B for HFIRCE-3

Table 9.1. Fuel, Fuel-Plate, and Aluminum-Plate Coefficients

Item	Coefficient
Fuel[a]	
Inner element	3.7×10^{-5} $(\Delta k/k)/g$ ^{235}U
	0.097 $(\Delta k/k)/(\Delta m/m)$
Outer element	1.09×10^{-5} $(\Delta k/k)/g$ ^{235}U
	0.074 $(\Delta k/k)/(\Delta m/m)$
Total average	0.171 $(\Delta k/k)/(\Delta m/m)$
Fuel plate[b]	
Inner element	−0.058 $(\Delta k/k)/(\Delta V/V)$
	-1.10×10^{-4} $(\Delta k/k)/in.^3$
Outer element	−0.113 $(\Delta k/k)/(\Delta V/V)$
	-11.6×10^{-5} $(\Delta k/k)/in.^3$
Aluminum plate[c]	
Inner element	−0.104 $(\Delta k/k)/(\Delta V/V)$
	-16.7×10^{-5} $(\Delta k/k)/in.^3$
	-2.3×10^{-3} $(\Delta k/k)/mil$
Outer element	−0.188 $(\Delta k/k)/(\Delta V/V)$
	-15.9×10^{-5} $(\Delta k/k)/in.^3$
	-4.1×10^{-3} $(\Delta k/k)/mil$

[a] m refers to weight of fuel in specified element.
[b] V refers to active volume of fuel plate.
[c] V refers to the entire volume of fuel plate.

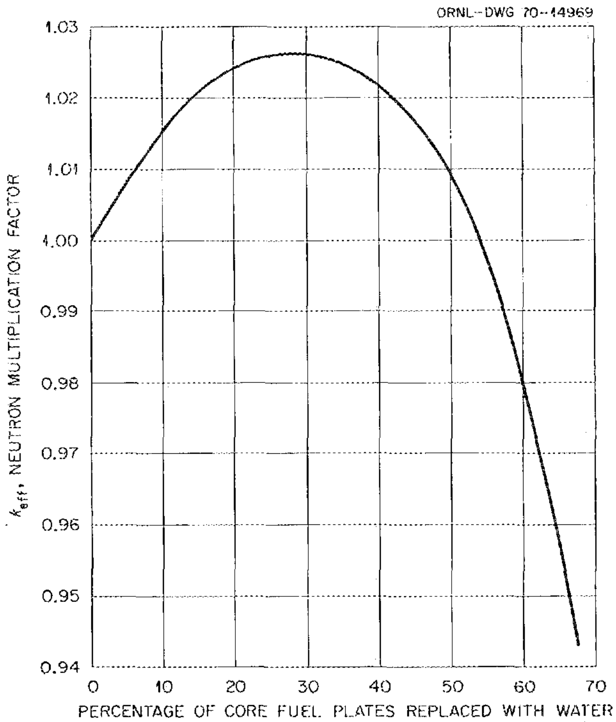

Fig. 9.7. Neutron Multiplication Factor as a Function of Fuel-Plate Replacement with Water.

core and 2.80 g ^{10}B for HFIR production core). The coefficients given in Table 9.1 were corrected to be consistent with the HFIR production cores, and the curve in Fig. 9.7 applies to the core with 2.8 g ^{10}B. It should also be remembered that these values apply to a clean core. Fuel-plate coefficients are quite sensitive to fuel and burnable-poison burnup and to the variations in fission-product concentrations.

The aluminum-plate coefficient is of some interest because of the reactivity effect associated with tolerances on fuel-plate thickness. In Table 9.1 the aluminum-plate coefficients presented as $(\Delta k/k)$/mil represent the positive reactivity addition associated with removal of 0.001 in. of plate thickness from each plate in the specified element.

Burnable-poison (^{10}B) coefficients were not determined experimentally but were calculated on the basis of complete removal of boron, with the specified radial distribution, from the inner element of the HFIRCE-3 core. The resulting coefficient was –0.018 $(\Delta k/k)/g\ ^{10}B$.

9.4 Boron–Stainless Steel Poison Strips

Under certain emergency conditions it might be desirable to poison the fuel elements with poison strips fitted between the fuel plates. For this purpose boron-stainless steel strips were proposed, and their worths were experimentally determined. The results are discussed in Ref. 28.

10. FISSION DENSITIES AND PLATE TEMPERATURE DATA ASSOCIATED WITH RADIATION DAMAGE

The degree of radiation damage in the HFIR fuel plates appears to be dependent on the concentration of fission-gas atoms generated in the fuel and on the temperature of the fuel. Results from preliminary radiation-damage experiments[29] associated with the HFIR and ATR programs indicated that the HFIR design and operating conditions are close to those that could result in significant radiation damage. Additional experiments were therefore conducted to obtain more applicable data,[30] and a detailed computation of fission densities and temperatures in the HFIR fuel plates was made.

In order to evaluate radiation damage in terms of fuel-plate mechanical integrity and heat-removal capabilities, several factors must be considered. Among the more obvious are (1) the effective areas associated with the hot-spot and hot-plate conditions and (2) the location of the thermal hot-spot and hot-plate conditions relative to the fission-density distribution. A detailed discussion of the effects of these and other factors in the overall evaluation of HFIR fuel-plate radiation damage is outside the scope of this report; however, basic information concerning the possible fuel-plate surface areas covered by the hot-spot and hot-plate conditions and the fission densities and temperatures that occur in these areas is given here. Criteria governing the acceptable extent of radiation damage by the end of a fuel cycle from the standpoint of heat removal are the following: (1) plate swelling no greater than 4% for hot-streak conditions and 5% for hot-spot conditions; (2) no blisters or nonbonds greater than 0.06 in. in diameter.

10.1 Analysis of the Nominal Core

The total number of fission-gas atoms generated per unit volume at a particular location in the fuel over a specified period of time was assumed to be directly proportional to the time-integrated power density at that point. One-dimensional HFIR fuel-cycle calculations and two-dimensional correction factors were used to obtain the time-integrated fission density (henceforth referred to as "fission density") for a typical 23-day HFIR core as a function of space and time. The results are shown in Figs. 10.1 through 10.5.

The fission densities in Figs. 10.1 and 10.2 are expressed in terms of averages over the volume of a unit cell in the fuel region. These curves were then multiplied by the ratio of unit-cell thickness to fuel-plate fuel core thickness to obtain fissions per unit volume of fuel-plate fuel core. The latter curves, which are useful in estimating the degree of radiation damage, are shown in Figs. 10.3 through 10.5. It is interesting to note in these figures that the peak fission densities occur adjacent to the four side plates instead of at the centers of the fuel annuli, where the "homogenized" fission densities peak. The reason for this is that next to the side plates the thicknesses of the fuel-plate fuel cores are one-half to one-third the thicknesses of the cores at the radial center of the annuli (see Figs. 7.1 and 7.2).

In the longitudinal direction there are three peaks in the fission density: one at the horizontal midplane and one at each end of the core. Since there is no variation in nominal fuel-core thickness in the longitudinal direction, the peaks result only from the neutron flux distribution.

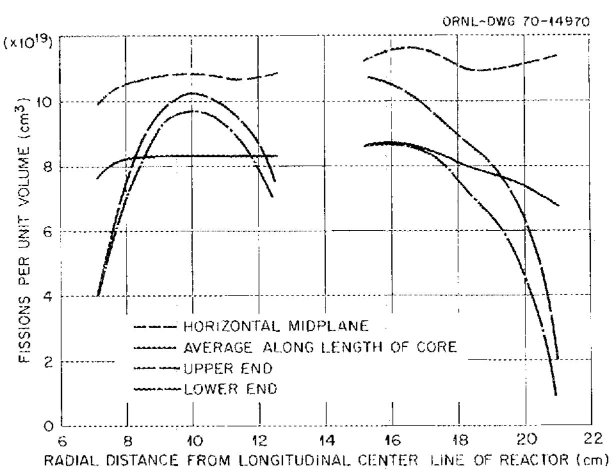

Fig. 10.1. Total Number of Fissions Per Unit Volume of Homogenized Unit Cell After 15 Days of Operation at 100 Mw.

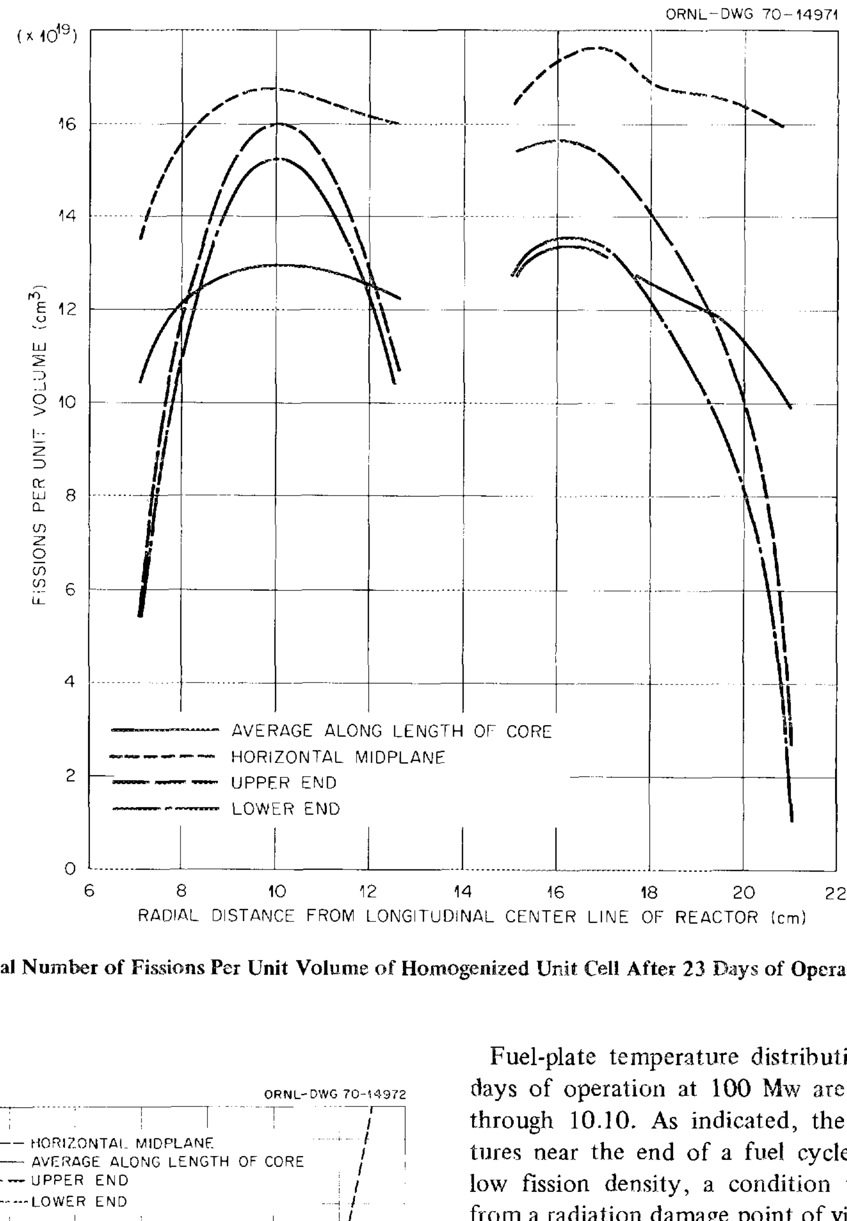

Fig. 10.2 Total Number of Fissions Per Unit Volume of Homogenized Unit Cell After 23 Days of Operation at 100 Mw.

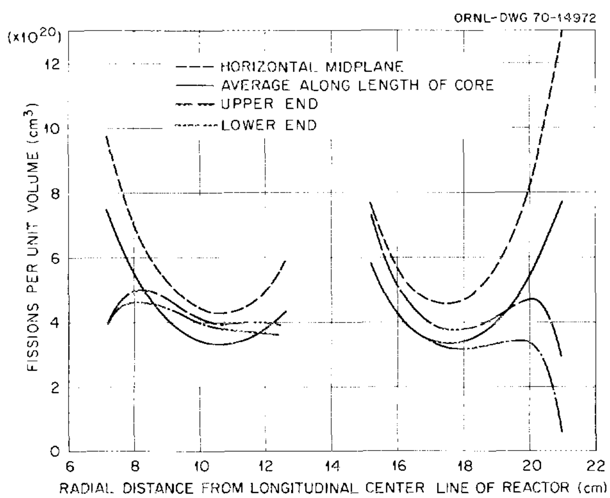

Fig. 10.3. Total Number of Fissions Per Unit Volume of Fuel-Plate Fuel Core After 15 Days of Operation at 100 Mw.

Fuel-plate temperature distributions after 15 and 23 days of operation at 100 Mw are shown in Figs. 10.6 through 10.10. As indicated, the maximum temperatures near the end of a fuel cycle occur in regions of low fission density, a condition that is advantageous from a radiation damage point of view.

The variation in fuel temperature with time, shown in Figs. 10.11 and 10.12, results from the variation in the relative power distribution and from an increase in the fuel-plate aluminum oxide thickness. It is not known at this time whether the time dependence of fuel temperature has a significant effect on radiation damage.

When calculating the fuel-plate temperatures reported, the most recent out-of-pile experimental data[20] were used for the rate of aluminum oxide buildup and for the oxide thermal resistance. It is possible of course that under reactor operating conditions the oxide film characteristics are significantly different. However, experiments in the ETR indicate that the in-pile and out-of-pile oxide films are about the same.[30]

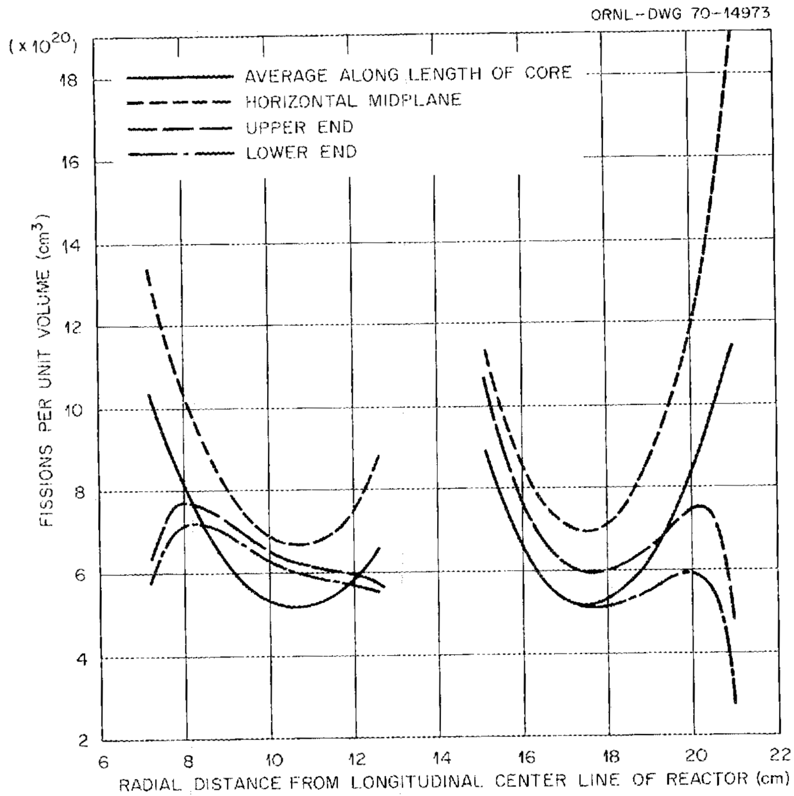

Fig. 10.4. Total Number of Fissions Per Unit Volume of Fuel-Plate Fuel Core After 23 Days of Operation at 100 Mw.

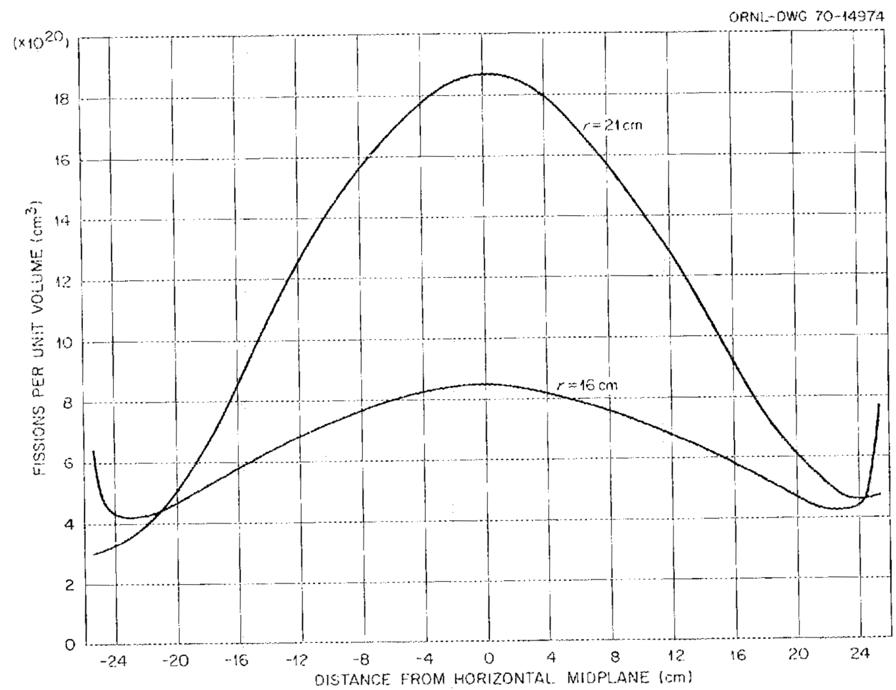

Fig. 10.5. Total Number of Fissions Per Unit Volume of Fuel-Plate Fuel Core After 23 Days of Operation at 100 Mw. Axial profile for two radial locations.

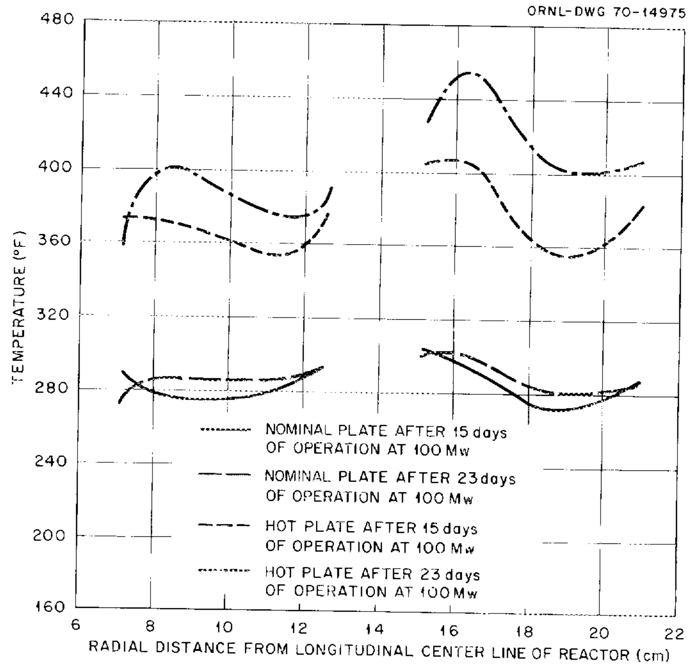

Fig. 10.6. Fuel-Plate Fuel Core Center Temperatures at Horizontal Midplane at 100 Mw.

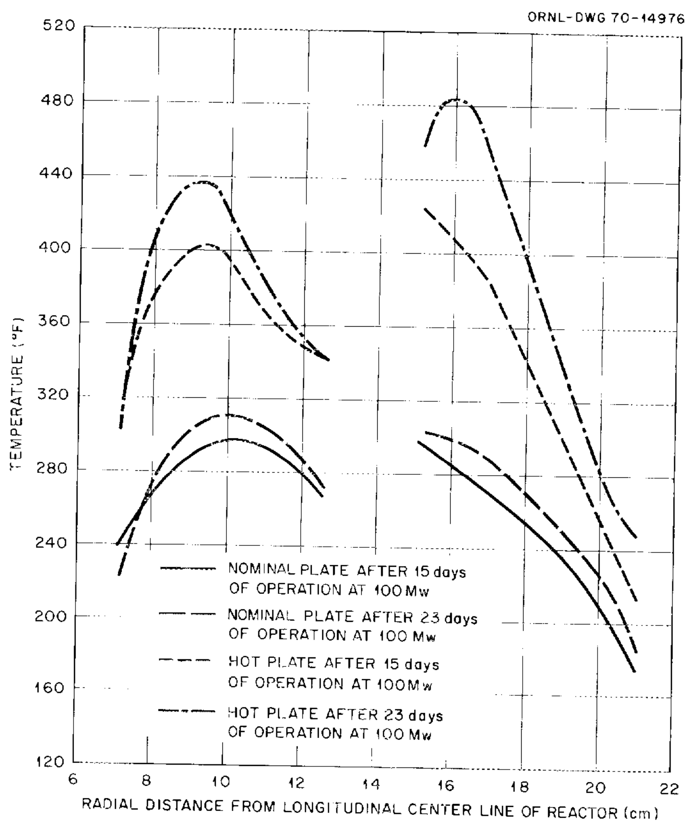

Fig. 10.7. Fuel-Plate Fuel Core Center Temperatures at Bottom End of Fuel Element at 100 Mw.

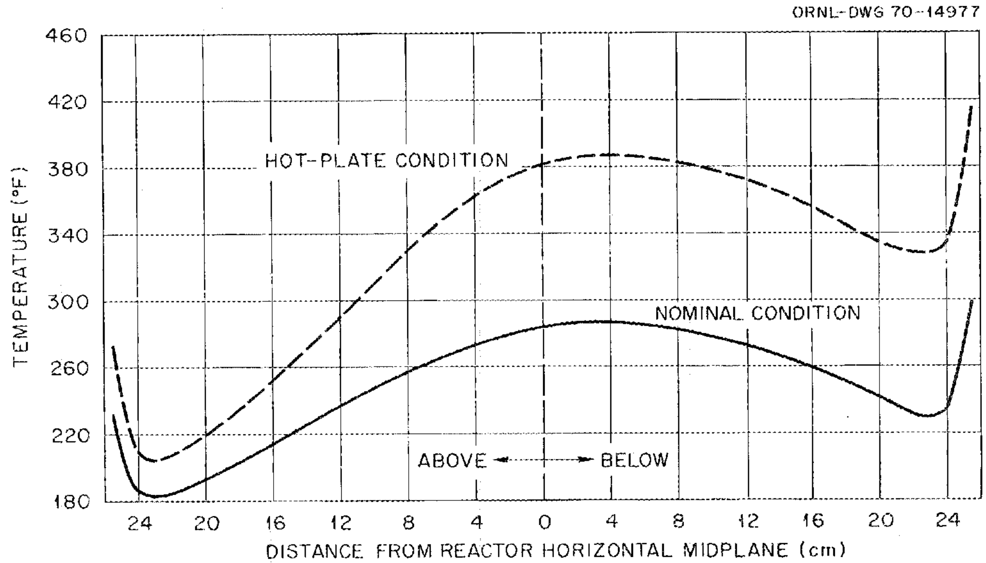

Fig 10.8. Axial Distribution of Fuel-Plate Fuel Core Center Temperature at a Radial Distance of 9 cm from Reactor Longitudinal Center Line After 23 Days of Operation at 100 Mw.

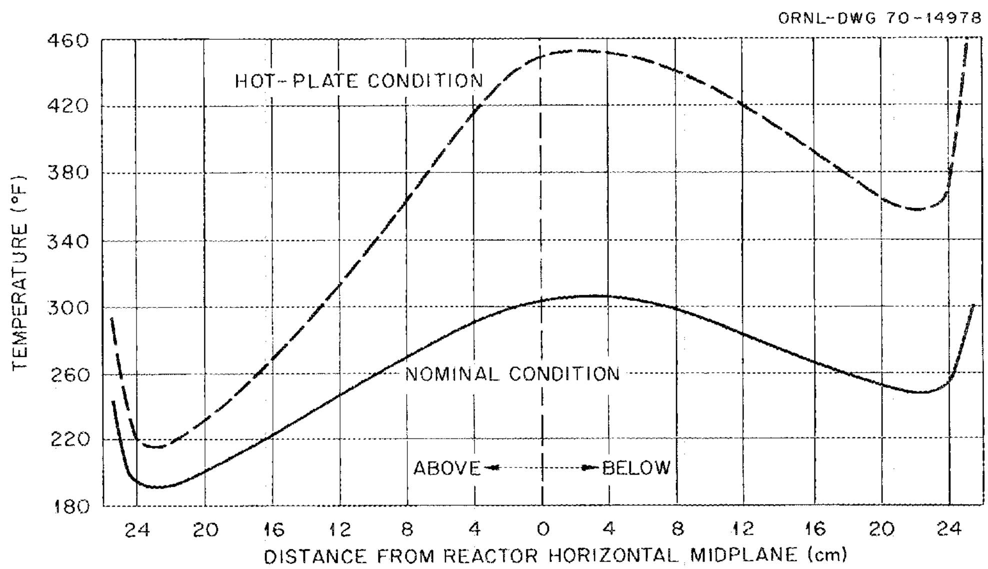

Fig. 10.9. Axial Distribution of Fuel-Plate Fuel Core Center Temperature Near Inner Edge of Outer Fuel Element (at a Radial Distance of 16 cm from Longitudinal Center Line of Reactor) After 23 Days of Operation at 100 Mw.

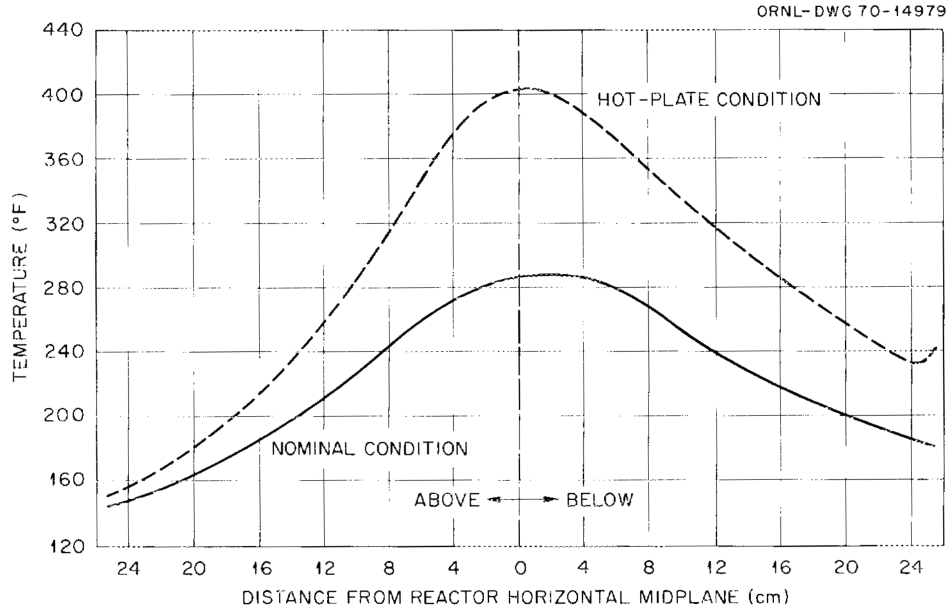

Fig. 10.10. Axial Distribution of Fuel-Plate Fuel Core Center Temperature Adjacent to Control Region (at a Radial Distance of 21 cm from Reactor Longitudinal Center Line) After 23 Days of Operation at 100 Mw.

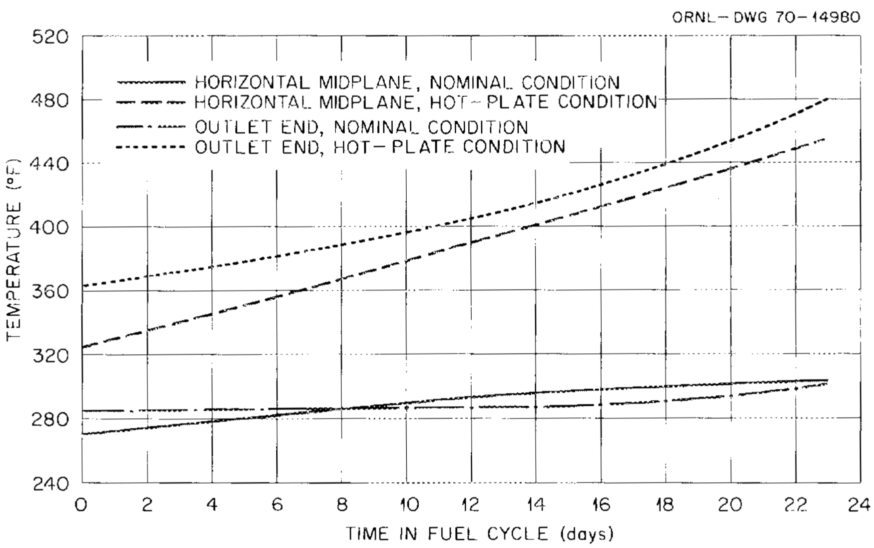

Fig. 10.11. Fuel-Plate Fuel Core Center Temperatures at Radial Distance of 16 cm from Reactor Longitudinal Center Line Versus Time in 100-Mw Fuel Cycle.

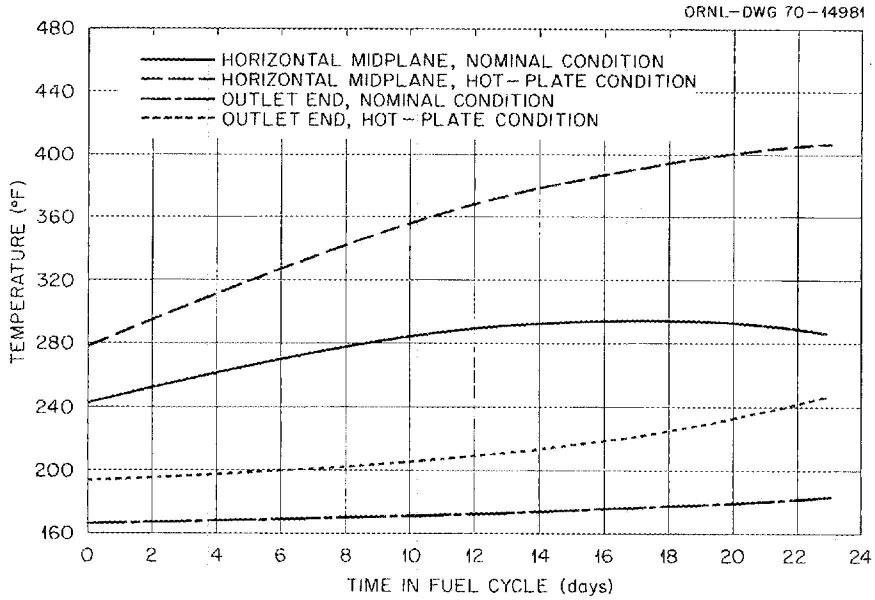

Fig. 10.12. Fuel-Plate Fuel Core Center Temperatures at Radial Distance of 21 cm (Adjacent to Control Region) from Reactor Longitudinal Center Line Versus Time in 100-Mw Fuel Cycle.

10.2 Hot-Spot and Hot-Plate Conditions

The hot-spot and hot-plate conditions define various combinations of deviations from the nominal core design and operating conditions and must be used when analyzing the heat removal from the core. It is also necessary to consider these conditions in connection with radiation damage because they affect both fission densities and temperatures.

To evaluate the possible radiation-damage problem at the hot-spot and hot-plate locations, it will be necessary to consider the effect these locations have on fission density and temperature distribution. One important consideration in this regard is the amount of fuel-plate area that can be covered by the hot-spot and hot-plate conditions (i.e., what size area can have a fuel-surface density 10% greater than nominal, etc.). From an analytical point of view the hot-spot and hot-plate areas are defined in terms of the fabrication specifications and the particular methods of inspection used. In the actual case, of course, the areas might be significantly less. However, until such data are made available, it seems prudent to consider the conditions defined by the present specifications.[31] Corresponding typical hot-spot and hot-plate conditions considered herein for determining the maximum fission densities are illustrated graphically in Figs. 10.13 and 10.14. It is evident that the specifications and the present methods of inspection permit about half the plate to have fuel-surface densities that are 10% greater than the specified nominal values. The maximum hot-spot area is considerably less, but several hot spots can exist on the same plate if they are separated longitudinally by about $\frac{1}{2}$ in.

The hot-spot and hot-plate conditions shown in Figs. 10.13 and 10.14 refer only to increases in local power densities that result from excessive fuel concentrations. The total hot-spot and hot-plate factors consist of the several individual factors indicated in the following equations:

Hot-spot factor = fuel-segregation factor × flux-distribution factor × core-volume factor × power-level factor × axial-position factor = 1.30 × 1.10 × 1.05 × 1.02 × E(r) = 1.53 × E(r)

Hot-plate factor = fuel-distribution factor × flux-distribution factor × core-volume factor × power-level factor = 1.10 × 1.10 × 1.05 × 1.02 = 1.30

It is assumed that the flux-distribution and core-volume factors cover the entire fuel-plate area; therefore, the

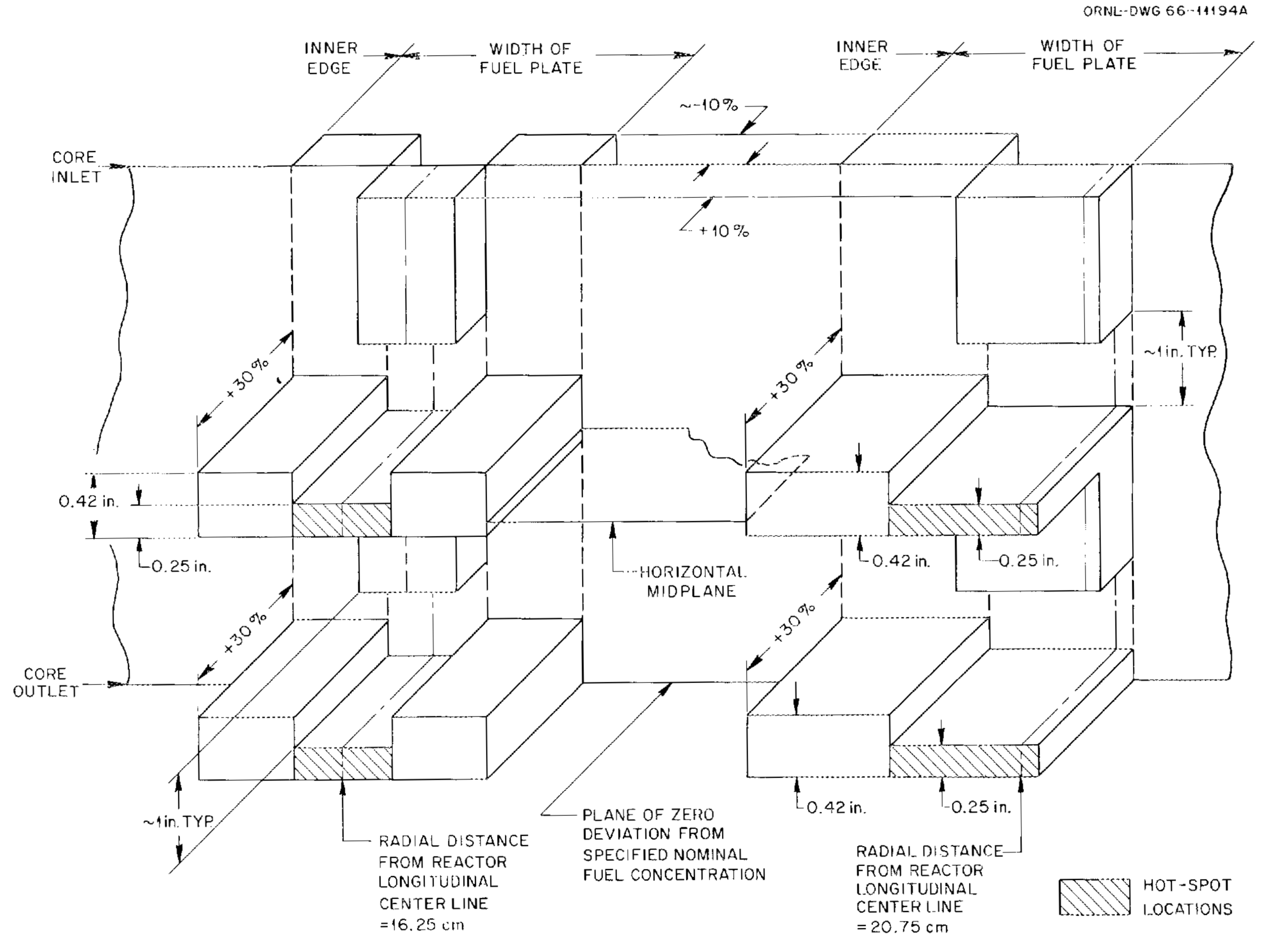

Fig. 10.13. Percentage Deviations from Specified Nominal Fuel Concentration and Typical Hot-Spot Conditions at Four Particular Locations.

diagrams in Figs. 10.13 and 10.14 qualitatively represent a superposition of the fuel-segregation and fuel-distribution factors on the other two factors. To obtain the approximate corresponding hot-spot and hot-plate fission densities, the curves in Figs. 10.1 through 10.5 should be multiplied by the above total factors, which take into account the restricted area coverage indicated in Figs. 10.13 and 10.14.

The quantity E(r) in the hot-spot factor equation accounts for axial extension of the fuel into the steep thermal flux gradient. This factor is a function of radial position and is plotted accordingly in Fig. 10.15. It should be noted that the factors in this figure apply only at the outlet end of the core. The inlet end of the core is considerably cooler than the outlet, and thus it constitutes a less severe case insofar as radiation damage is concerned.

In the above treatment of the hot spot it was assumed that the fuel in the hot-spot area was distributed uniformly over the area defined by the inspection head (sensing area of inspection device). However, it is possible for the fuel to be segregated within this area to an extent limited by the maximum packing fraction of the U_3O_8 particles and the effective diameter of the inspection head. Typical permissible configurations, including unbonded areas of the maximum permissible diameter, are shown in Fig. 10.16. In all cases a packing fraction of 0.74, an effective inspection head diameter 0.078 in., and a maximum nonbond diameter of 0.063 in. were considered.

The configuration in Fig. 10.16 can quite obviously result in much higher, though more localized, fission densities and fuel temperatures than the case discussed in the above paragraph. For instance, the area ratio of

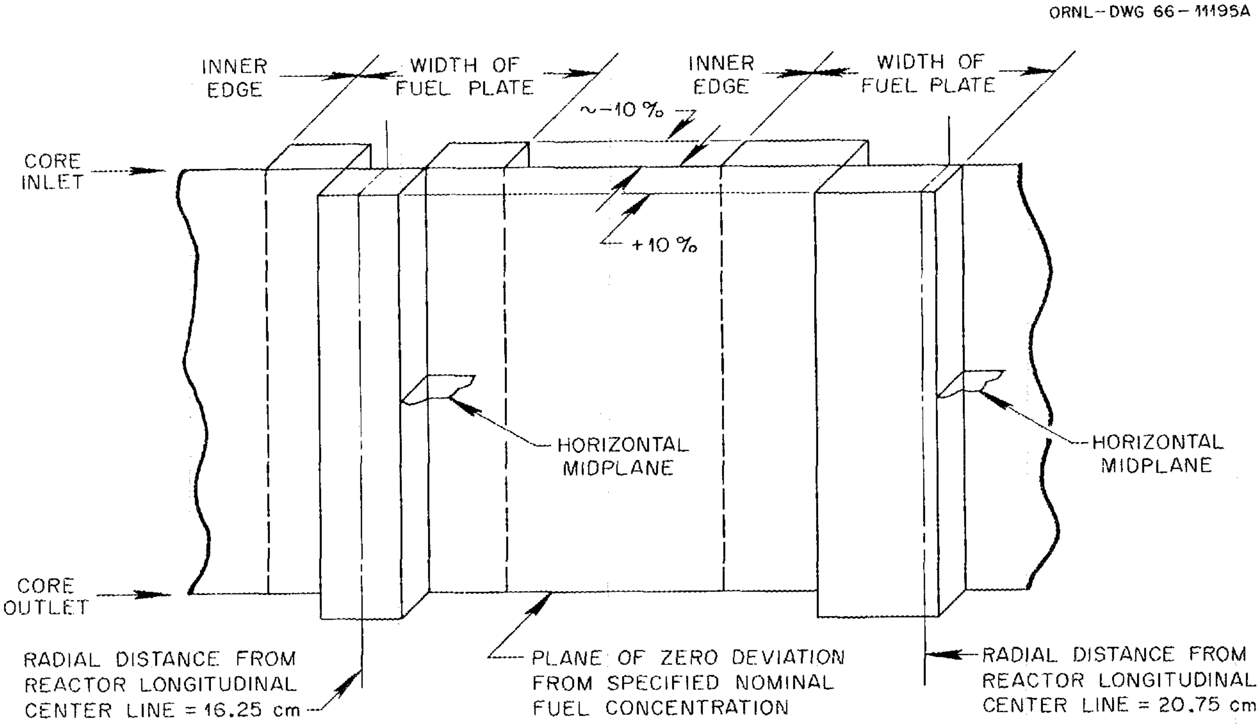

Fig. 10.14. Percentage Deviations from Specified Nominal Fuel Concentration and Typical Hot-Plate Conditions at Two Particular Locations.

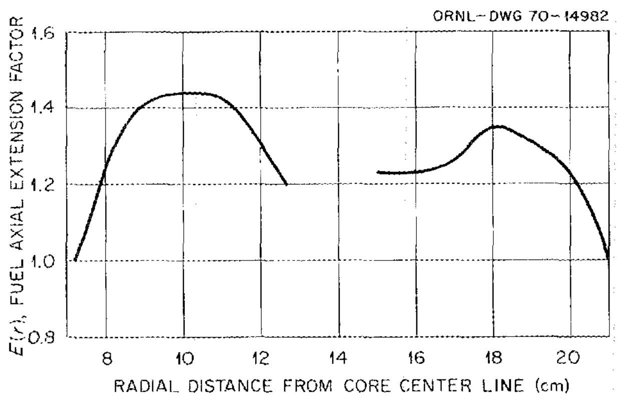

Fig. 10.15. Fuel Axial Extension Factor as a Function of Radial Distance from Core Center Line.

detector head to fully concentrated fuel is about 10:1, which means that the local fission density could be ten times that indicated by the inspection device. Temperatures corresponding to these cases are shown in Fig. 10.17;[32] as indicated, fuel temperatures as high as 1200°F can exist. There are other permissible, though less likely, combinations of segregations and blisters that can result in even higher temperatures.

At the present time there is probably no accurate method with which to correlate these extreme cases with the ETR experimental results because these burnups and temperatures were not achieved on a nominal basis, and the degree of perversity that actually existed in the experimental-program[29,30] sample plates is not known. It is of interest to note, however, that all HFIR cores operated thus far have shown no signs of significant radiation damage (no detectable fission-product release).* Of course, as was the case with the experiments, knowledge of the degree of perversity that exists is lacking.

10.3 Summary of Results

The maximum time-integrated fission density in the fuel-plate fuel core at the end of a 23-day fuel cycle

*Two spent HFIR fuel elements have undergone detailed hot-cell examinations, and no indications of blisters have been observed.[33]

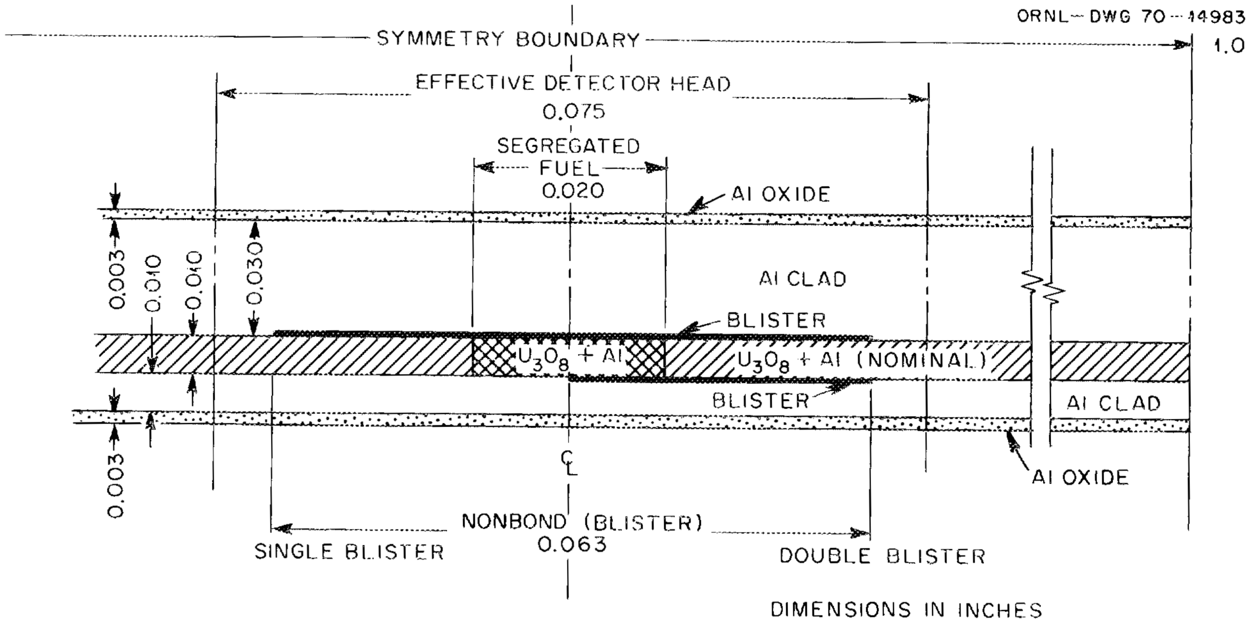

Fig. 10.16. Typical Maximum-Segregation Hot Spots with One and Two Blisters and with Maximum Oxide.

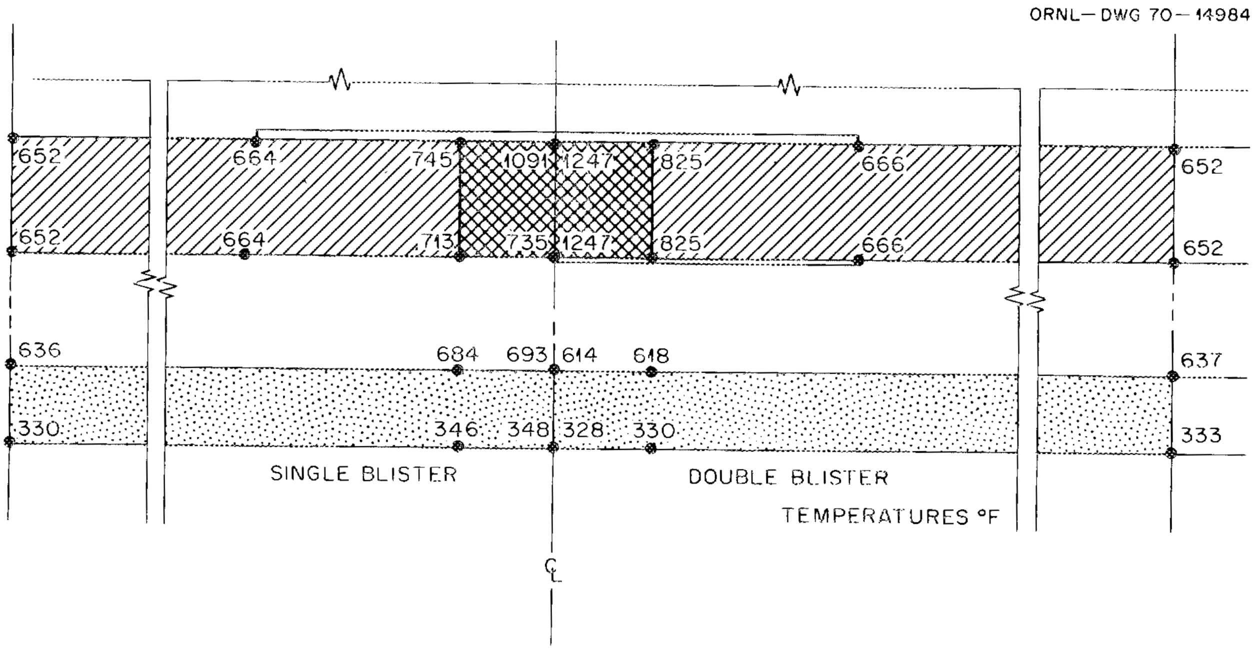

Fig. 10.17. Hot-Spot Temperatures for Cases Depicted in Fig. 10.16, r = 16 cm, Outlet End, Plus 30% Uniform Segregation Concentrated to Maximum Extent.

occurs at the horizontal midplane of the fuel element adjacent to the control region. The fission densities and temperatures at this point for the nominal, hot-plate, and hot-spot conditions are listed in Table 10.1.

The maximum fuel temperature at the end of the fuel cycle occurs at the outlet end of the core near the radial center of each fuel annulus. However, the fission densities at these locations are about a factor of 2 or 3 less than the maximum. Typical fission densities and temperatures at this location in the outer fuel annulus are also given in Table 10.1.

Since radiation damage appears to be a function of both fission density and temperature, it is quite possible that the data in Table 10.1 do not represent the worst combination of the two parameters. The curves in Figs. 10.1 through 10.12 can be used for a more detailed analysis when more experimental data are available.

When using the fission density and temperature data to evaluate the extent of radiation damage in terms of fuel-plate mechanical integrity and heat-removal capabilities, the distributions of the fission density and temperature must be considered. For instance, the maximum hot-spot fission density (see Table 10.1) exists only at a point. A short distance downstream from this point, both the temperature and fission density are only slightly less. Moving radially inward, however, the fission density decreases by a factor of about 2.5 in 1.4 in., while the temperature increases a few degrees. Starting at the outlet and near the radial center of the outer fuel annulus and moving up, the fission density decreases by a factor of 2.0 in 1.2 in., while the hot-spot temperature decreases by about 270°F. Thus it becomes apparent that determining the extent of radiation damage may be very difficult unless experiments simulating the above and similar conditions are conducted.

Table 10.1. Fission Densities and Temperatures in Fuel-Plate Fuel Core After 23 Days at 100 Mw

Condition	Horizontal Midplane Adjacent to Control Region		Radial Center at Outlet End of Outer Fuel Element	
	Fission Density (fissions/cm^3)	Temperature (°F)	Fission Density (fissions/cm^3)	Temperature (°F)
	$\times 10^{21}$		$\times 10^{21}$	
Nominal	1.9	184	0.7	300
Hot plate	2.4	250	0.9	485
Hot spot	2.8	~350	1.0	~600

11. MODIFIED CORE DESIGN FOR LONGER LIFE

The present design of the HFIR core does not necessarily yield the longest fuel-cycle time that can be achieved with a core of this size. During the early design stages the desired fuel-cycle time of 15 days required significant extrapolations in several areas of fuel and fuel-plate performance. As the design and research and development efforts progressed, limits that appeared to be realistic were applied to each parameter. It is now believed that several of these limits can be extended and thus contribute to the achievement of a longer fuel cycle. The major factors of concern are fuel-plate fabricability, fuel segregation, radiation damage, aluminum oxide buildup, corrosion, preservation of the high thermal-neutron fluxes in experimental facilities, and power-distribution and reactivity control.

Further addition of fuel to a fuel plate is eventually limited by increased fuel segregation; destruction of the continuous aluminum matrix in the compact by unacceptable cracking during fabrication; increased radiation damage; and steeper thermal flux gradients, which require more severe fuel gradients and in turn lead to greater fuel segregation. Of course the increased fuel loading extends the fuel-cycle time, and this increases radiation damage, oxide buildup, and corrosion. The oxide layer may increase in thickness to the point where it begins to slough off and introduce still further problems.

Without at first becoming concerned with the materials problems, fuel-cycle calculations were made with a 12-kg ^{235}U loading and with additional burnable poison in the form of a cadmium cylinder located between the two fuel annuli. The results of these calculations indicated a substantial increase in fuel-cycle time (~50%), a satisfactory power distribution, only slightly reduced thermal fluxes, and adequate reactivity control during normal operation. On the other hand the addition of more burnable poison, and particularly of a faster burning poison like cadmium, tended to cause an initial reactivity increase with time in the absence of xenon, as indicated in Fig. 11.1. Thus a partially burned core could be more reactive than a clean core and require modifications in the present shutdown criteria. It does not appear that this will constitute a serious problem, but it might on occasion require the use of the standby soluble-poison system.

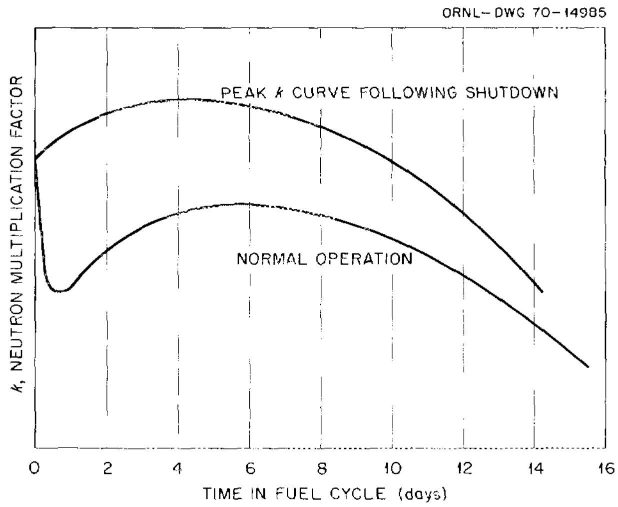

Fig. 11.1. Neutron Multiplication Factor Versus Time in Fuel Cycle for a Core Containing Cadmium Burnable Poison.

For the above calculations the cadmium burnable poison was smeared over the aluminum-water region between the two fuel annuli and thus was quite dilute. In actual practice it might be possible to lump the poison to prevent its burning out so rapidly during the early part of the cycle. This would tend to alleviate the peak reactivity condition mentioned above.

Several positions other than the position between the fuel annuli were considered for the additional burnable poison. If the poison were placed in the outer fuel element, the control-rod worth would be reduced; if it were placed in the inner element, the flux-trap thermal flux would be depressed by a few percent.

More recent extended-life fuel-cycle calculations indicate that because of the longer fuel cycle actually achieved in operation of the reactor (23 days instead of the predicted 16 days) it should be possible to use slower burning boron instead of cadmium as the additional burnable poison. The earlier calculations, which predicted shorter fuel-cycle times, indicated excessive loss in fuel-cycle time due to nonburned boron. This is not the case with the longer cycles.

Preliminary investigations of the materials problems indicate that from a fabrication point of view it will probably be possible to increase the total ^{235}U loading from 9.4 to 12 kg; radiation damage will probably not be a problem; but the increase in degree of segregation is as yet unknown. Oxide buildup and corrosion have the same origin but are considered separately because the oxide film constitutes a significant thermal resistance and corrosion can lead to fission-product release. The available data[20] show that when the oxide thickness approaches about 2 mils and the heat flux is close to 1.5×10^6 Btu/hr ft^2, the oxide will begin to slough off and thus reduce the thermal resistance. The empirical correlation relating the more significant parameters is

$$X = 443\,\theta^{0.778} \exp\left(-\frac{8280}{R}\right),$$

where

X = oxide thickness in mils,
θ = time in hours,
R = oxide-water interface temperature in °R.

A plot of the correlation for a range of temperatures and times of interest to the HFIR is shown in Fig. 11.2.

When the oxide sloughs off, the corrosion rate appears to accelerate, and there is some indication that severe pitting will take place. However, there is not enough data following the initiation of sloughing to predict just how severe the situation might be. Another complication associated with sloughing is the resultant variation in plate temperature patterns and the effect this will have on plate deflections and thus heat removal.

Returning to Fig. 11.2, it may be observed that if the surface temperatures are below about 310°F, exposure times of about 40 days would be required to initiate sloughing. This time is probably consistent with a 12-kg loading, and it is not expected that hot-plate surface temperatures will be significantly higher than 310°F. However, hot-spot and other localized and small areas are likely to experience considerably higher surface temperatures (~400°F). This would not be troublesome from the standpoint of plate thermal deflections, but excessive localized corrosion could be serious. This will have to be investigated further.

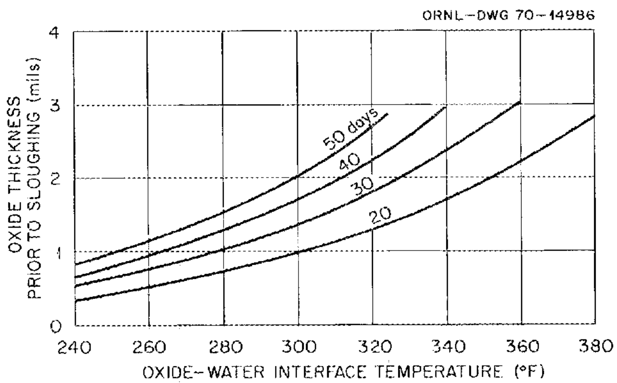

Fig. 11.2. Aluminum Oxide Buildup in pH 5.0 Water.

A possible remedy for a serious aluminum oxide and corrosion problem is the use of an electroless nickel coating on the aluminum-clad fuel plates. Recent developmental efforts[34] in this area indicate that 0.5 mils of electroless nickel on aluminum in a deionized-water environment will provide satisfactory protection and prevent the growth of aluminum oxide.

Another advanced design feature that tends to alleviate problems with the oxide is the incorporation of longitudinal spacers in the coolant channels between the fuel plates. Studies[35] conducted for the HFIR indicate that the more uniform channel thicknesses obtained with spacers result in lower temperatures and thus less oxide. Furthermore, the substantial increase in fuel-plate support permits higher plate temperatures and greater variations in temperature between adjacent plates.

REFERENCES

1. R. D. Cheverton et al., High Flux Research Reactor (ORSORT Study), Oak Ridge National Laboratory, unpublished internal memorandum, August 1956.
2. L. E. Link et al., The Mighty Mouse Research Reactor, USAEC Report ANL-5688, Argonne National Laboratory, March 1957.
3. C. F. Leyse et al., High Flux Reactors for University Research, Internuc-22, Internuclear Corporation, March 1958.
4. S. M. Feinberg et al., An Intermediate Reactor for Obtaining High Intensity Neutron Fluxes, *Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958,* Vol 10, pp. 296-320, United Nations, N.Y., 1958.
5. R. D. Cheverton, HFIR Preliminary Physics Report, USAEC Report ORNL-3006, Oak Ridge National Laboratory, October 1960.
6. J. K. Fox, L. W. Gilley, and D. W. Magnuson, Solution Experiments in a Flux-Trap Critical Assembly: Preliminary Study for HFIR, in Neutron Physics Division Annual Progress Report for Period Ending September 1, 1960, USAEC Report ORNL-3016, Oak Ridge National Laboratory, 1960.
7. H. C. Claiborne, Solution Critical Experiments for the High Flux Isotope Reactor: Preliminary Calculations, Oak Ridge National Laboratory, unpublished internal memorandum, August 1961.
8. J. K. Fox, L. W. Gilley, and D. W. Magnuson, Preliminary Solution Critical Experiments for the High Flux Isotope Reactor, USAEC Report ORNL-3359, Oak Ridge National Laboratory, May 1963.
9. D. W. Magnuson, HFIR Critical Experiment No. 2, in Neutron Physics Division Annual Progress Report for Period Ending September 1, 1961, USAEC Report ORNL-3193, Oak Ridge National Laboratory, 1961.
10. D. W. Magnuson, HFIR Critical Experiment No. 2, in Neutron Physics Division Annual Progress Report for Period Ending September 1, 1962, USAEC Report ORNL-3360, Oak Ridge National Laboratory, 1962.
11. D. W. Magnuson, HFIR Critical Experiment No. 2, in Neutron Physics Division Annual Progress Report for Period Ending August 1, 1963, USAEC Report ORNL-3499, Oak Ridge National Laboratory, 1963.
12. J. T. Thomas, HFIR Critical Experiment No. 3, in Neutron Physics Division Annual Progress Report for Period Ending August 1, 1964, USAEC Report ORNL-3714, Oak Ridge National Laboratory, 1964.
13. J. T. Thomas, HFIR Critical Experiment No. 3, in Neutron Physics Division Annual Progress Report for Period Ending August 1, 1965, USAEC Report ORNL-3858, Oak Ridge National Laboratory, 1965.
14. R. D. Cheverton, Void Coefficient of Reactivity Associated with the Island Region of the HFIR, USAEC Report ORNL-TM-114, Oak Ridge National Laboratory, November 1961.
15. R. D. Cheverton, O. W. Burke, and T. E. Cole, HFIR Transients and Reactivity Accountability, USAEC Report ORNL-TM-1747, Oak Ridge National Laboratory, January 1967.
16. H. A. McLain, HFIR Fuel Element Steady State Heat Transfer Analysis-Revised Version, USAEC Report ORNL-TM-1904, Oak Ridge National Laboratory, December 1967.
17. F. T. Binford, T. E. Cole, and E. N. Cramer (Eds.), The High Flux Isotope Reactor Accident Analysis, USAEC Report ORNL-3573, Oak Ridge National Laboratory, April 1967.
18. F. T. Binford, T. E. Cole, and E. N. Cramer (Eds.), The High Flux Isotope Reactor, A Functional Description, Vols. 1A and 1B, USAEC Report ORNL-3572 (Rev. 2), Oak Ridge National Laboratory, May 1968.
19. W. R. Gambill and R. D. Bundy, HFIR Heat Transfer Studies of Turbulent Water Flow in Thin Rectangular Channels, USAEC Report ORNL-3079, Oak Ridge National Laboratory, June 1961.
20. J. C. Griess et al., Effect of Heat Flux on the Corrosion of Aluminum by Water, Part IV. Tests Relative to the Advanced Test Reactor and Correlation with Previous Results, USAEC Report ORNL-3541, Oak Ridge National Laboratory, February 1964.

21. G. M. Adamson, Fabrication Procedures for the Initial HFIR Fuel Elements, USAEC Report ORNL-4342, Oak Ridge National Laboratory, February 1964.
22. R. D. Cheverton and W. H. Kelley, Experimental Investigation of HFIR Fuel Plate Deflections Induced by Temperature and Pressure Differentials, USAEC Report ORNL-TM-2325, Oak Ridge National Laboratory, August 1968.
23. V. A. Walker et al., ATR Fuel Materials Development Irradiation Results – Part II, USAEC Report IDO-17157, Phillips Petroleum Company, June 1966.
24. B. E. Foster, S. D. Snyder, and R. W. McClung, Continuous Scanning X-Ray Attenuation Technique for Determining Fuel Inhomogeneities in Dispersion Core Fuel Plates, USAEC Report ORNL-3737, Oak Ridge National Laboratory, January 1965.
25. F. B. R. Kam and J. H. Swanks, personal communication, Aug. 1, 1969.
26. T. V. Blosser and G. E. Thomas, Jr., Neutron Flux and Neutron and Gamma Ray Spectra Measurements at the HFIR, USAEC Report ORNL-TM-2221, Oak Ridge National Laboratory, June 1968.
27. H. C. Claiborne, Effects of Fast Neutron Reactions in the Beryllium Reflector of the HFIR, unpublished memorandum, Oak Ridge National Laboratory, March 1960.
28. S. J. Raffety and J. T. Thomas, Experimental Determination of Safe Handling Procedures for HFIR Fuel Elements Outside the Reactor, USAEC Report ORNL-TM-1488, Oak Ridge National Laboratory, July 1966.
29. M. C. Graber et al., Results of ATR Sample Fuel Plate Irradiation Experiment, USAEC Report IDO-16958, Phillips Petroleum Company, March 1964.
30. V. A. Walker et al., ATR Fuel Materials Development Irradiation Results – Part II, USAEC Report IDO-17157, Phillips Petroleum Company, June 1966.
31. G. M. Adamson, Jr., and J. R. McWherter, Specifications for High Flux Isotope-Reactor Fuel Elements, HFIR-FE-1, USAEC Report ORNL-TM-902, Oak Ridge National Laboratory, August 1964.
32. Personal communication with L. A. Haack, Oak Ridge National Laboratory, 1968.
33. R. W. Knight et al., Post Irradiation Examination of HFIR Fuel Elements 5-O, 5-I and 21-O, in preparation, November 1970.
34. R. D. Cheverton, J. C. Griess, and J. R. McGuffey, Development of Electroless Nickel Coating for High Performance Aluminum Fuel Plates, USAEC Report ORNL-TM-2642, Oak Ridge National Laboratory, Aug. 13, 1969.
35. R. D. Cheverton and W. H. Kelley, Partial Investigation of Fuel Channel Spacers for an HFIR-Type Fuel Element, USAEC Report ORNL-TM-2332, Oak Ridge National Laboratory, Aug. 13, 1968.
36. J. Replogle, MODRIC: A One-Dimensional Neutron Diffusion Code for the IBM-7090, USAEC Report K-1520, Oak Ridge Gaseous Diffusion Plant, September 1962.
37. G. E. Whitesides, MODBURN, unpublished multigroup multiregion one-dimensional diffusion-theory burnup code for the IBM-7090, Oak Ridge Computing Technology Center, 1962.
38. T. B. Fowler, M. L. Tobias, and D. R. Vondy, EXTERMINATOR: A Multigroup Code for Solving Neutron Diffusion Equations in One and Two Dimensions, USAEC Report ORNL-TM-842, Oak Ridge National Laboratory, 1965.
39. G. D. Joanou and J. S. Dudek, GAM-I: A Consistent P_1 Multigroup Code for the Calculation of Fast Neutron Spectra and Multigroup Constants, USAEC Report GA-1850, General Atomic, June 1961.
40. H. C. Honeck, THERMOS: A Thermalization Transport Theory Code for Reactor Lattice Calculations, USAEC Report BNL-5826, Brookhaven National Laboratory, May 1962.
41. H. Brown and D. St. John, Neutron Energy Spectrum in D_2O, USAEC Report DP-33, Savannah River Laboratory, 1954.
42. M. Nelkin, Scattering of Slow Neutrons by Water, Phys. Rev. 119 (2) (July 15, 1960).
43. D. J. Hughes and R. B. Schwartz, Neutron Cross Sections, Second Addition, USAEC Report BNL-325, Brookhaven National Laboratory, July 1, 1953.
44. R. P. Schuman and J. R. Berreth, Neutron Activation Cross Sections of ^{147}Pm, ^{148}Pm, and ^{148m}Pm, Nucl. Sci. Eng., 12:519–522 (1962).
45. N. F. Wikner and S. Jaye, Energy Dependent and Spectrum Averaged Thermal Cross Sections for the Heavy Elements and Fission Products for Various Temperatures and C: ^{235}U Ratios, USAEC Report GA-2113, General Atomic, 1961.
46. E. A. Nephew, Thermal and Resonance Absorption Cross Sections of the ^{233}U and ^{239}Pu Fission Products, USAEC Report ORNL-2869, Oak Ridge National Laboratory, Jan. 18, 1960.

47. G. D. Joanou et al., Nuclear Data for GAM-1 Data Tape, Vol. III, USAEC Report GA-2451, General Atomic, August 1961.
48. Communications from E. H. Gift, Oak Ridge National Laboratory, GAM-I and THERMOS Cross Section Libraries for use at ORNL.
49. M. L. Tobias and T. B. Fowler, SWAPS -- An Experimental Program for the Numerical Solution of the Transport Equation with Anisotropic Scattering in One Dimensional Slab Geometry, USAEC Report ORNL-TM-168, Oak Ridge National Laboratory, 1962.
50. S. Kaplan and A. F. Henry, An Experiment to Measure Effective Delayed Neutron Fractions, USAEC Report WAPD-TM-209, p. 5, Westinghouse Electric Corporation, 1960.

APPENDICES

Appendix A

CRITICAL EXPERIMENT DATA

Four sets of critical experiments were conducted in connection with the HFIR. The first was a solution critical that was used to explore basic characteristics of the flux trap geometry. The second (HFIRCE-2) was a complete mockup of the core essentials, including the fuel element. Very extensive tests were conducted on this assembly. At the conclusion of these tests the fuel loading was increased from 8.0 to 9.4 kg ^{235}U, and the radial distributions of the fuel and burnable poison were changed to some extent. These changes were required because of deficiencies in the calculational techniques and because of changes in criteria. The control rod design was also changed following the HFIRCE-2 experiments because of undesirable reactivity characteristics and fabrication difficulties.

Because of some concern over the ability to extrapolate with sufficient accuracy from the HFIRCE-2 conditions to the final design, a third set of critical experiments (HFIRCE-3) was conducted. With the exception of the boron loading and the temporary use of a simulated final control-rod design the HFIRCE-3 components were essentially exact duplicates of the present HFIR production components.

From the HFIRCE-2 and -3 experiments the following types of information were obtained:

	Series of Experiments
Power distributions	HFIRCE-2 and -3
Control-rod integral and differential worths	HFIRCE-2 and -3
Shutdown margins	HFIRCE-2 and -3
Temperature and void reactivity coefficients	HFIRCE-2
Fuel reactivity coefficients	HFIRCE-2 and -3
Neutron lifetimes	HFIRCE-2 and -3
Worths of simulated plutonium targets (flux trap)	HFIRCE-2 and -3
Flux distributions	HFIRCE-2 and -3
Worth of beam-tube flooding	HFIRCE-2

A fourth set of experiments was finally conducted with the HFIRCE-3 fuel elements and Eu_2O_3-Ta-Al control rods in the HFIR facility. These tests were included in the program because of a change in control-region dimensions, to fill gaps in the previous experimental data, and to verify that adequate simulation between critical facility and reactor facility really existed. No changes resulted from these experiments.

During the latter experiments, power distributions, control-rod differential and integral worths, shutdown margins, several reactivity coefficients, and simulated-plutonium-target worths were obtained. In addition there were many other experiments more closely associated with reactor startup; however, they will not be discussed here.

Results from the first three critical experiments have been published,[6–13] and as indicated above, these experiments were duplicated to a large extent in the final set of experiments. For these reasons only the HFIRCE-4 experiments are discussed in detail here.

In the HFIRCE-2, -3, and -4 experiments a flux-trap target simulating a 300-g plutonium target with maximum reactivity effect was used for determining the effect of the target on reactivities and power distributions. The target consisted of aluminum tubes bundled together with the proper metal-to-water ratio; some contained a mixture of ^{235}U, ^{238}U, silver, and aluminum, and some were open ended. For the HFIRCE-2 and -3 experiments (performed in the critical facility) this target was used uncanned, but in the HFIRCE-4 experiments the target was canned in a plastic cylinder that provided the optimum void space, which could be filled with water or air. The plastic cylinder just fit the flux trap so that no significant voids could enter the trap region. Since it was also important that voids not enter the flux trap in an uncontrolled manner without the target in place, a plastic cylinder without the target was also fabricated. It contained space for the optimum void associated with no target. Thus there were four basic types of flux traps considered in the HFIRCE-4 experiments. In the following discussions they are referred to as the plastic island filled with water (PI+W), the plastic island with optimum void (PI+V), the plastic target filled with water (PT+W), and the plastic target with optimum void (PT+V).

A.1 Power Distributions

Because of the symmetry of the HFIR core it was a relatively simple matter to obtain power distributions by exposing fuel foils that were previously punched from and reinserted into a few of the fuel plates. These special plates, which were removable, are shown in detail in Figs. A.1 and A.2. In order to obtain more detail than provided by the punched foils, several 0.002-in.-thick $^5/_{16}$-in.-diam ^{235}U foils were taped to the surface of the plates near the plate ends. The locations of these foils are shown in the above figures.

Before being exposed, each of the fuel foils was carefully counted in a scintillation counter to determine the weight of ^{235}U in each. After exposure, the foils were counted in a large (4-gal) high-pressure well-type gamma-ionization chamber in which the count rate was essentially independent of foil orientation in the chamber and power distribution within the foil. Relative power distributions were obtained by comparing the total gamma activity of each foil with the time-interpolated activity of a normalizing foil that had been irradiated at the same time and was counted periodically during the counting of the other foils. A plot of normalizing foil data as a function of time indicated a counting accuracy (reproducibility) of about ±1%.

All the fuel plates in both the inner and outer HFIRCE-3 fuel elements were removable; however, because of the high degree of symmetry, as few as three positions in each element would give satisfactory power-distribution data. In the critical facility, as many as six positions in each element were used. These positions are shown in Fig. A.3. They were selected to look at possible perturbations associated with the beam-tube facilities and with the longitudinal gaps in the control rods, as well as to look at the typical core. Results from the 12 positions indicated that the beam tubes have essentially no effect on power distribution and that plate positions la, 37a, 97a, lb, 78b, and 207b were sufficient for predicting power-distribution data. Thus these positions were used in the HFIR facility experiments. The circumferential location represented by positions 97a and 207b constituted the best average core position, and therefore all foils in these two plates were counted. In the other four plates, only the horizontal midplane foils were counted.

Power distributions were obtained for the clean core condition and for several different poisoned-moderator conditions, including the fully withdrawn rod condition; in all cases the rods were symmetrical. Reproducibility was investigated for the clean core and the fully poisoned conditions.

Three clean core power-distribution experiments were conducted prior to the time boron was used in the moderator (with the exception of that used in the HFIRCE-3 critical facility), and another was conducted after the boric acid rod-calibration experiments. Immediately following the rod-calibration tests and prior to the latter clean core power-distribution experiment, the fuel element was washed successively with 0.4% HNO_3, 0.8% HNO_3, ammonium hydroxide (pH 10), and finally 35% HNO_3. Only the latter was effective in removing the retained boron.

Since the boron retention following the rod-calibration tests appeared to be considerably in excess of that experienced during the previous critical experiments, borax ($Na_2B_4O_7 \cdot 10H_2O$), which was used in the HFIRCE-3 experiments, was substituted for boric acid in the remainder of the power-distribution experiments. However, there was still a problem with boron retention, and thus the HNO_3 rinses were continued. For this reason there was always some question regarding the actual value of the metal-to-water ratio, since the rinses removed part of the aluminum cladding. At the completion of the experiments and after a final rinse, several fuel plates were removed and their thicknesses measured. The results indicated a reduction in plate thickness of about 0.001 in., leaving a plate thickness just within minimum thickness specifications. The effect of the changing metal-to-water ratio on the power distributions is discussed in the following paragraphs.

The results from the reproducibility experiments were very encouraging, indicating that the overall accuracy of the relative power distribution was about ±5% (97% of the points agree within ±5%). There were a few scattered points that deviated by more than this, but in these cases it appeared obvious that the difference was due to incorrect foil weights, a change in rod position, or incorrect hot-foil activity measurements, or combinations of these.

For the clean core condition, five separate experiments with the same island condition (PI+W) were conducted. The first three were conducted before the first application of boron to the moderator; the fourth followed the acid rinse after the boric acid rod-calibration experiments; and the fifth followed the final

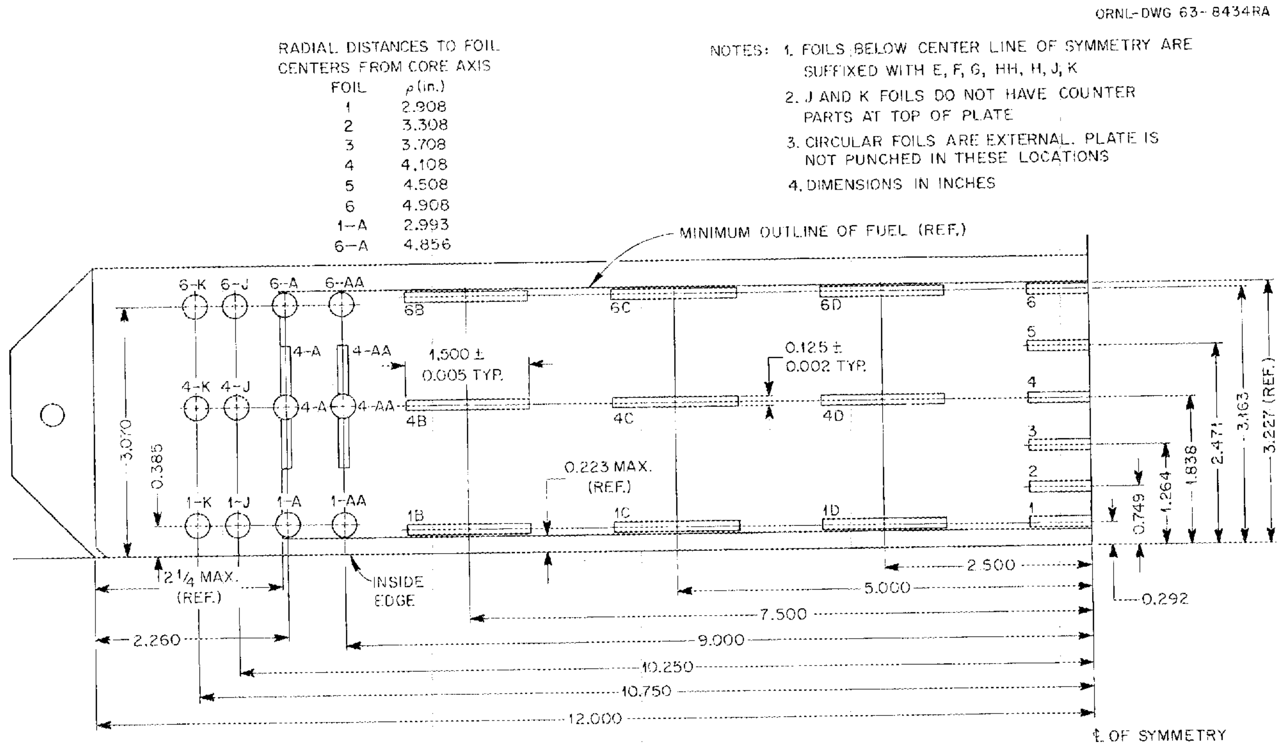

Fig. A.1. Location of Foils in Removable Fuel Plate from Inner Annulus of HFIRCE-3 Core.

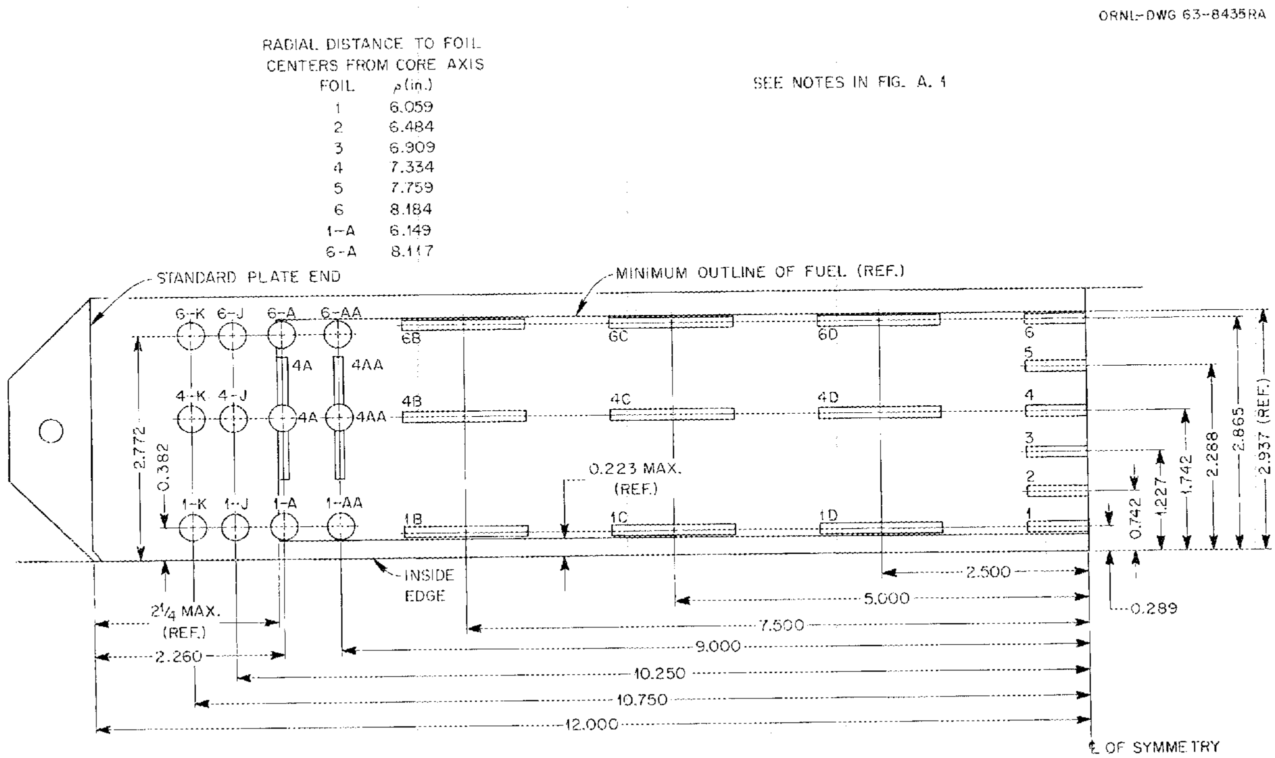

Fig. A.2. Location of Foils in Removable Fuel Plate from Outer Annulus of HFIRCE-3 Core.

