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AHSB (S) HANDBOOK 5

United Kingdom Atomic Energy Authority

HANDBOOK OF EXPERIMENTAL CRITICALITY DATA
PART 2 - Chapters 5 and 6

1968

AUTHORITY HEALTH AND SAFETY BRANCH
RISLEY, WARRINGTON, LANCASHIRE

HANDBOOK OF EXPERIMENTAL CRITICALITY DATA

PART II*

Compiled by

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*Part I (has been published)
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PREFACE

The literature of critical size measurements is extensive and can be confusing, the same measurement may be reported in a number of places and there may sometimes be variation in detail in the different accounts. Access to papers and reports can also be difficult and will depend on the library facilities available. To establish what measurements have been made in a particular area of interest, and to find detailed and authoritative accounts of the measurements can, therefore, be a time-consuming exercise. Nevertheless this material is the basic data of criticality and the criticality specialist must have recourse to it from time to time. For instance, he may need to check a calculational method and any associated nuclear data against reference experiments or a particular criticality clearance may depend on a detailed comparison of parameters.

It was felt, therefore, that a need existed for a compilation of data in relatively detailed form reference to which could take the place, at least in the first instance, of reference to the original literature. It is hoped that the present handbook which is to be published in three parts, goes at least some way to meeting this need.

In compiling the handbook reference has been made, wherever possible, to the primary account of the critical measurements reported and assemblies are described in as close approximation as possible to the actual assemblies on which measurements were made, (thus, subsequent shape changes, homogenisation etc., have been ignored). This is not to say however, that later accounts of an experiment have not sometimes provided useful additional information. Many excellent review articles and handbooks already exist in the criticality field, providing generalised guidance and data correlations for more or less simplified systems. It is in no way the aim of this handbook to replace these: rather it is to supplement them for the criticality specialist by collecting and assimilating into tabular form, convenient for quick reference, the detailed results on which they are founded and on which similar correlations can be based in the future.

It is intended that the handbook should include only data for systems which are relatively 'clean' and where it is clear that the measurements were sufficiently painstaking and the system was carried close enough to critical for the result to be accurate. With this proviso it is believed that the handbook is reasonably comprehensive so far as material generally available up to about the beginning of the 1964 Geneva Conference is concerned.

Perhaps the most difficult problem in compiling the handbook has been the allocation of the data into tables, determining the length and complexity of the tables. Generally the allocations have been made as a compromise between a desire to associate results for comparable and related systems and the need to avoid tables which are so complex as to be difficult to read.

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INTRODUCTION TO THE TABLES

The Skeleton contents page given at the front of the handbook is supplemented at the beginning of each chapter by a separate contents page showing the organisation of the chapter and listing the tables the chapter contains. Tables are identified by a title and additionally by a two part number of which the first part denotes the chapter in which the table appears and the second part the position of the table in the chapter. Also, as a further aid to rapid reference, each page of the tables carries a 'page-title' in the top left hand corner briefly summarising the type of system to which that chapter or part-chapter refers, (i.e., the degree of heterogeneity - single units, interacting arrays or latticed systems; the nature of the fissile nuclide; the nature of any moderating nuclide; and, in the case of U^{235} systems, whether the uranium is of high (> 90%) or lower enrichment).

Separate compilations of bibliographic references are given for each chapter and follow immediately after the chapter contents pages.

To facilitate easy understanding of the tables a standard form of table layout has been adopted, so far as possible, and an attempt has been made to ensure that each Table is self-contained. As exceptions to these rules information common to all (or nearly all) of the entries in a table is usually brought to the head of the table in note form, thus reducing the complexity of the Table layout, and material compositions and densities are omitted where the materials concerned are commonly-occurring and feature in a large number of Tables. The following compositions in densities may be used for these commonly-occurring materials:

Type 304 Stainless Steel -

(American Iron and Steel Institute Designation); 18·0-20·0 wt% Cr, 8·0-12·0 wt% Ni, 2·0 wt% (max) Mn, 1·0 wt% (max) Si; density 7·9 gm/cc

Type 347 Stainless Steel -

(American Iron and Steel Institute Designation); 17·0-19·0 wt% Cr, 9·0-13·0 wt% Ni, 2·0 wt% (max) Mn, 1·0 wt% max Si; density 7·93 gm/cc

Type 2S Aluminium -

(US Aluminium Assoc. Designation, now renamed Type 1100); 99·0 % aluminium (min.)

Type 3S Aluminium -

(US Aluminium Assoc. Designation, now renamed Type 3003); 1·2 wt% Mn

Zircaloy -

(Westinghouse Designation); zirconium with 1·20-1·70 % Sn; density 6·57 gm/cc

Lucite, Plexiglas or Perspex -

Polymethyl methacrylate plastics, atomic composition $C_5H_8O_2$, density 1·18 gm/cc

Polyethylene -

Atomic composition CH_2, density 0·92 gm/cc

Paraffin Wax -

Atomic composition CH_2, density approx. 0·9 gm/cc

Boric acid -

Atomic composition H_3BO_3

Only numerical values actually provided by the authors of a measurement have been entered in the standard form of Table and, in consequence, there are omissions in certain Tables. These can usually be filled, by interpolation in surrounding data. For instance, aqueous solutions of uranium are sometimes characterised only by the H/U atomic ratio. The specific gravity, uranium content, etc., can, however, be derived by comparison with similar solutions used in other experiments.

Information which has been generally excluded from the Tables includes:

(a) temperature of the assembly, provided this is near ambient

(b) detailed isotopic analysis of fissile materials

(c) detailed analysis of materials of construction, etc., for trace impurities except where significant quantities of neutron poisons are found.

Notes appended to the Tables have been phrased so far as possible in the words of the authors of the measurements referred to. Generally the notes contain information which may be thought:

(a) to extend the usefulness of the measurements (e.g., a number of subcritical observations are included under this heading), or

(b) to bear on the validity of the results (e.g., where available, the values of corrections for unavoidable experimental perturbations from ideal conditions, such as incidental neutron reflection from room walls are given).

Where corrections for experimental conditions are not given it may be assumed that suitable corrections have already been applied to the quoted result. If this is not the case, or is believed not to be the case, appropriate comment is made.

The following terminology and abbreviations are used:

Water - unless qualified this refers to ordinary light water

Mixture - unless qualified this means a mixture which is effectively homogeneous

O.D. - outer diameter

I.D. - inner diameter.

Where the information required to fill a space in a table is not available this is indicated by placing a dash - in the space.

(Note: as will be clear from an examination of the Tables an empty space in a Table implies repetition of the data for the preceeding entry in the Table. This is a device sometimes used to improve the legibility of the sentence).

CHAPTER 5 - SINGLE U^{235} CORES MODERATED BY HYDROGEN

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CHAPTER 5 - REFERENCES

1. THOMAS, J.T., FOX, J.K., and CALLIHAN, D. A Direct Comparison of some Nuclear Properties of U^{233} and U^{235}, USAEC Report ORNL 1992, Oak Ridge National Laboratory, December 12th, 1955

2. FOX, J.K., GILLEY, L.W., GWIN, R., and THOMAS, J.T. Critical Parameters of Uranium Solutions in Simple Geometry, in Neutron Physics Division Annual Progress Report for Period Ending September 1st, 1958, USAEC Report ORNL 2609, Oak Ridge National Laboratory, October 28th, 1958

3. WALFORD, J.G., UKAEA, Unpublished results

4. GWIN, R., and MAGNUSON, D.W. The measurement of Eta and Other Nuclear Properties of U^{233} and U^{235} in Critical Aqueous Solutions, Nucl. Sci. Eng. Vol. 12, No. 3, (March, 1962) pp 364-380

5. FOX, J.K., GILLEY, L.W., and CALLIHAN, D. Critical Mass Studies, Part IX, USAEC Report ORNL 2367, Oak Ridge National Laboratory, March 4th, 1958

6. THOMAS, J.T. Critical Parameters of U^{235} Enriched Solutions in Spherical Geometry, in Physics Division Semi-annual Progress Report for Period Ending March 10th, 1955, USAEC Report ORNL 1926, Oak Ridge National Laboratory, September 7th, 1955

7. FOX, J.K., GILLEY, L.W., GWIN, R., and MAGNUSON, D.W. Critical Parameters of U^{235} and U^{233} in Simple Geometry, in Neutron Physics Division Annual Progress Report for Period Ending September 1st, 1959, USAEC Report ORNL 2842, Oak Ridge National Laboratory, 1959.

8. FOX, J.K., and GILLEY, L.W. Critical Parameters of Aqueous Solutions of U^{235}, in Applied Nuclear Physics Division Annual Progress Report for Period Ending September 1st, 1957, USAEC Report ORNL 2389, Oak Ridge National Laboratory, 1958

9. BECK, C.K., CALLIHAN, D., MORFITT, J.W., and MURRAY, R.L. Critical Mass Studies, Part III, USAEC Report K343, Oak Ridge National Laboratory, April 19th, 1949

10. CALLIHAN, D., CRONIN, D.F., FOX, J.K., and MORFITT, J.W. Critical Mass Studies, Part V, USAEC Report K643, Oak Ridge National Laboratory, June 30th, 1950

11. WALFORD, J.G., UKAEA, Unpublished results

12. WALFORD, J.G., UKAEA, Unpublished results

13. BINNS, K.C. Dounreay Unpublished results

14. FOX, J.K. Critical Parameters of Solution of U^{235} Enriched Uranyl Nitrate in Cylindrical Containers, in Neutron Physics Division Annual Progress Report for Period Ending September 1st, 1961, USAEC Report ORNL 3193, Oak Ridge National Laboratory, November 17th, 1961

15. BROWN, J.R., NOORDHOFF, B.H., and BATESON, W.O. Critical Experiments on a Highly Enriched Homogeneous Reactor, USAEC Report WAPD 128, Atomic Power Division, Westinghouse Electrical Corporation, May, 1955

16. FOX, J.K., GILLEY, L.W. Critical Parameters of a Proton Moderated and Proton Reflected Slab of U^{235}, USAEC Report ORNL CF-56-2-63, Oak Ridge National Laboratory, February 7th, 1956

17. PAXTON, H.C., ORNDOFF, J.D., and LINENBERGER, G.A. Enriched Uranium Hydride Critical Assemblies, USAEC Report LA 1159 (DEL), Los Alamos Scientific Laboratory, 1950

18. LINENBERGER, G.A. Enriched Uranium Hydride Critical Assemblies, Nucl. Sci. Eng. 7: 44-57 (1960)

19. FOX, J.W., and GILLEY, L.W. Some Studies of Water, Styrafoam and Plexiglas Reflectors, USAEC Report ORNL CF-58-9-39, Oak Ridge National Laboratory, 3rd October, 1958

20. FOX, J.K., and GILLEY, L.W. Preliminary Report of Critical Experiments in Slab Geometry, USAEC Report ORNL CF-56-7-148, Oak Ridge National Laboratory, July 30th, 1956

21. FOX, J.K., and GILLEY, L.W. Critical Parameters for Poisoned Annular Cylinders Containing Aqueous Solutions of U^{235}, USAEC Report ORNL CF-58-8-5, Oak Ridge National Laboratory, August 1st, 1958

22. CLARKE, W.G., HORTON, C.C., and SMITH, M.F. Critical Assemblies of Aqueous Uranyl Fluoride Solutions, UKAEA Report AERE R/R 2051, AERE, Harwell, September 20th, 1956

23. SMITH, J.C., PARKER, A.V., WALFORD, J.G., and WHITE, C. UKAEA Unpublished results

24. MIHALCZO, J.T. Comparison of k_∞ Measurements in a Critical Assembly with k_∞ Measurements in the Physical Constants Testing Reactor, USAEC Report ORNL CF-60-4-24, Oak Ridge National Laboratory, May 3rd, 1960

25. MIHALCZO, J.T., LYNN, J.J., SCOTT, D., and CONNOLLY, W.C. Preliminary Report on 2% U^{235} Enriched UF_4-$C_{25}H_{52}$ Critical Assemblies, USAEC Report ORNL CF-59-4-120, Oak Ridge National Laboratory, April 22nd, 1959

26. MIHALCZO, J.T., and LYNN, J.J. Homogeneous Critical Assemblies of 2% Enriched UF_4 in Paraffin, in Neutron Physics Division Annual Progress Report for Period Ending September 1st, 1959, USAEC Report ORNL 2842, Oak Ridge National Laboratory, 1959.

27. CALLIHAN, D. USAEC, personal communication to J.G. Walford, UKAEA, May, 1960

28. SCOTT, J.M. UKAEA Unpublished results

29. HACK, R.C. 1·42% U^{235} Critical Experiments, UKAEA Report CRIT/Note 90, Dounreay Experimental Reactor Establishment, 1960

30. LANE, R.C. Measurements of the Critical Parameters of Undermoderated Uranium-Hydrogen Mixtures at Intermediate Enrichments, in Criticality Control Fissile Materials IAEA Symposium, Stockholm, 1965 also LANE, R.C., PERKIN, O.J.E., U.K.A.E.A. Internal Document

31. THOMAS, J.T., FOX, J.K., and JOHNSON, E.B. Critical Mass Studies Part XVI, USAEC Report ORNL-TM-499, Oak Ridge National Laboratory, February 6th, 1963

32. BERTRAND, J., BRUNET, J.P., CAIZERGUES, R., CLOUET d'ORVAL, C., KREMSER, J., VERRIERE, P. Proserfine Masses Critique En Uranium 235 et Etalous de Reactivitie, CEA Report No. 2309, Centre D'Etudes Nucleaires de Saclay, 1963

33. ALLRED, J.C., BERDT, P.J., and PETERSON, R.E. Critical Measurements in UO_3-H_3PO_4 Solutions, Nucl. Sci. Eng. 4 No. 3 pp 498-9

34. ~~HAUSEN~~ HANSEN, G.E., WOOD, D.P., and GEER, W.U. Critical Masses of Enriched Uranium Cylinders with Multiple Reflectors of Medium-Z Elements, Nucl. Sci. Eng. 8 No. 6 pp 588-594

35. PAXTON, H.C. Los Alamos Critical-Mass Data, USAEC Report LAMS 3067, Los Alamos Scientific Laboratory, May 6th, 1964

36. KING, L.D.P. Water Boilers, USAEC Report LA 1034, Los Alamos Scientific Laboratory, 1947, also Review of Scientific Instruments Vol. 22 pp 489-99

37. GWIN, R., TRUNBEY, D.K., and WEINBERG, A.M. Experimental and Theoretical Studies of Unreflected Aqueous U^{235} Critical Assemblies, in Proceedings of the Second International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958, P/593

38. LYNN, J.J., ~~MIHALCYO~~ MIHALCZO, J.T., and CONNELLY, W.C. Homogeneous Hydrogen Moderated Critical Assemblies with 2% U^{235} Enriched Uranium, in Neutron Physics Division Annual Progress Report for Period Ending September 1st, 1958, USAEC Report ORNL 2609, Oak Ridge National Laboratory, October 28th, 1958

39. FOX, J.K., and THOMAS, J.T. Critical Experiments with Mixtures of Aqueous U^{235} Enriched Uranyl Nitrate Solutions and Borosilicate Glass, in Neutron Physics Division Annual Progress Report for Period Ending September 1st, 1962, USAEC Report ORNL-3360, Oak Ridge National Laboratory, January 11th, 1963

40. THOMAS, J.T., FOX, J.K., and JOHNSON, E.B. Effects of Borosilicate Glass Raschig Rings on the Criticality of Aqueous Uranyl Nitrate Solutions, in Neutron Physics Division Annual Progress Report for Period Ending August 1st, 1963, USAEC Report ORNL-3499, Vol. 1, Oak Ridge National Laboratory, December 10th, 1963.

EXPERIMENTAL RESULTS FOR SINGLE U^{235} CORES MODERATED BY HYDROGEN - HIGH ENRICHMENTS

Table 5.1

Unreflected Spheres of Aqueous UO_2F_2 Solution

Spheres : Aluminium

SPHERE-WALL THICKNESS	URANIUM ENRICHMENT (wt%)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION (gm U^{235}/litre)	H/U^{235} ATOMIC RATIO	DELAYED CRITICAL PARAMETERS			REFERENCE
					Diameter	Volume (litres)	U^{235} Mass (kgm)	
0·127 cm [a]	~ 90	-	125·18	203·5	32·0 cm	17·020	2·1288	1,37
$\frac{1}{8}$ in	92·2	-	70·3	-	$13\frac{3}{4}$ ins	22·25	1·56	3
$\frac{1}{8}$ in	92·2	-	40·7	-	16 ins	34·95	1·42	3
0·2 cm [b]	93·2	1·03	-	1112	55·8 cm	91·1	2·13	2,37
0·32 cm [b]	93·2	1·02	-	1393	69·2 cm	174	3·25	2,37

a Type 3S Aluminium: solution feed and drain lines connected at top and bottom.

b Type 2S Aluminium.

Table 5.2

Unreflected Spheres of Aqueous $UO_2(NO_3)_2$ Solution

(Includes Systems with Added Boron)

Fissile Solutions : Contain small amounts of excess nitric acid
Boron added as boric acid

Spheres : Aluminium

URANIUM ENRICHMENT (wt %)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION (gm/gm of solution)			H/U^{235} ATOMIC RATIO	N/U^{235} ATOMIC RATIO	B/U^{235} ATOMIC RATIO	DELAYED CRITICAL PARAMETERS			REFERENCE
		Uranium	Total Nitrate Ion NO_3	Boron				Diameter	Volume (litres)	U^{235} Mass (kgm)	
Unpoisoned Solutions											
93·18	0·01881	-	-	-	1379	3·64	NIL	69·2 cm[a]	174[a]	3·27[a]	2
93·18	1·0288	0·01956	0·0187	-	1378	3·89	NIL	27·24 in.	-	-	4
93·21	1·0216	0·01482	0·0113	-	1835	3·08	NIL	48·04 in.	-	-	4
Boron Poisoned Solutions											
93·18	1·0333	0·02277	0·0212	0·0000905	1177	3·79	-	27·24 in.	-	-	4
93·18	1·0387	0·02577	0·0237	0·00018	1033	3·74	-		-	-	4
93·18	1·0445	0·02724	0·0251	0·00022	972	3·75	-		-	-	4

a. Cylinder wall thickness 0·32 cm

Table 5.3

Water Reflected Spheres of Aqueous UO_2F_2 Solution

(Includes Systems at Elevated Temperature)

Spheres : Aluminium

SPHERE WALL THICKNESS (cm)	URANIUM ENRICHMENT (wt%)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION gm U^{235}/litres	H/U^{235} ATOMIC RATIO	REFLECTOR THICKNESS (cm)	DELAYED CRITICAL CORE PARAMETERS				REFERENCE
						Diameter	Volume (litres)	U^{235} Mass (kgm)	Temperature (°C)	
-	-	-	506·1	47·3	Eff. inf.	9 ins [a]	6·32 [a]	3·20 [a]	-	5
0·16 [b]	93·18	1·40	-	76·1		23·0 cm	6·40	2·08	-	2
0·16 [b]	93·18	1·24	-	126·5		23·6 cm	6·96	1·39	-	2
0·127 [c]	~ 90	-	106·75	239·3	> 15	26·4 cm	9·726	1·0101	85·5	1
- [c]	-	-	104·09	245·4			9·713	0·9898	74·0	1
- [c]	-	-	97·10	263·3			9·675	0·9353	39·5	1
- [c]	-	-	95·14	268·8			9·661	0·9183	27·5	1
- [c]	-	-	55·525 [d]	468·2 [d]		32·0 cm	17·065	0·9158 [d]	87·5	1
- [c]	-	-	53·07 [d]	487·6 [d]			17·049	0·8903 [d]	64·5	1
- [c]	-	-	52·13 [d]	496·5 [d]			17·042	0·8792 [d]	54·0	1
- [c]	-	-	51·47 [d]	503·0 [d]			17·032	0·8714 [d]	43·0	1
- [c]	-	-	50·29 [d]	515·1 [d]			17·020	0·8558 [d]	27·0	1
- [e]	93·2	-	49·4	524	Eff. inf.	12·6 ins	17·0	0·841	-	6
0·20	-	-	20·5	1270		55·9 cm	91·2	1·87	-	7

a. Sphere lacked 80 cc. being full: the data extrapolate to a critical mass and concentration of 3·09 kg of U^{235} and 0·483 g U^{235}/cc (H/U^{235} = 49·9) in a full sphere of capacity 6·4 litres

b. Type 2S Aluminium

c. Type 3S Aluminium: Solution feed and drain lines connected at top and bottom

d. Concentrations and masses measured with this sphere are said to be about 2% high because of a systematic error

e. Type 2S Aluminium: Solution feed and drain line connected at top and bottom

Table 5.4

Spheres of UH_3/Polyethylene Mixture

Reference : 17, 18

Fissile Mixture : Uranium enrichment, 93·15 wt %.
Average atomic composition, $UH_{2\cdot97}\ C_{1\cdot11}\ O_{0\cdot25}$.