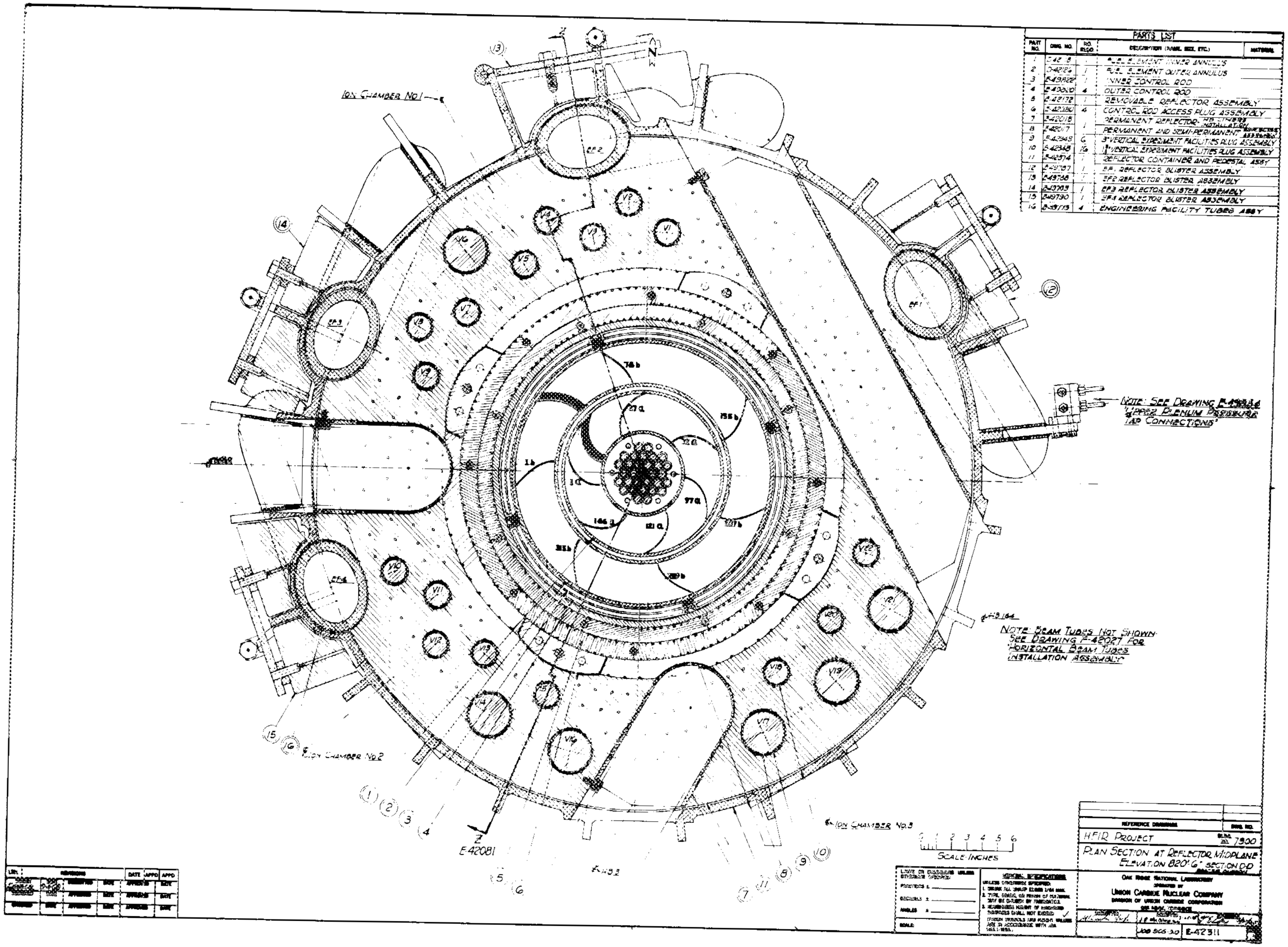

Fig. A.3. Location of Removable Fuel Plates in HFIRCE-3 Element in HFIR Facility.

acid rinse. A summary of typical point values and a simple comparison between sets of data are given in Table A.1. The data of September 8, 1965, had a negative bias because of a high-reading normalizing foil. The data taken on October 21, 1965, showed a negative bias for foil positions 3, 4, 5, and 6-OE because between September 29, 1965, and October 21, 1965, several acid rinses changed the clean core symmetrical rod position significantly and required further insertion of the rods.

Reproducibility was also checked on the fully poisoned core (rods essentially fully withdrawn). Two experiments were conducted; the first was on October 5 and the second on October 13, with the first being followed by several applications of boron and several acid rinses before the second was conducted. These

Table A.1. Comparison of Sets of Power Distribution Data for the Clean Core Condition and a (PI+W) Target

Foil	Position	Relative Power Density on 9/10/65	Deviation from Power Density of 9/10/65 (%)				Foil	Position	Relative Power Density on 9/10/65	Deviation from Power Density of 9/10/65 (%)			
			9/8/65	9/9/65	9/29/65	10/21/65				9/8/65	9/9/65	9/29/65	10/21/65
1-IE	1a	1.27	−3		+5		1-OE	1b	1.12	−4		+2	
2		1.11	−6		+3		2		1.04	−3		0	
3		1.03	−5		+3		3		0.958	−4		0	
4		1.04	−8		0		4		0.881	−2		−2	
5		1.04	−5		+1		5		0.854	−3		−2	
6		1.10	−4		+3		6		0.847	−1		−4	
1-IE	37a	1.28	−3		+3		1-OE	78b	1.11	−4		+3	
2		1.15	−9		−2		2		1.06	−3		+1	
3		1.06	−6		−1		3		0.969	−2		+2	
4		1.02	−3		+1		4		0.918	−2		0	
5		1.03	−5		+4		5		0.894	−1		−2	
6		1.10	−2		+1		6		0.929	−4		−5	
1-IE	97a	1.27		+2	+5	+2	1-OE	207b	1.10		+1	+4	+2
2		1.09		+2	+3	+2	2		1.03		+1	+2	0
3		1.00		+4	+3	+3	3		0.941		+3	+2	−1
4		1.00		+2	+2	+1	4		0.865		+3	0	−4
5		1.01		+1	0	+1	5		0.911		−6	−9	−16
6		1.09		+2	−7	0	6		0.836		+2	−1	−15
1B		0.826		−1	+2		1B		0.701		+4	+1	
4B		0.641		+2	+2		4B		0.459		+2	0	
6B		0.706		0	+2		6B		0.251		+1	+1	
1C		1.09		−2	+2		1C		0.909		+1	+4	
4C		0.832		+2	+1		4C		0.662		+4	−1	
6C		0.912		0	0		6C		0.507		+3	0	
1D		1.25		+2	+2		1D		1.06		+1	+3	
4D		1.00		0	+3		4D		0.813		+3	+1	
6D		1.06		+1	+2		6D		0.715		+2	+2	
1E		1.20		0	+3		1E		1.02		+2	+2	
4E		0.920		+4	+3		4E		0.762		+4	+2	
6E		1.01		+2	0		6E		0.635		+3	+1	
1F		1.01		−1	+3		1F		0.861		0	−1	
4F		0.777		+1	−2		4F		0.586		+3	0	
6F		0.857		+1	0		6F		0.418		+10	−3	
1G		0.748		−4	+4		1G		0.639		+2	+1	
4G		0.581		+2	+2		4G		0.363		+3	+3	
6G		0.650		+1	0		6G		0.144		+5	+13	
4A		0.860		+2	0	−4	4A		0.614		+4	+6	−4
4AA		0.588		−4	0	−3	4AA		0.375		+1	+1	−3
4H		0.710		+1	+2	−3	4H		0.437		+8	+2	−1
4HH		0.525		+3	+2	−2	4HH		0.294		−2	+2	−3

results are compared in Table A.2. A negative bias is observed in the outer element that is greater at the ends than at the middle and greater at the lower end than at the upper. This presumably results from the rods being further inserted during the October 13, 1965, experiment.

Table A.2. Comparison of Sets of Power Distribution Data for the Fully Poisoned Condition and a (PI+W) Target

Foil	Position	Relative Power Density on 10/5/65	Deviation on 10/13/65 from Power Density on 10/5/65 (%)	Foil	Position	Relative Power Density on 10/5/65	Deviation on 10/13/65 from Power Density on 10/5/65 (%)
1-IE	1a	1.27	0	1-OE	1b	1.14	+1
2		1.08	−22	2		1.13	0
3		1.02	0	3		1.11	−1
4		1.02	+1	4		1.09	0
5		1.04	−1	5		1.15	0
6		1.10	+1	6		1.32	−1
1-IE	37a	1.22	+2	1-OE	78b	1.15	0
2		1.05	0	2		1.16	−1
3		0.99	+1	3		1.14	−1
4		1.00	+1	4		1.13	−1
5		1.02	+2	5		1.21	−2
6		1.09	+2	6		1.38	−2
1-IE	97a	1.28	0	1-OE	207b	1.13	0
2		1.06	0	2		1.14	−2
3		1.00	+1	3		1.12	−1
4		1.01	−1	4		1.10	−2
5		1.00	+1	5		1.16	−3
6		1.08	0	6		1.31	−1
1B		0.77	+1	1B		0.76	−7
4B		0.61	+3	4B		0.74	−7
6B		0.67	+3	6B		0.89	−9
1C		1.05	−1	1C		0.98	−5
4C		0.81	0	4C		0.96	−6
6C		0.69	0	6C		1.15	−8
1D		1.22	−3	1D		1.12	−4
4D		0.96	0	4D		1.07	−5
6D		1.03	0	6D		1.32	−6
1E		1.22	−2	1E		1.12	−4
4E		0.96	−1	4E		1.09	−5
6E		1.05	−1	6E		1.33	−6
1F		1.06	−1	1F		0.99	−6
4F		0.83	−1	4F		0.95	−5
6F		0.91	−2	6F		1.16	−7
1G		0.73	−2	1G		0.78	−11
4G		0.63	0	4G		0.73	−11
6G		0.68	+2	6G		0.91	−10
4A		0.67	−3	4A		0.80	−8
4AA		0.51	+4	4AA		0.59	−9
4H		0.61	+5	4H		0.73	−12
4HH		0.53	0	4HH		0.57	−12

All but one of the power distribution experiments was conducted with the (PI+W) target in the island. To obtain a comparison between target and no target, one clean core experiment was conducted with the (PT+W) target.

A few general comments can be made regarding azimuthal and longitudinal symmetry. A comparison of 6-OE foils for plate positions 1b, 78b, and 207b indicates that there is essentially no effect of beam holes on power distribution but that the window between control-rod position quadrants and the greater water concentration in that area increases the local power density by as much as 25% and by no less than 5%. The latter value exists with the rods fully withdrawn, in which case the peaking presumably results from the greater water concentration associated with the stationary divider strip between the safety rods. The largest peaking occurs with the rods in their innermost critical position (clean core plus maximum fission target). These effects will have to be considered when evaluating the overall window peaking problem for future cores. However, the present core design has sufficient margin in the area of interest to accommodate these local peaks, since they are no different than observed in previous experiments.

In the longitudinal direction there is a tendency for the power density to be greater at the inlet end than at the outlet because of the slight longitudinal asymmetry associated with the radial displacement of the safety rods relative to the regulating rod. The effect is more pronounced for the clean core condition than for the fully withdrawn-rod condition because as the rods are withdrawn the "reflector' asymmetry decreases. An analysis of the data indicates that for the clean core plus symmetrical rod condition the power density at the outlet end of the core is approximately 17% less than at the inlet end for the inner element and about 28% less for the outer element. When the rods are fully withdrawn, the corresponding values are about 3 and 11%. These values agree reasonably well with previous data, and even after making a correction for inaccuracies they indicate a significant improvement in heat removal (compared with a completely symmetrical case) in the early part of a fuel cycle.

Figures A.1 and A.2 show uranium foils located beyond the lower end of the fuel core on the removable fuel plates. These foils were used for determining flux gradients, which were helpful in extrapolating the other foil data to the ends of the fuel cores. These data were also useful in determining end-peaking effects associated with relative axial locations of adjacent fuel cores. Fabrication tolerances were such that a single fuel core could extend beyond the others by as much as 1.34 cm. The power density at the end of this core would be considerably greater than for the others. Figure A.4 shows the ^{235}U fission densities at the indicated circular-foil locations relative to the values at the nominal position of the end of the fuel core. It may be observed that for a 1.34-cm protrusion the increase in core-edge density, relative to the nominal core, would be 19 to 50%, depending on the radial position.

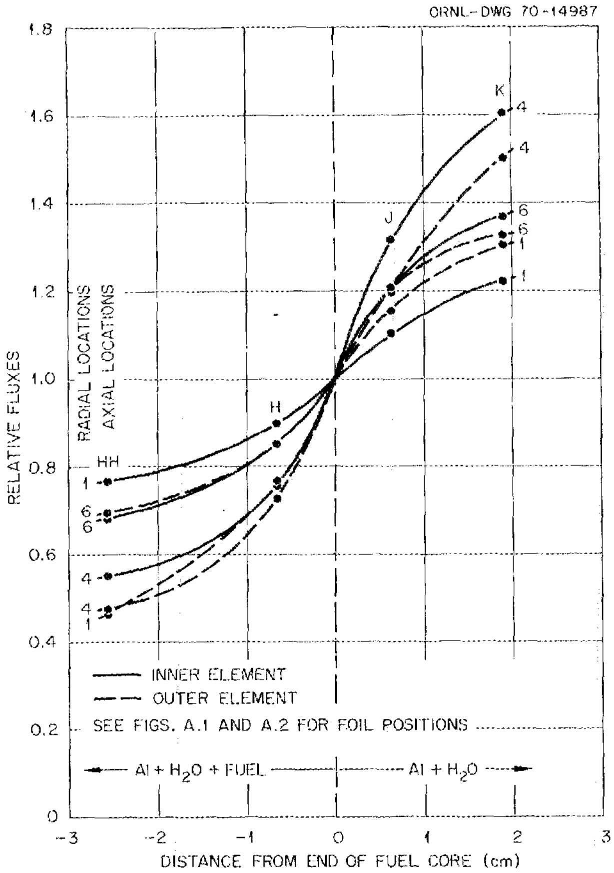

Fig. A.4. Fission Flux Relative to Axial Distributions at Bottom of Core for Clean Core Condition.

A.2 Moderator-Poison Data

Since the power-distribution data were to be used for obtaining correction factors for calculated results, it was necessary that the experiments be calculated accurately; that is, calculated with accurate concentrations, etc. Because the boron would tend to plate out on the fuel plates and precipitate out with the aluminum hydroxide that was sometimes present, there was some question regarding the accuracy with which the actual effective concentration could be determined. An accurate account of the weights of material used to make up a solution and the application of correction factors based on the difference in rod position before and after an experiment resulted in a comparison between the boric acid concentrations and the borax concentrations that is very close. The data are summarized in Fig. A.5. It is believed that these data were quite satisfactory for their intended purpose.

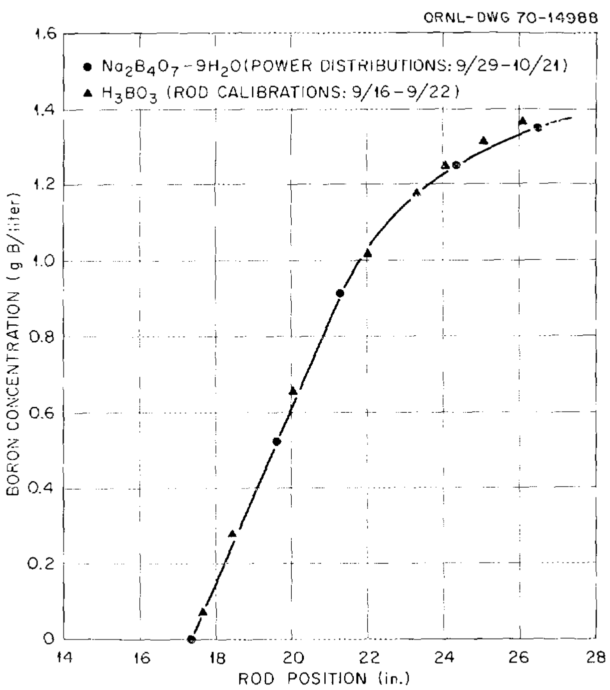

Fig. A.5. Boron Concentration in Moderator Versus Symmetrical Rod Position; HFIRCE-3 Core and Rods in HFIR Facility with (PI+W) Flux Trap.

A.3 Symmetrical Rod Positions in Clean Core

It is of some interest to discuss the symmetrical rod positions in the clean core for the HFIRCE-3 element and rods as a function of time because it sheds some light on reproducibility, target worths, boron retention, and effect of source. In many cases the so-called critical position was obtained with the source remaining in the reflector. On August 27, 1965, the power level at "criticality" was increased in increments to determine what level was required to make the source negligible in terms of rod position at "criticality." The minimum level corresponded to a reading of about 1×10^{-7} on the micromicroammeter (ion-chamber output). In other experiments the source was removed.

Table A.3 lists the rod positions considered to be of particular interest. Reproducibility of rod position at criticality was very good if the fuel element was not removed from the core. For instance, rod position reproducibility was investigated without removing the fuel element on August 31, September 13, September 15, and September 16; the rod positions checked within 2 or 3 mils after extensive scramming and fast rundowns. However, the symmetrical rod positions achieved after removal and reinstallation of the element varied from 17.520 to 17.547, which amounts to about 8 cents in reactivity. From August 25 through September 16 the trend seemed to be toward a decreasing rod position, although maximum and minimum positions occurred on September 8 and September 9, respectively.

The above variations can be attributed to many things: (1) criticality not actually achieved, (2) tolerances in rod-position indicators, (3) element positioning within the core, (4) exchange of removable fuel plates, (5) temperature, (6) radial positioning of control rods, (7) bubbles on the metallic surfaces, and (8) a void trapped under the element. Based on observations of power-versus-time curves (ion-chamber output recordings) during the experiments, it is concluded that item 1 would generally account for no more than 3 mils. The good reproducibility obtained following considerable rod movement but without removing the element indicates that items 2 and 6 would also account for no more than 3 mils total. It does not seem reasonable that item 3 would amount to anything because of the tight positioning tolerances and the circumferential symmetry, which negates radial-displacement effects; in addition, the element was always located in the same relative circumferential position. This leaves items 4, 5, 7, and 8 as the possible significant contributors.

The exchange of removable fuel plates should not account for more than about 0.034 in. (equivalent to 10 cents), based on the permissible variation in fuel and burnable-poison loadings and distributions. Fuel-plate inspection records indicate that there was not nearly this difference in the fuel plates. The biggest difference in rod position was observed on September 8 and September 9 (0.027 in.). In that case only two removable plates were exchanged (one inner and one outer). Therefore the maximum change in rod position

Table A.3. Symmetrical Rod Positions for HFIRCE-3 Clean Core and Rods in thw HFIR Facility

Date in 1965	Symmetrical Rod Position (in.)	Conditions: Target[a]	Conditions: Ion-Chamber Output (amp)	Indicated Moderator Temperature (°C)	Comments
8/25	17.536	(PI+W)(S)	1.2×10^{-7}	27.2	First symmetrical critical experiment
8/27	17.535	(PI+W)(S)	4.9×10^{-7}	28.2	
8/31	17.528	(PI+W)(S)	1×10^{-7}	29	
8/31	17.530	(PI+W)(S)	2.0×10^{-7}	29.6	Check after considerable rod movement
8/31	17.529	(PI+W)(S)	2.0×10^{-7}	30.0	Check after considerable rod movement
9/2	18.777	(PI+W)(S)	2.0×10^{-7}	28.5	ORNL first production core
9/8[b]	17.510	(PI+W)(S)	1×10^{-8}	31	HFIRCE-3 element reinstalled; contained four punched plates with 24 fuel foils and 88 aluminum foils
9/8	17.547	(PI+W)(NS)	1×10^{-6}	30.9	Source removed at "criticality"
9/9	17.520	(PI+W)(NS)	1×10^{-6}	30.8	HFIRCE-3 element reinstalled; contained two punched plates with all fuel foils
9/10	17.534	(PI+W)(NS)	1×10^{-6}	28.6	HFIRCE-3 element reinstalled; contained six plates with all fuel foils
9/13	17.197	(PT+W)(S)	2×10^{-7}	33	HFIRCE-3 element reinstalled; no punched plates
9/13	17.197	(PT+W)(S)	8×10^{-7}	33.4	Check after several scrams
9/14	16.345	(PT+V)(S)	2×10^{-7}	32.9	
9/15	15.850	(PI+V)(S)	2×10^{-7}	33	
9/15	15.847	(PI+V)(S)	8×10^{-7}	33	Check after scram
9/15	15.849	(PI+V)(S)	8×10^{-7}	33	Check after scram
9/15	15.849	(PI+V)(S)	8×10^{-7}	33	Check after fast rundown
9/16	17.520	(PI+W)(S)		30	HFIRCE-3 element reinstalled after drilling vent hole
9/16	17.522	(PI+W)(S)	8×10^{-7}	30	Check after scram
9/16	17.520	(PI+W)(S)	8×10^{-7}	30	Check after scram
9/16	17.522	(PI+W)(S)	8×10^{-7}	30	Check after scram; last of the prepoison experiments
9/22	17.722	(PI+W)(S)	2×10^{-7}		First "clean core" since boric acid experiments; two water rinses
9/22	17.718	(PI+W)(S)	2×10^{-7}		Two more water rinses
9/23	17.677	(PI+W)(S)	2×10^{-7}		After 0.4% HNO_3 rinse in situ
9/23	17.636	(PI+W)(S)	2×10^{-7}	28.5	After 0.8% HNO_3 rinse in situ
9/23	17.625	(PI+W)(S)	2×10^{-7}		After NH_4OH (pH 10.4) rinse in situ
9/23	17.620	(PI+W)(S)	2×10^{-7}		After NH_4OH (pH 10.6) rinse in situ

[a](S) means source in; (NS) means source out.

[b]On 9/1/65 the drain plug in the bottom of the HFIRCE-3 element was installed. Prior to this time the vessel and element water were common. After this time a void was possibly present under the element. On 9/16/65, a vent hole was drilled to eliminate possible voids.

Table A.3 (continued)

Date in 1965	Symmetrical Rod Position (in.)	Conditions: Target[a]	Conditions: Ion-Chamber Output (amp)	Indicated Moderator Temperature (°C)	Comments
9/24	17.392	(PI+W)(S)	2×10^{-7}		Reinstalled element after 35% HNO_3 rinse on decontamination pad
9/29	17.340	(PI+W)(S)	1×10^{-8}	24.0	Reinstalled element after further water rinse; six punched plates, all fuel foils
9/29	17.371	(PI+W)(NS)	1×10^{-8}	24.0	
9/29	17.371	(PI+W)(NS)	10×10^{-7}	24.8	
9/30	17.437	(PI+W)(NS)	1×10^{-8}		After water rinse following fully poisoned moderator (first use of $Na_2B_4O_7$)
10/1	17.432	(PI+W)(NS)	1×10^{-8}		After 1% HNO_3 rinse in situ
10/4	17.451	(PI+W)(NS)	1×10^{-8}	24.0	After 1% HNO_3 rinse in situ following fully poisoned moderator
10/5	17.601	(PI+W)(S)	1×10^{-7}		Reinstalled element after water rinse and fully poisoned moderator
10/6	17.535	(PI+W)(NS)	1×10^{-8}		Reinstalled element after 10% HNO_3 rinse
10/6	17.431	(PI+W)(NS)	1×10^{-8}		Reinstalled element after 21% HNO_3 rinse
10/7	17.611	(PI+W)(NS)	1×10^{-8}	24.0	Reinstalled element after water rinse following partially poisoned moderator
10/8	17.663	(PI+W)(NS)	1×10^{-8}	25.2	Reinstalled element after water rinse following partially poisoned moderator
10/11	17.265	(PI+W)(NS)	1×10^{-8}		Reinstalled element after 21% HNO_3 rinse
10/11	17.555	(PI+W)(NS)	1×10^{-8}		After water rinse in situ following partially poisoned moderator
10/12	17.200	(PI+W)(NS)	1×10^{-8}		Reinstalled element after 21% HNO_3 rinse
10/12	17.335	(PI+W)(NS)	1×10^{-8}		After water rinse in situ following fully poisoned moderator
10/14[c]	16.988	(PI+W)(NS)	1×10^{-8}	23.0	Reinstalled element after 21% HNO_3 rinse following fully poisoned moderator
10/14	16.599	(PT+W)(NS)	1×10^{-8}	23.0	
10/15	15.090	(PI+V)(NS)	1×10^{-8}	23.3	Reinstalled element
10/20	16.987	(PI+W)(S)	2×10^{-7}		
10/20	16.959	(PI+W)(S)	4×10^{-7}		Reinstalled element after water rinse
10/21	16.939	(PI+W)(NS)	10×10^{-7}	24.6	Reinstalled element (24 circular foils)
10/22	18.788	(PI+W)(S)	4×10^{-7}	24.2	ORNL first production core

[c]On 10/13, following the power distribution run with a fully poisoned moderator, the drain plug was removed and left out for the rest of the experiments.

associated with this change would be $0.034/6 \cong 0.006$ in., and as mentioned it is expected that it would actually be significantly less than this.

Differences associated with temperature variations cannot be accurately accounted for because sufficient temperature data were not obtained. The only temperature recorded before the poisoned-moderator experiments was the water temperature just above the top of the fuel plates. Other important temperatures are those in the island and in the reflector. Since the island consisted of a water-filled plastic container, the effective island temperature was not necessarily the same as the vessel water or the fuel-element water temperature.

Maximum effects from temperature variations were estimated to be the following:

	Change in Rod Position (in./°F)
Island	−0.004
Fuel	+0.003
Fuel and island	−0.001

In terms of the observed and postulated temperature changes and differences, the above coefficients are not negligible. However, the inability to apply this information under the circumstances is illustrated by a comparison of rod positions achieved with the ORNL first production element on September 2 and October 22. The rod positions were only 1 mil different, and yet the element temperature was different by about 4°C.

The only clue to the possible existence of bubbles on the surfaces of the various components comes from the results obtained with the HFIRCE-2 element at the critical facility. After experiencing inability to achieve the same rod position following lowering and raising of the water level in all regions of the core, a very small amount of wetting agent was added to the water, presumably to eliminate a bubble problem. It was decided not to use a wetting agent in the HFIR facility experiments unless there was some further indication that it was needed. Appropriate tests were not conducted for isolating the bubble variable, and thus it remained at large.

Another possible bubble problem was associated with a cavity formed by the fuel-element grid ring and the bottom of the HFIRCE-3 fuel element. Originally there was no positive provision for venting this cavity unless the drain plug in the bottom of the HFIRCE-3 fuel element was removed. On August 24, when the vessel was first filled with water for the purpose of achieving criticality, it was discovered that the bottom of the element was vented, since water entered the element unexpectedly. It was later discovered that the drain plug had been inadvertently left out. On September 1 the plug was replaced, and following this it was observed that the ratio of ion-chamber output to fission-chamber output had changed, indicating the presence of a void under the element. This condition existed until September 16, at which time a vent hole was drilled in the bottom flange of the element in such a way that the cavity could be vented around, not through, the element. Thus during the period September 1 to September 16 there was presumably a void of unknown size and effect under the element. Although the maximum possible size of the void can be estimated, the actual size is not known because some venting might have occurred at the element-grid interface. Reactivity effects of voids in this area have never been determined, but the coefficient is probably very close to zero.

The tentative conclusion drawn from this brief discussion and analysis of rod-position reproducibility is that the variations observed were quite small in terms of reactivity (8 cents) and appeared to be within limits associated with known tolerances.

Following September 16, boron was used as a poison in the fuel-element moderator, and in several instances retained boron was removed by removing the aluminum oxide with HNO_3 solutions. This reduced the metal-to-water ratio slightly and at the same time probably did not completely remove all the boron; the two conditions therefore tended to compensate for each other. In addition, the apparent formation of a very loosely adherent aluminum hydroxide powder, following the HNO_3 rinses, complicated achieving a supposedly predictable rod position because the powder, which was known by chemical analysis to retain some of the boron, could not always be thoroughly washed out of the element. Thus, checks on symmetrical rod-position reproducibility in the clean core after September 16 were not very meaningful for the HFIRCE-3 fuel element.

It is of interest, however, to note that after the boric acid rod-calibration experiments (first poison experiments in the HFIR facility) and the HNO_3 rinse on September 24, the rod position decreased to 17.392 from the previous values of 17.520. The solid residue (aluminum oxide) was analyzed and found to contain a relatively high percentage of boron. These results indicate that there must have been a significant amount of retained boron in the core at the end of the HFIRCE-3 critical experiments.

The change in control-rod position associated with boron retention appears to be easily distinguishable from the apparent random variation discussed above because it is considerably greater. Between September 16 and September 22 the rod position changed from approximately 17.522 to 17.722 (boric acid experiments); between September 29 and October 5 the rod position changed from 17.371 to 17.601 (first borax experiments); between October 6 and October 7 the rod position changed from 17.431 to 17.611; between October 7 and October 8 the rod position changed from 17.611 to 17.633; and on October 11 the rod position changed from 17.265 to 17.555. In the first two cases the fully poisoned boron solution was in and out of the element over a several-day period. In the third, fourth, and fifth cases the boron concentrations in the solution were in decreasing order, and the solutions were in the element for only a brief period of time (~2 hr). Between the third and fourth cases, no acid rinse was used. It appears from these results that the boron retention tends to saturate, but time in the element and the range of concentrations used seemed to have little predictable effect. However, this is just an observation and has little bearing on the results of interest.

A.4. Shutdown Margins

As discussed in the text the reactor must be subcritical for four specific combinations of conditions. In the HFIRCE-2 and -3 critical experiments, shutdown margins for these and other cases were measured directly by the pulsed-neutron technique. These data were then extrapolated to the actual HFIR conditions. Of course the real proof of shutdown margin adequacy was obtained from the HFIRCE-4 experiments in the actual HFIR facility. These results are discussed below.

Even in the actual reactor facility there are problems associated with extrapolation to the most reactive combination of conditions and tolerances. In this particular situation it was possible to "measure" the shutdown margin for the nominally most reactive case (case IV), but there was still some question regarding the effect of boron retention and acid rinses.

The change in reactivity of the HFIRCE-3 element as a result of exposure to the boric acid and borax solutions and the nitric acid rinses while in the HFIR facility was about

$$(17.530 - 16.959)\ \text{in.} \times 2.90\ \frac{\$}{\text{in.}} \times 0.0071\ \frac{\Delta k}{\$} = 0.571\ \text{in.} \times 0.0206\ \Delta k/\text{in.} = +0.012\ \Delta k\ .$$

The first nitric acid rinse increased the neutron multiplication factor by about

$$(17.530 - 17.371) \times 2.90 \times 0.0071 = 0.159\ \text{in.} \times 0.0206\ \frac{\Delta k}{\text{in.}} = +0.003\ \Delta k\ .$$

If it is assumed that the latter rinse removed essentially all the retained boron accumulated up until that time, the difference between 0.012 Δk and 0.003 Δk would be attributed to a decrease in the metal-to-water ratio. The "void" coefficient that corresponds to the uniform removal of small amounts of aluminum from the fuel element is $1.6 \times 10^{-4}\ \Delta k/\text{in.}^3$. To account for the $0.012 - 0.003 = 0.009\ \Delta k$, $0.009\ \Delta k/1.6 \times 10^{-4}\ \Delta k/\text{in.}^3 = 56\ \text{in.}^3$ of aluminum would have to be removed. This amounts to $(56\ \text{in.}^3 \times 16.4\ \text{cm}^3/\text{in.}^3/25 \times 10^3\ \text{cm}^3) \times 0.050\ \text{in.} = 0.0018$ in. of fuel-plate thickness, which appears quite reasonable in view of the oxide thickness. It is known from observations that most of the oxide was removed during some of the rinses and reformed afterward. In addition, an amount of solids was collected which, when roughly extrapolated to include the solids that were not collected, appeared to be consistent with the above calculated volume.

To check on the change in plate thickness several of the permanent fuel plates were removed on November 2 for thickness measurements. The results indicate that the plates are still within the specified tolerances (0.50 ± 0.001 in.) but that the average thickness was decreased from 0.0505 to 0.0495 in. This is about 56% of the above predicted change based on the change in control-rod position. The discrepancy is probably associated with the fact that no means was available for making a precise check on the change in average fuel-plate thickness. Thus it appeared that from the standpoint of metal-to-water ratio the "cleaned" HFIRCE-3 element represented the most reactive state permissible within specified fuel-plate thickness tolerances.

The only shutdown margin of the four cases actually measured was that for case IV, which is the most reactive case for which the reactor must be subcritical. In this case the reactor should be subcritical with the regulating rod at the symmetrical, clean core, critical position, with one of the safety rods fully withdrawn, the other three safety rods fully inserted, and the maximum fission target (containing no voids) in the island. Based on previous experiments and on analysis of tolerance reactivity effects, it was determined that the shutdown margin for the HFIRCE-3 element in the HFIR facility should be about 0.022 Δk with nominal fuel-plate thickness and about 0.010 Δk with minimum fuel-plate thickness. Since the worth of the optimum void in the target was known to be 0.015 Δk, it was decided to add the optimum void to case IV as a first check on shutdown capability. Under these conditions the reactor was subcritical, and the extent of subcriticality was determined through the use of the Rhoette to be 1.04$ × 0.0071 Δk/$ = 0.007 Δk. Thus the "measured" shutdown margin for the HFIRCE-3 element in the HFIR facility was 0.015 + 0.007 = 0.022 Δk for case IV.

As indicated above, the difference in control-rod position before and after the acid rinses was equivalent to a reactivity addition of about 0.012 Δk. Thus the "cleaned" core would have the desired minimum shutdown margin of 0.010 Δk. This was verified by a Rhoette reading taken after the final rinse that indicated a shutdown margin of about 0.013 Δk/k for case IV.

The reactivity difference between the HFIRCE-3 core when considered as being a nearly minimum reactivity core and a similar maximum reactivity core is 0.0215 Δk/k. Thus an actual production core would have to have 0.0215 − 0.010 = 0.0115 Δk/k more in negative reactivity to assure a shutdown margin for case IV. This was provided by adding 0.68 g more ^{10}B to the burnable poison, making a total ^{10}B loading of 2.80 g for the production cores. Under these exact conditions a production core exposed to case IV would have exactly zero shutdown margin. However, because of the conservatism associated with the specified tolerances, it is expected that the margin will always be significantly greater than zero. As an example, the first production core (containing 2.8 g ^{10}B) was installed with the HFIRCE-3 modified Eu_2O_3-Ta-Al control rods, and the case IV shutdown margin was determined, with the Rhoette, to be about 0.021 Δk/k. Of all the cores fabricated to date and reactivity-checked against a standard in a special critical facility (about 56 cores) the first was the least reactive. However, the most reactive was more reactive than the first by only 0.006 Δk/k. If a core should happen to be out of tolerance with respect to reactivity, the preoperational criticality check would presumably identify it as such, in which case the core would be rejected or used with an acceptably lower reactivity assembly.

A.5 Control-Rod Differential Worth

Differential worth of the control rods was determined for different rod positions by maintaining criticality with the rods (asymmetrical rods) and also by supplementing the control with boron in the confined moderator (approximately symmetrical rods). The former type of rod calibration was performed at the HFIR facility before any of the boron experiments were conducted. Therefore these experiments provided data with which to compare the reactive state of the HFIRCE-3 and HFIR facilities. A summary of these data is presented in Fig. 6.1. As indicated, the agreement between the results for the two facilities is very good. A comparison of the dashed curves, representing the HFIRCE-3 data, with the solid curves presumably shows the effect of the different coolant channels in the control regions of the two facilities. As was expected, this difference tended to reduce the worth of the safety rods in the HFIR facility. The differences observed in the differential worth curves are probably within the degree of accuracy associated with the experiments; however, the rod-position data should be accurate enough to indicate a real difference

At symmetrical criticality the rod positions in the HFIRCE-3 were 15.68, and in the HFIR they were 17.531. To compare these positions the HFIR value should be decreased by 2.000 in. because of the bias in the rod position indicators, and it should be increased by 0.155 in. to correct for dimensional changes associated with the modification of the HFIRCE-3 rods for HFIR use. Thus, for comparison the HFIR rod positions should be 15.69, which indicates satisfactory agreement with the HFIRCE-3 rod positions.

Differential rod-worth data obtained for symmetrical rod positions with boron in the moderator as a supplementary poison are shown in Fig. 6.2. It may be observed that with the rods withdrawn to 27.00 in. the differential worth of the safety rods is 12 cents/in., which is the value assumed in the HFIR analog transient analysis. The slope of the right-hand portion of the curve in Fig. 6.2 is significantly greater than assumed in the transient analysis, and thus at least for a new set of rods the actual available rod worth during a transient will be greater than used in the calculations.

It is of some interest to compare the above curves with the results obtained at the HFIRCE-3 facility with the same element and rods. Results from the latter are shown in Fig. A.6. It may be noted that for the fully withdrawn rod position (25.00 in.) the safety-rod

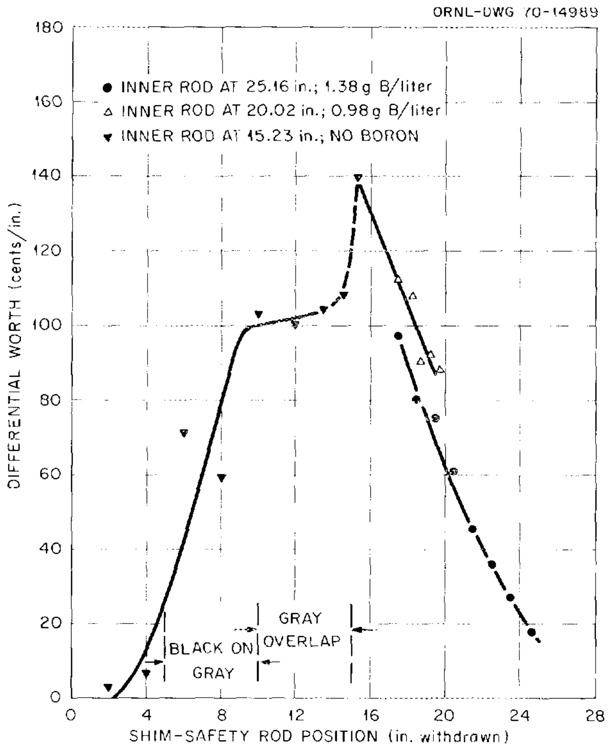

Fig. A.6. Differential Rod Worth for Eu_2O_3-Ta-Al Safety Rods in HFIRCE-3 with Target.

Table A.4. Summary of Reactivity Worths and Coefficients

(PT+W) – (PI+W)	+0.0070 Δk/k
(PT+V) – (PT+W)	+0.015 Δk/k
(PI+V) – (PI+W)	+0.032 Δk/k
Fuel coefficient[a]	
Inner element	$+3.72 \times 10^{-5}$ (Δk/k)/g ^{235}U
	+0.0966 (Δk/k)/(Δm/m)
Outer element	$+1.09 \times 10^{-5}$ (Δk/k)/g ^{235}U
	+0.0744 (Δk/k)/(Δm/m)
Total average	+0.171 (Δk/k)/(Δm/m)
Fuel-plate coefficient[b]	
Inner element	–0.0458 (Δk/k)/(ΔV/V)
	-8.72×10^{-5} (Δk/k)/in.^{3}
Outer element	–0.113 (Δk/k)/(ΔV/V)
	-11.6×10^{-5} (Δk/k)/in.^{3}
Fuel-region aluminum coefficient[c]	
Inner element	–0.104 (Δk/k)/(ΔV/V)
	-16.7×10^{-5} (Δk/k)/in.^{3}
Outer element	–0.188 (Δk/k)/(ΔV/V)
	-15.9×10^{-5} (Δk/k)/in.^{3}
Fuel-region void coefficient[d]	
Inner element	–0.080 (Δk/k)/(ΔV/V)
Outer element	–0.170 (Δk/k)/(ΔV/V)

[a]m refers to weight of fuel in specified region.
[b]V refers to active volume of fuel plate.
[c]V refers to the entire volume of fuel plate.
[d]V refers to the volume of water.

differential worth is 15 cents/in. instead of 12 cents/in. Assuming that the accuracy of the results permits, the difference is attributed to the difference in control-region coolant gaps and water content, and this is at least consistent with the predicted trends.

A.6 Worth of Target and Voids in the Island

The reactivity worths of voids and the HFIRCE-3 target in the island can be derived from the information in Table A.3 and Fig. 6.2 and are summarized in Table A.4. The worth of the (PT+W) target relative to the (PI+W) target is obtained from two sets of data (September 10–September 13 and October 14):

$$(17.534 - 17.097)\ \text{in.} \times 2.80\ \frac{\$}{\text{in.}} \times 0.0071 \frac{\Delta k}{\$} = 0.0067\ \Delta k\ ,$$

$$(16.988 - 16.599) \times 2.54 \times 0.0071 = 0.0070\ \Delta k\ .$$

The experiment of September 10–September 13 involved replacement of the element and six removable fuel plates, whereas the October 14 experiment did not. The October 14 value is the same as measured in the HFIRCE-3 critical experiments.

The worth of the void in the target was obtained from the September 13–September 14 data set:

$$(17.197 - 16.345) \times 2.52 \times 0.0071 = 0.015\ \Delta k\ ,$$

which is the same as obtained in the HFIRCE-3 critical experiments.

The worth of the void in the island without the target was obtained from the September 15–September 16 and October 15–October 20 data sets:

$$(17.520 - 15.850) \times 2.56 \times 0.0071 = 0.030\ \Delta k\ ,$$

$$(16.987 - 15.090) \times 2.34 \times 0.0071 = 0.032\ \Delta k\ .$$

The value obtained from the HFIRCE-3 critical experiments was 0.031 Δk.

A.7 Worth of Fuel Plates, Aluminum Plates, and Fuel in the Fuel Element

A summary of the worths and associated coefficients is presented in Table A.4. The removal of the six fuel plates from the inner fuel element resulted in a reactivity addition of 0.0377 dollar per plate, while the six removed from the outer element added 0.0433 dollar per plate. Removal of six aluminum plates from the inner element added 0.0860 dollar per plate, while three aluminum plates removed from the outer element added 0.0717 dollar per plate. Therefore in the inner element the fuel and boron alone are worth

$$(0.0377 - 0.0860)\frac{\$}{\text{plate}} \times 0.0071\frac{\Delta k}{\$} = 0.000343\ \Delta k \text{ per plate} .$$

The worth of the boron was calculated to be

$$0.00038\frac{\Delta k}{\%\text{B}} \times \frac{1 \times 10^2\%\text{B}}{171 \text{ plate}} = 0.000222\ \Delta\text{ k per plate} .$$

Thus, the fuel worth is

$$0.000343 + 0.000222 = 0.000565\ \Delta k \text{ per plate}$$

or

$$0.000565\frac{\Delta k}{\text{plate}} \times \frac{\text{plate}}{15.18\text{ g }^{235}\text{U}} = 3.72 \times 10^{-5}\ (\Delta k/k)/\text{g }^{235}\text{U}$$

or

$$0.000565\frac{\Delta k}{\text{plate}} \times 171 \text{ plates} = 0.0966 \times (\Delta k/k)/(\Delta m/m) .$$

For the outer element the corresponding values are

$$(0.0433 - 0.0717) \times 0.0071/18.44 = 1.09 \times 10^{-5}\ (\Delta k/k)/\text{g }^{235}\text{U}$$

or

$$1.09 \times 10^{-5} \times 18.44 \times 369 = 0.0744\ (\Delta k/k)/(\Delta m/m) .$$

Therefore, the total average coefficient for the core (both elements) is

$$0.0966 + 0.0744 = 0.171\ (\Delta k/k)/(\Delta m/m) .$$

The calculated value was 0.15, and the value determined in the HFIRCE-2 critical experiments (8-kg core) was 0.167 $(\Delta k/k)/(\Delta m/m)$.

For purposes of evaluating reactivity accidents associated with fuel-plate melting, fuel-plate coefficients can be obtained directly from the above data. The following coefficients are based on the active volume of the plates:

Inner element,

$$0.0377\frac{\$}{\text{plate}} \times 0.0071\frac{\Delta k/k}{\$} \times 171 \text{ plates} = -0.0458\ (\Delta k/k)/(\Delta V/V)$$

or

$$0.0377 \times 0.0071 \times \frac{\text{plate}}{3.07\text{ in.}^3} = -8.72 \times 10^{-5}\ (\Delta k/k)/\text{in.}^3 .$$

Outer element,

$$0.0433 \times 0.0071 \times 269 = -0.113\ (\Delta k/k)/(\Delta V/V)$$

or

$$0.0433 \times 0.0071 \times \frac{\text{plate}}{2.66\text{ in.}^3} = -11.6 \times 10^{-5}\ (\Delta k/k)/\text{in.}^3 .$$

It should be pointed out that according to calculations these latter coefficients become positive after about 2.5% Δk has been added by uniform removal of fuel plates. The volume associated with the 2.5% Δk is about 30%.

Aluminum coefficients, which are nearly the same as void coefficients, are the following:

Inner element,

$$0.0860\frac{\$}{\text{plate}} \times 0.0071\frac{\Delta k/k}{\$} \times 171 \text{ plates} = -0.104\ (\Delta k/k)/(\Delta V/V)$$

or

$$0.0860 \times 0.0071 \times \frac{\text{plate}}{3.65\text{ in.}^3} = -16.7 \times 10^{-5}\ (\Delta k/k)/\text{in.}^3 .$$

Outer element,

$$0.0717 \times 0.0071 \times 369 = -0.188\ (\Delta k/k)/(\Delta V/V)$$

or

$$0.0717 \times 0.0071 \times \frac{1}{3.21} = -15.9 \times 10^{-5}\ (\Delta k/k)/\text{in.}^3\ .$$

To convert these to void coefficients a correction should be made for the absorption in aluminum. This can be estimated from the following:

Inner element,

$$\frac{(0.0301\ \text{at./b·cm}) \times 0.150\ \text{b}}{0.19\ \text{cm}^{-1}} = +0.024\ (\Delta k/k)/(\Delta V/V)\ .$$

Outer element,

$$\frac{0.0301 \times 0.150}{0.25} = +0.018\ (\Delta k/k)/(\Delta V/V)\ .$$

After making these corrections, the void coefficients become the following:

Inner element,

$$-0.104 + 0.024 = -0.080\ (\Delta k/k)/(\Delta V/V)\ .$$

Outer element,

$$-0.188 + 0.018 = -0.170\ (\Delta k/k)/(\Delta V/V)\ ,$$

where V refers to the volume of water. If the coefficients are to be based on total region volume (plate + water), these values should be multiplied by 2.0.

A.8 Temperature Coefficients

Temperature coefficients were measured in the HFIRCE-2 experiments only, with the exception of an isothermal measurement in the reactor facility. The HFIRCE-2 experimental apparatus was set up in such a way that the moderator within the bounds of the outer side plate of the outer element and the inner side plate of the inner element and a bottom blind flange could be circulated separately from the water in the island, control region, and external reflector regions, all of which had a common circulating system. The two side plates mentioned above were each composed of two concentric cylinders that were separated by a narrow air gap. The air gaps provided thermal insulation, and the separate circulating systems made it possible to heat or cool the fuel- and reflector-region coolants separately. Thus it was possible to maintain different temperatures in the fuel and reflector regions.

The temperature-coefficient experiments consisted of heating the fuel region a few degrees above the reflector-region temperature and then allowing the reflector-region temperature to rise to the same as the fuel-region temperature. Changes in reactivity were determined from critical control-rod positions. Results obtained from these experiments with and without the target in the island are shown in Figs. 9.1 and 9.2.

The source of error in an experiment of this type is the difference in differential expansion of core support and control-rod drive mechanisms between the critical facility and the actual reactor. The effect of such differences had been estimated to be quite small, and the isothermal experiments in the reactor confirmed the estimate. In the range 80 to 120°F the HFIRCE-2 isothermal coefficient was -1.2×10^{-5} to -2.2×10^{-5} $(\Delta k/k)/°\text{F}$, whereas in the reactor facility the change in reactivity over the same temperature range appeared to be essentially zero or perhaps slightly positive. Of course a slightly positive isothermal coefficient is not troublesome because the fuel-region coefficient, which is relatively prompt, is quite negative.

These experiments were conducted for clean core conditions only and thus did not provide information for later times in the fuel cycle. It was necessary to resort to calculations for this type of information, and it was believed that the calculated difference in coefficients between clean and spent core was reasonably accurate. The calculations indicated that the fuel-region negative coefficient at the end of the fuel cycle was about one half that at the beginning of the fuel cycle.

A.9 Neutron Lifetime and Effective Delayed-Neutron Fraction

The prompt neutron lifetime was determined with the aid of results from the HFIRCE-2 pulsed-neutron experiments. For a critical system the following relationship is obtained for the neutron-density decay rate following a neutron pulse, provided the relatively short-term higher modes of decay are insignificant:

$$\lambda = \beta_{\text{eff}}/\ell\ ,$$

where

λ = decay constant,

β_{eff} = effective delayed-neutron fraction,

ℓ = neutron lifetime.

The value of λ was determined from the slope of the decay curve, and β_{eff} was calculated. Measured values of λ are shown in Fig. A.6 for different positions of the control rods. For comparison, calculated values of λ are also shown in Fig. A.7. Calculated and "measured" values of β_{eff} and ℓ are shown in Table A.5.

A.10 Description of HFIRCE-4 Physical Characteristics

Since considerable effort was expended in obtaining useful and accurate experimental data from the HFIR critical experiments, it is possible that others will be interested in trying their calculational techniques on HFIR. For this reason a detailed dimensional and material description of the HFIRCE-4 experimental core is given herein. Figure A.8 shows the dimensions of the "microscopic" regions used in most of the calculations; Figs. A.9 and A.10 show the specified nominal radial fuel and burnable-poison distributions; and Table A.6 gives the material densities for the regions specified in Fig. A.8.

Table A.5. Calculated and "Measured" Values of ℓ and β_{eff}

Control-Rod Condition	λ Measured (sec^{-1})	β_{eff} Calculated	ℓ "Measured" (μsec)	ℓ Calculated (μsec)
Black (fully inserted)		0.00629		35
Gray (clean critical)	213	0.00704	33	38
White (fully withdrawn, poisoned moderator)	98.5	0.00714	74	76

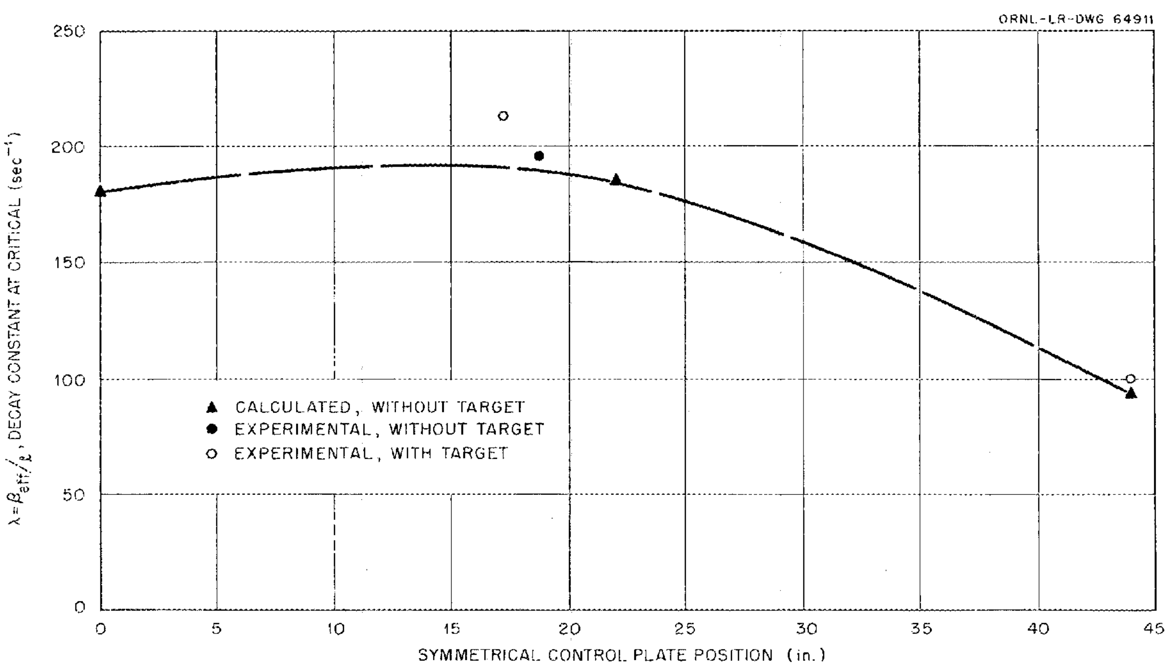

Fig. A.7. Calculated and Experimental Values of the Decay Constant at Criticality.

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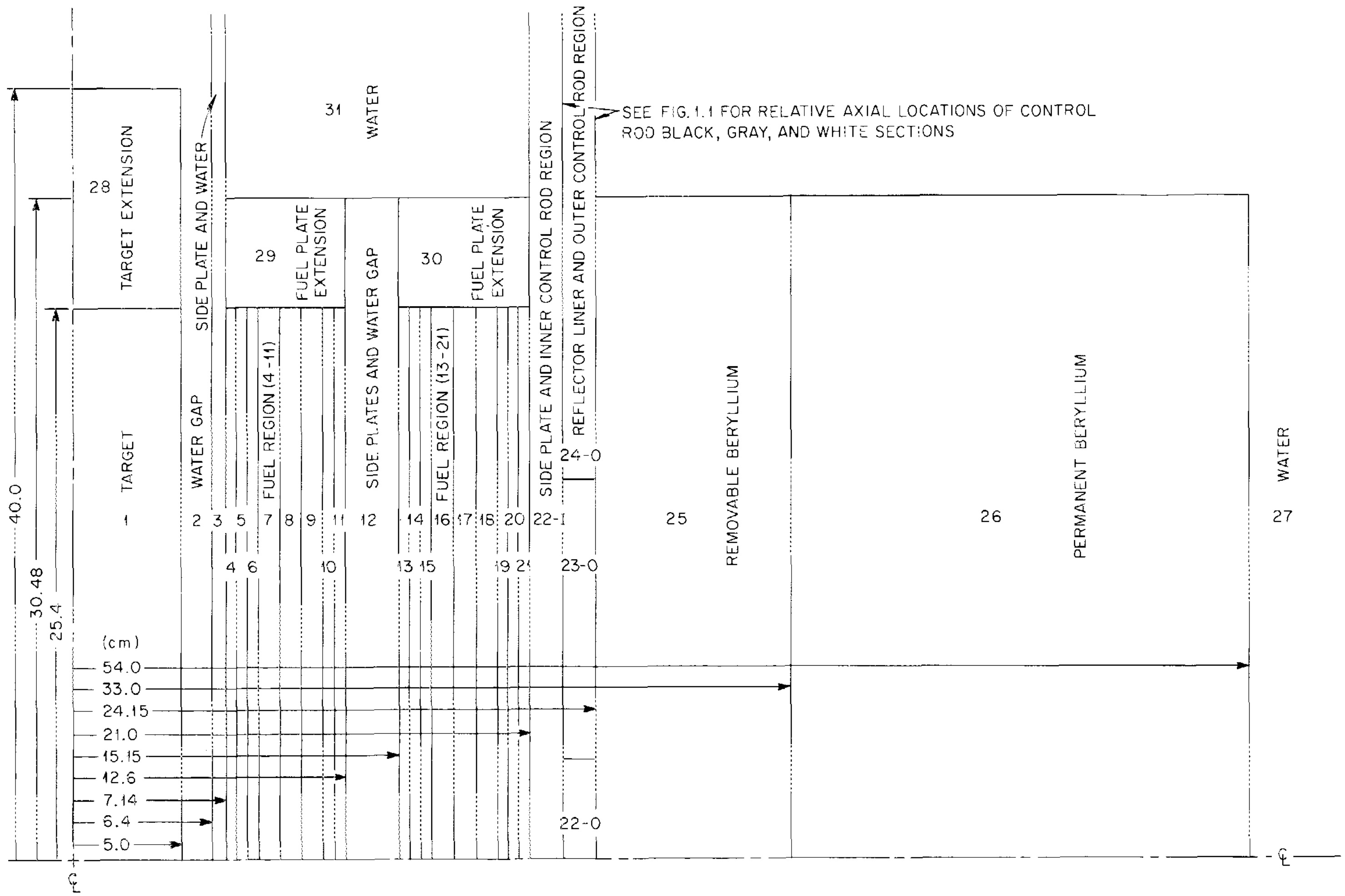
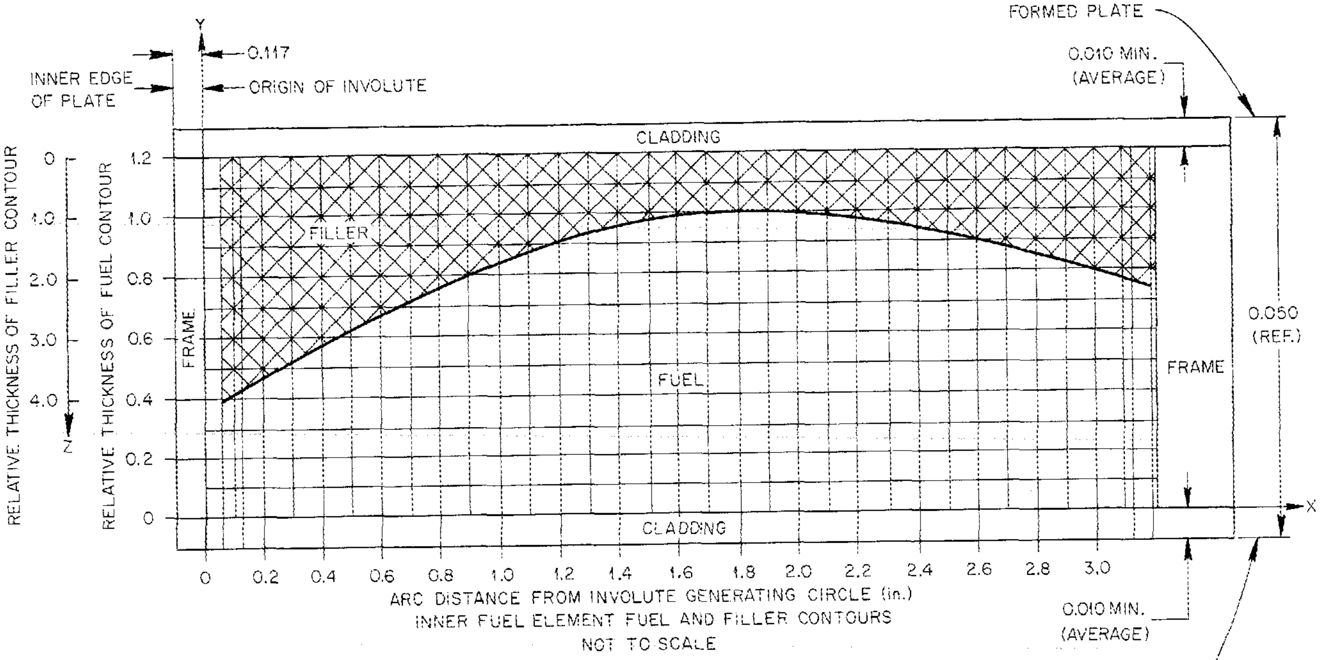


Fig. A.8. Region Structure Used in HFIR Calculations.



SURFACE DENSITIES (g/cm^2)
0.0459 x Y FOR ^{235}U IN HFIRCE-3 AND PRODUCTION CORES
1.72 x 10^{-5} x Z FOR ^{10}B IN HFIRCE-3 CORE
2.27 x 10^{-5} x Z FOR ^{10}B IN PRODUCTION CORES

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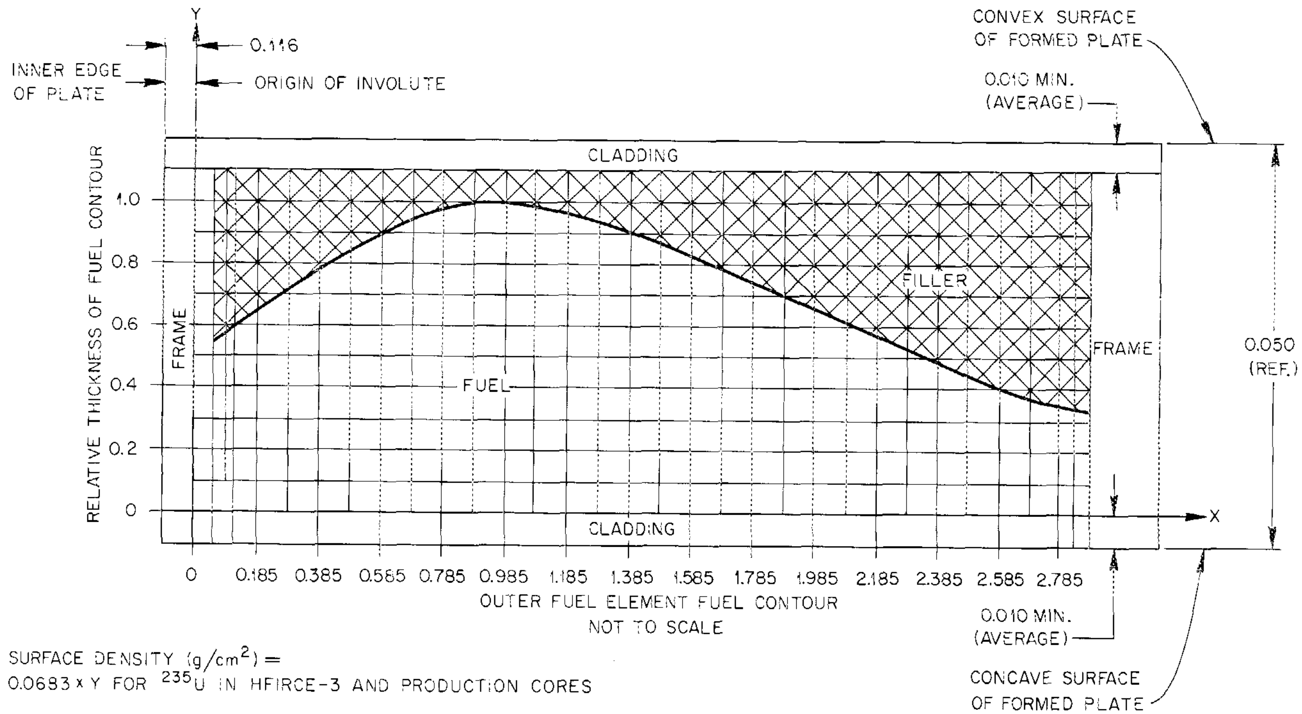
COORDINATES

X	Y	Z
0.060	0.389	4.06
0.100	0.411	3.95
0.123	0.423	3.89
0.200	0.465	3.68
0.300	0.518	3.41
0.400	0.570	3.15
0.500	0.620	2.90
0.600	0.668	2.66
0.700	0.714	2.43
0.800	0.758	2.21
0.900	0.799	2.01
1.000	0.837	1.82
1.100	0.872	1.64
1.200	0.903	1.49
1.300	0.931	1.35
1.400	0.955	1.23
1.500	0.974	1.13
1.600	0.988	1.06
1.700	0.997	1.02
1.809	1.000	1.00
1.900	0.998	1.01
2.000	0.993	1.04
2.100	0.984	1.08
2.200	0.972	1.14
2.300	0.957	1.22
2.400	0.939	1.31
2.500	0.919	1.41
2.600	0.897	1.52
2.700	0.873	1.64
2.800	0.847	1.77
2.900	0.819	1.91
3.000	0.790	2.05
3.100	0.760	2.20
3.127	0.752	2.24
3.190	0.732	2.34

Fig. A.9. Fuel and Burnable-Poison Distributions in Inner Element of HFIRCE-3 and Production Cores.



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COORDINATES

X	Y
0.060	0.553
0.085	0.572
0.108	0.589
0.185	0.645
0.285	0.715
0.385	0.782
0.485	0.844
0.585	0.899
0.685	0.942
0.785	0.973
0.885	0.993
1.006	1.000
1.085	0.997
1.185	0.984
1.285	0.963
1.385	0.935
1.485	0.903
1.585	0.867
1.685	0.828
1.785	0.787
1.885	0.744
1.985	0.700
2.085	0.656
2.185	0.612
2.285	0.569
2.385	0.527
2.485	0.486
2.585	0.447
2.685	0.410
2.785	0.376
2.822	0.364
2.870	0.349

Fig. A.10. Fuel Distribution in Outer Element of HFIRCE-3 and Production Cores.

Table A.6. Material Densities and Dimensions of Regions in Fig. A.8

Region Number	Outside Radius (cm)	Location of Upper and Lower Region Boundaries Relative to Horizontal Midplane (cm)		Composition			
				Two-Dimensional Model		One-Dimensional Model	
		Upper	Lower	Element	Concentration (at./b·cm)	Element	Concentration (at./b·cm)
1	5.0	25.4	−25.4	H	3.83×10^{-2}	Same as two-dimensional model through region 21	
				O	1.92×10^{-2}		
				Al	2.36×10^{-2}		
				^{10}B	1.184×10^{-6}		
				^{11}B	4.8×10^{-6}		
				^{109}Ag	7.32×10^{-5}		
				^{235}U	5.361×10^{-6}		
				^{238}U	8.25×10^{-5}		
2	6.4			H	6.854×10^{-2}		
				O	3.427×10^{-2}		
3	7.14			H	1.074×10^{-2}		
				O	5.37×10^{-3}		
				Al	4.8×10^{-2}		
4	7.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{10}B	1.5448×10^{-5}		
				^{11}B	6.257×10^{-5}		
				^{234}U	2.207×10^{-6}		
				^{235}U	2.057×10^{-4}		
				^{236}U	8.82×10^{-7}		
				^{238}U	1.192×10^{-5}		
5	8.0	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{10}B	1.3404×10^{-5}		
				^{11}B	5.429×10^{-5}		
				^{234}U	2.693×10^{-5}		
				^{235}U	2.51×10^{-4}		
				^{236}U	1.077×10^{-6}		
				^{238}U	1.454×10^{-5}		
6	8.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{10}B	1.1117×10^{-5}		
				^{11}B	4.503×10^{-5}		
				^{234}U	3.252×10^{-6}		
				^{235}U	3.031×10^{-4}		
				^{236}U	1.30×10^{-6}		
				^{238}U	1.756×10^{-5}		
7	9.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{10}B	7.847×10^{-6}		
				^{11}B	3.178×10^{-5}		
				^{234}U	4.04×10^{-6}		
				^{235}U	3.765×10^{-4}		
				^{236}U	1.615×10^{-6}		
				^{238}U	2.181×10^{-5}		

Table A.6 (continued)

Region Number	Outside Radius (cm)	Location of Upper and Lower Region Boundaries Relative to Horizontal Midplane (cm)		Composition			
				Two-Dimensional Model		One-Dimensional Model	
		Upper	Lower	Element	Concentration (at./b·cm)	Element	Concentration (at./b·cm)
8	10.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{10}B	4.658×10^{-6}		
				^{11}B	1.887×10^{-5}		
				^{234}U	4.807×10^{-6}		
				^{235}U	4.48×10^{-4}		
				^{236}U	1.922×10^{-6}		
				^{238}U	2.596×10^{-5}		
9	11.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{10}B	4.373×10^{-6}		
				^{11}B	1.771×10^{-5}		
				^{234}U	4.877×10^{-6}		
				^{235}U	4.545×10^{-4}		
				^{236}U	1.95×10^{-6}		
				^{238}U	2.633×10^{-5}		
10	12.0	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{10}B	6.089×10^{-6}		
				^{11}B	2.466×10^{-5}		
				^{234}U	4.475×10^{-6}		
				^{235}U	4.171×10^{-4}		
				^{236}U	1.789×10^{-6}		
				^{238}U	2.417×10^{-5}		
11	12.6	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{10}B	8.051×10^{-6}		
				^{11}B	3.261×10^{-5}		
				^{234}U	3.989×10^{-6}		
				^{235}U	3.718×10^{-4}		
				^{236}U	1.595×10^{-6}		
				^{238}U	2.154×10^{-5}		
12	15.15	30.48	−30.48	H	2.75×10^{-2}		
				O	1.375×10^{-2}		
				Al	3.534×10^{-2}		
13	15.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{234}U	4.528×10^{-6}		
				^{235}U	4.22×10^{-4}		
				^{236}U	1.81×10^{-6}		
				^{238}U	2.445×10^{-5}		
14	16.0	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{234}U	5.422×10^{-6}		
				^{235}U	5.053×10^{-4}		
				^{236}U	2.168×10^{-6}		
				^{238}U	2.928×10^{-5}		

Table A.6 (continued)

Region Number	Outside Radius (cm)	Location of Upper and Lower Region Boundaries Relative to Horizontal Midplane (cm)		Composition			
				Two-Dimensional Model		One-Dimensional Model	
		Upper	Lower	Element	Concentration (at./b·cm)	Element	Concentration (at./b·cm)
15	16.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{234}U	6.375×10^{-6}		
				^{235}U	5.941×10^{-4}		
				^{236}U	2.549×10^{-6}		
				^{238}U	3.442×10^{-5}		
16	17.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{234}U	7.24×10^{-6}		
				^{235}U	6.747×10^{-4}		
				^{236}U	2.894×10^{-6}		
				^{238}U	3.909×10^{-5}		
17	18.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{234}U	6.975×10^{-6}		
				^{235}U	6.50×10^{-4}		
				^{236}U	2.27×10^{-6}		
				^{238}U	3.066×10^{-5}		
18	19.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{234}U	5.678×10^{-6}		
				^{235}U	5.292×10^{-4}		
				^{236}U	2.27×10^{-6}		
				^{238}U	3.066×10^{-5}		
19	20.0	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{234}U	4.448×10^{-6}		
				^{235}U	4.145×10^{-4}		
				^{236}U	1.778×10^{-6}		
				^{238}U	2.402×10^{-5}		
20	20.5	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{234}U	3.634×10^{-6}		
				^{235}U	3.387×10^{-4}		
				^{236}U	1.453×10^{-6}		
				^{238}U	1.962×10^{-5}		
21	21.0	25.4	−25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
				^{234}U	2.895×10^{-6}		
				^{235}U	2.698×10^{-4}		
				^{236}U	1.157×10^{-6}		
				^{238}U	1.563×10^{-5}		

Table A.6 (continued)

Region Number	Outside Radius (cm)	Location of Upper and Lower Region Boundaries Relative to Horizontal Midplane (cm)		Composition			
				Two-Dimensional Model		One-Dimensional Model	
		Upper	Lower	Element	Concentration (at./b·cm)	Element	Concentration (at./b·cm)
22-I	22.8	Variable		H	2.067×10^{-2}	For regions 22-I through 24-O	
				O	1.033×10^{-2}		
				Al	4.237×10^{-2}		
23-I	22.8	Variable		H	2.067×10^{-2}		
				O	1.033×10^{-2}		
				Al	3.617×10^{-2}		
		(Length is 5 inches)		^{181}Ta	5.683×10^{-3}		
24-I	22.8	Variable		H	1.956×10^{-2}		
				O	9.78×10^{-3}		
				Al	4.337×10^{-2}	H	2.38×10^{-2}
				^{10}B	2.632×10^{-3}	O	1.19×10^{-2}
						Al	Variable
						^{181}Ta	Variable
22-O	24.15	Variable		H	2.783×10^{-2}		
				O	1.391×10^{-2}		
				Al	3.404×10^{-2}		
23-O	24.15	Variable		H	2.783×10^{-2}		
				O	1.391×10^{-2}		
				Al	2.601×10^{-2}		
		(Length is 5 inches)		^{181}Ta	7.708×10^{-3}		
24-O	24.15	Variable		H	2.645×10^{-2}		
				O	1.3225×10^{-2}		
				Al	3.528×10^{-2}		
				^{10}B	3.394×10^{-3}		
25	33.0	30.48	−30.48	H	3.28×10^{-3}	Same as two-dimensional model through region 27	
				O	1.64×10^{-4}		
				Al	5.52×10^{-4}		
				Be	1.167×10^{-1}		
26	54.0	30.48	−30.48	H	9.94×10^{-4}		
				O	4.97×10^{-4}		
				Al	5.6×10^{-4}		
				Be	1.208×10^{-1}		
				B.L.*	1.000×10^{0}		
27				H	6.666×10^{-2}		
				O	3.333×10^{-2}		
28	5.0	40.0	25.4	H	3.83×10^{-2}	Not applicable through region 31	
				O	1.92×10^{-2}		
				Al	2.36×10^{-2}		
29	12.6	30.48	25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
30	21.0	30.48	25.4	H	3.333×10^{-2}		
				O	1.667×10^{-2}		
				Al	3.01×10^{-2}		
31	21.0		30.48	H	6.666×10^{-2}		
				O	3.333×10^{-2}		

Appendix B

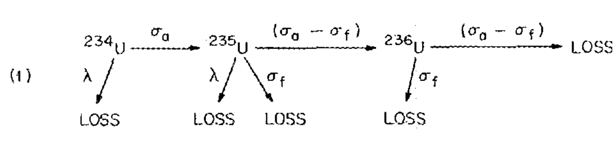
NUCLEAR CALCULATION TECHNIQUES

During the early phases of the HFIR design, many nuclear parameter studies were conducted, and most of the calculations were made with a two-group one-dimensional diffusion code. In order to assess the accuracy of a particular code prior to the time that HFIR critical experiment data became available, more sophisticated codes were used in a few cases, and Russian flux-trap criticals were also examined. All this work is discussed in detail in Ref. 5.

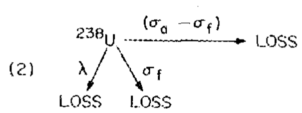
More recently MODRIC[36] and MODBURN[37] were adopted as the "work-horse" codes. They are multigroup one-dimensional diffusion codes, with MODBURN being the depletion version of MODRIC. Considerable emphasis was placed on the one-dimensional code because two-dimensional depletion calculations in sufficient space detail to account for nonuniform burnup were economically unattractive. As explained in Chapters 7 and 8, axial power distributions during a fuel cycle were estimated with the aid of critical-experiment data. Of course a few two-dimensional calculations were made, and in most of these cases EXTERMINATOR,[38] a multigroup diffusion code, was used. As discussed in Chapter 7 reasonably good results in terms of power distribution and neutron multiplication were achieved with these techniques.

B.1 Depletion and Fission-Product Chains in MODBURN

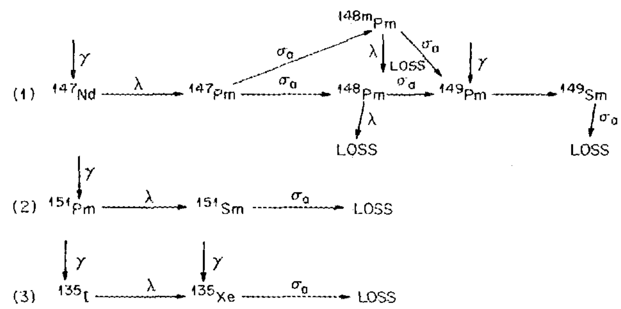
The model used for calculation of the HFIR fuel cycle included two fissile, four fission-product, and one burnable-poison chain. The fissile chains considered were



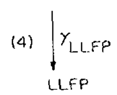
and



The fission-product chains considered were



and



where LLFP is long-lived fission products.

The burnable-poison chain used was

$$^{10}B \xrightarrow{\sigma_a} \text{Loss} .$$

Chain number 4 is for the nonsaturating fission products. One such atom was born per fission and was not destroyed.

B.2 Cross Sections

For the MODRIC and MODBURN calculations, 32 nonthermal and one thermal group of neutrons were used, with the thermal-group upper energy being 0.414 ev. The nonthermal group cross sections were calculated with GAM-I[39] and the thermal cross sections with THERMOS.[40] The axial buckling was determined from a calculation of an HFIR critical assembly with the rods out and with criticality maintained with soluble poison in the moderator. It was assumed that the axial buckling was independent of energy, radial position, and time in the fuel cycle.

When making the THERMOS calculations, the core geometric-region division was as shown in Fig. B.1. In this particular case the entire core was treated as a unit cell to make it possible to calculate the thermal spectrum and thus thermal cross sections as a function of radial position. For the GAM calculations a single

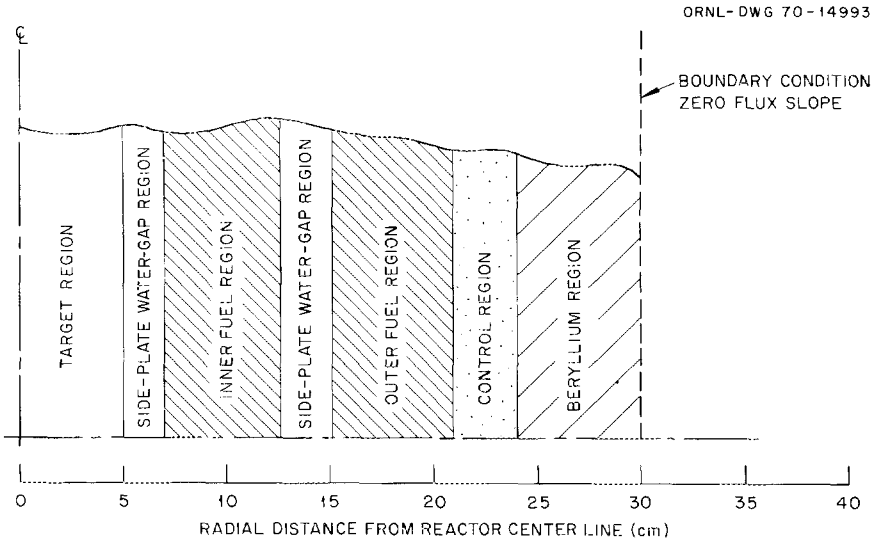


Fig. B.1. Core Geometric Region Division Used in THERMOS Calculations.

region (point calculation with provision for buckling addition) having the composition of the fuel annuli was used. Nonthermal cross sections for all regions were based on this spectrum. The fine-group structure used in GAM and the condensed group structure used in MODRIC and MODBURN are given in Table B.1.

The particular version of THERMOS used for the HFIR calculations provided 30 neutron groups, 25 space points, and 7 mixtures. The scattering models used were the Brown and St. John form of the free-gas kernel[41] for everything but water and the Nelkin[42] bound-proton scattering kernel for water.

When preparing cross sections for MODRIC it was assumed that the only microscopic cross sections that varied radially within a fuel annulus were those for ^{235}U, ^{10}B, and ^{135}Xe. Typical radial variations calculated with THERMOS are shown in Figs. B.2, B.3, and B.4. Thermal cross sections for the other materials were averaged over spectrums corresponding to each of the other regions and to each of the two fuel annuli.

The thermal-group transport cross sections for all material but water were obtained from

$$\sigma_{tr} = \sigma_s(1 - \bar{\mu}_0) + 0.2\sigma_a ,$$

where σ_s and σ_a are the scattering and absorption cross sections from THERMOS. For water it was found that much better agreement between calculated and measured power distributions was obtained if σ_{tr} was assumed equal to σ_s. Thus this deviation from the usual prescription was used in most of the calculations.

Input microscopic cross sections for the THERMOS calculations were taken from several sources. Most of the 1/v cross sections (H_2O, B, ^{236}U, ^{238}U, Al, Be, ^{181}Ta, ^{109}Ag) were obtained from Ref. 43; ^{147}Pm and ^{148}Pm were also assumed to be 1/v, and their cross sections were fabricated from data given in Ref. 44; ^{235}U cross sections were taken from Ref. 40, and the remaining non-1/v cross sections (^{234}U, ^{149}Sm, ^{151}Sm, ^{135}Xe) were obtained from Ref. 45. A cross section of 40 b was estimated for the lumped nonsaturating fission products, primarily on the basis of data given in Ref. 46.

Most of the cross sections used in the GAM-I calculation were those already in the GAM-I library.[47] These cross sections, as well as those used in THERMOS were reviewed and updated[48] several times by ORNL during the design and analysis of the HFIR. When revised cross-section compilations became available they were used. However, these revisions made little difference in the results of the reactor calculations.

In the course of these studies, five different sets of THERMOS cross sections and two sets of GAM cross sections were calculated. Four of the THERMOS and one of the GAM sets were for the room-temperature critical experiments, in which case different moderator soluble-poison concentrations required different thermal sets. The other THERMOS and GAM sets were calculated for a partially burned (9-day-old) core at 100 Mw. These cross sections were used for the fuel-cycle calculations without further consideration for variation in cross sections with time in the cycle.

Table B.1. Comparison of GAM-1 and Modric-Modburn Neutron-Energy Group Structure

Modric-Modburn Group	GAM-I Group	μ, Lethargy (Lower)	E, Energy (Lower) (ev)	Modric-Modburn Group	GAM-I Group	μ, Lethargy (Lower)	E, Energy (Lower) (ev)
1	1	0.25	7.79×10^6	17	37	9.25	961
	2	0.50	6.07×10^6		38	9.50	748
	3	0.75	4.72×10^6	18	39	9.75	583
	4	1.00	3.68×10^6		40	10.00	454
2	5	1.25	2.87×10^6	19	41	10.25	354
	6	1.50	2.23×10^6		42	10.50	275
	7	1.75	1.74×10^6	20	43	10.75	215
	8	2.00	1.35×10^6		44	11.00	167
3	9	2.25	1.05×10^6	21	45	11.25	130
	10	2.50	8.21×10^5		46	11.50	101
4	11	2.75	6.39×10^5	22	47	11.75	78.9
	12	3.00	4.98×10^5		48	12.00	61.4
5	13	3.25	3.88×10^5	23	49	12.25	47.9
	14	3.50	3.02×10^5		50	12.50	37.3
6	15	3.75	2.35×10^5	24	51	12.75	29.0
	16	4.00	1.83×10^5		52	13.00	22.6
7	17	4.25	1.43×10^5	25	53	13.25	17.6
	18	4.50	1.11×10^5		54	13.50	13.7
8	19	4.75	8.65×10^4	26	55	13.75	10.68
	20	5.00	6.74×10^4		56	14.00	8.32
9	21	5.25	5.25×10^4	27	57	14.25	6.48
	22	5.50	4.09×10^4		58	14.50	5.04
10	23	5.75	3.18×10^4	28	59	14.75	3.93
	24	6.00	2.48×10^4		60	15.00	3.06
11	25	6.25	1.93×10^4	29	61	15.25	2.38
	26	6.50	1.50×10^4		62	15.50	1.86
12	27	6.75	1.17×10^4	30	63	15.75	1.44
	28	7.00	9.12×10^3		64	16.00	1.125
13	29	7.25	7.10×10^3	31	65	16.25	0.876
	30	7.50	5.53×10^3		66	16.50	0.683
14	31	7.75	4.31×10^3	32	67	16.75	0.532
	32	8.00	3.36×10^3		68	17.00	0.414
15	33	8.25	2.61×10^3	33	Thermal Group		
	34	8.50	2.04×10^3				
16	35	8.75	1.59×10^3				
	36	9.00	1.23×10^3				

The two-dimensional calculations were made with four groups of neutrons, and the cross sections were generated with cylindrical and slab MODRIC calculations. No attempt was made to obtain appropriate self-shielding factors for the black portion of the control rods that extended into the core region. This apparently accounts for the relatively poor agreement between calculated and measured power distributions near the control rods, particularly in the core outer corners.

Self shielding of the fuel and burnable poison in the fuel plates was investigated early in the studies with SWAPS,[49] a one-dimensional slab-geometry transport code. The results of these calculations for the thickest section of fuel are shown in Fig. B.5. As indicated the moderator average flux is only 5% greater than the fuel average flux. Everywhere else along the length of the involute plates the ratio is even smaller because of the thinner sections of fuel. Thus the self shielding in the fuel plates was neglected.

B.3 Temperature-Coefficient Calculations

Early attempts to calculate the temperature coefficients are discussed in Ref. 5. Because of difficulties in obtaining consistent sets of data on microscopic cross section versus energy the results of the calculations left much to be desired. For this reason the emphasis was placed on measuring the coefficients in the HFIR critical experiments. The most recent data on cross

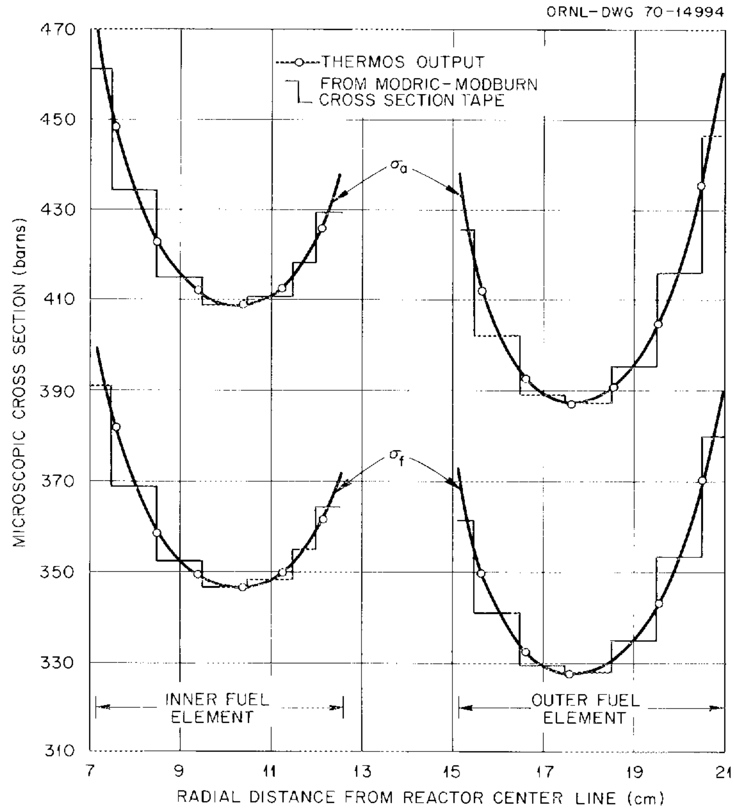


Fig. B.2. ^{235}U Microscopic Thermal-Group Absorption and Fission Cross Sections in the HFIR.

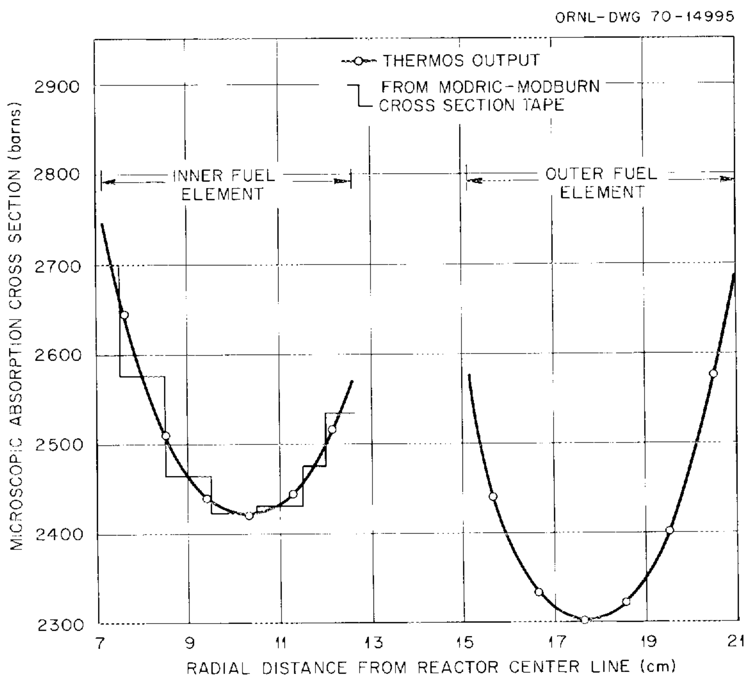


Fig. B.3. ^{10}B Microscopic Thermal-Group Absorption Cross Sections in HFIR.

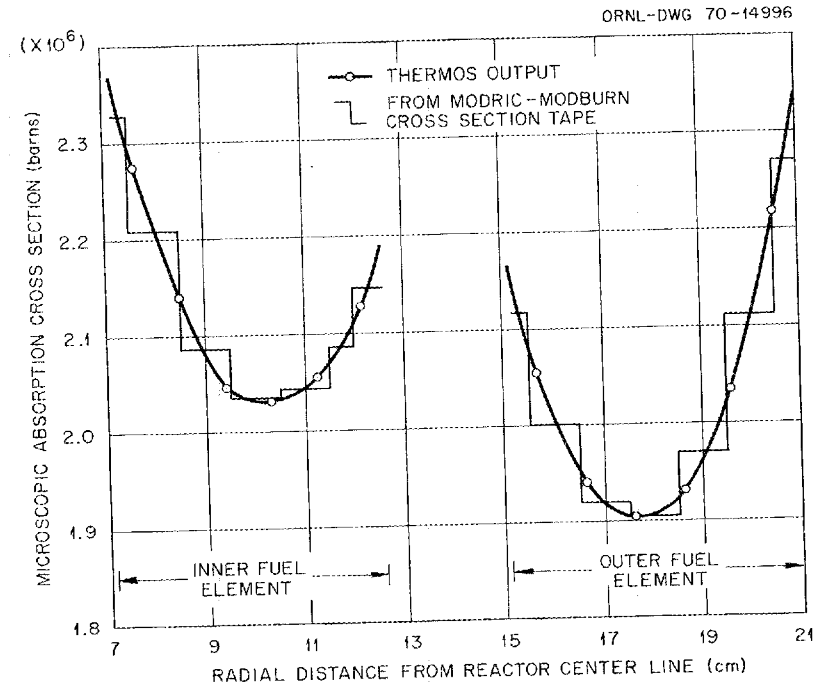


Fig. B.4. ^{135}**Xe Microscopic Thermal-Group Absorption Cross Sections in HFIR.**

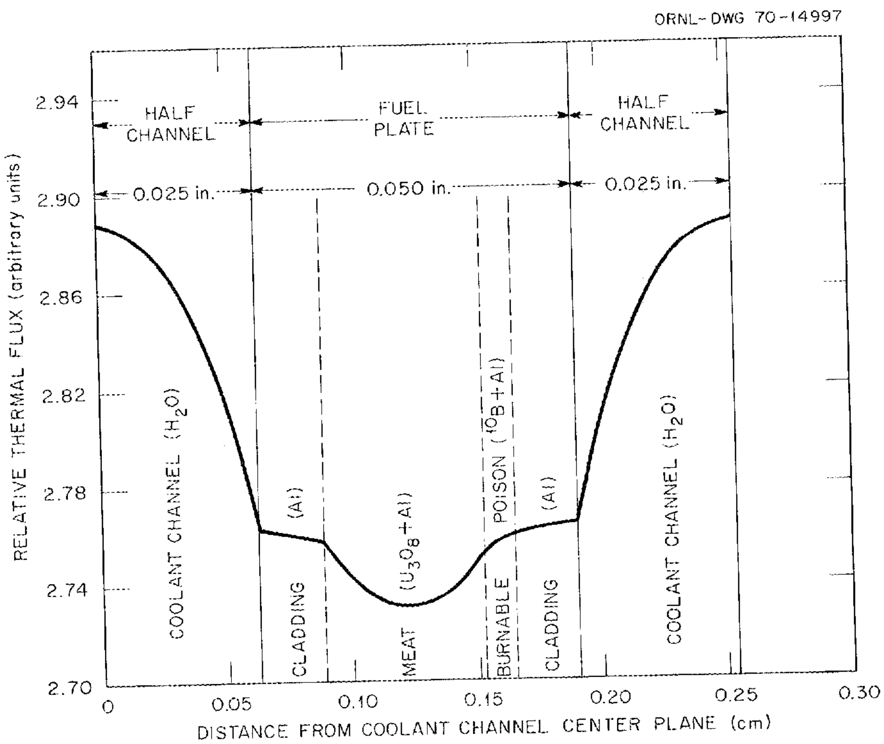


Fig. B.5. Thermal-Flux Variation in Fuel-Plate Coolant-Channel Cell.

sections would probably facilitate a more accurate calculational estimate, but this has not as yet been attempted.

B.4 Prompt-Neutron Lifetime and Effective Delayed-Neutron Fraction Calculations

As discussed in Ref. 5, both the period method and first-order perturbation theory were used to calculate the prompt-neutron lifetime. Values were also obtained from the critical experiments by using the pulsed-neutron technique. Under appropriate conditions the slope of the decay curve after pulsing a critical assembly is equal to β_{eff}/ℓ. The effective delayed-neutron fraction, β_{eff}, was calculated by the method proposed by Kaplan and Henry.[50] Agreement between calculated and "measured" prompt-neutron lifetime was satisfactory.

Appendix C

SPACE-, TIME-, AND ENERGY-DEPENDENT FLUXES FROM ONE-DIMENSIONAL 33-GROUP DIFFUSION-THEORY CALCULATIONS

An attempt was made in Chapter 5 to provide most of the neutron flux information of interest to prospective users of the reactor but, recognizing that users may desire flux information in even greater detail than is presented there, the computer output fluxes from the one-dimensional 33-group diffusion-theory calculations for several times in the fuel cycle are given in Tables C.3 through C.6,* which follow Tables C.1 and C.2, which give the radial locations of the mesh points shown in Tables C.3 through C.6 (Table C.1) and the neutron-group structure applicable to Tables C.3 through C.6 (Table C.2).

*In all these calculations the flux trap contained the standard transplutonium target bundle containing 300 g ^{242}Pu. As discussed in Chapter 5, flux levels in the flux trap are influenced by its content.

Table C.1. Mesh Point Locations for Tables C.3 Through C.6

Region Number	Region Description	Region Boundary Mesh Points		Radial Location of Region Boundary Mesh Points Relative to Reactor Vertical Center Line (cm)		Region Thickness (cm)	Distance Between Mesh Points Within Region (cm)
		Inner	Outer	Inner	Outer		
1	Target	1	11	0	5.0	5.0	0.5
2	Water gap	12	16	5.0	6.4	1.4	0.35
3	Side plate	17	21	6.4	7.14	0.74	0.185
4	Fuel	22	26	7.14	7.5	0.36	0.09
5	Fuel	27	31	7.5	8.0	0.5	0.125
6	Fuel	32	36	8.0	8.5	0.5	0.125
7	Fuel	37	41	8.5	9.5	1.0	0.25
8	Fuel	42	46	9.5	10.5	1.0	0.25
9	Fuel	47	51	10.5	11.5	1.0	0.25
10	Fuel	52	56	11.5	12.0	0.5	0.125
11	Fuel	57	61	12.0	12.6	0.6	0.15
12	Water-gap side-plate region	62	74	12.6	15.5	2.55	0.2125
13	Fuel	75	79	15.15	16.0	0.35	0.0875
14	Fuel	80	84	15.5	16.0	0.5	0.125
15	Fuel	85	89	16.0	16.5	0.5	0.125
16	Fuel	90	94	16.5	17.5	1.0	0.250
17	Fuel	95	99	17.5	18.5	1.0	0.250
18	Fuel	100	104	18.5	19.5	1.0	0.250
19	Fuel	105	109	19.5	20.0	0.5	0.125
20	Fuel	110	114	20.0	20.5	0.5	0.125
21	Fuel	115	119	20.5	21.0	0.5	0.125
22	Control	120	135	21.0	24.15	3.15	0.21
23	Be reflector	136	151	24.15	33.0	8.85	0.59
24	Be reflector	152	173	33.0	54.0	21.0	1.0
25	Water	174	180	54.0	60.0	6.0	1.0

Table C.2. Neutron Group Structure Applicable to Tables C.3 Through C.6

g, Neutron Group	Lower Energy Boundary (ev)
1	3.68×10^6
2	1.35×10^6
3	8.21×10^5
4	4.98×10^5
5	3.02×10^5
6	1.83×10^5
7	1.11×10^5
8	6.74×10^4
9	4.09×10^4
10	2.48×10^4
11	1.50×10^4
12	9.12×10^3
13	5.53×10^3
14	3.36×10^3
15	2.04×10^3
16	1.23×10^3
17	748
18	454
19	275
20	167
21	101
22	61.4
23	37.3
24	22.6
25	13.7
26	8.32
27	5.04
28	3.06
29	1.86
30	1.125
31	0.683
32	0.414
33 (thermal group)	

Conversion of the computer output group fluxes to absolute group flux per unit power (i.e., neutrons/cm^2·sec·Mw) can be made as follows:

1. For the reactor horizontal midplane,

$$\left.\frac{\phi_{HMP}(r)}{p}\right]_{g=1,2,\text{ or }33} = 1.92 \times 10^{12} \times \phi(r)_{comp}\Big]_{g=1,2,\text{ or }33}$$

and

$$\left.\frac{\phi_{HMP}(r)}{p}\right]_{g=3,4,\ldots,31\text{ or }32} = 0.96 \times 10^{12} \times \phi(r)_{comp}\Big]_{g=3,4,\ldots31,\text{ or }32},$$

where

$\left.\frac{\phi_{HMP}(r)}{p}\right]_g$ = group g neutron flux per unit power at the horizontal midplane at a radial distance r from the reactor vertical center line in neutrons/cm^2·sec·Mw,

$\phi(r)_{comp}\Big]_g$ = group g computer output flux from Tables C.3 through C.6.

2. For axially averaged flux values,

$$\left.\frac{\phi_{\bar{z}}(r)}{p}\right]_{g=1,2,\text{ or }33} = 1.5 \times 10^{12} \times \phi(r)_{comp}\Big]_{g=1,2,\text{ or }33}$$

and

$$\left.\frac{\phi_{\bar{z}}(r)}{p}\right]_{g=3,4,\ldots31,\text{ or }32} = 0.75 \times 10^{12} \times \phi(r)_{comp}\Big]_{g=3,4,\ldots31,\text{ or }32},$$

where

$\left.\frac{\phi_{\bar{z}}(r)}{p}\right]_g$ = group g axially averaged (over the length of the fuel core, 20 in.) neutron flux per unit power at a radial distance r from the reactor vertical center line in neutrons/cm^2·sec·Mw.

GROUP FLUXES

Table C.3. HFIR 33-Group Fluxes, 0 Mwd

R. NO.	GROUPS 1- 9								
1	5.73007E-01	2.14107E 00	1.91341E 00	1.83941E 00	1.29359E 00	1.13792E 00	9.03331E-01	7.72586E-01	7.08834E-01
2	5.74065E-01	2.14575E 00	1.91807E 00	1.84347E 00	1.29639E 00	1.14023E 00	9.05133E-01	7.74072E-01	7.10101E-01
3	5.77244E-01	2.15983E 00	1.93210E 00	1.85565E 00	1.30481E 00	1.14715E 00	9.10542E-01	7.78532E-01	7.13899E-01
4	5.82562E-01	2.18339E 00	1.95561E 00	1.87602E 00	1.31889E 00	1.15871E 00	9.19572E-01	7.85966E-01	7.20208E-01
5	5.90049E-01	2.21661E 00	1.98880E 00	1.90471E 00	1.33871E 00	1.17493E 00	9.32243E-01	7.96375E-01	7.28999E-01
6	5.99745E-01	2.25970E 00	2.03197E 00	1.94187E 00	1.36437E 00	1.19585E 00	9.48584E-01	8.09758E-01	7.40219E-01
7	6.11705E-01	2.31296E 00	2.08548E 00	1.98770E 00	1.39602E 00	1.22152E 00	9.68626E-01	8.26106E-01	7.53793E-01
8	6.25995E-01	2.37675E 00	2.14980E 00	2.04247E 00	1.43380E 00	1.25198E 00	9.92407E-01	8.45400E-01	7.69610E-01
9	6.42695E-01	2.45149E 00	2.22549E 00	2.10646E 00	1.47793E 00	1.28728E 00	1.01996E 00	8.67605E-01	7.87511E-01
10	6.61897E-01	2.53770E 00	2.31323E 00	2.18001E 00	1.52861E 00	1.32745E 00	1.05132E 00	8.92660E-01	8.07275E-01
11	6.83709E-01	2.63597E 00	2.41379E 00	2.26351E 00	1.58611E 00	1.37252E 00	1.08650E 00	9.20467E-01	8.28591E-01
12	6.83709E-01	2.63597E 00	2.41379E 00	2.26351E 00	1.58611E 00	1.37252E 00	1.08650E 00	9.20467E-01	8.28591E-01
13	7.03613E-01	2.72980E 00	2.51862E 00	2.34671E 00	1.64397E 00	1.41671E 00	1.11427E 00	9.42396E-01	8.52449E-01
14	7.25819E-01	2.83895E 00	2.64432E 00	2.44633E 00	1.71342E 00	1.46882E 00	1.14606E 00	9.67547E-01	8.80046E-01
15	7.50382E-01	2.96380E 00	2.79179E 00	2.56251E 00	1.79456E 00	1.52854E 00	1.18116E 00	9.95325E-01	9.11514E-01
16	7.77378E-01	3.10486E 00	2.96232E 00	2.69558E 00	1.88766E 00	1.59553E 00	1.21871E 00	1.02503E 00	9.47080E-01
17	7.77378E-01	3.10486E 00	2.96232E 00	2.69558E 00	1.88766E 00	1.59553E 00	1.21871E 00	1.02503E 00	9.47080E-01
18	7.88865E-01	3.16259E 00	3.02187E 00	2.74662E 00	1.92261E 00	1.62099E 00	1.24024E 00	1.04186E 00	9.55287E-01
19	8.00580E-01	3.22020E 00	3.08073E 00	2.79654E 00	1.95677E 00	1.64575E 00	1.26125E 00	1.05814E 00	9.63226E-01
20	8.12533E-01	3.27778E 00	3.13896E 00	2.84540E 00	1.99017E 00	1.66984E 00	1.28178E 00	1.07388E 00	9.70886E-01
21	8.24735E-01	3.33539E 00	3.19666E 00	2.89327E 00	2.02287E 00	1.69329E 00	1.30184E 00	1.08912E 00	9.78258E-01
22	8.24735E-01	3.33539E 00	3.19666E 00	2.89327E 00	2.02287E 00	1.69329E 00	1.30184E 00	1.08912E 00	9.78258E-01
23	8.31415E-01	3.36728E 00	3.23095E 00	2.92022E 00	2.04147E 00	1.70646E 00	1.31127E 00	1.09627E 00	9.83694E-01
24	8.37791E-01	3.39777E 00	3.26373E 00	2.94608E 00	2.05932E 00	1.71917E 00	1.32039E 00	1.10321E 00	9.89006E-01
25	8.43887E-01	3.42698E 00	3.29513E 00	2.97093E 00	2.07647E 00	1.73145E 00	1.32922E 00	1.10996E 00	9.94193E-01
26	8.49726E-01	3.45502E 00	3.32525E 00	2.99484E 00	2.09299E 00	1.74332E 00	1.33778E 00	1.11653E 00	9.99256E-01
27	8.49726E-01	3.45502E 00	3.32525E 00	2.99484E 00	2.09299E 00	1.74332E 00	1.33778E 00	1.11653E 00	9.99256E-01
28	8.57399E-01	3.49198E 00	3.36493E 00	3.02649E 00	2.11485E 00	1.75913E 00	1.34921E 00	1.12532E 00	1.00609E 00
29	8.64566E-01	3.52663E 00	3.40213E 00	3.05630E 00	2.13546E 00	1.77414E 00	1.36009E 00	1.13374E 00	1.01266E 00
30	8.71282E-01	3.55922E 00	3.43711E 00	3.08447E 00	2.15493E 00	1.78840E 00	1.37047E 00	1.14180E 00	1.01899E 00
31	8.77594E-01	3.58998E 00	3.47013E 00	3.11116E 00	2.17339E 00	1.80198E 00	1.38036E 00	1.14950E 00	1.02507E 00
32	8.77594E-01	3.58998E 00	3.47013E 00	3.11116E 00	2.17339E 00	1.80198E 00	1.38036E 00	1.14950E 00	1.02507E 00
33	8.83488E-01	3.61885E 00	3.50112E 00	3.13631E 00	2.19080E 00	1.81486E 00	1.38977E 00	1.15685E 00	1.03090E 00
34	8.88934E-01	3.64569E 00	3.52994E 00	3.15984E 00	2.20709E 00	1.82700E 00	1.39866E 00	1.16383E 00	1.03648E 00
35	8.93976E-01	3.67070E 00	3.55681E 00	3.18189E 00	2.22236E 00	1.83844E 00	1.40707E 00	1.17045E 00	1.04179E 00
36	8.98653E-01	3.69405E 00	3.58194E 00	3.20259E 00	2.23671E 00	1.84924E 00	1.41501E 00	1.17673E 00	1.04684E 00
37	8.98653E-01	3.69405E 00	3.58194E 00	3.20259E 00	2.23671E 00	1.84924E 00	1.41501E 00	1.17673E 00	1.04684E 00
38	9.06775E-01	3.73524E 00	3.62628E 00	3.23951E 00	2.26234E 00	1.86874E 00	1.42944E 00	1.18821E 00	1.05618E 00
39	9.13342E-01	3.76943E 00	3.66322E 00	3.27076E 00	2.28406E 00	1.88555E 00	1.44197E 00	1.19828E 00	1.06447E 00
40	9.18586E-01	3.79768E 00	3.69394E 00	3.29714E 00	2.30243E 00	1.89995E 00	1.45275E 00	1.20701E 00	1.07174E 00
41	9.22691E-01	3.82085E 00	3.71936E 00	3.31927E 00	2.31788E 00	1.91219E 00	1.46195E 00	1.21451E 00	1.07804E 00

42	9.22691E-01	3.82085E 00	3.71936E 00	3.31927E 00	2.31788E 00	1.91219E 00	1.46195E 00	1.21451E 00	1.07804E 00
43	9.25588E-01	3.83866E 00	3.73917E 00	3.33697E 00	2.33027E 00	1.92221E 00	1.46954E 00	1.22077E 00	1.08337E 00
44	9.27181E-01	3.85067E 00	3.75294E 00	3.34995E 00	2.33942E 00	1.92990E 00	1.47545E 00	1.22575E 00	1.08771E 00
45	9.27572E-01	3.85736E 00	3.76117E 00	3.35856E 00	2.34556E 00	1.93541E 00	1.47979E 00	1.22953E 00	1.09112E 00
46	9.26829E-01	3.85904E 00	3.76421E 00	3.36307E 00	2.34888E 00	1.93886E 00	1.48262E 00	1.23216E 00	1.09362E 00
47	9.26829E-01	3.85905E 00	3.76421E 00	3.36307E 00	2.34888E 00	1.93886E 00	1.48262E 00	1.23216E 00	1.09362E 00
48	9.24963E-01	3.85579E 00	3.76215E 00	3.36356E 00	2.34943E 00	1.94030E 00	1.48401E 00	1.23367E 00	1.09525E 00
49	9.21963E-01	3.84756E 00	3.75493E 00	3.36001E 00	2.34720E 00	1.93976E 00	1.48396E 00	1.23411E 00	1.09603E 00
50	9.17811E-01	3.83427E 00	3.74246E 00	3.35241E 00	2.34219E 00	1.93725E 00	1.48250E 00	1.23350E 00	1.09600E 00
51	9.12460E-01	3.81572E 00	3.72454E 00	3.34066E 00	2.33431E 00	1.93277E 00	1.47966E 00	1.23187E 00	1.09520E 00
52	9.12460E-01	3.81572E 00	3.72454E 00	3.34066E 00	2.33431E 00	1.93277E 00	1.47966E 00	1.23187E 00	1.09520E 00
53	9.09335E-01	3.80449E 00	3.71353E 00	3.33323E 00	2.32932E 00	1.92981E 00	1.47773E 00	1.23070E 00	1.09453E 00
54	9.05931E-01	3.79203E 00	3.70126E 00	3.32485E 00	2.32366E 00	1.92641E 00	1.47549E 00	1.22930E 00	1.09368E 00
55	9.02233E-01	3.77829E 00	3.68765E 00	3.31547E 00	2.31732E 00	1.92255E 00	1.47293E 00	1.22767E 00	1.09267E 00
56	8.98226E-01	3.76320E 00	3.67263E 00	3.30504E 00	2.31027E 00	1.91822E 00	1.47006E 00	1.22582E 00	1.09150E 00
57	8.98226E-01	3.76320E 00	3.67263E 00	3.30504E 00	2.31027E 00	1.91822E 00	1.47006E 00	1.22582E 00	1.09150E 00
58	8.93039E-01	3.74344E 00	3.65288E 00	3.29125E 00	2.30093E 00	1.91246E 00	1.46621E 00	1.22334E 00	1.08989E 00
59	8.87444E-01	3.72190E 00	3.63128E 00	3.27611E 00	2.29066E 00	1.90610E 00	1.46196E 00	1.22058E 00	1.08808E 00
60	8.81401E-01	3.69841E 00	3.60763E 00	3.25949E 00	2.27938E 00	1.89911E 00	1.45728E 00	1.21754E 00	1.08607E 00
61	8.74866E-01	3.67276E 00	3.58172E 00	3.24125E 00	2.26700E 00	1.89145E 00	1.45216E 00	1.21422E 00	1.08388E 00
62	8.74866E-01	3.67276E 00	3.58172E 00	3.24125E 00	2.26700E 00	1.89145E 00	1.45216E 00	1.21422E 00	1.08388E 00
63	8.66239E-01	3.63914E 00	3.54831E 00	3.21724E 00	2.25074E 00	1.88124E 00	1.44498E 00	1.20949E 00	1.08098E 00
64	8.58775E-01	3.61037E 00	3.51996E 00	3.19642E 00	2.23665E 00	1.87211E 00	1.43844E 00	1.20502E 00	1.07805E 00
65	8.52442E-01	3.58635E 00	3.49653E 00	3.17872E 00	2.22469E 00	1.86403E 00	1.43257E 00	1.20082E 00	1.07511E 00
66	8.47214E-01	3.56695E 00	3.47792E 00	3.16410E 00	2.21483E 00	1.85702E 00	1.42735E 00	1.19691E 00	1.07219E 00
67	8.43066E-01	3.55207E 00	3.46401E 00	3.15248E 00	2.20702E 00	1.85106E 00	1.42279E 00	1.19330E 00	1.06930E 00
68	8.39975E-01	3.54163E 00	3.45473E 00	3.14382E 00	2.20124E 00	1.84614E 00	1.41888E 00	1.18999E 00	1.06644E 00
69	8.37920E-01	3.53554E 00	3.44997E 00	3.13806E 00	2.19743E 00	1.84222E 00	1.41560E 00	1.18696E 00	1.06361E 00
70	8.36884E-01	3.53373E 00	3.44968E 00	3.13515E 00	2.19558E 00	1.83931E 00	1.41293E 00	1.18421E 00	1.06081E 00
71	8.36849E-01	3.53614E 00	3.45379E 00	3.13503E 00	2.19564E 00	1.83736E 00	1.41085E 00	1.18172E 00	1.05802E 00
72	8.37801E-01	3.54270E 00	3.46224E 00	3.13766E 00	2.19759E 00	1.83634E 00	1.40934E 00	1.17946E 00	1.05523E 00
73	8.39726E-01	3.55336E 00	3.47498E 00	3.14298E 00	2.20139E 00	1.83622E 00	1.40837E 00	1.17740E 00	1.05241E 00
74	8.42615E-01	3.56809E 00	3.49198E 00	3.15095E 00	2.20701E 00	1.83696E 00	1.40790E 00	1.17550E 00	1.04954E 00
75	8.42615E-01	3.56809E 00	3.49198E 00	3.15095E 00	2.20701E 00	1.83696E 00	1.40790E 00	1.17550E 00	1.04954E 00
76	8.43943E-01	3.57483E 00	3.49985E 00	3.15460E 00	2.20960E 00	1.83730E 00	1.40770E 00	1.17467E 00	1.04816E 00
77	8.45042E-01	3.58058E 00	3.50668E 00	3.15752E 00	2.21169E 00	1.83736E 00	1.40730E 00	1.17373E 00	1.04670E 00
78	8.45928E-01	3.58541E 00	3.51255E 00	3.15976E 00	2.21332E 00	1.83713E 00	1.40672E 00	1.17267E 00	1.04517E 00
79	8.46616E-01	3.58939E 00	3.51754E 00	3.16136E 00	2.21452E 00	1.83664E 00	1.40597E 00	1.17149E 00	1.04357E 00
80	8.46616E-01	3.58939E 00	3.51754E 00	3.16136E 00	2.21452E 00	1.83664E 00	1.40597E 00	1.17149E 00	1.04357E 00
81	8.47226E-01	3.59347E 00	3.52298E 00	3.16246E 00	2.21543E 00	1.83544E 00	1.40455E 00	1.16959E 00	1.04115E 00
82	8.47394E-01	3.59566E 00	3.52644E 00	3.16213E 00	2.21538E 00	1.83364E 00	1.40274E 00	1.16743E 00	1.03855E 00
83	8.47159E-01	3.59611E 00	3.52809E 00	3.16051E 00	2.21445E 00	1.83128E 00	1.40054E 00	1.16501E 00	1.03580E 00
84	8.46555E-01	3.59498E 00	3.52812E 00	3.15768E 00	2.21272E 00	1.82841E 00	1.39799E 00	1.16235E 00	1.03287E 00
85	8.46555E-01	3.59498E 00	3.52812E 00	3.15768E 00	2.21272E 00	1.82841E 00	1.39799E 00	1.16235E 00	1.03287E 00
86	8.45549E-01	3.59213E 00	3.52637E 00	3.15356E 00	2.21011E 00	1.82496E 00	1.39504E 00	1.15941E 00	1.02976E 00
87	8.44114E-01	3.58744E 00	3.52269E 00	3.14803E 00	2.20656E 00	1.82090E 00	1.39168E 00	1.15620E 00	1.02646E 00

88	8.42282E-01	3.58104E 00	3.51725E 00	3.14121E 00	2.20213E 00	1.81628E 00	1.38793E 00	1.15271E 00	1.02298E 00
89	8.40079E-01	3.57307E 00	3.51017E 00	3.13317E 00	2.19689E 00	1.81111E 00	1.38381E 00	1.14896E 00	1.01932E 00
90	8.40079E-01	3.57307E 00	3.51017E 00	3.13317E 00	2.19689E 00	1.81111E 00	1.38381E 00	1.14896E 00	1.01932E 00
91	8.34474E-01	3.55196E 00	3.49069E 00	3.11316E 00	2.18377E 00	1.79903E 00	1.37435E 00	1.14061E 00	1.01140E 00
92	8.27358E-01	3.52440E 00	3.46453E 00	3.08819E 00	2.16733E 00	1.78473E 00	1.36337E 00	1.13117E 00	1.00273E 00
93	8.18853E-01	3.49093E 00	3.43228E 00	3.05866E 00	2.14785E 00	1.76835E 00	1.35094E 00	1.12070E 00	9.93321E-01
94	8.09038E-01	3.45189E 00	3.39432E 00	3.02481E 00	2.12552E 00	1.75002E 00	1.33715E 00	1.10922E 00	9.83200E-01
95	8.09038E-01	3.45189E 00	3.39432E 00	3.02481E 00	2.12552E 00	1.75002E 00	1.33715E 00	1.10922E 00	9.83200E-01
96	7.98031E-01	3.40783E 00	3.35119E 00	2.98705E 00	2.10062E 00	1.72989E 00	1.32210E 00	1.09682E 00	9.72412E-01
97	7.85894E-01	3.35902E 00	3.30321E 00	2.94560E 00	2.07331E 00	1.70807E 00	1.30586E 00	1.08353E 00	9.60976E-01
98	7.72605E-01	3.30534E 00	3.25025E 00	2.90038E 00	2.04356E 00	1.68455E 00	1.28845E 00	1.06938E 00	9.48919E-01
99	7.58110E-01	3.24657E 00	3.19205E 00	2.85125E 00	2.01130E 00	1.65932E 00	1.26988E 00	1.05438E 00	9.36269E-01
100	7.58110E-01	3.24657E 00	3.19205E 00	2.85125E 00	2.01130E 00	1.65932E 00	1.26988E 00	1.05438E 00	9.36269E-01
101	7.42638E-01	3.18374E 00	3.12963E 00	2.79897E 00	1.97706E 00	1.63274E 00	1.25039E 00	1.03870E 00	9.23160E-01
102	7.26286E-01	3.11727E 00	3.06352E 00	2.74389E 00	1.94111E 00	1.60494E 00	1.23007E 00	1.02239E 00	9.09597E-01
103	7.08937E-01	3.04662E 00	2.99313E 00	2.68567E 00	1.90323E 00	1.57585E 00	1.20890E 00	1.00545E 00	8.95614E-01
104	6.90455E-01	2.97119E 00	2.91778E 00	2.62388E 00	1.86316E 00	1.54536E 00	1.18684E 00	9.87905E-01	8.81249E-01
105	6.90455E-01	2.97119E 00	2.91778E 00	2.62388E 00	1.86316E 00	1.54536E 00	1.18684E 00	9.87905E-01	8.81249E-01
106	6.80827E-01	2.93187E 00	2.87839E 00	2.59178E 00	1.84241E 00	1.52967E 00	1.17555E 00	9.78961E-01	8.73984E-01
107	6.70984E-01	2.89165E 00	2.83807E 00	2.55903E 00	1.82128E 00	1.51375E 00	1.16412E 00	9.69914E-01	8.66659E-01
108	6.60904E-01	2.85044E 00	2.79674E 00	2.52556E 00	1.79974E 00	1.49758E 00	1.15254E 00	9.60766E-01	8.59279E-01
109	6.50565E-01	2.80814E 00	2.75427E 00	2.49130E 00	1.77774E 00	1.48113E 00	1.14080E 00	9.51518E-01	8.51852E-01
110	6.50565E-01	2.80814E 00	2.75427E 00	2.49130E 00	1.77774E 00	1.48113E 00	1.14080E 00	9.51518E-01	8.51852E-01
111	6.40028E-01	2.76503E 00	2.71093E 00	2.45646E 00	1.75543E 00	1.46451E 00	1.12898E 00	9.42219E-01	8.44416E-01
112	6.29306E-01	2.72117E 00	2.66681E 00	2.42109E 00	1.73284E 00	1.44774E 00	1.11708E 00	9.32868E-01	8.36965E-01
113	6.18376E-01	2.67644E 00	2.62180E 00	2.38512E 00	1.70994E 00	1.43078E 00	1.10510E 00	9.23469E-01	8.29505E-01
114	6.07216E-01	2.63075E 00	2.57577E 00	2.34848E 00	1.68668E 00	1.41364E 00	1.09303E 00	9.14024E-01	8.22045E-01
115	6.07216E-01	2.63075E 00	2.57577E 00	2.34848E 00	1.68668E 00	1.41364E 00	1.09303E 00	9.14024E-01	8.22045E-01
116	5.95872E-01	2.58431E 00	2.52894E 00	2.31133E 00	1.66318E 00	1.39639E 00	1.08094E 00	9.04576E-01	8.14620E-01
117	5.84343E-01	2.53712E 00	2.48131E 00	2.27367E 00	1.63944E 00	1.37903E 00	1.06882E 00	8.95123E-01	8.07226E-01
118	5.72607E-01	2.48906E 00	2.43278E 00	2.23544E 00	1.61542E 00	1.36154E 00	1.05667E 00	8.85670E-01	7.99869E-01
119	5.60639E-01	2.44003E 00	2.38322E 00	2.19657E 00	1.59109E 00	1.34392E 00	1.04449E 00	8.76221E-01	7.92561E-01
120	5.60639E-01	2.44003E 00	2.38322E 00	2.19657E 00	1.59109E 00	1.34392E 00	1.04449E 00	8.76221E-01	7.92561E-01
121	5.40101E-01	2.35857E 00	2.30450E 00	2.13380E 00	1.55257E 00	1.31589E 00	1.02387E 00	8.60216E-01	7.82074E-01
122	5.20404E-01	2.28051E 00	2.22907E 00	2.07328E 00	1.51581E 00	1.28888E 00	1.00409E 00	8.44668E-01	7.71845E-01
123	5.01514E-01	2.20571E 00	2.15682E 00	2.01494E 00	1.48081E 00	1.26291E 00	9.85165E-01	8.29605E-01	7.61925E-01
124	4.83400E-01	2.13406E 00	2.08762E 00	1.95876E 00	1.44756E 00	1.23800E 00	9.67118E-01	8.15051E-01	7.52360E-01
125	4.66032E-01	2.06544E 00	2.02138E 00	1.90466E 00	1.41606E 00	1.21416E 00	9.49968E-01	8.01025E-01	7.43195E-01
126	4.49379E-01	1.99975E 00	1.95799E 00	1.85262E 00	1.38630E 00	1.19141E 00	9.33736E-01	7.87545E-01	7.34473E-01
127	4.33415E-01	1.93688E 00	1.89735E 00	1.80259E 00	1.35828E 00	1.16975E 00	9.18442E-01	7.74625E-01	7.26233E-01
128	4.18112E-01	1.87673E 00	1.83935E 00	1.75451E 00	1.33201E 00	1.14920E 00	9.04105E-01	7.62277E-01	7.18514E-01
129	4.03444E-01	1.81920E 00	1.78392E 00	1.70835E 00	1.30749E 00	1.12976E 00	8.90745E-01	7.50508E-01	7.11353E-01
130	3.89388E-01	1.76421E 00	1.73097E 00	1.66406E 00	1.28472E 00	1.11144E 00	8.78383E-01	7.39325E-01	7.04787E-01
131	3.75920E-01	1.71167E 00	1.68040E 00	1.62160E 00	1.26372E 00	1.09426E 00	8.67042E-01	7.28730E-01	6.98850E-01
132	3.63018E-01	1.66149E 00	1.63215E 00	1.58094E 00	1.24450E 00	1.07821E 00	8.56743E-01	7.18723E-01	6.93579E-01
133	3.50660E-01	1.61360E 00	1.58614E 00	1.54203E 00	1.22708E 00	1.06330E 00	8.47512E-01	7.09302E-01	6.89008E-01

134	3.38826E-01	1.56792E 00	1.54229E 00	1.50483E 00	1.21148E 00	1.04954E 00	8.39375E-01	7.00462E-01	6.85173E-01
135	3.27496E-01	1.52439E 00	1.50055E 00	1.46931E 00	1.19773E 00	1.03694E 00	8.32359E-01	6.92193E-01	6.82110E-01

136	3.27496E-01	1.52439E 00	1.50055E 00	1.46931E 00	1.19773E 00	1.03694E 00	8.32359E-01	6.92193E-01	6.82111E-01
137	2.86523E-01	1.36669E 00	1.33364E 00	1.29148E 00	1.11859E 00	9.68084E-01	7.94271E-01	6.51432E-01	6.58012E-01
138	2.50800E-01	1.22506E 00	1.18625E 00	1.13763E 00	1.03145E 00	8.98172E-01	7.49399E-01	6.11166E-01	6.27143E-01
139	2.19633E-01	1.09788E 00	1.05589E 00	1.00404E 00	9.42499E-01	8.28338E-01	7.00663E-01	5.70871E-01	5.92232E-01
140	1.92425E-01	9.83703E-01	9.40423E-01	8.87626E-01	8.55586E-01	7.59811E-01	6.50216E-01	5.30663E-01	5.55107E-01
141	1.68660E-01	8.81226E-01	8.38025E-01	7.85866E-01	7.72984E-01	6.93662E-01	5.99654E-01	4.90929E-01	5.17060E-01
142	1.47888E-01	7.89264E-01	7.47110E-01	6.96666E-01	6.95926E-01	6.30716E-01	5.50143E-01	4.52128E-01	4.79041E-01
143	1.29723E-01	7.06752E-01	6.66309E-01	6.18279E-01	6.24963E-01	5.71543E-01	5.02516E-01	4.14693E-01	4.41759E-01
144	1.13828E-01	6.32728E-01	5.94434E-01	5.49241E-01	5.60213E-01	5.16477E-01	4.57340E-01	3.78983E-01	4.05745E-01
145	9.99107E-02	5.66326E-01	5.30448E-01	4.88319E-01	5.01528E-01	4.65667E-01	4.14974E-01	3.45265E-01	3.71386E-01
146	8.77171E-02	5.06766E-01	4.73447E-01	4.34464E-01	4.48606E-01	4.19116E-01	3.75618E-01	3.13721E-01	3.38956E-01
147	7.70271E-02	4.53344E-01	4.22639E-01	3.86787E-01	4.01062E-01	3.76722E-01	3.39354E-01	2.84452E-01	3.08636E-01
148	6.76487E-02	4.05429E-01	3.77330E-01	3.44525E-01	3.58482E-01	3.38313E-01	3.06174E-01	2.57497E-01	2.80533E-01
149	5.94151E-02	3.62450E-01	3.36910E-01	3.07022E-01	3.20449E-01	3.03674E-01	2.76010E-01	2.32843E-01	2.54699E-01
150	5.21807E-02	3.23897E-01	3.00841E-01	2.73712E-01	2.86568E-01	2.72566E-01	2.48756E-01	2.10438E-01	2.31148E-01
151	4.58186E-02	2.89307E-01	2.68652E-01	2.44108E-01	2.56476E-01	2.44744E-01	2.24286E-01	1.90200E-01	2.09872E-01

152	4.58186E-02	2.89307E-01	2.68652E-01	2.44108E-01	2.56476E-01	2.44744E-01	2.24286E-01	1.90200E-01	2.09872E-01
153	3.67532E-02	2.38690E-01	2.21708E-01	2.00880E-01	2.12144E-01	2.03370E-01	1.87405E-01	1.59500E-01	1.77361E-01
154	2.95127E-02	1.96883E-01	1.82930E-01	1.65408E-01	1.75252E-01	1.68630E-01	1.56062E-01	1.33247E-01	1.49013E-01
155	2.37226E-02	1.62361E-01	1.50904E-01	1.36252E-01	1.44659E-01	1.39600E-01	1.29629E-01	1.10976E-01	1.24645E-01
156	1.90870E-02	1.33862E-01	1.24459E-01	1.12261E-01	1.19345E-01	1.15428E-01	1.07463E-01	9.22037E-02	1.03909E-01
157	1.53713E-02	1.10340E-01	1.02625E-01	9.25023E-02	9.84235E-02	9.53544E-02	8.89546E-02	7.64594E-02	8.63950E-02
158	1.23896E-02	9.09282E-02	8.46004E-02	7.62199E-02	8.11450E-02	7.87149E-02	7.35470E-02	6.33060E-02	7.16825E-02
159	9.99423E-03	7.49103E-02	6.97214E-02	6.27956E-02	6.68799E-02	6.49394E-02	6.07493E-02	5.23491E-02	5.93743E-02
160	8.06765E-03	6.16927E-02	5.74388E-02	5.17234E-02	5.51036E-02	5.35438E-02	5.01356E-02	4.32411E-02	4.91082E-02
161	6.51633E-03	5.07849E-02	4.72985E-02	4.25875E-02	4.53807E-02	4.41205E-02	4.13415E-02	3.56807E-02	4.05634E-02
162	5.26566E-03	4.17813E-02	3.89247E-02	3.50457E-02	3.73506E-02	3.63282E-02	3.40582E-02	2.94098E-02	3.34605E-02
163	4.25607E-03	3.43463E-02	3.20067E-02	2.88160E-02	3.07145E-02	2.98822E-02	2.80254E-02	2.42093E-02	2.75594E-02
164	3.43991E-03	2.82026E-02	2.62875E-02	2.36656E-02	2.52254E-02	2.45452E-02	2.30248E-02	1.98940E-02	2.26553E-02
165	2.77900E-03	2.31207E-02	2.15541E-02	1.94020E-02	2.06783E-02	2.01197E-02	1.88736E-02	1.63080E-02	1.85743E-02
166	2.24274E-03	1.89107E-02	1.76301E-02	1.58656E-02	1.69028E-02	1.64406E-02	1.54182E-02	1.33201E-02	1.51693E-02
167	1.80651E-03	1.54149E-02	1.43692E-02	1.29239E-02	1.37568E-02	1.33699E-02	1.25297E-02	1.08193E-02	1.23156E-02
168	1.45047E-03	1.25028E-02	1.16494E-02	1.04660E-02	1.11206E-02	1.07910E-02	1.00987E-02	8.71150E-03	9.90687E-03
169	1.15861E-03	1.00653E-02	9.36911E-03	8.39858E-03	8.89218E-03	8.60454E-03	8.03124E-03	6.91592E-03	7.85225E-03
170	9.17918E-04	8.01162E-03	7.44269E-03	6.64188E-03	6.98274E-03	6.72456E-03	6.24545E-03	5.36243E-03	6.07330E-03
171	7.17820E-04	6.26511E-03	5.79770E-03	5.12635E-03	5.31237E-03	5.07556E-03	4.66759E-03	3.98930E-03	4.50199E-03
172	5.49625E-04	4.76095E-03	4.37185E-03	3.78911E-03	3.80553E-03	3.59033E-03	3.22833E-03	2.74219E-03	3.07948E-03
173	4.06147E-04	3.44358E-03	3.11065E-03	2.57027E-03	2.38608E-03	2.20952E-03	1.85758E-03	1.57538E-03	1.75567E-03

174	4.06147E-04	3.44358E-03	3.11065E-03	2.57027E-03	2.38608E-03	2.20952E-03	1.85758E-03	1.57538E-03	1.75567E-03
175	3.13133E-04	2.55173E-03	2.25052E-03	1.92101E-03	1.66011E-03	1.54141E-03	1.30468E-03	1.11813E-03	1.12818E-03
176	2.34393E-04	1.84578E-03	1.59671E-03	1.39637E-03	1.14645E-03	1.06334E-03	9.02682E-04	7.78265E-04	7.43952E-04
177	1.66478E-04	1.27490E-03	1.08654E-03	9.66943E-04	7.66302E-04	7.08884E-04	6.02228E-04	5.20897E-04	4.84049E-04
178	1.06444E-04	7.98481E-04	6.73339E-04	6.06298E-04	4.69619E-04	4.33248E-04	3.67964E-04	3.18777E-04	2.92037E-04
179	5.17211E-05	3.83077E-04	3.20999E-04	2.90999E-04	2.22531E-04	2.04898E-04	1.73942E-04	1.50793E-04	1.37241E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO. GROUPS 10- 18

R. NO.	10	11	12	13	14	15	16	17	18
1	6.30152E-01	6.13494E-01	5.87972E-01	5.71910E-01	5.69583E-01	5.71175E-01	5.77573E-01	5.82734E-01	5.88294E-01
2	6.31258E-01	6.14509E-01	5.88904E-01	5.72780E-01	5.70408E-01	5.71962E-01	5.78330E-01	5.83456E-01	5.88983E-01
3	6.34574E-01	6.17548E-01	5.91693E-01	5.75381E-01	5.72874E-01	5.74317E-01	5.80595E-01	5.85616E-01	5.91041E-01
4	6.40085E-01	6.22588E-01	5.96318E-01	5.79692E-01	5.76959E-01	5.78214E-01	5.84340E-01	5.89186E-01	5.94441E-01
5	6.47767E-01	6.29592E-01	6.02740E-01	5.85676E-01	5.82620E-01	5.83611E-01	5.89523E-01	5.94120E-01	5.99136E-01
6	6.57584E-01	6.38501E-01	6.10905E-01	5.93277E-01	5.89799E-01	5.90447E-01	5.96081E-01	6.00354E-01	6.05059E-01
7	6.69480E-01	6.49230E-01	6.20736E-01	6.02422E-01	5.98415E-01	5.98641E-01	6.03931E-01	6.07803E-01	6.12123E-01
8	6.83382E-01	6.61667E-01	6.32133E-01	6.13016E-01	6.08367E-01	6.08091E-01	6.12971E-01	6.16362E-01	6.20221E-01
9	6.99190E-01	6.75658E-01	6.44966E-01	6.24941E-01	6.19528E-01	6.18673E-01	6.23077E-01	6.25903E-01	6.29222E-01
10	7.16769E-01	6.90998E-01	6.59077E-01	6.38054E-01	6.31744E-01	6.30237E-01	6.34101E-01	6.36274E-01	6.38974E-01
11	7.35949E-01	7.07420E-01	6.74269E-01	6.52187E-01	6.44830E-01	6.42609E-01	6.45874E-01	6.47303E-01	6.49300E-01
12	7.35949E-01	7.07420E-01	6.74269E-01	6.52187E-01	6.44830E-01	6.42609E-01	6.45874E-01	6.47303E-01	6.49300E-01
13	7.53130E-01	7.27830E-01	6.92686E-01	6.69019E-01	6.60468E-01	6.57400E-01	6.59858E-01	6.60340E-01	6.61373E-01
14	7.73339E-01	7.50347E-01	7.12605E-01	6.86961E-01	6.77233E-01	6.73060E-01	6.74462E-01	6.73823E-01	6.73625E-01
15	7.96068E-01	7.75194E-01	7.33867E-01	7.05683E-01	6.94745E-01	6.89160E-01	6.89211E-01	6.87256E-01	6.85516E-01
16	8.20773E-01	8.02501E-01	7.56102E-01	7.24629E-01	7.12498E-01	7.05144E-01	7.03496E-01	7.00028E-01	6.96379E-01
17	8.20773E-01	8.02501E-01	7.56102E-01	7.24629E-01	7.12498E-01	7.05144E-01	7.03496E-01	7.00028E-01	6.96379E-01
18	8.31696E-01	8.05913E-01	7.59195E-01	7.27414E-01	7.15105E-01	7.07398E-01	7.05483E-01	7.01774E-01	6.97823E-01
19	8.41959E-01	8.09315E-01	7.62289E-01	7.30206E-01	7.17681E-01	7.09636E-01	7.07463E-01	7.03511E-01	6.99263E-01
20	8.51583E-01	8.12697E-01	7.65380E-01	7.33001E-01	7.20223E-01	7.11856E-01	7.09434E-01	7.05237E-01	7.00698E-01
21	8.60587E-01	8.16048E-01	7.68460E-01	7.35796E-01	7.22732E-01	7.14058E-01	7.11398E-01	7.06954E-01	7.02126E-01
22	8.60587E-01	8.16048E-01	7.68460E-01	7.35796E-01	7.22732E-01	7.14058E-01	7.11398E-01	7.06954E-01	7.02126E-01
23	8.65174E-01	8.19837E-01	7.71615E-01	7.38515E-01	7.25155E-01	7.16233E-01	7.13343E-01	7.08663E-01	7.03556E-01
24	8.69662E-01	8.23553E-01	7.74719E-01	7.41194E-01	7.27543E-01	7.18377E-01	7.15261E-01	7.10348E-01	7.04965E-01
25	8.74048E-01	8.27196E-01	7.77768E-01	7.43831E-01	7.29894E-01	7.20488E-01	7.17149E-01	7.12006E-01	7.06353E-01
26	8.78333E-01	8.30762E-01	7.80762E-01	7.46423E-01	7.32205E-01	7.22563E-01	7.19006E-01	7.13637E-01	7.07717E-01
27	8.78333E-01	8.30762E-01	7.80762E-01	7.46423E-01	7.32205E-01	7.22563E-01	7.19006E-01	7.13637E-01	7.07717E-01
28	8.84119E-01	8.35597E-01	7.84831E-01	7.49952E-01	7.35356E-01	7.25394E-01	7.21540E-01	7.15864E-01	7.09580E-01
29	8.89700E-01	8.40276E-01	7.88783E-01	7.53386E-01	7.38424E-01	7.28151E-01	7.24010E-01	7.18035E-01	7.11398E-01
30	8.95073E-01	8.44796E-01	7.92612E-01	7.56720E-01	7.41405E-01	7.30832E-01	7.26411E-01	7.20146E-01	7.13166E-01
31	9.00241E-01	8.49154E-01	7.96314E-01	7.59948E-01	7.44294E-01	7.33431E-01	7.28740E-01	7.22193E-01	7.14878E-01
32	9.00241E-01	8.49154E-01	7.96314E-01	7.59948E-01	7.44294E-01	7.33431E-01	7.28740E-01	7.22193E-01	7.14878E-01
33	9.05206E-01	8.53357E-01	7.99894E-01	7.63075E-01	7.47097E-01	7.35954E-01	7.31003E-01	7.24183E-01	7.16544E-01
34	9.09955E-01	8.57390E-01	8.03339E-01	7.66091E-01	7.49803E-01	7.38392E-01	7.33191E-01	7.26108E-01	7.18158E-01
35	9.14490E-01	8.61253E-01	8.06647E-01	7.68993E-01	7.52409E-01	7.40742E-01	7.35300E-01	7.27965E-01	7.19713E-01
36	9.18811E-01	8.64943E-01	8.09816E-01	7.71776E-01	7.54912E-01	7.43000E-01	7.37328E-01	7.29750E-01	7.21208E-01
37	9.18811E-01	8.64943E-01	8.09816E-01	7.71776E-01	7.54912E-01	7.43000E-01	7.37328E-01	7.29750E-01	7.21208E-01
38	9.26820E-01	8.71824E-01	8.15750E-01	7.77006E-01	7.59627E-01	7.47262E-01	7.41164E-01	7.33134E-01	7.24054E-01
39	9.33963E-01	8.78002E-01	8.21108E-01	7.81748E-01	7.63916E-01	7.51149E-01	7.44670E-01	7.36234E-01	7.26674E-01
40	9.40262E-01	8.83479E-01	8.25882E-01	7.85990E-01	7.67767E-01	7.54644E-01	7.47829E-01	7.39033E-01	7.29045E-01
41	9.45740E-01	8.88262E-01	8.30068E-01	7.89723E-01	7.71167E-01	7.57739E-01	7.50629E-01	7.41515E-01	7.31149E-01

42	9.45740E-01	8.88262E-01	8.30068E-01	7.89723E-01	7.71167E-01	7.57739E-01	7.50629E-01	7.41515E-01	7.31149E-01
43	9.50417E-01	8.92370E-01	8.33684E-01	7.92962E-01	7.74133E-01	7.60445E-01	7.53085E-01	7.43699E-01	7.33011E-01
44	9.54291E-01	8.95798E-01	8.36724E-01	7.95702E-01	7.76658E-01	7.62757E-01	7.55191E-01	7.45581E-01	7.34636E-01
45	9.57392E-01	8.98560E-01	8.39195E-01	7.97945E-01	7.78743E-01	7.64673E-01	7.56945E-01	7.47157E-01	7.36015E-01
46	9.59751E-01	9.00674E-01	8.41110E-01	7.99700E-01	7.80392E-01	7.66196E-01	7.58346E-01	7.48422E-01	7.37141E-01
47	9.59751E-01	9.00674E-01	8.41110E-01	7.99700E-01	7.80392E-01	7.66196E-01	7.58346E-01	7.48422E-01	7.37141E-01
48	9.61398E-01	9.02160E-01	8.42481E-01	8.00977E-01	7.81615E-01	7.67331E-01	7.59397E-01	7.49379E-01	7.38016E-01
49	9.62367E-01	9.03040E-01	8.43327E-01	8.01788E-01	7.82421E-01	7.68085E-01	7.60103E-01	7.50032E-01	7.38642E-01
50	9.62694E-01	9.03335E-01	8.43666E-01	8.02148E-01	7.82823E-01	7.68469E-01	7.60471E-01	7.50386E-01	7.39024E-01
51	9.62418E-01	9.03072E-01	8.43519E-01	8.02077E-01	7.82836E-01	7.68492E-01	7.60511E-01	7.50447E-01	7.39168E-01
52	9.62418E-01	9.03072E-01	8.43519E-01	8.02077E-01	7.82836E-01	7.68492E-01	7.60511E-01	7.50447E-01	7.39168E-01
53	9.62071E-01	9.02743E-01	8.43273E-01	8.01885E-01	7.82702E-01	7.68372E-01	7.60410E-01	7.50369E-01	7.39150E-01
54	9.61594E-01	9.02284E-01	8.42913E-01	8.01592E-01	7.82476E-01	7.68165E-01	7.60228E-01	7.50217E-01	7.39069E-01
55	9.60993E-01	9.01700E-01	8.42442E-01	8.01199E-01	7.82159E-01	7.67872E-01	7.59965E-01	7.49992E-01	7.38926E-01
56	9.60272E-01	9.00995E-01	8.41865E-01	8.00709E-01	7.81754E-01	7.67496E-01	7.59624E-01	7.49695E-01	7.38722E-01
57	9.60272E-01	9.00995E-01	8.41865E-01	8.00709E-01	7.81754E-01	7.67496E-01	7.59624E-01	7.49695E-01	7.38722E-01
58	9.59263E-01	8.99996E-01	8.41037E-01	7.99997E-01	7.81154E-01	7.66935E-01	7.59112E-01	7.49245E-01	7.38395E-01
59	9.58110E-01	8.98834E-01	8.40065E-01	7.99153E-01	7.80433E-01	7.66256E-01	7.58486E-01	7.48688E-01	7.37974E-01
60	9.56826E-01	8.97518E-01	8.38954E-01	7.98181E-01	7.79595E-01	7.65462E-01	7.57750E-01	7.48029E-01	7.37463E-01
61	9.55422E-01	8.96052E-01	8.37712E-01	7.97088E-01	7.78644E-01	7.64558E-01	7.56908E-01	7.47269E-01	7.36864E-01
62	9.55422E-01	8.96053E-01	8.37712E-01	7.97088E-01	7.78645E-01	7.64558E-01	7.56908E-01	7.47270E-01	7.36864E-01
63	9.53339E-01	8.94187E-01	8.36086E-01	7.95629E-01	7.77351E-01	7.63324E-01	7.55746E-01	7.46206E-01	7.35985E-01
64	9.51109E-01	8.92203E-01	8.34324E-01	7.94021E-01	7.75884E-01	7.61911E-01	7.54393E-01	7.44933E-01	7.34854E-01
65	9.48759E-01	8.90113E-01	8.32436E-01	7.92271E-01	7.74250E-01	7.60326E-01	7.52854E-01	7.43455E-01	7.33479E-01
66	9.46310E-01	8.87930E-01	8.30430E-01	7.90388E-01	7.72456E-01	7.58575E-01	7.51134E-01	7.41777E-01	7.31867E-01
67	9.43774E-01	8.85661E-01	8.28314E-01	7.88376E-01	7.70507E-01	7.56660E-01	7.49237E-01	7.39904E-01	7.30023E-01
68	9.41158E-01	8.83310E-01	8.26089E-01	7.86239E-01	7.68407E-01	7.54587E-01	7.47167E-01	7.37840E-01	7.27951E-01
69	9.38462E-01	8.80880E-01	8.23760E-01	7.83977E-01	7.66158E-01	7.52357E-01	7.44925E-01	7.35586E-01	7.25653E-01
70	9.35680E-01	8.78370E-01	8.21324E-01	7.81592E-01	7.63760E-01	7.49970E-01	7.42513E-01	7.33144E-01	7.23131E-01
71	9.32798E-01	8.75777E-01	8.18779E-01	7.79082E-01	7.61213E-01	7.47428E-01	7.39931E-01	7.30515E-01	7.20387E-01
72	9.29799E-01	8.73094E-01	8.16122E-01	7.76443E-01	7.58515E-01	7.44728E-01	7.37180E-01	7.27700E-01	7.17419E-01
73	9.26656E-01	8.70314E-01	8.13345E-01	7.73671E-01	7.55661E-01	7.41871E-01	7.34258E-01	7.24697E-01	7.14225E-01
74	9.23340E-01	8.67427E-01	8.10440E-01	7.70759E-01	7.52648E-01	7.38852E-01	7.31163E-01	7.21505E-01	7.10805E-01
75	9.23340E-01	8.67427E-01	8.10440E-01	7.70759E-01	7.52648E-01	7.38852E-01	7.31163E-01	7.21505E-01	7.10805E-01
76	9.21854E-01	8.65933E-01	8.08958E-01	7.69284E-01	7.51120E-01	7.37315E-01	7.29582E-01	7.19865E-01	7.09027E-01
77	9.20321E-01	8.64392E-01	8.07435E-01	7.67772E-01	7.49559E-01	7.35746E-01	7.27971E-01	7.18199E-01	7.07228E-01
78	9.18739E-01	8.62804E-01	8.05870E-01	7.66223E-01	7.47964E-01	7.34145E-01	7.26330E-01	7.16507E-01	7.05410E-01
79	9.17106E-01	8.61168E-01	8.04263E-01	7.64635E-01	7.46336E-01	7.32512E-01	7.24659E-01	7.14787E-01	7.03569E-01
80	9.17106E-01	8.61168E-01	8.04263E-01	7.64635E-01	7.46336E-01	7.32512E-01	7.24659E-01	7.14787E-01	7.03569E-01
81	9.14672E-01	8.58735E-01	8.01882E-01	7.62290E-01	7.43941E-01	7.30113E-01	7.22209E-01	7.12273E-01	7.00888E-01
82	9.12120E-01	8.56197E-01	7.99412E-01	7.59866E-01	7.41480E-01	7.27652E-01	7.19704E-01	7.09713E-01	6.98176E-01
83	9.09447E-01	8.53553E-01	7.96851E-01	7.57363E-01	7.38949E-01	7.25128E-01	7.17143E-01	7.07105E-01	6.95432E-01
84	9.06649E-01	8.50799E-01	7.94196E-01	7.54777E-01	7.36347E-01	7.22539E-01	7.14525E-01	7.04449E-01	6.92653E-01
85	9.06649E-01	8.50799E-01	7.94197E-01	7.54777E-01	7.36347E-01	7.22539E-01	7.14525E-01	7.04449E-01	6.92653E-01
86	9.03711E-01	8.47921E-01	7.91435E-01	7.52098E-01	7.33664E-01	7.19875E-01	7.11838E-01	7.01732E-01	6.89823E-01
87	9.00636E-01	8.44929E-01	7.88580E-01	7.49339E-01	7.30913E-01	7.17152E-01	7.09101E-01	6.98976E-01	6.86974E-01

88	8.97423E-01	8.41823E-01	7.85630E-01	7.46499E-01	7.28094E-01	7.14369E-01	7.06314E-01	6.96181E-01	6.84104E-01
89	8.94072E-01	8.38601E-01	7.82583E-01	7.43578E-01	7.25206E-01	7.11526E-01	7.03476E-01	6.93347E-01	6.81212E-01
90	8.94072E-01	8.38601E-01	7.82583E-01	7.43578E-01	7.25206E-01	7.11526E-01	7.03476E-01	6.93347E-01	6.81212E-01
91	8.86922E-01	8.31786E-01	7.76180E-01	7.37471E-01	7.19209E-01	7.05646E-01	6.97636E-01	6.87547E-01	6.75348E-01
92	8.79202E-01	8.24509E-01	7.69401E-01	7.31053E-01	7.12955E-01	6.99549E-01	6.91625E-01	6.81629E-01	6.69451E-01
93	8.70920E-01	8.16777E-01	7.62251E-01	7.24326E-01	7.06450E-01	6.93243E-01	6.85449E-01	6.75595E-01	6.63519E-01
94	8.62090E-01	8.08601E-01	7.54739E-01	7.17302E-01	6.99702E-01	6.86734E-01	6.79115E-01	6.69452E-01	6.57555E-01
95	8.62090E-01	8.08601E-01	7.54739E-01	7.17302E-01	6.99702E-01	6.86734E-01	6.79115E-01	6.69452E-01	6.57555E-01
96	8.52745E-01	8.00009E-01	7.46890E-01	7.10002E-01	6.92732E-01	6.80044E-01	6.72643E-01	6.63218E-01	6.51571E-01
97	8.42901E-01	7.91009E-01	7.38711E-01	7.02430E-01	6.85543E-01	6.73173E-01	6.66027E-01	6.56884E-01	6.45551E-01
98	8.32584E-01	7.81625E-01	7.30224E-01	6.94610E-01	6.78154E-01	6.66141E-01	6.59288E-01	6.50467E-01	6.39510E-01
99	8.21824E-01	7.71884E-01	7.21457E-01	6.86566E-01	6.70591E-01	6.58969E-01	6.52447E-01	6.43988E-01	6.33469E-01
100	8.21824E-01	7.71884E-01	7.21457E-01	6.86566E-01	6.70591E-01	6.58969E-01	6.52447E-01	6.43988E-01	6.33469E-01
101	8.10724E-01	7.61880E-01	7.12489E-01	6.78371E-01	6.62919E-01	6.51718E-01	6.45559E-01	6.37499E-01	6.27475E-01
102	7.99287E-01	7.51586E-01	7.03293E-01	6.69993E-01	6.55102E-01	6.44349E-01	6.38574E-01	6.30935E-01	6.21433E-01
103	7.87555E-01	7.41043E-01	6.93907E-01	6.61469E-01	6.47176E-01	6.36892E-01	6.31520E-01	6.24326E-01	6.15375E-01
104	7.75576E-01	7.30289E-01	6.84373E-01	6.52839E-01	6.39178E-01	6.29382E-01	6.24429E-01	6.17700E-01	6.09333E-01
105	7.75576E-01	7.30289E-01	6.84373E-01	6.52839E-01	6.39178E-01	6.29382E-01	6.24430E-01	6.17700E-01	6.09333E-01
106	7.69546E-01	7.24882E-01	6.79593E-01	6.48524E-01	6.35188E-01	6.25641E-01	6.20904E-01	6.14415E-01	6.06354E-01
107	7.63483E-01	7.19441E-01	6.74791E-01	6.44193E-01	6.31189E-01	6.21892E-01	6.17372E-01	6.11124E-01	6.03370E-01
108	7.57394E-01	7.13970E-01	6.69971E-01	6.39853E-01	6.27186E-01	6.18140E-01	6.13837E-01	6.07831E-01	6.00386E-01
109	7.51289E-01	7.08478E-01	6.65140E-01	6.35508E-01	6.23183E-01	6.14389E-01	6.10303E-01	6.04540E-01	5.97406E-01
110	7.51289E-01	7.08478E-01	6.65140E-01	6.35508E-01	6.23184E-01	6.14389E-01	6.10303E-01	6.04540E-01	5.97406E-01
111	7.45198E-01	7.02991E-01	6.60323E-01	6.31182E-01	6.19203E-01	6.10659E-01	6.06790E-01	6.01271E-01	5.94450E-01
112	7.39115E-01	6.97497E-01	6.55506E-01	6.26860E-01	6.15230E-01	6.06935E-01	6.03280E-01	5.98004E-01	5.91493E-01
113	7.33052E-01	6.92001E-01	6.50697E-01	6.22549E-01	6.11270E-01	6.03222E-01	5.99777E-01	5.94743E-01	5.88541E-01
114	7.27017E-01	6.86511E-01	6.45901E-01	6.18256E-01	6.07331E-01	5.99526E-01	5.96287E-01	5.91493E-01	5.85597E-01
115	7.27017E-01	6.86511E-01	6.45901E-01	6.18256E-01	6.07331E-01	5.99526E-01	5.96287E-01	5.91493E-01	5.85597E-01
116	7.21039E-01	6.81053E-01	6.41142E-01	6.14000E-01	6.03429E-01	5.95862E-01	5.92827E-01	5.88270E-01	5.82681E-01
117	7.15118E-01	6.75614E-01	6.36409E-01	6.09772E-01	5.99555E-01	5.92220E-01	5.89382E-01	5.85058E-01	5.79770E-01
118	7.09264E-01	6.70203E-01	6.31709E-01	6.05578E-01	5.95715E-01	5.88604E-01	5.85956E-01	5.81861E-01	5.76869E-01
119	7.03488E-01	6.64826E-01	6.27049E-01	6.01423E-01	5.91913E-01	5.85019E-01	5.82553E-01	5.78683E-01	5.73983E-01
120	7.03488E-01	6.64826E-01	6.27049E-01	6.01423E-01	5.91913E-01	5.85019E-01	5.82553E-01	5.78683E-01	5.73983E-01
121	6.94125E-01	6.57954E-01	6.20957E-01	5.95926E-01	5.86870E-01	5.80284E-01	5.78057E-01	5.74486E-01	5.70178E-01
122	6.84914E-01	6.51247E-01	6.15019E-01	5.90566E-01	5.81925E-01	5.75630E-01	5.73622E-01	5.70328E-01	5.66381E-01
123	6.75894E-01	6.44739E-01	6.09258E-01	5.85362E-01	5.77092E-01	5.71068E-01	5.69257E-01	5.66217E-01	5.62600E-01
124	6.67099E-01	6.38462E-01	6.03696E-01	5.80330E-01	5.72385E-01	5.66609E-01	5.64971E-01	5.62159E-01	5.58844E-01
125	6.58560E-01	6.32447E-01	5.98356E-01	5.75486E-01	5.67815E-01	5.62260E-01	5.60770E-01	5.58162E-01	5.55120E-01
126	6.50302E-01	6.26724E-01	5.93258E-01	5.70846E-01	5.63393E-01	5.58031E-01	5.56659E-01	5.54230E-01	5.51433E-01
127	6.42349E-01	6.21321E-01	5.88422E-01	5.66424E-01	5.59131E-01	5.53928E-01	5.52645E-01	5.50368E-01	5.47789E-01
128	6.34722E-01	6.16267E-01	5.83866E-01	5.62233E-01	5.55035E-01	5.49957E-01	5.48731E-01	5.46579E-01	5.44193E-01
129	6.27438E-01	6.11587E-01	5.79607E-01	5.58285E-01	5.51113E-01	5.46122E-01	5.44920E-01	5.42867E-01	5.40648E-01
130	6.20509E-01	6.07308E-01	5.75663E-01	5.54591E-01	5.47371E-01	5.42427E-01	5.41214E-01	5.39232E-01	5.37157E-01
131	6.13949E-01	6.03455E-01	5.72047E-01	5.51160E-01	5.43813E-01	5.38873E-01	5.37612E-01	5.35676E-01	5.33720E-01
132	6.07762E-01	6.00054E-01	5.68774E-01	5.48002E-01	5.40440E-01	5.35460E-01	5.34114E-01	5.32197E-01	5.30340E-01
133	6.01955E-01	5.97129E-01	5.65857E-01	5.45122E-01	5.37254E-01	5.32189E-01	5.30718E-01	5.28795E-01	5.27016E-01

134	5.96526E-01	5.94705E-01	5.63309E-01	5.42526E-01	5.34252E-01	5.29055E-01	5.27420E-01	5.25465E-01	5.23747E-01
135	5.91474E-01	5.92806E-01	5.61139E-01	5.40219E-01	5.31433E-01	5.26054E-01	5.24214E-01	5.22205E-01	5.20530E-01

136	5.91474E-01	5.92806E-01	5.61139E-01	5.40219E-01	5.31433E-01	5.26054E-01	5.24214E-01	5.22205E-01	5.20530E-01
137	5.65573E-01	5.76098E-01	5.44285E-01	5.23090E-01	5.11553E-01	5.04791E-01	5.01593E-01	4.99006E-01	4.97325E-01
138	5.37929E-01	5.53839E-01	5.24045E-01	5.03611E-01	4.90923E-01	4.83327E-01	4.79245E-01	4.76198E-01	4.74438E-01
139	5.08603E-01	5.27807E-01	5.00963E-01	4.82029E-01	4.69298E-01	4.61434E-01	4.56911E-01	4.53600E-01	4.51789E-01
140	4.78050E-01	4.99304E-01	4.75718E-01	4.58731E-01	4.46692E-01	4.39046E-01	4.34464E-01	4.31108E-01	4.29327E-01
141	4.46844E-01	4.69338E-01	4.49003E-01	4.34171E-01	4.23279E-01	4.16220E-01	4.11884E-01	4.08686E-01	4.07040E-01
142	4.15555E-01	4.38713E-01	4.21460E-01	4.08823E-01	3.99323E-01	3.93098E-01	3.89235E-01	3.86363E-01	3.84951E-01
143	3.84691E-01	4.08076E-01	3.93656E-01	3.83141E-01	3.75127E-01	3.69876E-01	3.66634E-01	3.64208E-01	3.63112E-01
144	3.54676E-01	3.77946E-01	3.66076E-01	3.57536E-01	3.50996E-01	3.46772E-01	3.44229E-01	3.42326E-01	3.41600E-01
145	3.25848E-01	3.48733E-01	3.39120E-01	3.32367E-01	3.27221E-01	3.24007E-01	3.22182E-01	3.20833E-01	3.20506E-01
146	2.98462E-01	3.20755E-01	3.13109E-01	3.07936E-01	3.04056E-01	3.01786E-01	3.00654E-01	2.99852E-01	2.99925E-01
147	2.72704E-01	2.94246E-01	2.88295E-01	2.84486E-01	2.81719E-01	2.80292E-01	2.79789E-01	2.79497E-01	2.79947E-01
148	2.48695E-01	2.69376E-01	2.64861E-01	2.62205E-01	2.60381E-01	2.59674E-01	2.59713E-01	2.59870E-01	2.60657E-01
149	2.26509E-01	2.46256E-01	2.42940E-01	2.41229E-01	2.40172E-01	2.40045E-01	2.40522E-01	2.41052E-01	2.42122E-01
150	2.06175E-01	2.24954E-01	2.22612E-01	2.21647E-01	2.21177E-01	2.21484E-01	2.22284E-01	2.23100E-01	2.24393E-01
151	1.87688E-01	2.05499E-01	2.03917E-01	2.03505E-01	2.03438E-01	2.04030E-01	2.05033E-01	2.06049E-01	2.07503E-01

152	1.87688E-01	2.05499E-01	2.03917E-01	2.03505E-01	2.03438E-01	2.04030E-01	2.05033E-01	2.06049E-01	2.07503E-01
153	1.59262E-01	1.75507E-01	1.74944E-01	1.75251E-01	1.75716E-01	1.76671E-01	1.77920E-01	1.79178E-01	1.80817E-01
154	1.34353E-01	1.48868E-01	1.49072E-01	1.49931E-01	1.50837E-01	1.52097E-01	1.53559E-01	1.55006E-01	1.56774E-01
155	1.12791E-01	1.25562E-01	1.26278E-01	1.27509E-01	1.28732E-01	1.30213E-01	1.31829E-01	1.33410E-01	1.35254E-01
156	9.43173E-02	1.05416E-01	1.06431E-01	1.07871E-01	1.09285E-01	1.10895E-01	1.12598E-01	1.14253E-01	1.16123E-01
157	7.86194E-02	8.81664E-02	8.93205E-02	9.08394E-02	9.23352E-02	9.39692E-02	9.57107E-02	9.73836E-02	9.92316E-02
158	6.53664E-02	7.35097E-02	7.46918E-02	7.61940E-02	7.76853E-02	7.93120E-02	8.09944E-02	8.26333E-02	8.44184E-02
159	5.42333E-02	6.11306E-02	6.22691E-02	6.36909E-02	6.51160E-02	6.66623E-02	6.82598E-02	6.98231E-02	7.15116E-02
160	4.49161E-02	5.07240E-02	5.17766E-02	5.30800E-02	5.43989E-02	5.58292E-02	5.73095E-02	5.87668E-02	6.03334E-02
161	3.71400E-02	4.20060E-02	4.29513E-02	4.41173E-02	4.53081E-02	4.66016E-02	4.79452E-02	4.92763E-02	5.07049E-02
162	3.06616E-02	3.47204E-02	3.55510E-02	3.65741E-02	3.76277E-02	3.87757E-02	3.99735E-02	4.11680E-02	4.24502E-02
163	2.52695E-02	2.86407E-02	2.93576E-02	3.02411E-02	3.11578E-02	3.21602E-02	3.32112E-02	3.42663E-02	3.54005E-02
164	2.07814E-02	2.35691E-02	2.41785E-02	2.49309E-02	2.57166E-02	2.65795E-02	2.74887E-02	2.84073E-02	2.93971E-02
165	1.70415E-02	1.93350E-02	1.98457E-02	2.04780E-02	2.11424E-02	2.18752E-02	2.26514E-02	2.34405E-02	2.42932E-02
166	1.39171E-02	1.57920E-02	1.62137E-02	1.67379E-02	1.72923E-02	1.79067E-02	1.85608E-02	1.92299E-02	1.99555E-02
167	1.12954E-02	1.28148E-02	1.31572E-02	1.35857E-02	1.40418E-02	1.45501E-02	1.50943E-02	1.56543E-02	1.62640E-02
168	9.08002E-03	1.02961E-02	1.05690E-02	1.09135E-02	1.12830E-02	1.16976E-02	1.21443E-02	1.26069E-02	1.31124E-02
169	7.18842E-03	8.14453E-03	8.35703E-03	8.62864E-03	8.92295E-03	9.25605E-03	9.61754E-03	9.99426E-03	1.04072E-02
170	5.54947E-03	6.28169E-03	6.44299E-03	6.65212E-03	6.88215E-03	7.14542E-03	7.43343E-03	7.73533E-03	8.06650E-03
171	4.10137E-03	4.64127E-03	4.76028E-03	4.91646E-03	5.09284E-03	5.29758E-03	5.52318E-03	5.76041E-03	6.01939E-03
172	2.78990E-03	3.16856E-03	3.25272E-03	3.36434E-03	3.49802E-03	3.65514E-03	3.82843E-03	4.00971E-03	4.20391E-03
173	1.56637E-03	1.82228E-03	1.87261E-03	1.94696E-03	2.05067E-03	2.17052E-03	2.30004E-03	2.43180E-03	2.56551E-03