In these experiments the cores were pseudospheres assembled from tablets that were multiples of $\frac{1}{2}$ in. cubic units. The average density of the assembled cores was 7·40 gm/cc.

REFLECTOR			DELAYED CRITICAL CORE PARAMETERS		
Material	Density gm/cc	Thickness (ins)	Volume (litres)	"Hydride" Mass (kgm)	Uranium Mass (kgm)
Natural Uranium	19	~$8\frac{1}{2}$	1·980	14·68 [a,b]	13·54 [a,b]
Nickel	8·8	~$8\frac{1}{2}$	1·990	14·72	13·56
Nickel (against core) Natural Uranium	8·8 19·0	~ $\frac{1}{2}$ ~8	-	13·6	-
Nickel (against core) Natural Uranium	8·8 19·0	~1 ~$1\frac{1}{2}$	-	13·8	-

a. Critical mass increased by the order of 1% over a period of about 4 months

b. Changing core to cube increases critical mass by about 3%

EXPERIMENTAL RESULTS FOR SINGLE U^{233} CORES MODERATED BY HYDROGEN - HIGH ENRICHMENTS

Table 5.5

Unreflected Cylinders of Aqueous UO_2F_2 Solution in Aluminium Containers

Cylinders : $\frac{1}{16}$ in. wall thickness

URANIUM ENRICHMENT (wt %)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION (gm U^{233}/litre)	H/U^{233} ATOMIC RATIO	DELAYED CRITICAL PARAMETERS					REFERENCE
				Diameter (ins)	Height (cms)	Height / Diameter	Volume (litres)	U^{233} Mass (kgm)	
93·2	-	537·6	44·3	8·76	219 [a]	9·85 [a]	85·2 [a]	45·8 [a]	5
93·2	-	480	50·1		202·2[a]	9·10 [a]	78·7 [a]	37·8 [a]	8,37
93·2	-	470	51·5		149·1[a]		58·0 [a]	27·2 [a]	8
93·2	-	437	55·4		171·6[a]	7·72 [a]	66·8 [a]	29·2 [a]	8
93·2	-	402	60·8		162·5[a]	7·31 [a]	63·2 [a]	25·4 [a]	8,37
93·2	-	373	66·1		159·8[a]	7·19 [a]	62·2 [a]	23·2 [a]	8
93·2	-	350	71·5		163·2[a]	7·35 [a]	63·5 [a]	22·2 [a]	8
93·2	-	537·6	44·3	9·5	44·4[a]	1·84 [a]	20·3 [a]	10·9 [a]	5
93·2	-	828·8	27·1	10	38·9[a]	1·53 [a]	19·8 [a]	16·4 [a]	5
93·2	-	537·6	44·3		35·1[a]	1·38 [a]	17·8 [a]	9·6 [a]	5
93·2	-	480	50·1		34·8[a]	1·37 [a]	- [a]	8·40[a]	8,37
93·2	-	480	50·1		33·9[b]	1·33 [b]	- [b]	- [b]	8
93·2	-	480	50·1		33·6[c]	1·32 [c]	16·9 [c]	- [c]	8
93·4	-	459	52·9		34·0[d,e]	1·34 [d,e]	17·22[d,e]	7·90[d,e]	9
93·2	-	437	55·4		34·3[a]	1·35 [a]	17·4 [a]	7·60[a]	8
93·2	-	402	60·8		34·1[a]	1·34 [a]	17·3 [a]	6·96[a]	8,37
93·2	-	373	66·1		34·1[a]	1·34 [a]	17·3 [a]	6·45[a]	8
93·2	-	350	71·5		34·1[a]	1·34 [a]	17·3 [a]	6·06[a]	8
93·2	-	337	73·4		33·7[a]	1·33 [a]	17·1 [a]	5·81[a]	5
93·2	-	300	83·1		34·4[a]	1·36 [a]	17·4 [a]	5·22[a]	8,37
93·2	-	291	85·7		34·9[a]	1·38 [a]	17·7 [a]	5·15[a]	8
93·4	-	151	169·0		41·2[d,e]	1·62 [d,e]	20·87[d,e]	3·15[d,e]	9
93·2	-	77·9	328		147·8[a]	5·81 [a]	74·9 [a]	5·83[a]	8
93·2	-	76·4	331		170·1[a]	6·73 [a]	86·2 [a]	6·72[a]	8,37
93·4	-	52·2	499		>61·9[d,e]	>2·44 [d,e]	- [d,e]	>1·64[d,e]	9
93·2	-	537·6	44·3	12	23·2[a]	0·760[a]	16·9 [a]	9·1 [a]	5
93·2	-	480	50·1		22·6[a]	0·740[a]	16·5 [a]	7·92[a]	8,37
93·2	-	437	55·4		22·7[a]	0·744[a]	16·6 [a]	7·25[a]	8
93·2	-	402	60·8		22·7[a]	0·744[a]	16·6 [a]	6·67[a]	8,37
93·2	-	76·4	331		32·8[a]	1·08 [a]	23·9 [a]	1·86[a]	8,37

Table 5.5 (Cont'd)

URANIUM ENRICHMENT (wt %)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION (gm U^{235}/litre)	H/U^{235} ATOMIC RATIO	DELAYED CRITICAL PARAMETERS					REFERENCE
				Diameter (ins)	Height (cms)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)	
93·2	-	828·8	27·1	15	18·5 [a]	0·485 [a]	21·1 [a]	17·5 [a]	5
93·2	-	537·6	44·3		17·9 [a]	0·470 [a]	20·4 [a]	11·0 [a]	5
93·2	-	480	50·1		17·9 [a]	0·470 [a]	20·4 [b]	9·79 [b]	8,37
93·2	-	480	50·1		17·2 [b]	0·451 [b]	- [b]	- [b]	8
93·2	-	331·4	74·6	-	16·8 [a]	0·441 [a]	19·2 [a]	6·4 [a]	5
93·4	-	151	169·0		18·5 [d,e]	0·485 [d,e]	21·09 [d,e]	3·18 [d,e]	9
93·4	-	78·7	328·7		21·7 [d,e]	0·570 [d,e]	24·73 [d,e]	1·95 [d,e]	9
93·2	-	76·4	331		22·9 [a]	0·601 [a]	26·1 [a]	2·03 [a]	8,37
93·4	-	52·2	499·0		27·4 [d,e]	0·718 [d,e]	31·24 [d,e]	1·63 [d,e]	9
93·4	-	34·3	755		43·6 [d,e]	1·14 [d,e]	49·7 [d,e]	1·70 [d,e]	9
93·2	-	828·8	27·1	20	15·8 [a]	0·311 [a]	32·0 [a]	26·5 [a]	5
93·2	-	537·6	44·3		15·0 [a]	0·295 [a]	30·4 [a]	16·3 [a]	5
93·2	-	480	50·1		15·4 [a]	0·302 [a]	31·0 [a]	14·9 [a]	8,37
93·2	-	480	50·1		14·7 [b]	0·288 [b]	- [b]	- [b]	8
93·2	-	480	50·1		14·4 [c]	0·282 [c]	- [c]	- [c]	8
93·2	-	402	60·8		15·3 [a]	0·301 [a]	31·0 [a]	12·5 [a]	8,37
93·0	-	337	73·4		15·2 [a]	0·295 [a]	30·8 [a]	10·4 [a]	5
93·2	-	79·1	325		13·7 [a]	0·368 [a]	37·9 [a]	2·97 [a]	8,37
93·2	-	537·6	44·3	30	13·7 [a]	0·180 [a]	62·5	33·6	5
93·2	-	480	50·1		13·8 [a]	0·181 [a]	62·9 [a]	30·2 [a]	8,37
93·2	-	480	50·1		12·9 [c]	- [c]	- [c]	- [c]	8
93·2	-	342·3	72·4		13·9 [a]	0·182 [a]	63 [a]	21·6 [a]	5
93·2	-	76·4	331		16·3 [a]	0·214 [a]	74·3 [a]	5·79 [a]	8,37
93·2	-	-	331		15·5 [b]	- [b]	- [b]	- [b]	5
93·2	-	-	331		15·2 [c]	- [c]	- [c]	- [c]	5

a. Experimentally determined critical height increased by 0.4 cm to correct for the effect of the $\frac{1}{2}$ in. thick cylinder base

b. Cylinder base 1 in. thick

c. Cylinder base $1\frac{1}{2}$ in. thick

d. Type 3S aluminium cylinder

e. Experiments performed with the core surrounded by a 24 in. dia coaxial iron tank. One experiment repeated without the tank said to show no observable change

Table 5.6

Unreflected Cylinders of Aqueous UO_2F_2 Solution in Stainless Steel Containers

Cylinders : Type 347 Stainless Steel, $\frac{1}{16}$ in. Wall Thickness

These experiments were performed with the core surrounded by a 24 in. diameter co-axial iron tank. One experiment repeated without the tank was said to show no observable change.

CORE				DIAMETER (in.)	DELAYED CRITICAL PARAMETERS				REFERENCE
Uranium Enrichment	Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio		Height (cm)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)	
93·4	-	868·8	24·4	6	>63·1[a]	-[a]	-[a]	>10·0[a]	9
93·4	-	868·8	24·4	7	>43·5[a]	-[a]	-[a]	> 9·38[a]	9
	-	724	31·6		>47·9[a]	-[a]	-[a]	> 8·61[a]	9
	-	538	43·9		>62·0[a]	-[a]	-[a]	> 8·28[a]	9
	-	394	61·1		>87·1[a]	-[a]	-[a]	> 8·52[a]	9
93·4	-	868·8	24·4	8	>31·2[a]	-[a]	-[a]	> 8·79[a]	9
	-	724	31·6		>39·3[a]	-[a]	-[a]	> 9·22[a]	9
	-	538	43·9		>54·8[a]	-[a]	-[a]	> 9·56[a]	9
	-	356	62·7		>71·5[a]	-[a]	-[a]	> 9·18[a]	9
	-	288	86·4		>81·2[a]	-[a]	-[a]	> 7·58[a]	9
	-	205	123·2		>81·7[a]	-[a]	-[a]	> 5·43[a]	9
	-	148	174		>85·8[a]	-[a]	-[a]	> 4·12[a]	9
	-	114	226		>85·8[a]	-[a]	-[a]	> 3·17[a]	9
93·2	-	400	66·0	8·5	>203[ab]	-[ab]	-[ab]	-[ab]	5
93·4	-	868·8	24·4	9	>24·9[a]	-[a]	-[a]	> 8·88[a]	9
	-	724	31·6		>32·0[a]	-[a]	-[a]	> 9·51[a]	9
	-	538	43·9		>50·0	-	-	>20·4	9
	-	396	62·7		>56·0	-	-	> 9·1	9
	-	331·4	74·6		59·0[b]	2·58[b]	24·3[b]	8·1[b]	5
	-	288	86·4		>57·5	-	-	> 6·80	9
	-	205	123·2		>70·0	-	-	> 5·9	9
	-	148	174·0		>46·2[a]	-	-	> 2·81[a]	9
93·4	-	868·8	24·4	10	>28·0	-	-	>12·4	9
	-	827	26·2		>25·0	-	-	>10·5	9
	-	724	31·6		>35·0	-	-	>12·8	9
	-	538	43·9		32·3	1·27	16·36	8·80	9
	-	396	62·7		31·7	1·25	16·05	6·36	9
	-	288	86·4		31·9	1·26	16·16	4·65	9
	-	205	123·2		34·3	1·35	17·35	3·56	9
	-	143	174		38·7	1·52	19·61	2·9	9

Table 5.6 (Cont'd.)

CORE				DIAMETER (in.)	DELAYED CRITICAL PARAMETERS				REFERENCE
Uranium Enrichment	Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio		Height (cm)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)	
93·4	-	114	226	10	46·6	1·83	23·61	2·69	9
	-	80·5	320		>75·0	-	-	3·0	9
	-	52·2	490		45·9[a]	-	-	1·21[a]	9
93·4	-	394	62·6	12	21·7	0·712	-	6·24	9
	-	148	174		24·7	0·809	18·02	2·67	9
	-	114	226		26·2	0·857	19·11	2·18	9
	-	80·5	320		30·3	0·992	22·10	1·78	9
	-	52·2	499		48·9	1·60	35·67	1·86	9
93·4	-	424	56·7	15	17·1	0·449	19·49	8·26	9
	-	116	221		19·5	0·551	22·23	2·58	9
	-	52·2	499		27·0	0·709	30·78	1·61	9
	-	34·3	755		41·7	1·09	47·54	1·63	9
93·4	-	212	119	20	14·3	0·281	28·98	6·14	9
	-	116	221		15·7	0·308	31·81	3·69	9
	-	78·7	329		17·4	0·342	35·25	2·77	9
	-	52·2	499		20·5	0·403	41·45	2·17	9
	-	34·3	755		26·7	0·525	54·10	1·86	9
	-	26·0	999·0		36·0	0·709	-	1·90	9

a. Believed not to be critical at any height

b. No iron tank surrounding core

In the original document, Table 5.7 appeared on a single foldout page number 107. It is reproduced here on the next 2 pages. The column headings appear on each page for convenience.

Table 5.7

Unreflected Cylinders of Aqueous $UO_2(NO_3)_2$ Solution in Aluminium Containers

(Includes Systems with added phosphorus)

Fissile Solutions : Contain small amounts of excess nitric acid.
Phosphorus added as onthophosphoric acid (H_3PO_4)

CYLINDER WALL THICKNESS [a]	URANIUM ENRICHMENT (wt.%)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION (gmU/litre)	H/U^{235} ATOMIC RATIO	N/U^{235} ATOMIC RATIO	P/U^{235} ATOMIC RATIO	DELAYED CRITICAL PARAMETERS					REFERENCE
							Diameter	Height (cm)	Height/Diameter	Volume (litres)	U^{235} Mass (kgm)	
Unpoisoned Solutions												
1/16 in.	93·3	1·55	359	61·8	2·86	Nil	8·0 in.	∞	∞	-	∞	10
1/16 in.	93·3	1·55	359	61·8	2·86	Nil	9·0 in.	∞	∞	-	∞	10
15·9 mm	92·6	1·55	380	59·0	-	Nil	24·1 cm	71·7 [b]	- [b]	-	12·50 [b]	14
15·9 mm	92·6	1·55	380	59·0	-	Nil	25·4 cm	45·8	-	-	8·82	14
1/16 in.	93·3	1·16	105	240	2·86	Nil	10·0 in.	72·4	2·85	-	3·82	10
1/16 in.	93·3	1·17	73	327	7·48	Nil		∞	∞	-	∞	10
1/16 in.	93·3	1·11	73	352	2·86	Nil		∞	∞	-	∞	10
1/16 in.	93·3	1·51	236	88·0	7·48	Nil	12·0 in.	35·2	1·15	-	6·06	10
1/16 in.	93·3	1.23	102	230	7·48	Nil		32·9	1·08	-	2·44	10
1/16 in.	93·3	1·16	105	240	2·86	Nil		29·2	0·958	-	2·23	10
1/16 in.	93·3	1·17	73	327	7·48	Nil		40·2	1·32	-	2·15	10
1/16 in.	93·3	1·11	73	352	2·86	Nil		36·8	1·21	-	1·94	10
1/16 in.	93·3	1·08	53	493	2·86	Nil		49·5	1·62	-	1·91	10
1/16 in.	93·3	1·06	36	733	2·86	Nil		∞	∞	-	∞	10

CYLINDER WALL THICKNESS [a]	URANIUM ENRICHMENT (wt.%)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION (gmU/litre)	H/U^{235} ATOMIC RATIO	N/U^{235} ATOMIC RATIO	P/U^{235} ATOMIC RATIO	DELAYED CRITICAL PARAMETERS					REFERENCE
							Diameter	Height (cm)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)	
Unpoisoned Solutions												
15·9 mm	92·6	1·55	380	59·0	-	Nil	30·5 cm	25·8	-	-	7·45	14
15·9 mm	92·6	1·55	380	59·0	-	Nil	38·1 cm	19·7	-	-	8·51	14
1/16 in.	93·3	1·51	236	88·0	7·48	Nil	15 in.	22·6	0·593	-	6·09	10
1/16 in.	93·3	1·23	102	230	7·48	Nil		22·7	0·596	-	2·63	10
1/16 in.	93·3	1·16	105	240	2·86	Nil		20·9	0·549	-	2	10
1/16 in.	93·3	1·17	73	327	7·48	Nil		25·1	0·659	-	2·09	10
1/16 in.	93·3	1·11	73	352	2·86	Nil		24·0	0·630	-	1·99	10
1/16 in.	93·3	1·08	53	493	2·86	Nil		28·3	0·743	-	1·71	10
1/16 in.	93·3	1·06	36	733	2·86	Nil		44·6	1·17	-	1·79	10
Phosphorus Poisoned Solutions												
1/16 in.	93·3	1·67	55	316	2·9	53·1	15 in.	43·2	1·13	-	2·72	10

a. Type 3S aluminium

b. Experimentally determined critical height increased by 0·4cm to correct for the effect of the $\frac{1}{2}$ in. thick cylinder base

EXPERIMENTAL RESULTS FOR SINGLE U^{235} CORES MODERATED BY HYDROGEN

Table 5.8

Unreflected Cylinders of Aqueous $UO_2(NO_3)_2$ Solution in Stainless Steel Containers

Fissile Solution : Contained small amounts of excess nitric acid

URANIUM ENRICHMENT (wt %)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION			H/U^{235} ATOMIC RATIO	N/U^{235} ATOMIC RATIO	DELAYED CRITICAL PARAMETERS					REFERENCE
		U^{235} (gm/litre)	Uranium (gm/gm)	Total Nitrate Ion, NO_3 (gm/gm)			Diameter	Height	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)	
92·8	-	25·9	-	-	1,000	3·8	50·8 cm	38·3 cm	0·754	77·7	2·01	7
92·8	-	16·13	-	-	1,604	3·8	154·7 cm	45·1 cm	0·292	848	13·68	7
93·22	1·0229	-	0·01692	0·0128	1,604	3·08	60·92 in.	18·31 in.	-	-	-	4
93·03	1·0247	-	0·01661	0·0142	1,634	3·47	60·92 in.	19·20 in.	-	-	-	4
92·8	-	14·22	-	-	1,821	3·8	154·7 cm	72·7 cm	0·470	1,368	19·45	7
93·12	1·0209	-	0·01496	0·0120	1,821	3·25	60·92 in.	29·23 in.	-	-	-	4
92·8	-	13·59	-	-	1,905	3·8	154·7 cm	105·2 cm	0·680	1,978	26·88	7
93·11	1·0204	-	0·01431	0·0122	1,905	3·47	60·92 in.	42·06 in.	-	-	-	4
92·8	-	13·07	-	-	1,981	3·8	154·7 cm	203·3 cm	1·31	3,822	49·95	7
93·01	1·0197	-	0·01379	0·0126	1,981	3·71	60·92 in.	80·68 in.	-	-	-	4
92·8	-	13·24	-	-	1,951	3·8	274 cm	90·9 cm	0·332	5,340	70·8	7
92·79	1·0194	-	0·01400	0·0142	1,955	4·15	107·7 in.	35·8 in.	-	-	-	4
92·8	-	12·92	-	-	2,000	3·8	274 cm	122·4 cm	0·447	7,190	92·3	7
92·78	1·0218	-	0·01366	0·0138	2,004	4·13	107·7 in.	47·0 in.	-	-	-	4
92·8	-	12·61	-	-	2,052	3·8	274 cm	241·2 cm	0·880	14,180	178·8	7
92·82	1·0210	-	0·01333	0·0135	2,052	4·14	107·7 in.	94·9 in.	-	-	-	4