174	1.56637E-03	1.82228E-03	1.87261E-03	1.94696E-03	2.05067E-03	2.17052E-03	2.30004E-03	2.43180E-03	2.56551E-03
175	1.03426E-03	1.10061E-03	1.12697E-03	1.16680E-03	1.22847E-03	1.30259E-03	1.38764E-03	1.47592E-03	1.56691E-03
176	6.86128E-04	6.98336E-04	7.05488E-04	7.22504E-04	7.54915E-04	7.96377E-04	8.46744E-04	8.99910E-04	9.56173E-04
177	4.45672E-04	4.44065E-04	4.43021E-04	4.48819E-04	4.64715E-04	4.86596E-04	5.14537E-04	5.44502E-04	5.76944E-04
178	2.68014E-04	2.64436E-04	2.61552E-04	2.62868E-04	2.70182E-04	2.81031E-04	2.95490E-04	3.11127E-04	3.28364E-04
179	1.25647E-04	1.23445E-04	1.21521E-04	1.21569E-04	1.24388E-04	1.28828E-04	1.34925E-04	1.41538E-04	1.48910E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO.	GROUPS 19- 27								
1	5.93004E-01	5.96984E-01	6.00319E-01	6.00934E-01	5.97896E-01	5.97436E-01	6.00174E-01	5.98492E-01	4.09162E-01
2	5.93660E-01	5.97602E-01	6.00902E-01	6.01484E-01	5.98402E-01	5.97899E-01	6.00587E-01	5.98842E-01	4.09539E-01
3	5.95617E-01	5.99448E-01	6.02643E-01	6.03126E-01	5.99912E-01	5.99280E-01	6.01814E-01	5.99882E-01	4.10697E-01
4	5.98848E-01	6.02491E-01	6.05511E-01	6.05832E-01	6.02396E-01	6.01547E-01	6.03821E-01	6.01572E-01	4.12733E-01
5	6.03304E-01	6.06684E-01	6.09458E-01	6.09555E-01	6.05806E-01	6.04650E-01	6.06547E-01	6.03845E-01	4.15862E-01
6	6.08919E-01	6.11957E-01	6.14414E-01	6.14230E-01	6.10076E-01	6.08518E-01	6.09904E-01	6.06606E-01	4.20503E-01
7	6.15604E-01	6.18220E-01	6.20291E-01	6.19776E-01	6.15116E-01	6.13059E-01	6.13779E-01	6.09730E-01	4.27457E-01
8	6.23251E-01	6.25361E-01	6.26977E-01	6.26091E-01	6.20821E-01	6.18156E-01	6.18024E-01	6.13054E-01	4.38235E-01
9	6.31730E-01	6.33246E-01	6.34340E-01	6.33058E-01	6.27062E-01	6.23670E-01	6.22453E-01	6.16378E-01	4.55661E-01
10	6.40888E-01	6.41719E-01	6.42229E-01	6.40548E-01	6.33688E-01	6.29435E-01	6.26837E-01	6.19456E-01	4.84995E-01
11	6.50551E-01	6.50598E-01	6.50469E-01	6.48418E-01	6.40527E-01	6.35257E-01	6.30892E-01	6.21987E-01	5.36000E-01
12	6.50551E-01	6.50598E-01	6.50469E-01	6.48418E-01	6.40527E-01	6.35257E-01	6.30892E-01	6.21987E-01	5.36000E-01
13	6.61738E-01	6.60681E-01	6.59618E-01	6.56952E-01	6.47511E-01	6.40773E-01	6.34458E-01	6.23488E-01	5.67902E-01
14	6.72905E-01	6.70440E-01	6.68140E-01	6.64551E-01	6.53014E-01	6.44345E-01	6.36220E-01	6.22713E-01	5.85291E-01
15	6.83514E-01	6.79298E-01	6.75461E-01	6.70727E-01	6.56414E-01	6.45304E-01	6.35433E-01	6.18840E-01	5.92390E-01
16	6.92922E-01	6.86552E-01	6.80883E-01	6.74875E-01	6.56888E-01	6.42774E-01	6.31251E-01	6.10896E-01	5.91424E-01
17	6.92922E-01	6.86552E-01	6.80883E-01	6.74875E-01	6.56888E-01	6.42774E-01	6.31251E-01	6.10896E-01	5.91424E-01
18	6.94146E-01	6.87435E-01	6.81480E-01	6.75285E-01	6.56666E-01	6.42044E-01	6.30312E-01	6.09271E-01	5.90752E-01
19	6.95369E-01	6.88319E-01	6.82080E-01	6.75703E-01	6.56451E-01	6.41323E-01	6.29391E-01	6.07659E-01	5.90062E-01
20	6.96592E-01	6.89203E-01	6.82681E-01	6.76128E-01	6.56239E-01	6.40608E-01	6.28486E-01	6.06057E-01	5.89355E-01
21	6.97813E-01	6.90084E-01	6.83282E-01	6.76557E-01	6.56028E-01	6.39893E-01	6.27594E-01	6.04460E-01	5.88629E-01
22	6.97813E-01	6.90084E-01	6.83282E-01	6.76557E-01	6.56028E-01	6.39893E-01	6.27594E-01	6.04460E-01	5.88629E-01
23	6.99039E-01	6.90974E-01	6.83892E-01	6.76996E-01	6.55815E-01	6.39154E-01	6.26674E-01	6.02775E-01	5.87847E-01
24	7.00247E-01	6.91853E-01	6.84494E-01	6.77429E-01	6.55610E-01	6.38433E-01	6.25776E-01	6.01133E-01	5.87050E-01
25	7.01436E-01	6.92717E-01	6.85087E-01	6.77855E-01	6.55410E-01	6.37728E-01	6.24895E-01	5.99527E-01	5.86239E-01
26	7.02604E-01	6.93565E-01	6.85667E-01	6.78270E-01	6.55210E-01	6.37031E-01	6.24027E-01	5.97951E-01	5.85414E-01
27	7.02604E-01	6.93565E-01	6.85667E-01	6.78270E-01	6.55211E-01	6.37031E-01	6.24027E-01	5.97951E-01	5.85414E-01
28	7.04201E-01	6.94726E-01	6.86463E-01	6.78840E-01	6.54942E-01	6.36078E-01	6.22840E-01	5.95785E-01	5.84246E-01
29	7.05758E-01	6.95861E-01	6.87243E-01	6.79398E-01	6.54690E-01	6.35165E-01	6.21698E-01	5.93706E-01	5.83078E-01
30	7.07272E-01	6.96964E-01	6.87999E-01	6.79938E-01	6.54445E-01	6.34280E-01	6.20592E-01	5.91698E-01	5.81910E-01
31	7.08738E-01	6.98029E-01	6.88727E-01	6.80456E-01	6.54198E-01	6.33411E-01	6.19511E-01	5.89746E-01	5.80741E-01
32	7.08738E-01	6.98029E-01	6.88727E-01	6.80456E-01	6.54198E-01	6.33411E-01	6.19511E-01	5.89746E-01	5.80741E-01
33	7.10165E-01	6.99066E-01	6.89436E-01	6.80959E-01	6.53955E-01	6.32556E-01	6.18451E-01	5.87823E-01	5.79569E-01
34	7.11546E-01	7.00073E-01	6.90126E-01	6.81450E-01	6.53730E-01	6.31744E-01	6.17441E-01	5.85991E-01	5.78425E-01
35	7.12879E-01	7.01043E-01	6.90792E-01	6.81922E-01	6.53514E-01	6.30965E-01	6.16472E-01	5.84238E-01	5.77306E-01
36	7.14159E-01	7.01973E-01	6.91427E-01	6.82372E-01	6.53297E-01	6.30208E-01	6.15536E-01	5.82549E-01	5.76209E-01
37	7.14159E-01	7.01973E-01	6.91427E-01	6.82372E-01	6.53298E-01	6.30208E-01	6.15536E-01	5.82549E-01	5.76209E-01
38	7.16599E-01	7.03765E-01	6.92666E-01	6.83255E-01	6.52946E-01	6.28834E-01	6.13816E-01	5.79403E-01	5.74131E-01
39	7.18851E-01	7.05440E-01	6.93845E-01	6.84105E-01	6.52722E-01	6.27715E-01	6.12369E-01	5.76730E-01	5.72294E-01
40	7.20892E-01	7.06968E-01	6.94931E-01	6.84890E-01	6.52566E-01	6.26777E-01	6.11135E-01	5.74434E-01	5.70673E-01
41	7.22703E-01	7.08321E-01	6.95893E-01	6.85585E-01	6.52429E-01	6.25958E-01	6.10060E-01	5.72432E-01	5.69243E-01

42	7.22703E-01	7.08321E-01	6.95893E-01	6.85585E-01	6.52430E-01	6.25958E-01	6.10060E-01	5.72632E-01	5.69243E-01
43	7.24309E-01	7.09542E-01	6.96776E-01	6.86227E-01	6.52378E-01	6.25328E-01	6.09202E-01	5.70784E-01	5.68052E-01
44	7.25717E-01	7.10645E-01	6.97606E-01	6.86842E-01	6.52487E-01	6.25000E-01	6.08656E-01	5.69664E-01	5.67188E-01
45	7.26915E-01	7.11617E-01	6.98365E-01	6.87412E-01	6.52724E-01	6.24934E-01	6.08387E-01	5.69018E-01	5.66630E-01
46	7.27897E-01	7.12446E-01	6.99040E-01	6.87923E-01	6.53067E-01	6.25100E-01	6.08368E-01	5.68805E-01	5.66355E-01
47	7.27897E-01	7.12446E-01	6.99040E-01	6.87923E-01	6.53067E-01	6.25100E-01	6.08368E-01	5.68805E-01	5.66355E-01
48	7.28663E-01	7.13131E-01	6.99628E-01	6.88371E-01	6.53511E-01	6.25494E-01	6.08589E-01	5.69016E-01	5.66354E-01
49	7.29212E-01	7.13675E-01	7.00130E-01	6.88754E-01	6.54061E-01	6.26119E-01	6.09047E-01	5.69653E-01	5.66617E-01
50	7.29547E-01	7.14078E-01	7.00546E-01	6.89068E-01	6.54719E-01	6.26977E-01	6.09735E-01	5.70715E-01	5.67130E-01
51	7.29672E-01	7.14346E-01	7.00880E-01	6.89314E-01	6.55493E-01	6.28079E-01	6.10653E-01	5.72212E-01	5.67877E-01
52	7.29672E-01	7.14346E-01	7.00880E-01	6.89314E-01	6.55493E-01	6.28079E-01	6.10653E-01	5.72212E-01	5.67877E-01
53	7.29654E-01	7.14425E-01	7.01010E-01	6.89404E-01	6.55911E-01	6.28702E-01	6.11178E-01	5.73094E-01	5.68317E-01
54	7.29578E-01	7.14461E-01	7.01108E-01	6.89464E-01	6.56337E-01	6.29356E-01	6.11732E-01	5.74046E-01	5.68788E-01
55	7.29445E-01	7.14456E-01	7.01175E-01	6.89495E-01	6.56773E-01	6.30046E-01	6.12316E-01	5.75072E-01	5.69287E-01
56	7.29256E-01	7.14412E-01	7.01212E-01	6.89498E-01	6.57223E-01	6.30776E-01	6.12931E-01	5.76178E-01	5.69812E-01
57	7.29256E-01	7.14412E-01	7.01212E-01	6.89498E-01	6.57223E-01	6.30776E-01	6.12931E-01	5.76178E-01	5.69812E-01
58	7.28953E-01	7.14298E-01	7.01208E-01	6.89453E-01	6.57756E-01	6.31665E-01	6.13677E-01	5.77548E-01	5.70448E-01
59	7.28560E-01	7.14112E-01	7.01141E-01	6.89347E-01	6.58272E-01	6.32563E-01	6.14422E-01	5.78969E-01	5.71076E-01
60	7.28080E-01	7.13858E-01	7.01017E-01	6.89181E-01	6.58781E-01	6.33481E-01	6.15170E-01	5.80453E-01	5.71694E-01
61	7.27517E-01	7.13539E-01	7.00839E-01	6.88959E-01	6.59293E-01	6.34430E-01	6.15926E-01	5.82012E-01	5.72298E-01
62	7.27517E-01	7.13539E-01	7.00839E-01	6.88959E-01	6.59293E-01	6.34430E-01	6.15926E-01	5.82012E-01	5.72298E-01
63	7.26677E-01	7.12973E-01	7.00423E-01	6.88495E-01	6.59583E-01	6.35127E-01	6.16446E-01	5.83240E-01	5.72670E-01
64	7.25580E-01	7.12085E-01	6.99650E-01	6.87683E-01	6.59353E-01	6.35211E-01	6.16390E-01	5.83736E-01	5.72502E-01
65	7.24230E-01	7.10885E-01	6.98529E-01	6.86530E-01	6.58621E-01	6.34702E-01	6.15772E-01	5.83523E-01	5.71797E-01
66	7.22634E-01	7.09381E-01	6.97070E-01	6.85042E-01	6.57401E-01	6.33618E-01	6.14603E-01	5.82618E-01	5.70562E-01
67	7.20797E-01	7.07580E-01	6.95278E-01	6.83225E-01	6.55705E-01	6.31970E-01	6.12894E-01	5.81036E-01	5.68802E-01
68	7.18722E-01	7.05487E-01	6.93159E-01	6.81084E-01	6.53542E-01	6.29770E-01	6.10650E-01	5.78790E-01	5.66522E-01
69	7.16411E-01	7.03104E-01	6.90717E-01	6.78621E-01	6.50916E-01	6.27023E-01	6.07879E-01	5.75888E-01	5.63729E-01
70	7.13866E-01	7.00435E-01	6.87954E-01	6.75840E-01	6.47830E-01	6.23732E-01	6.04585E-01	5.72335E-01	5.60428E-01
71	7.11094E-01	6.97479E-01	6.84871E-01	6.72743E-01	6.44285E-01	6.19899E-01	6.00769E-01	5.68132E-01	5.56624E-01
72	7.08088E-01	6.94236E-01	6.81467E-01	6.69329E-01	6.40276E-01	6.15520E-01	5.96433E-01	5.63280E-01	5.52325E-01
73	7.04850E-01	6.90704E-01	6.77740E-01	6.65600E-01	6.35798E-01	6.10590E-01	5.91576E-01	5.57774E-01	5.47536E-01
74	7.01380E-01	6.86879E-01	6.73688E-01	6.61554E-01	6.30843E-01	6.05101E-01	5.86195E-01	5.51608E-01	5.42265E-01
75	7.01380E-01	6.86879E-01	6.73688E-01	6.61554E-01	6.30843E-01	6.05101E-01	5.86195E-01	5.51608E-01	5.42265E-01
76	6.99574E-01	6.84845E-01	6.71511E-01	6.59394E-01	6.28321E-01	6.01846E-01	5.83068E-01	5.47777E-01	5.39279E-01
77	6.97748E-01	6.82802E-01	6.69330E-01	6.57226E-01	6.25222E-01	5.98629E-01	5.80005E-01	5.44005E-01	5.36303E-01
78	6.95904E-01	6.80748E-01	6.67143E-01	6.55049E-01	6.22441E-01	5.95444E-01	5.76943E-01	5.40287E-01	5.33339E-01
79	6.94039E-01	6.78682E-01	6.64948E-01	6.52863E-01	6.19675E-01	5.92287E-01	5.73900E-01	5.36617E-01	5.30385E-01
80	6.94039E-01	6.78682E-01	6.64948E-01	6.52863E-01	6.19675E-01	5.92287E-01	5.73900E-01	5.36617E-01	5.30385E-01
81	6.91326E-01	6.75686E-01	6.61769E-01	6.49698E-01	6.15681E-01	5.87721E-01	5.69502E-01	5.31301E-01	5.26116E-01
82	6.88588E-01	6.72688E-01	6.58602E-01	6.46542E-01	6.11764E-01	5.83274E-01	5.65201E-01	5.26163E-01	5.21927E-01
83	6.85823E-01	6.69684E-01	6.55443E-01	6.43390E-01	6.07914E-01	5.78931E-01	5.60988E-01	5.21184E-01	5.17817E-01
84	6.83030E-01	6.66671E-01	6.52286E-01	6.40241E-01	6.04120E-01	5.74678E-01	5.56854E-01	5.16346E-01	5.13783E-01
85	6.83030E-01	6.66671E-01	6.52286E-01	6.40241E-01	6.04120E-01	5.74678E-01	5.56854E-01	5.16346E-01	5.13783E-01
86	6.80191E-01	6.63621E-01	6.49101E-01	6.37066E-01	6.00313E-01	5.70414E-01	5.52718E-01	5.11505E-01	5.09758E-01
87	6.77341E-01	6.60587E-01	6.45949E-01	6.33922E-01	5.96615E-01	5.66306E-01	5.48724E-01	5.06892E-01	5.05870E-01

88	6.74478E-01	6.57566E-01	6.42826E-01	6.30807E-01	5.93014E-01	5.62342E-01	5.44861E-01	5.02489E-01	5.02115E-01
89	6.71602E-01	6.54553E-01	6.39727E-01	6.27718E-01	5.89501E-01	5.58508E-01	5.41123E-01	4.98281E-01	4.98489E-01
90	6.71602E-01	6.54553E-01	6.39728E-01	6.27718E-01	5.89501E-01	5.58508E-01	5.41123E-01	4.98281E-01	4.98489E-01
91	6.65795E-01	6.48537E-01	6.33587E-01	6.21598E-01	5.82698E-01	5.51164E-01	5.33965E-01	4.90347E-01	4.91588E-01
92	6.59994E-01	6.42641E-01	6.27643E-01	6.15675E-01	5.76409E-01	5.44540E-01	5.27491E-01	4.83445E-01	4.85394E-01
93	6.54198E-01	6.36850E-01	6.21880E-01	6.09934E-01	5.70583E-01	5.38569E-01	5.21651E-01	4.77482E-01	4.79885E-01
94	6.48409E-01	6.31160E-01	6.16287E-01	6.04361E-01	5.65189E-01	5.33201E-01	5.16409E-01	4.72394E-01	4.75037E-01
95	6.48409E-01	6.31160E-01	6.16287E-01	6.04362E-01	5.65189E-01	5.33201E-01	5.16409E-01	4.72394E-01	4.75037E-01
96	6.42639E-01	6.25573E-01	6.10861E-01	5.98954E-01	5.60230E-01	5.28396E-01	5.11729E-01	4.68117E-01	4.70828E-01
97	6.36867E-01	6.20051E-01	6.05554E-01	5.93660E-01	5.55523E-01	5.24026E-01	5.07503E-01	4.64498E-01	4.67169E-01
98	6.31110E-01	6.14604E-01	6.00373E-01	5.88480E-01	5.51164E-01	5.20093E-01	5.03727E-01	4.61536E-01	4.64057E-01
99	6.25385E-01	6.09246E-01	5.95330E-01	5.83416E-01	5.47137E-01	5.16607E-01	5.00404E-01	4.59248E-01	4.61491E-01
100	6.25385E-01	6.09246E-01	5.95330E-01	5.83416E-01	5.47137E-01	5.16607E-01	5.00404E-01	4.59248E-01	4.61491E-01
101	6.19733E-01	6.04008E-01	5.90444E-01	5.78477E-01	5.43412E-01	5.13494E-01	4.97461E-01	4.57468E-01	4.59387E-01
102	6.14055E-01	5.98740E-01	5.85539E-01	5.73488E-01	5.39715E-01	5.10423E-01	4.94611E-01	4.55846E-01	4.57524E-01
103	6.08379E-01	5.93465E-01	5.80640E-01	5.68458E-01	5.36086E-01	5.07432E-01	4.91882E-01	4.54439E-01	4.55921E-01
104	6.02736E-01	5.88212E-01	5.75771E-01	5.63393E-01	5.32568E-01	5.04565E-01	4.89302E-01	4.53308E-01	4.54604E-01
105	6.02736E-01	5.88212E-01	5.75771E-01	5.63393E-01	5.32568E-01	5.04565E-01	4.89302E-01	4.53308E-01	4.54604E-01
106	5.99959E-01	5.85629E-01	5.73382E-01	5.60875E-01	5.30885E-01	5.03202E-01	4.88083E-01	4.52833E-01	4.54046E-01
107	5.97178E-01	5.83025E-01	5.70967E-01	5.58312E-01	5.29169E-01	5.01788E-01	4.86828E-01	4.52325E-01	4.53501E-01
108	5.94398E-01	5.80404E-01	5.68531E-01	5.55703E-01	5.27427E-01	5.00329E-01	4.85544E-01	4.51794E-01	4.52973E-01
109	5.91623E-01	5.77769E-01	5.66075E-01	5.53050E-01	5.25664E-01	4.98831E-01	4.84234E-01	4.51249E-01	4.52468E-01
110	5.91623E-01	5.77769E-01	5.66075E-01	5.53050E-01	5.25664E-01	4.98831E-01	4.84234E-01	4.51249E-01	4.52468E-01
111	5.88870E-01	5.75142E-01	5.63621E-01	5.50372E-01	5.23903E-01	4.97312E-01	4.82910E-01	4.50680E-01	4.51979E-01
112	5.86116E-01	5.72484E-01	5.61128E-01	5.47625E-01	5.22086E-01	4.95705E-01	4.81517E-01	4.50037E-01	4.51479E-01
113	5.83364E-01	5.69799E-01	5.58597E-01	5.44807E-01	5.20220E-01	4.94014E-01	4.80061E-01	4.49330E-01	4.50974E-01
114	5.80619E-01	5.67090E-01	5.56033E-01	5.41919E-01	5.18312E-01	4.92245E-01	4.78547E-01	4.48568E-01	4.50472E-01
115	5.80619E-01	5.67090E-01	5.56033E-01	5.41919E-01	5.18312E-01	4.92245E-01	4.78547E-01	4.48568E-01	4.50472E-01
116	5.77897E-01	5.64376E-01	5.53455E-01	5.38981E-01	5.16385E-01	4.90425E-01	4.76990E-01	4.47752E-01	4.49971E-01
117	5.75177E-01	5.61623E-01	5.50824E-01	5.35948E-01	5.14387E-01	4.88484E-01	4.75340E-01	4.46833E-01	4.49448E-01
118	5.72462E-01	5.58831E-01	5.48143E-01	5.32818E-01	5.12324E-01	4.86427E-01	4.73600E-01	4.45819E-01	4.48913E-01
119	5.69757E-01	5.56004E-01	5.45412E-01	5.29590E-01	5.10202E-01	4.84257E-01	4.71775E-01	4.44719E-01	4.48373E-01
120	5.69757E-01	5.56004E-01	5.45412E-01	5.29590E-01	5.10202E-01	4.84257E-01	4.71775E-01	4.44719E-01	4.48373E-01
121	5.66183E-01	5.52155E-01	5.41669E-01	5.24977E-01	5.07291E-01	4.81164E-01	4.69221E-01	4.43150E-01	4.47617E-01
122	5.62605E-01	5.48382E-01	5.38009E-01	5.20602E-01	5.04398E-01	4.78191E-01	4.66719E-01	4.41578E-01	4.46736E-01
123	5.59029E-01	5.44682E-01	5.34430E-01	5.16449E-01	5.01533E-01	4.75338E-01	4.64275E-01	4.40020E-01	4.45748E-01
124	5.55463E-01	5.41058E-01	5.30934E-01	5.12505E-01	4.98707E-01	4.72609E-01	4.61895E-01	4.38490E-01	4.44671E-01
125	5.51913E-01	5.37508E-01	5.27521E-01	5.08760E-01	4.95929E-01	4.70007E-01	4.59587E-01	4.37003E-01	4.43520E-01
126	5.48384E-01	5.34034E-01	5.24191E-01	5.05205E-01	4.93207E-01	4.67535E-01	4.57355E-01	4.35570E-01	4.42308E-01
127	5.44880E-01	5.30637E-01	5.20946E-01	5.01833E-01	4.90548E-01	4.65197E-01	4.55204E-01	4.34206E-01	4.41047E-01
128	5.41407E-01	5.27319E-01	5.17787E-01	4.98640E-01	4.87959E-01	4.62999E-01	4.53140E-01	4.32922E-01	4.39746E-01
129	5.37966E-01	5.24082E-01	5.14716E-01	4.95622E-01	4.85445E-01	4.60947E-01	4.51168E-01	4.31731E-01	4.38412E-01
130	5.34561E-01	5.20927E-01	5.11735E-01	4.92778E-01	4.83013E-01	4.59047E-01	4.49290E-01	4.30643E-01	4.37051E-01
131	5.31193E-01	5.17856E-01	5.08846E-01	4.90107E-01	4.80667E-01	4.57308E-01	4.47512E-01	4.29672E-01	4.35669E-01
132	5.27863E-01	5.14873E-01	5.06051E-01	4.87612E-01	4.78411E-01	4.55737E-01	4.45837E-01	4.28829E-01	4.34266E-01
133	5.24571E-01	5.11979E-01	5.03353E-01	4.85294E-01	4.76250E-01	4.54344E-01	4.44269E-01	4.28126E-01	4.32844E-01

134	5.21316E-01	5.09177E-01	5.00755E-01	4.83159E-01	4.74188E-01	4.53141E-01	4.42810E-01	4.27575E-01	4.31402E-01
135	5.18097E-01	5.06471E-01	4.98260E-01	4.81211E-01	4.72228E-01	4.52138E-01	4.41463E-01	4.27190E-01	4.29937E-01
136	5.18097E-01	5.06471E-01	4.98260E-01	4.81211E-01	4.72226E-01	4.52138E-01	4.41463E-01	4.27190E-01	4.29937E-01
137	4.94883E-01	4.86749E-01	4.80253E-01	4.67245E-01	4.57825E-01	4.43578E-01	4.31663E-01	4.22579E-01	4.19375E-01
138	4.72009E-01	4.66062E-01	4.61086E-01	4.51021E-01	4.42099E-01	4.31707E-01	4.20034E-01	4.14333E-01	4.08391E-01
139	4.49418E-01	4.44860E-01	4.41150E-01	4.33274E-01	4.25247E-01	4.17528E-01	4.06755E-01	4.03400E-01	3.96483E-01
140	4.27076E-01	4.23494E-01	4.20755E-01	4.14539E-01	4.07525E-01	4.01748E-01	3.92114E-01	3.90473E-01	3.83524E-01
141	4.04978E-01	4.02094E-01	4.00142E-01	3.95211E-01	3.89193E-01	3.84883E-01	3.76423E-01	3.76080E-01	3.69583E-01
142	3.83144E-01	3.80817E-01	3.79498E-01	3.75585E-01	3.70488E-01	3.67319E-01	3.59975E-01	3.60638E-01	3.54816E-01
143	3.61617E-01	3.59771E-01	3.58976E-01	3.55886E-01	3.51616E-01	3.49358E-01	3.43034E-01	3.44484E-01	3.39417E-01
144	3.40456E-01	3.39048E-01	3.38697E-01	3.36291E-01	3.32753E-01	3.31234E-01	3.25824E-01	3.27892E-01	3.23581E-01
145	3.19733E-01	3.18734E-01	3.18768E-01	3.16941E-01	3.14048E-01	3.13135E-01	3.08536E-01	3.11085E-01	3.07492E-01
146	2.99523E-01	2.98906E-01	2.99279E-01	2.97947E-01	2.95622E-01	2.95212E-01	2.91329E-01	2.94250E-01	2.91317E-01
147	2.79902E-01	2.79638E-01	2.80305E-01	2.79403E-01	2.77577E-01	2.77586E-01	2.74334E-01	2.77538E-01	2.75200E-01
148	2.60936E-01	2.60990E-01	2.61914E-01	2.61382E-01	2.59996E-01	2.60356E-01	2.57656E-01	2.61073E-01	2.59265E-01
149	2.42684E-01	2.43017E-01	2.44159E-01	2.43946E-01	2.42946E-01	2.43599E-01	2.41382E-01	2.44960E-01	2.43618E-01
150	2.25189E-01	2.25758E-01	2.27081E-01	2.27138E-01	2.26479E-01	2.27379E-01	2.25577E-01	2.29284E-01	2.28344E-01
151	2.08480E-01	2.09243E-01	2.10712E-01	2.10993E-01	2.10636E-01	2.11745E-01	2.10291E-01	2.14118E-01	2.13513E-01
152	2.08480E-01	2.09243E-01	2.10712E-01	2.10993E-01	2.10636E-01	2.11745E-01	2.10291E-01	2.14118E-01	2.13513E-01
153	1.82028E-01	1.83040E-01	1.84687E-01	1.85279E-01	1.85313E-01	1.86666E-01	1.85730E-01	1.89601E-01	1.89513E-01
154	1.58160E-01	1.59362E-01	1.61118E-01	1.61949E-01	1.62288E-01	1.63797E-01	1.63286E-01	1.67065E-01	1.67367E-01
155	1.36759E-01	1.38093E-01	1.39907E-01	1.40912E-01	1.41484E-01	1.43080E-01	1.42908E-01	1.46523E-01	1.47105E-01
156	1.17693E-01	1.19108E-01	1.20933E-01	1.22056E-01	1.22797E-01	1.24429E-01	1.24521E-01	1.27930E-01	1.28706E-01
157	1.00818E-01	1.02266E-01	1.04064E-01	1.05255E-01	1.06110E-01	1.07737E-01	1.08028E-01	1.11207E-01	1.12110E-01
158	8.59787E-02	8.74176E-02	8.91551E-02	9.03717E-02	9.12953E-02	9.28834E-02	9.33186E-02	9.62551E-02	9.72309E-02
159	7.30102E-02	7.44054E-02	7.60555E-02	7.72615E-02	7.82141E-02	7.97371E-02	8.02697E-02	8.29591E-02	8.39662E-02
160	6.17430E-02	6.30667E-02	6.46089E-02	6.57752E-02	6.67246E-02	6.81622E-02	6.87532E-02	7.11963E-02	7.22018E-02
161	5.20060E-02	5.32379E-02	5.46577E-02	5.57622E-02	5.66826E-02	5.80200E-02	5.86376E-02	6.08390E-02	6.18176E-02
162	4.36310E-02	4.47576E-02	4.60465E-02	4.70729E-02	4.79450E-02	4.91724E-02	4.97911E-02	5.17589E-02	5.26912E-02
163	3.64555E-02	3.74698E-02	3.86242E-02	3.95621E-02	4.03719E-02	4.14840E-02	4.20841E-02	4.38285E-02	4.47005E-02
164	3.03263E-02	3.12259E-02	3.22468E-02	3.30905E-02	3.38292E-02	3.48241E-02	3.53913E-02	3.69243E-02	3.77263E-02
165	2.51006E-02	2.58876E-02	2.67790E-02	2.75269E-02	2.81897E-02	2.90687E-02	2.95926E-02	3.09274E-02	3.16535E-02
166	2.06478E-02	2.13270E-02	2.20958E-02	2.27493E-02	2.33345E-02	2.41012E-02	2.45753E-02	2.57255E-02	2.63724E-02
167	1.68499E-02	1.74281E-02	1.80826E-02	1.86454E-02	1.91539E-02	1.98133E-02	2.02339E-02	2.12131E-02	2.17798E-02
168	1.36015E-02	1.40867E-02	1.46358E-02	1.51130E-02	1.55474E-02	1.61054E-02	1.64707E-02	1.72919E-02	1.77793E-02
169	1.08091E-02	1.12096E-02	1.16625E-02	1.20600E-02	1.24235E-02	1.28861E-02	1.31963E-02	1.38713E-02	1.42812E-02
170	8.39057E-03	8.71438E-03	9.07969E-03	9.40355E-03	9.69954E-03	1.00721E-02	1.03285E-02	1.08668E-02	1.12026E-02
171	6.27398E-03	6.52814E-03	6.81326E-03	7.06967E-03	7.30033E-03	7.58679E-03	7.79270E-03	8.20007E-03	8.46748E-03
172	4.39615E-03	4.58613E-03	4.79690E-03	4.99218E-03	5.15672E-03	5.35934E-03	5.52144E-03	5.79617E-03	6.00723E-03
173	2.70134E-03	2.83019E-03	2.97049E-03	3.11216E-03	3.20296E-03	3.32274E-03	3.45581E-03	3.57946E-03	3.76361E-03
174	2.70134E-03	2.83019E-03	2.97049E-03	3.11216E-03	3.20296E-03	3.32274E-03	3.45581E-03	3.57946E-03	3.76361E-03
175	1.65857E-03	1.75233E-03	1.84923E-03	1.94643E-03	2.02979E-03	2.12553E-03	2.21373E-03	2.31353E-03	2.40760E-03
176	1.01343E-03	1.07442E-03	1.13711E-03	1.20037E-03	1.26089E-03	1.32898E-03	1.38812E-03	1.46015E-03	1.51547E-03
177	6.10399E-04	6.46970E-04	6.84877E-04	7.23501E-04	7.62374E-04	8.06415E-04	8.44154E-04	8.91688E-04	9.25343E-04
178	3.46335E-04	3.66312E-04	3.87241E-04	4.08757E-04	4.30977E-04	4.56476E-04	4.78339E-04	5.06396E-04	5.25689E-04
179	1.56648E-04	1.65334E-04	1.74505E-04	1.83991E-04	1.93908E-04	2.05410E-04	2.15304E-04	2.28134E-04	2.36876E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO.	GROUPS 28- 33					
1	4.77451E-01	5.00413E-01	4.99813E-01	4.91028E-01	4.73134E-01	1.46620E 01
2	4.77967E-01	5.00938E-01	5.00323E-01	4.91504E-01	4.73565E-01	1.46504E 01
3	4.79540E-01	5.02525E-01	5.01860E-01	4.92933E-01	4.74855E-01	1.46150E 01
4	4.82246E-01	5.05208E-01	5.04441E-01	4.95315E-01	4.76994E-01	1.45538E 01
5	4.86226E-01	5.09046E-01	5.08089E-01	4.98647E-01	4.79962E-01	1.44639E 01
6	4.91699E-01	5.14114E-01	5.12829E-01	5.02915E-01	4.83719E-01	1.43405E 01
7	4.98981E-01	5.20492E-01	5.18673E-01	5.08078E-01	4.88195E-01	1.41777E 01
8	5.08500E-01	5.28238E-01	5.25588E-01	5.14047E-01	4.93273E-01	1.39677E 01
9	5.20775E-01	5.37319E-01	5.33452E-01	5.20646E-01	4.98756E-01	1.37010E 01
10	5.36324E-01	5.47479E-01	5.41960E-01	5.27556E-01	5.04332E-01	1.33658E 01
11	5.55397E-01	5.57992E-01	5.50470E-01	5.34218E-01	5.09515E-01	1.29483E 01
12	5.55397E-01	5.57992E-01	5.50470E-01	5.34218E-01	5.09515E-01	1.29483E 01
13	5.71647E-01	5.67640E-01	5.58093E-01	5.39789E-01	5.13465E-01	1.21316E 01
14	5.81214E-01	5.73570E-01	5.62403E-01	5.42156E-01	5.14297E-01	1.08070E 01
15	5.84825E-01	5.75400E-01	5.62899E-01	5.40703E-01	5.11379E-01	8.97161E 00
16	5.83049E-01	5.73110E-01	5.59349E-01	5.34960E-01	5.04150E-01	6.61655E 00
17	5.83049E-01	5.73110E-01	5.59349E-01	5.34960E-01	5.04150E-01	6.61655E 00
18	5.82447E-01	5.72516E-01	5.58544E-01	5.33759E-01	5.02709E-01	6.36959E 00
19	5.81856E-01	5.71944E-01	5.57761E-01	5.32582E-01	5.01291E-01	6.12744E 00
20	5.81277E-01	5.71394E-01	5.57000E-01	5.31426E-01	4.99894E-01	5.88966E 00
21	5.80708E-01	5.70866E-01	5.56258E-01	5.30287E-01	4.98515E-01	5.65579E 00
22	5.80708E-01	5.70866E-01	5.56258E-01	5.30287E-01	4.98515E-01	5.65579E 00
23	5.80116E-01	5.70328E-01	5.55500E-01	5.29101E-01	4.97058E-01	5.37753E 00
24	5.79517E-01	5.69792E-01	5.54758E-01	5.27954E-01	4.95656E-01	5.11874E 00
25	5.78911E-01	5.69259E-01	5.54033E-01	5.26842E-01	4.94304E-01	4.87785E 00
26	5.78301E-01	5.68730E-01	5.53324E-01	5.25762E-01	4.92999E-01	4.65337E 00
27	5.78301E-01	5.68730E-01	5.53324E-01	5.25762E-01	4.92999E-01	4.65337E 00
28	5.77447E-01	5.68002E-01	5.52363E-01	5.24308E-01	4.91253E-01	4.36696E 00
29	5.76594E-01	5.67282E-01	5.51432E-01	5.22917E-01	4.89595E-01	4.10753E 00
30	5.75745E-01	5.66574E-01	5.50530E-01	5.21584E-01	4.88017E-01	3.87198E 00
31	5.74901E-01	5.65880E-01	5.49656E-01	5.20302E-01	4.86510E-01	3.65754E 00
32	5.74901E-01	5.65880E-01	5.49656E-01	5.20302E-01	4.86510E-01	3.65754E 00
33	5.74065E-01	5.65199E-01	5.48808E-01	5.19064E-01	4.85065E-01	3.46284E 00
34	5.73245E-01	5.64534E-01	5.47991E-01	5.17883E-01	4.83695E-01	3.28762E 00
35	5.72445E-01	5.63888E-01	5.47203E-01	5.16754E-01	4.82393E-01	3.12965E 00
36	5.71664E-01	5.63261E-01	5.46443E-01	5.15671E-01	4.81154E-01	2.98692E 00
37	5.71664E-01	5.63261E-01	5.46443E-01	5.15671E-01	4.81154E-01	2.98692E 00
38	5.70178E-01	5.62064E-01	5.45013E-01	5.13657E-01	4.78866E-01	2.74582E 00
39	5.68830E-01	5.60957E-01	5.43710E-01	5.11871E-01	4.76859E-01	2.55479E 00
40	5.67620E-01	5.59947E-01	5.42531E-01	5.10283E-01	4.75094E-01	2.40352E 00
41	5.66547E-01	5.59040E-01	5.41468E-01	5.08867E-01	4.73540E-01	2.28388E 00

42	5.66547E-01	5.59040E-01	5.41468E-01	5.08867E-01	4.73540E-01	2.28388E 00
43	5.65528E-01	5.58233E-01	5.40521E-01	5.07632E-01	4.72203E-01	2.19382E 00
44	5.64887E-01	5.57524E-01	5.39698E-01	5.06612E-01	4.71118E-01	2.13293E 00
45	5.64315E-01	5.56908E-01	5.38990E-01	5.05789E-01	4.70265E-01	2.09744E 00
46	5.63900E-01	5.56377E-01	5.38384E-01	5.05147E-01	4.69626E-01	2.08500E 00
47	5.63900E-01	5.56377E-01	5.38384E-01	5.05147E-01	4.69626E-01	2.08500E 00
48	5.63626E-01	5.55916E-01	5.37869E-01	5.04675E-01	4.69194E-01	2.09517E 00
49	5.63478E-01	5.55506E-01	5.37431E-01	5.04367E-01	4.68964E-01	2.12865E 00
50	5.63432E-01	5.55126E-01	5.37054E-01	5.04215E-01	4.68930E-01	2.18672E 00
51	5.63460E-01	5.54747E-01	5.36721E-01	5.04211E-01	4.69091E-01	2.27193E 00
52	5.63460E-01	5.54747E-01	5.36721E-01	5.04211E-01	4.69091E-01	2.27193E 00
53	5.63486E-01	5.54546E-01	5.36562E-01	5.04259E-01	4.69240E-01	2.32567E 00
54	5.63513E-01	5.54335E-01	5.36403E-01	5.04332E-01	4.69427E-01	2.38688E 00
55	5.63535E-01	5.54108E-01	5.36244E-01	5.04432E-01	4.69654E-01	2.45627E 00
56	5.63547E-01	5.53860E-01	5.36080E-01	5.04558E-01	4.69923E-01	2.53465E 00
57	5.63547E-01	5.53860E-01	5.36080E-01	5.04558E-01	4.69923E-01	2.53465E 00
58	5.63537E-01	5.53529E-01	5.35872E-01	5.04734E-01	4.70289E-01	2.64072E 00
59	5.63485E-01	5.53153E-01	5.35645E-01	5.04932E-01	4.70701E-01	2.76096E 00
60	5.63382E-01	5.52722E-01	5.35395E-01	5.05154E-01	4.71162E-01	2.89733E 00
61	5.63216E-01	5.52226E-01	5.35118E-01	5.05404E-01	4.71678E-01	3.05205E 00
62	5.63216E-01	5.52226E-01	5.35118E-01	5.05404E-01	4.71678E-01	3.05205E 00
63	5.62808E-01	5.51472E-01	5.34620E-01	5.05466E-01	4.72015E-01	3.22709E 00
64	5.62033E-01	5.50437E-01	5.33793E-01	5.05092E-01	4.71885E-01	3.36288E 00
65	5.60887E-01	5.49114E-01	5.32636E-01	5.04293E-01	4.71300E-01	3.46040E 00
66	5.59364E-01	5.47497E-01	5.31153E-01	5.03080E-01	4.70275E-01	3.52052E 00
67	5.57464E-01	5.45585E-01	5.29346E-01	5.01463E-01	4.68818E-01	3.54408E 00
68	5.55188E-01	5.43379E-01	5.27220E-01	4.99448E-01	4.65940E-01	3.53182E 00
69	5.52541E-01	5.40884E-01	5.24781E-01	4.97044E-01	4.64647E-01	3.48444E 00
70	5.49527E-01	5.38105E-01	5.22033E-01	4.94255E-01	4.61948E-01	3.40257E 00
71	5.46156E-01	5.35052E-01	5.18985E-01	4.91088E-01	4.58845E-01	3.28677E 00
72	5.42438E-01	5.31735E-01	5.15643E-01	4.87545E-01	4.55344E-01	3.13758E 00
73	5.38386E-01	5.28170E-01	5.12019E-01	4.83631E-01	4.51446E-01	2.95545E 00
74	5.34015E-01	5.24374E-01	5.08120E-01	4.79347E-01	4.47153E-01	2.74081E 00
75	5.34015E-01	5.24374E-01	5.08120E-01	4.79347E-01	4.47153E-01	2.74081E 00
76	5.31698E-01	5.22410E-01	5.06053E-01	4.76956E-01	4.44713E-01	2.63237E 00
77	5.29362E-01	5.20422E-01	5.03975E-01	4.74577E-01	4.42292E-01	2.52994E 00
78	5.27011E-01	5.18412E-01	5.01887E-01	4.72207E-01	4.39887E-01	2.43295E 00
79	5.24647E-01	5.16385E-01	4.99791E-01	4.69846E-01	4.37496E-01	2.34085E 00
80	5.24647E-01	5.16385E-01	4.99791E-01	4.69846E-01	4.37496E-01	2.34085E 00
81	5.21223E-01	5.13445E-01	4.96760E-01	4.66438E-01	4.34046E-01	2.21790E 00
82	5.17809E-01	5.10496E-01	4.93742E-01	4.63089E-01	4.30671E-01	2.10565E 00
83	5.14411E-01	5.07544E-01	4.90740E-01	4.59795E-01	4.27364E-01	2.00264E 00
84	5.11034E-01	5.04596E-01	4.87757E-01	4.56552E-01	4.24120E-01	1.90759E 00
85	5.11034E-01	5.04596E-01	4.87757E-01	4.56552E-01	4.24120E-01	1.90759E 00
86	5.07656E-01	5.01641E-01	4.84770E-01	4.53310E-01	4.20883E-01	1.82080E 00
87	5.04335E-01	4.98718E-01	4.81832E-01	4.50163E-01	4.17757E-01	1.74367E 00

88	5.01075E-01	4.95830E-01	4.78946E-01	4.47108E-01	4.14737E-01	1.67505E 00
89	4.97878E-01	4.92983E-01	4.76113E-01	4.44140E-01	4.11818E-01	1.61393E 00
90	4.97878E-01	4.92983E-01	4.76113E-01	4.44140E-01	4.11818E-01	1.61393E 00
91	4.91665E-01	4.87409E-01	4.70595E-01	4.38438E-01	4.06252E-01	1.51562E 00
92	4.85820E-01	4.82091E-01	4.65396E-01	4.33228E-01	4.01243E-01	1.44642E 00
93	4.80345E-01	4.77045E-01	4.60520E-01	4.28490E-01	3.96765E-01	1.40210E 00
94	4.75227E-01	4.72278E-01	4.55965E-01	4.24209E-01	3.92798E-01	1.38011E 00
95	4.75227E-01	4.72278E-01	4.55965E-01	4.24209E-01	3.92798E-01	1.38011E 00
96	4.70451E-01	4.67792E-01	4.51731E-01	4.20368E-01	3.89321E-01	1.37725E 00
97	4.65953E-01	4.63557E-01	4.47776E-01	4.16904E-01	3.86264E-01	1.39159E 00
98	4.61698E-01	4.59559E-01	4.44095E-01	4.13816E-01	3.83629E-01	1.42441E 00
99	4.57644E-01	4.55781E-01	4.40680E-01	4.11109E-01	3.81426E-01	1.47811E 00
100	4.57644E-01	4.55781E-01	4.40680E-01	4.11109E-01	3.81426E-01	1.47811E 00
101	4.53741E-01	4.52208E-01	4.37514E-01	4.08737E-01	3.79588E-01	1.54790E 00
102	4.49799E-01	4.48737E-01	4.34464E-01	4.06514E-01	3.77925E-01	1.63039E 00
103	4.45756E-01	4.45346E-01	4.31528E-01	4.04460E-01	3.76465E-01	1.73022E 00
104	4.41542E-01	4.42014E-01	4.28701E-01	4.02598E-01	3.75239E-01	1.85288E 00
105	4.41542E-01	4.42014E-01	4.28701E-01	4.02598E-01	3.75239E-01	1.85288E 00
106	4.39359E-01	4.40373E-01	4.27338E-01	4.01748E-01	3.74713E-01	1.92269E 00
107	4.37072E-01	4.38723E-01	4.25973E-01	4.00899E-01	3.74195E-01	1.99646E 00
108	4.34671E-01	4.37064E-01	4.24607E-01	4.00058E-01	3.73690E-01	2.07501E 00
109	4.32140E-01	4.35392E-01	4.23242E-01	3.99228E-01	3.73204E-01	2.15924E 00
110	4.32140E-01	4.35393E-01	4.23242E-01	3.99228E-01	3.73204E-01	2.15924E 00
111	4.29487E-01	4.33716E-01	4.21883E-01	3.98414E-01	3.72733E-01	2.24751E 00
112	4.26659E-01	4.32016E-01	4.20509E-01	3.97586E-01	3.72252E-01	2.33907E 00
113	4.23641E-01	4.30292E-01	4.19122E-01	3.96750E-01	3.71768E-01	2.43476E 00
114	4.20416E-01	4.28546E-01	4.17723E-01	3.95911E-01	3.71287E-01	2.53549E 00
115	4.20416E-01	4.28546E-01	4.17723E-01	3.95911E-01	3.71287E-01	2.53549E 00
116	4.16992E-01	4.26786E-01	4.16324E-01	3.95077E-01	3.70807E-01	2.64022E 00
117	4.13309E-01	4.24999E-01	4.14904E-01	3.94222E-01	3.70308E-01	2.74865E 00
118	4.09345E-01	4.23187E-01	4.13469E-01	3.93355E-01	3.69798E-01	2.86163E 00
119	4.05079E-01	4.21355E-01	4.12022E-01	3.92481E-01	3.69283E-01	2.98008E 00
120	4.05079E-01	4.21355E-01	4.12022E-01	3.92481E-01	3.69283E-01	2.98008E 00
121	3.97622E-01	4.18904E-01	4.10097E-01	3.91316E-01	3.68589E-01	3.13867E 00
122	3.91237E-01	4.16506E-01	4.08201E-01	3.90121E-01	3.67865E-01	3.29108E 00
123	3.85795E-01	4.14176E-01	4.06348E-01	3.88915E-01	3.67128E-01	3.43850E 00
124	3.81191E-01	4.11927E-01	4.04550E-01	3.87712E-01	3.66391E-01	3.58206E 00
125	3.77342E-01	4.09766E-01	4.02817E-01	3.86524E-01	3.65670E-01	3.72285E 00
126	3.74180E-01	4.07698E-01	4.01155E-01	3.85364E-01	3.64975E-01	3.86193E 00
127	3.71658E-01	4.05723E-01	3.99570E-01	3.84239E-01	3.64319E-01	4.00034E 00
128	3.69740E-01	4.03842E-01	3.98066E-01	3.83158E-01	3.63712E-01	4.13908E 00
129	3.68405E-01	4.02051E-01	3.96645E-01	3.82127E-01	3.63163E-01	4.27916E 00
130	3.67648E-01	4.00344E-01	3.95308E-01	3.81152E-01	3.62681E-01	4.42157E 00
131	3.67473E-01	3.98713E-01	3.94056E-01	3.80235E-01	3.62275E-01	4.56731E 00
132	3.67899E-01	3.97147E-01	3.92885E-01	3.79380E-01	3.61952E-01	4.71738E 00
133	3.68957E-01	3.95633E-01	3.91794E-01	3.78588E-01	3.61721E-01	4.87278E 00

134	3.70690E-01	3.94154E-01	3.90778E-01	3.77861E-01	3.61588E-01	5.03457E 00
135	3.73159E-01	3.92689E-01	3.89832E-01	3.77198E-01	3.61561E-01	5.20379E 00

136	3.73159E-01	3.92689E-01	3.89832E-01	3.77198E-01	3.61561E-01	5.20379E 00
137	3.81496E-01	3.84644E-01	3.82925E-01	3.71777E-01	3.59944E-01	5.53277E 00
138	3.81863E-01	3.77367E-01	3.75194E-01	3.64922E-01	3.55617E-01	5.80869E 00
139	3.76981E-01	3.69347E-01	3.66538E-01	3.56816E-01	3.49218E-01	6.03432E 00
140	3.68549E-01	3.60041E-01	3.56864E-01	3.47586E-01	3.41186E-01	6.21250E 00
141	3.57670E-01	3.49376E-01	3.46164E-01	3.37341E-01	3.31840E-01	6.34609E 00
142	3.45090E-01	3.37490E-01	3.34506E-01	3.26200E-01	3.21427E-01	6.43796E 00
143	3.31336E-01	3.24604E-01	3.22017E-01	3.14294E-01	3.10154E-01	6.49094E 00
144	3.16798E-01	3.10957E-01	3.08854E-01	3.01763E-01	2.98201E-01	6.50782E 00
145	3.01771E-01	2.96777E-01	2.95184E-01	2.88750E-01	2.85734E-01	6.49130E 00
146	2.86487E-01	2.82266E-01	2.81173E-01	2.75400E-01	2.72902E-01	6.44404E 00
147	2.71132E-01	2.67602E-01	2.66974E-01	2.61849E-01	2.59846E-01	6.36860E 00
148	2.55855E-01	2.52933E-01	2.52726E-01	2.48222E-01	2.46696E-01	6.26743E 00
149	2.40775E-01	2.38384E-01	2.38552E-01	2.34635E-01	2.33572E-01	6.14287E 00
150	2.25987E-01	2.24056E-01	2.24555E-01	2.21189E-01	2.20585E-01	5.99715E 00
151	2.11565E-01	2.10030E-01	2.10828E-01	2.07974E-01	2.07843E-01	5.83237E 00

152	2.11565E-01	2.10030E-01	2.10828E-01	2.07974E-01	2.07843E-01	5.83237E 00
153	1.88196E-01	1.87234E-01	1.88407E-01	1.86292E-01	1.86803E-01	5.55995E 00
154	1.66565E-01	1.66065E-01	1.67484E-01	1.65974E-01	1.66890E-01	5.27863E 00
155	1.46711E-01	1.46575E-01	1.48145E-01	1.47123E-01	1.48294E-01	4.99271E 00
156	1.28627E-01	1.28770E-01	1.30417E-01	1.29784E-01	1.31107E-01	4.70588E 00
157	1.12267E-01	1.12617E-01	1.14287E-01	1.13959E-01	1.15360E-01	4.42130E 00
158	9.75610E-02	9.80562E-02	9.97062E-02	9.96126E-02	1.01038E-01	4.14158E 00
159	8.44160E-02	8.50081E-02	8.66049E-02	8.66874E-02	8.80966E-02	3.86886E 00
160	7.27285E-02	7.33775E-02	7.48969E-02	7.51072E-02	7.64707E-02	3.60486E 00
161	6.23867E-02	6.30606E-02	6.44856E-02	6.47839E-02	6.60799E-02	3.35088E 00
162	5.32752E-02	5.39490E-02	5.52680E-02	5.56221E-02	5.68354E-02	3.10793E 00
163	4.52780E-02	4.59323E-02	4.71385E-02	4.75225E-02	4.86428E-02	2.87669E 00
164	3.82809E-02	3.89012E-02	3.99913E-02	4.03847E-02	4.14059E-02	2.65761E 00
165	3.21731E-02	3.27490E-02	3.37226E-02	3.41096E-02	3.50285E-02	2.45094E 00
166	2.68487E-02	2.73731E-02	2.82321E-02	2.86007E-02	2.94165E-02	2.25674E 00
167	2.22073E-02	2.26761E-02	2.34240E-02	2.37655E-02	2.44789E-02	2.07495E 00
168	1.81551E-02	1.85666E-02	1.92079E-02	1.95159E-02	2.01284E-02	1.90538E 00
169	1.46049E-02	1.49594E-02	1.54992E-02	1.57688E-02	1.62817E-02	1.74780E 00
170	1.14761E-02	1.17758E-02	1.22191E-02	1.24460E-02	1.28591E-02	1.60190E 00
171	8.69604E-03	8.94438E-03	9.29395E-03	9.47321E-03	9.78341E-03	1.46734E 00
172	6.20003E-03	6.40031E-03	6.65431E-03	6.77905E-03	6.97771E-03	1.34380E 00
173	3.93343E-03	4.08501E-03	4.23164E-03	4.29256E-03	4.36193E-03	1.23095E 00

174	3.93343E-03	4.08501E-03	4.23164E-03	4.29256E-03	4.36193E-03	1.23095E 00
175	2.49550E-03	2.58739E-03	2.68630E-03	2.74573E-03	2.76647E-03	8.55464E-01
176	1.56640E-03	1.62291E-03	1.68636E-03	1.72964E-03	1.73764E-03	5.82816E-01
177	9.55913E-04	9.90428E-04	1.02978E-03	1.05811E-03	1.06220E-03	3.82104E-01
178	5.43096E-04	5.62842E-04	5.85470E-04	6.02179E-04	6.04483E-04	2.29759E-01
179	2.44745E-04	2.53685E-04	2.63952E-04	2.71620E-04	2.72688E-04	1.07396E-01
180	0.	0.	0.	0.	0.	0.

GROUP FLUXES

Table C.4. HFIR 33-Group Fluxes, 100 Mwd

R. NO.	GROUPS 1- 9								
1	5.55025E-01	2.07400E 00	1.85295E 00	1.78208E 00	1.25337E 00	1.10277E 00	8.75504E-01	7.48850E-01	6.87130E-01
2	5.56050E-01	2.07854E 00	1.85746E 00	1.78601E 00	1.25609E 00	1.10501E 00	8.77255E-01	7.50295E-01	6.88363E-01
3	5.59130E-01	2.09217E 00	1.87104E 00	1.79782E 00	1.26426E 00	1.11173E 00	8.82510E-01	7.54630E-01	6.92057E-01
4	5.64281E-01	2.11500E 00	1.89380E 00	1.81757E 00	1.27791E 00	1.12295E 00	8.91283E-01	7.61857E-01	6.98197E-01
5	5.71532E-01	2.14718E 00	1.92593E 00	1.84539E 00	1.29714E 00	1.13870E 00	9.03596E-01	7.71978E-01	7.06751E-01
6	5.80924E-01	2.18892E 00	1.96771E 00	1.88142E 00	1.32203E 00	1.15902E 00	9.19475E-01	7.84991E-01	7.17672E-01
7	5.92509E-01	2.24051E 00	2.01951E 00	1.92587E 00	1.35272E 00	1.18395E 00	9.38956E-01	8.00892E-01	7.30888E-01
8	6.06350E-01	2.30230E 00	2.08177E 00	1.97898E 00	1.38938E 00	1.21354E 00	9.62073E-01	8.19663E-01	7.46293E-01
9	6.22526E-01	2.37471E 00	2.15503E 00	2.04104E 00	1.43219E 00	1.24784E 00	9.88865E-01	8.41272E-01	7.63737E-01
10	6.41126E-01	2.45822E 00	2.23995E 00	2.11238E 00	1.48136E 00	1.28689E 00	1.01936E 00	8.65664E-01	7.83007E-01
11	6.62253E-01	2.55341E 00	2.33728E 00	2.19337E 00	1.53715E 00	1.33070E 00	1.05360E 00	8.92748E-01	8.03806E-01
12	6.62253E-01	2.55341E 00	2.33728E 00	2.19337E 00	1.53715E 00	1.33070E 00	1.05360E 00	8.92748E-01	8.03806E-01
13	6.81533E-01	2.64430E 00	2.43875E 00	2.27408E 00	1.59330E 00	1.37366E 00	1.08062E 00	9.14119E-01	8.27109E-01
14	7.03041E-01	2.75003E 00	2.56040E 00	2.37072E 00	1.66069E 00	1.42436E 00	1.11158E 00	9.38647E-01	8.54091E-01
15	7.26834E-01	2.87097E 00	2.70313E 00	2.48344E 00	1.73944E 00	1.48247E 00	1.14578E 00	9.65757E-01	8.84899E-01
16	7.52983E-01	3.00762E 00	2.86818E 00	2.61255E 00	1.82981E 00	1.54768E 00	1.18239E 00	9.94780E-01	9.19772E-01
17	7.52983E-01	3.00762E 00	2.86818E 00	2.61255E 00	1.82981E 00	1.54768E 00	1.18239E 00	9.94780E-01	9.19772E-01
18	7.64109E-01	3.06354E 00	2.92582E 00	2.66208E 00	1.86374E 00	1.57247E 00	1.20340E 00	1.01123E 00	9.27829E-01
19	7.75456E-01	3.11934E 00	2.98277E 00	2.71052E 00	1.89690E 00	1.59659E 00	1.22390E 00	1.02715E 00	9.35626E-01
20	7.87034E-01	3.17512E 00	3.03913E 00	2.75794E 00	1.92933E 00	1.62005E 00	1.24393E 00	1.04256E 00	9.43153E-01
21	7.98853E-01	3.23093E 00	3.09497E 00	2.80440E 00	1.96108E 00	1.64290E 00	1.26352E 00	1.05746E 00	9.50400E-01
22	7.98853E-01	3.23093E 00	3.09497E 00	2.80440E 00	1.96108E 00	1.64290E 00	1.26352E 00	1.05746E 00	9.50400E-01
23	8.05326E-01	3.26182E 00	3.12817E 00	2.83056E 00	1.97914E 00	1.65574E 00	1.27272E 00	1.06446E 00	9.55747E-01
24	8.11510E-01	3.29140E 00	3.15993E 00	2.85569E 00	1.99649E 00	1.66813E 00	1.28163E 00	1.07127E 00	9.60976E-01
25	8.17428E-01	3.31975E 00	3.19037E 00	2.87986E 00	2.01318E 00	1.68013E 00	1.29027E 00	1.07789E 00	9.66088E-01
26	8.23102E-01	3.34700E 00	3.21961E 00	2.90314E 00	2.02927E 00	1.69173E 00	1.29866E 00	1.08433E 00	9.71083E-01
27	8.23102E-01	3.34700E 00	3.21961E 00	2.90314E 00	2.02927E 00	1.69173E 00	1.29866E 00	1.08433E 00	9.71083E-01
28	8.30567E-01	3.38294E 00	3.25816E 00	2.93399E 00	2.05058E 00	1.70721E 00	1.30986E 00	1.09298E 00	9.77831E-01
29	8.37548E-01	3.41668E 00	3.29433E 00	2.96308E 00	2.07070E 00	1.72191E 00	1.32055E 00	1.10127E 00	9.84340E-01
30	8.44096E-01	3.44845E 00	3.32838E 00	2.99059E 00	2.08973E 00	1.73591E 00	1.33075E 00	1.10921E 00	9.90611E-01
31	8.50259E-01	3.47846E 00	3.36055E 00	3.01669E 00	2.10780E 00	1.74926E 00	1.34049E 00	1.11682E 00	9.96649E-01
32	8.50259E-01	3.47846E 00	3.36055E 00	3.01669E 00	2.10780E 00	1.74926E 00	1.34049E 00	1.11682E 00	9.96649E-01
33	8.56021E-01	3.50667E 00	3.39078E 00	3.04133E 00	2.12486E 00	1.76194E 00	1.34978E 00	1.12410E 00	1.00246E 00
34	8.61355E-01	3.53293E 00	3.41893E 00	3.06441E 00	2.14085E 00	1.77391E 00	1.35857E 00	1.13102E 00	1.00801E 00
35	8.66301E-01	3.55744E 00	3.44521E 00	3.08608E 00	2.15587E 00	1.78522E 00	1.36690E 00	1.13761E 00	1.01333E 00
36	8.70900E-01	3.58037E 00	3.46982E 00	3.10646E 00	2.17001E 00	1.79592E 00	1.37479E 00	1.14386E 00	1.01840E 00
37	8.70900E-01	3.58037E 00	3.46982E 00	3.10646E 00	2.17001E 00	1.79592E 00	1.37479E 00	1.14386E 00	1.01840E 00
38	8.78918E-01	3.62095E 00	3.51340E 00	3.14295E 00	2.19535E 00	1.81534E 00	1.38919E 00	1.15536E 00	1.02782E 00
39	8.85454E-01	3.65486E 00	3.54992E 00	3.17404E 00	2.21697E 00	1.83219E 00	1.40178E 00	1.16552E 00	1.03624E 00
40	8.90737E-01	3.68315E 00	3.58054E 00	3.20051E 00	2.23543E 00	1.84677E 00	1.41273E 00	1.17443E 00	1.04372E 00
41	8.94950E-01	3.70666E 00	3.60618E 00	3.22300E 00	2.25114E 00	1.85931E 00	1.42219E 00	1.18217E 00	1.05028E 00

42	8.94950E-01	3.70666E 00	3.60618E 00	3.22300E 00	2.25114E 00	1.85931E 00	1.42219E 00	1.18217E 00	1.05028E 00
43	8.98028E-01	3.72514E 00	3.62656E 00	3.24134E 00	2.26400E 00	1.86978E 00	1.43014E 00	1.18875E 00	1.05593E 00
44	8.99884E-01	3.73819E 00	3.64128E 00	3.25525E 00	2.27381E 00	1.87807E 00	1.43653E 00	1.19415E 00	1.06067E 00
45	9.00616E-01	3.74626E 00	3.65083E 00	3.26509E 00	2.28081E 00	1.88433E 00	1.44144E 00	1.19842E 00	1.06454E 00
46	9.00293E-01	3.74971E 00	3.65557E 00	3.27112E 00	2.28519E 00	1.88868E 00	1.44496E 00	1.20161E 00	1.06756E 00
47	9.00293E-01	3.74971E 00	3.65557E 00	3.27112E 00	2.28519E 00	1.88868E 00	1.44496E 00	1.20161E 00	1.06756E 00
48	8.98926E-01	3.74855E 00	3.65556E 00	3.27342E 00	2.28701E 00	1.89116E 00	1.44713E 00	1.20378E 00	1.06978E 00
49	8.96504E-01	3.74277E 00	3.65077E 00	3.27197E 00	2.28624E 00	1.89180E 00	1.44796E 00	1.20494E 00	1.07121E 00
50	8.93007E-01	3.73228E 00	3.64110E 00	3.26675E 00	2.28289E 00	1.89061E 00	1.44749E 00	1.20513E 00	1.07189E 00
51	8.88390E-01	3.71689E 00	3.62634E 00	3.25766E 00	2.27688E 00	1.88759E 00	1.44573E 00	1.20437E 00	1.07186E 00
52	8.88390E-01	3.71689E 00	3.62634E 00	3.25766E 00	2.27688E 00	1.88759E 00	1.44573E 00	1.20437E 00	1.07186E 00
53	8.85660E-01	3.70735E 00	3.61705E 00	3.25167E 00	2.27288E 00	1.88542E 00	1.44438E 00	1.20366E 00	1.07160E 00
54	8.82669E-01	3.69668E 00	3.60657E 00	3.24479E 00	2.26827E 00	1.88282E 00	1.44274E 00	1.20274E 00	1.07118E 00
55	8.79402E-01	3.68481E 00	3.59485E 00	3.23697E 00	2.26302E 00	1.87980E 00	1.44080E 00	1.20161E 00	1.07060E 00
56	8.75843E-01	3.67166E 00	3.58180E 00	3.22818E 00	2.25710E 00	1.87635E 00	1.43856E 00	1.20028E 00	1.06987E 00
57	8.75843E-01	3.67166E 00	3.58180E 00	3.22818E 00	2.25710E 00	1.87635E 00	1.43856E 00	1.20028E 00	1.06987E 00
58	8.71218E-01	3.65433E 00	3.56453E 00	3.21643E 00	2.24918E 00	1.87168E 00	1.43551E 00	1.19842E 00	1.06882E 00
59	8.66209E-01	3.63535E 00	3.54552E 00	3.20342E 00	2.24039E 00	1.86645E 00	1.43208E 00	1.19631E 00	1.06758E 00
60	8.60778E-01	3.61452E 00	3.52459E 00	3.18901E 00	2.23066E 00	1.86063E 00	1.42825E 00	1.19395E 00	1.06616E 00
61	8.54882E-01	3.59166E 00	3.50152E 00	3.17309E 00	2.21989E 00	1.85419E 00	1.42402E 00	1.19133E 00	1.06457E 00
62	8.54882E-01	3.59166E 00	3.50152E 00	3.17309E 00	2.21989E 00	1.85419E 00	1.42402E 00	1.19133E 00	1.06457E 00
63	8.47117E-01	3.56178E 00	3.47188E 00	3.15220E 00	2.20579E 00	1.84562E 00	1.41808E 00	1.18758E 00	1.06244E 00
64	8.40479E-01	3.53660E 00	3.44713E 00	3.13439E 00	2.19380E 00	1.83810E 00	1.41278E 00	1.18410E 00	1.06030E 00
65	8.34937E-01	3.51602E 00	3.42715E 00	3.11963E 00	2.18388E 00	1.83162E 00	1.40813E 00	1.18088E 00	1.05816E 00
66	8.30467E-01	3.49992E 00	3.41185E 00	3.10784E 00	2.17599E 00	1.82618E 00	1.40412E 00	1.17796E 00	1.05604E 00
67	8.27045E-01	3.48822E 00	3.40111E 00	3.09898E 00	2.17010E 00	1.82176E 00	1.40075E 00	1.17533E 00	1.05395E 00
68	8.24650E-01	3.48084E 00	3.39487E 00	3.09300E 00	2.16618E 00	1.81835E 00	1.39802E 00	1.17300E 00	1.05190E 00
69	8.23263E-01	3.47768E 00	3.39303E 00	3.08984E 00	2.16420E 00	1.81594E 00	1.39591E 00	1.17095E 00	1.04989E 00
70	8.22866E-01	3.47870E 00	3.39554E 00	3.08946E 00	2.16411E 00	1.81450E 00	1.39441E 00	1.16917E 00	1.04790E 00
71	8.23446E-01	3.48382E 00	3.40234E 00	3.09180E 00	2.16590E 00	1.81400E 00	1.39349E 00	1.16765E 00	1.04594E 00
72	8.24987E-01	3.49300E 00	3.41338E 00	3.09683E 00	2.16953E 00	1.81443E 00	1.39312E 00	1.16637E 00	1.04397E 00
73	8.27479E-01	3.50619E 00	3.42861E 00	3.10449E 00	2.17497E 00	1.81573E 00	1.39329E 00	1.16528E 00	1.04198E 00
74	8.30911E-01	3.52335E 00	3.44801E 00	3.11474E 00	2.18220E 00	1.81788E 00	1.39395E 00	1.16436E 00	1.03994E 00
75	8.30911E-01	3.52335E 00	3.44801E 00	3.11474E 00	2.18220E 00	1.81788E 00	1.39395E 00	1.16436E 00	1.03994E 00
76	8.32474E-01	3.53115E 00	3.45694E 00	3.11939E 00	2.18549E 00	1.81884E 00	1.39423E 00	1.16394E 00	1.03894E 00
77	8.33821E-01	3.53802E 00	3.46490E 00	3.12336E 00	2.18831E 00	1.81953E 00	1.39432E 00	1.16342E 00	1.03787E 00
78	8.34967E-01	3.54402E 00	3.47195E 00	3.12668E 00	2.19071E 00	1.81996E 00	1.39424E 00	1.16278E 00	1.03674E 00
79	8.35925E-01	3.54922E 00	3.47817E 00	3.12941E 00	2.19270E 00	1.82014E 00	1.39400E 00	1.16204E 00	1.03553E 00
80	8.35925E-01	3.54922E 00	3.47817E 00	3.12941E 00	2.19270E 00	1.82014E 00	1.39400E 00	1.16204E 00	1.03553E 00
81	8.36942E-01	3.55515E 00	3.48548E 00	3.13219E 00	2.19479E 00	1.81993E 00	1.39333E 00	1.16077E 00	1.03368E 00
82	8.37542E-01	3.55928E 00	3.49093E 00	3.13363E 00	2.19598E 00	1.81915E 00	1.39229E 00	1.15925E 00	1.03167E 00
83	8.37760E-01	3.56179E 00	3.49468E 00	3.13384E 00	2.19634E 00	1.81785E 00	1.39089E 00	1.15749E 00	1.02950E 00
84	8.37631E-01	3.56281E 00	3.49692E 00	3.13293E 00	2.19595E 00	1.81606E 00	1.38915E 00	1.15550E 00	1.02717E 00
85	8.37631E-01	3.56281E 00	3.49692E 00	3.13293E 00	2.19595E 00	1.81606E 00	1.38915E 00	1.15550E 00	1.02717E 00
86	8.37124E-01	3.56223E 00	3.49749E 00	3.13080E 00	2.19474E 00	1.81373E 00	1.38704E 00	1.15325E 00	1.02467E 00
87	8.36211E-01	3.55991E 00	3.49625E 00	3.12736E 00	2.19264E 00	1.81083E 00	1.38455E 00	1.15074E 00	1.02198E 00

88	8.34923E-01	3.55598E 00	3.49336E 00	3.12269E 00	2.18973E 00	1.80739E 00	1.38168E 00	1.14796E 00	1.01912E 00
89	8.33285E-01	3.55057E 00	3.48893E 00	3.11689E 03	2.18605E 00	1.80344E 00	1.37845E 00	1.14494E 00	1.01608E 00
90	8.33285E-01	3.55057E 00	3.48893E 00	3.11689E 00	2.18605E 00	1.80344E 00	1.37845E 00	1.14494E 00	1.01608E 00
91	8.28872E-01	3.53490E 00	3.47509E 00	3.10156E 00	2.17620E 00	1.79388E 00	1.37086E 00	1.13808E 00	1.00942E 00
92	8.23020E-01	3.51310E 00	3.45493E 00	3.08153E 00	2.16322E 00	1.78220E 00	1.36180E 00	1.13017E 00	1.00203E 00
93	8.15839E-01	3.48568E 00	3.42900E 00	3.05715E 00	2.14734E 00	1.76853E 00	1.35135E 00	1.12125E 00	9.93915E-01
94	8.07397E-01	3.45292E 00	3.39761E 00	3.02863E 00	2.12873E 00	1.75296E 00	1.33957E 00	1.11136E 00	9.85087E-01
95	8.07397E-01	3.45292E 00	3.39761E 00	3.02863E 00	2.12873E 00	1.75296E 00	1.33957E 00	1.11136E 00	9.85087E-01
96	7.97792E-01	3.41529E 00	3.36125E 00	2.99630E 00	2.10763E 00	1.73564E 00	1.32655E 00	1.10054E 00	9.75583E-01
97	7.87071E-01	3.37298E 00	3.32013E 00	2.96034E 00	2.08417E 00	1.71663E 00	1.31235E 00	1.08882E 00	9.65417E-01
98	7.75192E-01	3.32581E 00	3.27405E 00	2.92061E 00	2.05828E 00	1.69591E 00	1.29696E 00	1.07622E 00	9.54605E-01
99	7.62078E-01	3.27343E 00	3.22263E 00	2.87687E 00	2.02981E 00	1.67342E 00	1.28036E 00	1.06274E 00	9.43163E-01
100	7.62078E-01	3.27343E 00	3.22263E 00	2.87687E 00	2.02981E 00	1.67342E 00	1.28036E 00	1.06274E 00	9.43163E-01
101	7.47932E-01	3.21677E 00	3.16677E 00	2.82980E 00	1.99924E 00	1.64949E 00	1.26278E 00	1.04852E 00	9.31211E-01
102	7.32830E-01	3.15615E 00	3.10691E 00	2.77971E 00	1.96681E 00	1.62423E 00	1.24428E 00	1.03361E 00	9.18748E-01
103	7.16624E-01	3.09090E 00	3.04231E 00	2.72610E 00	1.93223E 00	1.59750E 00	1.22481E 00	1.01798E 00	9.05797E-01
104	6.99133E-01	3.02021E 00	2.97208E 00	2.66844E 00	1.89512E 00	1.56915E 00	1.20431E 00	1.00163E 00	8.92383E-01
105	6.99133E-01	3.02021E 00	2.97208E 00	2.66844E 00	1.89512E 00	1.56915E 00	1.20431E 00	1.00163E 00	8.92383E-01
106	6.89929E-01	2.98294E 00	2.93492E 00	2.63817E 00	1.87569E 00	1.55444E 00	1.19373E 00	9.93239E-01	8.85557E-01
107	6.80462E-01	2.94457E 00	2.89663E 00	2.60709E 00	1.85578E 00	1.53942E 00	1.18296E 00	9.84711E-01	8.78647E-01
108	6.70706E-01	2.90499E 00	2.85708E 00	2.57511E 00	1.83534E 00	1.52407E 00	1.17200E 00	9.76047E-01	8.71658E-01
109	6.60631E-01	2.86405E 00	2.81612E 00	2.54216E 00	1.81432E 00	1.50836E 00	1.16082E 00	9.67246E-01	8.64595E-01
110	6.60631E-01	2.86405E 00	2.81612E 00	2.54216E 00	1.81432E 00	1.50836E 00	1.16082E 00	9.67246E-01	8.64595E-01
111	6.50296E-01	2.82204E 00	2.77400E 00	2.50841E 00	1.79284E 00	1.49240E 00	1.14950E 00	9.58354E-01	8.57496E-01
112	6.39714E-01	2.77899E 00	2.73082E 00	2.47394E 00	1.77096E 00	1.47619E 00	1.13805E 00	9.49372E-01	8.50354E-01
113	6.28856E-01	2.73479E 00	2.68644E 00	2.43863E 00	1.74861E 00	1.45972E 00	1.12645E 00	9.40301E-01	8.43175E-01
114	6.17689E-01	2.68928E 00	2.64069E 00	2.40241E 00	1.72574E 00	1.44295E 00	1.11470E 00	9.31141E-01	8.35967E-01
115	6.17689E-01	2.68928E 00	2.64069E 00	2.40241E 00	1.72574E 00	1.44295E 00	1.11470E 00	9.31141E-01	8.35967E-01
116	6.06261E-01	2.64269E 00	2.59376E 00	2.36541E 00	1.70245E 00	1.42596E 00	1.10286E 00	9.21933E-01	8.28765E-01
117	5.94568E-01	2.59498E 00	2.54567E 00	2.32766E 00	1.67875E 00	1.40876E 00	1.09092E 00	9.12677E-01	8.21563E-01
118	5.82580E-01	2.54603E 00	2.49627E 00	2.28904E 00	1.65459E 00	1.39133E 00	1.07889E 00	9.03375E-01	8.14371E-01
119	5.70263E-01	2.49568E 00	2.44538E 00	2.24947E 00	1.62989E 00	1.37363E 00	1.06674E 00	8.94027E-01	8.07196E-01
120	5.70263E-01	2.49568E 00	2.44538E 00	2.24947E 00	1.62989E 00	1.37363E 00	1.06674E 00	8.94027E-01	8.07196E-01
121	5.49703E-01	2.41335E 00	2.36527E 00	2.18594E 00	1.59084E 00	1.34550E 00	1.04602E 00	8.78053E-01	7.96964E-01
122	5.29988E-01	2.33446E 00	2.28851E 00	2.12467E 00	1.55358E 00	1.31837E 00	1.02614E 00	8.62515E-01	7.86961E-01
123	5.11082E-01	2.25886E C0	2.21498E 00	2.06559E 00	1.51810E 00	1.29227E 00	1.00711E 00	8.47444E-01	7.77239E-01
124	4.92954E-01	2.18644E 00	2.14457E 00	2.00868E 00	1.48439E 00	1.26723E 00	9.88952E-01	8.32866E-01	7.67849E-01
125	4.75575E-01	2.11709E 00	2.07716E 00	1.95387E 00	1.45246E 00	1.24324E 00	9.71696E-01	8.18804E-01	7.58838E-01
126	4.58915E-01	2.05070E 00	2.01265E 00	1.90113E 00	1.42229E 00	1.22034E 00	9.55359E-01	8.05275E-01	7.50249E-01
127	4.42946E-01	1.98716E 00	1.95093E 00	1.85040E 00	1.39388E 00	1.19853E 00	9.39962E-01	7.92296E-01	7.42126E-01
128	4.27642E-01	1.92638E 00	1.89191E 00	1.80165E 00	1.36724E 00	1.17782E 00	9.25527E-01	7.79878E-01	7.34509E-01
129	4.12978E-01	1.86826E 00	1.83550E C0	1.75483E 00	1.34238E 00	1.15822E 00	9.12074E-01	7.68033E-01	7.27437E-01
130	3.98929E-01	1.81270E 00	1.78160E 00	1.70990E 00	1.31930E 00	1.13975E 00	8.99625E-01	7.56765E-01	7.20948E-01
131	3.85473E-01	1.75962E 00	1.73014E 00	1.66681E 00	1.29801E 00	1.12241E 00	8.88205E-01	7.46079E-01	7.15079E-01
132	3.72586E-01	1.70894E 00	1.68104E 00	1.62553E 00	1.27853E 00	1.10621E 00	8.77836E-01	7.35975E-01	7.09867E-01
133	3.60249E-01	1.66058E 00	1.63421E 00	1.58601E 00	1.26087E 00	1.09116E 00	8.68544E-01	7.26451E-01	7.05348E-01

134	3.48440E-01	1.61446E 00	1.58958E 00	1.54823E 00	1.24505E 00	1.07725E 00	8.60357E-01	7.17500E-01	7.01560E-01
135	3.37141E-01	1.57051E 00	1.54710E 00	1.51214E 00	1.23111E 00	1.06450E 00	8.53304E-01	7.09114E-01	6.98540E-01
136	3.37141E-01	1.57051E 00	1.54710E 00	1.51214E 00	1.23111E 00	1.06450E 00	8.53304E-01	7.09114E-01	6.98540E-01
137	2.94967E-01	1.40803E 00	1.37490E 00	1.32945E 00	1.15026E 00	9.94392E-01	8.14928E-01	6.67904E-01	6.74362E-01
138	2.58195E-01	1.26211E 00	1.22286E 00	1.17132E 00	1.06101E 00	9.23022E-01	7.69398E-01	6.27062E-01	6.43153E-01
139	2.26112E-01	1.13108E 00	1.08840E 00	1.03394E 00	9.69787E-01	8.51599E-01	7.19752E-01	5.86074E-01	6.07709E-01
140	1.98105E-01	1.01344E 00	9.69327E-01	9.14177E-01	8.80562E-01	7.81412E-01	6.68232E-01	5.45076E-01	5.69911E-01
141	1.73641E-01	9.07866E-01	8.63735E-01	8.09458E-01	7.95703E-01	7.13586E-01	6.16503E-01	5.04484E-01	5.31093E-01
142	1.52259E-01	8.13122E-01	7.69995E-01	7.17638E-01	7.16496E-01	6.48990E-01	5.65783E-01	4.64786E-01	4.92241E-01
143	1.33559E-01	7.28114E-01	6.86690E-01	6.36932E-01	6.43522E-01	5.88223E-01	5.16943E-01	4.26441E-01	4.54093E-01
144	1.17196E-01	6.51851E-01	6.12593E-01	5.65839E-01	5.76915E-01	5.31644E-01	4.70579E-01	3.89826E-01	4.17203E-01
145	1.02868E-01	5.83441E-01	5.46635E-01	5.03094E-01	5.16529E-01	4.79413E-01	4.27071E-01	3.55229E-01	3.81978E-01
146	9.03152E-02	5.22080E-01	4.87880E-01	4.47622E-01	4.62060E-01	4.31543E-01	3.86635E-01	3.22840E-01	3.48706E-01
147	7.93099E-02	4.67044E-01	4.35512E-01	3.98509E-01	4.13118E-01	3.87934E-01	3.49359E-01	2.92773E-01	3.17579E-01
148	6.96548E-02	4.17680E-01	3.88814E-01	3.54971E-01	3.69277E-01	3.48415E-01	3.15240E-01	2.65070E-01	2.88714E-01
149	6.11780E-02	3.73403E-01	3.47156E-01	3.16334E-01	3.30113E-01	3.12766E-01	2.84214E-01	2.39722E-01	2.62168E-01
150	5.37299E-02	3.33685E-01	3.09985E-01	2.82016E-01	2.95220E-01	2.80745E-01	2.56174E-01	2.16680E-01	2.37960E-01
151	4.71798E-02	2.98050E-01	2.76814E-01	2.51514E-01	2.64228E-01	2.52102E-01	2.30992E-01	1.95861E-01	2.16081E-01
152	4.71798E-02	2.98050E-01	2.76814E-01	2.51514E-01	2.64228E-01	2.52102E-01	2.30992E-01	1.95861E-01	2.16081E-01
153	3.78462E-02	2.45904E-01	2.28439E-01	2.06976E-01	2.18563E-01	2.09500E-01	1.93029E-01	1.64268E-01	1.82639E-01
154	3.03913E-02	2.02834E-01	1.88481E-01	1.70427E-01	1.80560E-01	1.73722E-01	1.60758E-01	1.37246E-01	1.53467E-01
155	2.44296E-02	1.67269E-01	1.55481E-01	1.40386E-01	1.49043E-01	1.43821E-01	1.33538E-01	1.14316E-01	1.28383E-01
156	1.96565E-02	1.37910E-01	1.28233E-01	1.15667E-01	1.22963E-01	1.18922E-01	1.10710E-01	9.49840E-02	1.07035E-01
157	1.58304E-02	1.13677E-01	1.05737E-01	9.53088E-02	1.01408E-01	9.82428E-02	9.16452E-02	7.87687E-02	8.89991E-02
158	1.27601E-02	9.36795E-02	8.71657E-02	7.85325E-02	8.36066E-02	8.11008E-02	7.57737E-02	6.52205E-02	7.38469E-02
159	1.02934E-02	7.71776E-02	7.18357E-02	6.47011E-02	6.89092E-02	6.69087E-02	6.25899E-02	5.39339E-02	6.11695E-02
160	8.30948E-03	6.35607E-02	5.91809E-02	5.32932E-02	5.67760E-02	5.51682E-02	5.16556E-02	4.45512E-02	5.05946E-02
161	6.71190E-03	5.23233E-02	4.87334E-02	4.38802E-02	4.67584E-02	4.54595E-02	4.25956E-02	3.67625E-02	4.17923E-02
162	5.42390E-03	4.30475E-02	4.01059E-02	3.61098E-02	3.84848E-02	3.74311E-02	3.50918E-02	3.03020E-02	3.44749E-02
163	4.38414E-03	3.53877E-02	3.29784E-02	2.96912E-02	3.16475E-02	3.07898E-02	2.88763E-02	2.49441E-02	2.83955E-02
164	3.54355E-03	2.90582E-02	2.70858E-02	2.43846E-02	2.59920E-02	2.52910E-02	2.37242E-02	2.04981E-02	2.33429E-02
165	2.86285E-03	2.38225E-02	2.22090E-02	1.99918E-02	2.13069E-02	2.07312E-02	1.94471E-02	1.68035E-02	1.91384E-02
166	2.31050E-03	1.94850E-02	1.81661E-02	1.63481E-02	1.74159E-02	1.69405E-02	1.58870E-02	1.37249E-02	1.56302E-02
167	1.86116E-03	1.58833E-02	1.48062E-02	1.33172E-02	1.41754E-02	1.37766E-02	1.29108E-02	1.11483E-02	1.26899E-02
168	1.49441E-03	1.28829E-02	1.20039E-02	1.07846E-02	1.14591E-02	1.11194E-02	1.04059E-02	8.97648E-03	1.02081E-02
169	1.19374E-03	1.03715E-02	9.65436E-03	8.65437E-03	9.16298E-03	8.86650E-03	8.27568E-03	7.12636E-03	8.09111E-03
170	9.45786E-04	8.25544E-03	7.66939E-03	6.84425E-03	7.19547E-03	6.92937E-03	6.43560E-03	5.52565E-03	6.25811E-03
171	7.39632E-04	6.45586E-03	5.97436E-03	5.28260E-03	5.47427E-03	5.23019E-03	4.80975E-03	4.11076E-03	4.63902E-03
172	5.66338E-04	4.90595E-03	4.50510E-03	3.90463E-03	3.92154E-03	3.69974E-03	3.32668E-03	2.82570E-03	3.17324E-03
173	4.18500E-04	3.54846E-03	3.20546E-03	2.64863E-03	2.45882E-03	2.27686E-03	1.91418E-03	1.62338E-03	1.80914E-03
174	4.18500E-04	3.54846E-03	3.20546E-03	2.64863E-03	2.45882E-03	2.27686E-03	1.91418E-03	1.62338E-03	1.80914E-03
175	3.22656E-04	2.62945E-03	2.31911E-03	1.97957E-03	1.71071E-03	1.58839E-03	1.34443E-03	1.15220E-03	1.16255E-03
176	2.41521E-04	1.90199E-03	1.64537E-03	1.43893E-03	1.18139E-03	1.09574E-03	9.30189E-04	8.01980E-04	7.66618E-04
177	1.71541E-04	1.31373E-03	1.11965E-03	9.96414E-04	7.89657E-04	7.30488E-04	6.20580E-04	5.36770E-04	4.98798E-04
178	1.09681E-04	8.22801E-04	6.93857E-04	6.24777E-04	4.83932E-04	4.46452E-04	3.79178E-04	3.28491E-04	3.00935E-04
179	5.32941E-05	3.94744E-04	3.30780E-04	2.99667E-04	2.29313E-04	2.11143E-04	1.79243E-04	1.55388E-04	1.41423E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO.	GROUPS 10- 18								
1	6.10898E-01	5.94815E-01	5.70134E-01	5.54623E-01	5.52436E-01	5.54056E-01	5.60344E-01	5.65445E-01	5.70940E-01
2	6.11975E-01	5.95804E-01	5.71043E-01	5.55471E-01	5.53242E-01	5.54826E-01	5.61086E-01	5.66154E-01	5.71617E-01
3	6.15203E-01	5.98765E-01	5.73763E-01	5.58011E-01	5.55653E-01	5.57130E-01	5.63305E-01	5.68274E-01	5.73641E-01
4	6.20568E-01	6.03676E-01	5.78273E-01	5.62220E-01	5.59645E-01	5.60944E-01	5.66976E-01	5.71778E-01	5.76985E-01
5	6.28049E-01	6.10502E-01	5.84539E-01	5.68063E-01	5.65180E-01	5.66228E-01	5.72058E-01	5.76625E-01	5.81605E-01
6	6.37609E-01	6.19187E-01	5.92507E-01	5.75489E-01	5.72202E-01	5.72925E-01	5.78491E-01	5.82752E-01	5.87438E-01
7	6.49200E-01	6.29651E-01	6.02105E-01	5.84429E-01	5.80637E-01	5.80957E-01	5.86200E-01	5.90081E-01	5.94402E-01
8	6.62751E-01	6.41786E-01	6.13238E-01	5.94791E-01	5.90386E-01	5.90230E-01	5.95085E-01	5.98510E-01	6.02395E-01
9	6.78167E-01	6.55445E-01	6.25785E-01	6.06466E-01	6.01331E-01	6.00624E-01	6.05031E-01	6.07920E-01	6.11295E-01
10	6.95323E-01	6.70435E-01	6.39594E-01	6.19317E-01	6.13325E-01	6.12000E-01	6.15897E-01	6.18169E-01	6.20957E-01
11	7.14058E-01	6.86498E-01	6.54478E-01	6.33187E-01	6.26195E-01	6.24192E-01	6.27526E-01	6.29091E-01	6.31214E-01
12	7.14058E-01	6.86498E-01	6.54478E-01	6.33187E-01	6.26195E-01	6.24192E-01	6.27526E-01	6.29091E-01	6.31214E-01
13	7.30854E-01	7.06494E-01	6.72556E-01	6.49742E-01	6.41611E-01	6.38808E-01	6.41379E-01	6.42047E-01	6.43255E-01
14	7.50629E-01	7.28600E-01	6.92159E-01	6.67443E-01	6.58192E-01	6.54341E-01	6.55913E-01	6.55518E-01	6.55554E-01
15	7.72894E-01	7.53056E-01	7.13151E-01	6.85982E-01	6.75583E-01	6.70390E-01	6.70676E-01	6.69029E-01	6.67593E-01
16	7.97128E-01	7.80021E-01	7.35194E-01	7.04841E-01	6.93309E-01	6.86427E-01	6.85092E-01	6.82002E-01	6.78740E-01
17	7.97128E-01	7.80021E-01	7.35194E-01	7.04841E-01	6.93309E-01	6.86427E-01	6.85092E-01	6.82002E-01	6.78740E-01
18	8.07857E-01	7.83397E-01	7.38270E-01	7.07623E-01	6.95923E-01	6.88700E-01	6.87109E-01	6.83789E-01	6.80237E-01
19	8.17943E-01	7.86764E-01	7.41347E-01	7.10412E-01	6.98505E-01	6.90956E-01	6.89118E-01	6.85565E-01	6.81729E-01
20	8.27409E-01	7.90112E-01	7.44420E-01	7.13204E-01	7.01056E-01	6.93195E-01	6.91120E-01	6.87332E-01	6.83216E-01
21	8.36274E-01	7.93430E-01	7.47483E-01	7.15996E-01	7.03573E-01	6.95415E-01	6.93113E-01	6.89088E-01	6.84697E-01
22	8.36274E-01	7.93430E-01	7.47483E-01	7.15996E-01	7.03573E-01	6.95415E-01	6.93113E-01	6.89088E-01	6.84697E-01
23	8.40793E-01	7.97182E-01	7.50621E-01	7.18713E-01	7.06005E-01	6.97610E-01	6.95088E-01	6.90837E-01	6.86178E-01
24	8.45218E-01	8.00866E-01	7.53711E-01	7.21393E-01	7.08404E-01	6.99775E-01	6.97037E-01	6.92563E-01	6.87641E-01
25	8.49547E-01	8.04481E-01	7.56751E-01	7.24033E-01	7.10769E-01	7.01910E-01	6.98959E-01	6.94265E-01	6.89083E-01
26	8.53781E-01	8.08025E-01	7.59739E-01	7.26631E-01	7.13098E-01	7.04013E-01	7.00853E-01	6.95942E-01	6.90503E-01
27	8.53781E-01	8.08025E-01	7.59739E-01	7.26631E-01	7.13098E-01	7.04013E-01	7.00853E-01	6.95942E-01	6.90503E-01
28	8.59507E-01	8.12834E-01	7.63806E-01	7.30175E-01	7.16278E-01	7.06885E-01	7.03441E-01	6.98235E-01	6.92448E-01
29	8.65037E-01	8.17498E-01	7.67763E-01	7.33630E-01	7.19381E-01	7.09690E-01	7.05970E-01	7.00477E-01	6.94350E-01
30	8.70373E-01	8.22012E-01	7.71606E-01	7.36991E-01	7.22403E-01	7.12423E-01	7.08436E-01	7.02664E-01	6.96206E-01
31	8.75514E-01	8.26374E-01	7.75329E-01	7.40254E-01	7.25340E-01	7.15081E-01	7.10834E-01	7.04791E-01	6.98011E-01
32	8.75514E-01	8.26374E-01	7.75329E-01	7.40255E-01	7.25340E-01	7.15081E-01	7.10834E-01	7.04791E-01	6.98011E-01
33	8.80464E-01	8.30590E-01	7.78939E-01	7.43425E-01	7.28197E-01	7.17669E-01	7.13172E-01	7.06867E-01	6.99774E-01
34	8.85210E-01	8.34647E-01	7.82423E-01	7.46491E-01	7.30964E-01	7.20178E-01	7.15441E-01	7.08883E-01	7.01489E-01
35	8.89754E-01	8.38544E-01	7.85779E-01	7.49450E-01	7.33638E-01	7.22605E-01	7.17638E-01	7.10836E-01	7.03150E-01
36	8.94097E-01	8.42279E-01	7.89004E-01	7.52299E-01	7.36216E-01	7.24948E-01	7.19759E-01	7.12722E-01	7.04755E-01
37	8.94097E-01	8.42279E-01	7.89004E-01	7.52300E-01	7.36216E-01	7.24948E-01	7.19759E-01	7.12722E-01	7.04755E-01
38	9.02189E-01	8.49282E-01	7.95079E-01	7.57686E-01	7.41135E-01	7.29398E-01	7.23799E-01	7.16326E-01	7.07837E-01
39	9.09465E-01	8.55625E-01	8.00617E-01	7.62619E-01	7.45598E-01	7.33501E-01	7.27535E-01	7.19669E-01	7.10713E-01
40	9.15950E-01	8.61314E-01	8.05609E-01	7.67085E-01	7.49683E-01	7.37242E-01	7.30951E-01	7.22734E-01	7.13361E-01
41	9.21666E-01	8.66353E-01	8.10053E-01	7.71078E-01	7.53351E-01	7.40610E-01	7.34033E-01	7.25506E-01	7.15762E-01

42	9.21666E-01	8.66353E-01	8.10053E-01	7.71078E-01	7.53351E-01	7.40610E-01	7.34033E-01	7.25506E-01	7.15762E-01
43	9.26636E-01	8.70766E-01	8.13969E-01	7.74614E-01	7.56617E-01	7.43621E-01	7.36800E-01	7.28006E-01	7.17946E-01
44	9.30857E-01	8.74545E-01	8.17348E-01	7.77686E-01	7.59474E-01	7.46267E-01	7.39245E-01	7.30228E-01	7.19914E-01
45	9.34359E-01	8.77705E-01	8.20200E-01	7.80298E-01	7.61924E-01	7.48547E-01	7.41363E-01	7.32168E-01	7.21656E-01
46	9.37171E-01	8.80265E-01	8.22535E-01	7.82456E-01	7.63971E-01	7.50463E-01	7.43156E-01	7.33823E-01	7.23168E-01
47	9.37171E-01	8.80265E-01	8.22535E-01	7.82456E-01	7.63971E-01	7.50463E-01	7.43156E-01	7.33823E-01	7.23168E-01
48	9.39324E-01	8.82243E-01	8.24367E-01	7.84171E-01	7.65622E-01	7.52020E-01	7.44625E-01	7.35193E-01	7.24449E-01
49	9.40849E-01	8.83660E-01	8.25713E-01	7.85456E-01	7.66889E-01	7.53225E-01	7.45776E-01	7.36283E-01	7.25503E-01
50	9.41782E-01	8.84537E-01	8.26590E-01	7.86324E-01	7.67782E-01	7.54087E-01	7.46614E-01	7.37096E-01	7.26332E-01
51	9.42158E-01	8.84900E-01	8.27019E-01	7.86792E-01	7.68315E-01	7.54615E-01	7.47148E-01	7.37638E-01	7.26942E-01
52	9.42158E-01	8.84900E-01	8.27019E-01	7.86792E-01	7.68315E-01	7.54615E-01	7.47148E-01	7.37638E-01	7.26942E-01
53	9.42155E-01	8.84899E-01	8.27073E-01	7.86882E-01	7.68451E-01	7.54758E-01	7.47302E-01	7.37808E-01	7.27164E-01
54	9.42031E-01	8.84779E-01	8.27022E-01	7.86878E-01	7.68502E-01	7.54819E-01	7.47381E-01	7.37909E-01	7.27327E-01
55	9.41792E-01	8.84544E-01	8.26870E-01	7.86781E-01	7.68468E-01	7.54800E-01	7.47385E-01	7.37942E-01	7.27433E-01
56	9.41445E-01	8.84197E-01	8.26619E-01	7.86595E-01	7.68354E-01	7.54704E-01	7.47316E-01	7.37909E-01	7.27482E-01
57	9.41445E-01	8.84197E-01	8.26619E-01	7.86595E-01	7.68354E-01	7.54704E-01	7.47316E-01	7.37909E-01	7.27482E-01
58	9.40896E-01	8.83641E-01	8.26193E-01	7.86256E-01	7.68110E-01	7.54487E-01	7.47137E-01	7.37780E-01	7.27463E-01
59	9.40216E-01	8.82936E-01	8.25633E-01	7.85794E-01	7.67754E-01	7.54159E-01	7.46851E-01	7.37551E-01	7.27355E-01
60	9.39417E-01	8.82089E-01	8.24947E-01	7.85214E-01	7.67289E-01	7.53724E-01	7.46463E-01	7.37225E-01	7.27162E-01
61	9.38510E-01	8.81106E-01	8.24139E-01	7.84522E-01	7.66720E-01	7.53186E-01	7.45974E-01	7.36806E-01	7.26887E-01
62	9.38510E-01	8.81106E-01	8.24139E-01	7.84522E-01	7.66720E-01	7.53186E-01	7.45974E-01	7.36806E-01	7.26887E-01
63	9.37119E-01	8.79819E-01	8.23041E-01	7.83554E-01	7.65892E-01	7.52397E-01	7.45241E-01	7.36152E-01	7.26394E-01
64	9.35590E-01	8.78425E-01	8.21818E-01	7.82446E-01	7.64900E-01	7.51439E-01	7.44325E-01	7.35297E-01	7.25659E-01
65	9.33951E-01	8.76937E-01	8.20478E-01	7.81207E-01	7.63751E-01	7.50318E-01	7.43232E-01	7.34246E-01	7.24690E-01
66	9.32219E-01	8.75364E-01	8.19030E-01	7.79842E-01	7.62450E-01	7.49037E-01	7.41966E-01	7.33003E-01	7.23491E-01
67	9.30409E-01	8.73713E-01	8.17478E-01	7.78357E-01	7.61002E-01	7.47602E-01	7.40530E-01	7.31572E-01	7.22068E-01
68	9.28526E-01	8.71987E-01	8.15826E-01	7.76752E-01	7.59410E-01	7.46013E-01	7.38927E-01	7.29956E-01	7.20423E-01
69	9.26568E-01	8.70188E-01	8.14074E-01	7.75030E-01	7.57674E-01	7.44273E-01	7.37158E-01	7.28155E-01	7.18559E-01
70	9.24530E-01	8.68313E-01	8.12222E-01	7.73189E-01	7.55795E-01	7.42382E-01	7.35224E-01	7.26172E-01	7.16477E-01
71	9.22399E-01	8.66359E-01	8.10265E-01	7.71228E-01	7.53772E-01	7.40340E-01	7.33124E-01	7.24006E-01	7.14176E-01
72	9.20156E-01	8.64319E-01	8.08199E-01	7.69142E-01	7.51601E-01	7.38145E-01	7.30859E-01	7.21658E-01	7.11657E-01
73	9.17777E-01	8.62184E-01	8.06017E-01	7.66927E-01	7.49278E-01	7.35794E-01	7.28426E-01	7.19125E-01	7.08915E-01
74	9.15230E-01	8.59942E-01	8.03710E-01	7.64575E-01	7.46800E-01	7.33286E-01	7.25824E-01	7.16405E-01	7.05949E-01
75	9.15230E-01	8.59942E-01	8.03710E-01	7.64575E-01	7.46800E-01	7.33286E-01	7.25824E-01	7.16405E-01	7.05949E-01
76	9.14076E-01	8.58772E-01	8.02523E-01	7.63374E-01	7.45533E-01	7.32000E-01	7.24486E-01	7.15000E-01	7.04400E-01
77	9.12879E-01	8.57556E-01	8.01296E-01	7.62138E-01	7.44235E-01	7.30683E-01	7.23119E-01	7.13570E-01	7.02830E-01
78	9.11636E-01	8.56294E-01	8.00029E-01	7.60864E-01	7.42904E-01	7.29334E-01	7.21722E-01	7.12112E-01	7.01239E-01
79	9.10344E-01	8.54985E-01	7.98719E-01	7.59553E-01	7.41540E-01	7.27954E-01	7.20295E-01	7.10628E-01	6.99627E-01
80	9.10345E-01	8.54985E-01	7.98719E-01	7.59553E-01	7.41540E-01	7.27954E-01	7.20295E-01	7.10628E-01	6.99627E-01
81	9.08405E-01	8.53023E-01	7.96768E-01	7.57606E-01	7.39525E-01	7.25918E-01	7.18196E-01	7.08452E-01	6.97274E-01
82	9.06354E-01	8.50959E-01	7.94729E-01	7.55582E-01	7.37443E-01	7.23821E-01	7.16042E-01	7.06230E-01	6.94889E-01
83	9.04187E-01	8.48790E-01	7.92599E-01	7.53479E-01	7.35292E-01	7.21660E-01	7.13832E-01	7.03959E-01	6.92471E-01
84	9.01902E-01	8.46513E-01	7.90378E-01	7.51294E-01	7.33071E-01	7.19435E-01	7.11564E-01	7.01640E-01	6.90017E-01
85	9.01902E-01	8.46513E-01	7.90378E-01	7.51294E-01	7.33071E-01	7.19435E-01	7.11564E-01	7.01640E-01	6.90017E-01
86	8.99484E-01	8.44117E-01	7.88053E-01	7.49018E-01	7.30771E-01	7.17136E-01	7.09228E-01	6.99260E-01	6.87513E-01
87	8.96934E-01	8.41609E-01	7.85635E-01	7.46663E-01	7.28402E-01	7.14777E-01	7.06842E-01	6.96841E-01	6.84988E-01

88	8.94251E-01	8.38988E-01	7.83122E-01	7.44226E-01	7.25965E-01	7.12358E-01	7.04405E-01	6.94382E-01	6.82441E-01
89	8.91433E-01	8.36253E-01	7.80514E-01	7.41707E-01	7.23459E-01	7.09878E-01	7.01916E-01	6.91881E-01	6.79870E-01
90	8.91433E-01	8.36253E-01	7.80514E-01	7.41707E-01	7.23459E-01	7.09878E-01	7.01916E-01	6.[illegible]1881E-01	6.79870E-01
91	8.85367E-01	8.30416E-01	7.74991E-01	7.36409E-01	7.18225E-01	7.04723E-01	6.96771E-01	6.86747E-01	6.74646E-01
92	8.78743E-01	8.24119E-01	7.69088E-01	7.30793E-01	7.12728E-01	6.99344E-01	6.91448E-01	6.81486E-01	6.69380E-01
93	8.71564E-01	8.17363E-01	7.62808E-01	7.24861E-01	7.06970E-01	6.93746E-01	6.85950E-01	6.76099E-01	6.64067E-01
94	8.63837E-01	8.10155E-01	7.56157E-01	7.18621E-01	7.00958E-01	6.87933E-01	6.80281E-01	6.70591E-01	6.58710E-01
95	8.63837E-01	8.10155E-01	7.56157E-01	7.18621E-01	7.00959E-01	6.87933E-01	6.80281E-01	6.70591E-01	6.58710E-01
96	8.55588E-01	8.02516E-01	7.49153E-01	7.12088E-01	6.94709E-01	6.81924E-01	6.74458E-01	6.64975E-01	6.53318E-01
97	8.46826E-01	7.94452E-01	7.41800E-01	7.05267E-01	6.88222E-01	6.75716E-01	6.68475E-01	6.59243E-01	6.47873E-01
98	8.37571E-01	7.85979E-01	7.34116E-01	6.98174E-01	6.81515E-01	6.69326E-01	6.62350E-01	6.53411E-01	6.42391E-01
99	8.27845E-01	7.77119E-01	7.26125E-01	6.90833E-01	6.74611E-01	6.62776E-01	6.56101E-01	6.47497E-01	6.36890E-01
100	8.27845E-01	7.77119E-01	7.26125E-01	6.90833E-01	6.74611E-01	6.62776E-01	6.56101E-01	6.47498E-01	6.36890E-01
101	8.17737E-01	7.67954E-01	7.17895E-01	6.83306E-01	6.67566E-01	6.56118E-01	6.49778E-01	6.41547E-01	6.31410E-01
102	8.07247E-01	7.58458E-01	7.09400E-01	6.75564E-01	6.60347E-01	6.49313E-01	6.43332E-01	6.35499E-01	6.25862E-01
103	7.96411E-01	7.48662E-01	7.00674E-01	6.67640E-01	6.52987E-01	6.42393E-01	6.36791E-01	6.29381E-01	6.20275E-01
104	7.85267E-01	7.38603E-01	6.91754E-01	6.59570E-01	6.45520E-01	6.35387E-01	6.30185E-01	6.23220E-01	6.14681E-01
105	7.85267E-01	7.38603E-01	6.91754E-01	6.59570E-01	6.45520E-01	6.35387E-01	6.30185E-01	6.23220E-01	6.14681E-01
106	7.79627E-01	7.33518E-01	6.87262E-01	6.55518E-01	6.41782E-01	6.31884E-01	6.26889E-01	6.20156E-01	6.11914E-01
107	7.73936E-01	7.28384E-01	6.82733E-01	6.51439E-01	6.38024E-01	6.28365E-01	6.23579E-01	6.17078E-01	6.09137E-01
108	7.68203E-01	7.23204E-01	6.78175E-01	6.47340E-01	6.34252E-01	6.24835E-01	6.20257E-01	6.13992E-01	6.06352E-01
109	7.62433E-01	7.17986E-01	6.73592E-01	6.43226E-01	6.30472E-01	6.21297E-01	6.16929E-01	6.10902E-01	6.03565E-01
110	7.62433E-01	7.17986E-01	6.73592E-01	6.43226E-01	6.30472E-01	6.21297E-01	6.16929E-01	6.10902E-01	6.03566E-01
111	7.56657E-01	7.12756E-01	6.69008E-01	6.39117E-01	6.26703E-01	6.17771E-01	6.13613E-01	6.07824E-01	6.00795E-01
112	7.50872E-01	7.07501E-01	6.64411E-01	6.35002E-01	6.22932E-01	6.14241E-01	6.10292E-01	6.04741E-01	5.98018E-01
113	7.45086E-01	7.02227E-01	6.59808E-01	6.30886E-01	6.19165E-01	6.10715E-01	6.06971E-01	6.01657E-01	5.95238E-01
114	7.39308E-01	6.96941E-01	6.55204E-01	6.26777E-01	6.15407E-01	6.07195E-01	6.03654E-01	5.98577E-01	5.92461E-01
115	7.39308E-01	6.96941E-01	6.55204E-01	6.26777E-01	6.15407E-01	6.07195E-01	6.03654E-01	5.98577E-01	5.92461E-01
116	7.33568E-01	6.91668E-01	6.50622E-01	6.22693E-01	6.11678E-01	6.03699E-01	6.00358E-01	5.95516E-01	5.89703E-01
117	7.27865E-01	6.86397E-01	6.46053E-01	6.18625E-01	6.07967E-01	6.00216E-01	5.97069E-01	5.92459E-01	5.86945E-01
118	7.22210E-01	6.81136E-01	6.41503E-01	6.14580E-01	6.04279E-01	5.96750E-01	5.93791E-01	5.89409E-01	5.84189E-01
119	7.16615E-01	6.75890E-01	6.36979E-01	6.10564E-01	6.00622E-01	5.93307E-01	5.90529E-01	5.86372E-01	5.81442E-01
120	7.16615E-01	6.75890E-01	6.36979E-01	6.10564E-01	6.00622E-01	5.93307E-01	5.90529E-01	5.86372E-01	5.81442E-01
121	7.07476E-01	6.69300E-01	6.31153E-01	6.05320E-01	5.95834E-01	5.88822E-01	5.86277E-01	5.82415E-01	5.77869E-01
122	6.98459E-01	6.62854E-01	6.25462E-01	6.00198E-01	5.91129E-01	5.84403E-01	5.82073E-01	5.78485E-01	5.74292E-01
123	6.89604E-01	6.56587E-01	6.19930E-01	5.95215E-01	5.86519E-01	5.80063E-01	5.77926E-01	5.74588E-01	5.70720E-01
124	6.80948E-01	6.50531E-01	6.14582E-01	5.90390E-01	5.82021E-01	5.75810E-01	5.73844E-01	5.70733E-01	5.67161E-01
125	6.72523E-01	6.44720E-01	6.09439E-01	5.85738E-01	5.77645E-01	5.71655E-01	5.69834E-01	5.66925E-01	5.63622E-01
126	6.64357E-01	6.39184E-01	6.04523E-01	5.81277E-01	5.73403E-01	5.67606E-01	5.65902E-01	5.63170E-01	5.60109E-01
127	6.56477E-01	6.33953E-01	5.99855E-01	5.77019E-01	5.69306E-01	5.63669E-01	5.62053E-01	5.59473E-01	5.56627E-01
128	6.48904E-01	6.29055E-01	5.95453E-01	5.72980E-01	5.65363E-01	5.59851E-01	5.58293E-01	5.55837E-01	5.53181E-01
129	6.41656E-01	6.24518E-01	5.91336E-01	5.69172E-01	5.61581E-01	5.56157E-01	5.54622E-01	5.52265E-01	5.49775E-01
130	6.34749E-01	6.20369E-01	5.87520E-01	5.65606E-01	5.57965E-01	5.52591E-01	5.51045E-01	5.48760E-01	5.46411E-01
131	6.28194E-01	6.16635E-01	5.84022E-01	5.62292E-01	5.54522E-01	5.49154E-01	5.47560E-01	5.45321E-01	5.43091E-01
132	6.21999E-01	6.13341E-01	5.80856E-01	5.59238E-01	5.51252E-01	5.45847E-01	5.44169E-01	5.41948E-01	5.39817E-01
133	6.16169E-01	6.10514E-01	5.78036E-01	5.56454E-01	5.48157E-01	5.42669E-01	5.40867E-01	5.38640E-01	5.36587E-01

134	6.10705E-01	6.08177E-01	5.75574E-01	5.53944E-01	5.45236E-01	5.39618E-01	5.37652E-01	5.35395E-01	5.33401E-01
135	6.05603E-01	6.06358E-01	5.73483E-01	5.51713E-01	5.42486E-01	5.36689E-01	5.34520E-01	5.32208E-01	5.30257E-01
136	6.05603E-01	6.06358E-01	5.73483E-01	5.51714E-01	5.42486E-01	5.36689E-01	5.34520E-01	5.32208E-01	5.30257E-01
137	5.79470E-01	5.89811E-01	5.56827E-01	5.34784E-01	5.22718E-01	5.15523E-01	5.11980E-01	5.09083E-01	5.07129E-01
138	5.51489E-01	5.67457E-01	5.36583E-01	5.15341E-01	5.02091E-01	4.94059E-01	4.89629E-01	4.86271E-01	4.84245E-01
139	5.21720E-01	5.41139E-01	5.13327E-01	4.93648E-01	4.80362E-01	4.72072E-01	4.67208E-01	4.63595E-01	4.61527E-01
140	4.90631E-01	5.12209E-01	4.87770E-01	4.70111E-01	4.57551E-01	4.49502E-01	4.44597E-01	4.40953E-01	4.38931E-01
141	4.58817E-01	4.81710E-01	4.60634E-01	4.45211E-01	4.33845E-01	4.26416E-01	4.21782E-01	4.18318E-01	4.16449E-01
142	4.26867E-01	4.50479E-01	4.32589E-01	4.19442E-01	4.09522E-01	4.02967E-01	3.98837E-01	3.95724E-01	3.94111E-01
143	3.95309E-01	4.19187E-01	4.04225E-01	3.93277E-01	3.84901E-01	3.79363E-01	3.75888E-01	3.73251E-01	3.71977E-01
144	3.64586E-01	3.88374E-01	3.76049E-01	3.67148E-01	3.60303E-01	3.55836E-01	3.53095E-01	3.51010E-01	3.50133E-01
145	3.35050E-01	3.58469E-01	3.48478E-01	3.41429E-01	3.36031E-01	3.32618E-01	3.30630E-01	3.29129E-01	3.28675E-01
146	3.06970E-01	3.29802E-01	3.21849E-01	3.16437E-01	3.12354E-01	3.09925E-01	3.08662E-01	3.07737E-01	3.07708E-01
147	2.80542E-01	3.02622E-01	2.96422E-01	2.92426E-01	2.89500E-01	2.87950E-01	2.87347E-01	2.86958E-01	2.87329E-01
148	2.55895E-01	2.77105E-01	2.72395E-01	2.69594E-01	2.67649E-01	2.66850E-01	2.66816E-01	2.66899E-01	2.67628E-01
149	2.33108E-01	2.53373E-01	2.49904E-01	2.48086E-01	2.46939E-01	2.46747E-01	2.47172E-01	2.47649E-01	2.48679E-01
150	2.12214E-01	2.31495E-01	2.29037E-01	2.27995E-01	2.27460E-01	2.27723E-01	2.28489E-01	2.29270E-01	2.30538E-01
151	1.93211E-01	2.11507E-01	2.09838E-01	2.09372E-01	2.09259E-01	2.09822E-01	2.10805E-01	2.11799E-01	2.13241E-01
152	1.93211E-01	2.11507E-01	2.09838E-01	2.09372E-01	2.09259E-01	2.09822E-01	2.10805E-01	2.11799E-01	2.13241E-01
153	1.63979E-01	1.80677E-01	1.80066E-01	1.80351E-01	1.80796E-01	1.81743E-01	1.82991E-01	1.84245E-01	1.85889E-01
154	1.38354E-01	1.53280E-01	1.53468E-01	1.54329E-01	1.55236E-01	1.56506E-01	1.57981E-01	1.59439E-01	1.61225E-01
155	1.16164E-01	1.29302E-01	1.30023E-01	1.31273E-01	1.32513E-01	1.34017E-01	1.35659E-01	1.37263E-01	1.39135E-01
156	9.71470E-02	1.08568E-01	1.09602E-01	1.11072E-01	1.12514E-01	1.14157E-01	1.15893E-01	1.17580E-01	1.19484E-01
157	8.09844E-02	9.08113E-02	9.19919E-02	9.35471E-02	9.50774E-02	9.67692E-02	9.85294E-02	1.00238E-01	1.02126E-01
158	6.73369E-02	7.57206E-02	7.69326E-02	7.84735E-02	8.00020E-02	8.16690E-02	8.33923E-02	8.50698E-02	8.68967E-02
159	5.58709E-02	6.29731E-02	6.41420E-02	6.56020E-02	6.70646E-02	6.86512E-02	7.02897E-02	7.18922E-02	7.36226E-02
160	4.62742E-02	5.22554E-02	5.33371E-02	5.46766E-02	5.60315E-02	5.75004E-02	5.90203E-02	6.05156E-02	6.21228E-02
161	3.82642E-02	4.32760E-02	4.42481E-02	4.54470E-02	4.66711E-02	4.80004E-02	4.93809E-02	5.07480E-02	5.22148E-02
162	3.15906E-02	3.57713E-02	3.66258E-02	3.76783E-02	3.87619E-02	3.99423E-02	4.11736E-02	4.24012E-02	4.37186E-02
163	2.60357E-02	2.95083E-02	3.02461E-02	3.11554E-02	3.20984E-02	3.31296E-02	3.42106E-02	3.52954E-02	3.64613E-02
164	2.14119E-02	2.42837E-02	2.49110E-02	2.56854E-02	2.64941E-02	2.73820E-02	2.83174E-02	2.92622E-02	3.02801E-02
165	1.75588E-02	1.99216E-02	2.04474E-02	2.10983E-02	2.17823E-02	2.25366E-02	2.33353E-02	2.41471E-02	2.50244E-02
166	1.43398E-02	1.62714E-02	1.67056E-02	1.72454E-02	1.78161E-02	1.84486E-02	1.91219E-02	1.98105E-02	2.05571E-02
167	1.16386E-02	1.32040E-02	1.35567E-02	1.39979E-02	1.44675E-02	1.49908E-02	1.55511E-02	1.61276E-02	1.67551E-02
168	9.35604E-03	1.06090E-02	1.08900E-02	1.12448E-02	1.16253E-02	1.20522E-02	1.25122E-02	1.29884E-02	1.35088E-02
169	7.40702E-03	8.39211E-03	8.61096E-03	8.89070E-03	9.19381E-03	9.53684E-03	9.90909E-03	1.02970E-02	1.07221E-02
170	5.71828E-03	6.47271E-03	6.63883E-03	6.85424E-03	7.09115E-03	7.36230E-03	7.65891E-03	7.96979E-03	8.31079E-03
171	4.22617E-03	4.78245E-03	4.90503E-03	5.06590E-03	5.24757E-03	5.45845E-03	5.69080E-03	5.93512E-03	6.20182E-03
172	2.87482E-03	3.26497E-03	3.35166E-03	3.46664E-03	3.60434E-03	3.76619E-03	3.94469E-03	4.13140E-03	4.33142E-03
173	1.61406E-03	1.87775E-03	1.92960E-03	2.00619E-03	2.11304E-03	2.23651E-03	2.36995E-03	2.50568E-03	2.64341E-03
174	1.61406E-03	1.87775E-03	1.92960E-03	2.00619E-03	2.11304E-03	2.23651E-03	2.36995E-03	2.50568E-03	2.64341E-03
175	1.06576E-03	1.13412E-03	1.16129E-03	1.20231E-03	1.26585E-03	1.34222E-03	1.43005E-03	1.52080E-03	1.61453E-03
176	7.07030E-04	7.19608E-04	7.26975E-04	7.44505E-04	7.77899E-04	8.20619E-04	8.72513E-04	9.27290E-04	9.85256E-04
177	4.59251E-04	4.57594E-04	4.56516E-04	4.62490E-04	4.78868E-04	5.01413E-04	5.30203E-04	5.61076E-04	5.94501E-04
178	2.76180E-04	2.72493E-04	2.69521E-04	2.70876E-04	2.78412E-04	2.89590E-04	3.04489E-04	3.20600E-04	3.38360E-04
179	1.29476E-04	1.27207E-04	1.25224E-04	1.25273E-04	1.28178E-04	1.32753E-04	1.39035E-04	1.45848E-04	1.53445E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO. GROUPS 19- 27

R. NO.									
1	5.75616E-01	5.79597E-01	5.82955E-01	5.83677E-01	5.80872E-01	5.80577E-01	5.83386E-01	5.81934E-01	3.97780E-01
2	5.76262E-01	5.80207E-01	5.83532E-01	5.84223E-01	5.81376E-01	5.81039E-01	5.83801E-01	5.82289E-01	3.98157E-01
3	5.78190E-01	5.82029E-01	5.85255E-01	5.85852E-01	5.82878E-01	5.82419E-01	5.85034E-01	5.83342E-01	3.99312E-01
4	5.81373E-01	5.85035E-01	5.88095E-01	5.88538E-01	5.85353E-01	5.84686E-01	5.87052E-01	5.85056E-01	4.01344E-01
5	5.85767E-01	5.89180E-01	5.92006E-01	5.92237E-01	5.88753E-01	5.87794E-01	5.89798E-01	5.87367E-01	4.04462E-01
6	5.91309E-01	5.94397E-01	5.96923E-01	5.96888E-01	5.93017E-01	5.91675E-01	5.93188E-01	5.90184E-01	4.09077E-01
7	5.97914E-01	6.00601E-01	6.02761E-01	6.02412E-01	5.98060E-01	5.96241E-01	5.97114E-01	5.93387E-01	4.15977E-01
8	6.05480E-01	6.07687E-01	6.09416E-01	6.08717E-01	6.03781E-01	6.01382E-01	6.01433E-01	5.96821E-01	4.26642E-01
9	6.13885E-01	6.15529E-01	6.16763E-01	6.15690E-01	6.10059E-01	6.06965E-01	6.05970E-01	6.00294E-01	4.43839E-01
10	6.22984E-01	6.23977E-01	6.24658E-01	6.23210E-01	6.16752E-01	6.12834E-01	6.10504E-01	6.03569E-01	4.72716E-01
11	6.32613E-01	6.32860E-01	6.32935E-01	6.31141E-01	6.23696E-01	6.18804E-01	6.14762E-01	6.06358E-01	5.22833E-01
12	6.32613E-01	6.32860E-01	6.32935E-01	6.31141E-01	6.23696E-01	6.18804E-01	6.14762E-01	6.06358E-01	5.22833E-01
13	6.43813E-01	6.43008E-01	6.42193E-01	6.39816E-01	6.30879E-01	6.24574E-01	6.18651E-01	6.08250E-01	5.54288E-01
14	6.55078E-01	6.52927E-01	6.50928E-01	6.47669E-01	6.36711E-01	6.28543E-01	6.20873E-01	6.08018E-01	5.71702E-01
15	6.65895E-01	6.62064E-01	6.58592E-01	6.54233E-01	6.40592E-01	6.30066E-01	6.20713E-01	6.04867E-01	5.79182E-01
16	6.75647E-01	6.69747E-01	6.64514E-01	6.58925E-01	6.41730E-01	6.28296E-01	6.17354E-01	5.97856E-01	5.78885E-01
17	6.75647E-01	6.69747E-01	6.64514E-01	6.58925E-01	6.41730E-01	6.28296E-01	6.17354E-01	5.97856E-01	5.78885E-01
18	6.76933E-01	6.70706E-01	6.65197E-01	6.59428E-01	6.41623E-01	6.27699E-01	6.16553E-01	5.96393E-01	5.78330E-01
19	6.78218E-01	6.71665E-01	6.65882E-01	6.59937E-01	6.41522E-01	6.27110E-01	6.15770E-01	5.94943E-01	5.77757E-01
20	6.79501E-01	6.72623E-01	6.66568E-01	6.60452E-01	6.41423E-01	6.26525E-01	6.15002E-01	5.93502E-01	5.77164E-01
21	6.80783E-01	6.73579E-01	6.67254E-01	6.60971E-01	6.41325E-01	6.25940E-01	6.14245E-01	5.92064E-01	5.76553E-01
22	6.80783E-01	6.73579E-01	6.67254E-01	6.60971E-01	6.41325E-01	6.25940E-01	6.14245E-01	5.92064E-01	5.76553E-01
23	6.82068E-01	6.74542E-01	6.67949E-01	6.61500E-01	6.41228E-01	6.25338E-01	6.13468E-01	5.90555E-01	5.75892E-01
24	6.83338E-01	6.75495E-01	6.68636E-01	6.62023E-01	6.41137E-01	6.24751E-01	6.12708E-01	5.89082E-01	5.75215E-01
25	6.84589E-01	6.76434E-01	6.69313E-01	6.62538E-01	6.41049E-01	6.24175E-01	6.11963E-01	5.87640E-01	5.74521E-01
26	6.85821E-01	6.77357E-01	6.69978E-01	6.63043E-01	6.40960E-01	6.23607E-01	6.11228E-01	5.86223E-01	5.73812E-01
27	6.85821E-01	6.77357E-01	6.69978E-01	6.63043E-01	6.40960E-01	6.23607E-01	6.11228E-01	5.86223E-01	5.73812E-01
28	6.87509E-01	6.78626E-01	6.70894E-01	6.63738E-01	6.40845E-01	6.22830E-01	6.10223E-01	5.84273E-01	5.72802E-01
29	6.89161E-01	6.79870E-01	6.71794E-01	6.64422E-01	6.40745E-01	6.22089E-01	6.09259E-01	5.82402E-01	5.71792E-01
30	6.90772E-01	6.81083E-01	6.72672E-01	6.65090E-01	6.40650E-01	6.21373E-01	6.08326E-01	5.80595E-01	5.70779E-01
31	6.92339E-01	6.82261E-01	6.73523E-01	6.65736E-01	6.40552E-01	6.20670E-01	6.07416E-01	5.78838E-01	5.69762E-01
32	6.92339E-01	6.82261E-01	6.73523E-01	6.65736E-01	6.40552E-01	6.20671E-01	6.07416E-01	5.78838E-01	5.69762E-01
33	6.93870E-01	6.83416E-01	6.74359E-01	6.66370E-01	6.40450E-01	6.19982E-01	6.06526E-01	5.77107E-01	5.68742E-01
34	6.95361E-01	6.84543E-01	6.75178E-01	6.66994E-01	6.40385E-01	6.19335E-01	6.05684E-01	5.75463E-01	5.67750E-01
35	6.96806E-01	6.85636E-01	6.75974E-01	6.67601E-01	6.40319E-01	6.18719E-01	6.04881E-01	5.73892E-01	5.66781E-01
36	6.98202E-01	6.86691E-01	6.76742E-01	6.68187E-01	6.40253E-01	6.18124E-01	6.04108E-01	5.72382E-01	5.65834E-01
37	6.98202E-01	6.86691E-01	6.76742E-01	6.68187E-01	6.40253E-01	6.18124E-01	6.04108E-01	5.72382E-01	5.65834E-01
38	7.00891E-01	6.88748E-01	6.78259E-01	6.69353E-01	6.40209E-01	6.17079E-01	6.02718E-01	5.69592E-01	5.64057E-01
39	7.03408E-01	6.90701E-01	6.79727E-01	6.70494E-01	6.40295E-01	6.16285E-01	6.01597E-01	5.67262E-01	5.62522E-01
40	7.05733E-01	6.92522E-01	6.81113E-01	6.71583E-01	6.40455E-01	6.15672E-01	6.00687E-01	5.65301E-01	5.61203E-01
41	7.07846E-01	6.94185E-01	6.82389E-01	6.72593E-01	6.40640E-01	6.15179E-01	5.99938E-01	5.63629E-01	5.60076E-01

42	7.07846E-01	6.94185E-01	6.82389E-01	6.72593E-01	6.40640E-01	6.15179E-01	5.99938E-01	5.63629E-01	5.60076E-01
43	7.09777E-01	6.95733E-01	6.83603E-01	6.73566E-01	6.40922E-01	6.14886E-01	5.99411E-01	5.62313E-01	5.59193E-01
44	7.11528E-01	6.97181E-01	6.84777E-01	6.74523E-01	6.41371E-01	6.14896E-01	5.99197E-01	5.61520E-01	5.58642E-01
45	7.13089E-01	6.98513E-01	6.85894E-01	6.75447E-01	6.41954E-01	6.15170E-01	5.99263E-01	5.61197E-01	5.58398E-01
46	7.14453E-01	6.99718E-01	6.86939E-01	6.76325E-01	6.42650E-01	6.15680E-01	5.99580E-01	5.61305E-01	5.58443E-01
47	7.14453E-01	6.99718E-01	6.86939E-01	6.76325E-01	6.42650E-01	6.15680E-01	5.99560E-01	5.61305E-01	5.58443E-01
48	7.15619E-01	7.00796E-01	6.87913E-01	6.77153E-01	6.43457E-01	6.16422E-01	6.00140E-01	5.61835E-01	5.58765E-01
49	7.16588E-01	7.01748E-01	6.88813E-01	6.77928E-01	6.44376E-01	6.17399E-01	6.00940E-01	5.62790E-01	5.59356E-01
50	7.17361E-01	7.02574E-01	6.89640E-01	6.78646E-01	6.45410E-01	6.18613E-01	6.01974E-01	5.64167E-01	5.60203E-01
51	7.17941E-01	7.03279E-01	6.90398E-01	6.79307E-01	6.46567E-01	6.20073E-01	6.03239E-01	5.65977E-01	5.61289E-01
52	7.17941E-01	7.03279E-01	6.90398E-01	6.79307E-01	6.46567E-01	6.20073E-01	6.03239E-01	5.65977E-01	5.61289E-01
53	7.18156E-01	7.03582E-01	6.90744E-01	6.79608E-01	6.47178E-01	6.20874E-01	6.03937E-01	5.67012E-01	5.61901E-01
54	7.18317E-01	7.03845E-01	6.91059E-01	6.79881E-01	6.47797E-01	6.21707E-01	6.04664E-01	5.68116E-01	5.62543E-01
55	7.18425E-01	7.04069E-01	6.91347E-01	6.80129E-01	6.48428E-01	6.22577E-01	6.05422E-01	5.69294E-01	5.63216E-01
56	7.18481E-01	7.04258E-01	6.91608E-01	6.80350E-01	6.49074E-01	6.23487E-01	6.06212E-01	5.70550E-01	5.63917E-01
57	7.18481E-01	7.04258E-01	6.91608E-01	6.80350E-01	6.49074E-01	6.23487E-01	6.06212E-01	5.70550E-01	5.63917E-01
58	7.18475E-01	7.04426E-01	6.91873E-01	6.80569E-01	6.49841E-01	6.24589E-01	6.07164E-01	5.72096E-01	5.64763E-01
59	7.18384E-01	7.04525E-01	6.92079E-01	6.80730E-01	6.50593E-01	6.25700E-01	6.08116E-01	5.73690E-01	5.65603E-01
60	7.18211E-01	7.04560E-01	6.92231E-01	6.80834E-01	6.51339E-01	6.26831E-01	6.09070E-01	5.75344E-01	5.66435E-01
61	7.17959E-01	7.04535E-01	6.92331E-01	6.80885E-01	6.52088E-01	6.27992E-01	6.10033E-01	5.77071E-01	5.67257E-01
62	7.17959E-01	7.04535E-01	6.92331E-01	6.80885E-01	6.52088E-01	6.27992E-01	6.10033E-01	5.77071E-01	5.67257E-01
63	7.17491E-01	7.04313E-01	6.92241E-01	6.80741E-01	6.52646E-01	6.28924E-01	6.10784E-01	5.78483E-01	5.67872E-01
64	7.16774E-01	7.03780E-01	6.91805E-01	6.80259E-01	6.52700E-01	6.29260E-01	6.10977E-01	5.79184E-01	5.67955E-01
65	7.15814E-01	7.02945E-01	6.91031E-01	6.79446E-01	6.52265E-01	6.29021E-01	6.10623E-01	5.79194E-01	5.67513E-01
66	7.14615E-01	7.01816E-01	6.89929E-01	6.78308E-01	6.51356E-01	6.28221E-01	6.09733E-01	5.78531E-01	5.66549E-01
67	7.13182E-01	7.00398E-01	6.88504E-01	6.76850E-01	6.49983E-01	6.26872E-01	6.08317E-01	5.77209E-01	5.65070E-01
68	7.11518E-01	6.98695E-01	6.86760E-01	6.75076E-01	6.48155E-01	6.24984E-01	6.06380E-01	5.75239E-01	5.63081E-01
69	7.09625E-01	6.96710E-01	6.84701E-01	6.72989E-01	6.45874E-01	6.22562E-01	6.03929E-01	5.72627E-01	5.60587E-01
70	7.07504E-01	6.94445E-01	6.82328E-01	6.70591E-01	6.43145E-01	6.19608E-01	6.00968E-01	5.69379E-01	5.57595E-01
71	7.05157E-01	6.91899E-01	6.79641E-01	6.67884E-01	6.39964E-01	6.16124E-01	5.97497E-01	5.65496E-01	5.54109E-01
72	7.02582E-01	6.89072E-01	6.76640E-01	6.64867E-01	6.36329E-01	6.12104E-01	5.93517E-01	5.60977E-01	5.50136E-01
73	6.99779E-01	6.85959E-01	6.73321E-01	6.61540E-01	6.32234E-01	6.07544E-01	5.89027E-01	5.55816E-01	5.45681E-01
74	6.96746E-01	6.82558E-01	6.69681E-01	6.57903E-01	6.27669E-01	6.02434E-01	5.84025E-01	5.50008E-01	5.40751E-01
75	6.96746E-01	6.82558E-01	6.69681E-01	6.57903E-01	6.27669E-01	6.02434E-01	5.84025E-01	5.50008E-01	5.40751E-01
76	6.95160E-01	6.80743E-01	6.67721E-01	6.55955E-01	6.25066E-01	5.99403E-01	5.81136E-01	5.46404E-01	5.37952E-01
77	6.93555E-01	6.78918E-01	6.65755E-01	6.54000E-01	6.22485E-01	5.96409E-01	5.78271E-01	5.42858E-01	5.35167E-01
78	6.91930E-01	6.77082E-01	6.63783E-01	6.52037E-01	6.19921E-01	5.93446E-01	5.75427E-01	5.39364E-01	5.32395E-01
79	6.90286E-01	6.75233E-01	6.61802E-01	6.50064E-01	6.17371E-01	5.90509E-01	5.72601E-01	5.35917E-01	5.29635E-01
80	6.90286E-01	6.75233E-01	6.61802E-01	6.50064E-01	6.17371E-01	5.90510E-01	5.72601E-01	5.35917E-01	5.29635E-01
81	6.87888E-01	6.72550E-01	6.58933E-01	6.47208E-01	6.13691E-01	5.86267E-01	5.68522E-01	5.30928E-01	5.25655E-01
82	6.85465E-01	6.69864E-01	6.56076E-01	6.44360E-01	6.10087E-01	5.82141E-01	5.64540E-01	5.26116E-01	5.21758E-01
83	6.83014E-01	6.67170E-01	6.53224E-01	6.41519E-01	6.06549E-01	5.78117E-01	5.60646E-01	5.21461E-01	5.17945E-01
84	6.80533E-01	6.64466E-01	6.50374E-01	6.38680E-01	6.03065E-01	5.74183E-01	5.56832E-01	5.16947E-01	5.14213E-01
85	6.80533E-01	6.64466E-01	6.50374E-01	6.38680E-01	6.03065E-01	5.74183E-01	5.56832E-01	5.16947E-01	5.14213E-01
86	6.78008E-01	6.61729E-01	6.47499E-01	6.35820E-01	5.99576E-01	5.70247E-01	5.53026E-01	5.12441E-01	5.10502E-01
87	6.75470E-01	6.59005E-01	6.44656E-01	6.32992E-01	5.96194E-01	5.66468E-01	5.49363E-01	5.08165E-01	5.06933E-01

88	6.72918E-01	6.56293E-01	6.41841E-01	6.30194E-01	5.92909E-01	5.62833E-01	5.45834E-01	5.04100E-01	5.03501E-01
89	6.70350E-01	6.53587E-01	6.39051E-01	6.27422E-01	5.89714E-01	5.59330E-01	5.42431E-01	5.00232E-01	5.00206E-01
90	6.70350E-01	6.53587E-01	6.39051E-01	6.27422E-01	5.89714E-01	5.59330E-01	5.42431E-01	5.00232E-01	5.00206E-01
91	6.65158E-01	6.48188E-01	6.33530E-01	6.21950E-01	5.83559E-01	5.52668E-01	5.35971E-01	4.93009E-01	4.93995E-01
92	6.59962E-01	6.42901E-01	6.28203E-01	6.16681E-01	5.77924E-01	5.46741E-01	5.30212E-01	4.86839E-01	4.88521E-01
93	6.54761E-01	6.37715E-01	6.23056E-01	6.11603E-01	5.72762E-01	5.41486E-01	5.25113E-01	4.81640E-01	4.83761E-01
94	6.49554E-01	6.32624E-01	6.18079E-01	6.06706E-01	5.68046E-01	5.36861E-01	5.20641E-01	4.77354E-01	4.79698E-01
95	6.49554E-01	6.32624E-01	6.18079E-01	6.06706E-01	5.68046E-01	5.36861E-01	5.20641E-01	4.77354E-01	4.79698E-01
96	6.44350E-01	6.27628E-01	6.13267E-01	6.01986E-01	5.63748E-01	5.32824E-01	5.16762E-01	4.73917E-01	4.76307E-01
97	6.39130E-01	6.22693E-01	6.08578E-01	5.97401E-01	5.59785E-01	5.29266E-01	5.13382E-01	4.71195E-01	4.73508E-01
98	6.33909E-01	6.17830E-01	6.04022E-01	5.92954E-01	5.56169E-01	5.26196E-01	5.10504E-01	4.69201E-01	4.71301E-01
99	6.28703E-01	6.13055E-01	5.99612E-01	5.88654E-01	5.52920E-01	5.23634E-01	5.08140E-01	4.67962E-01	4.69692E-01
100	6.28703E-01	6.13055E-01	5.99612E-01	5.88654E-01	5.52920E-01	5.23634E-01	5.08140E-01	4.67962E-01	4.69692E-01
101	6.23544E-01	6.08391E-01	5.95357E-01	5.84501E-01	5.49986E-01	5.21477E-01	5.06188E-01	4.67263E-01	4.68564E-01
102	6.18340E-01	6.03698E-01	5.91100E-01	5.80341E-01	5.47124E-01	5.19439E-01	5.04403E-01	4.66818E-01	4.67726E-01
103	6.13119E-01	5.99005E-01	5.86868E-01	5.76192E-01	5.44383E-01	5.17574E-01	5.02822E-01	4.66698E-01	4.67201E-01
104	6.07908E-01	5.94343E-01	5.82693E-01	5.72071E-01	5.41814E-01	5.15941E-01	5.01486E-01	4.66979E-01	4.67016E-01
105	6.07908E-01	5.94343E-01	5.82693E-01	5.72071E-01	5.41814E-01	5.15941E-01	5.01486E-01	4.66979E-01	4.67016E-01
106	6.05336E-01	5.92056E-01	5.80656E-01	5.70045E-01	5.40615E-01	5.15214E-01	5.00904E-01	4.67223E-01	4.67026E-01
107	6.02756E-01	5.89753E-01	5.78601E-01	5.67993E-01	5.39399E-01	5.14467E-01	5.00313E-01	4.67468E-01	4.67059E-01
108	6.00170E-01	5.87437E-01	5.76534E-01	5.65917E-01	5.38176E-01	5.13708E-01	4.99719E-01	4.67724E-01	4.67119E-01
109	5.97582E-01	5.85113E-01	5.74459E-01	5.63820E-01	5.36952E-01	5.12945E-01	4.99129E-01	4.68003E-01	4.67212E-01
110	5.97583E-01	5.85113E-01	5.74459E-01	5.63820E-01	5.36952E-01	5.12945E-01	4.99129E-01	4.68003E-01	4.67212E-01
111	5.95011E-01	5.82800E-01	5.72392E-01	5.61716E-01	5.35737E-01	5.12176E-01	4.98535E-01	4.68266E-01	4.67317E-01
112	5.92432E-01	5.80464E-01	5.70298E-01	5.59570E-01	5.34488E-01	5.11358E-01	4.97902E-01	4.68493E-01	4.67418E-01
113	5.89849E-01	5.78110E-01	5.68181E-01	5.57384E-01	5.33211E-01	5.10498E-01	4.97237E-01	4.68697E-01	4.67520E-01
114	5.87267E-01	5.75741E-01	5.66045E-01	5.55160E-01	5.31915E-01	5.09603E-01	4.96547E-01	4.68887E-01	4.67631E-01
115	5.87267E-01	5.75741E-01	5.66045E-01	5.55160E-01	5.31915E-01	5.09603E-01	4.96547E-01	4.68887E-01	4.67631E-01
116	5.84701E-01	5.73376E-01	5.63907E-01	5.52912E-01	5.30613E-01	5.08680E-01	4.95829E-01	4.69034E-01	4.67732E-01
117	5.82131E-01	5.70983E-01	5.61735E-01	5.50607E-01	5.29264E-01	5.07683E-01	4.95050E-01	4.69120E-01	4.67812E-01
118	5.79561E-01	5.68567E-01	5.59531E-01	5.48245E-01	5.27876E-01	5.06621E-01	4.94217E-01	4.69157E-01	4.67877E-01
119	5.76993E-01	5.66131E-01	5.57300E-01	5.45827E-01	5.26457E-01	5.05501E-01	4.93336E-01	4.69154E-01	4.67935E-01
120	5.76993E-01	5.66131E-01	5.57300E-01	5.45827E-01	5.26457E-01	5.05501E-01	4.93336E-01	4.69154E-01	4.67935E-01
121	5.73649E-01	5.62915E-01	5.54342E-01	5.42555E-01	5.24563E-01	5.03966E-01	4.92116E-01	4.69041E-01	4.67913E-01
122	5.70288E-01	5.59698E-01	5.51375E-01	5.39342E-01	5.22577E-01	5.02357E-01	4.90801E-01	4.68765E-01	4.67721E-01
123	5.66918E-01	5.56486E-01	5.48403E-01	5.36187E-01	5.20516E-01	5.00686E-01	4.89402E-01	4.68346E-01	4.67372E-01
124	5.63547E-01	5.53284E-01	5.45434E-01	5.33089E-01	5.18393E-01	4.98966E-01	4.87930E-01	4.67804E-01	4.66880E-01
125	5.60179E-01	5.50097E-01	5.42470E-01	5.30047E-01	5.16219E-01	4.97208E-01	4.86395E-01	4.67156E-01	4.66255E-01
126	5.56822E-01	5.46929E-01	5.39518E-01	5.27061E-01	5.14007E-01	4.95422E-01	4.84806E-01	4.66419E-01	4.65509E-01
127	5.53479E-01	5.43784E-01	5.36583E-01	5.24133E-01	5.11765E-01	4.93621E-01	4.83172E-01	4.65608E-01	4.64652E-01
128	5.50154E-01	5.40666E-01	5.33667E-01	5.21262E-01	5.09504E-01	4.91812E-01	4.81502E-01	4.64738E-01	4.63692E-01
129	5.46852E-01	5.37579E-01	5.30775E-01	5.18450E-01	5.07232E-01	4.90007E-01	4.79801E-01	4.63824E-01	4.62637E-01
130	5.43573E-01	5.34526E-01	5.27912E-01	5.15699E-01	5.04955E-01	4.88214E-01	4.78078E-01	4.62877E-01	4.61494E-01
131	5.40320E-01	5.31509E-01	5.25079E-01	5.13011E-01	5.02681E-01	4.86442E-01	4.76338E-01	4.61913E-01	4.60269E-01
132	5.37095E-01	5.28531E-01	5.22281E-01	5.10388E-01	5.00417E-01	4.84701E-01	4.74587E-01	4.60941E-01	4.58967E-01
133	5.33896E-01	5.25595E-01	5.19520E-01	5.07833E-01	4.98167E-01	4.82999E-01	4.72829E-01	4.59976E-01	4.57591E-01

134	5.30725E-01	5.22701E-01	5.16799E-01	5.05348E-01	4.95936E-01	4.81345E-01	4.71070E-01	4.59028E-01	4.56145E-01
135	5.27578E-01	5.19853E-01	5.14120E-01	5.02936E-01	4.93730E-01	4.79748E-01	4.69312E-01	4.58109E-01	4.54628E-01
136	5.27578E-01	5.19853E-01	5.14120E-01	5.02936E-01	4.93731E-01	4.79748E-01	4.69312E-01	4.58109E-01	4.54628E-01
137	5.04431E-01	4.98601E-01	4.94092E-01	4.85154E-01	4.75525E-01	4.66440E-01	4.55631E-01	4.49084E-01	4.42671E-01
138	4.81560E-01	4.76937E-01	4.73440E-01	4.66202E-01	4.58401E-01	4.50972E-01	4.40668E-01	4.37143E-01	4.29761E-01
139	4.58906E-01	4.55095E-01	4.52410E-01	4.46485E-01	4.39575E-01	4.34032E-01	4.24602E-01	4.23129E-01	4.15781E-01
140	4.36441E-01	4.33225E-01	4.31190E-01	4.26306E-01	4.20261E-01	4.16108E-01	4.07666E-01	4.07644E-01	4.00812E-01
141	4.14164E-01	4.11431E-01	4.09931E-01	4.05893E-01	4.00651E-01	3.97561E-01	3.90099E-01	3.91133E-01	3.85023E-01
142	3.92100E-01	3.89800E-01	3.88756E-01	3.85426E-01	3.80916E-01	3.78663E-01	3.72122E-01	3.73941E-01	3.68613E-01
143	3.70299E-01	3.68412E-01	3.67771E-01	3.65050E-01	3.61203E-01	3.59627E-01	3.53929E-01	3.56338E-01	3.51778E-01
144	3.48828E-01	3.47346E-01	3.47071E-01	3.44885E-01	3.41638E-01	3.40622E-01	3.35686E-01	3.38541E-01	3.34701E-01
145	3.27764E-01	3.26679E-01	3.26741E-01	3.25035E-01	3.22331E-01	3.21785E-01	3.17535E-01	3.20726E-01	3.17545E-01
146	3.07191E-01	3.06488E-01	3.06860E-01	3.05586E-01	3.03375E-01	3.03230E-01	2.99596E-01	3.03037E-01	3.00450E-01
147	2.87190E-01	2.86847E-01	2.87501E-01	2.86616E-01	2.84851E-01	2.85049E-01	2.81968E-01	2.85593E-01	2.83538E-01
148	2.67834E-01	2.67819E-01	2.68726E-01	2.68188E-01	2.66827E-01	2.67321E-01	2.64733E-01	2.68492E-01	2.66910E-01
149	2.49185E-01	2.49462E-01	2.50587E-01	2.50357E-01	2.49359E-01	2.50109E-01	2.47959E-01	2.51817E-01	2.50652E-01
150	2.31293E-01	2.31819E-01	2.33129E-01	2.33164E-01	2.32494E-01	2.33464E-01	2.31699E-01	2.35637E-01	2.34835E-01
151	2.14190E-01	2.14921E-01	2.16384E-01	2.16643E-01	2.16269E-01	2.17430E-01	2.15992E-01	2.20014E-01	2.19516E-01
152	2.14190E-01	2.14921E-01	2.16384E-01	2.16643E-01	2.16269E-01	2.17430E-01	2.15992E-01	2.20014E-01	2.19516E-01
153	1.87091E-01	1.88088E-01	1.89739E-01	1.90314E-01	1.90331E-01	1.91721E-01	1.90781E-01	1.94804E-01	1.94786E-01
154	1.62617E-01	1.63818E-01	1.65589E-01	1.66413E-01	1.66739E-01	1.68277E-01	1.67755E-01	1.71658E-01	1.72006E-01
155	1.40656E-01	1.42001E-01	1.43838E-01	1.44846E-01	1.45411E-01	1.47036E-01	1.46852E-01	1.50571E-01	1.51187E-01
156	1.21079E-01	1.22513E-01	1.24369E-01	1.25502E-01	1.26244E-01	1.27906E-01	1.27989E-01	1.31488E-01	1.32291E-01
157	1.03743E-01	1.05216E-01	1.07049E-01	1.08257E-01	1.09120E-01	1.10777E-01	1.11065E-01	1.14325E-01	1.15250E-01
158	8.84910E-02	8.99593E-02	9.17338E-02	9.29716E-02	9.39081E-02	9.55285E-02	9.59647E-02	9.89752E-02	9.99728E-02
159	7.51566E-02	7.65832E-02	7.82712E-02	7.95014E-02	8.04707E-02	8.20267E-02	8.25645E-02	8.53218E-02	8.63506E-02
160	6.35676E-02	6.49232E-02	6.65029E-02	6.76950E-02	6.86635E-02	7.01340E-02	7.07336E-02	7.32389E-02	7.42663E-02
161	5.35497E-02	5.48127E-02	5.62686E-02	5.73992E-02	5.83400E-02	5.97095E-02	6.03380E-02	6.25965E-02	6.35969E-02
162	4.49310E-02	4.60872E-02	4.74099E-02	4.84618E-02	4.93545E-02	5.06125E-02	5.12438E-02	5.32633E-02	5.42171E-02
163	3.75452E-02	3.85868E-02	3.97723E-02	4.07344E-02	4.15644E-02	4.27051E-02	4.33186E-02	4.51095E-02	4.60024E-02
164	3.12353E-02	3.21597E-02	3.32086E-02	3.40748E-02	3.48325E-02	3.58537E-02	3.64342E-02	3.80088E-02	3.88307E-02
165	2.58547E-02	2.66637E-02	2.75801E-02	2.83484E-02	2.90287E-02	2.99315E-02	3.04683E-02	3.18398E-02	3.25843E-02
166	2.12693E-02	2.19678E-02	2.27584E-02	2.34300E-02	2.40311E-02	2.48189E-02	2.53051E-02	2.64873E-02	2.71511E-02
167	1.73580E-02	1.79528E-02	1.86260E-02	1.92046E-02	1.97272E-02	2.04050E-02	2.08366E-02	2.18433E-02	2.24252E-02
168	1.40121E-02	1.45114E-02	1.50764E-02	1.55672E-02	1.60137E-02	1.65875E-02	1.69627E-02	1.78072E-02	1.83077E-02
169	1.11358E-02	1.15480E-02	1.20141E-02	1.24230E-02	1.27968E-02	1.32726E-02	1.35913E-02	1.42856E-02	1.47068E-02
170	8.64443E-03	8.97775E-03	9.35376E-03	9.68701E-03	9.99149E-03	1.03747E-02	1.06383E-02	1.11921E-02	1.15372E-02
171	6.46397E-03	6.72562E-03	7.01915E-03	7.28304E-03	7.52038E-03	7.81513E-03	8.02686E-03	8.44603E-03	8.72097E-03
172	4.52939E-03	4.72500E-03	4.94203E-03	5.14305E-03	5.31238E-03	5.52091E-03	5.68767E-03	5.97040E-03	6.18749E-03
173	2.78332E-03	2.91602E-03	3.06051E-03	3.20640E-03	3.29987E-03	3.42317E-03	3.56015E-03	3.68740E-03	3.87694E-03
174	2.78332E-03	2.91602E-03	3.06051E-03	3.20640E-03	3.29987E-03	3.42317E-03	3.56015E-03	3.68740E-03	3.87694E-03
175	1.70896E-03	1.80554E-03	1.90535E-03	2.00547E-03	2.09131E-03	2.18990E-03	2.28072E-03	2.38347E-03	2.48031E-03
176	1.04424E-03	1.10708E-03	1.17166E-03	1.23682E-03	1.29915E-03	1.36929E-03	1.43019E-03	1.50437E-03	1.56133E-03
177	6.28970E-04	6.66648E-04	7.05701E-04	7.45491E-04	7.85535E-04	8.30902E-04	8.69774E-04	9.18732E-04	9.53393E-04
178	3.56876E-04	3.77459E-04	3.99021E-04	4.21189E-04	4.44079E-04	4.70347E-04	4.92869E-04	5.21770E-04	5.41641E-04
179	1.61418E-04	1.70366E-04	1.79815E-04	1.89588E-04	1.99805E-04	2.11655E-04	2.21847E-04	2.35064E-04	2.44069E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO.	GROUPS 28- 33					
1	4.64340E-01	4.86843E-01	4.86414E-01	4.78029E-01	4.60749E-01	1.43161E 01
2	4.64855E-01	4.87368E-01	4.86925E-01	4.78508E-01	4.61184E-01	1.43051E 01
3	4.66424E-01	4.88955E-01	4.88466E-01	4.79944E-01	4.62486E-01	1.42717E 01
4	4.69123E-01	4.91639E-01	4.91054E-01	4.82341E-01	4.64646E-01	1.42138E 01
5	4.73091E-01	4.95478E-01	4.94713E-01	4.85696E-01	4.67647E-01	1.41286E 01
6	4.78544E-01	5.00547E-01	4.99470E-01	4.89997E-01	4.71451E-01	1.40114E 01
7	4.85795E-01	5.06929E-01	5.05337E-01	4.95207E-01	4.75992E-01	1.38564E 01
8	4.95265E-01	5.14682E-01	5.12289E-01	5.01242E-01	4.81160E-01	1.36560E 01
9	5.07467E-01	5.23779E-01	5.20209E-01	5.07935E-01	4.86765E-01	1.34008E 01
10	5.22914E-01	5.33974E-01	5.28802E-01	5.14978E-01	4.92508E-01	1.30792E 01
11	5.41857E-01	5.44560E-01	5.37447E-01	5.21829E-01	4.97919E-01	1.26778E 01
12	5.41857E-01	5.44560E-01	5.37447E-01	5.21829E-01	4.97919E-01	1.26778E 01
13	5.58119E-01	5.54412E-01	5.45340E-01	5.27730E-01	5.02240E-01	1.18880E 01
14	5.67963E-01	5.60734E-01	5.50102E-01	5.30608E-01	5.03626E-01	1.06017E 01
15	5.72105E-01	5.63163E-01	5.51253E-01	5.29871E-01	5.01465E-01	8.81560E 00
16	5.71107E-01	5.61690E-01	5.48580E-01	5.25072E-01	4.95226E-01	6.52016E 00
17	5.71107E-01	5.61690E-01	5.48580E-01	5.25072E-01	4.95226E-01	6.52016E 00
18	5.70634E-01	5.61228E-01	5.47918E-01	5.24030E-01	4.93952E-01	6.27928E 00
19	5.70171E-01	5.60787E-01	5.47278E-01	5.23010E-01	4.92701E-01	6.04311E 00
20	5.69719E-01	5.60367E-01	5.46658E-01	5.22010E-01	4.91469E-01	5.81118E 00
21	5.69276E-01	5.59967E-01	5.46057E-01	5.21026E-01	4.90253E-01	5.58309E 00
22	5.69276E-01	5.59967E-01	5.46057E-01	5.21026E-01	4.90253E-01	5.58309E 00
23	5.68815E-01	5.59561E-01	5.45445E-01	5.20010E-01	4.88981E-01	5.31147E 00
24	5.68343E-01	5.59153E-01	5.44844E-01	5.19022E-01	4.87751E-01	5.05782E 00
25	5.67862E-01	5.58744E-01	5.44253E-01	5.18060E-01	4.86559E-01	4.82064E 00
26	5.67372E-01	5.58333E-01	5.43670E-01	5.17121E-01	4.85403E-01	4.59856E 00
27	5.67372E-01	5.58333E-01	5.43670E-01	5.17121E-01	4.85403E-01	4.59856E 00
28	5.66680E-01	5.57763E-01	5.42876E-01	5.15849E-01	4.83845E-01	4.31384E 00
29	5.65986E-01	5.57198E-01	5.42106E-01	5.14631E-01	4.82362E-01	4.05506E 00
30	5.65293E-01	5.56640E-01	5.41357E-01	5.13460E-01	4.80947E-01	3.81920E 00
31	5.64600E-01	5.56090E-01	5.40631E-01	5.12331E-01	4.79591E-01	3.60352E 00
32	5.64601E-01	5.56090E-01	5.40631E-01	5.12331E-01	4.79591E-01	3.60352E 00
33	5.63914E-01	5.55551E-01	5.39925E-01	5.11238E-01	4.78286E-01	3.40694E 00
34	5.63242E-01	5.55026E-01	5.39246E-01	5.10197E-01	4.77050E-01	3.22966E 00
35	5.62588E-01	5.54517E-01	5.38594E-01	5.09203E-01	4.75875E-01	3.06941E 00
36	5.61951E-01	5.54026E-01	5.37968E-01	5.08251E-01	4.74757E-01	2.92415E 00
37	5.61951E-01	5.54026E-01	5.37968E-01	5.08251E-01	4.74757E-01	2.92415E 00
38	5.60756E-01	5.53102E-01	5.36801E-01	5.06493E-01	4.72704E-01	2.67833E 00
39	5.59698E-01	5.52270E-01	5.35763E-01	5.04961E-01	4.70927E-01	2.48362E 00
40	5.58780E-01	5.51537E-01	5.34850E-01	5.03625E-01	4.69390E-01	2.32922E 00
41	5.58000E-01	5.50909E-01	5.34055E-01	5.02460E-01	4.68063E-01	2.20666E 00

42	5.58000E-01	5.50909E-01	5.34055E-01	5.02460E-01	4.68063E-01	2.20666E 00
43	5.57379E-01	5.50387E-01	5.33381E-01	5.01480E-01	4.66955E-01	2.11421E 00
44	5.56941E-01	5.49970E-01	5.32839E-01	5.00723E-01	4.66107E-01	2.05182E 00
45	5.56677E-01	5.49655E-01	5.32419E-01	5.00171E-01	4.65500E-01	2.01550E 00
46	5.56575E-01	5.49431E-01	5.32110E-01	4.99806E-01	4.65115E-01	2.00271E 00
47	5.56575E-01	5.49431E-01	5.32110E-01	4.99806E-01	4.65115E-01	2.00271E 00
48	5.56620E-01	5.49284E-01	5.31900E-01	4.99619E-01	4.64945E-01	2.01292E 00
49	5.56796E-01	5.49197E-01	5.31775E-01	4.99604E-01	4.64984E-01	2.04685E 00
50	5.57079E-01	5.49147E-01	5.31719E-01	4.99752E-01	4.65227E-01	2.10581E 00
51	5.57443E-01	5.49107E-01	5.31715E-01	5.00056E-01	4.65674E-01	2.19244E 00
52	5.57443E-01	5.49107E-01	5.31715E-01	5.00056E-01	4.65674E-01	2.19244E 00
53	5.57639E-01	5.49078E-01	5.31724E-01	5.00260E-01	4.65966E-01	2.24703E 00
54	5.57837E-01	5.49040E-01	5.31734E-01	5.00489E-01	4.66298E-01	2.30910E 00
55	5.58030E-01	5.48988E-01	5.31745E-01	5.00746E-01	4.66670E-01	2.37939E 00
56	5.58216E-01	5.48917E-01	5.31752E-01	5.01030E-01	4.67084E-01	2.45872E 00
57	5.58216E-01	5.48917E-01	5.31752E-01	5.01030E-01	4.67084E-01	2.45872E 00
58	5.58413E-01	5.48799E-01	5.31750E-01	5.01394E-01	4.67622E-01	2.56580E 00
59	5.58570E-01	5.48637E-01	5.31729E-01	5.01779E-01	4.68202E-01	2.68679E 00
60	5.58676E-01	5.48421E-01	5.31685E-01	5.02185E-01	4.68828E-01	2.82370E 00
61	5.58721E-01	5.48141E-01	5.31614E-01	5.02618E-01	4.69507E-01	2.97879E 00
62	5.58721E-01	5.48141E-01	5.31614E-01	5.02618E-01	4.69507E-01	2.97879E 00
63	5.58559E-01	5.47644E-01	5.31357E-01	5.02888E-01	4.70027E-01	3.15415E 00
64	5.58044E-01	5.46878E-01	5.30785E-01	5.02738E-01	4.70096E-01	3.29036E 00
65	5.57170E-01	5.45834E-01	5.29897E-01	5.02180E-01	4.69728E-01	3.38836E 00
66	5.55933E-01	5.44510E-01	5.28696E-01	5.01222E-01	4.68933E-01	3.44902E 00
67	5.54331E-01	5.42904E-01	5.27185E-01	4.99875E-01	4.67723E-01	3.47315E 00
68	5.52367E-01	5.41017E-01	5.25370E-01	4.98146E-01	4.66106E-01	3.46147E 00
69	5.50045E-01	5.38853E-01	5.23254E-01	4.96041E-01	4.64090E-01	3.41465E 00
70	5.47370E-01	5.36418E-01	5.20844E-01	4.93566E-01	4.61679E-01	3.33330E 00
71	5.44351E-01	5.33723E-01	5.18147E-01	4.90725E-01	4.58879E-01	3.21798E 00
72	5.41000E-01	5.30779E-01	5.15171E-01	4.87523E-01	4.55693E-01	3.06917E 00
73	5.37328E-01	5.27600E-01	5.11925E-01	4.83963E-01	4.52123E-01	2.88731E 00
74	5.33354E-01	5.24205E-01	5.08421E-01	4.80046E-01	4.48170E-01	2.67280E 00
75	5.33354E-01	5.24205E-01	5.08421E-01	4.80046E-01	4.48170E-01	2.67280E 00
76	5.31247E-01	5.22448E-01	5.06562E-01	4.77860E-01	4.45924E-01	2.56436E 00
77	5.29125E-01	5.20671E-01	5.04695E-01	4.75687E-01	4.43699E-01	2.46212E 00
78	5.26990E-01	5.18876E-01	5.02823E-01	4.73527E-01	4.41491E-01	2.36546E 00
79	5.24845E-01	5.17066E-01	5.00945E-01	4.71377E-01	4.39299E-01	2.27383E 00
80	5.24845E-01	5.17066E-01	5.00945E-01	4.71377E-01	4.39299E-01	2.27383E 00
81	5.21745E-01	5.14447E-01	4.98234E-01	4.68282E-01	4.36145E-01	2.15178E 00
82	5.18662E-01	5.11825E-01	4.95543E-01	4.65250E-01	4.33069E-01	2.04076E 00
83	5.15602E-01	5.09209E-01	4.92876E-01	4.62279E-01	4.30067E-01	1.93925E 00
84	5.12572E-01	5.06605E-01	4.90234E-01	4.59364E-01	4.27133E-01	1.84589E 00
85	5.12572E-01	5.06605E-01	4.90234E-01	4.59364E-01	4.27133E-01	1.84589E 00
86	5.09553E-01	5.04005E-01	4.87600E-01	4.56464E-01	4.24219E-01	1.76101E 00
87	5.06600E-01	5.01444E-01	4.85024E-01	4.53667E-01	4.21423E-01	1.68605E 00

88	5.03718E-01	4.98929E-01	4.82508E-01	4.50967E-01	4.18740E-01	1.61983E 00
89	5.00910E-01	4.96464E-01	4.80053E-01	4.48363E-01	4.16165E-01	1.56131E 00
90	5.00910E-01	4.96464E-01	4.80053E-01	4.48363E-01	4.16165E-01	1.56131E 00
91	4.95515E-01	4.91688E-01	4.75328E-01	4.43426E-01	4.11324E-01	1.46897E 00
92	4.90540E-01	4.87209E-01	4.70960E-01	4.39018E-01	4.07077E-01	1.40690E 00
93	4.85991E-01	4.83048E-01	4.66958E-01	4.35122E-01	4.03400E-01	1.37100E 00
94	4.81868E-01	4.79214E-01	4.63322E-01	4.31726E-01	4.00276E-01	1.35898E 00
95	4.81868E-01	4.79214E-01	4.63322E-01	4.31726E-01	4.00276E-01	1.35898E 00
96	4.78158E-01	4.75710E-01	4.60051E-01	4.28811E-01	3.97682E-01	1.36799E 00
97	4.74812E-01	4.72512E-01	4.57110E-01	4.26323E-01	3.95557E-01	1.39663E 00
98	4.71810E-01	4.69612E-01	4.54498E-01	4.24264E-01	3.93907E-01	1.44701E 00
99	4.69125E-01	4.66994E-01	4.52207E-01	4.22643E-01	3.92744E-01	1.52260E 00
100	4.69125E-01	4.66994E-01	4.52207E-01	4.22643E-01	3.92744E-01	1.52260E 00
101	4.66695E-01	4.64630E-01	4.50202E-01	4.21379E-01	3.91965E-01	1.61893E 00
102	4.64372E-01	4.62434E-01	4.48368E-01	4.20317E-01	3.91412E-01	1.73335E 00
103	4.62116E-01	4.60384E-01	4.46702E-01	4.19478E-01	3.91115E-01	1.87223E 00
104	4.59881E-01	4.58459E-01	4.45202E-01	4.18887E-01	3.91108E-01	2.04321E 00
105	4.59881E-01	4.58459E-01	4.45202E-01	4.18887E-01	3.91108E-01	2.04321E 00
106	4.58754E-01	4.57537E-01	4.44509E-01	4.18672E-01	3.91191E-01	2.14105E 00
107	4.57581E-01	4.56621E-01	4.43826E-01	4.18469E-01	3.91292E-01	2.24534E 00
108	4.56355E-01	4.55709E-01	4.43153E-01	4.18285E-01	3.91418E-01	2.35726E 00
109	4.55066E-01	4.54798E-01	4.42489E-01	4.18122E-01	3.91574E-01	2.47808E 00
110	4.55066E-01	4.54798E-01	4.42489E-01	4.18122E-01	3.91574E-01	2.47808E 00
111	4.53712E-01	4.53889E-01	4.41834E-01	4.17969E-01	3.91740E-01	2.60586E 00
112	4.52260E-01	4.52966E-01	4.41170E-01	4.17810E-01	3.91904E-01	2.74000E 00
113	4.50699E-01	4.52030E-01	4.40499E-01	4.17650E-01	3.92072E-01	2.88173E 00
114	4.49019E-01	4.51078E-01	4.39821E-01	4.17493E-01	3.92252E-01	3.03236E 00
115	4.49019E-01	4.51078E-01	4.39821E-01	4.17493E-01	3.92252E-01	3.03236E 00
116	4.47218E-01	4.50111E-01	4.39137E-01	4.17331E-01	3.92425E-01	3.19065E 00
117	4.45259E-01	4.49119E-01	4.38433E-01	4.17150E-01	3.92584E-01	3.35645E 00
118	4.43129E-01	4.48101E-01	4.37711E-01	4.16956E-01	3.92734E-01	3.53109E 00
119	4.40813E-01	4.47059E-01	4.36973E-01	4.16756E-01	3.92884E-01	3.71595E 00
120	4.40813E-01	4.47059E-01	4.36973E-01	4.16756E-01	3.92884E-01	3.71595E 00
121	4.37331E-01	4.45671E-01	4.35986E-01	4.16446E-01	3.93021E-01	3.96119E 00
122	4.34245E-01	4.44268E-01	4.34961E-01	4.16043E-01	3.93059E-01	4.19349E 00
123	4.31509E-01	4.42855E-01	4.33904E-01	4.15558E-01	3.93013E-01	4.41399E 00
124	4.29085E-01	4.41435E-01	4.32823E-01	4.15001E-01	3.92896E-01	4.62376E 00
125	4.26941E-01	4.40010E-01	4.31722E-01	4.14384E-01	3.92719E-01	4.82386E 00
126	4.25055E-01	4.38582E-01	4.30606E-01	4.13715E-01	3.92493E-01	5.01524E 00
127	4.23409E-01	4.37149E-01	4.29478E-01	4.13002E-01	3.92230E-01	5.19886E 00
128	4.21990E-01	4.35712E-01	4.28342E-01	4.12251E-01	3.91938E-01	5.37560E 00
129	4.20791E-01	4.34268E-01	4.27200E-01	4.11470E-01	3.91629E-01	5.54632E 00
130	4.19810E-01	4.32816E-01	4.26054E-01	4.10664E-01	3.91310E-01	5.71184E 00
131	4.19049E-01	4.31351E-01	4.24907E-01	4.09838E-01	3.90992E-01	5.87297E 00
132	4.18515E-01	4.29869E-01	4.23760E-01	4.08997E-01	3.90683E-01	6.03045E 00
133	4.18219E-01	4.28364E-01	4.22612E-01	4.08144E-01	3.90393E-01	6.18505E 00

134	4.18175E-01	4.26828E-01	4.21466E-01	4.07283E-01	3.90130E-01	6.33747E 00
135	4.18405E-01	4.25253E-01	4.20320E-01	4.06417E-01	3.89904E-01	6.48844E 00

136	4.18405E-01	4.25253E-01	4.20320E-01	4.06417E-01	3.89904E-01	6.48844E 00
137	4.16956E-01	4.14858E-01	4.11342E-01	3.99006E-01	3.86483E-01	6.77233E 00
138	4.10567E-01	4.04433E-01	4.01221E-01	3.90023E-01	3.80232E-01	7.00273E 00
139	4.00819E-01	3.93202E-01	3.90058E-01	3.79735E-01	3.71859E-01	7.18263E 00
140	3.88745E-01	3.80934E-01	3.77928E-01	3.68350E-01	3.61866E-01	7.31507E 00
141	3.75050E-01	3.67662E-01	3.64926E-01	3.56048E-01	3.50623E-01	7.40313E 00
142	3.60233E-01	3.53537E-01	3.51180E-01	3.42991E-01	3.38417E-01	7.44984E 00
143	3.44667E-01	3.38748E-01	3.36836E-01	3.29337E-01	3.25479E-01	7.45820E 00
144	3.28637E-01	3.23492E-01	3.22047E-01	3.15235E-01	3.12005E-01	7.43114E 00
145	3.12366E-01	3.07950E-01	3.06965E-01	3.00827E-01	2.98163E-01	7.37148E 00
146	2.96035E-01	2.92284E-01	2.91732E-01	2.86248E-01	2.84101E-01	7.28195E 00
147	2.79787E-01	2.76635E-01	2.76477E-01	2.71617E-01	2.69952E-01	7.16517E 00
148	2.63741E-01	2.61120E-01	2.61316E-01	2.57046E-01	2.55834E-01	7.02365E 00
149	2.47991E-01	2.45839E-01	2.46347E-01	2.42633E-01	2.41855E-01	6.85976E 00
150	2.32615E-01	2.30871E-01	2.31658E-01	2.28463E-01	2.28117E-01	6.67572E 00
151	2.17670E-01	2.16281E-01	2.17322E-01	2.14611E-01	2.14713E-01	6.47366E 00

152	2.17670E-01	2.16281E-01	2.17322E-01	2.14611E-01	2.14713E-01	6.47366E 00
153	1.93530E-01	1.92665E-01	1.94021E-01	1.92007E-01	1.92710E-01	6.14719E 00
154	1.71240E-01	1.70803E-01	1.72361E-01	1.70920E-01	1.71990E-01	5.81610E 00
155	1.50813E-01	1.50719E-01	1.52395E-01	1.51419E-01	1.52712E-01	5.48440E 00
156	1.32224E-01	1.32396E-01	1.34128E-01	1.33525E-01	1.34944E-01	5.15551E 00
157	1.15417E-01	1.15788E-01	1.17526E-01	1.17218E-01	1.18697E-01	4.83228E 00
158	1.00311E-01	1.00824E-01	1.02531E-01	1.02451E-01	1.03940E-01	4.51708E 00
159	8.68092E-02	8.74176E-02	8.90633E-02	8.91563E-02	9.06189E-02	4.21181E 00
160	7.48029E-02	7.54675E-02	7.70302E-02	7.72495E-02	7.86586E-02	3.91794E 00
161	6.41771E-02	6.48665E-02	6.63302E-02	6.66371E-02	6.79729E-02	3.63658E 00
162	5.48132E-02	5.55023E-02	5.68564E-02	5.72192E-02	5.84675E-02	3.36854E 00
163	4.65924E-02	4.72619E-02	4.84999E-02	4.88927E-02	5.00442E-02	3.11432E 00
164	3.93979E-02	4.00329E-02	4.11518E-02	4.15541E-02	4.26031E-02	2.87420E 00
165	3.31163E-02	3.37062E-02	3.47056E-02	3.51016E-02	3.60452E-02	2.64828E 00
166	2.76391E-02	2.81766E-02	2.90585E-02	2.94359E-02	3.02736E-02	2.43647E 00
167	2.28635E-02	2.33443E-02	2.41123E-02	2.44621E-02	2.51948E-02	2.23858E 00
168	1.86933E-02	1.91156E-02	1.97743E-02	2.00899E-02	2.07190E-02	2.05432E 00
169	1.50390E-02	1.54030E-02	1.59577E-02	1.62341E-02	1.67610E-02	1.88332E 00
170	1.18182E-02	1.21260E-02	1.25816E-02	1.28143E-02	1.32388E-02	1.72519E 00
171	8.95584E-03	9.21103E-03	9.57041E-03	9.75436E-03	1.00731E-02	1.57949E 00
172	6.38573E-03	6.59165E-03	6.85285E-03	6.98090E-03	7.18504E-03	1.44582E 00
173	4.05170E-03	4.20764E-03	4.35847E-03	4.42100E-03	4.49222E-03	1.32376E 00

174	4.05170E-03	4.20764E-03	4.35847E-03	4.42100E-03	4.49222E-03	1.32376E 00
175	2.57079E-03	2.66536E-03	2.76715E-03	2.82825E-03	2.84950E-03	9.18378E-01
176	1.61377E-03	1.67194E-03	1.73727E-03	1.78179E-03	1.78997E-03	6.24793E-01
177	9.84872E-04	1.02041E-03	1.06093E-03	1.09008E-03	1.09427E-03	4.09168E-01
178	5.59569E-04	5.79904E-04	6.03206E-04	6.20408E-04	6.22768E-04	2.45833E-01
179	2.52173E-04	2.61381E-04	2.71955E-04	2.79850E-04	2.80945E-04	1.14852E-01
180	0.	0.	0.	0.	0.	0.