Table 5.9

Cylinders of Aqueous UO_2F_2 Solution in Aluminium Containers with Full Water Reflector

Cylinders $\frac{1}{16}$ in. wall thickness

CORE				REFLECTOR THICKNESS (in.)	DIAMETER (ins)	DELAYED CRITICAL CORE PARAMETERS				REFERENCE
Uranium Enrichment (wt %)	Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio			Height (cm)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)	
93·2	-	537·6	44·3	Eff. Inf.	5·5	>22·8[a]	- [a]	- [a]	- [a]	5, 8
93·4	-	424	56·7	>4½[c]		>74·3[a,b]	- [a,b]	- [a,b]	>4·83[a,b]	9
93·2	-	828·8	27·1	Eff. Inf.	6	89·3[d]	5·85 [d]	16·25[d]	13·47[d]	5
93·2	-	532	43·2	Eff. Inf.		70·1[d]	4·60 [d]	12·8 [d]	6·87[d]	8
93·4	-	459	52·9	>4½[c]		70·9[b]	4·64 [b]	12·93[b]	5·93[b]	9
93·4	-	415	58·8	>4½[c]		71·8[b]	4·71 [b]	13·10[b]	5·44[b]	9
93·4	-	212	119·0	>4½[c]		>72·6[a]	- [a]	- [a]	>2·81[a]	9
93·4	-	827	26·2	>4½[c]	6·5	44·5[b]	2·70 [b]	9·56[b]	7·91[b]	9
93·2	-	537·6	44·3	Eff. Inf.		38·7[b]	2·34 [b]	8·25[b]	4·45[b]	5
93·4	-	459	52·9	>4½[c]		39·2[b]	2·37 [b]	8·39[b]	3·85[b]	9
93·4	-	424	56·7	>4½[c]		40·4[b]	2·44 [b]	8·65[b]	3·67[b]	9
93·2	-	315	78·7	Eff. Inf.		42·6	2·58	9·12	2·87	7
93·4	-	212	119·0	>4½[c]		52·6[b]	3·19 [b]	11·26[b]	2·39[b]	9
93·4	-	116	221	>4½[c]		>61·6[a,b]	- [a,b]	- [a,b]	>1·47[a,b]	9
93·4	-	827	26·2	>4½[c]	8	21·5[b]	1·06 [b]	6·92[b]	5·76[b]	9
93·4	-	759	29·9	>4½[c]		20·7[b]	1·02 [b]	6·71[b]	5·09[b]	9
93·2	-	537	43·2	Eff. Inf.		18·6[d]	0·915[d]	6·05[d]	3·25[d]	8
93·2	-	488	49·5	Eff. Inf.		18·8	0·925	6·09	2·97	7
93·4	-	459	52·9	>4½[c]		19·5[b]	0·960[b]	6·32[b]	2·90[b]	9
93·4	-	415	58·8	>4½[c]		20·5[b]	1·01 [b]	6·65[b]	2·76[b]	9
93·2	-	315	78·7	Eff. Inf.		19·4	0·955	6·28	1·98	7
93·4	-	254	99·5	>4½[c]		22·4[b]	1·10 [b]	7·26[b]	1·84[b]	9
93·4	-	134	192·0	>4½[c]		28·1[b]	1·38 [b]	9·11[b]	1·22[b]	9
93·4	-	88·1	290·0	>4½[c]		40·1[b]	1·97 [b]	13·00[b]	1·15[b]	9
93·4	-	52·2	499	>4½[c]		>74·5[a,b]	- [a,b]	- [a,b]	>1·26[a,b]	9
93·2	-	828·8	27·1	Eff. Inf.	10	12·4[d]	0·488[d]	6·3 [d]	5·2 [d]	5
93·2	-	537	43·2	Eff. Inf.		12·5[d]	0·492[d]	6·34[d]	3·40[d]	8
93·2	-	488	49·5	Eff. Inf.		12·6	0·496	6·25	3·10	7
93·4	-	459	52·9	>4½[c]		13·4[b]	0·527[b]	6·79[b]	3·12[b]	9

Table 5.9 (Cont'd.)

CORE				REFLECTOR THICKNESS (in.)	DIAMETER (ins)	DELAYED CRITICAL CORE PARAMETERS				REFERENCE
Uranium Enrichment (wt %)	Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio			Height (cm)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)	
93·2	-	199	127	Eff. Inf.		14·4	0·566	7·30	1·45	7
93·4	-	78·7	328·7	> $4\frac{1}{2}$[c]		22·4[b]	0·882[b]	11·35[b]	0·893[b]	9
93·4	-	55·2	499	> $4\frac{1}{2}$[c]		35·2[b]	1·39[b]	17·83[b]	0·930[b]	9
93·4	-	34·3	755	> $4\frac{1}{2}$[c]		> 56·4[a,b]	-[a,b]	-[a,b]	> 0·98[a,b]	9
93·2	-	828·8	27·1	Eff. Inf.	15	7·7[d]	0·202[d]	8·8[d]	7·3[d]	5
93·4	-	459	52·9	> $4\frac{1}{2}$[c]		7·90[b]	0·207[b]	9·01[b]	4·14[b]	9
93·4	-	424	56·7	> $4\frac{1}{2}$[c]		8·50[b]	0·223[b]	9·69[b]	4·11[b]	9
93·4	-	116	221·0	> $4\frac{1}{2}$[c]		11·30[b]	0·296[b]	12·88[b]	1·49[b]	9
93·4	-	55·2	499·0	> $4\frac{1}{2}$[c]		16·90[b]	0·448[b]	19·27[b]	1·01[b]	9
93·4	-	34·3	755·0	> $4\frac{1}{2}$[c]		27·10[b]	0·710[b]	29·75[b]	1·02[b]	9
93·4	-	26·0	999·0	> $4\frac{1}{2}$[c]		44·30[b]	1·16[b]	50·50[b]	1·31[b]	9

a. Believed not to be critical at any height

b. Type 3S aluminium cylinder

c. These experiments were performed inside a 24 in. dia water tank, maintaining at least $4\frac{1}{2}$ in. of water on the core bottom. A small aluminium water tank, 6 in. deep and fitting snugly into the core cylinder provided reflection to the top surface of the core

d. Experimentally determined critical height reduced by 0·7 cm to correct for the effect of the $\frac{1}{2}$ in. thick cylinder base

Table 5.10

Cylinders of Aqueous UO_2F_2 Solution in Stainless Steel Containers with Full Water Reflector

Cylinders: Type 347 Stainless Steel, $\frac{1}{16}$ ins. wall thickness

SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION (gm U^{235}/litre)	CORE		REFLECTOR THICKNESS (in.)	DELAYED CRITICAL CORE PARAMETERS					REFERENCE
		Uranium Enrichment (wt %)	H/U^{235} Atomic Ratio		Diameter (ins)	Height (cms)	Height/Diameter	Volume (litres)	U^{235} Mass (kgm)	
-	868·8	93·4	24·4	> $4\frac{1}{2}$ [b]	6	> 56·9 [a]	- [a]	- [a]	> 9·02 [a]	9
-	724	93·4	31·6	> $4\frac{1}{2}$ [b]		> 66·6 [a]	- [a]	- [a]	> 8·80 [a]	9
-	537·6	93·2	44·3	Eff.Inf		118·4	7·76	21·55	11·59	5
-	394	93·4	61·1	> $4\frac{1}{2}$ [b]		> 87·6 [a]	- [a]	- [a]	> 6·30 [a]	9
-	331·4	93·2	74·6	Eff.Inf		>143·7 [a]	- [a]	- [a]	- [a]	5
-	288	93·4	86·4	> $4\frac{1}{2}$ [b]		> 72·9 [a]	- [a]	- [a]	> 3·83 [a]	9
-	724	93·4	31·6	> $4\frac{1}{2}$ [b]	6·5	49·0	2·96	10·49	7·59	9
-	538		43·9	> $4\frac{1}{2}$ [b]		47·1	2·85	10·08	5·42	9
-	396		62·7	> $4\frac{1}{2}$ [b]		47·9	2·90	10·25	4·06	9
-	288		86·4	> $4\frac{1}{2}$ [b]		53·8	3·26	11·51	3·31	9
-	205		123·2			80	4·85	-	3·50	9
-	148		174·0	> $4\frac{1}{2}$ [b]		>72·3 [a]	- [a]	- [a]	> 2·29 [a]	9
-	869	93·4	24·4	> $4\frac{1}{2}$ [b]	7	35·4	1·98	8·79	7·63	9
-	724		31·6	> $4\frac{1}{2}$ [b]		34·0	1·91	8·44	6·11	9
-	538		43·9	> $4\frac{1}{2}$ [b]		32·7	1·84	8·12	4·37	9
-	394		61·1	> $4\frac{1}{2}$ [b]		32·6	1·83	8·09	3·19	9
-	288		86·4	> $4\frac{1}{2}$ [b]		36·0	2·02	8·94	2·57	9
-	205		123·2	> $4\frac{1}{2}$ [b]		42·3	2·38	10·50	2·15	9
-	148		174	> $4\frac{1}{2}$ [b]		57·3	3·22	14·22	2·10	9
-	114		226	> $4\frac{1}{2}$ [b]		>69·9	-	-	> 1·98	9
-	869	93·4	24·4	> $4\frac{1}{2}$ [b]	8	23·4	1·15	7·59	6·59	9
-	827		26·2	> $4\frac{1}{2}$ [b]		23·5	1·16	7·62	6·30	9
-	724		31·6	> $4\frac{1}{2}$ [b]		22·6	1·11	7·33	5·31	9
-	538		43·9	> $4\frac{1}{2}$ [b]		21·9	1·08	7·10	3·82	9
-	424		56·7	> $4\frac{1}{2}$ [b]		22·2	1·09	7·20	3·05	9
-	415		58·8	> $4\frac{1}{2}$ [b]		20·8	1·02	6·74	2·80	9
-	396		62·7	> $4\frac{1}{2}$ [b]		22·9	1·13	7·42	2·94	9
-	288		86·4	> $4\frac{1}{2}$ [b]		23·8	1·17	7·72	2·22	9
-	254		99·5	> $4\frac{1}{2}$ [b]		24·2	1·19	7·85	1·99	9
-	205		123·2	> $4\frac{1}{2}$ [b]		26·0	1·28	8·43	1·73	9
-	148		174	> $4\frac{1}{2}$ [b]		30·1	1·48	9·76	1·44	9
-	134		192	> $4\frac{1}{2}$ [b]		29·4	1·45	9·53	1·28	9
-	114		226	> $4\frac{1}{2}$ [b]		36·3	1·79	11·77	1·34	9
-	80·5		320	> $4\frac{1}{2}$ [b]		60·1	2·96	19·48	1·57	9
-	869	93·4	24·4	> $4\frac{1}{2}$ [b]	9	18·4	0·805	7·55	6·56	9

Table 5.10 (Contd)

SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION (gm U^{235}/litre)	CORE		REFLECTOR THICKNESS (in.)	DELAYED CRITICAL CORE PARAMETERS					REFERENCE
		Uranium Enrichment (wt %)	H/U^{235} Atomic Ratio		Diameter (ins)	Height (cms)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)	
-	724		31·6	> 4½[b]		18·1	0·791	7·43	5·38	9
-	538		43·9	> 4½[b]		17·8	0·778	7·30	3·93	9
-	396		62·7	> 4½[b]		18·0	0·787	7·39	2·93	9
-	288		86·4	> 4½[b]		18·7	0·816	7·67	2·21	9
-	205		123·2	> 4½[b]		19·9	0·870	8·16	1·67	9
-	148		174	> 4½[b]		22·2	0·970	9·11	1·35	9
-	114		226	> 4½[b]		25·3	1·11	10·38	1·18	9
-	80·5		320	> 4½[b]		33·0	1·44	13·54	1·09	9
-	52·2		499	> 4½[b]		> 40·5	-	-	> 0·87	9
-	869	93·4	24·4	> 4½[b]	10	15·3	0·603	7·75	6·73	9
-	724		31·6	> 4½[b]		-	-	-	5·61	9
-	538		43·9	> 4½[b]		14·9	0·586	7·55	4·06	9
-	396		62·7	> 4½[b]		15·2	0·598	7·70	3·05	9
-	288		86·4	> 4½[b]		15·4	0·606	7·80	2·25	9
-	205		123·2	> 4½[b]		16·8	0·661	8·51	1·74	9
-	148		174	> 4½[b]		18·1	0·713	9·17	1·36	9
-	114		226	> 4½[b]		20·0	0·788	10·13	1·15	9
-	80·5		320	> 4½[b]		25·0	0·985	12·67	1·02	9
-	52·2		499	> 4½[b]		40·7	1·60	-	1·08	9
-	394	93·4	62·6	> 4½[b]	12	12·3	0·403	8·97	3·53	9
-	148		174	> 4½[b]		14·9	0·488	10·87	1·61	9
-	114		226	> 4½[b]		16·5	0·541	12·04	1·37	9
-	80·5		320	> 4½[b]		18·5	0·606	13·50	1·09	9
-	52·2		499	> 4½[b]		26·3	0·862	19·19	1·00	9
-	34·3		755	> 4½[b]		48·7	1·60	35·53	1·22	9
-	26·2		999·0	> 4½[b]		> 69·0[a]	-[a]	-[a]	> 1·31[a]	9
-	42·4	93·4	56·7	> 4½[b]	15	10·1	0·265	11·51	4·88	9
-	116		221	> 4½[b]		13·0	0·341	14·82	1·72	9
-	52·2		499	> 4½[b]		20·0	0·525	22·12	1·15	9
-	34·3		755	> 4½[b]		28·8	0·755	32·83	1·13	9
-	26·2		999·0	> 4½[b]		52·4	1·38	-	1·55	9

a. Believed not to be critical at any height

b. These experiments were performed inside a 24 inch diameter water tank, maintaining at least 4½ inches of water on the core bottom. A small aluminium water tank, 6 inches deep and fitting snugly into the core cylinder provided reflection to the top surface of the core.

Table 5.11

Cylinders of Aqueous $UO_2(NO_3)_2$ Solution with Full Water Reflector

(Includes Systems With Added Phosphorus)

Reference : 10
Fissile Solutions : Uranium enrichment 93·3%
Solutions contain small amounts of excess nitric acid.
Phosphorus added as orthophaspheric acid (H_3PO_4).
Cylinders : 1/16 in. thick Type 3S aluminium.
Reflector Thickness: Effectively infinite.

CORE					DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235}	N/U^{235}	P/U^{235}	Diameter (ins.)	Height (cms)	Height / Diameter	U^{235} Mass (kgm)
Unpoisoned Solutions								
-	359	61·8	2·86	NIL	8·0	25·5	1·25	2·97
-	105	240	2·86			36·7	1·81	1·24
-	359	61·8	2·86	NIL	9·0	19·7	0·862	2·90
-	236	88·0	7·48			27·7	1·21	2·69
-	105	240	2·86			25·3	1·11	1·08
-	73	352	2·86			35·0	1·53	1·04
-	359	61·8	2·86	NIL	10·0	16·6	0·654	3·02
-	236	88·0	7·48			22·4	0·882	2·67
-	102	230	7·48			22·6	0·890	1·17
-	105	240	2·86			20·1	0·791	1·06
-	73	327	7·48			28·2	1·11	1·05
-	73	352	2·86			26·2	1·03	0·96
-	53	493	2·86			37·0	1·46	1·00
-	236	88·0	7·48	NIL	12·0	16·3	0·535	2·81
-	102	230	7·48			16·8	0·551	1·25
-	105	240	2·86			15·1	0·495	1·15
-	73	327	7·48			20·0	0·656	1·07
-	73	352	2·86			19·3	0·633	1·02
-	53	493	2·86			24·6	0·807	0·95
-	36	733	2·86			43·2	1·41	1·11
-	359	61·8	2·86	NIL	15·0	9·4	0·247	3·85
-	236	88·0	7·48			12·7	0·333	3·42
-	102	230	7·48			13·2	0·346	1·53
-	105	240	2·86			12·2	0·320	1·45
-	73	327	7·48			15·1	0·396	1·26
-	73	352	2·86			14·4	0·378	1·20
-	53	493	2·86			17·9	0·470	1·08
-	36	733	2·86			26·7	0·701	1·07

Table 5.11 (Contd.)

CORE					DELAYED CRITICAL CORE PARAMETER			
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235}	N/U^{235}	P/U^{235}	Diameter (ins)	Height (cms)	Height / Diameter	U^{235} Mass (kgm)
Phosphorus Poisoned Solutions								
-	55	316	2·9	53·1	12·0	43·5	1·43	1·75
-	11	180	5·5	12·4	15·0	18·9	0·496	2·5
-						15·4	0·404	2·0
-	55	316	2·9	53·1		26·8	0·703	1·69
-						29·5	0·774	1·86

Table 5.12 (a)

Partially Water Reflected Cylinders of Aqueous UO_2F_2 Solution

(see also Table 5.12 (b), (c), (d))

Reference: 8

Fissile Solution: Uranium enrichment, 93·2 wt%
Specific gravity, -
Concentration, 537 gmU^{235}/litre
H/U^{235} Atomic Ratio, 43·2

Cylinders: 1/16 in. thick aluminium

Reflector: Effectively infinite thickness, but with a void space immediately above the fissile solution the thickness of which is noted in the table.

REFLECTOR VOID THICKNESS (cm)	DELAYED CRITICAL CORE PARAMETERS				
	Diameter (ins)	Height (cms)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)
nil	10	12·5	-	-	-
1		13·6	-	-	-
2		13·75	-	-	-
4		14·15	-	-	-
6		14·5	-	-	-

Table 5.12 (b)

Partially Water Reflected Cylinders of Aqueous UO_2F_2 Solution

(See also Tables 5.12 (a), (c), (d))

Uranium enrichment: 93·2 wt%

Cylinders: $\frac{1}{16}$ in. thick aluminium

Reflector: Effectively infinite thickness on bottom and sides of core to a height equal to that of the fissile solution.

CORE			DELAYED CRITICAL CORE PARAMETERS					REFERENCE
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio	Diameter (ins.)	Height (cms)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)	
-	537·6	44·3	6	75·0[a]	4·92 [a]	13·65[a]	7·34[a]	5
-	537·6	44·3	7·5	25·7[a]	1·35 [a]	7·32[a]	3·93[a]	5
-	537·6	44·3	8	23·6[a]	1·16 [a]	7·67[a]	4·12[a]	5
-	342·3	72·4		23·3[a]	1·15 [a]	7·57[a]	2·59[a]	5
-	488	49·5	10	16·5	0·650	8·35	4·08	7
-	342·3	72·4		16·7[a]	0·658[a]	8·48[a]	2·90[a]	5
-	337	73·4		16·8[a]	0·661[a]	8·53[a]	2·87[a]	5
-	331·4	74·6	15	12·0[a]	0·315[a]	13·7 [a]	4·5 [a]	5
-	342·3	72·4	20	10·6[a]	0·285[a]	21·5 [a]	7·3 [a]	5
-	342·3	72·4	30	9·2[a]	0·121[a]	42·9 [a]	14·4 [a]	5

a. Experimentally determined critical height reduced by 0·7 cm to correct for the effect of the ½ in. thick cylinder base

Table 5.12 (c)

Partially Water Reflected Cylinders of Aqueous UO_2F_2 Solution

(see also Table 5.12 (a) (b) (d))

Reference: 9

Fissile Solution: Uranium enrichment, 93·4 wt%
Concentration, 459 gm U^{235}/litre
H/U^{235} Atomic Ratio, 52·9

Cylinder: $\frac{1}{16}$ in. thick Type 3S aluminium

Reflector: Effectively infinite thickness on bottom and side of core to the height shown in the table. The experiments were performed inside a 24 in. dia. water tank maintaining at least $4\frac{1}{2}$ in. water on the core bottom.