GROUP FLUXES

Table C.5. HFIR 33-Group Fluxes, 1100 Mwd

R. NO.	GROUPS 1- 9								
1	5.62982E-01	2.10441E 00	1.88010E 00	1.80810E 00	1.27162E 00	1.11881E 00	8.88247E-01	7.59755E-01	6.97140E-01
2	5.64021E-01	2.10901E 00	1.88468E 00	1.81209E 00	1.27437E 00	1.12108E 00	8.90023E-01	7.61221E-01	6.98391E-01
3	5.67145E-01	2.12285E 00	1.89846E 00	1.82407E 00	1.28265E 00	1.12790E 00	8.95354E-01	7.65619E-01	7.02140E-01
4	5.72370E-01	2.14602E 00	1.92155E 00	1.84411E 00	1.29651E 00	1.13928E 00	9.04253E-01	7.72951E-01	7.08369E-01
5	5.79725E-01	2.17867E 00	1.95415E 00	1.87233E 00	1.31600E 00	1.15526E 00	9.16743E-01	7.83219E-01	7.17049E-01
6	5.89252E-01	2.22103E 00	1.99655E 00	1.90888E 00	1.34125E 00	1.17587E 00	9.32852E-01	7.96423E-01	7.28131E-01
7	6.01002E-01	2.27338E 00	2.04911E 00	1.95397E 00	1.37238E 00	1.20116E 00	9.52613E-01	8.12555E-01	7.41541E-01
8	6.15042E-01	2.33607E 00	2.11228E 00	2.00785E 00	1.40955E 00	1.23117E 00	9.76064E-01	8.31601E-01	7.57174E-01
9	6.31450E-01	2.40954E 00	2.18662E 00	2.07081E 00	1.45297E 00	1.26596E 00	1.00324E 00	8.53528E-01	7.74876E-01
10	6.50316E-01	2.49429E 00	2.27279E 00	2.14318E 00	1.50284E 00	1.30556E 00	1.03418E 00	8.78279E-01	7.94433E-01
11	6.71747E-01	2.59088E 00	2.37155E 00	2.22534E 00	1.55941E 00	1.35000E 00	1.06891E 00	9.05764E-01	8.15545E-01
12	6.71747E-01	2.59088E 00	2.37155E 00	2.22534E 00	1.55941E 00	1.35000E 00	1.06891E 00	9.05764E-01	8.15545E-01
13	6.91302E-01	2.68311E 00	2.47450E 00	2.30721E 00	1.61635E 00	1.39358E 00	1.09633E 00	9.27453E-01	8.39200E-01
14	7.13119E-01	2.79040E 00	2.59794E 00	2.40525E 00	1.68469E 00	1.44499E 00	1.12773E 00	9.52349E-01	8.66594E-01
15	7.37253E-01	2.91312E 00	2.74276E 00	2.51959E 00	1.76454E 00	1.50393E 00	1.16243E 00	9.79870E-01	8.97879E-01
16	7.63777E-01	3.05178E 00	2.91023E 00	2.65057E 00	1.85617E 00	1.57006E 00	1.19957E 00	1.00934E 00	9.33300E-01
17	7.63777E-01	3.05178E 00	2.91023E 00	2.65057E 00	1.85617E 00	1.57006E 00	1.19957E 00	1.00934E 00	9.33300E-01
18	7.75062E-01	3.10852E 00	2.96871E 00	2.70080E 00	1.89057E 00	1.59521E 00	1.22089E 00	1.02605E 00	9.41485E-01
19	7.86572E-01	3.16515E 00	3.02650E 00	2.74994E 00	1.92419E 00	1.61967E 00	1.24169E 00	1.04222E 00	9.49406E-01
20	7.98316E-01	3.22175E 00	3.08369E 00	2.79804E 00	1.95707E 00	1.64347E 00	1.26201E 00	1.05786E 00	9.57053E-01
21	8.10305E-01	3.27838E 00	3.14035E 00	2.84517E 00	1.98925E 00	1.66664E 00	1.28189E 00	1.07300E 00	9.64417E-01
22	8.10305E-01	3.27838E 00	3.14035E 00	2.84517E 00	1.98925E 00	1.66664E 00	1.28189E 00	1.07300E 00	9.64417E-01
23	8.16892E-01	3.30981E 00	3.17414E 00	2.87178E 00	2.00761E 00	1.67967E 00	1.29123E 00	1.08011E 00	9.69841E-01
24	8.23248E-01	3.34018E 00	3.20678E 00	2.89753E 00	2.02538E 00	1.69234E 00	1.30033E 00	1.08704E 00	9.75155E-01
25	8.29388E-01	3.36956E 00	3.23835E 00	2.92250E 00	2.04261E 00	1.70465E 00	1.30918E 00	1.09381E 00	9.80359E-01
26	8.35330E-01	3.39802E 00	3.26892E 00	2.94672E 00	2.05933E 00	1.71664E 00	1.31781E 00	1.10042E 00	9.85452E-01
27	8.35330E-01	3.39802E 00	3.26893E 00	2.94672E 00	2.05933E 00	1.71664E 00	1.31781E 00	1.10042E 00	9.85452E-01
28	8.43212E-01	3.43588E 00	3.30957E 00	2.97902E 00	2.08163E 00	1.73269E 00	1.32939E 00	1.10931E 00	9.92340E-01
29	8.50636E-01	3.47164E 00	3.34795E 00	3.00965E 00	2.10278E 00	1.74801E 00	1.34046E 00	1.11785E 00	9.98987E-01
30	8.57647E-01	3.50552E 00	3.38432E 00	3.03876E 00	2.12290E 00	1.76263E 00	1.35106E 00	1.12604E 00	1.00539E 00
31	8.64288E-01	3.53771E 00	3.41888E 00	3.06651E 00	2.14207E 00	1.77662E 00	1.36120E 00	1.13389E 00	1.01156E 00
32	8.64288E-01	3.53771E 00	3.41888E 00	3.06651E 00	2.14207E 00	1.77662E 00	1.36120E 00	1.13389E 00	1.01156E 00
33	8.70520E-01	3.56807E 00	3.45146E 00	3.09276E 00	2.16023E 00	1.78992E 00	1.37087E 00	1.14141E 00	1.01749E 00
34	8.76297E-01	3.59635E 00	3.48184E 00	3.11736E 00	2.17725E 00	1.80248E 00	1.38003E 00	1.14855E 00	1.02316E 00
35	8.81660E-01	3.62277E 00	3.51022E 00	3.14046E 00	2.19323E 00	1.81433E 00	1.38869E 00	1.15533E 00	1.02857E 00
36	8.86651E-01	3.64750E 00	3.53682E 00	3.16218E 00	2.20828E 00	1.82553E 00	1.39689E 00	1.16177E 00	1.03372E 00
37	8.86651E-01	3.64750E 00	3.53682E 00	3.16218E 00	2.20828E 00	1.82553E 00	1.39689E 00	1.16177E 00	1.03372E 00
38	8.95287E-01	3.69094E 00	3.58356E 00	3.20080E 00	2.23505E 00	1.84572E 00	1.41175E 00	1.17353E 00	1.04324E 00
39	9.02194E-01	3.72661E 00	3.62207E 00	3.23317E 00	2.25754E 00	1.86300E 00	1.42458E 00	1.18380E 00	1.05167E 00
40	9.07642E-01	3.75575E 00	3.65370E 00	3.26023E 00	2.27638E 00	1.87772E 00	1.43558E 00	1.19269E 00	1.05907E 00
41	9.11854E-01	3.77937E 00	3.67957E 00	3.28273E 00	2.29208E 00	1.89014E 00	1.44492E 00	1.20029E 00	1.06546E 00

42	9.11854E-01	3.77937E 00	3.67957E 00	3.28273E 00	2.29208E 00	1.89014E 00	1.44492E 00	1.20029E 00	1.06546E 00
43	9.14741E-01	3.79711E 00	3.69927E 00	3.30042E 00	2.30448E 00	1.90021E 00	1.45255E 00	1.20661E 00	1.07086E 00
44	9.16197E-01	3.80849E 00	3.71232E 00	3.31298E 00	2.31335E 00	1.90779E 00	1.45843E 00	1.21160E 00	1.07526E 00
45	9.16360E-01	3.81415E 00	3.71940E 00	3.32088E 00	2.31902E 00	1.91309E 00	1.46266E 00	1.21534E 00	1.07870E 00
46	9.15328E-01	3.81454E 00	3.72100E 00	3.32448E 00	2.32174E 00	1.91626E 00	1.46535E 00	1.21791E 00	1.08122E 00
47	9.15328E-01	3.81454E 00	3.72100E 00	3.32448E 00	2.32174E 00	1.91626E 00	1.46535E 00	1.21791E 00	1.08122E 00
48	9.13134E-01	3.80982E 00	3.71731E 00	3.32394E 00	2.32160E 00	1.91739E 00	1.46656E 00	1.21936E 00	1.08287E 00
49	9.09783E-01	3.80002E 00	3.70835E 00	3.31931E 00	2.31866E 00	1.91651E 00	1.46634E 00	1.21973E 00	1.08369E 00
50	9.05274E-01	3.78514E 00	3.69412E 00	3.31062E 00	2.31292E 00	1.91367E 00	1.46472E 00	1.21907E 00	1.08370E 00
51	8.99575E-01	3.76506E 00	3.67447E 00	3.29781E 00	2.30436E 00	1.90890E 00	1.46173E 00	1.21740E 00	1.08296E 00
52	8.99575E-01	3.76506E 00	3.67447E 00	3.29781E 00	2.30436E 00	1.90890E 00	1.46173E 00	1.21740E 00	1.08296E 00
53	8.96290E-01	3.75311E 00	3.66287E 00	3.28991E 00	2.29905E 00	1.90582E 00	1.45975E 00	1.21622E 00	1.08233E 00
54	8.92744E-01	3.74003E 00	3.64969E 00	3.28112E 00	2.29314E 00	1.90232E 00	1.45748E 00	1.21483E 00	1.08154E 00
55	8.88924E-01	3.72576E 00	3.63547E 00	3.27140E 00	2.28658E 00	1.89840E 00	1.45491E 00	1.21323E 00	1.08059E 00
56	8.84817E-01	3.71023E 00	3.61994E 00	3.26071E 00	2.27937E 00	1.89405E 00	1.45204E 00	1.21142E 00	1.07949E 00
57	8.84817E-01	3.71023E 00	3.61994E 00	3.26071E 00	2.27937E 00	1.89405E 00	1.45204E 00	1.21142E 00	1.07949E 00
58	8.79556E-01	3.69016E 00	3.59981E 00	3.24677E 00	2.26994E 00	1.88832E 00	1.44825E 00	1.20901E 00	1.07798E 00
59	8.73952E-01	3.66860E 00	3.57814E 00	3.23169E 00	2.25974E 00	1.88208E 00	1.44411E 00	1.20635E 00	1.07629E 00
60	8.67973E-01	3.64541E 00	3.55478E 00	3.21538E 00	2.24870E 00	1.87531E 00	1.43961E 00	1.20346E 00	1.07443E 00
61	8.61585E-01	3.62044E 00	3.52956E 00	3.19774E 00	2.23674E 00	1.86799E 00	1.43473E 00	1.20033E 00	1.07241E 00
62	8.61585E-01	3.62044E 00	3.52956E 00	3.19774E 00	2.23674E 00	1.86799E 00	1.43473E 00	1.20033E 00	1.07241E 00
63	8.53194E-01	3.58790E 00	3.49726E 00	3.17467E 00	2.22115E 00	1.85829E 00	1.42793E 00	1.19589E 00	1.06974E 00
64	8.45947E-01	3.56014E 00	3.46993E 00	3.15475E 00	2.20771E 00	1.84966E 00	1.42178E 00	1.19172E 00	1.06706E 00
65	8.39812E-01	3.53704E 00	3.44745E 00	3.13791E 00	2.19637E 00	1.84209E 00	1.41630E 00	1.18784E 00	1.06439E 00
66	8.34764E-01	3.51849E 00	3.42970E 00	3.12411E 00	2.18710E 00	1.83558E 00	1.41148E 00	1.18426E 00	1.06176E 00
67	8.30779E-01	3.50440E 00	3.41658E 00	3.11327E 00	2.17985E 00	1.83011E 00	1.40732E 00	1.18099E 00	1.05916E 00
68	8.27834E-01	3.49468E 00	3.40801E 00	3.10536E 00	2.17460E 00	1.82568E 00	1.40381E 00	1.17803E 00	1.05661E 00
69	8.25909E-01	3.48924E 00	3.40390E 00	3.10031E 00	2.17131E 00	1.82227E 00	1.40094E 00	1.17537E 00	1.05411E 00
70	8.24986E-01	3.48802E 00	3.40419E 00	3.09807E 00	2.16994E 00	1.81984E 00	1.39869E 00	1.17300E 00	1.05165E 00
71	8.25048E-01	3.49096E 00	3.40880E 00	3.09860E 00	2.17048E 00	1.81838E 00	1.39703E 00	1.17090E 00	1.04922E 00
72	8.26082E-01	3.49798E 00	3.41769E 00	3.10185E 00	2.17287E 00	1.81786E 00	1.39596E 00	1.16905E 00	1.04681E 00
73	8.28075E-01	3.50906E 00	3.43081E 00	3.10776E 00	2.17710E 00	1.81824E 00	1.39543E 00	1.16741E 00	1.04439E 00
74	8.31016E-01	3.52414E 00	3.44813E 00	3.11630E 00	2.18314E 00	1.81949E 00	1.39541E 00	1.16596E 00	1.04193E 00
75	8.31016E-01	3.52414E 00	3.44813E 00	3.11630E 00	2.18314E 00	1.81949E 00	1.39541E 00	1.16596E 00	1.04193E 00
76	8.32381E-01	3.53109E 00	3.45621E 00	3.12025E 00	2.18594E 00	1.82008E 00	1.39542E 00	1.16533E 00	1.04075E 00
77	8.33554E-01	3.53722E 00	3.46343E 00	3.12359E 00	2.18833E 00	1.82043E 00	1.39527E 00	1.16461E 00	1.03951E 00
78	8.34550E-01	3.54259E 00	3.46986E 00	3.12638E 00	2.19035E 00	1.82055E 00	1.39496E 00	1.16378E 00	1.03820E 00
79	8.35381E-01	3.54726E 00	3.47557E 00	3.12865E 00	2.19202E 00	1.82045E 00	1.39450E 00	1.16286E 00	1.03684E 00
80	8.35381E-01	3.54726E 00	3.47557E 00	3.12865E 00	2.19202E 00	1.82045E 00	1.39450E 00	1.16286E 00	1.03684E 00
81	8.36245E-01	3.55256E 00	3.48229E 00	3.13036E 00	2.19371E 00	1.81988E 00	1.39356E 00	1.16136E 00	1.03476E 00
82	8.36714E-01	3.55617E 00	3.48725E 00	3.13181E 00	2.19455E 00	1.81878E 00	1.39226E 00	1.15962E 00	1.03254E 00
83	8.36823E-01	3.55824E 00	3.49063E 00	3.13161E 00	2.19461E 00	1.81719E 00	1.39063E 00	1.15765E 00	1.03016E 00
84	8.36606E-01	3.55893E 00	3.49257E 00	3.13036E 00	2.19398E 00	1.81513E 00	1.38867E 00	1.15546E 00	1.02764E 00
85	8.36606E-01	3.55893E 00	3.49257E 00	3.13036E 00	2.19398E 00	1.81513E 00	1.38867E 00	1.15546E 00	1.02764E 00
86	8.36022E-01	3.55806E 00	3.49291E 00	3.12793E 00	2.19255E 00	1.81256E 00	1.38636E 00	1.15303E 00	1.02494E 00
87	8.35037E-01	3.55547E 00	3.49147E 00	3.12420E 00	2.19025E 00	1.80942E 00	1.38367E 00	1.15033E 00	1.02207E 00

88	8.33683E-01	3.55130E 00	3.48840E 00	3.11927E 00	2.18714E 00	1.80576E 00	1.38061E 00	1.14738E 00	1.01902E 00
89	8.31983E-01	3.54567E 00	3.48382E 00	3.11322E 00	2.18328E 00	1.80160E 00	1.37721E 00	1.14418E 00	1.01580E 00
90	8.31983E-01	3.54567E 00	3.48382E 00	3.11322E 00	2.18328E 00	1.80160E 00	1.37721E 00	1.14418E 00	1.01580E 00
91	8.27438E-01	3.52952E 00	3.46961E 00	3.09738E 00	2.17307E 00	1.79161E 00	1.36925E 00	1.13699E 00	1.00881E 00
92	8.21426E-01	3.50712E 00	3.44894E 00	3.07675E 00	2.15966E 00	1.77948E 00	1.35982E 00	1.12874E 00	1.00108E 00
93	8.14061E-01	3.47898E 00	3.42238E 00	3.05170E 00	2.14330E 00	1.76535E 00	1.34900E 00	1.11949E 00	9.92636E-01
94	8.05410E-01	3.44540E 00	3.39025E 00	3.02244E 00	2.12417E 00	1.74929E 00	1.33684E 00	1.10926E 00	9.83485E-01
95	8.05410E-01	3.44540E 00	3.39025E 00	3.02244E 00	2.12417E 00	1.74929E 00	1.33684E 00	1.10926E 00	9.83485E-01
96	7.95569E-01	3.40682E 00	3.35299E 00	2.98929E 00	2.10249E 00	1.73146E 00	1.32342E 00	1.09810E 00	9.73661E-01
97	7.84578E-01	3.36341E 00	3.31081E 00	2.95240E 00	2.07838E 00	1.71191E 00	1.30881E 00	1.08604E 00	9.63178E-01
98	7.72389E-01	3.31496E 00	3.26348E 00	2.91161E 00	2.05176E 00	1.69061E 00	1.29299E 00	1.07309E 00	9.52050E-01
99	7.58915E-01	3.26107E 00	3.21056E 00	2.86666E 00	2.02245E 00	1.66749E 00	1.27592E 00	1.05924E 00	9.40293E-01
100	7.58915E-01	3.26107E 00	3.21056E 00	2.86666E 00	2.02245E 00	1.66749E 00	1.27592E 00	1.05924E 00	9.40293E-01
101	7.44375E-01	3.20275E 00	3.15303E 00	2.81827E 00	1.99097E 00	1.64290E 00	1.25787E 00	1.04465E 00	9.28030E-01
102	7.28864E-01	3.14040E 00	3.09142E 00	2.76681E 00	1.95760E 00	1.61696E 00	1.23889E 00	1.02937E 00	9.15263E-01
103	7.12221E-01	3.07330E 00	3.02493E 00	2.71177E 00	1.92202E 00	1.58954E 00	1.21894E 00	1.01339E 00	9.02016E-01
104	6.94254E-01	3.00058E 00	2.95261E 00	2.65254E 00	1.88384E 00	1.56047E 00	1.19794E 00	9.96677E-01	8.88313E-01
105	6.94254E-01	3.00058E 00	2.95261E 00	2.65254E 00	1.88384E 00	1.56047E 00	1.19794E 00	9.96677E-01	8.88313E-01
106	6.84803E-01	2.96226E 00	2.91436E 00	2.62146E 00	1.86385E 00	1.54539E 00	1.18712E 00	9.88106E-01	8.81347E-01
107	6.75099E-01	2.92288E 00	2.87502E 00	2.58961E 00	1.84340E 00	1.53002E 00	1.17611E 00	9.79409E-01	8.74304E-01
108	6.65113E-01	2.88232E 00	2.83446E 00	2.55690E 00	1.82246E 00	1.51434E 00	1.16492E 00	9.70585E-01	8.67187E-01
109	6.54816E-01	2.84043E 00	2.79253E 00	2.52323E 00	1.80094E 00	1.49832E 00	1.15352E 00	9.61631E-01	8.60002E-01
110	6.54816E-01	2.84043E 00	2.79253E 00	2.52323E 00	1.80094E 00	1.49832E 00	1.15352E 00	9.61631E-01	8.60002E-01
111	6.44274E-01	2.79754E 00	2.74951E 00	2.48882E 00	1.77900E 00	1.48206E 00	1.14201E 00	9.52598E-01	8.52788E-01
112	6.33508E-01	2.75373E 00	2.70554E 00	2.45376E 00	1.75672E 00	1.46559E 00	1.13037E 00	9.43490E-01	8.45541E-01
113	6.22490E-01	2.70886E 00	2.66048E 00	2.41796E 00	1.73402E 00	1.44888E 00	1.11862E 00	9.34309E-01	8.38267E-01
114	6.11189E-01	2.66280E 00	2.61417E 00	2.38132E 00	1.71086E 00	1.43192E 00	1.10674E 00	9.25055E-01	8.30972E-01
115	6.11189E-01	2.66280E 00	2.61417E 00	2.38132E 00	1.71086E 00	1.43192E 00	1.10674E 00	9.25055E-01	8.30972E-01
116	5.99664E-01	2.61582E 00	2.56687E 00	2.34405E 00	1.68737E 00	1.41480E 00	1.09480E 00	9.15775E-01	8.23696E-01
117	5.87927E-01	2.56796E 00	2.51866E 00	2.30618E 00	1.66359E 00	1.39753E 00	1.08282E 00	9.06474E-01	8.16435E-01
118	5.75949E-01	2.51911E 00	2.46940E 00	2.26764E 00	1.63947E 00	1.38010E 00	1.07077E 00	8.97154E-01	8.09197E-01
119	5.63700E-01	2.46911E 00	2.41894E 00	2.22834E 00	1.61496E 00	1.36249E 00	1.05867E 00	8.87818E-01	8.01991E-01
120	5.63700E-01	2.46911E 00	2.41894E 00	2.22834E 00	1.61496E 00	1.36249E 00	1.05867E 00	8.87818E-01	8.01991E-01
121	5.43476E-01	2.38796E 00	2.33995E 00	2.16553E 00	1.57632E 00	1.33455E 00	1.03801E 00	8.71845E-01	7.91742E-01
122	5.24082E-01	2.31018E 00	2.26427E 00	2.10495E 00	1.53945E 00	1.30761E 00	1.01819E 00	8.56319E-01	7.81727E-01
123	5.05485E-01	2.23566E 00	2.19176E 00	2.04654E 00	1.50435E 00	1.28171E 00	9.99231E-01	8.41267E-01	7.71999E-01
124	4.87654E-01	2.16428E 00	2.12233E 00	1.99027E 00	1.47100E 00	1.25685E 00	9.81151E-01	8.26714E-01	7.62607E-01
125	4.70560E-01	2.09592E 00	2.05586E 00	1.93608E 00	1.43940E 00	1.23305E 00	9.63972E-01	8.12682E-01	7.53597E-01
126	4.54173E-01	2.03047E 00	1.99223E 00	1.88393E 00	1.40955E 00	1.21032E 00	9.47712E-01	7.99188E-01	7.45013E-01
127	4.38468E-01	1.96784E 00	1.93137E 00	1.83378E 00	1.38145E 00	1.18868E 00	9.32391E-01	7.86247E-01	7.36896E-01
128	4.23417E-01	1.90792E 00	1.87316E 00	1.78557E 00	1.35510E 00	1.16813E 00	9.18031E-01	7.73869E-01	7.29286E-01
129	4.08996E-01	1.85062E 00	1.81753E 00	1.73928E 00	1.33051E 00	1.14869E 00	9.04650E-01	7.62065E-01	7.22221E-01
130	3.95182E-01	1.79586E 00	1.76437E 00	1.69485E 00	1.30768E 00	1.13037E 00	8.92271E-01	7.50839E-01	7.15738E-01
131	3.81952E-01	1.74354E 00	1.71362E 00	1.65224E 00	1.28662E 00	1.11317E 00	8.80916E-01	7.40195E-01	7.09874E-01
132	3.69283E-01	1.69359E 00	1.66519E 00	1.61142E 00	1.26735E 00	1.09710E 00	8.70607E-01	7.30132E-01	7.04665E-01
133	3.57156E-01	1.64593E 00	1.61900E 00	1.57235E 00	1.24988E 00	1.08216E 00	8.61371E-01	7.20647E-01	7.00146E-01

134	3.45550E-01	1.60048E 00	1.57498E 00	1.53498E 00	1.23423E 00	1.06837E 00	8.53232E-01	7.11734E-01	6.96355E-01
135	3.34447E-01	1.55717E 00	1.53307E 00	1.49929E 00	1.22044E 00	1.05572E 00	8.46221E-01	7.03383E-01	6.93328E-01
136	3.34447E-01	1.55717E 00	1.53307E 00	1.49929E 00	1.22044E 00	1.05572E 00	8.46221E-01	7.03383E-01	6.93328E-01
137	2.92604E-01	1.39607E 00	1.36250E 00	1.31806E 00	1.14029E 00	9.86075E-01	8.08120E-01	6.62426E-01	6.69128E-01
138	2.56121E-01	1.25137E 00	1.21189E 00	1.16122E 00	1.05182E 00	9.15227E-01	7.62930E-01	6.21861E-01	6.38022E-01
139	2.24292E-01	1.12145E 00	1.07868F 00	1.02498E 00	9.61375E-01	8.44354E-01	7.13665E-01	5.81168E-01	6.02765E-01
140	1.96506E-01	1.00481E 00	9.60706E-01	9.06233E-01	8.72915E-01	7.74726E-01	6.62552E-01	5.40480E-01	5.65206E-01
141	1.72236F-01	9.00125E-01	8.56080E-01	8.02405E-01	7.88784E-01	7.07453E-01	6.11238E-01	5.00205E-01	5.26660E-01
142	1.51023E-01	8.06183E-01	7.63190E-01	7.11375E-01	7.10258E-01	6.43392E-01	5.60932E-01	4.60824E-01	4.88097E-01
143	1.32473E-01	7.21895E-01	6.80637E-01	6.31366E-01	6.37914E-01	5.83135E-01	5.12495E-01	4.22790E-01	4.50244E-01
144	1.16240E-01	6.46279E-01	6.07206E-01	5.60890E-01	5.71882E-01	5.27034E-01	4.66518E-01	3.86477E-01	4.13647E-01
145	1.02027E-01	5.78450E-01	5.41836E-01	4.98691E-01	5.12019E-01	4.75248E-01	4.23377E-01	3.52167E-01	3.78707E-01
146	8.95751E-02	5.17610E-01	4.83604E-01	4.43704E-01	4.58023E-01	4.27788E-01	3.83283E-01	3.20051E-01	3.45709E-01
147	7.86583E-02	4.63041E-01	4.31700E-01	3.95021E-01	4.09506E-01	3.84554E-01	3.46325E-01	2.90237E-01	3.14841E-01
148	6.90810E-02	4.14097E-01	3.85414E-01	3.51863E-01	3.66047E-01	3.45375E-01	3.12498E-01	2.62770E-01	2.86218E-01
149	6.06728E-02	3.70197E-01	3.44123E-01	3.13564E-01	3.27224E-01	3.10035E-01	2.81738E-01	2.37639E-01	2.59897E-01
150	5.32851E-02	3.30816E-01	3.07278E-01	2.79547E-01	2.92636E-01	2.78292E-01	2.53940E-01	2.14794E-01	2.35894E-01
151	4.67882E-02	2.95485E-01	2.74397E-01	2.49312E-01	2.61914E-01	2.49897E-01	2.28976E-01	1.94154E-01	2.14202E-01
152	4.67882E-02	2.95485E-01	2.74397E-01	2.49312E-01	2.61914E-01	2.49897E-01	2.28976E-01	1.94154E-01	2.14202E-01
153	3.75307E-02	2.43785E-01	2.26445E-01	2.05164E-01	2.15649E-01	2.07666E-01	1.91341E-01	1.62834E-01	1.81047E-01
154	3.01368E-02	2.01082E-01	1.86836E-01	1.68934E-01	1.78977E-01	1.72200E-01	1.59351E-01	1.36045E-01	1.52127E-01
155	2.42242E-02	1.65822E-01	1.54124E-01	1.39157E-01	1.47736E-01	1.42560E-01	1.32368E-01	1.13315E-01	1.27261E-01
156	1.94905E-02	1.36715E-01	1.27113E-01	1.14653E-01	1.21884E-01	1.17879E-01	1.09739E-01	9.41515E-02	1.06097E-01
157	1.56962E-02	1.12690E-01	1.04812E-01	9.44729E-02	1.00518E-01	9.73802E-02	9.08408E-02	7.80777E-02	8.82190E-02
158	1.26514E-02	9.28645E-02	8.64027E-02	7.78431E-02	8.28720E-02	8.03881E-02	7.51080E-02	6.46478E-02	7.31989E-02
159	1.02054E-02	7.65050E-02	7.12061E-02	6.41326E-02	6.83032E-02	6.63202E-02	6.20396E-02	5.34598E-02	6.06322E-02
160	8.23812E-03	6.30057E-02	5.86616E-02	5.28244E-02	5.62762E-02	5.46825E-02	5.12010E-02	4.41593E-02	5.01498E-02
161	6.65402E-03	5.18655E-02	4.83051E-02	4.34938E-02	4.63464E-02	4.50589E-02	4.22204E-02	3.64388E-02	4.14244E-02
162	5.37694E-03	4.26702E-02	3.97529E-02	3.57914E-02	3.81452E-02	3.71010E-02	3.47824E-02	3.00349E-02	3.41712E-02
163	4.34603E-03	3.50769E-02	3.26877E-02	2.94290E-02	3.13680E-02	3.05179E-02	2.86214E-02	2.47240E-02	2.81451E-02
164	3.51264E-03	2.88025E-02	2.68467E-02	2.41690E-02	2.57621E-02	2.50674E-02	2.35145E-02	2.03170E-02	2.31369E-02
165	2.83778E-03	2.36125E-02	2.20126E-02	1.98147E-02	2.11182E-02	2.05477E-02	1.92750E-02	1.66549E-02	1.89692E-02
166	2.29019E-03	1.93129E-02	1.80052E-02	1.62032E-02	1.72625E-02	1.67904E-02	1.57462E-02	1.36034E-02	1.54919E-02
167	1.84475E-03	1.57428E-02	1.46749E-02	1.31989E-02	1.40495E-02	1.36544E-02	1.27963E-02	1.10495E-02	1.25775E-02
168	1.48119E-03	1.27688E-02	1.18973E-02	1.06887E-02	1.13572E-02	1.10206E-02	1.03136E-02	8.89684E-03	1.01176E-02
169	1.18315E-03	1.02795E-02	9.56849E-03	8.57732E-03	9.08142E-03	8.78765E-03	8.20214E-03	7.06308E-03	8.01931E-03
170	9.37374E-04	8.18211E-03	7.60111E-03	6.78325E-03	7.13136E-03	6.86768E-03	6.37836E-03	5.47654E-03	6.20253E-03
171	7.33040E-04	6.39844E-03	5.92111E-03	5.23548E-03	5.42545E-03	5.18360E-03	4.76693E-03	4.07420E-03	4.59779E-03
172	5.61283E-04	4.86229E-03	4.46493E-03	3.86978E-03	3.88655E-03	3.66676E-03	3.29704E-03	2.80055E-03	3.14502E-03
173	4.14762E-04	3.51687E-03	3.17688E-03	2.62499E-03	2.43688E-03	2.25656E-03	1.89712E-03	1.60892E-03	1.79304E-03
174	4.14762E-04	3.51687E-03	3.17688E-03	2.62499E-03	2.43688E-03	2.25656E-03	1.89712E-03	1.60892E-03	1.79304E-03
175	3.19775E-04	2.60604E-03	2.29843E-03	1.96191E-03	1.69545E-03	1.57423E-03	1.33245E-03	1.14193E-03	1.15219E-03
176	2.39365E-04	1.88506E-03	1.63070E-03	1.42610E-03	1.17085E-03	1.08597E-03	9.21897E-04	7.94832E-04	7.59788E-04
177	1.70009E-04	1.30204E-03	1.10967E-03	9.87528E-04	7.82615E-04	7.23974E-04	6.15047E-04	5.31985E-04	4.94353E-04
178	1.08702E-04	8.15476E-04	6.87672E-04	6.19205E-04	4.79616E-04	4.42471E-04	3.75797E-04	3.25562E-04	2.98253E-04
179	5.28182E-05	3.91230E-04	3.27831E-04	2.97193E-04	2.27268E-04	2.09260E-04	1.77644E-04	1.54003E-04	1.40162E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO.	GROUPS 10- 18								
1	6.19802E-01	6.03489E-01	5.78452E-01	5.62719E-01	5.60504E-01	5.62152E-01	5.68539E-01	5.73723E-01	5.79313E-01
2	6.20895E-01	6.04493E-01	5.79374E-01	5.63580E-01	5.61322E-01	5.62934E-01	5.69292E-01	5.74443E-01	5.80002E-01
3	6.24171E-01	6.07498E-01	5.82135E-01	5.66157E-01	5.63769E-01	5.65273E-01	5.71545E-01	5.76596E-01	5.82058E-01
4	6.29615E-01	6.12482E-01	5.86713E-01	5.70429E-01	5.67821E-01	5.69145E-01	5.75272E-01	5.80155E-01	5.85456E-01
5	6.37207E-01	6.19410E-01	5.93072E-01	5.76361E-01	5.73440E-01	5.74509E-01	5.80432E-01	5.85077E-01	5.90152E-01
6	6.46909E-01	6.28224E-01	6.01160E-01	5.83899E-01	5.80569E-01	5.81308E-01	5.86965E-01	5.91301E-01	5.96081E-01
7	6.58673E-01	6.38845E-01	6.10903E-01	5.92973E-01	5.89131E-01	5.89463E-01	5.94793E-01	5.98745E-01	6.03162E-01
8	6.72427E-01	6.51163E-01	6.22204E-01	6.03493E-01	5.99029E-01	5.98878E-01	6.03818E-01	6.07310E-01	6.11292E-01
9	6.88075E-01	6.65029E-01	6.34942E-01	6.15345E-01	6.10141E-01	6.09433E-01	6.13920E-01	6.16872E-01	6.20348E-01
10	7.05492E-01	6.80247E-01	6.48961E-01	6.28393E-01	6.22320E-01	6.20984E-01	6.24959E-01	6.27289E-01	6.30185E-01
11	7.24515E-01	6.96557E-01	6.64074E-01	6.42477E-01	6.35389E-01	6.33367E-01	6.36776E-01	6.38394E-01	6.40637E-01
12	7.24515E-01	6.96557E-01	6.64074E-01	6.42477E-01	6.35389E-01	6.33367E-01	6.36776E-01	6.38394E-01	6.40637E-01
13	7.41573E-01	7.16863E-01	6.82433E-01	6.59288E-01	6.51046E-01	6.48214E-01	6.50858E-01	6.51575E-01	6.52924E-01
14	7.61660E-01	7.39319E-01	7.02344E-01	6.77266E-01	6.67889E-01	6.63995E-01	6.65639E-01	6.65289E-01	6.65504E-01
15	7.84283E-01	7.64168E-01	7.23670E-01	6.96099E-01	6.85556E-01	6.80304E-01	6.80666E-01	6.79062E-01	6.77865E-01
16	8.08916E-01	7.91576E-01	7.46070E-01	7.15260E-01	7.03569E-01	6.96607E-01	6.95358E-01	6.92311E-01	6.89383E-01
17	8.08916E-01	7.91576E-01	7.46070E-01	7.15260E-01	7.03569E-01	6.96607E-01	6.95358E-01	6.92312E-01	6.89383E-01
18	8.19824E-01	7.95009E-01	7.49196E-01	7.18086E-01	7.06224E-01	6.98918E-01	6.97415E-01	6.94139E-01	6.90939E-01
19	8.30081E-01	7.98432E-01	7.52323E-01	7.20920E-01	7.08848E-01	7.01213E-01	6.99465E-01	6.95956E-01	6.92491E-01
20	8.39709E-01	8.01835E-01	7.55446E-01	7.23756E-01	7.11440E-01	7.03489E-01	7.01507E-01	6.97763E-01	6.94038E-01
21	8.48726E-01	8.05209E-01	7.58559E-01	7.26593E-01	7.13998E-01	7.05747E-01	7.03541E-01	6.99560E-01	6.95579E-01
22	8.48726E-01	8.05209E-01	7.58559E-01	7.26593E-01	7.13998E-01	7.05747E-01	7.03541E-01	6.99560E-01	6.95579E-01
23	8.53316E-01	8.09012E-01	7.61737E-01	7.29343E-01	7.16459E-01	7.07969E-01	7.05545E-01	7.01339E-01	6.97108E-01
24	8.57815E-01	8.12748E-01	7.64866E-01	7.32052E-01	7.18885E-01	7.10158E-01	7.07521E-01	7.03091E-01	6.98613E-01
25	8.62221E-01	8.16413E-01	7.67942E-01	7.34720E-01	7.21273E-01	7.12313E-01	7.09465E-01	7.04814E-01	7.00091E-01
26	8.66533E-01	8.20006E-01	7.70963E-01	7.37342E-01	7.23621E-01	7.14432E-01	7.11376E-01	7.06507E-01	7.01541E-01
27	8.66533E-01	8.20006E-01	7.70963E-01	7.37342E-01	7.23621E-01	7.14432E-01	7.11376E-01	7.06507E-01	7.01541E-01
28	8.72369E-01	8.24882E-01	7.75073E-01	7.40915E-01	7.26823E-01	7.17321E-01	7.13982E-01	7.08817E-01	7.03520E-01
29	8.78006E-01	8.29607E-01	7.79068E-01	7.44394E-01	7.29942E-01	7.20137E-01	7.16522E-01	7.11068E-01	7.05447E-01
30	8.83444E-01	8.34177E-01	7.82942E-01	7.47772E-01	7.32974E-01	7.22874E-01	7.18992E-01	7.13256E-01	7.07318E-01
31	8.88682E-01	8.38588E-01	7.86690E-01	7.51046E-01	7.35913E-01	7.25529E-01	7.21386E-01	7.15377E-01	7.09127E-01
32	8.88682E-01	8.38588E-01	7.86690E-01	7.51046E-01	7.35913E-01	7.25529E-01	7.21386E-01	7.15377E-01	7.09127E-01
33	8.93720E-01	8.42846E-01	7.90317E-01	7.54219E-01	7.38766E-01	7.28108E-01	7.23713E-01	7.17439E-01	7.10887E-01
34	8.98544E-01	8.46936E-01	7.93811E-01	7.57282E-01	7.41522E-01	7.30600E-01	7.25964E-01	7.19434E-01	7.12589E-01
35	9.03152E-01	8.50855E-01	7.97168E-01	7.60230E-01	7.44178E-01	7.33004E-01	7.28135E-01	7.21359E-01	7.14230E-01
36	9.07548E-01	8.54602E-01	8.00385E-01	7.63059E-01	7.46730E-01	7.35315E-01	7.30223E-01	7.23210E-01	7.15805E-01
37	9.07548E-01	8.54602E-01	8.00385E-01	7.63059E-01	7.46730E-01	7.35315E-01	7.30223E-01	7.23210E-01	7.15805E-01
38	9.15696E-01	8.61595E-01	8.06418E-01	7.68384E-01	7.51545E-01	7.39684E-01	7.34177E-01	7.26722E-01	7.18807E-01
39	9.22958E-01	8.67877E-01	8.11873E-01	7.73222E-01	7.55935E-01	7.43677E-01	7.37800E-01	7.29948E-01	7.21573E-01
40	9.29358E-01	8.73452E-01	8.16740E-01	7.77558E-01	7.59885E-01	7.47279E-01	7.41075E-01	7.32870E-01	7.24084E-01
41	9.34922E-01	8.78326E-01	8.21019E-01	7.81385E-01	7.63386E-01	7.50479E-01	7.43989E-01	7.35473E-01	7.26320E-01

42	9.34922E-01	8.78326E-01	8.21019E-01	7.81385E-01	7.63386E-01	7.50479E-01	7.43989E-01	7.35473E-01	7.26320E-01
43	9.39670E-01	8.82519E-01	8.24725E-01	7.84720E-01	7.66454E-01	7.53294E-01	7.46561E-01	7.37779E-01	7.28313E-01
44	9.43598E-01	8.86027E-01	8.27855E-01	7.87557E-01	7.69084E-01	7.55718E-01	7.48786E-01	7.39784E-01	7.30066E-01
45	9.46742E-01	8.88867E-01	8.30418E-01	7.89901E-01	7.71277E-01	7.57749E-01	7.50661E-01	7.41485E-01	7.31570E-01
46	9.49139E-01	8.91060E-01	8.32427E-01	7.91760E-01	7.73039E-01	7.59392E-01	7.52185E-01	7.42877E-01	7.32820E-01
47	9.49139E-01	8.91060E-01	8.32427E-01	7.91760E-01	7.73039E-01	7.59392E-01	7.52185E-01	7.42877E-01	7.32820E-01
48	9.50824E-01	8.92629E-01	8.33899E-01	7.93147E-01	7.74380E-01	7.60651E-01	7.53364E-01	7.43966E-01	7.33819E-01
49	9.51835E-01	8.93599E-01	8.34853E-01	7.94077E-01	7.75312E-01	7.61537E-01	7.54204E-01	7.44753E-01	7.34568E-01
50	9.52214E-01	8.93997E-01	8.35310E-01	7.94565E-01	7.75848E-01	7.62059E-01	7.54711E-01	7.45245E-01	7.35071E-01
51	9.52004E-01	8.93851E-01	8.35295E-01	7.94633E-01	7.76005E-01	7.62229E-01	7.54895E-01	7.45449E-01	7.35336E-01
52	9.52004E-01	8.93851E-01	8.35295E-01	7.94633E-01	7.76005E-01	7.62229E-01	7.54895E-01	7.45449E-01	7.35336E-01
53	9.51699E-01	8.93587E-01	8.35120E-01	7.94516E-01	7.75947E-01	7.62186E-01	7.54869E-01	7.45444E-01	7.35378E-01
54	9.51269E-01	8.93200E-01	8.34836E-01	7.94301E-01	7.75798E-01	7.62058E-01	7.54762E-01	7.45366E-01	7.35355E-01
55	9.50721E-01	8.92693E-01	8.34446E-01	7.93989E-01	7.75562E-01	7.61846E-01	7.54577E-01	7.45215E-01	7.35270E-01
56	9.50062E-01	8.92070E-01	8.33954E-01	7.93584E-01	7.75242E-01	7.61553E-01	7.54315E-01	7.44994E-01	7.35123E-01
57	9.50062E-01	8.92070E-01	8.33954E-01	7.93584E-01	7.75242E-01	7.61553E-01	7.54315E-01	7.44994E-01	7.35123E-01
58	9.49138E-01	8.91179E-01	8.33234E-01	7.92979E-01	7.74747E-01	7.61095E-01	7.53898E-01	7.44635E-01	7.34863E-01
59	9.48084E-01	8.90137E-01	8.32378E-01	7.92247E-01	7.74134E-01	7.60522E-01	7.53370E-01	7.44170E-01	7.34505E-01
60	9.46914E-01	8.88951E-01	8.31390E-01	7.91393E-01	7.73409E-01	7.59837E-01	7.52733E-01	7.43603E-01	7.34053E-01
61	9.45640E-01	8.87627E-01	8.30279E-01	7.90423E-01	7.72575E-01	7.59044E-01	7.51991E-01	7.42937E-01	7.33511E-01
62	9.45640E-01	8.87627E-01	8.30279E-01	7.90423E-01	7.72575E-01	7.59044E-01	7.51991E-01	7.42937E-01	7.33511E-01
63	9.43752E-01	8.85938E-01	8.28818E-01	7.89119E-01	7.71429E-01	7.57949E-01	7.50954E-01	7.41988E-01	7.32703E-01
64	9.41737E-01	8.84147E-01	8.27237E-01	7.87681E-01	7.70124E-01	7.56692E-01	7.49744E-01	7.40848E-01	7.31670E-01
65	9.39620E-01	8.82268E-01	8.25546E-01	7.86119E-01	7.68668E-01	7.55279E-01	7.48365E-01	7.39521E-01	7.30417E-01
66	9.37422E-01	8.80312E-01	8.23753E-01	7.84437E-01	7.67069E-01	7.53715E-01	7.46823E-01	7.38012E-01	7.28950E-01
67	9.35156E-01	8.78285E-01	8.21864E-01	7.82642E-01	7.65329E-01	7.52003E-01	7.45120E-01	7.36324E-01	7.27273E-01
68	9.32829E-01	8.76193E-01	8.19883E-01	7.80736E-01	7.63454E-01	7.50147E-01	7.43260E-01	7.34461E-01	7.25389E-01
69	9.30440E-01	8.74037E-01	8.17812E-01	7.78721E-01	7.61444E-01	7.48148E-01	7.41243E-01	7.32424E-01	7.23301E-01
70	9.27983E-01	8.71816E-01	8.15649E-01	7.76597E-01	7.59299E-01	7.46007E-01	7.39073E-01	7.30215E-01	7.21009E-01
71	9.25446E-01	8.69526E-01	8.13392E-01	7.74361E-01	7.57019E-01	7.43724E-01	7.36747E-01	7.27834E-01	7.18514E-01
72	9.22810E-01	8.67163E-01	8.11037E-01	7.72011E-01	7.54602E-01	7.41298E-01	7.34267E-01	7.25281E-01	7.15816E-01
73	9.20053E-01	8.64717E-01	8.08577E-01	7.69542E-01	7.52044E-01	7.38727E-01	7.31630E-01	7.22555E-01	7.12912E-01
74	9.17143E-01	8.62179E-01	8.06004E-01	7.66948E-01	7.49340E-01	7.36009E-01	7.28836E-01	7.19655E-01	7.09800E-01
75	9.17143E-01	8.62179E-01	8.06004E-01	7.66948E-01	7.49340E-01	7.36009E-01	7.28836E-01	7.19655E-01	7.09800E-01
76	9.15843E-01	8.60869E-01	8.04693E-01	7.65636E-01	7.47971E-01	7.34627E-01	7.27411E-01	7.18169E-01	7.08190E-01
77	9.14503E-01	8.59517E-01	8.03345E-01	7.64289E-01	7.46570E-01	7.33214E-01	7.25957E-01	7.16657E-01	7.06559E-01
78	9.13122E-01	8.58121E-01	8.01957E-01	7.62906E-01	7.45138E-01	7.31770E-01	7.24473E-01	7.15118E-01	7.04904E-01
79	9.11696E-01	8.56681E-01	8.00529E-01	7.61486E-01	7.43672E-01	7.30295E-01	7.22959E-01	7.13552E-01	7.03227E-01
80	9.11696E-01	8.56681E-01	8.00529E-01	7.61486E-01	7.43672E-01	7.30295E-01	7.22959E-01	7.13552E-01	7.03227E-01
81	9.09570E-01	8.54535E-01	7.98411E-01	7.59385E-01	7.41513E-01	7.28123E-01	7.20735E-01	7.11257E-01	7.00777E-01
82	9.07338E-01	8.52292E-01	7.96208E-01	7.57210E-01	7.39288E-01	7.25891E-01	7.18455E-01	7.08915E-01	6.98293E-01
83	9.04997E-01	8.49949E-01	7.93918E-01	7.54957E-01	7.36996E-01	7.23596E-01	7.16119E-01	7.06526E-01	6.95773E-01
84	9.02543E-01	8.47503E-01	7.91539E-01	7.52625E-01	7.34636E-01	7.21237E-01	7.13725E-01	7.04086E-01	6.93216E-01
85	9.02543E-01	8.47503E-01	7.91539E-01	7.52625E-01	7.34636E-01	7.21237E-01	7.13725E-01	7.04086E-01	6.93216E-01
86	8.99959E-01	8.44941E-01	7.89059E-01	7.50203E-01	7.32196E-01	7.18806E-01	7.11264E-01	7.01586E-01	6.90606E-01
87	8.97248E-01	8.42270E-01	7.86489E-01	7.47704E-01	7.29690E-01	7.16315E-01	7.08752E-01	6.99047E-01	6.87974E-01

88	8.94407E-01	8.39490E-01	7.83826E-01	7.45126E-01	7.27118E-01	7.13765E-01	7.06189E-01	6.96467E-01	6.85317E-01
89	8.91435E-01	8.36598E-01	7.81070E-01	7.42467E-01	7.24477E-01	7.11155E-01	7.03575E-01	6.93846E-01	6.82635E-01
90	8.91435E-01	8.36598E-01	7.81070E-01	7.42467E-01	7.24477E-01	7.11155E-01	7.03575E-01	6.93846E-01	6.82635E-01
91	8.85067E-01	8.30456E-01	7.75258E-01	7.36893E-01	7.18977E-01	7.05742E-01	6.98181E-01	6.88469E-01	6.77183E-01
92	8.78147E-01	8.23862E-01	7.69075E-01	7.31010E-01	7.13220E-01	7.00110E-01	6.92610E-01	6.82967E-01	6.71685E-01
93	8.70678E-01	8.16817E-01	7.62522E-01	7.24818E-01	7.07209E-01	6.94263E-01	6.86867E-01	6.77341E-01	6.66139E-01
94	8.62667E-01	8.09328E-01	7.55604E-01	7.18323E-01	7.00949E-01	6.88208E-01	6.80958E-01	6.71595E-01	6.60545E-01
95	8.62667E-01	8.09328E-01	7.55605E-01	7.18323E-01	7.00949E-01	6.88208E-01	6.80958E-01	6.71595E-01	6.60545E-01
96	8.54138E-01	8.01415E-01	7.48342E-01	7.11543E-01	6.94457E-01	6.81960E-01	6.74897E-01	6.65745E-01	6.54915E-01
97	8.45100E-01	7.93082E-01	7.40736E-01	7.04481E-01	6.87734E-01	6.75519E-01	6.68681E-01	6.59783E-01	6.49235E-01
98	8.35572E-01	7.84347E-01	7.32807E-01	6.97155E-01	6.80798E-01	6.68904E-01	6.62328E-01	6.53724E-01	6.43518E-01
99	8.25575E-01	7.75230E-01	7.24577E-01	6.89587E-01	6.73671E-01	6.62133E-01	6.55857E-01	6.47587E-01	6.37783E-01
100	8.25575E-01	7.75230E-01	7.24577E-01	6.89587E-01	6.73671E-01	6.62133E-01	6.55857E-01	6.47587E-01	6.37783E-01
101	8.15203E-01	7.65815E-01	7.16117E-01	6.81842E-01	6.66412E-01	6.55261E-01	6.49317E-01	6.41420E-01	6.32073E-01
102	8.04458E-01	7.56078E-01	7.07401E-01	6.73889E-01	6.58986E-01	6.48251E-01	6.42661E-01	6.35161E-01	6.26298E-01
103	7.93374E-01	7.46050E-01	6.98461E-01	6.65763E-01	6.51427E-01	6.41132E-01	6.35916E-01	6.28836E-01	6.20486E-01
104	7.81993E-01	7.35768E-01	6.89337E-01	6.57501E-01	6.43769E-01	6.33934E-01	6.29112E-01	6.22473E-01	6.14669E-01
105	7.81993E-01	7.35768E-01	6.89337E-01	6.57501E-01	6.43769E-01	6.33934E-01	6.29112E-01	6.22473E-01	6.14669E-01
106	7.76239E-01	7.30576E-01	6.84747E-01	6.53356E-01	6.39938E-01	6.30339E-01	6.25719E-01	6.19310E-01	6.11792E-01
107	7.70440E-01	7.25338E-01	6.80124E-01	6.49188E-01	6.36091E-01	6.26729E-01	6.22314E-01	6.16136E-01	6.08905E-01
108	7.64603E-01	7.20058E-01	6.75474E-01	6.45001E-01	6.32232E-01	6.23110E-01	6.18899E-01	6.12954E-01	6.06011E-01
109	7.58735E-01	7.14743E-01	6.70802E-01	6.40802E-01	6.28367E-01	6.19485E-01	6.15479E-01	6.09769E-01	6.03115E-01
110	7.58735E-01	7.14743E-01	6.70802E-01	6.40802E-01	6.28367E-01	6.19485E-01	6.15479E-01	6.09769E-01	6.03115E-01
111	7.52868E-01	7.09420E-01	6.66133E-01	6.36611E-01	6.24514E-01	6.15874E-01	6.12072E-01	6.06598E-01	6.00237E-01
112	7.46999E-01	7.04077E-01	6.61454E-01	6.32417E-01	6.20663E-01	6.12262E-01	6.08662E-01	6.03424E-01	5.97352E-01
113	7.41137E-01	6.98719E-01	6.56772E-01	6.28225E-01	6.16817E-01	6.08654E-01	6.05254E-01	6.00250E-01	5.94465E-01
114	7.35292E-01	6.93354E-01	6.52093E-01	6.24041E-01	6.12984E-01	6.05055E-01	6.01851E-01	5.97080E-01	5.91580E-01
115	7.35292E-01	6.93354E-01	6.52093E-01	6.24041E-01	6.12984E-01	6.05055E-01	6.01851E-01	5.97080E-01	5.91580E-01
116	7.29494E-01	6.88007E-01	6.47441E-01	6.19887E-01	6.09182E-01	6.01483E-01	5.98471E-01	5.93932E-01	5.88716E-01
117	7.23743E-01	6.82668E-01	6.42804E-01	6.15751E-01	6.05400E-01	5.97925E-01	5.95099E-01	5.90788E-01	5.85851E-01
118	7.18052E-01	6.77343E-01	6.38190E-01	6.11640E-01	6.01644E-01	5.94386E-01	5.91740E-01	5.87654E-01	5.82989E-01
119	7.12432E-01	6.72039E-01	6.33606E-01	6.07561E-01	5.97919E-01	5.90872E-01	5.88398E-01	5.84533E-01	5.80135E-01
120	7.12432E-01	6.72039E-01	6.33606E-01	6.07561E-01	5.97919E-01	5.90872E-01	5.88398E-01	5.84533E-01	5.80135E-01
121	7.03240E-01	6.65408E-01	6.27724E-01	6.02252E-01	5.93060E-01	5.86308E-01	5.84054E-01	5.80477E-01	5.76430E-01
122	6.94179E-01	6.58927E-01	6.21984E-01	5.97071E-01	5.88289E-01	5.81818E-01	5.79767E-01	5.76457E-01	5.72733E-01
123	6.85289E-01	6.52629E-01	6.16410E-01	5.92036E-01	5.83622E-01	5.77413E-01	5.75544E-01	5.72478E-01	5.69051E-01
124	6.76604E-01	6.46549E-01	6.11025E-01	5.87165E-01	5.79070E-01	5.73102E-01	5.71393E-01	5.68547E-01	5.65392E-01
125	6.68156E-01	6.40716E-01	6.05850E-01	5.82473E-01	5.74648E-01	5.68895E-01	5.67321E-01	5.64671E-01	5.61763E-01
126	6.59974E-01	6.35162E-01	6.00906E-01	5.77975E-01	5.70365E-01	5.64799E-01	5.63334E-01	5.60855E-01	5.58168E-01
127	6.52082E-01	6.29915E-01	5.96214E-01	5.73686E-01	5.66231E-01	5.60821E-01	5.59437E-01	5.57103E-01	5.54614E-01
128	6.44500E-01	6.25004E-01	5.91791E-01	5.69620E-01	5.62256E-01	5.56967E-01	5.55633E-01	5.53419E-01	5.51103E-01
129	6.37246E-01	6.20455E-01	5.87656E-01	5.65788E-01	5.58446E-01	5.53242E-01	5.51925E-01	5.49805E-01	5.47640E-01
130	6.30335E-01	6.16296E-01	5.83825E-01	5.62201E-01	5.54807E-01	5.49648E-01	5.48316E-01	5.46263E-01	5.44226E-01
131	6.23777E-01	6.12552E-01	5.80313E-01	5.58870E-01	5.51343E-01	5.46189E-01	5.44804E-01	5.42793E-01	5.40864E-01
132	6.17581E-01	6.09249E-01	5.77136E-01	5.55802E-01	5.48057E-01	5.42864E-01	5.41391E-01	5.39394E-01	5.37553E-01
133	6.11750E-01	6.06411E-01	5.74306E-01	5.53005E-01	5.44949E-01	5.39672E-01	5.38072E-01	5.36066E-01	5.34293E-01

134	6.06284E-01	6.04064E-01	5.71836E-01	5.50485E-01	5.42019E-01	5.36610E-01	5.34845E-01	5.32805E-01	5.31083E-01
135	6.01180E-01	6.02232E-01	5.69736E-01	5.48246E-01	5.39262E-01	5.33675E-01	5.31705E-01	5.29607E-01	5.27922E-01
136	6.01180E-01	6.02232E-01	5.69736E-01	5.48247E-01	5.39262E-01	5.33675E-01	5.31705E-01	5.29607E-01	5.27922E-01
137	5.75087E-01	5.85576E-01	5.52981E-01	5.31222E-01	5.19393E-01	5.12400E-01	5.09042E-01	5.06337E-01	5.04605E-01
138	5.47198E-01	5.63216E-01	5.32710E-01	5.11742E-01	4.98718E-01	4.90876E-01	4.86617E-01	4.83433E-01	4.81594E-01
139	5.17568E-01	5.36969E-01	5.09490E-01	4.90064E-01	4.76989E-01	4.68875E-01	4.64167E-01	4.60709E-01	4.58802E-01
140	4.86655E-01	5.08166E-01	4.84020E-01	4.66589E-01	4.54220E-01	4.46330E-01	4.41565E-01	4.38059E-01	4.36175E-01
141	4.55045E-01	4.77836E-01	4.57011E-01	4.41788E-01	4.30591E-01	4.23303E-01	4.18793E-01	4.15449E-01	4.13699E-01
142	4.23318E-01	4.46800E-01	4.29123E-01	4.16147E-01	4.06374E-01	3.99941E-01	3.95918E-01	3.92909E-01	3.91397E-01
143	3.91993E-01	4.15722E-01	4.00938E-01	3.90133E-01	3.81880E-01	3.76447E-01	3.73062E-01	3.70514E-01	3.69324E-01
144	3.61504E-01	3.85132E-01	3.72953E-01	3.64169E-01	3.57427E-01	3.53046E-01	3.50380E-01	3.48369E-01	3.47561E-01
145	3.32201E-01	3.55452E-01	3.45579E-01	3.38625E-01	3.33310E-01	3.29966E-01	3.28039E-01	3.26598E-01	3.26200E-01
146	3.04347E-01	3.27008E-01	3.19149E-01	3.13812E-01	3.09795E-01	3.07419E-01	3.06204E-01	3.05326E-01	3.05341E-01
147	2.78135E-01	3.00044E-01	2.93918E-01	2.89979E-01	2.87103E-01	2.85594E-01	2.85027E-01	2.84674E-01	2.85079E-01
148	2.53692E-01	2.74734E-01	2.70080E-01	2.67322E-01	2.65415E-01	2.64645E-01	2.64636E-01	2.64747E-01	2.65500E-01
149	2.31095E-01	2.51196E-01	2.47770E-01	2.45982E-01	2.44863E-01	2.44690E-01	2.45133E-01	2.45629E-01	2.46676E-01
150	2.10377E-01	2.29500E-01	2.27073E-01	2.26052E-01	2.25536E-01	2.25811E-01	2.26588E-01	2.27382E-01	2.28661E-01
151	1.91535E-01	2.09679E-01	2.08033E-01	2.07580E-01	2.07479E-01	2.08050E-01	2.09039E-01	2.10041E-01	2.11488E-01
152	1.91535E-01	2.09679E-01	2.08033E-01	2.07580E-01	2.07479E-01	2.08050E-01	2.09039E-01	2.10041E-01	2.11488E-01
153	1.62553E-01	1.79110E-01	1.78510E-01	1.78799E-01	1.79248E-01	1.80195E-01	1.81443E-01	1.82698E-01	1.84341E-01
154	1.37147E-01	1.51947E-01	1.52137E-01	1.52994E-01	1.53899E-01	1.55164E-01	1.56634E-01	1.58089E-01	1.59869E-01
155	1.15149E-01	1.28175E-01	1.28892E-01	1.30134E-01	1.31367E-01	1.32863E-01	1.34495E-01	1.36091E-01	1.37954E-01
156	9.62973E-02	1.07620E-01	1.08646E-01	1.10106E-01	1.11538E-01	1.13170E-01	1.14894E-01	1.16570E-01	1.18464E-01
157	8.02751E-02	9.00169E-02	9.11883E-02	9.27313E-02	9.42500E-02	9.59292E-02	9.76766E-02	9.93737E-02	1.01249E-01
158	6.67464E-02	7.50573E-02	7.62595E-02	7.77878E-02	7.93042E-02	8.09582E-02	8.26682E-02	8.43332E-02	8.61468E-02
159	5.53804E-02	6.24208E-02	6.35800E-02	6.50279E-02	6.64785E-02	6.80523E-02	6.96778E-02	7.12678E-02	7.29848E-02
160	4.58676E-02	5.17966E-02	5.28692E-02	5.41974E-02	5.55410E-02	5.69978E-02	5.85052E-02	5.99885E-02	6.15830E-02
161	3.79276E-02	4.28955E-02	4.38594E-02	4.50482E-02	4.62619E-02	4.75801E-02	4.89491E-02	5.03050E-02	5.17599E-02
162	3.13124E-02	3.54565E-02	3.63037E-02	3.73473E-02	3.84216E-02	3.95921E-02	4.08130E-02	4.20304E-02	4.33368E-02
163	2.58062E-02	2.92484E-02	2.99799E-02	3.08813E-02	3.18163E-02	3.28387E-02	3.39105E-02	3.49862E-02	3.61423E-02
164	2.12229E-02	2.40695E-02	2.46915E-02	2.54593E-02	2.62610E-02	2.71413E-02	2.80687E-02	2.90055E-02	3.00148E-02
165	1.74037E-02	1.97458E-02	2.02671E-02	2.09124E-02	2.15904E-02	2.23382E-02	2.31301E-02	2.39350E-02	2.48048E-02
166	1.42130E-02	1.61276E-02	1.65581E-02	1.70933E-02	1.76590E-02	1.82861E-02	1.89536E-02	1.96362E-02	2.03765E-02
167	1.15356E-02	1.30872E-02	1.34368E-02	1.38743E-02	1.43398E-02	1.48586E-02	1.54141E-02	1.59856E-02	1.66077E-02
168	9.27315E-03	1.05151E-02	1.07936E-02	1.11454E-02	1.15226E-02	1.19458E-02	1.24018E-02	1.28740E-02	1.33898E-02
169	7.34134E-03	8.31776E-03	8.53472E-03	8.81205E-03	9.11253E-03	9.45259E-03	9.82161E-03	1.02061E-02	1.06276E-02
170	5.66753E-03	6.41531E-03	6.58001E-03	6.79355E-03	7.02841E-03	7.29721E-03	7.59124E-03	7.89943E-03	8.23747E-03
171	4.18864E-03	4.74001E-03	4.86153E-03	5.02101E-03	5.20111E-03	5.41015E-03	5.64048E-03	5.88268E-03	6.14706E-03
172	2.84927E-03	3.23597E-03	3.32192E-03	3.43589E-03	3.57240E-03	3.73283E-03	3.90977E-03	4.09486E-03	4.29313E-03
173	1.59970E-03	1.86106E-03	1.91246E-03	1.98838E-03	2.09429E-03	2.21668E-03	2.34894E-03	2.48348E-03	2.62000E-03
174	1.59970E-03	1.86106E-03	1.91246E-03	1.98838E-03	2.09429E-03	2.21668E-03	2.34894E-03	2.48348E-03	2.62000E-03
175	1.05627E-03	1.12403E-03	1.15096E-03	1.19163E-03	1.25460E-03	1.33030E-03	1.41735E-03	1.50730E-03	1.60021E-03
176	7.00732E-04	7.13200E-04	7.20503E-04	7.37880E-04	7.70980E-04	8.13322E-04	8.64759E-04	9.19052E-04	9.76508E-04
177	4.55159E-04	4.53517E-04	4.52450E-04	4.58372E-04	4.74605E-04	4.96951E-04	5.25486E-04	5.56087E-04	5.89217E-04
178	2.73719E-04	2.70065E-04	2.67119E-04	2.68463E-04	2.75932E-04	2.87012E-04	3.01778E-04	3.17747E-04	3.35350E-04
179	1.28322E-04	1.26073E-04	1.24108E-04	1.24156E-04	1.27036E-04	1.31570E-04	1.37797E-04	1.44550E-04	1.52079E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO. GROUPS 19- 27

1	5.84078E-01	5.88152E-01	5.91608E-01	5.92399E-01	5.89654E-01	5.89502E-01	5.92526E-01	5.91328E-01	4.04118E-01
2	5.84734E-01	5.88774E-01	5.92197E-01	5.92956E-01	5.90172E-01	5.89981E-01	5.92959E-01	5.91705E-01	4.04511E-01
3	5.86695E-01	5.90629E-01	5.93954E-01	5.94623E-01	5.91717E-01	5.91410E-01	5.94248E-01	5.92826E-01	4.05719E-01
4	5.89933E-01	5.93692E-01	5.96854E-01	5.97371E-01	5.94262E-01	5.93761E-01	5.96362E-01	5.94655E-01	4.07843E-01
5	5.94402E-01	5.97914E-01	6.00848E-01	6.01158E-01	5.97765E-01	5.96990E-01	5.99244E-01	5.97133E-01	4.11101E-01
6	6.00040E-01	6.03233E-01	6.05874E-01	6.05925E-01	6.02163E-01	6.01033E-01	6.02819E-01	6.00176E-01	4.15922E-01
7	6.06763E-01	6.09562E-01	6.11847E-01	6.11594E-01	6.07378E-01	6.05806E-01	6.06980E-01	6.03669E-01	4.23119E-01
8	6.14468E-01	6.16797E-01	6.18666E-01	6.18074E-01	6.13313E-01	6.11209E-01	6.11595E-01	6.07469E-01	4.34223E-01
9	6.23032E-01	6.24814E-01	6.26208E-01	6.25258E-01	6.19853E-01	6.17117E-01	6.16497E-01	6.11398E-01	4.52084E-01
10	6.32312E-01	6.33465E-01	6.34332E-01	6.33027E-01	6.26866E-01	6.23388E-01	6.21479E-01	6.15237E-01	4.82003E-01
11	6.42143E-01	6.42584E-01	6.42880E-01	6.41254E-01	6.34201E-01	6.29854E-01	6.26284E-01	6.18722E-01	5.33813E-01
12	6.42143E-01	6.42584E-01	6.42880E-01	6.41254E-01	6.34201E-01	6.29854E-01	6.26284E-01	6.18722E-01	5.33813E-01
13	6.53603E-01	6.53042E-01	6.52503E-01	6.50320E-01	6.41920E-01	6.36311E-01	6.30943E-01	6.21596E-01	5.66552E-01
14	6.65167E-01	6.63340E-01	6.61689E-01	6.58650E-01	6.48444E-01	6.41175E-01	6.34171E-01	6.22656E-01	5.85200E-01
15	6.76330E-01	6.72943E-01	6.69916E-01	6.65796E-01	6.53223E-01	6.43867E-01	6.35307E-01	6.21190E-01	5.93923E-01
16	6.86486E-01	6.81208E-01	6.76549E-01	6.71199E-01	6.55537E-01	6.43628E-01	6.33614E-01	6.16364E-01	5.94874E-01
17	6.86486E-01	6.81208E-01	6.76549E-01	6.71199E-01	6.55537E-01	6.43628E-01	6.33614E-01	6.16364E-01	5.94874E-01
18	6.87836E-01	6.82265E-01	6.77351E-01	6.71817E-01	6.55636E-01	6.43303E-01	6.33097E-01	6.15290E-01	5.94496E-01
19	6.89186E-01	6.83322E-01	6.78156E-01	6.72442E-01	6.55743E-01	6.42986E-01	6.32600E-01	6.14230E-01	5.94093E-01
20	6.90534E-01	6.84378E-01	6.78963E-01	6.73073E-01	6.55854E-01	6.42675E-01	6.32118E-01	6.13181E-01	5.93668E-01
21	6.91881E-01	6.85434E-01	6.79771E-01	6.73709E-01	6.55967E-01	6.42367E-01	6.31649E-01	6.12138E-01	5.93220E-01
22	6.91881E-01	6.85434E-01	6.79771E-01	6.73709E-01	6.55967E-01	6.42367E-01	6.31649E-01	6.12138E-01	5.93220E-01
23	6.93221E-01	6.86485E-01	6.80575E-01	6.74345E-01	6.56078E-01	6.42053E-01	6.31175E-01	6.11078E-01	5.92725E-01
24	6.94538E-01	6.87516E-01	6.81362E-01	6.74965E-01	6.56178E-01	6.41731E-01	6.30695E-01	6.10019E-01	5.92200E-01
25	6.95831E-01	6.88524E-01	6.82129E-01	6.75567E-01	6.56263E-01	6.41398E-01	6.30206E-01	6.08958E-01	5.91644E-01
26	6.97098E-01	6.89509E-01	6.82873E-01	6.76150E-01	6.56331E-01	6.41050E-01	6.29706E-01	6.07890E-01	5.91057E-01
27	6.97098E-01	6.89509E-01	6.82873E-01	6.76150E-01	6.56331E-01	6.41050E-01	6.29706E-01	6.07890E-01	5.91057E-01
28	6.98825E-01	6.90850E-01	6.83886E-01	6.76938E-01	6.56410E-01	6.40551E-01	6.28996E-01	6.06381E-01	5.90196E-01
29	7.00506E-01	6.92153E-01	6.84865E-01	6.77697E-01	6.56477E-01	6.40053E-01	6.28289E-01	6.04898E-01	5.89309E-01
30	7.02136E-01	6.93411E-01	6.85807E-01	6.78425E-01	6.56523E-01	6.39545E-01	6.27579E-01	6.03428E-01	5.88395E-01
31	7.03711E-01	6.94621E-01	6.86707E-01	6.79115E-01	6.56541E-01	6.39020E-01	6.26858E-01	6.01961E-01	5.87452E-01
32	7.03711E-01	6.94621E-01	6.86707E-01	6.79115E-01	6.56541E-01	6.39020E-01	6.26858E-01	6.01961E-01	5.87452E-01
33	7.05242E-01	6.95796E-01	6.87577E-01	6.79780E-01	6.56543E-01	6.38481E-01	6.26129E-01	6.00480E-01	5.86483E-01
34	7.06722E-01	6.96930E-01	6.88417E-01	6.80420E-01	6.56541E-01	6.37956E-01	6.25418E-01	5.99046E-01	5.85521E-01
35	7.08148E-01	6.98020E-01	6.89220E-01	6.81030E-01	6.56528E-01	6.37435E-01	6.24718E-01	5.97646E-01	5.84564E-01
36	7.09516E-01	6.99061E-01	6.89983E-01	6.81607E-01	6.56495E-01	6.36910E-01	6.24022E-01	5.96269E-01	5.83609E-01
37	7.09516E-01	6.99061E-01	6.89983E-01	6.81607E-01	6.56495E-01	6.36910E-01	6.24022E-01	5.96269E-01	5.83609E-01
38	7.12126E-01	7.01061E-01	6.91458E-01	6.82723E-01	6.56470E-01	6.35943E-01	6.22721E-01	5.93654E-01	5.81769E-01
39	7.14535E-01	7.02923E-01	6.92846E-01	6.83778E-01	6.56519E-01	6.35156E-01	6.21614E-01	5.91397E-01	5.80129E-01
40	7.16723E-01	7.04620E-01	6.94115E-01	6.84744E-01	6.56591E-01	6.34485E-01	6.20649E-01	5.89416E-01	5.78657E-01
41	7.18672E-01	7.06126E-01	6.95240E-01	6.85596E-01	6.56639E-01	6.33874E-01	6.19780E-01	5.87642E-01	5.77329E-01