REFLECTOR HEIGHT (see notes prefacing Table) (cms)	DELAYED CRITICAL CORE PARAMETERS				
	Diameter (ins.)	Height (cms)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)
82·5	10	15·25	-	-	-
55·5		15·50	-	-	-
22·5		15·75	-	-	-
16·75		16·75	-	-	-
8·25		23·75	-	-	-
NIL		29·0	-	-	-

Table 5.12 (d)

Partially Water Reflected Cylinders of Aqueous UO_2F_2

(See also Tables 5.12 (a), (b), (c)
Reference: 8
Uranium enrichment: 93·2 wt%
Cylinders: $\frac{1}{16}$ in. thick aluminium

CORE			REFLECTOR GEOMETRY	DELAYED CRITICAL CORE PARAMETERS				
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio		Diameter (in.)	Height (cms)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)
-	470	51·5	Effectively infinite reflector separated from core on the lateral surface only by a 6 in. thick annular air-gap	8	66·4	-	21·6	10·2
			6 in. thick radial reflector only	-	25·3	-	8·2	3·85
			6 in. thick on half (180°) of radial surface only	-	46·1	-	15·0	7·05
-	78·5	328	4 in. thick on bottom and on one half (180°) of radial surface	10	38·0	-	19·3	1·52

Table 5.13 (a)

Cylinders of Aqueous $UO_2(NO_3)_2$ Solution with Partial Water and/or Lucite Reflector

REFERENCES: 10, 14

Fissile Solution: Uranium enrichment, 93·3 wt%
N/U^{235} atomic ratio, = 2·86

Cylinders: $\frac{1}{16}$ in. thick type 3S aluminium

Reflector: Effectively infinite thickness but separated from the core radially by an annular air gap. The air gap was maintained by a series of nesting concentric annuli split longitudinally along a diameter and fabricated in $\frac{1}{16}$ in. aluminium. The outside thickness of the four inner annuli, measured along a radius, was 1 in. and the thickness of the remaining annulus 2 in.

CORE			REFLECTOR VOID THICKNESS (ins.)	DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gm U/litre)	H/U^{235} Atomic Ratio		Diameter (ins.)	Height (cm)	Height/Diameter	U^{235} Mass (kgm)
-	359	61·8	1·0	10	19·0	0·748	3·45
			2·0		21·0	0·827	3·81
			3·0		22·4	0·882	4·08
			4·0		23·6	0·929	4·28
-	105	240	1·0	10	24·0	0·945	1·27
			2·0		26·5	1·04	1·40
			4·0		72·4	2·85	1·57

Table 5.13 (b)

Cylinders of Aqueous $UO_2(NO_3)_2$ Solution with Partial Water and/or Lucite Reflector

(see also Tables 5.13(a)(c)(d))

Reference : 15
Uranium enrichment : > 90 wt%
Cylinders : $\frac{1}{8}$ in. thick stainless steel

Reflector: 10 in. thick Lucite on core bottom and 8 in. thick water on side to a height equal to that of the fissile solution (see Figure 5.1). There are said to be indications that the upper base plate acted as a partial top reflector; the magnitude of this effect was not measured, however.

CORE				DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration	H/U^{235} Atomic Ratio	N/U^{235} Atomic Ratio	Diameter (ins.)	Height (cm)	Height / Diameter	U^{235} Mass (kgm)
-	-	1633 ± 2	-	35·48	58·7	-	5·91
-	-	1688	-		69·2	-	6·75
-	-	1710	-		75·2	-	7·24
-	-	1721	-		79·1	-	7·57
-	-	1739	-		86·6	-	8·20
-	-	1757	-		95·5	-	8·95
-	-	1773	-		106·2	-	9·87
-	-	1776	-		110·0	-	10·21

Table 5.13 (c)

Cylinders of Aqueous $UO_2(NO_3)_2$ Solution with Partial Water and/or Lucite Reflector

(see also Tables 5.13(a)(b)(d))

Reference : 10
Uranium enrichment : 93·3 wt%.
Cylinders : $\frac{1}{16}$ in. thick Type 3S Aluminium
Reflector : Radial Reflector only, contained in a series of nesting concentric annuli split longitudinally along a diameter and fabricated in $\frac{1}{16}$ in. aluminium. The outside thickness of the four inner annuli, measured along a radius, was 1 in. and the thickness of the remaining annuli 2 in.

CORE				REFLECTOR THICKNESS (See notes prefacing Table) (in.)	DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gmU/litre)	H/U^{235} Atomic Ratio	N/U^{235} Atomic Ratio		Diameter (in.)	Height (cm)	Height / Diameter	U^{235} Mass (kgm)
-	359	61·8	2·86	0·88	10	28·6	1·13	5·20
				1·75		24·6	0·969	4·47
				2·63		23·3	0·917	4·24
				3·50		22·9	0·902	4·16
	105	240	2·86	0.88	10	33·6	1·32	1·78
				1·75		28·4	1·12	1·51
				2·63		26·9	1·06	1·42
				3·50		26·6	1·05	1·41
-	73	352	2·86	0·88	10	43·9	1·73	1·61
				1·75		35·3	1·39	1·30
				3·50		32·5	1·28	1·20

Table 5.13 (d)

Cylinders of Aqueous $UO_2(NO_3)_2$ Solution with Partial Water and/or Lucite Reflector

(See also Tables 5.13(a)(b)(c))

Reference : 15
Uranium enrichment : > 90 wt%
Cylinders : 8 in. thick Stainless Steel

Reflector : 10 in. thick Lucite Bottom Reflector only; See Figure 5.1. There are said to be indications that the upper base plate acted as a partial top reflector; the magnitude of this effect was not measured, however.

CORE				DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration	H/U^{235} Atomic Ratio	N/U^{235} Atomic Ratio	Diameter (in.)	Height (cm)	Height/Diameter	U^{235} Mass (kgm)
-	-	1633	-	35·48	61·7	-	6·21
-	-	1688	-		74·2	-	7·24
-	-	1710	-		81·5	-	7·85
-	-	1721	-		86·1	-	8·24
-	-	1739	-		95·3	-	9·03
-	-	1757	-		106·7	-	10·00
-	-	1773	-		120·9	-	11·24
-	-	1776	-		127·0	-	11·78

Table 5.14

Cadmium Clad Cylinders of aqueous UO_2F_2 Solution with Water Reflector

Reference : 9
Uranium Enrichment : 93·4 wt%
Cylinders : $\frac{1}{16}$ inch thick Type 347 Stainless Steel Clad with 0·44 gm/sq. cm Cadmium.
Reflector Thickness : These experiments were performed inside a 24 inch diameter water tank, maintaining at least $4\frac{1}{2}$ inches water on the core bottom. A small aluminium water tank, 6 inches deep and fitting snugly into the core cylinder provided reflection to the top of the core.

CORE			DIAMETER (in.)	DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio		Height (cm)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)
-	724	31·6	7	> 50·3 [a]	- [a]	- [a]	> 9·04 [a]
-	238	86·4		> 71·9 [a]	- [a]	- [a]	> 5·15 [a]
-	868·8	24·4	8	> 30·8	-	-	> 8·69
-	724	31·6		> 35·9 [a]	-	-	> 8·43 [a]
-	538	43·9		51·5	2·54	16·70	8·98
-	396	62·7		48·4	2·38	15·69	6·21
-	288	86·4		56·5	2·78	18·32	5·28
-	868·8	24·4	9	> 24·7	-	-	> 8·80
-	724	31·6		29·0	1·27	11·90	8·62
-	538	43·9		28·8	1·26	11·82	6·36
-	396	62·7		28·3	1·24	11·64	4·61
-	288	86·4		29·2	1·28	11·98	3·45
-	205	123·2		32·0	1·40	13·13	2·69
-	148	174·0		37·3	1·63	15·30	2·26
-	114	226·0		> 41·2	-	-	> 1·93
-	805	320		> 40·5 [a]	- [a]	- [a]	> 1·34 [a]
-	868·8	24·4	10	23·4	0·921	-	10·3
-	724	31·6		21·1	0·832	10·69	7·74
-	538	43·9		21·4	0·843	10·84	5·83
-	396	62·7		22·0	0·866	11·15	4·42
-	288	86·4		-	-	-	3·21
-	116	221·0		28·7	1·13	14·54	1·69
-	827	26·2	12	15·5	0·509	-	9·35
-	424	56·7		15·8	0·518	11·53	4·89
-	148	174·0		19·5	0·639	14·22	2·10
-	114	226·0		20·9	0·685	15·25	1·74
-	52	499·0		32·8	1·08	25·93	1·25
-	34·3	755·0		> 58·3 [a]	- [a]	- [a]	> 1·46 [a]

a. Believed not be critical at any height

Table 5.15

Cylinders of Aqueous Solution with Beryllium Oxide/Graphite Reflector

Reference : 32

Fissile Solution : Fissile Material, UO_2SO_4 at 89·84 wt% enrichment. Solutions contain approx. 4·9 gm/litre sulphuric acid.

Cylinder : Zircalloy, 25 cm dia. x 30 cm, wall thickness 1 mm. [a] A 6 mm x 8 mm solution feed pipe was attached to the centre base of the cylinder and the top was closed by a cover surmounted by two 20 mm dia. and one 10 mm dia. access tubes.
The cylinder including feed pipe, was wrapped in a layer of blotting paper and then enclosed within a close-fitting aluminium jacket. A gap of 1-2 mm then intervened between the aluminium jacket and the reflector.

Reflector [b] A parallelepiped of beryllium oxide (average density 2·95 gm/cc) giving a minimum thickness in any direction of 27·5 cm enclosed in a layer of graphite (average density 1·65 gm/cc) 50 cm thick. The portion of the reflector located in the upward projection of the tank was a removeable plug resting on an aluminium plate 2 cm thick.

CORE			DELAYED CRITICAL CORE PARAMETERS				
Specific Gravity of Solution	Solution Concentration (gm U/litre)	H/U^{235} Atomic Ratio	Diameter (cm)	Height (cm)	Height / Diameter	Volume (litres)	Uranium Mass (gm)
-	36·588	-	25	23·875	-	11·500	420·76
-	37·597	-		22·785	-	10.990	413·19
-	38·234	-		22·38	-	10.790	412·43
-	39·17	-		21·83	-	10.530	412·44
-	39·665	-		21·418	-	10.340	410.13
-	40.383	-		21·013	-	10.150	409·85
-	41·6	-		20.44	-	9·880	411
-	43·062	-		19·71	-	9·530	410.38
-	43·66	-		19·4	-	9·380	409·59
-	46·14	-		18·275	-	8·850	408·35

a The thickness of the cylinder cover and base is different from that of the walls. An "effective uniform thickness" of 1·4-2·1 mm is evaluated by calculation

b This reflector is shown by calculation to be equivalent to a 60 cm thick beryllium oxide reflector, increasing the critical mass by only one 1% relative to the infinite beryllium oxide reflector

Table 5.16

Cylinders of Aqueous Solution with Iron Reflector
(with Added Phosphorus)

Reference : 33

Fissile Solution : 93·5 wt% enriched UO_3 dissolved in 4·3 Molar Orthophosphoric acid (H_3PO_4)

Cylinder : 0·1 cm thick stainless steel

Reflector Thickness : 9 cm

CORE				DELAYED CRITICAL CORE PARAMETERS				
Density of Solution (gm/cc)	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio	P/U^{235} Atomic Ratio	Diameter (cm)	Height (cm)	Height / Diameter	Volume (litres)	Mass (kgm)
1·326	120	198	-	31·5	16·4	-	12·8	1·53
1·316	108	220	-		17·2	-	13·4	1·45
1·308	96	248	-		18·0	-	14·0	1·34
1·293	80	300	-		19·5	-	15·2	1·22

Table 5.17

Cylinders of Aqueous Solutions with Stainless Steel Reflector

Reference : 10

Fissile Solution : $UO_2(NO_3)_2$ at 93·3 wt% enrichment. Solutions contained small amounts of excess nitric acid, N/U^{235} atomic ratio = 2·86

Cylinders : $\frac{1}{16}$ in. thick - Type 3S aluminium

Reflector : Type 347 Stainless steel, density 7·9 gm/cc. Radial reflector only.

CORE			REFLECTOR THICKNESS	DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gm U/litre)	H/U^{235} Atomic Ratio		Diameter (in.)	Height (cm)	Height / Diameter	U^{235} Mass (kgm)
1·55	359	61·8	1·50 in.	8·0	47·8	2·35	5·56
			2·00 in.		39·7	1·95	4·63
			3·00 in.		33·2	1·63	3·86
			3·50 in.		31·5	1·55	3·66
1·55	359	61·8	1·00 in.	10·0	28·0	1·10	5·09
			2·50 in.		21·2	0·835	3·85
1·16	105	240	0·25 in.		47·3	1·86	2·51
			0·50 in.		39·5	1·56	2·09
			1·00 in.		32·8	1·29	1·73
			2·50 in.		26·8	1·06	1·42
1·11	73	352	0·50 in.		58·7	2·31	2·15
			0·75 in.		48·6	1·91	1·78
			1·50 in.		37·3	1·47	1·37
			2·50 ft.		33·1	1·30	1·22
1·08	53	403	2·50 in.		47·6	1·87	1·28

Table 5.18

Cylinders of Aqueous Solutions with Stainless Steel/Water Reflector

Reference : 10

Fissile Solution : $UO_2(NO_3)_2$ at 93·3 wt% enrichment. Solutions contained small amounts of excess nitric acid, N/U^{235} atomic ratio = 2·86

Cylinders : $\frac{1}{16}$ in. thick-type 3S aluminium.

Reflector : Effectively infinite thickness water separated from the core radially by an annulus of Type 347 stainless steel, density 7·9 gm/cc.

CORE			STAINLESS STEEL REFLECTOR THICKNESS (see notes prefacing Table)(in.)	DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gm U/litre)	H/U^{235} Atomic Ratio		Diameter (in.)	Height (cm)	Height / Diameter	U^{235} Mass (kgm)
1·55	359	61·8	2·00	8·0	27·4	1·35	3·18
			3·50		24·2	1·19	2·82
1·55	359	61·8	0·50	10·0	18·6	0·732	3·39
			1·00		18·0	0·709	3·27
			2·50		16·4	0·646	2·98
1·16	105	240	0·25		23·4	0·921	1·24
			0·50		23·6	0·929	1·25
			1·00		22·8	0·899	1·20
			2·50		20·4	0·803	1·08
1·11	73	352	0·50		31·3	1·23	1·15
			0·75		30·7	1·21	1·13
			1·50		28·4	1·12	1·04
			2·50		26·5	1·04	0·97
1·08	53	433	2·50		38·9	1·53	1·04

Table 5.19 (a)

Cylinders of Aqueous Solution with Miscellaneous Reflectors

(See also Tables 5.19(b), (c), (d))

Reference : 10

Fissile Solution : $UO_2(NO_3)_2$ at 93·3 wt% enrichment

Solution contained small amounts of excess nitric acid. N/U^{235} atomic ratio = 2·86

Cylinder : $\frac{1}{16}$ in. thick Type 3S aluminium

Reflector : Aqueous solution of natural $UO_2(NO_3)_2$

CORE			REFLECTOR		DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gm U/litre)	H/U^{235} Atomic Ratio	Density (gmu/cc)	Thickness (in.)	Diameter (in.)	Height (cm)	Height / Diameter	U^{235} Mass (kgm)
1·55	359	618	0·426	0·88	10·0	29·9	1·18	5·40
				1·75		25·3	0·996	4·60
				2·63		23·6	0·929	4·29
				3·50		23·0	0·906	4·17
1·16	105	240	0·426	0·88	10·0	34·8	1·37	1·84
				1·75		29·0	1·14	1·53
				2·63		27·3	1·07	1·45
				3·50		26·4	1·04	1·40
1·17	73	352	0·426	0·88	10·0	47·1	1·85	1·73
				1·75		36·1	1·42	1·33
				3·50		32·0	1·26	1·17
			0·217	0·88		44·7	1·76	1·64
				1·75		35·7	1·41	1·31
				3·50		32·5	1·28	1·20
1·08	53	493	0·217	0·88	12·0	35·2	1·15	1·36
				4·50		29·8	0·978	1·15

Table 5.19 (b)

Cylinders of Aqueous Solution with Miscellaneous Reflectors

(See also Tables 5.19(a), (c), (d))

Reference : 10

Fissile Solution : $UO_2(NO_3)_2$ at 93·3 wt% enrichment. Solution contained small amounts of excess nitric acid, N/U^{235} atomic ratio = 2·86

Cylinders : $\frac{1}{16}$ in. thick Type 3S aluminium

Reflector : Aqueous solution of orthophosphoric acid (H_3PO_4) containing 0·465 gm P/cc.

CORE			REFLECTOR	DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gm U/litre)	H/U^{235} Atomic Ratio	Thickness (in.)	Diameter (in.)	Height (cm)	Height/Diameter	U^{235} Mass (kgm)
1·55	359	61·8	1·75	10·0	25·8	1·02	4·68
			2·63		23·6	0·929	4·28
			3·50		22·6	0·890	4·11
			3·50		16·0[a]	0·630[a]	2·91[a]
1·16	105	240	0·88	10·0	34·6	1·36	1·83
			1·75		29·2	1·15	1·55
			3·50		28·3	1·11	1·50

a. Values obtained with core and reflector enclosed in water

EXPERIMENTAL RESULTS FOR SINGLE U^{235} CORES MODERATED BY HYDROGEN - HIGH ENRICHMENTS

Table 5.19(c)

Cylinders of Aqueous Solution with Miscellaneous Reflectors

(See also Tables 5.19(a), (b), (d))

Reference: 10

Fissile Solution: $UO_2(NO_3)_2$ at 93·3 wt.% enrichment. Solution contain small amounts of excess nitric acid, H/U^{235} atomic ratio = 2·86

Cylinders: $\frac{1}{16}$ in. thick Type 3S aluminium

Reflector: Powdered bismuth sub-carbonate ($Bi\ O_2\ CO_3$) containing 0·52 gm Bi/cc

CORE			REFLECTOR THICKNESS (in.)	DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gm U/litre)	H/U^{235} Atomic Ratio		Diameter (in.)	Height (cm)	Height / Diameter	U^{235} Mass (kgm)
1·55	359	61·8	3·50	10·0	21·8	0·858	3·96
1·15	105	240	1·75	10·0	53·6	2·11	2·84
			3·50		48·8	1·92	2·58
1·17	73	352	0·88	12·0	35·4	1·16	1·87
			4·50		33·5	1·10	1·77

Table 5.19(d)

Cylinders of Aqueous Solution with Miscellaneous Reflectors

(See also Tables 5.19(a), (b), (c))

Reference: 10.

Fissile Solution: $UO_2(NO_3)_2$ at 93·3 wt.% enrichment.

Solution contained small amounts of excess nitric acid N/U^{235} atomic ratio = 2·86.

Cylinders: $\frac{1}{16}$ in. Thick Type 3S aluminium.

Reflector: Aqueous slurry of bismuth sub-carbonate ($Bi\ O_2\ CO_3$) containing 0·85 gm Bi/CC and 0·82 gm H_2O/cc.

CORE			REFLECTOR THICKNESS (in.)	DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution	Solution Concentration (gm U/litre)	H/U^{235} Atomic Ratio		Diameter (in.)	Height (cm)	Height / Diameter	U^{235} Mass (kgm)
1·17	73	352	0·88	12·0	28·7	0·942	1·52
			4·50		24·7	0·810	1·31
1·08	53	493	4·50	12·0	30·1	0·988	1·17

Table 5.20

Cylinders of $UO_2(NO_3)_2$ Solution in Tributyl Phosphate Diluted with Kerosene

Reference: 11

Fissile Solution: Uranium enrichment 92·7 wt%.
All solutions have the formula $UO_2(NO_3)_2$: 2·50 $(C_4H_9O)_3PO$: x $CH_{2\cdot08}$

Cylinders: Stainless steel, 0·16 cm thick walls, 0·9 cm thick base

Reflector: Radial reflector only of effectively infinitely thick water

CORE			DIAMETER (cm)	DELAYED CRITICAL CORE PARAMETERS			
Solution Density (gm/cc)	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio		Height (cm)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)
1·369	280·4	73·7 [a]	30·5	21·8	0·715	15·91	4·461
1·084	146·7	160·6		20·5	0·673	14·96	2·195
0·969	92·6	267·3		22·3	0·732	16·27	1·507
0·928	73·1	344·5		24·15	0·792	17·62	1·288
0·900	59·9	425·7		27·1	0·889	19·77	1·184
0·871	45·4	569·6		33·8	1·109	24·66	1·120
0·857	38·7	673·5		42·15	1·383	30·76	1·190
0·851	36·15	721·0		48·9	1·604	35·68	1·290
1·370	296·2	67·6 [a]	12·7 [b]	>44·9 [c]	- [c]	- [c]	>1·66 [c]

a. These solutions contained no kerosene (x = 0)

b. A hollow stainless steel tube (1·6 cm O.D.; 0·09 cm wall thickness) introduced along the core axis

c. Believed not to be critical at any height

Table 5.21

Cylinders of Uranium Metal Diluted with Polyethylene

Reference: 34

Uranium Enrichment 93·2 wt%

These experiments were performed on a vertical approach machine. The cores were assembled from alternate 0·125 in. thick uranium discs, and polyethylene discs and the reflectors from 0·375 in. thick discs, the reflector discs being machine to 0·0005 in. flatness. Core and reflector formed a 15·0 in. dia cylinder, the core being reflected on the lower end only.

The reflectors contained 27 discs and were supported, together with the lower part of the core containing 9 uranium discs, on a low mass aluminium cylinder attached to the lift. The remainder of the core was supported on a 0·019 in. thick stainless steel diaphragm.

A series of reflectors consisting of a single material or of two materials at ~ 25 vol% increments was investigated, (see Figure 5.2). Results indicated that any effect introduced by the non-homogeneity of the reflectors was within the total uncertainty of the critical mass measurements (± 0·3kgm).

REFLECTOR AVERAGE COMPOSITION (Vol%)	DELAYED CRITICAL CORE PARAMETERS		
	Height	Height / Diameter	Uranium Mass (kgm)
H/U ATOMIC RATIO 2·59			
Mild Steel	-	-	82·1
Stainless Steel	-	-	79·7
Nickel	-	-	76·4
25·9% Mild Steel 74·1% Nickel	-	-	76·7
48·2% Mild Steel 51·8% Nickel	-	-	77·0
74·1% Mild Steel 25·9% Nickel	-	-	78·2
25·9% Stainless Steel 74·1% Nickel	-	-	76·3
48·2% Stainless Steel 51·8% Nickel	-	-	76·1
74·1% Stainless Steel 25·9% Nickel	-	-	76·8
H/U ATOMIC RATIO = 4·88			
Mild Steel	-	-	62·5
Stainless Steel	-	-	61·9
Nickel	-	-	59·4
25·9% Mild Steel 74·1% Nickel	-	-	59·6
48·2% Mild Steel 51·8% Nickel	-	-	59·8
74·1% Mild Steel 25·9% Nickel	-	-	60·6
25·9% Stainless Steel 74·1% Nickel	-	-	59·5
51·8% Stainless Steel 48·2% Nickel	-	-	59·6
74·1% Stainless Steel 25·9% Nickel	-	-	60·1

Table 5.22

Unreflected Parallelepipeds of Aqueous UO_2F_2 Solution

Uranium Enrichment: 93·2 wt%

Containers: Aluminium

CONTAINER WALL THICKNESS (in.)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION (gmU^{235}/litre)	H/U^{235} ATOMIC RATIO	DELAYED CRITICAL PARAMETERS						REFERENCE
				Thickness (in.)	Width (in.)	Height	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Volume (litres)	U^{235} Mass (kgm)	
$\frac{1}{16}$	-	828·8	27·1	20	20	15 cm	-	38	32	5
$\frac{1}{16}$	-	342·3	72·4	20	20	14·3 cm	-	36·9	12·6	5
$\frac{1}{8}$[a]	-	87·8	293	6	48	27·25 in	-	-	-	2, 19
$\frac{1}{16}$	-	77·9	331	20	20	17·9 cm[b]	-[b]	46·2[b]	3·60[b]	8, 37

a. Type 25 aluminium

b. Experimentally determined critical height increased by 0·4 cm to correct for the effect of the ½ in. thick container base

Table 5.23

Parallelepipeds of Aqueous UO_2F_2 Solution with Water Reflector

Reflector: Effectively infinite thickness on bottom and sides of the core to the height noted in the Table

CONTAINER[a] TYPE	CORE				REFLECTOR HEIGHT (see notes prefacing Table)	DELAYED CRITICAL CORE PARAMETERS						REFERENCE
	Uranium Enrichment wt.%	Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio		Thickness (in.)	Width (in.)	Height (in.)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Volume (litres)	U^{235} Mass (kgm)	
A	93·2	-	532	44·7	64·0	1·995	58	47·20	-	89·5	47·6	8, 16
A					59·0			45·38		86·0	45·7	8, 16
A			469	51·5	64·0			51·28		97·2	45·6	8, 16
A					65·5			51·99		98·6	46·2	8, 16
A	93·2	-	532	44·7	56·7	2·00	58	43·08	-	81·9	43·6	8, 16
A					54·5			42·09		80·0	42·6	8, 16
A	93·2	-	532	44·7	53·5	2·06	58	35·02	-	68·5	36·4	8, 16
A					51·0			34·91		68·3	36·5	8, 16
A			469	51·5	64·0			37·62		75·7	34·6	8, 16
A					53·5			36·73		71·9	33·7	8, 16
A	93·2	-	532	44·7	45·7	2·12	58	28·18	-	56·8	30·2	8, 16
B	93·18	1·108	87·8	293	-	6·00	48	8·09	-	-	-	2, 19

a. The Type A container was fabricated in ¼" thick Lucite reinforced by stiffening members, also of Lucite, attached to the outside. The nominal inside dimensions were 58" x 71" x 2·25". The thickness was altered by inserting plastic sheets adjacent to one inside surface. Blocks of plastic about 1" square and of approximate length were placed within the slab on 12" centres in two directions in an attempt to maintain constant thickness as the hydrostatic pressures varied with the inner and outer liquid heights.

The Type B container was fabricated in ⅛" thick aluminium.

Table 5.24 (a)

Parallelepipeds of Aqueous UO_2F_2 with Miscellaneous Reflectors

(See also Tables 5.24 (b), (c).)

References: 2, 19

Fissile Solution: Uranium Enrichment, 93·18 wt%
Specific Gravity, -
Concentration, -
H/U^{235} Atomic Ratio, 293

Containers: $\frac{1}{8}$ in. thick aluminium

Reflector: Styrafoam[a] in two larger faces of core plus water on the bottom and sides of the core styrafoam assembly to a height equal to that of the Fissile Solution.

REFLECTOR THICKNESS (in.)		DELAYED CRITICAL CORE PARAMETERS					
Styrafoam	Water	Thickness (in.)	Width (in.)	Height (in.)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Volume (litres)	U^{235} Mass (kgm)
3	Nil	6	48	22·09	-	-	-
6				12·35	-	-	-
3	6	6	48	10·84	-	-	-
6				12·35	-	-	-

a. Styrafoam is a foamlike form of polystyrene (Atomic composition CH) in which small gas bubbles are homogeneously distributed. The bubbles are apparently closed since styrafoam does not absorb water.

Table 5.24(b)

Parallelepipeds of Aqueous UO_2F_2 with Miscellaneous Reflectors

(See also Tables 5.24(a), (c))

Reference: 20

Fissile Solution: Uranium Enrichment, ~90 wt%
Specific gravity
Concentration, 76·28 gm U^{235}/litre
H/U^{235} atomic ratio, 337

Containers: $\frac{1}{8}$ in. thick aluminium

REFLECTOR		DELAYED CRITICAL CORE PARAMETERS					
Thickness (in.)	Density (gm/cc)	Thickness (in.)	Width (in.)	Height (cm)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Volume (litres)	U^{235} Mass (kgm)
PLEXIGLAS REFLECTOR							
1·0	-	6	47·5	30·84	-	56·64	4·32
MAGNESIA REFLECTOR							
2·0	0·32	5·84	47·5	56·39	-	103·6	7·90
4·0	0·24			54·97	-	101·0	7·70
6·0	a			48·84	-	86·0	6·56
6·0	b	5·84	47·6	49·73	-	91·4	6·97

a. Density of 2 in. thickness of magnesia adjacent to core 0·32 gm/cc, remainder 0·24 gm/cc

b. Density of 4 in. thickness of magnesia adjacent to core 0·24 gm/cc, remainder 0·32 gm/cc

Table 5.24(c)

Parallelepipeds of Aqueous UO_2F_2 with Miscellaneous Reflectors

(See also Tables 5.24(a), (b))

Reference:

Fissile Solution: Uranium Enrichment ~90 wt%
Specific gravity,
Concentration, 76·28 gm U^{235}/litre
H/U^{235} atomic ratio, 337

Containers: $\frac{1}{8}$ in. thick aluminium

Reflector: 48 in. x 48 in. steel plate placed at various distances from the core

REFLECTOR SPACING (in.)	DELAYED CRITICAL CORE PARAMETERS					
	Thickness (in.)	Width (in.)	Height (cm)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Volume (litres)	U^{235} Mass (kgm)
0	5·84	47·5	55·25	-	101·5	7·74
3·0			63·22	-	116·1	8·86
6·0			70·49	-	129·5	9·88
12·0			81·28	-	149·1	11·38
24·0			92·3	-	169·6	12·93
36·0			97·13	-	178·4	13·61

Table 5.25

Unreflected Parallelepipeds of Uranium Metal Diluted with Lucite

Reference: 35

Uranium Enrichment: 93·16 wt%

These systems were assembled in an aluminium matrix and, hence, contain 0·165 gm/cc aluminium (average). The matrix also extended outside the core, providing some incidental reflection.

Core elements were built up from alternate layers of Uranium and Lucite; the thicknesses of the repeated layers are shown in the table as well as the average composition of the core.

LAYER THICKNESSES		AVERAGE URANIUM DENSITY (gm/cc)	H/U^{235} ATOMIC RATIO	C/U^{235} ATOMIC RATIO	DELAYED CRITICAL CORE PARAMETERS			U^{235} MASS (kgm
Uranium (in.)	Lucite (in.)				Area (in.)	Thickness (in.)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	
0·012	$\frac{1}{16}$	2·12	5·99	3·74	23·5 x 12	10·87	-	106·5
0·012	$\frac{1}{16}$	2·31	5·99	3·74	-	9·26	-	98·8
0·006	$\frac{1}{16}$	1·317	12·12	7·57	15 x 11·4	12	-	44·2
0·002	$\frac{1}{16}$	0·491	35·4	22·1	15 x 12	11·46	-	16·61
0·004	$\frac{1}{8}$	0·476	35·6	22·3	-	12	-	16·83
0·008	$\frac{1}{4}$	0·477	35·4	22·1	-	12	-	16·89
0·012	$\frac{3}{8}$	0·489	35·3	22·2	-	11·65	-	16·78
0·016	$\frac{1}{2}$	0·484	35·2	22·0	-	12·06	-	17·22
0·022	$\frac{11}{16}$	0·494	35·1	22·0	-	12	-	17·48
0·030	$\frac{15}{16}$	0·495	35·1	22·0	-	12·47	-	18·22

Table 5.26

Parallelepipeds of Uranium Metal Diluted with Lucite with Full Lucite Reflector

Reference: 35

Uranium Enrichment: 93·16 wt%

Reflector Thicknesses: Ends, 8-25 in.[a]
Top and bottom, 6 in.
Sides, see table

The systems were assembled in an aluminium matrix and, hence, core and reflector both contain 0·165 gm/cc aluminium (average).
Core elements were built up from alternate layers of Uranium and Lucite; the thicknesses of the repeated layers are shown in the table as well as the average composition.

					REFLECTOR (See Notes Prefacing Table)		DELAYED CRITICAL CORE PARAMETERS				
Layer Thicknesses		Average Uranium Density (gm/cc)	H/U^{235} Atomic Ratio	C/U^{235} Atomic Ratio	Side Reflector Thickness (in.)	Average Lucite Density (gm/cc)	Length (in.)	Height (in.)	Width (in.)	$\frac{\text{Length}}{\sqrt{\text{Area}}}$	U^{235} Mass (kgm)
Lucite (in.)	Uranium (in.)										
1/16	0·006	1·311	12·2	7·6	9	1·007	15[b]	6[b]	8·23[b]	15·90[b]	-[b]
1/16	0·006	1·213	13·3	8·3	6	1·048			8·0	14·32	-
1/16	0·006	1·109	12·1	7·6	6	1·037		9	7·5	18·41	-
1/16	0·006	0·950	12·0	7·5	6	1·036			10·5	22·06	
7/16	·030	1·021	16·6	10·4	7·05	1·030	15	6	7·89	11·89	
9/16	·030	0·818	21·2	13·2	6·83	1·031	15	6	8·34	10·06	
11/16	·030	0·685	26·0	16·2	6·98	1·030	15	6	8·04	8·12	
13/16	·030	0·582	30·6	19·1	6·26	1·031	15	6	9·48	8·13	
15/16	·030	0·509	35·3	22·0	6·09	1·031	15	6	10·26	7·70	
1/16	·002	0·363	35·6	22·3	6	1·036	15	9	10·5	8·43	
1/16	·002	0·452	35·3	22·0	6	1·044	15	6	10·5	7·00	
1/16	·002	0·517	34·3	21·5		1·040			8·0	6·10	
1/8	·004	0·518	34·3	21·5		1·040			8·03	6·14	
1/4	·008	0·518	39·3	21·4		1·048			8·10	6·19	
3/8	·012	0·518	34·3	21·5	6·12	1·048			8·13	6·21	
1/2	·016	0·521	34·3	21·5	6·06	1·050			8·39	6·45	
3/4	·024	0·532	33·5	20·9	6·06	1·035			9·11	7·14	
9/16	·008	0·229	79·4	49·6	9·11	1·000	15	6	10·79	3·65	
11/16	·008	0·186	97·8	61·1	8·33	1·000	15	6	12·35	3·38	
15/16	·008	0·138	133·3	83·2	6·04	1·001	15	6	17·09	3·47	

a. Reflector thickness on ends averaged to allow for ½ in. irregularity

b. Top reflector thickness 6 in., bottom reflector thickness 9 in.

Table 5.27

Parallelepipeds of Uranium Metal Diluted with Lucite, with Partial Lucite Reflector

Reference: 35

Uranium Enrichment: 93·16 wt.%

Reflector: 6 in. thick reflector on top and bottom of core only.

These systems were assembled in an aluminium matrix and, hence both core and reflector contain 0·165 gm/cc aluminium.

Core elements were built up from alternate 0·002 in. thick uranium and 1/16 in. thick Lucite layers. The table shows the average composition of the core.

CORE			AVERAGE LUCITE DENSITY IN REFLECTOR (gm/cc)	DELAYED CRITICAL CORE PARAMETERS				
Average Uranium Density (gm/cc)	H/U^{235} Atomic Ratio	C/U^{235} Atomic Ratio		Length (in.)	Height (in.)	Width (in.)	$\frac{\text{Length}}{\sqrt{\text{Area}}}$	U^{235} Mass (kgm)
0·488	35·3	22·1	0·977	15[a]	6	14·53	-	10·45
0·422	36·0	22·5	1·007	32	6	13·06	-	17·34
0·372	35·7	22·3	1·006			17·03		19·96
0·478	36·0	22·5	1·022		5·24	12	-	15·79
0·491	35·9	22·4	1·022		5	12	-	15·44
0·479	37·3	23·3	1·041		3	23·03	-	17·37
0·479	35·6	22·2	1·002			28·5	-	21·5
0·431	35·7	22·3	1·041		3	54	-	36·6
0·474	36·2	22·6	1·040		2·71	48	-	32·4
0·473	36·1	22·6	1·037		2·69	52·8	-	35·2
0·498	36·2	22·6	1·041		2·50	58·9	-	38·5

a. Reflector overhangs fuel $\frac{1}{2}$ in. on both sides

Table 5.23

Unreflected Parallelepipeds of Uranium Metal Diluted with Lucite and Graphite

Reference: 35

Uranium enrichment: 93·16 wt%

These systems were assembled in an aluminium matrix and, hence, contain 0·165 gm/cc aluminium (average). The matrix also extended outside the core, providing some incidental reflection.

Core elements were built up from alternate layers of uranium, Lucite and graphite, the thickness of the repeated layers are shown in the table as well as the average composition of the core.

LAYER THICKNESSES			AVERAGE URANIUM DENSITY	H/U^{235} ATOMIC RATIO	C/U^{235} ATOMIC RATIO	DELAYED CRITICAL PARAMETERS			
Uranium (in.)	Lucite (in.)	Graphite (in.)				Area (in.)	Thickness (in.)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	U^{235} Mass (kgm)
0·012	1/16	0·120	0·916	6·02	24·1	23·5 x 18·14	18	-	115·2
0·012	1/16	0·280	0·518	6·04	48·7	23·5 x 28·02	24	-	134·2
0·006	1/16	0·280	0·258	12·41	98·2	32 x 24·70	24·70	-	82·4
0·006	1/16	0·280	0·258	12·41	98·7	23·5 x 28·5	28·79	-	81·4
0·002	1/16	0·120	0·337	35·2	51·8	15 x 15	15·69	-	19·51
0·002	1/16	0·120	0·337	35·2	48·2	15 x 15	16·69	-	20·7
0·002	1/16	0·280	0·224	35·0	101·5	15 x 21	21	-	24·2

Table 5.29

Parallelepipeds of Uranium Metal Diluted with Lucite & Graphite, with Full Lucite Reflector

Reference: 35

Uranium Enrichment: 93·16 wt%

These systems were assembled in an aluminium matrix and, hence, core and reflector both contain 0·165 gm/cc aluminium (average).

Core elements were built up from alternate layers of uranium, lucite and graphite; the thicknesses of the repeated layers are shown in the table as well as the average composition of the core.

CORE						REFLECTOR					DELAYED CRITICAL CORE PARAMETERS				
Layer Thicknesses			Average Uranium Density	H/U^{235} Atomic Ratio	C/U^{235} Atomic Ratio	Thickness			Average Lucite Density (gm/cc)		Length (in.)	Height (in.)	Width (in.)	$\frac{\text{Length}}{\sqrt{\text{Area}}}$	U^{235} Mass (kgm)
Uranium (in.)	Lucite (in.)	Graphite (in.)				Ends[a] (in.)	Top and Bottom (in.)	Sides (in.)	Ends	Sides					
0·006	1/16	0·280	0·255	12·46	100·3	~ 6	1·50	1·50	1·021	0·938	23·5	24	24	-	43·2
0·006	1/16	0·280	0·223	12·48	100·6	~ 6	4	4	1·021	0·969		21	21	-	37·8
0·006	1/16	0·280	0·252	12·12	101·2	~ 6	3·75	3·75	1·042	0·984		18	18	-	31·5
0·006	1/16	0·280	0·244	12·12	101·2	~ 6	7·50	7·50	1·042	1·021		18	18	-	30·5
0·006	1/16	0·280	0·252	12·05	101·5	~ 6	6·38	6·32	1·042	0·982		17·25	17·4	-	29·0
0·006	1/16	0·004 av.[b]	934	12·05	8·89	8·25	6	6	1·036	1·036	15	9	10·5	-	21·7

a. Low-density 1·5 in. extension of 6 in. thick reflector; 8·25 in. end reflector thickness is averaged over ½ in. irregularity

b. Average of non-uniformly - distributed 0·120 in. thick graphite

Table 5.30

Parallelepipeds of Uranium Metal Diluted with Lucite and Graphite, with Partial Lucite Reflector

Reference: 35
Uranium Enrichment: 93·16 wt%
Reflector: 6 in. thick reflector on top and bottom of core only

These systems were assembled in an aluminium matrix and, hence, both core and reflector contain 0·165 gm/cc aluminium.