42	7.18672E-01	7.06126E-01	6.95240E-01	6.85596E-01	6.56639E-01	6.33874E-01	6.19780E-01	5.87642E-01	5.77329E-01
43	7.20412E-01	7.07489E-01	6.96269E-01	6.86379E-01	6.56741E-01	6.33406E-01	6.19074E-01	5.86145E-01	5.76207E-01
44	7.21950E-01	7.08724E-01	6.97231E-01	6.87122E-01	6.56974E-01	6.33196E-01	6.18635E-01	5.85112E-01	5.75401E-01
45	7.23275E-01	7.09818E-01	6.98108E-01	6.87808E-01	6.57306E-01	6.33206E-01	6.18431E-01	5.84492E-01	5.74886E-01
46	7.24380E-01	7.10761E-01	6.98888E-01	6.88422E-01	6.57716E-01	6.33408E-01	6.18433E-01	5.84245E-01	5.74641E-01
47	7.24381E-01	7.10761E-01	6.98888E-01	6.88422E-01	6.57716E-01	6.33408E-01	6.18433E-01	5.84245E-01	5.74641E-01
48	7.25267E-01	7.11551E-01	6.99567E-01	6.88962E-01	6.58200E-01	6.33796E-01	6.18633E-01	5.84360E-01	5.74659E-01
49	7.25935E-01	7.12190E-01	7.00147E-01	6.89425E-01	6.58760E-01	6.34373E-01	6.19026E-01	5.84838E-01	5.74935E-01
50	7.26386E-01	7.12678E-01	7.00627E-01	6.89808E-01	6.59395E-01	6.35135E-01	6.19603E-01	5.85671E-01	5.75456E-01
51	7.26624E-01	7.13020E-01	7.01009E-01	6.90109E-01	6.60113E-01	6.36091E-01	6.20362E-01	5.86864E-01	5.76212E-01
52	7.26624E-01	7.13020E-01	7.01009E-01	6.90109E-01	6.60113E-01	6.36091E-01	6.20362E-01	5.86864E-01	5.76212E-01
53	7.26661E-01	7.13132E-01	7.01157E-01	6.90222E-01	6.60487E-01	6.36619E-01	6.20788E-01	5.87563E-01	5.76657E-01
54	7.26639E-01	7.13197E-01	7.01267E-01	6.90300E-01	6.60858E-01	6.37162E-01	6.21226E-01	5.88307E-01	5.77130E-01
55	7.26558E-01	7.13216E-01	7.01340E-01	6.90344E-01	6.61226E-01	6.37724E-01	6.21678E-01	5.89100E-01	5.77629E-01
56	7.26421E-01	7.13191E-01	7.01378E-01	6.90356E-01	6.61596E-01	6.38308E-01	6.22146E-01	5.89945E-01	5.78156E-01
57	7.26421E-01	7.13191E-01	7.01378E-01	6.90356E-01	6.61596E-01	6.38308E-01	6.22146E-01	5.89945E-01	5.78156E-01
58	7.26175E-01	7.13094E-01	7.01366E-01	6.90314E-01	6.62013E-01	6.38996E-01	6.22691E-01	5.90966E-01	5.78790E-01
59	7.25836E-01	7.12916E-01	7.01280E-01	6.90201E-01	6.62390E-01	6.39660E-01	6.23205E-01	5.91989E-01	5.79412E-01
60	7.25406E-01	7.12661E-01	7.01125E-01	6.90020E-01	6.62733E-01	6.40309E-01	6.23691E-01	5.93021E-01	5.80022E-01
61	7.24889E-01	7.12332E-01	7.00903E-01	6.89772E-01	6.63052E-01	6.40951E-01	6.24152E-01	5.94073E-01	5.80622E-01
62	7.24889E-01	7.12332E-01	7.00903E-01	6.89772E-01	6.63052E-01	6.40951E-01	6.24152E-01	5.94073E-01	5.80622E-01
63	7.24110E-01	7.11763E-01	7.00449E-01	6.89288E-01	6.63158E-01	6.41366E-01	6.24390E-01	5.94858E-01	5.80997E-01
64	7.23098E-01	7.10908E-01	6.99679E-01	6.88493E-01	6.62808E-01	6.41247E-01	6.24128E-01	5.95012E-01	5.80842E-01
65	7.21859E-01	7.09775E-01	6.98600E-01	6.87391E-01	6.62018E-01	6.40612E-01	6.23378E-01	5.94552E-01	5.80163E-01
66	7.20397E-01	7.08372E-01	6.97220E-01	6.85988E-01	6.60799E-01	6.39473E-01	6.22148E-01	5.93493E-01	5.78970E-01
67	7.18716E-01	7.06704E-01	6.95544E-01	6.84290E-01	6.59160E-01	6.37840E-01	6.20446E-01	5.91846E-01	5.77269E-01
68	7.16820E-01	7.04774E-01	6.93576E-01	6.82299E-01	6.57108E-01	6.35722E-01	6.18276E-01	5.89621E-01	5.75067E-01
69	7.14711E-01	7.02584E-01	6.91320E-01	6.80019E-01	6.54646E-01	6.33121E-01	6.15644E-01	5.86822E-01	5.72368E-01
70	7.12390E-01	7.00137E-01	6.88776E-01	6.77451E-01	6.51776E-01	6.30041E-01	6.12552E-01	5.83453E-01	5.69179E-01
71	7.09858E-01	6.97432E-01	6.85944E-01	6.74597E-01	6.48497E-01	6.26481E-01	6.09001E-01	5.79515E-01	5.65504E-01
72	7.07114E-01	6.94469E-01	6.82825E-01	6.71457E-01	6.44806E-01	6.22439E-01	6.04992E-01	5.75006E-01	5.61346E-01
73	7.04159E-01	6.91245E-01	6.79415E-01	6.68030E-01	6.40696E-01	6.17907E-01	6.00523E-01	5.69922E-01	5.56709E-01
74	7.00991E-01	6.87756E-01	6.75711E-01	6.64316E-01	6.36160E-01	6.12879E-01	5.95592E-01	5.64256E-01	5.51597E-01
75	7.00991E-01	6.87756E-01	6.75711E-01	6.64316E-01	6.36160E-01	6.12879E-01	5.95592E-01	5.64256E-01	5.51597E-01
76	6.99349E-01	6.85915E-01	6.73741E-01	6.62345E-01	6.33624E-01	6.09971E-01	5.92808E-01	5.60860E-01	5.48693E-01
77	6.97686E-01	6.84062E-01	6.71761E-01	6.60365E-01	6.31100E-01	6.07087E-01	5.90039E-01	5.57504E-01	5.45810E-01
78	6.96002E-01	6.82193E-01	6.69771E-01	6.58373E-01	6.28584E-01	6.04222E-01	5.87280E-01	5.54182E-01	5.42947E-01
79	6.94296E-01	6.80309E-01	6.67769E-01	6.56370E-01	6.26074E-01	6.01373E-01	5.84531E-01	5.50890E-01	5.40101E-01
80	6.94296E-01	6.80309E-01	6.67769E-01	6.56370E-01	6.26074E-01	6.01373E-01	5.84531E-01	5.50890E-01	5.40101E-01
81	6.91808E-01	6.77569E-01	6.64863E-01	6.53465E-01	6.22437E-01	5.97236E-01	5.80547E-01	5.46097E-01	5.36001E-01
82	6.89291E-01	6.74821E-01	6.61960E-01	6.50564E-01	6.18862E-01	5.93194E-01	5.76642E-01	5.41450E-01	5.31995E-01
83	6.86744E-01	6.72060E-01	6.59057E-01	6.47665E-01	6.15338E-01	5.89237E-01	5.72809E-01	5.36932E-01	5.28079E-01
84	6.84165E-01	6.69283E-01	6.56150E-01	6.44765E-01	6.11856E-01	5.85351E-01	5.69041E-01	5.32530E-01	5.24249E-01
85	6.84165E-01	6.69283E-01	6.56150E-01	6.44765E-01	6.11856E-01	5.85351E-01	5.69041E-01	5.32530E-01	5.24249E-01
86	6.81539E-01	6.66467E-01	6.53211E-01	6.41839E-01	6.08356E-01	5.81448E-01	5.65268E-01	5.28115E-01	5.20443E-01
87	6.78897E-01	6.63661E-01	6.50299E-01	6.38941E-01	6.04952E-01	5.77684E-01	5.61622E-01	5.23903E-01	5.16784E-01

88	6.76239E-01	6.60861E-01	6.47409E-01	6.36069E-01	6.01636E-01	5.74050E-01	5.58097E-01	5.19882E-01	5.13268E-01
89	6.73564E-01	6.58065E-01	6.44539E-01	6.33221E-01	5.98398E-01	5.70534E-01	5.54686E-01	5.16038E-01	5.09890E-01
90	6.73564E-01	6.58066E-01	6.44539E-01	6.33221E-01	5.98398E-01	5.70534E-01	5.54686E-01	5.16038E-01	5.09890E-01
91	6.68150E-01	6.52471E-01	6.38843E-01	6.27583E-01	5.92127E-01	5.63802E-01	5.48170E-01	5.08800E-01	5.03524E-01
92	6.62728E-01	6.46979E-01	6.33328E-01	6.22142E-01	5.86349E-01	5.57769E-01	5.42320E-01	5.02562E-01	4.97909E-01
93	6.57295E-01	6.41578E-01	6.27981E-01	6.16885E-01	5.81024E-01	5.52377E-01	5.37099E-01	4.97251E-01	4.93021E-01
94	6.51854E-01	6.36265E-01	6.22794E-01	6.11806E-01	5.76126E-01	5.47588E-01	5.32479E-01	4.92814E-01	4.88841E-01
95	6.51854E-01	6.36265E-01	6.22794E-01	6.11806E-01	5.76126E-01	5.47588E-01	5.32479E-01	4.92814E-01	4.88841E-01
96	6.46414E-01	6.31042E-01	6.17765E-01	6.06904E-01	5.71632E-01	5.43369E-01	5.28432E-01	4.89200E-01	4.85342E-01
97	6.40958E-01	6.25878E-01	6.12857E-01	6.02138E-01	5.67470E-01	5.39623E-01	5.24875E-01	4.86290E-01	4.82442E-01
98	6.35500E-01	6.20787E-01	6.08081E-01	5.97517E-01	5.63650E-01	5.36360E-01	5.21813E-01	4.84096E-01	4.80143E-01
99	6.30056E-01	6.15782E-01	6.03450E-01	5.93048E-01	5.60193E-01	5.33601E-01	5.19258E-01	4.82646E-01	4.78453E-01
100	6.30056E-01	6.15782E-01	6.03450E-01	5.93048E-01	5.60193E-01	5.33601E-01	5.19258E-01	4.82646E-01	4.78453E-01
101	6.24663E-01	6.10893E-01	5.98980E-01	5.88739E-01	5.57058E-01	5.31256E-01	5.17120E-01	4.81740E-01	4.77254E-01
102	6.19227E-01	6.05979E-01	5.94512E-01	5.84437E-01	5.53999E-01	5.29037E-01	5.15150E-01	4.81085E-01	4.76346E-01
103	6.13773E-01	6.01070E-01	5.90075E-01	5.80160E-01	5.51064E-01	5.26997E-01	5.13386E-01	4.80749E-01	4.75757E-01
104	6.08330E-01	5.96196E-01	5.85698E-01	5.75930E-01	5.48302E-01	5.25195E-01	5.11867E-01	4.80805E-01	4.75518E-01
105	6.08330E-01	5.96196E-01	5.85698E-01	5.75930E-01	5.48302E-01	5.25195E-01	5.11867E-01	4.80805E-01	4.75518E-01
106	6.05644E-01	5.93807E-01	5.83565E-01	5.73858E-01	5.47010E-01	5.24389E-01	5.11197E-01	4.80937E-01	4.75505E-01
107	6.02949E-01	5.91403E-01	5.81417E-01	5.71766E-01	5.45703E-01	5.23566E-01	5.10519E-01	4.81068E-01	4.75516E-01
108	6.00248E-01	5.88988E-01	5.79259E-01	5.69656E-01	5.44388E-01	5.22733E-01	5.09839E-01	4.81207E-01	4.75555E-01
109	5.97546E-01	5.86567E-01	5.77094E-01	5.67533E-01	5.43073E-01	5.21899E-01	5.09163E-01	4.81366E-01	4.75629E-01
110	5.97546E-01	5.86567E-01	5.77094E-01	5.67533E-01	5.43073E-01	5.21899E-01	5.09163E-01	4.81366E-01	4.75629E-01
111	5.94861E-01	5.84160E-01	5.74941E-01	5.65410E-01	5.41771E-01	5.21065E-01	5.08487E-01	4.81510E-01	4.75716E-01
112	5.92168E-01	5.81733E-01	5.72765E-01	5.63254E-01	5.40435E-01	5.20186E-01	5.07774E-01	4.81617E-01	4.75799E-01
113	5.89471E-01	5.79291E-01	5.70569E-01	5.61066E-01	5.39074E-01	5.19269E-01	5.07031E-01	4.81698E-01	4.75886E-01
114	5.86775E-01	5.76837E-01	5.68359E-01	5.58850E-01	5.37695E-01	5.18324E-01	5.06264E-01	4.81763E-01	4.75982E-01
115	5.86775E-01	5.76837E-01	5.68359E-01	5.58850E-01	5.37695E-01	5.18324E-01	5.06264E-01	4.81763E-01	4.75982E-01
116	5.84096E-01	5.74392E-01	5.66152E-01	5.56622E-01	5.36313E-01	5.17356E-01	5.05474E-01	4.81786E-01	4.76070E-01
117	5.81413E-01	5.71923E-01	5.63914E-01	5.54347E-01	5.34886E-01	5.16321E-01	5.04625E-01	4.81745E-01	4.76138E-01
118	5.78728E-01	5.69434E-01	5.61650E-01	5.52028E-01	5.33420E-01	5.15227E-01	5.03723E-01	4.81651E-01	4.76193E-01
119	5.76047E-01	5.66930E-01	5.59364E-01	5.49667E-01	5.31924E-01	5.14081E-01	5.02776E-01	4.81513E-01	4.76243E-01
120	5.76047E-01	5.66930E-01	5.59364E-01	5.49667E-01	5.31924E-01	5.14081E-01	5.02776E-01	4.81513E-01	4.76243E-01
121	5.72563E-01	5.63642E-01	5.56352E-01	5.46513E-01	5.29935E-01	5.12520E-01	5.01471E-01	4.81226E-01	4.76205E-01
122	5.69073E-01	5.60352E-01	5.53325E-01	5.43387E-01	5.27856E-01	5.10867E-01	5.00064E-01	4.80776E-01	4.75983E-01
123	5.65586E-01	5.57065E-01	5.50289E-01	5.40289E-01	5.25699E-01	5.09138E-01	4.98564E-01	4.80181E-01	4.75592E-01
124	5.62107E-01	5.53787E-01	5.47250E-01	5.37221E-01	5.23477E-01	5.07343E-01	4.96983E-01	4.79460E-01	4.75046E-01
125	5.58641E-01	5.50522E-01	5.44213E-01	5.34185E-01	5.21202E-01	5.05494E-01	4.95328E-01	4.78628E-01	4.74357E-01
126	5.55195E-01	5.47275E-01	5.41184E-01	5.31182E-01	5.18885E-01	5.03602E-01	4.93610E-01	4.77701E-01	4.73537E-01
127	5.51772E-01	5.44051E-01	5.38167E-01	5.28214E-01	5.16533E-01	5.01676E-01	4.91837E-01	4.76692E-01	4.72597E-01
128	5.48376E-01	5.40853E-01	5.35167E-01	5.25283E-01	5.14158E-01	4.99728E-01	4.90015E-01	4.75615E-01	4.71546E-01
129	5.45009E-01	5.37684E-01	5.32186E-01	5.22391E-01	5.11765E-01	4.97765E-01	4.88153E-01	4.74484E-01	4.70392E-01
130	5.41674E-01	5.34548E-01	5.29230E-01	5.19541E-01	5.09362E-01	4.95797E-01	4.86256E-01	4.73309E-01	4.69145E-01
131	5.38373E-01	5.31446E-01	5.26301E-01	5.16734E-01	5.06956E-01	4.93831E-01	4.84330E-01	4.72104E-01	4.67810E-01
132	5.35106E-01	5.28382E-01	5.23401E-01	5.13972E-01	5.04552E-01	4.91876E-01	4.82380E-01	4.70878E-01	4.66393E-01
133	5.31873E-01	5.25356E-01	5.20534E-01	5.11258E-01	5.02155E-01	4.89940E-01	4.80410E-01	4.69644E-01	4.64899E-01

134	5.28673E-01	5.22370E-01	5.17701E-01	5.08594E-01	4.99771E-01	4.88029E-01	4.78426E-01	4.68411E-01	4.63332E-01
135	5.25504E-01	5.19425E-01	5.14904E-01	5.05982E-01	4.97404E-01	4.86152E-01	4.76429E-01	4.67191E-01	4.61695E-01
136	5.25504E-01	5.19425E-01	5.14904E-01	5.05982E-01	4.97404E-01	4.86152E-01	4.76429E-01	4.67191E-01	4.61695E-01
137	5.02137E-01	4.97391E-01	4.93877E-01	4.86598E-01	4.78772E-01	4.70643E-01	4.60772E-01	4.55794E-01	4.48571E-01
138	4.79109E-01	4.75215E-01	4.72503E-01	4.66494E-01	4.59497E-01	4.53521E-01	4.44174E-01	4.41939E-01	4.34420E-01
139	4.56354E-01	4.53046E-01	4.50963E-01	4.45955E-01	4.39774E-01	4.35336E-01	4.26790E-01	4.26390E-01	4.19260E-01
140	4.33835E-01	4.30973E-01	4.29396E-01	4.25199E-01	4.19778E-01	4.16480E-01	4.08814E-01	4.09683E-01	4.03240E-01
141	4.11542E-01	4.09067E-01	4.07912E-01	4.04390E-01	3.99666E-01	3.97242E-01	3.90442E-01	3.92212E-01	3.86554E-01
142	3.89496E-01	3.87388E-01	3.86603E-01	3.83662E-01	3.79573E-01	3.77841E-01	3.71853E-01	3.74276E-01	3.69401E-01
143	3.67739E-01	3.65998E-01	3.65552E-01	3.63126E-01	3.59616E-01	3.58447E-01	3.53204E-01	3.56105E-01	3.51968E-01
144	3.46334E-01	3.44964E-01	3.44836E-01	3.42875E-01	3.39895E-01	3.39197E-01	3.34633E-01	3.37883E-01	3.34422E-01
145	3.25353E-01	3.24355E-01	3.24528E-01	3.22993E-01	3.20500E-01	3.20202E-01	3.16253E-01	3.19759E-01	3.16906E-01
146	3.04877E-01	3.04242E-01	3.04698E-01	3.03554E-01	3.01508E-01	3.01555E-01	2.98164E-01	3.01853E-01	2.99546E-01
147	2.84981E-01	2.84691E-01	2.85408E-01	2.84623E-01	2.82987E-01	2.83334E-01	2.80448E-01	2.84265E-01	2.82444E-01
148	2.65738E-01	2.65765E-01	2.66717E-01	2.66256E-01	2.64996E-01	2.65603E-01	2.63172E-01	2.67079E-01	2.65690E-01
149	2.47206E-01	2.47514E-01	2.48673E-01	2.48501E-01	2.47582E-01	2.48418E-01	2.46394E-01	2.50363E-01	2.49357E-01
150	2.29433E-01	2.29982E-01	2.31316E-01	2.31395E-01	2.30787E-01	2.31821E-01	2.30156E-01	2.34177E-01	2.33504E-01
151	2.12449E-01	2.13197E-01	2.14676E-01	2.14968E-01	2.14641E-01	2.15851E-01	2.14493E-01	2.18575E-01	2.18181E-01
152	2.12449E-01	2.13197E-01	2.14676E-01	2.14968E-01	2.14641E-01	2.15851E-01	2.14493E-01	2.18575E-01	2.18181E-01
153	1.85548E-01	1.86553E-01	1.88210E-01	1.88805E-01	1.88852E-01	1.90270E-01	1.89385E-01	1.93439E-01	1.93493E-01
154	1.61259E-01	1.62462E-01	1.64233E-01	1.65067E-01	1.65412E-01	1.66964E-01	1.66479E-01	1.70394E-01	1.70790E-01
155	1.39470E-01	1.40813E-01	1.42645E-01	1.43656E-01	1.44231E-01	1.45861E-01	1.45702E-01	1.49420E-01	1.50066E-01
156	1.20050E-01	1.21479E-01	1.23326E-01	1.24459E-01	1.25204E-01	1.26865E-01	1.26963E-01	1.30455E-01	1.31275E-01
157	1.02856E-01	1.04321E-01	1.06143E-01	1.07347E-01	1.08219E-01	1.09863E-01	1.10159E-01	1.13406E-01	1.14341E-01
158	8.77302E-02	8.91892E-02	9.09524E-02	9.21841E-02	9.31179E-02	9.47310E-02	9.51711E-02	9.81663E-02	9.91676E-02
159	7.45076E-02	7.59242E-02	7.76006E-02	7.88234E-02	7.97682E-02	8.13355E-02	8.18740E-02	8.46150E-02	8.56435E-02
160	6.30167E-02	6.43622E-02	6.59302E-02	6.71144E-02	6.80773E-02	6.95384E-02	7.01367E-02	7.26256E-02	7.36501E-02
161	5.30842E-02	5.43375E-02	5.57822E-02	5.69046E-02	5.78392E-02	5.91992E-02	5.98251E-02	6.20676E-02	6.30637E-02
162	4.45394E-02	4.56864E-02	4.69986E-02	4.80426E-02	4.89289E-02	5.01778E-02	5.08055E-02	5.28101E-02	5.37587E-02
163	3.72173E-02	3.82504E-02	3.94263E-02	4.03809E-02	4.12047E-02	4.23367E-02	4.29462E-02	4.47235E-02	4.56108E-02
164	3.09620E-02	3.18787E-02	3.29190E-02	3.37782E-02	3.45301E-02	3.55433E-02	3.61198E-02	3.76819E-02	3.84982E-02
165	2.56281E-02	2.64303E-02	2.73391E-02	2.81011E-02	2.87760E-02	2.96715E-02	3.02044E-02	3.15648E-02	3.23040E-02
166	2.10826E-02	2.17752E-02	2.25592E-02	2.32252E-02	2.38215E-02	2.46028E-02	2.50853E-02	2.62578E-02	2.69166E-02
167	1.72054E-02	1.77952E-02	1.84627E-02	1.90365E-02	1.95547E-02	2.02269E-02	2.06551E-02	2.16535E-02	2.22309E-02
168	1.38888E-02	1.43839E-02	1.49440E-02	1.54307E-02	1.58735E-02	1.64425E-02	1.68146E-02	1.76521E-02	1.81487E-02
169	1.10377E-02	1.14464E-02	1.19085E-02	1.23139E-02	1.26846E-02	1.31564E-02	1.34725E-02	1.41609E-02	1.45787E-02
170	8.56823E-03	8.89868E-03	9.27145E-03	9.60186E-03	9.90376E-03	1.02837E-02	1.05452E-02	1.10942E-02	1.14366E-02
171	6.40694E-03	6.66633E-03	6.95732E-03	7.21895E-03	7.45427E-03	7.74651E-03	7.95646E-03	8.37206E-03	8.64473E-03
172	4.48938E-03	4.68330E-03	4.89844E-03	5.09773E-03	5.26562E-03	5.47236E-03	5.63771E-03	5.91801E-03	6.13328E-03
173	2.75869E-03	2.89023E-03	3.03347E-03	3.17809E-03	3.27075E-03	3.39299E-03	3.52879E-03	3.65496E-03	3.84287E-03
174	2.75869E-03	2.89023E-03	3.03347E-03	3.17809E-03	3.27075E-03	3.39299E-03	3.52879E-03	3.65496E-03	3.84287E-03
175	1.69381E-03	1.78955E-03	1.88848E-03	1.98773E-03	2.07282E-03	2.17056E-03	2.26058E-03	2.36245E-03	2.45845E-03
176	1.03498E-03	1.09726E-03	1.16127E-03	1.22586E-03	1.28765E-03	1.35717E-03	1.41755E-03	1.49108E-03	1.54755E-03
177	6.23382E-04	6.60727E-04	6.99437E-04	7.38877E-04	7.78569E-04	8.23539E-04	8.62070E-04	9.10601E-04	9.44959E-04
178	3.53703E-04	3.74104E-04	3.95476E-04	4.17448E-04	4.40137E-04	4.66175E-04	4.88499E-04	5.17146E-04	5.36844E-04
179	1.59982E-04	1.68851E-04	1.78217E-04	1.87904E-04	1.98031E-04	2.09776E-04	2.19879E-04	2.32980E-04	2.41906E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO. GROUPS 28- 33

1	4.71979E-01	4.95128E-01	4.94968E-01	4.86764E-01	4.69476E-01	1.50418E 01
2	4.72520E-01	4.95683E-01	4.95513E-01	4.87278E-01	4.69949E-01	1.50342E 01
3	4.74168E-01	4.97361E-01	4.97154E-01	4.88824E-01	4.71366E-01	1.50108E 01
4	4.77003E-01	5.00202E-01	4.99913E-01	4.91407E-01	4.73722E-01	1.49699E 01
5	4.81173E-01	5.04268E-01	5.03820E-01	4.95030E-01	4.77004E-01	1.49088E 01
6	4.86908E-01	5.09646E-01	5.08910E-01	4.99690E-01	4.81185E-01	1.48233E 01
7	4.94537E-01	5.16429E-01	5.15206E-01	5.05360E-01	4.86209E-01	1.47079E 01
8	5.04507E-01	5.24689E-01	5.22695E-01	5.11968E-01	4.91977E-01	1.45556E 01
9	5.17359E-01	5.34411E-01	5.31270E-01	5.19361E-01	4.98316E-01	1.43577E 01
10	5.33642E-01	5.45361E-01	5.40651E-01	5.27243E-01	5.04943E-01	1.41036E 01
11	5.53638E-01	5.56832E-01	5.50219E-01	5.35088E-01	5.11406E-01	1.37803E 01
12	5.53638E-01	5.56832E-01	5.50219E-01	5.35088E-01	5.11406E-01	1.37803E 01
13	5.71084E-01	5.67813E-01	5.59314E-01	5.42304E-01	5.17140E-01	1.30887E 01
14	5.82251E-01	5.75452E-01	5.65513E-01	5.46793E-01	5.20284E-01	1.18957E 01
15	5.87907E-01	5.79413E-01	5.68376E-01	5.48024E-01	5.20307E-01	1.01980E 01
16	5.88669E-01	5.79724E-01	5.67751E-01	5.45641E-01	5.16791E-01	7.98558E 00
17	5.88669E-01	5.79724E-01	5.67751E-01	5.45641E-01	5.16791E-01	7.98558E 00
18	5.88470E-01	5.79537E-01	5.67418E-01	5.45004E-01	5.15979E-01	7.75255E 00
19	5.88280E-01	5.79370E-01	5.67106E-01	5.44390E-01	5.15191E-01	7.52476E 00
20	5.88099E-01	5.79223E-01	5.66814E-01	5.43796E-01	5.14423E-01	7.30175E 00
21	5.87929E-01	5.79096E-01	5.66542E-01	5.43221E-01	5.13675E-01	7.08309E 00
22	5.87929E-01	5.79096E-01	5.66542E-01	5.43221E-01	5.13675E-01	7.08309E 00
23	5.87743E-01	5.78963E-01	5.66265E-01	5.42642E-01	5.12920E-01	6.82198E 00
24	5.87523E-01	5.78802E-01	5.65965E-01	5.42047E-01	5.12155E-01	6.57052E 00
25	5.87270E-01	5.78615E-01	5.65643E-01	5.41435E-01	5.11377E-01	6.32789E 00
26	5.86985E-01	5.78401E-01	5.65298E-01	5.40805E-01	5.10585E-01	6.09332E 00
27	5.86985E-01	5.78401E-01	5.65298E-01	5.40805E-01	5.10585E-01	6.09332E 00
28	5.86544E-01	5.78068E-01	5.64788E-01	5.39901E-01	5.09457E-01	5.78214E 00
29	5.86065E-01	5.77701E-01	5.64252E-01	5.38988E-01	5.08330E-01	5.48975E 00
30	5.85550E-01	5.77303E-01	5.63692E-01	5.38062E-01	5.07198E-01	5.21399E 00
31	5.85002E-01	5.76876E-01	5.63108E-01	5.37119E-01	5.06056E-01	4.95282E 00
32	5.85002E-01	5.76876E-01	5.63108E-01	5.37119E-01	5.06056E-01	4.95282E 00
33	5.84427E-01	5.76427E-01	5.62503E-01	5.36158E-01	5.04901E-01	4.70704E 00
34	5.83841E-01	5.75964E-01	5.61893E-01	5.35208E-01	5.03765E-01	4.47922E 00
35	5.83245E-01	5.75490E-01	5.61276E-01	5.34263E-01	5.02643E-01	4.26731E 00
36	5.82640E-01	5.75007E-01	5.60652E-01	5.33321E-01	5.01532E-01	4.06940E 00
37	5.82640E-01	5.75007E-01	5.60652E-01	5.33321E-01	5.01532E-01	4.06940E 00
38	5.81447E-01	5.74039E-01	5.59421E-01	5.31491E-01	4.99382E-01	3.72273E 00
39	5.80330E-01	5.73106E-01	5.58257E-01	5.29812E-01	4.97428E-01	3.43826E 00
40	5.79291E-01	5.72214E-01	5.57154E-01	5.28256E-01	4.95634E-01	3.20345E 00
41	5.78330E-01	5.71369E-01	5.56105E-01	5.26798E-01	4.93969E-01	3.00810E 00

42	5.78330E-01	5.71369E-01	5.56105E-01	5.26798E-01	4.93969E-01	3.00810E 00
43	5.77480E-01	5.70588E-01	5.55134E-01	5.25472E-01	4.92465E-01	2.85312E 00
44	5.76785E-01	5.69893E-01	5.54279E-01	5.24356E-01	4.91214E-01	2.74131E 00
45	5.76236E-01	5.69277E-01	5.53528E-01	5.23429E-01	4.90191E-01	2.66669E 00
46	5.75820E-01	5.68732E-01	5.52868E-01	5.22669E-01	4.89373E-01	2.62509E 00
47	5.75820E-01	5.68732E-01	5.52868E-01	5.22670E-01	4.89373E-01	2.62509E 00
48	5.75524E-01	5.68244E-01	5.52288E-01	5.22068E-01	4.88751E-01	2.61496E 00
49	5.75333E-01	5.67796E-01	5.51776E-01	5.21618E-01	4.88319E-01	2.63621E 00
50	5.75223E-01	5.67367E-01	5.51313E-01	5.21308E-01	4.88068E-01	2.68916E 00
51	5.75168E-01	5.66930E-01	5.50883E-01	5.21128E-01	4.87991E-01	2.77562E 00
52	5.75168E-01	5.66930E-01	5.50883E-01	5.21128E-01	4.87991E-01	2.77562E 00
53	5.75144E-01	5.66696E-01	5.50668E-01	5.21076E-01	4.88005E-01	2.83146E 00
54	5.75111E-01	5.66443E-01	5.50444E-01	5.21034E-01	4.88040E-01	2.89490E 00
55	5.75065E-01	5.66167E-01	5.50209E-01	5.21002E-01	4.88096E-01	2.96654E 00
56	5.75001E-01	5.65863E-01	5.49959E-01	5.20981E-01	4.88174E-01	3.04707E 00
57	5.75001E-01	5.65863E-01	5.49959E-01	5.20981E-01	4.88174E-01	3.04707E 00
58	5.74883E-01	5.65453E-01	5.49629E-01	5.20951E-01	4.88274E-01	3.15398E 00
59	5.74704E-01	5.64979E-01	5.49252E-01	5.20900E-01	4.88365E-01	3.27181E 00
60	5.74454E-01	5.64430E-01	5.48823E-01	5.20829E-01	4.88452E-01	3.40208E 00
61	5.74123E-01	5.63799E-01	5.48338E-01	5.20740E-01	4.88537E-01	3.54649E 00
62	5.74123E-01	5.63799E-01	5.48338E-01	5.20740E-01	4.88537E-01	3.54649E 00
63	5.73534E-01	5.62891E-01	5.47607E-01	5.20446E-01	4.88433E-01	3.70765E 00
64	5.72632E-01	5.61746E-01	5.46602E-01	5.19789E-01	4.87944E-01	3.82949E 00
65	5.71407E-01	5.60356E-01	5.45324E-01	5.18779E-01	4.87079E-01	3.91299E 00
66	5.69857E-01	5.58718E-01	5.43772E-01	5.17422E-01	4.85848E-01	3.95901E 00
67	5.67978E-01	5.56827E-01	5.41949E-01	5.15724E-01	4.84258E-01	3.96836E 00
68	5.65772E-01	5.54686E-01	5.39856E-01	5.13691E-01	4.82314E-01	3.94177E 00
69	5.63241E-01	5.52297E-01	5.37499E-01	5.11328E-01	4.80023E-01	3.87990E 00
70	5.60391E-01	5.49665E-01	5.34882E-01	5.08640E-01	4.77388E-01	3.78336E 00
71	5.57230E-01	5.46799E-01	5.32010E-01	5.05628E-01	4.74412E-01	3.65269E 00
72	5.53768E-01	5.43710E-01	5.28892E-01	5.02298E-01	4.71098E-01	3.48835E 00
73	5.50016E-01	5.40411E-01	5.25534E-01	4.98650E-01	4.67446E-01	3.29077E 00
74	5.45991E-01	5.36918E-01	5.21948E-01	4.94686E-01	4.63457E-01	3.06032E 00
75	5.45991E-01	5.36918E-01	5.21948E-01	4.94686E-01	4.63457E-01	3.06032E 00
76	5.43885E-01	5.35129E-01	5.20073E-01	4.92521E-01	4.61246E-01	2.94440E 00
77	5.41763E-01	5.33321E-01	5.18190E-01	4.90365E-01	4.59050E-01	2.83420E 00
78	5.39627E-01	5.31496E-01	5.16299E-01	4.88217E-01	4.56867E-01	2.72916E 00
79	5.37479E-01	5.29658E-01	5.14403E-01	4.86076E-01	4.54695E-01	2.62875E 00
80	5.37479E-01	5.29658E-01	5.14403E-01	4.86076E-01	4.54695E-01	2.62875E 00
81	5.34373E-01	5.26998E-01	5.11664E-01	4.82984E-01	4.51559E-01	2.49388E 00
82	5.31281E-01	5.24337E-01	5.08945E-01	4.79951E-01	4.48494E-01	2.37023E 00
83	5.28210E-01	5.21682E-01	5.06246E-01	4.76971E-01	4.45495E-01	2.25629E 00
84	5.25166E-01	5.19040E-01	5.03573E-01	4.74042E-01	4.42556E-01	2.15073E 00
85	5.25166E-01	5.19040E-01	5.03573E-01	4.74042E-01	4.42556E-01	2.15073E 00
86	5.22131E-01	5.16402E-01	5.00905E-01	4.71122E-01	4.39631E-01	2.05415E 00
87	5.19159E-01	5.13804E-01	4.98293E-01	4.68300E-01	4.36816E-01	1.96836E 00

88	5.16255E-01	5.11250E-01	4.95740E-01	4.65571E-01	4.34109E-01	1.89214E 00
89	5.13424E-01	5.08746E-01	4.93248E-01	4.62933E-01	4.31504E-01	1.82441E 00
90	5.13424E-01	5.08746E-01	4.93248E-01	4.62933E-01	4.31504E-01	1.82441E 00
91	5.07974E-01	5.03890E-01	4.88440E-01	4.57915E-01	4.26586E-01	1.71706E 00
92	5.02941E-01	4.99333E-01	4.83989E-01	4.53419E-01	4.22251E-01	1.64505E 00
93	4.98336E-01	4.95094E-01	4.79902E-01	4.49430E-01	4.18477E-01	1.60393E 00
94	4.94158E-01	4.91183E-01	4.76181E-01	4.45935E-01	4.15248E-01	1.59126E 00
95	4.94158E-01	4.91183E-01	4.76181E-01	4.45935E-01	4.15248E-01	1.59126E 00
96	4.90401E-01	4.87606E-01	4.72825E-01	4.42920E-01	4.12544E-01	1.60411E 00
97	4.87023E-01	4.84340E-01	4.69805E-01	4.40334E-01	4.10309E-01	1.64117E 00
98	4.84007E-01	4.81379E-01	4.67116E-01	4.38180E-01	4.08549E-01	1.70485E 00
99	4.81332E-01	4.78709E-01	4.64756E-01	4.36467E-01	4.07276E-01	1.79913E 00
100	4.81332E-01	4.78709E-01	4.64756E-01	4.36467E-01	4.07276E-01	1.79913E 00
101	4.78942E-01	4.76303E-01	4.62686E-01	4.35115E-01	4.06388E-01	1.91847E 00
102	4.76697E-01	4.74074E-01	4.60795E-01	4.33965E-01	4.05725E-01	2.05945E 00
103	4.74564E-01	4.72004E-01	4.59077E-01	4.33037E-01	4.05314E-01	2.22910E 00
104	4.72507E-01	4.70070E-01	4.57530E-01	4.32354E-01	4.05184E-01	2.43576E 00
105	4.72507E-01	4.70070E-01	4.57530E-01	4.32354E-01	4.05184E-01	2.43576E 00
106	4.71491E-01	4.69147E-01	4.56816E-01	4.32092E-01	4.05203E-01	2.55286E 00
107	4.70448E-01	4.68234E-01	4.56111E-01	4.31841E-01	4.05237E-01	2.67679E 00
108	4.69370E-01	4.67327E-01	4.55417E-01	4.31604E-01	4.05292E-01	2.80878E 00
109	4.68251E-01	4.66424E-01	4.54732E-01	4.31386E-01	4.05372E-01	2.95010E 00
110	4.68251E-01	4.66424E-01	4.54733E-01	4.31386E-01	4.05372E-01	2.95010E 00
111	4.67088E-01	4.65524E-01	4.54056E-01	4.31177E-01	4.05460E-01	3.09841E 00
112	4.65852E-01	4.64614E-01	4.53371E-01	4.30957E-01	4.05542E-01	3.25278E 00
113	4.64535E-01	4.63690E-01	4.52678E-01	4.30732E-01	4.05623E-01	3.41446E 00
114	4.63130E-01	4.62753E-01	4.51977E-01	4.30505E-01	4.05708E-01	3.58470E 00
115	4.63130E-01	4.62753E-01	4.51977E-01	4.30505E-01	4.05708E-01	3.58470E 00
116	4.61634E-01	4.61802E-01	4.51268E-01	4.30269E-01	4.05783E-01	3.76159E 00
117	4.60016E-01	4.60825E-01	4.50536E-01	4.30007E-01	4.05836E-01	3.94449E 00
118	4.58266E-01	4.59823E-01	4.49784E-01	4.29725E-01	4.05873E-01	4.13461E 00
119	4.56374E-01	4.58794E-01	4.49011E-01	4.29428E-01	4.05899E-01	4.33318E 00
120	4.56374E-01	4.58794E-01	4.49011E-01	4.29428E-01	4.05899E-01	4.33318E 00
121	4.53638E-01	4.57421E-01	4.47974E-01	4.28990E-01	4.05877E-01	4.59502E 00
122	4.51144E-01	4.56025E-01	4.46895E-01	4.28461E-01	4.05762E-01	4.84225E 00
123	4.48863E-01	4.54608E-01	4.45777E-01	4.27851E-01	4.05565E-01	5.07591E 00
124	4.46770E-01	4.53170E-01	4.44627E-01	4.27168E-01	4.05297E-01	5.29700E 00
125	4.44844E-01	4.51712E-01	4.43446E-01	4.26421E-01	4.04969E-01	5.50645E 00
126	4.43071E-01	4.50235E-01	4.42239E-01	4.25617E-01	4.04590E-01	5.70516E 00
127	4.41440E-01	4.48738E-01	4.41009E-01	4.24764E-01	4.04171E-01	5.89398E 00
128	4.39942E-01	4.47221E-01	4.39759E-01	4.23867E-01	4.03719E-01	6.07370E 00
129	4.38573E-01	4.45683E-01	4.38492E-01	4.22933E-01	4.03245E-01	6.24510E 00
130	4.37332E-01	4.44122E-01	4.37208E-01	4.21966E-01	4.02757E-01	6.40890E 00
131	4.36219E-01	4.42536E-01	4.35912E-01	4.20971E-01	4.02264E-01	6.56580E 00
132	4.35239E-01	4.40921E-01	4.34603E-01	4.19954E-01	4.01775E-01	6.71648E 00
133	4.34398E-01	4.39274E-01	4.33285E-01	4.18918E-01	4.01298E-01	6.86157E 00

134	4.33706E-01	4.37590E-01	4.31958E-01	4.17866E-01	4.00843E-01	7.00168E 00
135	4.33174E-01	4.35864E-01	4.30624E-01	4.16804E-01	4.00418E-01	7.13741E 00
136	4.33174E-01	4.35864E-01	4.30624E-01	4.16804E-01	4.00418E-01	7.13741E 00
137	4.27561E-01	4.23947E-01	4.20172E-01	4.07880E-01	3.95523E-01	7.38749E 00
138	4.18204E-01	4.11829E-01	4.08588E-01	3.97476E-01	3.87891E-01	7.58483E 00
139	4.06271E-01	3.98986E-01	3.96032E-01	3.85868E-01	3.78238E-01	7.73253E 00
140	3.92547E-01	3.85292E-01	3.82625E-01	3.73282E-01	3.67077E-01	7.83374E 00
141	3.77584E-01	3.70807E-01	3.68491E-01	3.59904E-01	3.54785E-01	7.89160E 00
142	3.61787E-01	3.55676E-01	3.53767E-01	3.45904E-01	3.41651E-01	7.90923E 00
143	3.45461E-01	3.40071E-01	3.38597E-01	3.31438E-01	3.27904E-01	7.88965E 00
144	3.28844E-01	3.24162E-01	3.23126E-01	3.16650E-01	3.13736E-01	7.83583E 00
145	3.12126E-01	3.08107E-01	3.07490E-01	3.01672E-01	2.99308E-01	7.75061E 00
146	2.95458E-01	2.92045E-01	2.91815E-01	2.86627E-01	2.84760E-01	7.63671E 00
147	2.78965E-01	2.76096E-01	2.76217E-01	2.71625E-01	2.70213E-01	7.49675E 00
148	2.62745E-01	2.60362E-01	2.60794E-01	2.56763E-01	2.55778E-01	7.33319E 00
149	2.46881E-01	2.44927E-01	2.45633E-01	2.42129E-01	2.41551E-01	7.14839E 00
150	2.31437E-01	2.29858E-01	2.30809E-01	2.27796E-01	2.27625E-01	6.94454E 00
151	2.16461E-01	2.15208E-01	2.16386E-01	2.13832E-01	2.14084E-01	6.72371E 00
152	2.16461E-01	2.15208E-01	2.16386E-01	2.13832E-01	2.14084E-01	6.72371E 00
153	1.92327E-01	1.91560E-01	1.93013E-01	1.91119E-01	1.91935E-01	6.37077E 00
154	1.70087E-01	1.69720E-01	1.71343E-01	1.69993E-01	1.71146E-01	6.01601E 00
155	1.49736E-01	1.49691E-01	1.51410E-01	1.50500E-01	1.51852E-01	5.66316E 00
156	1.31238E-01	1.31442E-01	1.33201E-01	1.32646E-01	1.34105E-01	5.31539E 00
157	1.14527E-01	1.14919E-01	1.16672E-01	1.16397E-01	1.17902E-01	4.97532E 00
158	9.95173E-02	1.00043E-01	1.01757E-01	1.01700E-01	1.03204E-01	4.64511E 00
159	8.61083E-02	8.67235E-02	8.83702E-02	8.84786E-02	8.99489E-02	4.32645E 00
160	7.41893E-02	7.48567E-02	7.64166E-02	7.66457E-02	7.80572E-02	4.02065E 00
161	6.36439E-02	6.43334E-02	6.57920E-02	6.61046E-02	6.74393E-02	3.72866E 00
162	5.43531E-02	5.50406E-02	5.63883E-02	5.67539E-02	5.79989E-02	3.45114E 00
163	4.61982E-02	4.68648E-02	4.80959E-02	4.84895E-02	4.96364E-02	3.18846E 00
164	3.90623E-02	3.96939E-02	4.08057E-02	4.12076E-02	4.22513E-02	2.94079E 00
165	3.28326E-02	3.34189E-02	3.44115E-02	3.48061E-02	3.57443E-02	2.70812E 00
166	2.74012E-02	2.79351E-02	2.88107E-02	2.91863E-02	3.00187E-02	2.49029E 00
167	2.26660E-02	2.31434E-02	2.39056E-02	2.42534E-02	2.49811E-02	2.28701E 00
168	1.85314E-02	1.89504E-02	1.96041E-02	1.99177E-02	2.05423E-02	2.09792E 00
169	1.49084E-02	1.52695E-02	1.58199E-02	1.60944E-02	1.66173E-02	1.92259E 00
170	1.17152E-02	1.20206E-02	1.24726E-02	1.27036E-02	1.31249E-02	1.76057E 00
171	8.87768E-03	9.13081E-03	9.48726E-03	9.66987E-03	9.98613E-03	1.61139E 00
172	6.32988E-03	6.53410E-03	6.79314E-03	6.92021E-03	7.12275E-03	1.47457E 00
173	4.01614E-03	4.17077E-03	4.32034E-03	4.38239E-03	4.45306E-03	1.34968E 00
174	4.01614E-03	4.17077E-03	4.32034E-03	4.38239E-03	4.45306E-03	1.34968E 00
175	2.54816E-03	2.64192E-03	2.74284E-03	2.80344E-03	2.82454E-03	9.35335E-01
176	1.59953E-03	1.65720E-03	1.72196E-03	1.76611E-03	1.77424E-03	6.35756E-01
177	9.76165E-04	1.01140E-03	1.05156E-03	1.08047E-03	1.08463E-03	4.16050E-01
178	5.54615E-04	5.74773E-04	5.97873E-04	6.14926E-04	6.17270E-04	2.49838E-01
179	2.49939E-04	2.59067E-04	2.69548E-04	2.77375E-04	2.78462E-04	1.16686E-01
180	0.	0.	0.	0.	0.	0.

GROUP FLUXES

Table C.6. HFIR 33-Group Fluxes, 2100 Mwd

R. NO.	GROUPS 1- 9								
1	5.42128E-01	2.02515E 00	1.80754E 00	1.74056E 00	1.22436E 00	1.07793E 00	8.56052E-01	7.32422E-01	6.72292E-01
2	5.43129E-01	2.02958E 00	1.81194E 00	1.74440E 00	1.22702E 00	1.08013E 00	8.57776E-01	7.33848E-01	6.73512E-01
3	5.46137E-01	2.04290E 00	1.82516E 00	1.75596E 00	1.23502E 00	1.08673E 00	8.62952E-01	7.38127E-01	6.77169E-01
4	5.51168E-01	2.06519E 00	1.84733E 00	1.77530E 00	1.24839E 00	1.09776E 00	8.71595E-01	7.45262E-01	6.83247E-01
5	5.58251E-01	2.09661E 00	1.87862E 00	1.80253E 00	1.26721E 00	1.11325E 00	8.83727E-01	7.55258E-01	6.91720E-01
6	5.67425E-01	2.13736E 00	1.91931E 00	1.83780E 00	1.29159E 00	1.13324E 00	8.99381E-01	7.68117E-01	7.02546E-01
7	5.78740E-01	2.18774E 00	1.96976E 00	1.88132E 00	1.32164E 00	1.15777E 00	9.18593E-01	7.83841E-01	7.15660E-01
8	5.92260E-01	2.24806E 00	2.03039E 00	1.93332E 00	1.35754E 00	1.18690E 00	9.41407E-01	8.02419E-01	7.30964E-01
9	6.08060E-01	2.31876E 00	2.10174E 00	1.99410E 00	1.39948E 00	1.22068E 00	9.67867E-01	8.23831E-01	7.48321E-01
10	6.26227E-01	2.40030E 00	2.18442E 00	2.06398E 00	1.44765E 00	1.25917E 00	9.98017E-01	8.48032E-01	7.67534E-01
11	6.46864E-01	2.49324E 00	2.27919E 00	2.14333E 00	1.50232E 00	1.30239E 00	1.03190E 00	8.74949E-01	7.88326E-01
12	6.46864E-01	2.49324E 00	2.27919E 00	2.14333E 00	1.50232E 00	1.30239E 00	1.03190E 00	8.74949E-01	7.88326E-01
13	6.65695E-01	2.58198E 00	2.37798E 00	2.22242E 00	1.55735E 00	1.34481E 00	1.05868E 00	8.96231E-01	8.11694E-01
14	6.86704E-01	2.68522E 00	2.49642E 00	2.31714E 00	1.62341E 00	1.39491E 00	1.08940E 00	9.20715E-01	8.38850E-01
15	7.09944E-01	2.80330E 00	2.63537E 00	2.42764E 00	1.70062E 00	1.45241E 00	1.12342E 00	9.47852E-01	8.69990E-01
16	7.35485E-01	2.93673E 00	2.79604E 00	2.55426E 00	1.78925E 00	1.51702E 00	1.15991E 00	9.77012E-01	9.05422E-01
17	7.35485E-01	2.93673E 00	2.79604E 00	2.55426E 00	1.78925E 00	1.51702E 00	1.15991E 00	9.77012E-01	9.05422E-01
18	7.46353E-01	2.99132E 00	2.85215E 00	2.60283E 00	1.82253E 00	1.54161E 00	1.18089E 00	9.93589E-01	9.13640E-01
19	7.57436E-01	3.04581E 00	2.90759E 00	2.65035E 00	1.85506E 00	1.56554E 00	1.20137E 00	1.00964E 00	9.21603E-01
20	7.68745E-01	3.10027E 00	2.96245E 00	2.69687E 00	1.88687E 00	1.58884E 00	1.22140E 00	1.02519E 00	9.29303E-01
21	7.80290E-01	3.15476E 00	3.01680E 00	2.74247E 00	1.91802E 00	1.61154E 00	1.24099E 00	1.04026E 00	9.36730E-01
22	7.80290E-01	3.15476E 00	3.01680E 00	2.74247E 00	1.91802E 00	1.61154E 00	1.24100E 00	1.04026E 00	9.36730E-01
23	7.86667E-01	3.18515E 00	3.04937E 00	2.76832E 00	1.93586E 00	1.62435E 00	1.25023E 00	1.04735E 00	9.42209E-01
24	7.92899E-01	3.21486E 00	3.08122E 00	2.79361E 00	1.95331E 00	1.63691E 00	1.25929E 00	1.05431E 00	9.47602E-01
25	7.98998E-01	3.24394E 00	3.11238E 00	2.81838E 00	1.97042E 00	1.64922E 00	1.26818E 00	1.06114E 00	9.52908E-01
26	8.04973E-01	3.27245E 00	3.14293E 00	2.84268E 00	1.98719E 00	1.66131E 00	1.27691E 00	1.06786E 00	9.58125E-01
27	8.04973E-01	3.27245E 00	3.14293E 00	2.84268E 00	1.98719E 00	1.66131E 00	1.27691E 00	1.06786E 00	9.58125E-01
28	8.13013E-01	3.31087E 00	3.18406E 00	2.87545E 00	2.00981E 00	1.67766E 00	1.28872E 00	1.07696E 00	9.65219E-01
29	8.20707E-01	3.34770E 00	3.22349E 00	2.90693E 00	2.03155E 00	1.69342E 00	1.30013E 00	1.08576E 00	9.72111E-01
30	8.28090E-01	3.38310E 00	3.26138E 00	2.93725E 00	2.05249E 00	1.70864E 00	1.31115E 00	1.09428E 00	9.78799E-01
31	8.35192E-01	3.41721E 00	3.29790E 00	2.96650E 00	2.07270E 00	1.72335E 00	1.32180E 00	1.10253E 00	9.85281E-01
32	8.35192E-01	3.41721E 00	3.29790E 00	2.96650E 00	2.07270E 00	1.72335E 00	1.32180E 00	1.10253E 00	9.85281E-01
33	8.41962E-01	3.44982E 00	3.33281E 00	2.99452E 00	2.09206E 00	1.73749E 00	1.33206E 00	1.11047E 00	9.91554E-01
34	8.48336E-01	3.48065E 00	3.36580E 00	3.02111E 00	2.11044E 00	1.75096E 00	1.34185E 00	1.11809E 00	9.97590E-01
35	8.54350E-01	3.50984E 00	3.39706E 00	3.04637E 00	2.12791E 00	1.76382E 00	1.35121E 00	1.12538E 00	1.00339E 00
36	8.60039E-01	3.53756E 00	3.42676E 00	3.07043E 00	2.14455E 00	1.77610E 00	1.36015E 00	1.13236E 00	1.00896E 00
37	8.60039E-01	3.53756E 00	3.42676E 00	3.07043E 00	2.14455E 00	1.77610E 00	1.36015E 00	1.13236E 00	1.00896E 00
38	8.70123E-01	3.58721E 00	3.47995E 00	3.11391E 00	2.17466E 00	1.79855E 00	1.37658E 00	1.14527E 00	1.01936E 00
39	8.78471E-01	3.62906E 00	3.52487E 00	3.15116E 00	2.20050E 00	1.81813E 00	1.39102E 00	1.15673E 00	1.02872E 00
40	8.85341E-01	3.66431E 00	3.56281E 00	3.18307E 00	2.22266E 00	1.83516E 00	1.40364E 00	1.16684E 00	1.03707E 00
41	8.90953E-01	3.69394E 00	3.59489E 00	3.21036E 00	2.24166E 00	1.84991E 00	1.41462E 00	1.17569E 00	1.04445E 00

42	8.90953E-01	3.69394E 00	3.59489E 00	3.21037E 00	2.24166E 00	1.84991E 00	1.41462E 00	1.17569E 00	1.04445E 00
43	8.95157E-01	3.71733E 00	3.62039E 00	3.23261E 00	2.25719E 00	1.86223E 00	1.42387E 00	1.18323E 00	1.05085E 00
44	8.97797E-01	3.73377E 00	3.63860E 00	3.24929E 00	2.26891E 00	1.87193E 00	1.43127E 00	1.18942E 00	1.05623E 00
45	8.99026E-01	3.74397E 00	3.65026E 00	3.26095E 00	2.27717E 00	1.87921E 00	1.43695E 00	1.19432E 00	1.06065E 00
46	8.98958E-01	3.74845E 00	3.65596E 00	3.26798E 00	2.28227E 00	1.88425E 00	1.44103E 00	1.19802E 00	1.06414E 00
47	8.98958E-01	3.74845E 00	3.65596E 00	3.26798E 00	2.28227E 00	1.88425E 00	1.44103E 00	1.19802E 00	1.06415E 00
48	8.97632E-01	3.74739E 00	3.65591E 00	3.27058E 00	2.28431E 00	1.88713E 00	1.44357E 00	1.20056E 00	1.06675E 00
49	8.95059E-01	3.74086E 00	3.65016E 00	3.26879E 00	2.28334E 00	1.88791E 00	1.44462E 00	1.20198E 00	1.06852E 00
50	8.91257E-01	3.72894E 00	3.63880E 00	3.26272E 00	2.27944E 00	1.88666E 00	1.44422E 00	1.20235E 00	1.06947E 00
51	8.86212E-01	3.71158E 00	3.62178E 00	3.25236E 00	2.27260E 00	1.88341E 00	1.44242E 00	1.20170E 00	1.06968E 00
52	8.86212E-01	3.71158E 00	3.62178E 00	3.25236E 00	2.27260E 00	1.88341E 00	1.44242E 00	1.20170E 00	1.06968E 00
53	8.83246E-01	3.70097E 00	3.61125E 00	3.24567E 00	2.26814E 00	1.88109E 00	1.44103E 00	1.20103E 00	1.06952E 00
54	8.80024E-01	3.68924E 00	3.59957E 00	3.23811E 00	2.26309E 00	1.87835E 00	1.43935E 00	1.20014E 00	1.06920E 00
55	8.76537E-01	3.67636E 00	3.58670E 00	3.22964E 00	2.25741E 00	1.87521E 00	1.43738E 00	1.19906E 00	1.06872E 00
56	8.72774E-01	3.66228E 00	3.57258E 00	3.22025E 00	2.25111E 00	1.87165E 00	1.43513E 00	1.19777E 00	1.06810E 00
57	8.72774E-01	3.66228E 00	3.57258E 00	3.22025E 00	2.25111E 00	1.87165E 00	1.43513E 00	1.19777E 00	1.06810E 00
58	8.67954E-01	3.64407E 00	3.55427E 00	3.20796E 00	2.24284E 00	1.86691E 00	1.43209E 00	1.19599E 00	1.06718E 00
59	8.62838E-01	3.62459E 00	3.53466E 00	3.19469E 00	2.23391E 00	1.86172E 00	1.42874E 00	1.19399E 00	1.06608E 00
60	8.57402E-01	3.60373E 00	3.51362E 00	3.18038E 00	2.22426E 00	1.85607E 00	1.42507E 00	1.19177E 00	1.06483E 00
61	8.51622E-01	3.58138E 00	3.49104E 00	3.16495E 00	2.21384E 00	1.84995E 00	1.42108E 00	1.18935E 00	1.06343E 00
62	8.51622E-01	3.58138E 00	3.49104E 00	3.16495E 00	2.21384E 00	1.84995E 00	1.42108E 00	1.18935E 00	1.06343E 00
63	8.44081E-01	3.55248E 00	3.46240E 00	3.14494E 00	2.20039E 00	1.84191E 00	1.41554E 00	1.18592E 00	1.06155E 00
64	8.37659E-01	3.52827E 00	3.43862E 00	3.12802E 00	2.18903E 00	1.83490E 00	1.41063E 00	1.18274E 00	1.05967E 00
65	8.32327E-01	3.50862E 00	3.41959E 00	3.11411E 00	2.17972E 00	1.82892E 00	1.40637E 00	1.17985E 00	1.05779E 00
66	8.28060E-01	3.49343E 00	3.40521E 00	3.10317E 00	2.17244E 00	1.82398E 00	1.40276E 00	1.17725E 00	1.05594E 00
67	8.24835E-01	3.48263E 00	3.39538E 00	3.09515E 00	2.16715E 00	1.82006E 00	1.39979E 00	1.17495E 00	1.05413E 00
68	8.22632E-01	3.47611E 00	3.39001E 00	3.08999E 00	2.16381E 00	1.81715E 00	1.39745E 00	1.17295E 00	1.05237E 00
69	8.21431E-01	3.47381E 00	3.38903E 00	3.08764E 00	2.16239E 00	1.81524E 00	1.39574E 00	1.17124E 00	1.05065E 00
70	8.21217E-01	3.47566E 00	3.39238E 00	3.08805E 00	2.16287E 00	1.81429E 00	1.39463E 00	1.16981E 00	1.04896E 00
71	8.21973E-01	3.48160E 00	3.40000E 00	3.09119E 00	2.16520E 00	1.81429E 00	1.39411E 00	1.16865E 00	1.04730E 00
72	8.23687E-01	3.49159E 00	3.41185E 00	3.09700E 00	2.16938E 00	1.81520E 00	1.39415E 00	1.16772E 00	1.04564E 00
73	8.26347E-01	3.50557E 00	3.42787E 00	3.10544E 00	2.17536E 00	1.81700E 00	1.39473E 00	1.16700E 00	1.04397E 00
74	8.29943E-01	3.52351E 00	3.44806E 00	3.11646E 00	2.18312E 00	1.81964E 00	1.39580E 00	1.16645E 00	1.04225E 00
75	8.29943E-01	3.52351E 00	3.44806E 00	3.11646E 00	2.18312E 00	1.81964E 00	1.39580E 00	1.16645E 00	1.04225E 00
76	8.31598E-01	3.53174E 00	3.45743E 00	3.12152E 00	2.18669E 00	1.82085E 00	1.39627E 00	1.16620E 00	1.04141E 00
77	8.33085E-01	3.53925E 00	3.46607E 00	3.12605E 00	2.18991E 00	1.82185E 00	1.39659E 00	1.16587E 00	1.04051E 00
78	8.34416E-01	3.54610E 00	3.47402E 00	3.13010E 00	2.19280E 00	1.82264E 00	1.39677E 00	1.16544E 00	1.03956E 00
79	8.35603E-01	3.55235E 00	3.48136E 00	3.13369E 00	2.19538E 00	1.82323E 00	1.39682E 00	1.16492E 00	1.03854E 00
80	8.35603E-01	3.55235E 00	3.48136E 00	3.13369E 00	2.19538E 00	1.82323E 00	1.39682E 00	1.16492E 00	1.03854E 00
81	8.36999E-01	3.56000E 00	3.49053E 00	3.13788E 00	2.19844E 00	1.82368E 00	1.39662E 00	1.16400E 00	1.03696E 00
82	8.38019E-01	3.56605E 00	3.49803E 00	3.14086E 00	2.20069E 00	1.82362E 00	1.39607E 00	1.16284E 00	1.03523E 00
83	8.38693E-01	3.57063E 00	3.50402E 00	3.14274E 00	2.20220E 00	1.82308E 00	1.39519E 00	1.16147E 00	1.03335E 00
84	8.39054E-01	3.57389E 00	3.50865E 00	3.14362E 00	2.20303E 00	1.82209E 00	1.39400E 00	1.15987E 00	1.03131E 00
85	8.39054E-01	3.57389E 00	3.50865E 00	3.14362E 00	2.20303E 00	1.82209E 00	1.39400E 00	1.15987E 00	1.03131E 00
86	8.39053E-01	3.57562E 00	3.51170E 00	3.14333E 00	2.20309E 00	1.82059E 00	1.39245E 00	1.15802E 00	1.02910E 00
87	8.38646E-01	3.57561E 00	3.51296E 00	3.14173E 00	2.20226E 00	1.81852E 00	1.39051E 00	1.15590E 00	1.02670E 00

88	8.37863E-01	3.57400E 00	3.51255E 00	3.13890E 00	2.20061E 00	1.81590E 00	1.38820E 00	1.15353E 00	1.02412E 00
89	8.36729E-01	3.57089E 00	3.51062E 00	3.13493E 00	2.19820E 00	1.81277E 00	1.38553E 00	1.15089E 00	1.02136E 00
90	8.36729E-01	3.57089E 00	3.51062E 00	3.13493E 00	2.19820E 00	1.81277E 00	1.38553E 00	1.15089E 00	1.02136E 00
91	8.33259E-01	3.55957E 00	3.50146E 00	3.12307E 00	2.19074E 00	1.80477E 00	1.37899E 00	1.14478E 00	1.01524E 00
92	8.28225E-01	3.54156E 00	3.48540E 00	3.10609E 00	2.17987E 00	1.79448E 00	1.37088E 00	1.13755E 00	1.00834E 00
93	8.21737E-01	3.51739E 00	3.46299E 00	3.08434E 00	2.16583E 00	1.78203E 00	1.36126E 00	1.12922E 00	1.00065E 00
94	8.13854E-01	3.48730E 00	3.43451E 00	3.05802E 00	2.14876E 00	1.76749E 00	1.35019E 00	1.11984E 00	9.92196E-01
95	8.13854E-01	3.48730E 00	3.43451E 00	3.05802E 00	2.14876E 00	1.76749E 00	1.35019E 00	1.11984E 00	9.92196E-01
96	8.04663E-01	3.45170E 00	3.40038E 00	3.02741E 00	2.12887E 00	1.75099E 00	1.33774E 00	1.10943E 00	9.82994E-01
97	7.94194E-01	3.41071E 00	3.36075E 00	2.99262E 00	2.10626E 00	1.73257E 00	1.32396E 00	1.09803E 00	9.73060E-01
98	7.82378E-01	3.36403E 00	3.31528E 00	2.95345E 00	2.08080E 00	1.71218E 00	1.30882E 00	1.08563E 00	9.62403E-01
99	7.69108E-01	3.31118E 00	3.26344E 00	2.90953E 00	2.05227E 00	1.68973E 00	1.29227E 00	1.07221E 00	9.51035E-01
100	7.69108E-01	3.31118E 00	3.26344E 00	2.90953E 00	2.05227E 00	1.68973E 00	1.29227E 00	1.07221E 00	9.51035E-01
101	7.54621E-01	3.25323E 00	3.20631E 00	2.86168E 00	2.02123E 00	1.66557E 00	1.27458E 00	1.05795E 00	9.39080E-01
102	7.39044E-01	3.19074E 00	3.14456E 00	2.81035E 00	1.98803E 00	1.63990E 00	1.25585E 00	1.04291E 00	9.26553E-01
103	7.22186E-01	3.12285E 00	3.07725E 00	2.75495E 00	1.95229E 00	1.61252E 00	1.23599E 00	1.02705E 00	9.13472E-01
104	7.03824E-01	3.04855E 00	3.00328E 00	2.69476E 00	1.91354E 00	1.58324E 00	1.21492E 00	1.01036E 00	8.99862E-01
105	7.03824E-01	3.04855E 00	3.00328E 00	2.69476E 00	1.91354E 00	1.58324E 00	1.21492E 00	1.01036E 00	8.99862E-01
106	6.94115E-01	3.00917E 00	2.96392E 00	2.66300E 00	1.89313E 00	1.56797E 00	1.20401E 00	1.00177E 00	8.92916E-01
107	6.84135E-01	2.96866E 00	2.92340E 00	2.63041E 00	1.87224E 00	1.55239E 00	1.19290E 00	9.93032E-01	8.85881E-01
108	6.73852E-01	2.92688E 00	2.88157E 00	2.59689E 00	1.85079E 00	1.53646E 00	1.18158E 00	9.84152E-01	8.78761E-01
109	6.63235E-01	2.88369E 00	2.83825E 00	2.56233E 00	1.82872E 00	1.52016E 00	1.17003E 00	9.75129E-01	8.71561E-01
110	6.63235E-01	2.88369E 00	2.83825E 00	2.56233E 00	1.82872E 00	1.52016E 00	1.17003E 00	9.75129E-01	8.71561E-01
111	6.52360E-01	2.83942E 00	2.79380E 00	2.52700E 00	1.80621E 00	1.50360E 00	1.15835E 00	9.66015E-01	8.64322E-01
112	6.41261E-01	2.79424E 00	2.74841E 00	2.49102E 00	1.78335E 00	1.48683E 00	1.14656E 00	9.56822E-01	8.57043E-01
113	6.29907E-01	2.74799E 00	2.70192E 00	2.45429E 00	1.76009E 00	1.46982E 00	1.13463E 00	9.47552E-01	8.49732E-01
114	6.18269E-01	2.70055E 00	2.65419E 00	2.41673E 00	1.73635E 00	1.45256E 00	1.12258E 00	9.38204E-01	8.42396E-01
115	6.18269E-01	2.70055E 00	2.65419E 00	2.41673E 00	1.73635E 00	1.45256E 00	1.12258E 00	9.38204E-01	8.42396E-01
116	6.06418E-01	2.65225E 00	2.60553E 00	2.37856E 00	1.71231E 00	1.43514E 00	1.11048E 00	9.28833E-01	8.35074E-01
117	5.94383E-01	2.60321E 00	2.55610E 00	2.33990E 00	1.68806E 00	1.41761E 00	1.09834E 00	9.19451E-01	8.27769E-01
118	5.82137E-01	2.55329E 00	2.50578E 00	2.30067E 00	1.66354E 00	1.39996E 00	1.08618E 00	9.10061E-01	8.20490E-01
119	5.69651E-01	2.50239E 00	2.45442E 00	2.26078E 00	1.63869E 00	1.38216E 00	1.07397E 00	9.00667E-01	8.13245E-01
120	5.69651E-01	2.50239E 00	2.45442E 00	2.26078E 00	1.63869E 00	1.38216E 00	1.07397E 00	9.00667E-01	8.13245E-01
121	5.49393E-01	2.42067E 00	2.37465E 00	2.19741E 00	1.59968E 00	1.35399E 00	1.05309E 00	8.84536E-01	8.02975E-01
122	5.29967E-01	2.34235E 00	2.29822E 00	2.13627E 00	1.56245E 00	1.32684E 00	1.03307E 00	8.68854E-01	7.92934E-01
123	5.11340E-01	2.26731E 00	2.22499E 00	2.07732E 00	1.52700E 00	1.30072E 00	1.01391E 00	8.53650E-01	7.83176E-01
124	4.93481E-01	2.19542E 00	2.15487E 00	2.02052E 00	1.49333E 00	1.27565E 00	9.95637E-01	8.38948E-01	7.73751E-01
125	4.76361E-01	2.12658E 00	2.08773E 00	1.96582E 00	1.46143E 00	1.25165E 00	9.78279E-01	8.24769E-01	7.64705E-01
126	4.59951E-01	2.06068E 00	2.02348E 00	1.91318E 00	1.43129E 00	1.22872E 00	9.61852E-01	8.11133E-01	7.56084E-01
127	4.44225E-01	1.99761E 00	1.96201E 00	1.86254E 00	1.40291E 00	1.20689E 00	9.46374E-01	7.98053E-01	7.47929E-01
128	4.29156E-01	1.93728E 00	1.90322E 00	1.81386E 00	1.37631E 00	1.18616E 00	9.31867E-01	7.85540E-01	7.40282E-01
129	4.14720E-01	1.87959E 00	1.84703E 00	1.76711E 00	1.35147E 00	1.16654E 00	9.18351E-01	7.73605E-01	7.33180E-01
130	4.00894E-01	1.82445E 00	1.79334E 00	1.72224E 00	1.32842E 00	1.14805E 00	9.05847E-01	7.62251E-01	7.26662E-01
131	3.87653E-01	1.77178E 00	1.74208E 00	1.67920E 00	1.30716E 00	1.13068E 00	8.94378E-01	7.51482E-01	7.20766E-01
132	3.74978E-01	1.72150E 00	1.69316E 00	1.63796E 00	1.28770E 00	1.11446E 00	8.83968E-01	7.41298E-01	7.15526E-01
133	3.62847E-01	1.67352E 00	1.64650E 00	1.59848E 00	1.27006E 00	1.09937E 00	8.74642E-01	7.31695E-01	7.10981E-01

134	3.51240E-01	1.62777E 00	1.60204E 00	1.56072E 00	1.25427E 00	1.08544E 00	8.66426E-01	7.22666E-01	7.07167E-01
135	3.40139E-01	1.58419E 00	1.55971E 00	1.52464E 00	1.24034E 00	1.07266E 00	8.59350E-01	7.14202E-01	7.04121E-01
136	3.40139E-01	1.58419E 00	1.55971E 00	1.52464E 00	1.24034E 00	1.07266E 00	8.59350E-01	7.14202E-01	7.04121E-01
137	2.97585E-01	1.42028E 00	1.38617E 00	1.34044E 00	1.15909E 00	1.00206E 00	8.20888E-01	6.72777E-01	6.79628E-01
138	2.60481E-01	1.27307E 00	1.23293E 00	1.18100E 00	1.06931E 00	9.30203E-01	7.75157E-01	6.31714E-01	6.48124E-01
139	2.28111E-01	1.14088E 00	1.09740E 00	1.04249E 00	9.77467E-01	8.58278E-01	7.25235E-01	5.90488E-01	6.12395E-01
140	1.99853E-01	1.02222E 00	9.77368E-01	9.21747E-01	8.87606E-01	7.87588E-01	6.73394E-01	5.49237E-01	5.74314E-01
141	1.75169E-01	9.15714E-01	8.70921E-01	8.16167E-01	8.02119E-01	7.19266E-01	6.21319E-01	5.08380E-01	5.35215E-01
142	1.53596E-01	8.20141E-01	7.76416E-01	7.23593E-01	7.22309E-01	6.54189E-01	5.70244E-01	4.68413E-01	4.96082E-01
143	1.34730E-01	7.34389E-01	6.92428E-01	6.42222E-01	6.48769E-01	5.92961E-01	5.21051E-01	4.29798E-01	4.57658E-01
144	1.18221E-01	6.57461E-01	6.17720E-01	5.70544E-01	5.81638E-01	5.35947E-01	4.74344E-01	3.92919E-01	4.20498E-01
145	1.03766E-01	5.88455E-01	5.51215E-01	5.07281E-01	5.20772E-01	4.83310E-01	4.30508E-01	3.58065E-01	3.85013E-01
146	9.11016E-02	5.26560E-01	4.91972E-01	4.51351E-01	4.65866E-01	4.35064E-01	3.89761E-01	3.25433E-01	3.51491E-01
147	7.99989E-02	4.71046E-01	4.39167E-01	4.01831E-01	4.16528E-01	3.91109E-01	3.52196E-01	2.95136E-01	3.20128E-01
148	7.02585E-02	4.21254E-01	3.92079E-01	3.57931E-01	3.72331E-01	3.51274E-01	3.17809E-01	2.67218E-01	2.91042E-01
149	6.17071E-02	3.76593E-01	3.50072E-01	3.18973E-01	3.32847E-01	3.15338E-01	2.86537E-01	2.41673E-01	2.64290E-01
150	5.41935E-02	3.36531E-01	3.12589E-01	2.84369E-01	2.97658E-01	2.83059E-01	2.58273E-01	2.18448E-01	2.39893E-01
151	4.75859E-02	3.00588E-01	2.79138E-01	2.53614E-01	2.66420E-01	2.54182E-01	2.32890E-01	1.97464E-01	2.17842E-01
152	4.75859E-02	3.00588E-01	2.79138E-01	2.53614E-01	2.66420E-01	2.54182E-01	2.32890E-01	1.97464E-01	2.17842E-01
153	3.81707E-02	2.47993E-01	2.30356E-01	2.08703E-01	2.20379E-01	2.11232E-01	1.94619E-01	1.65617E-01	1.84133E-01
154	3.06508E-02	2.04552E-01	1.90061E-01	1.71849E-01	1.82060E-01	1.75161E-01	1.62085E-01	1.38375E-01	1.54726E-01
155	2.46374E-02	1.68683E-01	1.56783E-01	1.41557E-01	1.50282E-01	1.45013E-01	1.34642E-01	1.15258E-01	1.29440E-01
156	1.98230E-02	1.39072E-01	1.29305E-01	1.16630E-01	1.23984E-01	1.19908E-01	1.11625E-01	9.57683E-02	1.07917E-01
157	1.59640E-02	1.14633E-01	1.06619E-01	9.61015E-02	1.02250E-01	9.90569E-02	9.24034E-02	7.94196E-02	8.97335E-02
158	1.28673E-02	9.44649E-02	8.78920E-02	7.91847E-02	8.42998E-02	8.17724E-02	7.64005E-02	6.57596E-02	7.44566E-02
159	1.03796E-02	7.78230E-02	7.24331E-02	6.52376E-02	6.94799E-02	6.74623E-02	6.31075E-02	5.43796E-02	6.16746E-02
160	8.37871E-03	6.40908E-02	5.96721E-02	5.37343E-02	5.72455E-02	5.56242E-02	5.20824E-02	4.49192E-02	5.10123E-02
161	6.76758E-03	5.27586E-02	4.91369E-02	4.42428E-02	4.71444E-02	4.58348E-02	4.29472E-02	3.70659E-02	4.21371E-02
162	5.46871E-03	4.34046E-02	4.04373E-02	3.64075E-02	3.88020E-02	3.77397E-02	3.53811E-02	3.05519E-02	3.47592E-02
163	4.42021E-03	3.56806E-02	3.32502E-02	2.99355E-02	3.19079E-02	3.10432E-02	2.91140E-02	2.51495E-02	2.86294E-02
164	3.57259E-03	2.92980E-02	2.73086E-02	2.45849E-02	2.62054E-02	2.54988E-02	2.39192E-02	2.06667E-02	2.35350E-02
165	2.88622E-03	2.40187E-02	2.23912E-02	2.01556E-02	2.14815E-02	2.09012E-02	1.96067E-02	1.69415E-02	1.92956E-02
166	2.32929E-03	1.96450E-02	1.83148E-02	1.64818E-02	1.75594E-02	1.70792E-02	1.60171E-02	1.38375E-02	1.57585E-02
167	1.87623E-03	1.60135E-02	1.49272E-02	1.34258E-02	1.42911E-02	1.38892E-02	1.30164E-02	1.12395E-02	1.27939E-02
168	1.50647E-03	1.29882E-02	1.21018E-02	1.08725E-02	1.15525E-02	1.12101E-02	1.04909E-02	9.04986E-03	1.02916E-02
169	1.20335E-03	1.04562E-02	9.73294E-03	8.72473E-03	9.23752E-03	8.93873E-03	8.34317E-03	7.18454E-03	8.15723E-03
170	9.53373E-04	8.32269E-03	7.73171E-03	6.89981E-03	7.25392E-03	6.98573E-03	6.48802E-03	5.57070E-03	6.30919E-03
171	7.45552E-04	6.50837E-03	6.02284E-03	5.32543E-03	5.51868E-03	5.27269E-03	4.84887E-03	4.14424E-03	4.67685E-03
172	5.70863E-04	4.94581E-03	4.54162E-03	3.93626E-03	3.95332E-03	3.72977E-03	3.35371E-03	2.84869E-03	3.19908E-03
173	4.21841E-04	3.57728E-03	3.23144E-03	2.67008E-03	2.47874E-03	2.29533E-03	1.92972E-03	1.63657E-03	1.82385E-03
174	4.21841E-04	3.57728E-03	3.23144E-03	2.67008E-03	2.47874E-03	2.29533E-03	1.92972E-03	1.63657E-03	1.82386E-03
175	3.25233E-04	2.65080E-03	2.33791E-03	1.99560E-03	1.72458E-03	1.60127E-03	1.35534E-03	1.16156E-03	1.17199E-03
176	2.43450E-04	1.91744E-03	1.65871E-03	1.45059E-03	1.19097E-03	1.10463E-03	9.37736E-04	8.08489E-04	7.72843E-04
177	1.72911E-04	1.32440E-03	1.12873E-03	1.00449E-03	7.96058E-04	7.36411E-04	6.25614E-04	5.41125E-04	5.02846E-04
178	1.10557E-04	8.29481E-04	6.99483E-04	6.29840E-04	4.87854E-04	4.50071E-04	3.82253E-04	3.31155E-04	3.03377E-04
179	5.37197E-05	3.97949E-04	3.33462E-04	3.02298E-04	2.31172E-04	2.12855E-04	1.80696E-04	1.56649E-04	1.42570E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO.	GROUPS 10- 18								
1	5.97840E-01	5.82309E-01	5.58343E-01	5.43346E-01	5.41413E-01	5.43223E-01	5.49626E-01	5.54897E-01	5.60575E-01
2	5.98908E-01	5.83292E-01	5.59249E-01	5.44194E-01	5.42221E-01	5.43997E-01	5.50375E-01	5.55616E-01	5.61265E-01
3	6.02109E-01	5.86236E-01	5.61961E-01	5.46732E-01	5.44638E-01	5.46316E-01	5.52616E-01	5.57765E-01	5.63327E-01
4	6.07432E-01	5.91121E-01	5.66460E-01	5.50943E-01	5.48645E-01	5.50157E-01	5.56326E-01	5.61322E-01	5.66738E-01
5	6.14857E-01	5.97915E-01	5.72714E-01	5.56793E-01	5.54205E-01	5.55483E-01	5.61468E-01	5.66247E-01	5.71457E-01
6	6.24356E-01	6.06567E-01	5.80677E-01	5.64237E-01	5.61268E-01	5.62243E-01	5.67989E-01	5.72484E-01	5.77427E-01
7	6.35884E-01	6.17005E-01	5.90282E-01	5.73211E-01	5.69766E-01	5.70367E-01	5.75817E-01	5.79962E-01	5.84573E-01
8	6.49382E-01	6.29130E-01	6.01443E-01	5.83635E-01	5.79611E-01	5.79767E-01	5.84865E-01	5.88587E-01	5.92804E-01
9	6.64767E-01	6.42805E-01	6.14050E-01	5.95408E-01	5.90695E-01	5.90337E-01	5.95025E-01	5.98250E-01	6.02007E-01
10	6.81929E-01	6.57850E-01	6.27964E-01	6.08408E-01	6.02882E-01	6.01947E-01	6.06172E-01	6.08821E-01	6.12050E-01
11	7.00725E-01	6.74025E-01	6.43015E-01	6.22491E-01	6.16016E-01	6.14447E-01	6.18160E-01	6.20148E-01	6.22784E-01
12	7.00725E-01	6.74025E-01	6.43015E-01	6.22491E-01	6.16016E-01	6.14447E-01	6.18160E-01	6.20148E-01	6.22784E-01
13	7.17629E-01	6.94257E-01	6.61395E-01	6.39398E-01	6.31846E-01	6.29533E-01	6.32550E-01	6.33697E-01	6.35518E-01
14	7.37589E-01	7.16768E-01	6.81471E-01	6.57624E-01	6.49012E-01	6.45713E-01	6.47809E-01	6.47952E-01	6.48734E-01
15	7.60150E-01	7.41862E-01	7.03159E-01	6.76902E-01	6.67196E-01	6.62620E-01	6.63522E-01	6.62468E-01	6.61956E-01
16	7.84823E-01	7.69792E-01	7.26190E-01	6.96765E-01	6.85967E-01	6.79763E-01	6.79147E-01	6.76698E-01	6.74602E-01
17	7.84823E-01	7.69792E-01	7.26190E-01	6.96765E-01	6.85967E-01	6.79763E-01	6.79147E-01	6.76698E-01	6.74602E-01
18	7.95791E-01	7.73311E-01	7.29427E-01	6.99720E-01	6.88758E-01	6.82217E-01	6.81361E-01	6.78685E-01	6.76343E-01
19	8.06127E-01	7.76822E-01	7.32666E-01	7.02681E-01	6.91517E-01	6.84653E-01	6.83566E-01	6.80662E-01	6.78079E-01
20	8.15852E-01	7.80313E-01	7.35900E-01	7.05645E-01	6.94244E-01	6.87071E-01	6.85763E-01	6.82627E-01	6.79809E-01
21	8.24985E-01	7.83776E-01	7.39125E-01	7.08608E-01	6.96937E-01	6.89470E-01	6.87949E-01	6.84581E-01	6.81532E-01
22	8.24985E-01	7.83776E-01	7.39125E-01	7.08608E-01	6.96937E-01	6.89470E-01	6.87950E-01	6.84581E-01	6.81532E-01
23	8.29643E-01	7.87679E-01	7.42415E-01	7.11478E-01	6.99526E-01	6.91826E-01	6.90102E-01	6.86510E-01	6.83235E-01
24	8.34227E-01	7.91525E-01	7.45662E-01	7.14312E-01	7.02084E-01	6.94154E-01	6.92226E-01	6.88415E-01	6.84914E-01
25	8.38735E-01	7.95310E-01	7.48863E-01	7.17109E-01	7.04607E-01	6.96450E-01	6.94322E-01	6.90292E-01	6.86568E-01
26	8.43165E-01	7.99033E-01	7.52016E-01	7.19865E-01	7.07095E-01	6.98714E-01	6.96387E-01	6.92142E-01	6.88195E-01
27	8.43165E-01	7.99033E-01	7.52016E-01	7.19865E-01	7.07095E-01	6.98714E-01	6.96387E-01	6.92142E-01	6.88195E-01
28	8.49189E-01	8.04105E-01	7.56320E-01	7.23632E-01	7.10496E-01	7.01809E-01	6.99211E-01	6.94673E-01	6.90420E-01
29	8.55043E-01	8.09044E-01	7.60520E-01	7.27313E-01	7.13821E-01	7.04835E-01	7.01972E-01	6.97148E-01	6.92595E-01
30	8.60725E-01	8.13845E-01	7.64613E-01	7.30903E-01	7.17067E-01	7.07789E-01	7.04667E-01	6.99563E-01	6.94714E-01
31	8.66230E-01	8.18504E-01	7.68591E-01	7.34398E-01	7.20227E-01	7.10667E-01	7.07292E-01	7.01914E-01	6.96774E-01
32	8.66230E-01	8.18504E-01	7.68591E-01	7.34398E-01	7.20227E-01	7.10667E-01	7.07292E-01	7.01914E-01	6.96774E-01
33	8.71560E-01	8.23025E-01	7.72460E-01	7.37801E-01	7.23308E-01	7.13473E-01	7.09853E-01	7.04210E-01	6.98785E-01
34	8.76695E-01	8.27392E-01	7.76205E-01	7.41101E-01	7.26298E-01	7.16199E-01	7.12342E-01	7.06442E-01	7.00739E-01
35	8.81634E-01	8.31601E-01	7.79825E-01	7.44295E-01	7.29194E-01	7.18841E-01	7.14754E-01	7.08606E-01	7.02633E-01
36	8.86377E-01	8.35652E-01	7.83314E-01	7.47378E-01	7.31994E-01	7.21396E-01	7.17087E-01	7.10700E-01	7.04463E-01
37	8.86377E-01	8.35652E-01	7.83314E-01	7.47378E-01	7.31994E-01	7.21396E-01	7.17087E-01	7.10700E-01	7.04463E-01
38	8.95262E-01	8.43285E-01	7.89918E-01	7.53233E-01	7.37321E-01	7.26266E-01	7.21544E-01	7.14708E-01	7.07978E-01
39	9.03299E-01	8.50240E-01	7.95973E-01	7.58624E-01	7.42244E-01	7.30778E-01	7.25681E-01	7.18439E-01	7.11260E-01
40	9.10504E-01	8.56516E-01	8.01467E-01	7.63536E-01	7.46746E-01	7.34913E-01	7.29482E-01	7.21874E-01	7.14287E-01
41	9.16895E-01	8.62114E-01	8.06391E-01	7.67958E-01	7.50814E-01	7.38661E-01	7.32933E-01	7.24999E-01	7.17043E-01