Core elements were built up from alternate 0·006 in. thick uranium, $\frac{1}{16}$ in. thick Lucite and 0·280 in. thick graphite layers.

The Table shows the average composition of the core.

CORE			AVERAGE LUCITE DENSITY IN REFLECTOR (gm/cc)	DELAYED CRITICAL CORE PARAMETERS				
Average Uranium Density (gm/cc)	H/U^{235} Atomic Ratio	C/U^{235} Atomic Ratio		Length (in.)	Height (in.)	Width (in.)	$\frac{\text{Length}}{\sqrt{\text{Area}}}$	U^{235} Mass (kgm)
0·239	13·0	106·2	1·001	32	13·5	29·8		50·4
0·239	13·2	105·4	1·032		12	35·4		53·3
0·239	13·2	106·9	1·029		9	110		124·0
0·254	12·4	99·1	1·042	64	9	39·1		93·8
0·254	12·5	99·2	1·033		8	52·6		115·9

Table 5.31

Cylindrical Annuli of Aqueous UO_2F_2 Solution with Void, Unpoisoned Central Cavity

Reference: 5
Fissile Solution: Specific Gravity, 1·411
Concentration, 331·4 gm U^{235}/litre
H/U^{235} Atomic Ratio, 74·6
Container: Type 3S Aluminium; $\frac{1}{16}$ in. thick walls; $\frac{1}{4}$ in. thick base.

DELAYED CRITICAL CORE PARAMETERS					
Diameter		Thickness of Annulus (in.)	Height (cm)	Volume (litres)	U^{235} Mass (kgm)
Outside (in.)	Inside (in.)				
No Reflector					
10	2	4	49·6	24·2	8·01
15		6·5	17·6	19·7	6·52
	6	4·5	29·9	28·7	9·5
Effectively Infinite Water Reflector on Bottom and Side of the core to a height equal to that of the Fissile Solution					
10	2	4	20·7	10·2	3·37
	4	3	27·6	11·8	3·90
	6	2	76·8	25·0	8·30
15	2	6·5	13·3	15·0	4·95
	6	4·5	17·5	16·8	5·50

Table 5.32

Cylindrical Annuli of Aqueous UO_2F_2 Solution with Void Central Cavity lined with Cadmium

Reference: 5
Fissile Solution: Specific Gravity, 1·411
Concentration, 331·4 gm U^{235}/litre
H/U^{235} Atomic Ratio, 74·6
Container: Type 3S Aluminium; $\frac{1}{16}$ in. thick walls; $\frac{1}{2}$ in. thick base
Cadmium lines 0·02 in. thick

DELAYED CRITICAL CORE PARAMETERS					
Diameter		Thickness of Annulus (in.)	Height (cm)	Volume (litres)	U^{235} Mass (kgm)
Outside (in.)	Inside (in.)				
No Reflector					
10	2	4	70·0	34·1	11·3
15	6	4·5	33·2	31·9	10·6
	2	6·5	18·0	20·2	6·69
Effectively Infinite Water Reflector on Bottom and Sides of the core to a height equal to that of the Fissile Solution					
10	2	4	20·4	10·0	3·30
	4	3	31·9	13·6	4·52
	6	2	>120 [a]	- [a]	- [a]

a. Extrapolation of reciprocal multiplication curve is said to indicate that this assembly will not be critical at any height

Table 5.33

Cylindrical Annuli of Aqueous UO_2F_2 Solution with Water Filled, Unpoisoned Central Cavity

Reference : 5
Container : Type 2S aluminium; $\frac{1}{16}$ in. thick walls, $\frac{1}{2}$ in. thick base.

CORE			DELAYED CRITICAL CORE PARAMETERS					
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio	Diameter		Thickness of Annulus (in.)	Height (cm)	Volume (litres)	U^{235} Mass (kgm)
			Outside (in.)	Inside (in.)				
No Reflector								
1·411	331·4	74·6	10	4	3	>142·5	-	-
1·411	331·4	74·6	15	2	6·5	17·0	19·1	6·33
1·411	331·4	74·6	15	6	4·5	25·2	24·2	8·01
Effectively Infinite Water Reflector on Bottom and Sides of the Core to a Height Equal to that of the Fissile Solution								
1·425	342·3	72·4	8	2	3	27·10	8·3	2·83
1·425	342·3	72·4	8	4	2	50·0	12·2	4·18
1·416	337	73·4	10	2	4	17·8	8·7	2·92
1·411	331·4	74·6	10	4	3	23·8	10·1	3·36
1·411	331·4	74·6	10	6	2	64·1	20·9	6·93
1·411	331·4	74·6	15	2	6·5	12·9	14·4	4·77
1·425	342·3	72·4	15	4	5·5	13·9	14·9	5·11
1·411	331·4	74·6	15	6	4·5	16·0	15·3	5·08
1·425	342·3	72·4	15	8	3·5	21·0	17·1	5·87
1·425	342·3	72·4	15	10	2·5	41·6	26·3	9·01
1·425	342·3	72·4	20	2	9·5	11·4	22·8	7·79
1·425	342·3	72·4	20	6	7	12·6	23·3	7·96
1·425	342·3	72·4	20	10	5	16·4	24·9	8·51
1·425	342·3	72·4	20	15	2·5	44·3	39·3	13·4

Table 5.34

Cylindrical Annulus of Aqueous UO_2F_2 Solution with Water Filled Central Cavity Lined with Cadmium

Container: Type 2S aluminium; $\frac{1}{16}$ in. thick walls, $\frac{1}{2}$ in. thick base.

Cadmium liner 0·02 in. thick.

CORE			DELAYED CRITICAL CORE PARAMETERS						REFERENCE
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio	Diameter Outside (in.)	Diameter Inside (in.)	Thickness of Annulus (in.)	Height (cm)	Volume (litres)	U^{235} Mass (kgm)	
No Reflector									
1·599	481·3	50·4	10	2[a]	4	101·5	49·4	23·7	21
1·411	331·4	74·6			4	138·2	67·4	22·3	5
1·411	331·4	74·6		4	3	>120 [b]	- [b]	- [b]	5
1·599	481·3	50·4	12	2[a]	5	27·8	19·7	9·5	21
1·1051	83·6	309		[a]		46·2	32·8	2·74	21
1·599	481·3	50·4		4[a]	4	> 91 [b]	- [b]	- [b]	21
1·599	481·3	50·4	15	2[a]	6·5	19·2	21·5	10·4	21
1·411	331·4	74·6				18·2	20.4	6·76	5
1·1051	83·6	309		[a]		25·8	28·9	2·42	21
1·599	481·3	50·4		4[a]	5·5	24·9	26·4	12·7	21
1·1051	83·6	309				42·9	45·4	3·8	21
1·599	481·3	50·4		6[a]	4·5	50·5	48·4	23·3	21
1·411	331·4	74·6				54·3	52·1	17·3	5
1·1051	83·6	309		[a]		> 91 [b]	- [b]	- [b]	21
1·599	481·3	50·4		8[a]	3·5	> 91 [b]	- [b]	- [b]	21
1·599	481·3	50·4	20	6[a]	7	19·2	35·4	17·0	21
1·1051	83·6	309		[a]		25·5	47·0	3·93	21
1·599	481·3	50·4		8[a]	6	23·1	39·3	18·9	21
1·1051	83·6	309		[a]		35·0	59·6	4·98	21
1·599	481·3	50·4		10[a]	5	36·3	55·2	26·6	21
1·1051	83·6	309		[a]		> 91 [b]	- [b]	- [b]	21
1·599	481·3	50·4		12[a]	4	> 91 [b]	- [b]	- [b]	21
1·599	481·3	50·4	30	15[a]	7·5	18·8	64·3	31.0	21
1·1051	83·6	309		[a]		24·2	82·8	6·92	21
1·599	481·3	50·4		20[a]	5	38·8	98·3	47·3	21
Effectively Infinite Water on Bottom and Sides of Core to a Height Equal to that of Fissile Solution									
1·599	481·3	50·4	10	2[a]	4	20·2	9·6	4·7	21
1·411	331·4	74·6				20·5	10·0	3·31	5
1·1051	83·6	309		[a]		39·1	19·0	1·59	21

Table 5·34 (Cont'd)

CORE			DELAYED CRITICAL CORE PARAMETERS						REFERENCE
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio	Diameter		Thickness of Annulus (in.)	Height (cm)	Volume (litres)	U^{235} Mass (kgm)	
			Outside (in.)	Inside (in.)					
1·599	481·3	50·4		4[a]	3	40·9	17·4	8·4	21
1·411	331·4	74·6				45·4	19·4	6·43	5
1·411	331·4	74·6		6	2	>120 [b]	- [b]	- [b]	5
1·599	481·3	50·4	12	2[a]	5	16·0	11·3	5·4	21
1·1051	83·6	309		[a]		24·0	17·0	1·42	21
1·599	481·3	50·4		4[a]	4	21·8	14·2	6·8	21
1·1051	83·6	309		[a]		46·6	30·2	2·53	21
1·599	481·3	50·4		6[a]	3	48·7	26·6	12·8	21
1·1051	83·6	309	15	6[a]	6·5	18·3	20·5	1·71	21
1·599	481·3	50·4		4[a]	5·5	15·4	16·3	7·9	21
1·1051	83·6	309		[a]		22·7	24·0	2·01	21
1·599	481·3	50·4		6[a]	4·5	19·5	18·7	9·0	21
1·1051	83·6	309		[a]		34·6	33·1	2·77	21
1·599	481·3	50·4		8[a]	3·5	31·1	12·2	25·4	21
1·1051	83·6	309		[a]		>91 [b]	- [b]	- [b]	21
1·599	481·3	50·4		10[a]	2·5	>91 [b]	- [b]	- [b]	21
1·599	481·3	50·4	20	6[a]	7	13·3	25·5	11·8	21
1·1051	83·6	309		[a]		18·5	34·1	2·85	21
1·599	481·3	50·4		8[a]	6	15·0	26·5	12·3	21
1·1051	83·6	309		[a]		21·4	36·4	3·04	21
1·599	481·3	50·4		10[a]	5	18·4	28·0	13·5	21
1·1051	83·6	309		[a]		30·4	46·2	3·86	21
1·599	481·3	50·4		12[a]	4	26·0	33·7	16·2	21
1·1051	83·6	309		[a]		88·3	114·5	9·57	21
1·599	481·3	50·4		14[a]	3	93·3	96·4	46·4	21
1·599	481·3	50·4	30	15[a]	7·5	13·4	45·8	22·0	21
1·1051	83·6	309		[a]		18·1	61·9	5·17	21
1·599	481·3	50·4		20[a]	5	19·0	48·2	23·2	21
1·1051	83·6	309		[a]		31·6	80·1	6·7	21
1·599	481·3	50·4		24[a]	3	>577·4	-	-	21

a. Height of water in central cavity 48 in.

b. Extrapolation of reciprocal multiplication curve is said to indicate that this assembly will not be critical at any height

Table 5·35

44·6 wt% Enriched UO_2F_2 Aqueous Solutions

Reference: 22

In these experiments the fissile solution was contained in a 12 in. diameter stainless steel cylinder, wall thickness ⅛ in. The bottom of the cylinder was dished upwards ⅛ in. and a stainless steel tube 1·6 cm O.D., wall thickness 0·09 cm was positioned along the axis of the cylinder as a housing for a 28 in. long, ½ in. diameter, brass-walled natural BF_3 counter. Three similar counters, one containing enriched BF_3, were positioned symmetrically just outside the cylinder at a radius of 7½ in.
The radial surface only of the core was reflected by water 9 in. thick. In some instances a 13 in. diameter, stainlesss steel clad cadmium cut off cylinder was positioned coaxially round the core, in the water.
Fissile solution was drained from the core by a stainless steel tube dipping down to the bottom of the circumferential dishing.

CORE			DELAYED CRITICAL CORE PARAMETERS			
Specific Gravity of Solution (gm/cc)	Uranium Concentration Of Solution (gm/gm)	H/U^{235} Atomic Ratio	Diameter (in.)	Height (cm)	Height / Diameter	U^{235} Mass (kgm)
Without Cadmium Cut-off Cylinder						
1·247	0·1752	258	12	23·15	0·760	1·647
1·130	0·1029	493		33·75	1·11	1·264
1·096	0·07764	678		55·15	1·81	1·513
With Cadmium Cut-off Cylinder						
1·247	0·1752	258	12	24·75	0·812	1·759
1·130	0·1029	493		43·00	1·41	1·612

Table 5·36

Spheres of 30·45 wt % Enriched UO_2F_2 Aqueous Solution

Reference : 12

Spheres : $\frac{1}{8}$ in. thick aluminium

CORE			DELAYED CRITICAL CORE PARAMETERS		
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio	Diameter (in.)	Volume (litres)	U^{235} Mass (kgm)
No Reflector					
-	287	-	13·75	-	6·403
-	113	-		-	2·517
-	47·8	-	16	34·95	1·67
-	24·9	-	22	91·8	2·28
Effectively Infinite Water Reflector					
-	71·6	-	12	14·85	1·063
-	44	-	13·75	-	0·991
-	32·9	-	16	34·95	1·15
-	21·6	-	22	91·8	1·98

Table 5.37

Cylinders of 30·3 wt% Enriched UO_2F_2 Aqueous Solution

Reference: 23

Cylinders: Stainless steel; 0·064 in. wall thickness, heavy base; fissile solution drain line attached at the base (see Figure 5.3). Subsidiary experiments show that solutions held in the drain line affects the measured critical height by <0·1 cm.

Reflector: Radial reflector only, >7 in. thick. In some instances a 13 in. diameter stainless steel clad cadmium cut off cylinder was positioned coaxially round the core in the water. The cadmium of the cut off cylinder was 0·09 cm thick and the stainless steel cladding 0·16 cm thick.

CORE			DELAYED CRITICAL CORE PARAMETERS				
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litres)	H/U^{235} Atomic Ratio	Diameter (in.)	Height (cm)	Height/Diameter	Volume (litres)	U^{235} Mass (kgm)
Without Cadmium Cut-off Cylinder							
-	272	82·4	8	51·9	2·55	16·9	4·60
-	242	94·2		50·5	2·48	16·4	4·00
-	220	105·6		50·15	2·47	16·3	3·59
-	203	114·8		50·22	2·47	16·3	3·31
-	170	140·8		52·03	2·56	16·9	2·87
-	151	160·5		54·82	2·70	17·8	2·69
-	125	195		63·03	3·10	20·5	2·56
-	272	81·9	12	22·6	0·74	16·05	4·48
-	270	82·4		22·55	0·74	16·42	4·44
-	218	106		22·12	0·725	16·15	3·52
-	176	135		22·15	0·725	16·17	2·84
-	145	167		22·5	0·74	16·42	2·38
-	96·9	257		24·45	0·80	17·85	1·73
-	66·9	378		28·62	0·94	20·89	1·40
-	57·6	440		31·65	1·04	23·10	1·33
-	48·0	532		37·42	1·23	27·31	1·31
-	41·1	622		47·0	1·54	34·31	1·41
-	39·3	651		51·27	1·68	37·42	1·47

Table 5.37 (Cont'd)

CORE			DELAYED CRITICAL CORE PARAMETERS				
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litres)	H/U^{235} Atomic Ratio	Diameter (in.)	Height (cm)	Height / Diameter	Volume (litres)	U^{235} Mass (kgm)
-	288	76·7	16	18·10	0·45	23·4	6·74
-	211	110·4		17·70	0·44	22·9	4·83
-	141	173		17·95	0·44	23·2	3·27
-	930	269		19·25	0·47	24·9	2·32
-	57·9	439		22·60	0·56	29·3	1·70
-	39·0	657		29·54	0·73	38·2	1·49
-	31·5	815		37·42	0·92	48·4	1·52
-	27·3	942		48·70	1·20	63·0	1·72
With Cadmium Cut-off Cylinder							
-	176	135	12	24·2	0·795	17·68	3·27
-	o7·0	378		32·2	1·06	23·48	1·52

Table 5·38

Rectilinear Parallelepipeds of 30·37 wt% Enriched UO_2F_2 Aqueous Solution
(Includes Cadmium Shielded Systems)

Reference: 13

Fissile Solution: Concentration, 380·9 gm uranium/litre;
Density, 1·4355 gm/cc;
H/U^{235} Atomic Ratio, 212·4.

Container: Material, stainless steel;
Wall thickness, 0·19 in. (larger surfaces), $\frac{3}{8}$ in. (sides and base);
Dimensions, Height 6 ft. (external)
Width 4 ft. (external)
Thickness 3·4 ± 0·02 in. (internal) by both direct measurement and volume calibration; one of the larger surfaces bulged slightly outwards at the centre. The corners of the container were rounded on a radius of 2 in. and the bottom sloped downwards at an angle of about 1° to the horizontal to one corner at which fissile solution entered by a $1\frac{1}{2}$ in. dia. stub pipe. A $\frac{1}{2}$ in.OD, $\frac{3}{8}$ in. ID sparge pipe dipped down to the base of the container 8 in. off centre and a sight glass and scale were fitted at one edge.

These experiments were performed with the container bolted to a support framework attached to a steel table. The distance between the centre of the external base of the container and the table top was 11·7 in. One of the two larger surfaces of the core was reflected by a 'back reflector', consisting of either graphite (density 1·65 gm/cc), polyethylene[a] or concrete[b] and the front surface by the materials specified in the table. The edges of the core were unreflected.

FRONT REFLECTOR			DELAYED CRITICAL CORE PARAMETERS		
Material	Thickness (in.)	Density (gm/cc)	Height (in.)	Thickness / √Area	Mass
8 in. Graphite Back Reflector (See notes prefacing Table)					
Unreflected	-	-	Subcritical	-	-
Mild Steel[c]	10·8	7·79	18·3	-	-
Polyethylene	8·35	0·93	31·37	-	-
Polyethylene/Cadmium[d]	10	0·93	Subcritical	-	-
Concrete[b]	16·56	2·3	20·7	-	-
Concrete/Cadmium[b,d]	16·6	2·3	31·06	-	-
High density, γ ray shield barytes concrete	8·82	3·6	22·3	-	-
Jabroc (a wood product)	8·74	1·32	24·57	-	-
Beechwood	10·67	0·735	27·17	-	-
16 in. Graphite Back Reflector (See notes prefacing Table)					
Concrete[b]	16·56	2·3	18·3	-	-
Concrete/Cadmium[b,d]	16·6	2·3	24·69	-	-
8 in. Polyethylene Back Reflector (See notes prefacing Table)					
Concrete[b]	16·56	2·3	Subcritical	-	-

Table 5.38 (contd.)

FRONT REFLECTOR			DELAYED CRITICAL CORE PARAMETERS		
Material	Thickness (in.)	Density (gm/cc)	Height (in.)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Mass
9 in. Concrete Back Reflector (See notes prefacing Table)					
Concrete[b]	20·2	2·3	37·8	-	-
18 in. Concrete Back Reflector (See notes prefacing Table)					
Concrete[b]	20·2	2·3	37·2	-	-

a. Density 0·93 gm/cc

b. AERE, UKAEA Specification No. 338, Issue 4, made from clean granite aggregate, density 2·3 gm/cc

c. BS 15 No. 1 Quality, density 7·87 gm/cc

d. 0·031 in. thick cadmium sheet between core and reflector

In the original document, Tables 5.39 and 5.40 each appeared on a single foldout page numbered 156 (Table 5.39) and 157 (Table 5.40). These two tables are reproduced on the next 5 pages, Table 5.39 on the first 3 and Table 5.40 on the last 2. The column headings appear on each page, where appropriate, for convenience.

Table 5.39

30·14 wt% Enriched UO_2 Paraffin Wax Mixtures with Single Material Reflectors

(Includes cadmium shielded systems)

In these experiments the cores were rectilinear parallelepipeds assembled from tablets of the fissile mixture 1 in. square and either 1 in, ¾ in. or ½ in. thick. The lower density cores were obtained by pressing the 1 in. cubes with seven cylindrical holes in one direction. Subsidiary experiments showed that the effects of neutron streaming through the holes on the critical mass of the reflected cores was negligible.

FISSILE MIXTURE[a]			DELAYED CRITICAL CORE PARAMETERS			
Average Density	Average U^{235} Density (gm/cc)	H/U^{235} Atomic Ratio	Area (cm)	Thickness (cm)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Mass
No Reflector						
-	1·126	16·3	30·48 x 30·48	28·60	-	-
-	0·608	39·5	27·94 x 27·94	23·88	-	-
-	0·331	81·6	25·40 x 25·40	23·82	-	-
8 in. Thick Polyethylene Reflector, (density 0·919 gm/cc)						
-	0·754 x 1·569	8·2	30·48 x 30·48 33·02 x 33·02	35·36 29·87	- -	- -
-	1·126	16·3	22·86 x 22·86	19·68	-	-
-	0·748 x 1·126		27·94 x 27·94	28·60	-	-
-	0·608	39·5	15·24 x 15·24 20·32 x 20·32 27·94 x 27·94	40·66 17·58 11·52	- - -	- - -
-	0·331	81·6	15·24 x 15·24 17·78 x 17·78 20·32 x 20·32 25·40 x 25·40	31·60 20·07 15·52 11·61	- - - -	- - - -
-	0·746 x 0·331		22·86 x 22·86	26·31	-	-
-	0·243	82·0	17·78 x 17·78 22·86 x 22·86 27·94 x 27·94	41·10 20·33 15·00	- - -	- - -

Table 5.39

FISSILE MIXTURE[a]			DELAYED CRITICAL CORE PARAMETERS			
Average Density	Average U^{235} Density (gm/cc)	H/U^{235} Atomic Ratio	Area (cm)	Thickness (cm)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Mass
8 in. Thick Perspex Reflector, (density 1·193 gm/cc)						
-	1·569	8·2	22·86 x 22·86 25·40 x 25·40	26·59 21·92	- -	- -
-	0·754 x 1·569		30·48 x 30·48 35·56 x 35·56	30·05 23·10	- -	- -
-	1·126	16·3	20·32 x 20·32	22·78	-	-
-	0·748 x 1·126		27·94 x 27·94	24·94	-	-
-	0·608	39·5	20·32 x 20·32	16·36	-	-
-	0·331	81·6	17·78 x 17·78	18·47	-	-
8 in. Thick Concrete Reflector, (density 2·37 gm/cc)[b]						
-	0·331	81·6	20·32 x 20·32 20·32 x 20·32[c]	16·89 22·86[c]	- -[c]	- -[c]
8 in. Thick Beechwood Reflector, (density 0·69 gm/cc)[b]						
-	0·331	81·6	20·32 x 20·32 20·32 x 20·32[c]	19·0 30·73[c]	- -[c]	- -[c]

Table 5.39

a. The composition of the fuel mixture corresponding to the various H/U^{235} atomic ratios is given in the following Table, (in 10^{22} nuclei/cc):

Element	H/U^{235}				
	8·2	16·3	39·5	81·6	82·0*
Hydrogen	3·29	4·72	6·14	6·92	5·10
Carbon	1·63	2·34	3·05	3·43	5·30
Oxygen	2·72	1·96	1·05	0·574	0·422

*Contains added pile quality graphite

b. The composition of the concrete and beechwood reflector is given in the following Table (in 10^{22} nuclei/cc):

Element	Concrete	Beechwood
Hydrogen	1·23	2·65
Carbon	0·034	1·60
Nitrogen	-	0·0022
Oxygen	4·65	1·23
Silicon	1·650	-
Potassium	0·004	0·0013
Calcium	0·423	0·0008
Iron	0·018	-

c. 0·04 cm thick cadmium between core and reflector.

Table 5.40

30·14 wt% Enriched UO_2 Paraffin Wax Mixtures with Composite Reflectors

(Includes cadmium shielded systems)

Reference: 30

In these experiments the cores were rectilinear parallelepipeds assembled from tablets of the fissile mixture 1 in. square and either 1 in., $\frac{3}{4}$ in., $\frac{1}{2}$ in. thick. The lower density cores were obtained by pressing the 1 in. cubes with seven cylindrical holes in one direction. Subsidiary experiments showed that the effects of neutron streaming through the holes on the critical mass was negligible.

Only one of the two square faces of the core was reflected by the reflector specified in the Table, the remaining faces being reflected by an 8 in. thickness of polyethylene, (density 0·919 gm/cc).

FISSILE MIXTURE[a]			REFLECTOR (see notes prefacing Table)			DELAYED CRITICAL CORE PARAMETERS			
Average Density	Average U^{235} Density (gm/cc)	H/U^{235} Atomic Ratio	Material	Thickness (in.)	Density (gm/cc)	Area (in.)	Thickness (in.)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Mass
-	0·608	39·5	← Unreflected →			8·0 x 8·0	8·41	-	-
-	0·331	81·6				7·0 x 7·0	9·29	-	-
-	0·746 x 0·331	81·6				9·0 x 9·0	12·29	-	-
-	0·243	82·0				9·0 x 9·0	9·48	-	-
-	1·126	16·3	Water	8·0	-	9·0 x 9·0	7·82	-	-
-	0·608	39·5				8·0 x 8·0	6·98	-	-
-	0·331	81·6				7·0 x 7·0	7·97	-	-
-	0·746 x 0·331	81·6				9·0 x 9·0	10·46	-	-
-	0·243	82·0				9·0 x 9·0	8·05	-	-
-	0·608	39·5	Polyethylene	1·0	0·919	8·0 x 8·0	7·59	-	-
-				2·0			7·22	-	-
-				4·0			6·97	-	-
-				6·0			6·94	-	-
-				8·0			6·92	-	-
-	0·331	81·6		1·0		7·0 x 7·0	8·53	-	-
-				2·0			8·18	-	-
-				4·0			7·97	-	-
-				6·0			7·93	-	-
-				8·0			7·90	-	-
-	0·608	39·5	Polyethylene/Cadmium	8·0	0·919	8·0 x 8·0	7·96	-	-
-	0·331	81·6				7·0 x 7·0	8·74	-	-
-	1·126	16·3	Perspex	8·0	1·193	9·0 x 9·0	7·62	-	-
-	0·608	39·5				8·0 x 8·0	6·82	-	-
-	0·331	81·6				7·0 x 7·0	7·78	-	-
-	0·746 x 0·331	81·6				9·0 x 9·0	10·17	-	-
-	0·243	82·0				9·0 x 9·0	7·86	-	-
-	0·608	39·5	Paraffin Wax	8·0	0·86	8·0 x 8·0	7·02	-	-
-	0·331	81·6				7·0 x 7·0	7·93	-	-
-	0·608	39·5	Paraffin Wax/Cadmium	8·0	0·86	8·0 x 8·0	7·97	-	-
-	0·331	81·6				7·0 x 7·0	8·76	-	-

Table 5.40

FISSILE MIXTURE[a]			REFLECTOR (see notes prefacing Table)			DELAYED CRITICAL CORE PARAMETERS			
Average Density	Average U^{235} Density (gm/cc)	H/U^{235} Atomic Ratio	Material	Thickness (in.)	Density (gm/cc)	Area (in.)	Thickness (in.)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Mass
-	0·331	81·6	Concrete (A)[b]	8·0	2·37	7·0 x 7·0	8·03	-	-
-	0·331	81·6	Concrete (A)[b]/Cadmium[c]	8·0	2·37	7·0 x 7·0	8·48	-	-
- -	0·608 0·331	39·5 81·6	Concrete (B)[b]	8·0	2·37	8·0 x 8·0 7·0 x 7·0	7·16 8·06	- -	- -
- -	0·608 0·331	39·5 81·6	Concrete (B)[b]/Cadmium[c]	8·0	2·37	8·0 x 8·0 7·0 x 7·0	7·62 8·48	- -	- -
-	0·331	81·6	Beechwood (A)[b]	8·0	0·69	7·0 x 7·0	8·20	-	-
-	0·331	81·6	Beechwood (A)[b]/Cadmium[c]	8·0	0·69	7·0 x 7·0	8·78	-	-
- -	0·608 0·331	39·5 81·6	Beechwood (B)[b]	8·0	0·68	8·0 x 8·0 7·0 x 7·0	7·31 8·24	- -	- -
- -	0·608 0·331	39·5 81·6	Beechwood (B)[b]/Cadmium[c]	8·0	0·68	8·0 x 8·0 7·0 x 7·0	7·90 8·81	- -	- -
- -	0·608 0·331	39·5 81·6	Jabroc[b] (A wood product)	8·0	1·30	8·0 x 8·0 8·0 x 8·0	6·80 7·76	- -	- -

a. The composition of the fuel mixture corresponding to the various H/U^{235} atomic ratios is given in the following Table (in 10^{22} nuclei/cc):

Element	H/U^{235}			
	16·3	39·5	81·6	82·0*
Hydrogen	4·72	6·14	6·92	5·10
Carbon	2·34	3·05	3·43	5·30
Oxygen	1·96	1·05	0·574	0·472

*Contains added pile quality graphite

b. The composition of the concrete, beechwood and Jabrox reflectors is given in the following Table (in 10^{22} nuclei/cc):

Element	Concrete A	Concrete B	Beechwood A	Beechwood B	Jabroc
Hydrogen	1·23	1·36	2·65	3·00	4·9
Carbon	0·034	0·030	1·60	1·77	3·26
Nitrogen	-	-	0·0022	0·0021	0·0049
Oxygen	4·65	4·75	1·23	1·35	2·12
Silicon	1·650	1·743	-	-	-
Potassium	0·004	0·008	0·0013	0·0020	0·139
Calcium	0·423	0·291	0·0008	0·0009	0·0019

c. 0·015 in. thick cadmium between core and the reflector specified in the Table. (But not between the core and the 8 in. thick polyethylene reflector on the remaining core surfaces).

Table 5.41

14·67 wt % Enriched UO_2SO_4 Aqueous Solution

Reference: 36

Core Geometry: Spherical; $\frac{1}{32}$ in. thick Type 347 stainless steel container

CORE			REFLECTOR				DELAYED CRITICAL U^{235} MASS (kgm)
Specific Gravity of Solution	Solution Concentration (gm U^{235}/litre)	H/U^{235} Atomic Ratio	Geometry	Material	Outer Dimensions	Density (gm/cc)	
-	37·8	647	Pseudosphere [a]	BeO	~36 in. dia.	2·7	0·565
-	38·3	638	Pseudosphere [a]	BeO	~36 in. dia.	2·7	0·572
-	38·3	638	cube cube	BeO (against core) graphite	24 in. 18 in. thick	2·7 1·67	0·573
-	49·2	497	cube cube	graphite (against core) BeO	18 in. 12 in. thick	1·67 2·7	0·735
-	50·8	481	cube	graphite	48 in.	1·67	0·760

a. Supported on 12 in. thick graphite plate

Table 5.42

4·89 wt % Enriched UO_2F_2 Aqueous Solution

Reference: 6

Core Geometry: 27·3 cm dia. sphere; aluminium container with a 3 in. dia. solution feed pipe attached at the base

CORE			DELAYED CRITICAL CORE PARAMETERS	
Specific Gravity of Solution	Uranium Concentration of Solution (gm/gm)	H/U^{235} Atomic Ratio	Volume (litres)	U^{235} Mass (kgm)
No Reflector				
1·56	0·3161	1012	172	4·16
Effectively Infinite Water Reflector				
1·52	0·2934	1113	171	3·78

Table 5.43

Cylinders of 2·00 wt % Enriched UF_4/Paraffin Wax[a] Mixtures

Reference: 25, 38

The fissile mixture used in these experiments was prepared from UF_4 with an average particle size of 150 microns and no particles greater than 300 microns. Subsidiary experiments show that the effect of particle size on reactivity is small. The homogenity of mixing is also verified by analysis.
The cores were pseudocylinders assembled from tablets of the mixture that were 1, 2 or 4 in. square and ¼, 1, 2 or 4 in. high, and clad in 0·0008 in. thick aluminium foil. The core cross sections corresponding to various diameters are illustrated in Figure 5.4, the diameter being evaluated on an equal area basis. The critical dimensions given in the table are nominal, i.e., they represent the combined thicknesses of the fuel blocks. Horizontal dimensions should be increased by 0·61% and vertical dimensions by 0·45% to obtain the actual dimensions of the core.
Each core was penetrated by four aluminium control rod guide tubes.
The cores were supported on an aluminium honeycomb table consisting of a horizontal stack of 3 in. square x 6 ft. long Type 2S aluminium tubes, wall thickness 0·047 in. Where required the top two layers of cells in the honeycomb could be filled with Plexiglas blocks forming a 6 in. thick reflector of average composition 91·8 vol. % Plexiglas, 6·2 vol. % aluminium.

FISSILE MIXTURE			DELAYED CRITICAL CORE PARAMETERS				
Density	Uranium Density (gm/cc)	H/U^{235} Atomic Ratio	Diameter (in.)	Height (in.)	Height / Diameter	Volume	U^{235} Mass (kgm)
No Reflector							
3·93	2·6	294	24	54·0	-	-	21·0
			28	26·7	-	-	14·1
			32	21·7	-	-	14·9
			40	17·9	-	-	19·5
6 in. Plexiglas/Aluminium Reflector on Core Bottom and 6 in. Paraffin on Top and Sides							
4·5	3·1	195	24	47·7	-	-	21·9
			29	25·1	-	-	16·9
			31	22·2	-	-	17·3
			36	18·6	-	-	19·3
			44	16·2	-	-	24·8
3·93	2·6	294	20	48·4	-	-	13·1
			24	23·1	-	-	8·9
			28	17·9	-	-	9·5
			32	15·7	-	-	10·7
			44	12·8	-	-	16·6
			50	12·1	-	-	20·6

a. Atomic Composition $C_{25}H_{52}$

Table 5.44

Rectilinear Parallelepipeds of 2·00 wt % Enriched UF_4/Paraffin Wax[a] Mixture

The fissile mixture used in these experiments was prepared from UF_4 with an average particle size of 150 microne and no particle greater than 300 microne. Subsidiary experiments show that the effect of particle size on reactivity is small. The homogenity of mixing is also verified by analysis.

The cores were assembled from tablets of the mixture that were 1, 2 or 4 in. square and ¼, 1, 2 or 4 in. high, and clad in 0·008 in. thick aluminium foil. The critical dimensions given in the table are nominal, i.e. they represent the combined thicknesses of the fuel blocks. Horizontal dimensions should be increased by 0·61% and vertical dimensions by 0·45% to obtain the actual dimensions of the core.

Each core was penetrated by four aluminium control rod guide tubes.
The cores were supported on an aluminium honeycomb table consisting of a horizontal stack of 3 in. square x 6 ft. long Type 2S aluminium tubes, wall thickness 0·047 in. Where required the top two layers of cells in the honeycomb could be filled with Plexiglas blocks forming a 6 in. thick reflector of average composition 91·8 vol.% Plexiglas, 6·2 vol.% aluminium.

FISSILE MIXTURE			DELAYED CRITICAL CORE PARAMETERS					REFERENCE
Density	Uranium Density (gm/cc)	H/U^{235} Atomic Ratio	Base Dimensions	Height	Height / √Area	Volume (litres)	U^{235} Mass (kgm)	
No Reflector								
4·5	3·1	195	71·5 cm x 71·5 cm	94·1 cm [b]	-	-[b]	-[b]	24, 38
			76·65cm x 76·65cm	78·1 cm [c]	-	-[c]	-[c]	24, 38
			86·75cm x 86·75cm	66·7 cm [d]	-	-[d]	-[d]	24, 38
3·93	2·6	294	22 in.x 22 in.	48·0 in.	-	-	20·0	25, 38
			24 in.x 24 in.	31·2 in.	-	-	5·5	25, 38
			28 in.x 28 in.	22·7 in.	-	-	15·3	25, 38
			36 in.x 36 in.	18·1 in.	-	-	20·1	25, 38
	2·2	404	26 in.x 26 in.	22·1 in.	-	24	10·8	26, 27
6 in. Plexiglas/Aluminium Reflector on Core Bottom and 6 in Paraffin on Top and Sides								
4·5	3·1	195	22 in.x 22 in.	44·4 in.	-	-	22·0	25, 38
			24 in.x 24 in.	31·3 in.	-	-	18·4	25, 38
			28 in.x 28 in.	22·9 in.	-	-	18·4	25, 38
			29 in.x 29 in.	21·6 in.	-	-	18·6	25, 38
			36 in.x 36 in.	17·3 in.	-	-	22·9	25, 38
3·93	2·6	294	18 in.x 18 in.	53·0 in.	-	-	14·8	25, 38
			20 in.x 20 in.	29·2 in.	-	-	10·0	25, 38
			24 in.x 24 in.	19·5 in.[e]	-	-[e]	9·60[e]	25, 38
			28 in.x 28 in.	16·2 in.	-	-	10·9	25, 38
			36 in.x 36 in.	13·5 in.	-	-	15·0	25, 38
			44 in.x 44 in.	12·3 in.	-	-	20·5	25, 38
	2·2	404	21 in.x 21 in.	21·6 in.	-	156	6·9	26, 27
6 in. Paraffin Reflector on Two Sides Only								
4·5	3·1	195	28 in.x 28 in.	31·0 in.	-	-	24·9	25, 38
6 in. Paraffin Reflector on All Four Sides								
4·5	3·1	195	28 in.x 28 in.	27·1 in.	-	-	21·7	25, 38
			29 in.x 29 in.	26 in.	-	-	22·3	25, 38

Table 5.44 (Cont'd)

FISSILE MIXTURE			DELAYED CRITICAL CORE PARAMETERS					REFERENCE
Density	Uranium Density (gm/cc)	H/U^{235} Atomic Ratio	Base Dimensions	Height	$\frac{\text{Height}}{\sqrt{\text{Area}}}$	Volume (litres)	U^{235} Mass (kgm)	
6 in. Plexiglas/Aluminium Reflector on Core Bottom and 6 in. Paraffin on Top (Sides Unreflected)								
4·5	3·1	195	29 in.x 29 in.	29 in.	-	-	24·9	25, 38

a Atomic composition $C_{25}H_{52}$

b Aluminium honeycomb shown by subsidiary experiments to reduce measured critical height by 0·89 cm

c Aluminium honeycomb shown by subsidiary experiments to reduce measured critical height by 0·77 cm

d Aluminium honeycomb shown by subsidiary experiments to reduce measured critical height by 0·63 cm

e Control rod guide tables shown by subsidiary experiments to increase measured critical height by $\frac{1}{4}$ in. or 1·25%

Table 5.45

Cylinders of 1·42 Atomic % Enriched UF_4/Paraffin Wax Mixtures

In these experiments the cores were pseudocylinders assembled from tablets of the fissile mixture with dimensions of 6 in. x 3 in. x 1 in. or 3 in. x 3 in. x 1 in. (a small number of blocks of sub multiples of these sizes of 1 in. and ½ in. thickness were also used). The core cross-section corresponding to one diameter is illustrated in Figure 5.5.