42	9.16895E-01	8.62114E-01	8.06391E-01	7.67958E-01	7.50814E-01	7.38661E-01	7.32933E-01	7.24999E-01	7.17043E-01
43	9.22481E-01	8.67049E-01	8.10762E-01	7.71904E-01	7.54455E-01	7.42037E-01	7.36051E-01	7.27836E-01	7.19560E-01
44	9.27247E-01	8.71308E-01	8.14567E-01	7.75365E-01	7.57688E-01	7.45031E-01	7.38830E-01	7.30378E-01	7.21837E-01
45	9.31226E-01	8.74904E-01	8.17815E-01	7.78343E-01	7.60484E-01	7.47640E-01	7.41265E-01	7.32620E-01	7.23864E-01
46	9.34452E-01	8.77859E-01	8.20516E-01	7.80843E-01	7.62856E-01	7.49867E-01	7.43353E-01	7.34557E-01	7.25636E-01
47	9.34452E-01	8.77859E-01	8.20516E-01	7.80843E-01	7.62856E-01	7.49867E-01	7.43353E-01	7.34557E-01	7.25636E-01
48	9.36960E-01	8.80193E-01	8.22686E-01	7.82879E-01	7.64814E-01	7.51716E-01	7.45100E-01	7.36192E-01	7.27154E-01
49	9.38788E-01	8.81931E-01	8.24343E-01	7.84462E-01	7.66366E-01	7.53196E-01	7.46510E-01	7.37528E-01	7.28420E-01
50	9.39978E-01	8.83099E-01	8.25507E-01	7.85609E-01	7.67527E-01	7.54314E-01	7.47588E-01	7.38569E-01	7.29435E-01
51	9.40576E-01	8.83728E-01	8.26204E-01	7.86338E-01	7.68311E-01	7.55082E-01	7.48343E-01	7.39321E-01	7.30206E-01
52	9.40576E-01	8.83728E-01	8.26204E-01	7.86338E-01	7.68311E-01	7.55082E-01	7.48343E-01	7.39321E-01	7.30206E-01
53	9.40674E-01	8.83852E-01	8.26385E-01	7.86553E-01	7.68567E-01	7.55338E-01	7.48600E-01	7.39589E-01	7.30497E-01
54	9.40649E-01	8.83855E-01	8.26459E-01	7.86669E-01	7.68732E-01	7.55509E-01	7.48777E-01	7.39783E-01	7.30722E-01
55	9.40507E-01	8.83741E-01	8.26428E-01	7.86690E-01	7.68811E-01	7.55596E-01	7.48874E-01	7.39904E-01	7.30882E-01
56	9.40255E-01	8.83513E-01	8.26296E-01	7.86619E-01	7.68805E-01	7.55601E-01	7.48894E-01	7.39954E-01	7.30978E-01
57	9.40255E-01	8.83513E-01	8.26296E-01	7.86619E-01	7.68805E-01	7.55601E-01	7.48894E-01	7.39954E-01	7.30978E-01
58	9.39823E-01	8.83098E-01	8.26010E-01	7.86414E-01	7.68687E-01	7.55501E-01	7.48815E-01	7.39917E-01	7.31005E-01
59	9.39266E-01	8.82537E-01	8.25589E-01	7.86083E-01	7.68451E-01	7.55284E-01	7.48621E-01	7.39773E-01	7.30931E-01
60	9.38599E-01	8.81837E-01	8.25039E-01	7.85631E-01	7.68102E-01	7.54955E-01	7.48317E-01	7.39526E-01	7.30758E-01
61	9.37835E-01	8.81004E-01	8.24368E-01	7.85062E-01	7.67644E-01	7.54516E-01	7.47905E-01	7.39177E-01	7.30491E-01
62	9.37835E-01	8.81004E-01	8.24368E-01	7.85062E-01	7.67644E-01	7.54516E-01	7.47905E-01	7.39177E-01	7.30491E-01
63	9.36649E-01	8.79895E-01	8.23432E-01	7.84241E-01	7.66949E-01	7.53845E-01	7.47264E-01	7.38606E-01	7.30010E-01
64	9.35337E-01	8.78690E-01	8.22380E-01	7.83291E-01	7.66101E-01	7.53017E-01	7.46456E-01	7.37849E-01	7.29316E-01
65	9.33926E-01	8.77400E-01	8.21222E-01	7.82219E-01	7.65106E-01	7.52038E-01	7.45486E-01	7.36912E-01	7.28413E-01
66	9.32433E-01	8.76034E-01	8.19964E-01	7.81030E-01	7.63969E-01	7.50911E-01	7.44357E-01	7.35797E-01	7.27306E-01
67	9.30871E-01	8.74599E-01	8.18611E-01	7.79729E-01	7.62695E-01	7.49639E-01	7.43073E-01	7.34507E-01	7.25999E-01
68	9.29247E-01	8.73098E-01	8.17165E-01	7.78318E-01	7.61287E-01	7.48225E-01	7.41635E-01	7.33045E-01	7.24493E-01
69	9.27558E-01	8.71531E-01	8.15628E-01	7.76798E-01	7.59744E-01	7.46670E-01	7.40044E-01	7.31412E-01	7.22790E-01
70	9.25799E-01	8.69896E-01	8.13998E-01	7.75167E-01	7.58067E-01	7.44973E-01	7.38301E-01	7.29608E-01	7.20891E-01
71	9.23956E-01	8.68189E-01	8.12271E-01	7.73422E-01	7.56253E-01	7.43134E-01	7.36405E-01	7.27634E-01	7.18795E-01
72	9.22013E-01	8.66404E-01	8.10443E-01	7.71561E-01	7.54301E-01	7.41151E-01	7.34355E-01	7.25488E-01	7.16500E-01
73	9.19943E-01	8.64530E-01	8.08505E-01	7.69578E-01	7.52205E-01	7.39022E-01	7.32149E-01	7.23169E-01	7.14005E-01
74	9.17718E-01	8.62558E-01	8.06449E-01	7.67466E-01	7.49961E-01	7.36743E-01	7.29786E-01	7.20675E-01	7.11307E-01
75	9.17718E-01	8.62558E-01	8.06449E-01	7.67466E-01	7.49961E-01	7.36743E-01	7.29786E-01	7.20675E-01	7.11307E-01
76	9.16711E-01	8.61529E-01	8.05393E-01	7.66389E-01	7.48817E-01	7.35578E-01	7.28575E-01	7.19393E-01	7.09910E-01
77	9.15666E-01	8.60456E-01	8.04296E-01	7.65275E-01	7.47639E-01	7.34380E-01	7.27332E-01	7.18082E-01	7.08487E-01
78	9.14579E-01	8.59337E-01	8.03158E-01	7.64122E-01	7.46426E-01	7.33148E-01	7.26056E-01	7.16741E-01	7.07038E-01
79	9.13448E-01	8.58172E-01	8.01977E-01	7.62929E-01	7.45177E-01	7.31881E-01	7.24747E-01	7.15371E-01	7.05562E-01
80	9.13448E-01	8.58172E-01	8.01977E-01	7.62929E-01	7.45177E-01	7.31881E-01	7.24747E-01	7.15371E-01	7.05562E-01
81	9.11743E-01	8.56417E-01	8.00207E-01	7.61150E-01	7.43325E-01	7.30004E-01	7.22813E-01	7.13353E-01	7.03396E-01
82	9.09929E-01	8.54558E-01	7.98348E-01	7.59291E-01	7.41402E-01	7.28061E-01	7.20816E-01	7.11282E-01	7.01189E-01
83	9.08003E-01	8.52593E-01	7.96396E-01	7.57348E-01	7.39405E-01	7.26048E-01	7.18757E-01	7.09157E-01	6.98938E-01
84	9.05960E-01	8.50520E-01	7.94349E-01	7.55319E-01	7.37333E-01	7.23967E-01	7.16634E-01	7.06976E-01	6.96642E-01
85	9.05960E-01	8.50520E-01	7.94349E-01	7.55319E-01	7.37333E-01	7.23967E-01	7.16634E-01	7.06976E-01	6.96642E-01
86	9.03783E-01	8.48324E-01	7.92195E-01	7.53197E-01	7.35177E-01	7.21807E-01	7.14438E-01	7.04730E-01	6.94289E-01
87	9.01471E-01	8.46011E-01	7.89943E-01	7.50989E-01	7.32949E-01	7.19581E-01	7.12184E-01	7.02438E-01	6.91905E-01

88	8.99022E-01	8.43561E-01	7.87592E-01	7.48696E-01	7.30646E-01	7.17290E-01	7.09873E-01	7.00099E-01	6.89488E-01
89	8.96434E-01	8.41031E-01	7.85139E-01	7.46314E-01	7.28268E-01	7.14931E-01	7.07502E-01	6.97712E-01	6.87039E-01

90	8.96434E-01	8.41031E-01	7.85139E-01	7.46314E-01	7.28268E-01	7.14931E-01	7.07503E-01	6.97712E-01	6.87039E-01
91	8.90805E-01	8.35545E-01	7.79910E-01	7.41274E-01	7.23273E-01	7.10000E-01	7.02576E-01	6.92785E-01	6.82031E-01
92	8.84578E-01	8.29566E-01	7.74274E-01	7.35891E-01	7.17991E-01	7.04822E-01	6.97444E-01	6.87704E-01	6.76946E-01
93	8.77752E-01	8.23092E-01	7.68230E-01	7.30166E-01	7.12422E-01	6.99397E-01	6.92109E-01	6.82471E-01	6.71781E-01
94	8.70330E-01	8.16126E-01	7.61781E-01	7.24102E-01	7.06571E-01	6.93733E-01	6.86577E-01	6.77091E-01	6.66538E-01

95	8.70330E-01	8.16126E-01	7.61781E-01	7.24102E-01	7.06571E-01	6.93733E-01	6.86577E-01	6.77091E-01	6.66538E-01
96	8.62332E-01	8.08686E-01	7.54944E-01	7.17714E-01	7.00452E-01	6.87843E-01	6.80861E-01	6.71574E-01	6.61227E-01
97	8.53766E-01	8.00777E-01	7.47722E-01	7.11007E-01	6.94069E-01	6.81728E-01	6.74960E-01	6.65917E-01	6.55836E-01
98	8.44649E-01	7.92413E-01	7.40133E-01	7.03999E-01	6.87439E-01	6.75407E-01	6.68891E-01	6.60136E-01	6.50380E-01
99	8.34998E-01	7.83616E-01	7.32200E-01	6.96712E-01	6.80584E-01	6.68899E-01	6.62673E-01	6.54249E-01	6.44877E-01

100	8.34998E-01	7.83616E-01	7.32200E-01	6.96712E-01	6.80584E-01	6.68899E-01	6.62673E-01	6.54249E-01	6.44877E-01
101	8.24909E-01	7.74467E-01	7.23991E-01	6.89208E-01	6.73560E-01	6.62257E-01	6.56355E-01	6.48300E-01	6.39367E-01
102	8.14391E-01	7.64947E-01	7.15486E-01	6.81461E-01	6.66338E-01	6.55446E-01	6.49892E-01	6.42232E-01	6.33765E-01
103	8.03479E-01	7.55090E-01	7.06718E-01	6.73505E-01	6.58950E-01	6.48497E-01	6.43311E-01	6.36073E-01	6.28100E-01
104	7.92213E-01	7.44930E-01	6.97727E-01	6.65381E-01	6.51434E-01	6.41441E-01	6.36643E-01	6.29851E-01	6.22403E-01

105	7.92213E-01	7.44930E-01	6.97727E-01	6.65381E-01	6.51434E-01	6.41441E-01	6.36643E-01	6.29851E-01	6.22403E-01
106	7.86497E-01	7.39784E-01	6.93189E-01	6.61293E-01	6.47663E-01	6.37905E-01	6.33308E-01	6.26748E-01	6.19576E-01
107	7.80728E-01	7.34581E-01	6.88610E-01	6.57174E-01	6.43868E-01	6.34349E-01	6.29953E-01	6.23627E-01	6.16731E-01
108	7.74911E-01	7.29328E-01	6.83996E-01	6.53029E-01	6.40055E-01	6.30777E-01	6.26583E-01	6.20493E-01	6.13874E-01
109	7.69056E-01	7.24031E-01	6.79354E-01	6.48865E-01	6.36229E-01	6.27193E-01	6.23202E-01	6.17350E-01	6.11009E-01

110	7.69056E-01	7.24031E-01	6.79354E-01	6.48865E-01	6.36229E-01	6.27193E-01	6.23202E-01	6.17350E-01	6.11009E-01
111	7.63193E-01	7.18717E-01	6.74706E-01	6.44703E-01	6.32409E-01	6.23616E-01	6.19827E-01	6.14216E-01	6.08154E-01
112	7.57324E-01	7.13376E-01	6.70042E-01	6.40530E-01	6.28585E-01	6.20032E-01	6.16443E-01	6.11072E-01	6.05287E-01
113	7.51458E-01	7.08014E-01	6.65368E-01	6.36354E-01	6.24761E-01	6.16448E-01	6.13056E-01	6.07923E-01	6.02412E-01
114	7.45605E-01	7.02638E-01	6.60693E-01	6.32182E-01	6.20945E-01	6.12867E-01	6.09669E-01	6.04774E-01	5.99534E-01

115	7.45605E-01	7.02638E-01	6.60693E-01	6.32182E-01	6.20945E-01	6.12867E-01	6.09669E-01	6.04774E-01	5.99534E-01
116	7.39798E-01	6.97276E-01	6.56037E-01	6.28033E-01	6.17153E-01	6.09307E-01	6.06298E-01	6.01641E-01	5.96671E-01
117	7.34040E-01	6.91916E-01	6.51393E-01	6.23897E-01	6.13378E-01	6.05757E-01	6.02931E-01	5.98509E-01	5.93802E-01
118	7.28343E-01	6.86568E-01	6.46767E-01	6.19783E-01	6.09623E-01	6.02222E-01	5.99572E-01	5.95381E-01	5.90931E-01
119	7.22720E-01	6.81237E-01	6.42167E-01	6.15696E-01	6.05897E-01	5.98706E-01	5.96225E-01	5.92262E-01	5.88062E-01

120	7.22720E-01	6.81237E-01	6.42167E-01	6.15696E-01	6.05897E-01	5.98706E-01	5.96225E-01	5.92262E-01	5.88062E-01
121	7.13487E-01	6.74625E-01	6.36304E-01	6.10404E-01	6.01061E-01	5.94165E-01	5.91897E-01	5.88228E-01	5.84352E-01
122	7.04381E-01	6.68160E-01	6.30580E-01	6.05239E-01	5.96310E-01	5.89696E-01	5.87624E-01	5.84227E-01	5.80651E-01
123	6.95440E-01	6.61875E-01	6.25019E-01	6.00219E-01	5.91660E-01	5.85310E-01	5.83414E-01	5.80265E-01	5.76965E-01
124	6.86701E-01	6.55805E-01	6.19645E-01	5.95359E-01	5.87124E-01	5.81015E-01	5.79275E-01	5.76350E-01	5.73303E-01
125	6.78197E-01	6.49980E-01	6.14479E-01	5.90677E-01	5.82715E-01	5.76822E-01	5.75213E-01	5.72487E-01	5.69671E-01
126	6.69955E-01	6.44431E-01	6.09543E-01	5.86189E-01	5.78443E-01	5.72738E-01	5.71234E-01	5.68683E-01	5.66073E-01
127	6.62000E-01	6.39188E-01	6.04857E-01	5.81908E-01	5.74318E-01	5.68770E-01	5.67343E-01	5.64940E-01	5.62515E-01
128	6.54354E-01	6.34280E-01	6.00439E-01	5.77848E-01	5.70350E-01	5.64924E-01	5.63544E-01	5.61263E-01	5.59001E-01
129	6.47035E-01	6.29734E-01	5.96309E-01	5.74022E-01	5.66545E-01	5.61205E-01	5.59840E-01	5.57654E-01	5.55533E-01
130	6.40057E-01	6.25577E-01	5.92482E-01	5.70440E-01	5.62910E-01	5.57616E-01	5.56233E-01	5.54115E-01	5.52114E-01
131	6.33432E-01	6.21835E-01	5.88974E-01	5.67112E-01	5.59449E-01	5.54159E-01	5.52722E-01	5.50647E-01	5.48746E-01
132	6.27166E-01	6.18534E-01	5.85801E-01	5.64048E-01	5.56163E-01	5.50836E-01	5.49308E-01	5.47248E-01	5.45428E-01
133	6.21264E-01	6.15700E-01	5.82975E-01	5.61255E-01	5.53055E-01	5.47644E-01	5.45987E-01	5.43918E-01	5.42160E-01

134	6.15727E-01	6.13356E-01	5.80509E-01	5.58739E-01	5.50123E-01	5.44581E-01	5.42756E-01	5.40653E-01	5.38942E-01
135	6.10550E-01	6.11530E-01	5.78415E-01	5.56504E-01	5.47363E-01	5.41643E-01	5.39611E-01	5.37450E-01	5.35771E-01

136	6.10550E-01	6.11530E-01	5.78415E-01	5.56504E-01	5.47363E-01	5.41643E-01	5.39611E-01	5.37450E-01	5.35771E-01
137	5.84117E-01	5.94712E-01	5.61520E-01	5.39343E-01	5.27296E-01	5.20151E-01	5.16705E-01	5.13926E-01	5.12174E-01
138	5.55855E-01	5.72084E-01	5.41030E-01	5.19665E-01	5.06397E-01	4.98390E-01	4.94028E-01	4.90760E-01	4.88885E-01
139	5.25820E-01	5.45494E-01	5.17525E-01	4.97735E-01	4.84412E-01	4.76130E-01	4.71313E-01	4.67766E-01	4.65812E-01
140	4.94474E-01	5.16295E-01	4.91719E-01	4.73963E-01	4.61357E-01	4.53305E-01	4.48430E-01	4.44835E-01	4.42900E-01
141	4.62409E-01	4.85535E-01	4.64337E-01	4.48830E-01	4.37416E-01	4.29977E-01	4.25363E-01	4.21935E-01	4.20133E-01
142	4.30215E-01	4.54048E-01	4.36051E-01	4.22830E-01	4.12866E-01	4.06299E-01	4.02181E-01	3.99095E-01	3.97534E-01
143	3.98420E-01	4.22507E-01	4.07452E-01	3.96441E-01	3.88025E-01	3.82476E-01	3.79009E-01	3.76392E-01	3.75159E-01
144	3.67466E-01	3.91454E-01	3.79048E-01	3.70094E-01	3.63216E-01	3.58738E-01	3.56003E-01	3.53935E-01	3.53091E-01
145	3.37708E-01	3.61318E-01	3.51258E-01	3.44166E-01	3.38741E-01	3.35319E-01	3.33337E-01	3.31850E-01	3.31425E-01
146	3.09416E-01	3.32431E-01	3.24419E-01	3.18973E-01	3.14869E-01	3.12434E-01	3.11178E-01	3.10266E-01	3.10262E-01
147	2.82787E-01	3.05041E-01	2.98794E-01	2.94771E-01	2.91829E-01	2.90277E-01	2.89682E-01	2.89306E-01	2.89699E-01
148	2.57952E-01	2.79328E-01	2.74580E-01	2.71759E-01	2.69804E-01	2.69004E-01	2.68979E-01	2.69076E-01	2.69825E-01
149	2.34988E-01	2.55412E-01	2.51913E-01	2.50081E-01	2.48928E-01	2.48738E-01	2.49174E-01	2.49664E-01	2.50714E-01
150	2.13932E-01	2.33364E-01	2.30883E-01	2.29832E-01	2.29294E-01	2.29562E-01	2.30339E-01	2.31132E-01	2.32419E-01
151	1.94780E-01	2.13219E-01	2.11534E-01	2.11062E-01	2.10948E-01	2.11517E-01	2.12511E-01	2.13518E-01	2.14978E-01

152	1.94780E-01	2.13219E-01	2.11534E-01	2.11062E-01	2.10948E-01	2.11517E-01	2.12511E-01	2.13518E-01	2.14978E-01
153	1.65317E-01	1.82146E-01	1.81527E-01	1.81812E-01	1.82259E-01	1.83214E-01	1.84473E-01	1.85739E-01	1.87400E-01
154	1.39486E-01	1.54531E-01	1.54718E-01	1.55583E-01	1.56496E-01	1.57775E-01	1.59262E-01	1.60734E-01	1.62536E-01
155	1.17117E-01	1.30361E-01	1.31085E-01	1.32343E-01	1.33592E-01	1.35107E-01	1.36761E-01	1.38378E-01	1.40266E-01
156	9.79462E-02	1.09459E-01	1.10500E-01	1.11980E-01	1.13433E-01	1.15088E-01	1.16837E-01	1.18537E-01	1.20457E-01
157	8.16516E-02	9.15581E-02	9.27470E-02	9.43136E-02	9.58551E-02	9.75597E-02	9.93333E-02	1.01055E-01	1.02958E-01
158	6.78922E-02	7.63441E-02	7.75651E-02	7.91176E-02	8.06577E-02	8.23374E-02	8.40740E-02	8.57646E-02	8.76060E-02
159	5.63319E-02	6.34921E-02	6.46699E-02	6.61413E-02	6.76151E-02	6.92140E-02	7.08653E-02	7.24803E-02	7.42243E-02
160	4.66561E-02	5.26863E-02	5.37765E-02	5.51265E-02	5.64920E-02	5.79724E-02	5.95042E-02	6.10113E-02	6.26313E-02
161	3.85798E-02	4.36328E-02	4.46126E-02	4.58212E-02	4.70550E-02	4.83948E-02	4.97862E-02	5.11641E-02	5.26426E-02
162	3.18511E-02	3.60662E-02	3.69275E-02	3.79886E-02	3.90809E-02	4.02707E-02	4.15119E-02	4.27493E-02	4.40771E-02
163	2.62502E-02	2.97514E-02	3.04953E-02	3.14119E-02	3.23626E-02	3.34021E-02	3.44918E-02	3.55853E-02	3.67606E-02
164	2.15881E-02	2.44836E-02	2.51161E-02	2.58969E-02	2.67121E-02	2.76072E-02	2.85502E-02	2.95027E-02	3.05288E-02
165	1.77031E-02	2.00855E-02	2.06157E-02	2.12719E-02	2.19615E-02	2.27219E-02	2.35272E-02	2.43456E-02	2.52300E-02
166	1.44576E-02	1.64051E-02	1.68429E-02	1.73872E-02	1.79626E-02	1.86003E-02	1.92792E-02	1.99733E-02	2.07260E-02
167	1.17341E-02	1.33123E-02	1.36680E-02	1.41129E-02	1.45864E-02	1.51140E-02	1.56789E-02	1.62601E-02	1.68927E-02
168	9.43267E-03	1.06960E-02	1.09793E-02	1.13371E-02	1.17207E-02	1.21512E-02	1.26150E-02	1.30952E-02	1.36198E-02
169	7.46761E-03	8.46082E-03	8.68152E-03	8.96361E-03	9.26924E-03	9.61512E-03	9.99045E-03	1.03815E-02	1.08101E-02
170	5.76500E-03	6.52565E-03	6.69318E-03	6.91039E-03	7.14929E-03	7.42269E-03	7.72175E-03	8.03520E-03	8.37902E-03
171	4.26066E-03	4.82152E-03	4.94514E-03	5.10736E-03	5.29055E-03	5.50318E-03	5.73746E-03	5.98381E-03	6.25270E-03
172	2.89825E-03	3.29162E-03	3.37904E-03	3.49498E-03	3.63383E-03	3.79702E-03	3.97700E-03	4.16526E-03	4.36693E-03
173	1.62720E-03	1.89305E-03	1.94534E-03	2.02257E-03	2.13030E-03	2.25479E-03	2.38933E-03	2.52618E-03	2.66504E-03

174	1.62720E-03	1.89305E-03	1.94534E-03	2.02257E-03	2.13030E-03	2.25479E-03	2.38933E-03	2.52618E-03	2.66504E-03
175	1.07442E-03	1.14335E-03	1.17074E-03	1.21211E-03	1.27617E-03	1.35317E-03	1.44172E-03	1.53322E-03	1.62772E-03
176	7.12774E-04	7.25456E-04	7.32886E-04	7.50562E-04	7.84231E-04	8.27302E-04	8.79623E-04	9.34850E-04	9.93293E-04
177	4.62979E-04	4.61309E-04	4.60225E-04	4.66249E-04	4.82761E-04	5.05492E-04	5.34518E-04	5.65644E-04	5.99344E-04
178	2.78422E-04	2.74705E-04	2.71709E-04	2.73076E-04	2.80674E-04	2.91944E-04	3.06964E-04	3.23208E-04	3.41114E-04
179	1.30527E-04	1.28239E-04	1.26241E-04	1.26290E-04	1.29219E-04	1.33831E-04	1.40165E-04	1.47034E-04	1.54693E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO. GROUPS 19- 27

1	5.65466E-01	5.69726E-01	5.73396E-01	5.74493E-01	5.72234E-01	5.72525E-01	5.75902E-01	5.75318E-01	3.92984E-01
2	5.66127E-01	5.70355E-01	5.73995E-01	5.75064E-01	5.72769E-01	5.73026E-01	5.76361E-01	5.75727E-01	3.93396E-01
3	5.68102E-01	5.72234E-01	5.75786E-01	5.76772E-01	5.74367E-01	5.74520E-01	5.77729E-01	5.76944E-01	3.94660E-01
4	5.71366E-01	5.75339E-01	5.78743E-01	5.79592E-01	5.77003E-01	5.76985E-01	5.79977E-01	5.78938E-01	3.96878E-01
5	5.75879E-01	5.79628E-01	5.82825E-01	5.83486E-01	5.80640E-01	5.80380E-01	5.83056E-01	5.81656E-01	4.00272E-01
6	5.81583E-01	5.85041E-01	5.87974E-01	5.88400E-01	5.85223E-01	5.84650E-01	5.86897E-01	5.85023E-01	4.05272E-01
7	5.88402E-01	5.91503E-01	5.94115E-01	5.94265E-01	5.90682E-01	5.89721E-01	5.91406E-01	5.88938E-01	4.12692E-01
8	5.96244E-01	5.98919E-01	6.01155E-01	6.01000E-01	5.96932E-01	5.95506E-01	5.96464E-01	5.93274E-01	4.24056E-01
9	6.04996E-01	6.07175E-01	6.08986E-01	6.08509E-01	6.03872E-01	6.01897E-01	6.01920E-01	5.97873E-01	4.42206E-01
10	6.14528E-01	6.16139E-01	6.17480E-01	6.16687E-01	6.11387E-01	6.08772E-01	6.07589E-01	6.02541E-01	4.72409E-01
11	6.24691E-01	6.25660E-01	6.26495E-01	6.25421E-01	6.19346E-01	6.15988E-01	6.13237E-01	6.07044E-01	5.24431E-01
12	6.24691E-01	6.25660E-01	6.26495E-01	6.25421E-01	6.19346E-01	6.15988E-01	6.13237E-01	6.07044E-01	5.24431E-01
13	6.36659E-01	6.36723E-01	6.36807E-01	6.35221E-01	6.27968E-01	5.23516E-01	6.19100E-01	6.11357E-01	5.57633E-01
14	6.48928E-01	6.47849E-01	6.46927E-01	6.44532E-01	6.35709E-01	6.29820E-01	6.23903E-01	6.14305E-01	5.77338E-01
15	6.61024E-01	6.58544E-01	6.56374E-01	6.52935E-01	6.42078E-01	6.34389E-01	6.27054E-01	6.15263E-01	5.87575E-01
16	6.72378E-01	6.68213E-01	6.64562E-01	6.59905E-01	6.46435E-01	6.36558E-01	6.27893E-01	6.13510E-01	5.90371E-01
17	6.72378E-01	6.68213E-01	6.64562E-01	6.59905E-01	6.46435E-01	6.36558E-01	6.27893E-01	6.13510E-01	5.90371E-01
18	6.73923E-01	6.69501E-01	6.65621E-01	6.60776E-01	6.46881E-01	6.36648E-01	6.27800E-01	6.12972E-01	5.90275E-01
19	6.75465E-01	6.70788E-01	6.66681E-01	6.61651E-01	6.47334E-01	6.36745E-01	6.27724E-01	6.12447E-01	5.90150E-01
20	6.77005E-01	6.72074E-01	6.67741E-01	6.62530E-01	6.47791E-01	6.36847E-01	6.27661E-01	6.11931E-01	5.89996E-01
21	6.78542E-01	6.73358E-01	6.68800E-01	6.63412E-01	6.48250E-01	6.36953E-01	6.27611E-01	6.11422E-01	5.89813E-01
22	6.78542E-01	6.73358E-01	6.68800E-01	6.63412E-01	6.48250E-01	6.36953E-01	6.27611E-01	6.11422E-01	5.89813E-01
23	6.80065E-01	6.74628E-01	6.69849E-01	6.64290E-01	6.48700E-01	6.37052E-01	6.27558E-01	6.10912E-01	5.89593E-01
24	6.81566E-01	6.75876E-01	6.70877E-01	6.65150E-01	6.49132E-01	6.37133E-01	6.27490E-01	6.10388E-01	5.89340E-01
25	6.83043E-01	6.77102E-01	6.71883E-01	6.65989E-01	6.49543E-01	6.37193E-01	6.27403E-01	6.09845E-01	5.89054E-01
26	6.84495E-01	6.78302E-01	6.72865E-01	6.66807E-01	6.49930E-01	6.37230E-01	6.27297E-01	6.09281E-01	5.88734E-01
27	6.84495E-01	6.78302E-01	6.72865E-01	6.66807E-01	6.49930E-01	6.37230E-01	6.27297E-01	6.09281E-01	5.88734E-01
28	6.86480E-01	6.79942E-01	6.74204E-01	6.67919E-01	6.50446E-01	6.37258E-01	6.27125E-01	6.08464E-01	5.88243E-01
29	6.88417E-01	6.81539E-01	6.75505E-01	6.68998E-01	6.50936E-01	6.37265E-01	6.26937E-01	6.07638E-01	5.87720E-01
30	6.90304E-01	6.83089E-01	6.76763E-01	6.70040E-01	6.51392E-01	6.37244E-01	6.26726E-01	6.06796E-01	5.87162E-01
31	6.92137E-01	6.84589E-01	6.77975E-01	6.71039E-01	6.51808E-01	6.37188E-01	6.26486E-01	6.05929E-01	5.86565E-01
32	6.92137E-01	6.84589E-01	6.77975E-01	6.71039E-01	6.51808E-01	6.37188E-01	6.26486E-01	6.05929E-01	5.86565E-01
33	6.93926E-01	6.86052E-01	6.79155E-01	6.72011E-01	6.52201E-01	6.37109E-01	6.26227E-01	6.05034E-01	5.85938E-01
34	6.95664E-01	6.87471E-01	6.80298E-01	6.72952E-01	6.52576E-01	6.37024E-01	6.25966E-01	6.04153E-01	5.85308E-01
35	6.97348E-01	6.88843E-01	6.81400E-01	6.73857E-01	6.52926E-01	6.36924E-01	6.25695E-01	6.03276E-01	5.84671E-01
36	6.98974E-01	6.90163E-01	6.82457E-01	6.74725E-01	6.53245E-01	6.36802E-01	6.25411E-01	6.02394E-01	5.84025E-01
37	6.98974E-01	6.90163E-01	6.82457E-01	6.74725E-01	6.53245E-01	6.36802E-01	6.25411E-01	6.02394E-01	5.84025E-01
38	7.02101E-01	6.92715E-01	6.84510E-01	6.76411E-01	6.53897E-01	6.36604E-01	6.24891E-01	6.00709E-01	5.82785E-01
39	7.05026E-01	6.95117E-01	6.86454E-01	6.78014E-01	6.54572E-01	6.36512E-01	6.24488E-01	5.99264E-01	5.81702E-01
40	7.07728E-01	6.97342E-01	6.88261E-01	6.79508E-01	6.55225E-01	6.36470E-01	6.24157E-01	5.97992E-01	5.80745E-01
41	7.10189E-01	6.99367E-01	6.89906E-01	6.80870E-01	6.55814E-01	6.36429E-01	6.23857E-01	5.96832E-01	5.79885E-01

42	7.10189E-01	6.99367E-01	6.89906E-01	6.80870E-01	6.55814E-01	6.36429E-01	6.23857E-01	5.96832E-01	5.79885E-01
43	7.12443E-01	7.01243E-01	6.91445E-01	6.82151E-01	6.56429E-01	5.36488E-01	6.23671E-01	5.95878E-01	5.79200E-01
44	7.14492E-01	7.02979E-01	6.92898E-01	6.83372E-01	6.57133E-01	6.36746E-01	6.23690E-01	5.95297E-01	5.78800E-01
45	7.16325E-01	7.04563E-01	6.94249E-01	6.84519E-01	6.57898E-01	6.37168E-01	6.23884E-01	5.95042E-01	5.78660E-01
46	7.17935E-01	7.05983E-01	6.95485E-01	6.85578E-01	6.58704E-01	6.37728E-01	6.24228E-01	5.95078E-01	5.78760E-01
47	7.17935E-01	7.05983E-01	6.95485E-01	6.85578E-01	6.58704E-01	6.37728E-01	6.24228E-01	5.95078E-01	5.78760E-01
48	7.19321E-01	7.07240E-01	6.96605E-01	6.86545E-01	6.59547E-01	6.38423E-01	6.24714E-01	5.95399E-01	5.79097E-01
49	7.20483E-01	7.08332E-01	6.97607E-01	6.87418E-01	6.60431E-01	6.39254E-01	6.25340E-01	5.96004E-01	5.79668E-01
50	7.21422E-01	7.09260E-01	6.98489E-01	6.88193E-01	6.61351E-01	6.40216E-01	6.26096E-01	5.96883E-01	5.80465E-01
51	7.22141E-01	7.10025E-01	6.99253E-01	6.88869E-01	6.62311E-01	6.41312E-01	6.26975E-01	5.98035E-01	5.81484E-01
52	7.22141E-01	7.10025E-01	6.99253E-01	6.88869E-01	6.62311E-01	6.41312E-01	6.26975E-01	5.98035E-01	5.81484E-01
53	7.22414E-01	7.10341E-01	6.99582E-01	6.89160E-01	6.62789E-01	6.41887E-01	6.27439E-01	5.98681E-01	5.82055E-01
54	7.22625E-01	7.10606E-01	6.99869E-01	6.89412E-01	6.63253E-01	6.42463E-01	6.27901E-01	5.99351E-01	5.82651E-01
55	7.22776E-01	7.10820E-01	7.00112E-01	6.89626E-01	6.63703E-01	6.43042E-01	6.28363E-01	6.00047E-01	5.83271E-01
56	7.22867E-01	7.10986E-01	7.00315E-01	6.89801E-01	6.64142E-01	6.43627E-01	6.28825E-01	6.00771E-01	5.83918E-01
57	7.22867E-01	7.10986E-01	7.00315E-01	6.89801E-01	6.64142E-01	6.43627E-01	6.28825E-01	6.00771E-01	5.83918E-01
58	7.22891E-01	7.11110E-01	7.00491E-01	6.89948E-01	6.64627E-01	6.44295E-01	6.29345E-01	6.01621E-01	5.84692E-01
59	7.22817E-01	7.11146E-01	7.00585E-01	6.90017E-01	6.65054E-01	6.44917E-01	6.29813E-01	6.02439E-01	5.85455E-01
60	7.22649E-01	7.11097E-01	7.00600E-01	6.90010E-01	6.65429E-01	6.45499E-01	6.30232E-01	6.03232E-01	5.86208E-01
61	7.22388E-01	7.10965E-01	7.00539E-01	6.89928E-01	6.65758E-01	6.46046E-01	6.30603E-01	6.04004E-01	5.86956E-01
62	7.22388E-01	7.10965E-01	7.00539E-01	6.89928E-01	6.65758E-01	6.46046E-01	6.30603E-01	6.04004E-01	5.86956E-01
63	7.21913E-01	7.10630E-01	7.00277E-01	6.89643E-01	6.65896E-01	6.46391E-01	6.30769E-01	6.04549E-01	5.87496E-01
64	7.21218E-01	7.10032E-01	6.99726E-01	6.89068E-01	6.65629E-01	6.46267E-01	6.30495E-01	6.04547E-01	5.87505E-01
65	7.20308E-01	7.09179E-01	6.98893E-01	6.88209E-01	6.64967E-01	6.45685E-01	6.29790E-01	6.04011E-01	5.86995E-01
66	7.19187E-01	7.08074E-01	6.97782E-01	6.87070E-01	6.63921E-01	6.44656E-01	6.28660E-01	6.02953E-01	5.85976E-01
67	7.17857E-01	7.06723E-01	6.96398E-01	6.85655E-01	6.62496E-01	6.43188E-01	6.27110E-01	6.01380E-01	5.84457E-01
68	7.16320E-01	7.05127E-01	6.94743E-01	6.83966E-01	6.60697E-01	6.41285E-01	6.25144E-01	5.99299E-01	5.82443E-01
69	7.14579E-01	7.03288E-01	6.92821E-01	6.82006E-01	6.58527E-01	6.38951E-01	6.22765E-01	5.96713E-01	5.79940E-01
70	7.12634E-01	7.01206E-01	6.90630E-01	6.79775E-01	6.55986E-01	6.36186E-01	6.19974E-01	5.93623E-01	5.76954E-01
71	7.10485E-01	6.98882E-01	6.88170E-01	6.77274E-01	6.53072E-01	6.32988E-01	6.16771E-01	5.90029E-01	5.73486E-01
72	7.08132E-01	6.96313E-01	6.85441E-01	6.74503E-01	6.49781E-01	6.29354E-01	6.13157E-01	5.85928E-01	5.69538E-01
73	7.05572E-01	6.93498E-01	6.82440E-01	6.71462E-01	6.46107E-01	6.25278E-01	6.09128E-01	5.81314E-01	5.65112E-01
74	7.02806E-01	6.90431E-01	6.79162E-01	6.68148E-01	6.42042E-01	6.20751E-01	6.04682E-01	5.76182E-01	5.60206E-01
75	7.02806E-01	6.90431E-01	6.79162E-01	6.68148E-01	6.42042E-01	6.20751E-01	6.04682E-01	5.76182E-01	5.60206E-01
76	7.01370E-01	6.88818E-01	6.77427E-01	6.66393E-01	6.39799E-01	6.18165E-01	6.02217E-01	5.73197E-01	5.57412E-01
77	6.99910E-01	6.87187E-01	6.75677E-01	6.64625E-01	6.37559E-01	6.15630E-01	5.99755E-01	5.70235E-01	5.54643E-01
78	6.98426E-01	6.85536E-01	6.73910E-01	6.62842E-01	6.35318E-01	6.13082E-01	5.97296E-01	5.67289E-01	5.51898E-01
79	6.96916E-01	6.83865E-01	6.72127E-01	6.61043E-01	6.33073E-01	6.10537E-01	5.94336E-01	5.64358E-01	5.49173E-01
80	6.96916E-01	6.83865E-01	6.72127E-01	6.61043E-01	6.33073E-01	6.10537E-01	5.94836E-01	5.64358E-01	5.49173E-01
81	6.94705E-01	6.81424E-01	6.69528E-01	6.58427E-01	6.29808E-01	6.06829E-01	5.91260E-01	5.60074E-01	5.45253E-01
82	6.92457E-01	6.78964E-01	6.66922E-01	6.55808E-01	6.26586E-01	6.03193E-01	5.87745E-01	5.55902E-01	5.41433E-01
83	6.90171E-01	6.76482E-01	6.64305E-01	6.53181E-01	6.23399E-01	5.99619E-01	5.84282E-01	5.51830E-01	5.37707E-01
84	6.87846E-01	6.73974E-01	6.61674E-01	6.50547E-01	6.20238E-01	5.96096E-01	5.80868E-01	5.47847E-01	5.34069E-01
85	6.87846E-01	6.73974E-01	6.61674E-01	6.50547E-01	6.20238E-01	5.96096E-01	5.80868E-01	5.47847E-01	5.34069E-01
86	6.85469E-01	6.71423E-01	6.59006E-01	6.47881E-01	6.17052E-01	5.92548E-01	5.77441E-01	5.43839E-01	5.30460E-01
87	6.83068E-01	6.68870E-01	6.56353E-01	6.45237E-01	6.13945E-01	5.89120E-01	5.74124E-01	5.40008E-01	5.27001E-01

88	6.80643E-01	6.66314E-01	6.53713E-01	6.42610E-01	6.10910E-01	5.85800E-01	5.70912E-01	5.36341E-01	5.23685E-01
89	6.78193E-01	6.63753E-01	6.51082E-01	6.40000E-01	6.07940E-01	5.82582E-01	5.67797E-01	5.32828E-01	5.20509E-01
90	6.78193E-01	6.63753E-01	6.51082E-01	6.40000E-01	6.07940E-01	5.82582E-01	5.67797E-01	5.32828E-01	5.20509E-01
91	6.73210E-01	6.58605E-01	6.45841E-01	6.34821E-01	6.02173E-01	5.76408E-01	5.61840E-01	5.26202E-01	5.14555E-01
92	6.68187E-01	6.53524E-01	6.40746E-01	6.29813E-01	5.96853E-01	5.70876E-01	5.56499E-01	5.20506E-01	5.09359E-01
93	6.63123E-01	6.48502E-01	6.35785E-01	6.24965E-01	5.91946E-01	5.65939E-01	5.51743E-01	5.15677E-01	5.04893E-01
94	6.58019E-01	6.43535E-01	6.30953E-01	6.20275E-01	5.87430E-01	5.61566E-01	5.47551E-01	5.11675E-01	5.01140E-01
95	6.58019E-01	6.43535E-01	6.30953E-01	6.20275E-01	5.87430E-01	5.61566E-01	5.47551E-01	5.11675E-01	5.01140E-01
96	6.52885E-01	6.38627E-01	6.26249E-01	6.15742E-01	5.83287E-01	5.57729E-01	5.43899E-01	5.08455E-01	4.98066E-01
97	6.47707E-01	6.33753E-01	6.21642E-01	6.11333E-01	5.79456E-01	5.54350E-01	5.40721E-01	5.05923E-01	4.95595E-01
98	6.42499E-01	6.28926E-01	6.17146E-01	6.07060E-01	5.75951E-01	5.51444E-01	5.38025E-01	5.04094E-01	4.93733E-01
99	6.37277E-01	6.24165E-01	6.12776E-01	6.02935E-01	5.72796E-01	5.49035E-01	5.35829E-01	5.02999E-01	4.92490E-01
100	6.37277E-01	6.24165E-01	6.12776E-01	6.02935E-01	5.72796E-01	5.49035E-01	5.35829E-01	5.02999E-01	4.92490E-01
101	6.32074E-01	6.19493E-01	6.08545E-01	5.98962E-01	5.69944E-01	5.47025E-01	5.34032E-01	5.02428E-01	4.91731E-01
102	6.26802E-01	6.14779E-01	6.04303E-01	5.95000E-01	5.67164E-01	5.45152E-01	5.32409E-01	5.02115E-01	4.91265E-01
103	6.21487E-01	6.10055E-01	6.00083E-01	5.91073E-01	5.64506E-01	5.43472E-01	5.30997E-01	5.02126E-01	4.91125E-01
104	6.16155E-01	6.05351E-01	5.95915E-01	5.87209E-01	5.62020E-01	5.42044E-01	5.29840E-01	5.02535E-01	4.91347E-01
105	6.16155E-01	6.05352E-01	5.95915E-01	5.87209E-01	5.62020E-01	5.42044E-01	5.29840E-01	5.02535E-01	4.91347E-01
106	6.13514E-01	6.03042E-01	5.93883E-01	5.85325E-01	5.60862E-01	5.41427E-01	5.29349E-01	5.02837E-01	4.91562E-01
107	6.10858E-01	6.00715E-01	5.91835E-01	5.83427E-01	5.59691E-01	5.40799E-01	5.28855E-01	5.03142E-01	4.91800E-01
108	6.08191E-01	5.98377E-01	5.89777E-01	5.81520E-01	5.58514E-01	5.40169E-01	5.28362E-01	5.03458E-01	4.92068E-01
109	6.05515E-01	5.96031E-01	5.87714E-01	5.79607E-01	5.57339E-01	5.39547E-01	5.27878E-01	5.03797E-01	4.92372E-01
110	6.05515E-01	5.96031E-01	5.87714E-01	5.79607E-01	5.57339E-01	5.39547E-01	5.27878E-01	5.03797E-01	4.92372E-01
111	6.02850E-01	5.93697E-01	5.85662E-01	5.77702E-01	5.56174E-01	5.38928E-01	5.27395E-01	5.04121E-01	4.92685E-01
112	6.00171E-01	5.91344E-01	5.83589E-01	5.75776E-01	5.54981E-01	5.38276E-01	5.26883E-01	5.04414E-01	4.92994E-01
113	5.97483E-01	5.88976E-01	5.81500E-01	5.73831E-01	5.53767E-01	5.37601E-01	5.26348E-01	5.04688E-01	4.93306E-01
114	5.94790E-01	5.86599E-01	5.79401E-01	5.71872E-01	5.52539E-01	5.36910E-01	5.25798E-01	5.04952E-01	4.93627E-01
115	5.94790E-01	5.86599E-01	5.79401E-01	5.71872E-01	5.52539E-01	5.36910E-01	5.25798E-01	5.04952E-01	4.93627E-01
116	5.92109E-01	5.84231E-01	5.77307E-01	5.69913E-01	5.51309E-01	5.36205E-01	5.25227E-01	5.05176E-01	4.93936E-01
117	5.89417E-01	5.81843E-01	5.75189E-01	5.67925E-01	5.50040E-01	5.35450E-01	5.24608E-01	5.05345E-01	4.94222E-01
118	5.86720E-01	5.79441E-01	5.73052E-01	5.65913E-01	5.48739E-01	5.34654E-01	5.23946E-01	5.05469E-01	4.94493E-01
119	5.84021E-01	5.77028E-01	5.70899E-01	5.63880E-01	5.47413E-01	5.33825E-01	5.23248E-01	5.05557E-01	4.94757E-01
120	5.84021E-01	5.77028E-01	5.70899E-01	5.63880E-01	5.47413E-01	5.33825E-01	5.23249E-01	5.05557E-01	4.94757E-01
121	5.80528E-01	5.73896E-01	5.68099E-01	5.61227E-01	5.45659E-01	5.32686E-01	5.22269E-01	5.05538E-01	4.94963E-01
122	5.77031E-01	5.70736E-01	5.65250E-01	5.58526E-01	5.43783E-01	5.31393E-01	5.21139E-01	5.05313E-01	4.94957E-01
123	5.73537E-01	5.67554E-01	5.62361E-01	5.55784E-01	5.41796E-01	5.29961E-01	5.19869E-01	5.04900E-01	4.94753E-01
124	5.70051E-01	5.64357E-01	5.59440E-01	5.53005E-01	5.39714E-01	5.28403E-01	5.18470E-01	5.04316E-01	4.94364E-01
125	5.66579E-01	5.61153E-01	5.56493E-01	5.50197E-01	5.37546E-01	5.26733E-01	5.16952E-01	5.03576E-01	4.93803E-01
126	5.63126E-01	5.57947E-01	5.53528E-01	5.47364E-01	5.35303E-01	5.24962E-01	5.15325E-01	5.02695E-01	4.93082E-01
127	5.59696E-01	5.54744E-01	5.50548E-01	5.44511E-01	5.32996E-01	5.23103E-01	5.13597E-01	5.01687E-01	4.92212E-01
128	5.56293E-01	5.51549E-01	5.47561E-01	5.41643E-01	5.30632E-01	5.21165E-01	5.11775E-01	5.00565E-01	4.91204E-01
129	5.52919E-01	5.48365E-01	5.44570E-01	5.38762E-01	5.28221E-01	5.19158E-01	5.09868E-01	4.99341E-01	4.90067E-01
130	5.49576E-01	5.45196E-01	5.41580E-01	5.35873E-01	5.25769E-01	5.17091E-01	5.07882E-01	4.98026E-01	4.88810E-01
131	5.46266E-01	5.42043E-01	5.38593E-01	5.32978E-01	5.23282E-01	5.14972E-01	5.05822E-01	4.96633E-01	4.87440E-01
132	5.42990E-01	5.38909E-01	5.35612E-01	5.30079E-01	5.20768E-01	5.12809E-01	5.03695E-01	4.95171E-01	4.85966E-01
133	5.39747E-01	5.35796E-01	5.32641E-01	5.27180E-01	5.18231E-01	5.10609E-01	5.01505E-01	4.93650E-01	4.84394E-01

134	5.36536E-01	5.32704E-01	5.29680E-01	5.24281E-01	5.15676E-01	5.08378E-01	4.99256E-01	4.92081E-01	4.82729E-01
135	5.33356E-01	5.29632E-01	5.26732E-01	5.21384E-01	5.13107E-01	5.06123E-01	4.96951E-01	4.90473E-01	4.80976E-01

136	5.33356E-01	5.29633E-01	5.26732E-01	5.21384E-01	5.13107E-01	5.06123E-01	4.96951E-01	4.90473E-01	4.80976E-01
137	5.09688E-01	5.06377E-01	5.04165E-01	4.99396E-01	4.92337E-01	4.87154E-01	4.78304E-01	4.75537E-01	4.66391E-01
138	4.86367E-01	4.83339E-01	4.81612E-01	4.77371E-01	4.71252E-01	4.67388E-01	4.59161E-01	4.58759E-01	4.50504E-01
139	4.63322E-01	4.60527E-01	4.59161E-01	4.55397E-01	4.50036E-01	4.47154E-01	4.39658E-01	4.40796E-01	4.33586E-01
140	4.40512E-01	4.37947E-01	4.36876E-01	4.33548E-01	4.28825E-01	4.26693E-01	4.19939E-01	4.22099E-01	4.15914E-01
141	4.17926E-01	4.15615E-01	4.14809E-01	4.11890E-01	4.07726E-01	4.06182E-01	4.00139E-01	4.02988E-01	3.97739E-01
142	3.95584E-01	3.93560E-01	3.93011E-01	3.90484E-01	3.86826E-01	3.85760E-01	3.80381E-01	3.83699E-01	3.79279E-01
143	3.73529E-01	3.71826E-01	3.71537E-01	3.69390E-01	3.66201E-01	3.65537E-01	3.60773E-01	3.64410E-01	3.60715E-01
144	3.51825E-01	3.50466E-01	3.50442E-01	3.48667E-01	3.45920E-01	3.45602E-01	3.41407E-01	3.45260E-01	3.42199E-01
145	3.30545E-01	3.29545E-01	3.29787E-01	3.28374E-01	3.26045E-01	3.26033E-01	3.22364E-01	3.26360E-01	3.23855E-01
146	3.09772E-01	3.09129E-01	3.09631E-01	3.08566E-01	3.06634E-01	3.06895E-01	3.03713E-01	3.07801E-01	3.05785E-01
147	2.89583E-01	2.89284E-01	2.90034E-01	2.89298E-01	2.87740E-01	2.88247E-01	2.85513E-01	2.89656E-01	2.88075E-01
148	2.70051E-01	2.70071E-01	2.71048E-01	2.70619E-01	2.69409E-01	2.70139E-01	2.67817E-01	2.71989E-01	2.70795E-01
149	2.51238E-01	2.51542E-01	2.52722E-01	2.52570E-01	2.51684E-01	2.52613E-01	2.50666E-01	2.54854E-01	2.54004E-01
150	2.33191E-01	2.33739E-01	2.35093E-01	2.35187E-01	2.34599E-01	2.35707E-01	2.34095E-01	2.38298E-01	2.37750E-01
151	2.15943E-01	2.16693E-01	2.18192E-01	2.18494E-01	2.18183E-01	2.19451E-01	2.18129E-01	2.22365E-01	2.22071E-01

152	2.15943E-01	2.16693E-01	2.18192E-01	2.18494E-01	2.18183E-01	2.19451E-01	2.18129E-01	2.22365E-01	2.22071E-01
153	1.88617E-01	1.89630E-01	1.91308E-01	1.91914E-01	1.91969E-01	1.93430E-01	1.92565E-01	1.96738E-01	1.96862E-01
154	1.63942E-01	1.65157E-01	1.66951E-01	1.67796E-01	1.68148E-01	1.69735E-01	1.69260E-01	1.73270E-01	1.73716E-01
155	1.41801E-01	1.43160E-01	1.45017E-01	1.46041E-01	1.46624E-01	1.48284E-01	1.48131E-01	1.51929E-01	1.52611E-01
156	1.22066E-01	1.23513E-01	1.25386E-01	1.26533E-01	1.27289E-01	1.28977E-01	1.29081E-01	1.32639E-01	1.33489E-01
157	1.04589E-01	1.06075E-01	1.07923E-01	1.09144E-01	1.10018E-01	1.11697E-01	1.11999E-01	1.15305E-01	1.16263E-01
158	8.92130E-02	9.06935E-02	9.24831E-02	9.37324E-02	9.46791E-02	9.63173E-02	9.67642E-02	9.98109E-02	1.00833E-01
159	7.57706E-02	7.72087E-02	7.89107E-02	8.01516E-02	8.11303E-02	8.27016E-02	8.32480E-02	8.60349E-02	8.70822E-02
160	6.40875E-02	6.54539E-02	6.70465E-02	6.82487E-02	6.92258E-02	7.07097E-02	7.13167E-02	7.38467E-02	7.48888E-02
161	5.39882E-02	5.52613E-02	5.67289E-02	5.78688E-02	5.88176E-02	6.01991E-02	6.08342E-02	6.31135E-02	6.41260E-02
162	4.52992E-02	4.64647E-02	4.77930E-02	4.88585E-02	4.97586E-02	5.10273E-02	5.16645E-02	5.37019E-02	5.46659E-02
163	3.78532E-02	3.89031E-02	4.00982E-02	4.10681E-02	4.19049E-02	4.30550E-02	4.36739E-02	4.54803E-02	4.63819E-02
164	3.14916E-02	3.24235E-02	3.34809E-02	3.43540E-02	3.51180E-02	3.61476E-02	3.67330E-02	3.83209E-02	3.91503E-02
165	2.60670E-02	2.68825E-02	2.78063E-02	2.85808E-02	2.92667E-02	3.01768E-02	3.07182E-02	3.21011E-02	3.28521E-02
166	2.14440E-02	2.21481E-02	2.29452E-02	2.36222E-02	2.42282E-02	2.50224E-02	2.55126E-02	2.67046E-02	2.73740E-02
167	1.75005E-02	1.81002E-02	1.87789E-02	1.93622E-02	1.98890E-02	2.05723E-02	2.10075E-02	2.20225E-02	2.26092E-02
168	1.41272E-02	1.46306E-02	1.52002E-02	1.56949E-02	1.61451E-02	1.67235E-02	1.71018E-02	1.79533E-02	1.84580E-02
169	1.12272E-02	1.16428E-02	1.21128E-02	1.25250E-02	1.29018E-02	1.33815E-02	1.37028E-02	1.44028E-02	1.48274E-02
170	8.71540E-03	9.05145E-03	9.43054E-03	9.76651E-03	1.00735E-02	1.04598E-02	1.07256E-02	1.12839E-02	1.16319E-02
171	6.51701E-03	6.78082E-03	7.07675E-03	7.34281E-03	7.58208E-03	7.87924E-03	8.09270E-03	8.51530E-03	8.79251E-03
172	4.56653E-03	4.76375E-03	4.98256E-03	5.18523E-03	5.35596E-03	5.56619E-03	5.73431E-03	6.01935E-03	6.23823E-03
173	2.80611E-03	2.93990E-03	3.08559E-03	3.23267E-03	3.32691E-03	3.45122E-03	3.58933E-03	3.71762E-03	3.90872E-03

174	2.80611E-03	2.93990E-03	3.08559E-03	3.23267E-03	3.32691E-03	3.45122E-03	3.58933E-03	3.71762E-03	3.90872E-03
175	1.72293E-03	1.82031E-03	1.92093E-03	2.02188E-03	2.10843E-03	2.20783E-03	2.29939E-03	2.40299E-03	2.50062E-03
176	1.05277E-03	1.11612E-03	1.18123E-03	1.24693E-03	1.30977E-03	1.38048E-03	1.44189E-03	1.51668E-03	1.57411E-03
177	6.34097E-04	6.72084E-04	7.11458E-04	7.51575E-04	7.91948E-04	8.37689E-04	8.76881E-04	9.26241E-04	9.61187E-04
178	3.59782E-04	3.80534E-04	4.02273E-04	4.24622E-04	4.47701E-04	4.74186E-04	4.96892E-04	5.26031E-04	5.46066E-04
179	1.62731E-04	1.71753E-04	1.81280E-04	1.91133E-04	2.01434E-04	2.13381E-04	2.23657E-04	2.36983E-04	2.46062E-04
180	0.	0.	0.	0.	0.	0.	0.	0.	0.

GROUP FLUXES

R. NO.	GROUPS 28- 33					
1	4.59489E-01	4.82542E-01	4.82852E-01	4.75348E-01	4.58895E-01	1.51518E 01
2	4.60055E-01	4.83126E-01	4.83428E-01	4.75897E-01	4.59403E-01	1.51479E 01
3	4.61778E-01	4.84891E-01	4.85164E-01	4.77545E-01	4.60927E-01	1.51358E 01
4	4.64740E-01	4.87879E-01	4.88084E-01	4.80302E-01	4.63466E-01	1.51140E 01
5	4.69093E-01	4.92159E-01	4.92222E-01	4.84175E-01	4.67010E-01	1.50799E 01
6	4.75071E-01	4.97820E-01	4.97620E-01	4.89168E-01	4.71538E-01	1.50299E 01
7	4.83013E-01	5.04965E-01	5.04310E-01	4.95263E-01	4.77006E-01	1.49591E 01
8	4.93371E-01	5.13674E-01	5.12285E-01	5.02398E-01	4.83325E-01	1.48611E 01
9	5.06698E-01	5.23946E-01	5.21455E-01	5.10435E-01	4.90338E-01	1.47281E 01
10	5.23556E-01	5.35560E-01	5.31552E-01	5.19096E-01	4.97778E-01	1.45505E 01
11	5.44249E-01	5.47828E-01	5.41979E-01	5.27874E-01	5.05217E-01	1.43166E 01
12	5.44249E-01	5.47828E-01	5.41979E-01	5.27874E-01	5.05217E-01	1.43166E 01
13	5.62662E-01	5.59933E-01	5.52270E-01	5.36384E-01	5.12299E-01	1.37473E 01
14	5.75223E-01	5.69025E-01	5.59998E-01	5.42527E-01	5.17165E-01	1.26899E 01
15	5.82695E-01	5.74781E-01	5.64745E-01	5.45815E-01	5.19332E-01	1.11411E 01
16	5.85684E-01	5.77217E-01	5.66368E-01	5.45937E-01	5.18443E-01	9.09021E 00
17	5.85684E-01	5.77217E-01	5.66368E-01	5.45937E-01	5.18443E-01	9.09021E 00
18	5.85831E-01	5.77352E-01	5.66388E-01	5.45711E-01	5.18067E-01	8.87328E 00
19	5.85984E-01	5.77504E-01	5.66425E-01	5.45505E-01	5.17712E-01	8.66189E 00
20	5.86144E-01	5.77672E-01	5.66480E-01	5.45318E-01	5.17376E-01	8.45561E 00
21	5.86311E-01	5.77856E-01	5.66551E-01	5.45148E-01	5.17058E-01	8.25400E 00
22	5.86311E-01	5.77856E-01	5.66551E-01	5.45148E-01	5.17058E-01	8.25400E 00
23	5.86462E-01	5.78034E-01	5.66615E-01	5.44974E-01	5.16739E-01	8.01285E 00
24	5.86575E-01	5.78179E-01	5.66651E-01	5.44775E-01	5.16397E-01	7.77691E 00
25	5.86650E-01	5.78294E-01	5.66658E-01	5.44549E-01	5.16031E-01	7.54566E 00
26	5.86689E-01	5.78380E-01	5.66637E-01	5.44296E-01	5.15640E-01	7.31860E 00
27	5.86689E-01	5.78380E-01	5.66637E-01	5.44296E-01	5.15640E-01	7.31860E 00
28	5.86692E-01	5.78456E-01	5.66569E-01	5.43906E-01	5.15060E-01	7.01212E 00
29	5.86643E-01	5.78488E-01	5.66461E-01	5.43484E-01	5.14454E-01	6.71829E 00
30	5.86547E-01	5.78478E-01	5.66314E-01	5.43028E-01	5.13817E-01	6.43558E 00
31	5.86404E-01	5.78429E-01	5.66128E-01	5.42536E-01	5.13149E-01	6.16255E 00
32	5.86405E-01	5.78429E-01	5.66128E-01	5.42536E-01	5.13149E-01	6.16255E 00
33	5.86226E-01	5.78347E-01	5.65911E-01	5.42012E-01	5.12450E-01	5.90082E 00
34	5.86021E-01	5.78239E-01	5.65672E-01	5.41476E-01	5.11745E-01	5.65359E 00
35	5.85791E-01	5.78107E-01	5.65411E-01	5.40923E-01	5.11028E-01	5.41921E 00
36	5.85540E-01	5.77953E-01	5.65127E-01	5.40351E-01	5.10297E-01	5.19614E 00
37	5.85540E-01	5.77953E-01	5.65127E-01	5.40351E-01	5.10297E-01	5.19614E 00
38	5.85016E-01	5.77610E-01	5.64538E-01	5.39213E-01	5.08853E-01	4.79583E 00
39	5.84511E-01	5.77252E-01	5.63956E-01	5.38147E-01	5.07513E-01	4.45765E 00
40	5.84028E-01	5.76886E-01	5.63378E-01	5.37130E-01	5.06249E-01	4.16985E 00
41	5.83570E-01	5.76518E-01	5.62800E-01	5.36142E-01	5.05036E-01	3.92254E 00

42	5.83570E-01	5.76518E-01	5.62800E-01	5.36142E-01	5.05036E-01	3.92254E 00
43	5.83177E-01	5.76173E-01	5.62254E-01	5.35231E-01	5.03923E-01	3.72015E 00
44	5.82895E-01	5.75877E-01	5.61784E-01	5.34479E-01	5.03007E-01	3.56881E 00
45	5.82715E-01	5.75625E-01	5.61379E-01	5.33865E-01	5.02264E-01	3.46173E 00
46	5.82626E-01	5.75408E-01	5.61027E-01	5.33373E-01	5.01674E-01	3.39395E 00
47	5.82626E-01	5.75408E-01	5.61027E-01	5.33373E-01	5.01674E-01	3.39395E 00
48	5.82617E-01	5.75215E-01	5.60720E-01	5.32993E-01	5.01232E-01	3.36364E 00
49	5.82676E-01	5.75033E-01	5.60446E-01	5.32722E-01	5.00933E-01	3.37040E 00
50	5.82781E-01	5.74841E-01	5.60192E-01	5.32547E-01	5.00767E-01	3.41369E 00
51	5.82907E-01	5.74616E-01	5.59937E-01	5.32460E-01	5.00726E-01	3.49435E 00
52	5.82907E-01	5.74616E-01	5.59937E-01	5.32460E-01	5.00726E-01	3.49435E 00
53	5.82961E-01	5.74478E-01	5.59799E-01	5.32436E-01	5.00739E-01	3.54802E 00
54	5.82997E-01	5.74314E-01	5.59642E-01	5.32409E-01	5.00757E-01	3.60917E 00
55	5.83012E-01	5.74121E-01	5.59465E-01	5.32380E-01	5.00782E-01	3.67826E 00
56	5.83000E-01	5.73894E-01	5.59265E-01	5.32348E-01	5.00812E-01	3.75580E 00
57	5.83000E-01	5.73894E-01	5.59265E-01	5.32348E-01	5.00812E-01	3.75580E 00
58	5.82937E-01	5.73568E-01	5.58983E-01	5.32287E-01	5.00834E-01	3.85771E 00
59	5.82800E-01	5.73169E-01	5.58641E-01	5.32184E-01	5.00824E-01	3.96810E 00
60	5.82582E-01	5.72689E-01	5.58234E-01	5.32039E-01	5.00782E-01	4.08807E 00
61	5.82274E-01	5.72119E-01	5.57758E-01	5.31853E-01	5.00710E-01	4.21886E 00
62	5.82274E-01	5.72119E-01	5.57759E-01	5.31853E-01	5.00710E-01	4.21886E 00
63	5.81718E-01	5.71283E-01	5.57040E-01	5.31459E-01	5.00445E-01	4.36275E 00
64	5.80880E-01	5.70234E-01	5.56081E-01	5.30753E-01	4.99852E-01	4.46798E 00
65	5.79752E-01	5.68964E-01	5.54879E-01	5.29740E-01	4.98936E-01	4.53544E 00
66	5.78329E-01	5.67468E-01	5.53436E-01	5.28426E-01	4.97705E-01	4.56597E 00
67	5.76609E-01	5.65743E-01	5.51751E-01	5.26814E-01	4.96163E-01	4.56033E 00
68	5.74591E-01	5.63791E-01	5.49827E-01	5.24909E-01	4.94314E-01	4.51920E 00
69	5.72279E-01	5.61613E-01	5.47666E-01	5.22715E-01	4.92163E-01	4.44321E 00
70	5.69677E-01	5.59216E-01	5.45274E-01	5.20233E-01	4.89712E-01	4.33289E 00
71	5.66793E-01	5.56607E-01	5.42654E-01	5.17468E-01	4.86962E-01	4.18873E 00
72	5.63636E-01	5.53795E-01	5.39815E-01	5.14421E-01	4.83916E-01	4.01116E 00
73	5.60218E-01	5.50794E-01	5.36763E-01	5.11095E-01	4.80574E-01	3.80055E 00
74	5.56554E-01	5.47619E-01	5.33508E-01	5.07489E-01	4.76936E-01	3.55721E 00
75	5.56554E-01	5.47619E-01	5.33508E-01	5.07489E-01	4.76936E-01	3.55721E 00
76	5.54654E-01	5.46003E-01	5.31823E-01	5.05553E-01	4.74959E-01	3.43533E 00
77	5.52736E-01	5.44369E-01	5.30129E-01	5.03620E-01	4.72990E-01	3.31851E 00
78	5.50804E-01	5.42719E-01	5.28426E-01	5.01691E-01	4.71028E-01	3.20626E 00
79	5.48859E-01	5.41056E-01	5.26716E-01	4.99764E-01	4.69072E-01	3.09810E 00
80	5.48859E-01	5.41056E-01	5.26716E-01	4.99764E-01	4.69072E-01	3.09810E 00
81	5.46045E-01	5.38650E-01	5.24246E-01	4.96977E-01	4.66244E-01	2.95169E 00
82	5.43243E-01	5.36244E-01	5.21792E-01	4.94240E-01	4.63475E-01	2.81645E 00
83	5.40460E-01	5.33844E-01	5.19357E-01	4.91547E-01	4.60761E-01	2.69098E 00
84	5.37701E-01	5.31456E-01	5.16944E-01	4.88898E-01	4.58100E-01	2.57401E 00
85	5.37701E-01	5.31456E-01	5.16944E-01	4.88898E-01	4.58100E-01	2.57401E 00
86	5.34952E-01	5.29075E-01	5.14539E-01	4.86258E-01	4.55450E-01	2.46649E 00
87	5.32264E-01	5.26733E-01	5.12187E-01	4.83707E-01	4.52902E-01	2.37069E 00

88	5.29641E-01	5.24436E-01	5.09891E-01	4.81242E-01	4.50452E-01	2.28539E 00
89	5.27088E-01	5.22187E-01	5.07652E-01	4.78862E-01	4.48098E-01	2.20953E 00
90	5.27088E-01	5.22187E-01	5.07652E-01	4.78862E-01	4.48098E-01	2.20953E 00
91	5.22197E-01	5.17843E-01	5.03352E-01	4.74351E-01	4.43668E-01	2.09016E 00
92	5.17722E-01	5.13797E-01	4.99404E-01	4.70346E-01	4.39801E-01	2.01280E 00
93	5.13677E-01	5.10069E-01	4.95814E-01	4.66835E-01	4.36478E-01	1.97305E 00
94	5.10069E-01	5.06671E-01	4.92589E-01	4.63808E-01	4.33687E-01	1.96867E 00
95	5.10069E-01	5.06671E-01	4.92589E-01	4.63808E-01	4.33687E-01	1.96867E 00
96	5.06895E-01	5.03609E-01	4.89726E-01	4.61251E-01	4.31407E-01	1.99692E 00
97	5.04128E-01	5.00867E-01	4.87203E-01	4.59123E-01	4.29596E-01	2.05692E 00
98	5.01760E-01	4.98438E-01	4.85018E-01	4.57429E-01	4.28258E-01	2.15192E 00
99	4.99780E-01	4.96313E-01	4.83168E-01	4.56176E-01	4.27406E-01	2.28697E 00
100	4.99780E-01	4.96313E-01	4.83168E-01	4.56176E-01	4.27407E-01	2.28697E 00
101	4.98130E-01	4.94459E-01	4.81607E-01	4.55274E-01	4.26925E-01	2.45509E 00
102	4.96696E-01	4.92799E-01	4.80232E-01	4.54576E-01	4.26667E-01	2.65193E 00
103	4.95462E-01	4.91313E-01	4.79039E-01	4.54100E-01	4.26656E-01	2.88584E 00
104	4.94410E-01	4.89981E-01	4.78023E-01	4.53866E-01	4.26922E-01	3.16669E 00
105	4.94410E-01	4.89981E-01	4.78023E-01	4.53866E-01	4.26922E-01	3.16669E 00
106	4.93936E-01	4.89362E-01	4.77571E-01	4.53819E-01	4.27129E-01	3.32406E 00
107	4.93469E-01	4.88756E-01	4.77130E-01	4.53782E-01	4.27348E-01	3.48955E 00
108	4.93004E-01	4.88160E-01	4.76700E-01	4.53756E-01	4.27584E-01	3.66448E 00
109	4.92541E-01	4.87572E-01	4.76279E-01	4.53746E-01	4.27842E-01	3.85030E 00
110	4.92541E-01	4.87572E-01	4.76279E-01	4.53746E-01	4.27842E-01	3.85030E 00
111	4.92071E-01	4.86986E-01	4.75862E-01	4.53736E-01	4.28099E-01	4.04396E 00
112	4.91576E-01	4.86391E-01	4.75435E-01	4.53712E-01	4.28346E-01	4.24422E 00
113	4.91056E-01	4.85785E-01	4.74998E-01	4.53678E-01	4.28587E-01	4.45235E 00
114	4.90505E-01	4.85165E-01	4.74551E-01	4.53636E-01	4.28826E-01	4.66969E 00
115	4.90505E-01	4.85165E-01	4.74551E-01	4.53636E-01	4.28826E-01	4.66969E 00
116	4.89919E-01	4.84528E-01	4.74088E-01	4.53575E-01	4.29046E-01	4.89347E 00
117	4.89280E-01	4.83863E-01	4.73598E-01	4.53481E-01	4.29238E-01	5.12252E 00
118	4.88584E-01	4.83168E-01	4.73081E-01	4.53358E-01	4.29405E-01	5.35801E 00
119	4.87829E-01	4.82440E-01	4.72536E-01	4.53208E-01	4.29552E-01	5.60114E 00
120	4.87829E-01	4.82440E-01	4.72536E-01	4.53208E-01	4.29552E-01	5.60114E 00
121	4.86780E-01	4.81449E-01	4.71780E-01	4.52944E-01	4.29669E-01	5.91905E 00
122	4.85698E-01	4.80403E-01	4.70954E-01	4.52570E-01	4.29675E-01	6.21724E 00
123	4.84575E-01	4.79297E-01	4.70059E-01	4.52092E-01	4.29578E-01	6.49660E 00
124	4.83408E-01	4.78131E-01	4.69096E-01	4.51517E-01	4.29389E-01	6.75796E 00
125	4.82193E-01	4.76902E-01	4.68068E-01	4.50850E-01	4.29115E-01	7.00210E 00
126	4.80929E-01	4.75610E-01	4.66975E-01	4.50098E-01	4.28765E-01	7.22976E 00
127	4.79614E-01	4.74255E-01	4.65822E-01	4.49265E-01	4.28347E-01	7.44165E 00
128	4.78248E-01	4.72835E-01	4.64608E-01	4.48359E-01	4.27871E-01	7.63844E 00
129	4.76832E-01	4.71350E-01	4.63339E-01	4.47382E-01	4.27343E-01	7.82075E 00
130	4.75366E-01	4.69801E-01	4.62014E-01	4.46342E-01	4.26774E-01	7.98917E 00
131	4.73853E-01	4.68187E-01	4.60639E-01	4.45242E-01	4.26170E-01	8.14426E 00
132	4.72294E-01	4.66509E-01	4.59215E-01	4.44087E-01	4.25542E-01	8.28656E 00
133	4.70691E-01	4.64767E-01	4.57745E-01	4.42882E-01	4.24898E-01	8.41655E 00

134	4.69047E-01	4.62960E-01	4.56234E-01	4.41633E-01	4.24249E-01	8.53470E 00
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136	4.67365E-01	4.61088E-01	4.54683E-01	4.40343E-01	4.23602E-01	8.64144E 00
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141	3.90290E-01	3.84283E-01	3.82439E-01	3.73953E-01	3.69043E-01	9.07938E 00
142	3.72738E-01	3.67379E-01	3.66032E-01	3.58372E-01	3.54392E-01	9.03857E 00
143	3.54992E-01	3.50274E-01	3.49380E-01	3.42483E-01	3.39263E-01	8.96231E 00
144	3.37210E-01	3.33102E-01	3.32619E-01	3.26430E-01	3.23849E-01	8.85359E 00
145	3.19524E-01	3.15984E-01	3.15870E-01	3.10340E-01	3.08310E-01	8.71527E 00
146	3.02046E-01	2.99025E-01	2.99241E-01	2.94324E-01	2.92777E-01	8.55008E 00
147	2.84866E-01	2.82317E-01	2.82823E-01	2.78477E-01	2.77366E-01	8.36060E 00
148	2.68062E-01	2.65936E-01	2.66697E-01	2.62884E-01	2.62172E-01	8.14929E 00
149	2.51694E-01	2.49945E-01	2.50931E-01	2.47614E-01	2.47285E-01	7.91844E 00
150	2.35811E-01	2.34397E-01	2.35585E-01	2.32732E-01	2.32782E-01	7.67022E 00
151	2.20452E-01	2.19331E-01	2.20709E-01	2.18291E-01	2.18741E-01	7.40662E 00
152	2.20452E-01	2.19331E-01	2.20709E-01	2.18291E-01	2.18741E-01	7.40662E 00
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159	8.75585E-02	8.81902E-02	8.98742E-02	8.99969E-02	9.15086E-02	4.67846E 00
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163	4.69788E-02	4.76568E-02	4.89092E-02	4.93109E-02	5.04794E-02	3.42875E 00
164	3.97234E-02	4.03655E-02	4.14962E-02	4.19055E-02	4.29681E-02	3.15913E 00
165	3.33892E-02	3.39851E-02	3.49944E-02	3.53959E-02	3.63505E-02	2.90649E 00
166	2.78664E-02	2.84090E-02	2.92993E-02	2.96812E-02	3.05279E-02	2.67048E 00
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171	9.02931E-03	9.28664E-03	9.64903E-03	9.83463E-03	1.01562E-02	1.72265E 00
172	6.43811E-03	6.64573E-03	6.90911E-03	7.03827E-03	7.24418E-03	1.57559E 00
173	4.08491E-03	4.24214E-03	4.39422E-03	4.45729E-03	4.52912E-03	1.44142E 00
174	4.08491E-03	4.24214E-03	4.39422E-03	4.45729E-03	4.52912E-03	1.44142E 00
175	2.59185E-03	2.68720E-03	2.78983E-03	2.85144E-03	2.87287E-03	9.97095E-01
176	1.62698E-03	1.68563E-03	1.75149E-03	1.79638E-03	1.80464E-03	6.76716E-01
177	9.92925E-04	1.02876E-03	1.06961E-03	1.09901E-03	1.10323E-03	4.42327E-01
178	5.64141E-04	5.84644E-04	6.08138E-04	6.25481E-04	6.27863E-04	2.65385E-01
179	2.54233E-04	2.63516E-04	2.74177E-04	2.82138E-04	2.83242E-04	1.23881E-01
180	0.	0.	0.	0.	0.	0.

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