FISSILE MIXTURE			DELAYED CRITICAL CORE PARAMETERS					REFERENCE
Density (gm/cc)	Uranium Density (gm/cc)	H/U^{235} Atomic Ratio	Diameter (cm)	Height (cm)	Height / Diameter	Volume (litres)	Uranium Mass (tonne)	
No Reflector								
-	2·5	421·8	107·1	108·7	1·01	980	2·44	28
			116·4	91·8	0·789	977	2·43	28
			124·2	84·6	0·681	1025	2·55	28
			131·4	79·3	0·604	1076	2·68	28
3·35	2·15	570	107·5	112·9	1·050	1021	2·20	29
			124·4	87·0	0·699	1057	2·27	29
			136·4	78·4	0·575	1145	2·46	29
8 in. Thick Polyethylene Reflector, (density 0·92 gm/cc)								
	2·5	421·8	91·9	116·6	1·27	773	1·92	28
			107·1	82·5	0·770	744	1·85	28
			138·0	63·6	0·461	951	2·37	28
3·35	2·15	570	92·3	126·2	1·37	844	1·81	29
			107·5	87·5	0·814	793	1·70	29
			124·4	72·9	0·586	886	1·90	29

Table 5.46

Rectilinear Parallelepipeds of 1·42 Atomic % Enriched UF_4/Paraffin Wax Mixture with Single Material Reflectors
(See also Tables 9.29, 9.31)

In these experiments the cores were assembled from tablets of the fissile mixture with dimensions 6 in. x 3 in. x 1 in. or 3 in. x 3 in. x 3 in. (a small number of blocks of submultiples of these sizes of 1 in. and ½ in. thickness were also used)

FISSILE MIXTURE			DELAYED CRITICAL CORE PARAMETERS					
Density (gm/cc)	Uranium Density (gm/cc)	H/U^{235} Atomic Ratio	Area (cm)	Thickness (cm)	Thickness / √Area	Volume (litres)	Uranium Mass (tonne)	REFERENCE
				No Reflector				
-	2·5	421·8	86·8 x 86·8	174·4	-	1314	3·27	28
			93·1 x 93	123·8	-	1073	2·67	28
			100·0 x 99·9	103·1	-	1030	2·56	28
			107·7 x 107·8	90·2	-	1047	2·61	28
			115·4 x 115·4	82·7	-	1101	2·74	28
			123·0 x 122·9	77·8	-	1176	2·93	28
			130·7 x 130·6	74·2	-	1267	3·15	28
3·35	2·15	570	91·5 x 92·2	137·9	-	1163	2·50	29
			100·0 x 99·9	107·2	-	1071	2·30	29
			115·1 x 114·9	84·6	-	1114	2·40	29
			122·7 x 123·0	79·1	-	1194	2·57	29
			130·7 x 130·8	75·6	-	1292	2·78	29
			138·6 x 138·3	72·5	-	1390	2·99	29
				8 in. Thick Polyethylene Reflector (density 0·92 gm/cc)				
-	2·5	421·8	75·7 x 75·7	204·0	-	1169	2·91	28
			76·8 x 77·0	177·7	-	1051	2·62	28
			79·4 x 79·6	142·4	-	900	2·24	28
			84·5 x 84·7	111·5	-	798	1·99	28
			92·2 x 92·3	[illegible]	-	771	1·92	28
			107·7 x 107·8	72·5	-	842	2·10	28
			123·0 x 123·1	64·3	-	974	2·42	28
			138·3 x 138·5	59·9	-	1147	2·86	28
3·35	2·15	570	79·8 x 76·8	200·8	-	1231	2·65	29
			84·7 x 84·5	125·0	-	895	1·92	29
			92·6 x 92·2	97·0	-	828	1·78	29
			99·9 x 99·9	84·3	-	841	1·81	29
			107·4 x 107·5	76·4	-	882	1·90	29
			115·1 x 114·9	71·4	-	944	2·03	29
			123·0 x 122·7	67·2	-	1014	2·18	29
			138·3 x 138·6	62·4	-	1196	2·57	29

Table 5.47

Rectilinear Parallelepipeds of 1·42 Atomic % Enriched UF_4/Paraffin Wax Mixture with Composite Reflector

(Includes cadmium shielded systems)

Reference: 29

Fissile Mixture: Density, 3·35 gm/cc
Uranium density, 2·15 gm/cc
H/U^{235} atomic ratio, 570

In these experiments the cores were assembled from tablets of the fissile mixture with dimensions 6 in. x 3 in. x 1 in. or 3 in. x 3 in. x 1 in. (a small number of blocks of submultiples of these sizes of 1 in. x ½ in. thickness were also used).
Only one 45 in. x 45 in. face of the core was reflected as specified in the Table. The other 45 in. x 45 in. was reflected by 8 in. thick polythylene (density 0·92 gm/cc), and the remaining faces were unreflected.

REFLECTOR (See notes prefacing Table)			DELAYED CRITICAL PARAMETERS				
Material	Density (gm/cc)	Thickness (in.)	Area (in.)	Thickness (cm)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Volume	Mass
Unreflected	-	None	45 x 45	80·6	-	-	-
Polythene	0·92	½	45 x 45	79·1	-	-	-
		1		78·1	-	-	-
		2		77·1	-	-	-
		4		76·6	-	-	-
		8		76·7	-	-	-
Concrete	2·3	1	45 x 45	79·1	-	-	-
		2		78·1	-	-	-
		3		77·2	-	-	-
		5		76·1	-	-	-
		8		75·7	-	-	-
		10		75·7	-	-	-
Concrete/Cadmium [a]	2·3	4	45 x 45	78·5	-	-	-
		8		78·3	-	-	-
Jabroc (a wood product)	-	4	45 x 45	75·9	-	-	-
Jabroc/Cadmium [a]	-	4	45 x 45	79·3	-	-	-

a. 0·03 in. thick cadmium between core and the reflector specified in the Table (but not between the core and the 8" thick polyethylene reflector on the opposing core surface, or on the unreflected core surfaces).

Table 5.48

Borosilicate Glass Poisoning

Reference: 31, 39, 40

Fissile Material: $UO_2(NO_3)_2$ at 92·6 wt% Enrichment

These experiments were performed with cylindrical containers of an aqueous fissile solution into which the glass was introduced in the form of Raschig ring packing. In most instances the level of the solution had to be raised above the packed section of the cylinder to achieve criticality. A number of results were obtained with the core clad in 0·032 in. thick cadmium.

TYPE OF CYLINDER [a]	FISSILE SOLUTION			GLASS PACKING					DELAYED CRITICAL PARAMETERS		
	Specific Gravity	Uranium Concentration (gm/litre)	H/U^{235} Atomic Ratio	Size of Rings: Outer Dia. (in.)	Size of Rings: Inner Dia. (in.)	Size of Rings: Length (in.)	Boron Content of Glass (wt %)	Glass Content of Packed Section of Cylinder (wt %)	Diameter (in.)	Glass Height [b] (in.)	Solution Height (in.)
No Reflector											
A	-	415	59	1·50	1·25	1·70	0·5 [c]	24·0	20	21·4	10·86
				0·625	0·43	0·625	3·9 [d]	30·0		27·2	32·69
							4·0 [b]	21·0		33·6	38·67
				1·50	1·25	1·70	4·1 [d]	24·1		35·6	41·32
							5·7 [e]	24·1		34·6	41·03
A	-	279	92	1·50	1·25	1·70	4·1 [d]	24·1		35·6	41·48
A	-	141	191	1·50	1·25	1·70	0·5 [c]	24·0		21·0	25·63
D							0·5 [c]	24·0		21·0	25·63
A							4·1 [d]	24·1		35·6	41·47
D	-	94·4	290	1·50	1·25	1·70	0·5 [c]	24·0		21·0	26·86
D	-	63·3	436	1·50	1·25	1·70	0·5 [c]	24·0		21·0	28·23
B	-	415	59				4·0 [f]	20·9	30	35·9	39·75
C	-	415	59	1·50	1·25	1·70	5·7 [e]	24·1	48	30·0	34·31
							5·7 [e]	24·1		46·5	44·68 (Subcritical)
Effectively Infinite Water Reflector on Bottom and Sides of Core to a Height Equal to that of the Fissile Solution											
A	-	415	59	1·50	1·25	1·70	0·5 [c]	24·0	20	21·4	8·34
				0·625	0·43	0·625	3·9 [d]	30·0		27·2	32·37
							4·0 [f]	21·0		33·6	38·29
							4·0 [f]	20·9		33·8	38·53
				1·50	1·25	1·70	4·1 [d]	24·1		35·6	40·84
							5·7 [e]	24·1		34·6	40·64

Table 5.48 (Contd)

TYPE OF CYLINDER	FISSILE SOLUTION			GLASS PACKING					DELAYED CRITICAL PARAMETERS		
	Specific Gravity	Uranium Concentration (gm/litre)	H/U^{235} Atomic Ratio	Size of Rings: Outer Dia. (in.)	Size of Rings: Inner Dia. (in.)	Size of Rings: Length (in.)	Boron Content of Glass (wt %)	Glass Content of Packed Section of Cylinder (wt %)	Diameter (in.)	Glass Height[b] (in.)	Solution Height (in.)
A	-	279	92	1·50	1·25	1·70	4·1 [d]	24·1		35·6	41·12
A D	-	141	191	1·50	1·25	1·70	0·5 [b]	24·0		21·0	24·95 25·29
D	-	94·4	290	1·50	1·25	1·70	0·5 [b]	24·0		21·0	26·51
D	-	63·3	436	1·50	1·25	1·70	0·5 [b]	24·0		21·0	27·78
B	-	415	59				4·0 [f] 4·0 [b]	20·9 20·9		35·9 50·0	39·49 50·0 (Subcritical)
C	-	415	59	1·50	1·25	1·70	5·7 [e] 5·7 [e]	24·1 24·1		30·0 46·5	34·25 44·68

a. The Type A cylinder was stainless steel with $\frac{1}{16}$ in. thick walls and $\frac{1}{2}$ in. thick base

The Type B cylinder was aluminium with $\frac{1}{8}$ in. walls and $\frac{1}{2}$ in. thick base

The Type C cylinder was stainless steel with $\frac{1}{8}$ in. thick walls and a very shallow, $\frac{1}{4}$ in. thick dished base

The Type D cylinder was the Type A cylinder clad in 0·032 in. thick cadmium

b. Random irregularities in the top surface of the ring bed introduced an uncertainty of ± 0·3 in. in this measurement

c. Kimble Glass Co. Type R-6

d. Kimble Glass Co. Type KG33

CHAPTER 6 - SINGLE PLUTONIUM CORES MODERATED BY HYDROGEN

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CHAPTER 6 - REFERENCES

1. CLAYTON, E. D., REARDON, W. A., LLOYD, R. C., POWELL, T. J. and MASTERSON, R. H. Critical Mass Experiments with Plutonium Nitrate Solutions in Physics Research Quarterly Report July, August, September, 1961, USAEC Report HW-71747, Hanford Laboratories, October 13, 1961

2. CLAYTON, E. D., REARDON, W. A., LLOYD, R. C., POWELL, T. J., MASTERSON, R. H. and ODEGAARDEN, R. H. Critical Mass Experiments with Plutonium - Nitrate Solutions in Physics Research Quarterly Report, October, November, December, 1961, USAEC Report HW72586, Hanford Laboratories, January 31, 1962

3. CLAYTON, E. D., LLOYD, R. C. and REARDON, W. A. Critical Mass Experiments with Plutonium Nitrate Solutions; Trans. Am. Nucl. Soc. 5(1): 75 (1962)

4. KREUSI, F. E., ERKMAN, J. O. and LANNING, D. D. Critical Mass Studies of Plutonium Solutions, USAEC Report HW-24514 DEL, Hanford Laboratories, February 15, 1960

5. LLOYD, R. C., CLAYTON, E. D., RICHEY, C. R. and BIERMAN, S. R. Critical Experiments with Plutonium Nitrate Solutions, in Physics Research Quarterly Report, January, February, March, 1963, USAEC Report HW-77311, Hanford Laboratories, April 15, 1963

6. LLOYD, R. C. and CLAYTON, E. D. Critical Mass Experiments with Plutonium Nitrate Solutions, in Physics Research Quarterly Report, October, November, December 1962, USAEC Report HW-76128, Hanford Laboratories, January 15, 1963

7. LLOYD, R. C., CLAYTON, E. D. and RICHEY, C. R. Critical Mass Experiments with Plutonium Nitrate Solutions, in Physics Research Quarterly Report July, August, September, 1962, USAEC Report HW-75228, Hanford Laboratories, October 15, 1962

8. LLOYD, R. C. and CLAYTON, E. D. Critical Mass Experiments with Plutonium Nitrate Solutions, in Physics Research Quarterly Report, April, May, June, 1962, USAEC Report HW-74190, Hanford Laboratories, July 16, 1962

9. LLOYD, R. C., CLAYTON, E. D. and REARDON, W. A. Critical Mass Experiments with Plutonium Nitrate Solutions, in Physics Research Quarterly Report January, February, March 1962, USAEC Report HW-73116, Hanford Laboratories, April 16, 1962

10. SMITH, J. C. UKAEA, Unpublished results.

11. CROCKER, V. S., McCULLEN, J. D., HORTON, C. C., JENKINS, I. L., KEEN, N. J. and LISTER, B. A. Critical Assemblies of Plutonium Nitrate Solutions, UKAEA Report AERE C and R/R 1182, Atomic Energy Research Establishment, Harwell, 1953

12. HORTON, C. C. and McCULLEN, J. D. Plutonium - Water Critical Assemblies, in Proceedings of the First International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1955, P/428

13. BERTRAND, J., BONNOURE, P., CLOUET D'ORVAL, C., CORPEL, J., DE LAMORE, I., LECOUSTEY, P., PREVOT, I., ROCHE, R., SOUVE, M., TACHON, J. and VENDRYES, G. 'Proserpine', A Homogeneous Critical Experiment with Plutonium, in Proceedings of the Second International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958, P/1203

14. TACHON, J. Neutron Study of a Plutonium Thermal Neutron Reactor 'Proserpine', UKAEA Report TRG Information Series 17(D), Reactor Group, Risley, 1962.

15. RICHEY, C. R., WHITE, J. D. and CLAYTON, E. D. Sub-critical Experiments with PuO_2-Polystyrene Compacts, in Physics Research Quarterly Report, April, May, June, 1963, USAEC Report HW-77871, Hanford Laboratories, 1963

16. RICHEY, C. R., WHITE, J. D., CLAYTON, E. D., BIERMAN, S. R., GARLID, K. L. and SKEEN, D. R. Critical Experiments with PuO_2- Polystyrene Compacts, in Physics Research Quarterly Report, July, August, September, 1963, USAEC Report HW-79054, 1963

EXPERIMENTAL RESULTS FOR SINGLE Pu CORES MODERATED BY HYDROGEN

Table 6.1

Unreflected Spheres of Aqueous Solutions - Unpoisoned

Fissile Solutions: Plutonium dissolved in excess aqueous nitric acid.
Certain of the solutions were contaminated with small quantities of iron.

Spheres: Stainless steel.

SPHERE WALL-THICKNESS	Pu^{240} CONTENT OF PLUTONIUM (wt%)	SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION					H/Pu ATOMIC RATIO	DELAYED CRITICAL PARAMETERS			REFERENCES
			Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3 (gm/litre)	Water (gm/litre)	Iron (gm/litre)		Diameter (in.)	Volume (litres)	Pu Mass (kgm)	
0·044 in.	4·6	1·249 [a]	105·2 [a]	2·37 [a,b]	260·6 [a]	856·4 [a]	-	221·5 [a]	-	24·9 [c]	2·619 [c]	1, 2, 3
0·116 in.		1·249 [a]	105·2 [a]	2·37 [a,b]	260·6 [a]	856·4 [a]	-	221·5 [a]	-	23·9 [c]	2·514 [c]	1, 2, 3
0·116 in.		1·203 [a]	88·4 [a]	1·78 [a,b]	179·9 [a]	894·0 [a]	-	273·3 [a]	-	23·3 [c]	2·060 [c]	1, 2, 3
0·044 in.		1·191 [a]	68·4 [a]	2·24 [a,b]	227·0 [a]	891·7 [a]	-	353·9 [a]	-	25·0 [c]	1·710 [c]	1, 2, 3
0·050 in. [d]	4·17	1·1958	43·20	4·18	281·8	-	0·179	-	16 (Nominal)	34·15	1·483	4
d		1·1374	38·31	2·79	163·0	-	0·124	-			1·302	4
d		1·1396	38·15	2·58	180·0	-	0·178	-			1·303	4
d		1·0991	36·22	1·31	109·4	-	0·120	-			1·237	4
d		1·0961	34·80	1·12	104·4	-	0·104				1·194	4
0·050 in. [d,e]	4·2	1·1816	27·48	4·63	285·75	-	0·141	-	18 (Nominal)	49·0	1·347	4
d,e		1·1472	25·18	3·49	199·16	-	0·137	-			1·235	4
d,e		1·1020	23·85	2·27	148·41	-	0·123	-			1·167	4
d,e		1·0894	23·94	1·66	125·6	-	0·0389	-			1·173	4
d,e		1·0860	23·14	1·560	107·78	-	0·135	-			1·132	4
d,e		1·0788	23·40	1·431	97·77	-	0·126	-			1·140	4
d,e		1·0662	22·35	0·935	76·12	-	0·120	-			1·095	4

a. Plutonium said to be in tetravalent form, $Pu(NO_3)_4$

b. gm/litre

c. These experiments were performed with a sphere of fixed volume 23·22 litres and with supporting necks attached at top and bottom. The critical parameters are estimated by extrapolation of reciprocal multiplication curves. No correction is applied for the change in geometry which would be required to contain the extrapolated volume. Nor are corrections applied for the supporting necks or other incidental reflectors, (see Figure 6.1)

d. Type 347 stainless steel sphere with ⅜ in. OD solution feed pipe attached to the bottom and supporting neck to the top. Subsidiary experiments show correction for supporting neck ≤ 5 gm plutonium

Table 6.2

Unreflected Spheres of Aqueous Solutions with added Lithium

Reference: 4

Fissile Solutions: Plutonium (4·2 wt % Pu^{240}) dissolved in excess aqueous nitric acid.

Lithium added as lithium nitrate.

Small amounts of iron contamination also present. Where duplicate samples of the same solution are analysed the higher iron concentration is the more reliable.

Spheres: 0·050 in. thick Type 347 stainless steel clad in 0·020 in. thick cadmium; $\frac{3}{8}$ in. OD solution feed pipe attached to bottom and a supporting neck to top. Subsidiary experiments show correction for supporting neck $\leq$5 gm plutonium.

DENSITY OF SOLUTION (gm/cc)	SOLUTION CONCENTRATION					H/Pu ATOMIC RATIO	DELAYED CRITICAL PARAMETERS			
	Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion (gm/litre)	Lithium (gm/litre)	Iron (gm/litre)		Diameter (in.)	Volume (litres)	Pu Mass (kgm)	
1·0917	25·43	1·64	123·3	0·223	0·0407	-	18 (nominal)	49·0	1·242	Samples of the same solution
1·0914	25·47	1·45	116·5	0·223	0·165	-			1·244	
1·0964	25·98	1·74	132·6	0·528	0·0361	-			1·270	Samples of the same solution
1·0985	27·00	1·74	103·0	0·528	0·154	-			1·320	
1·1001	28·28	1·64	132·7	0·680	0·0392	-			1·386	Samples of the same solution
1·1006	28·54	1·37	132·2	0·680	0·133	-			1·399	
1·1043	29·83	1·69	141·4	0·88	0·0435	-			1·459	Samples of the same solution
1·1059	30·43	1·49	134·2	0·88	0·092	-			1·488	
1·1050	29·06	1·47	131·8	0·88	0·208	-			1·421	

Table 6.3

Spheres of Aqueous Solutions with Water Reflector - Unpoisoned

Fissile Solutions: Plutonium dissolved in excess aqueous nitric acid. Certain of the solutions were contaminated with small quantities of iron.

Spheres: Stainless Steel.

Reflector: Effectively infinite thickness.

SPHERE WALL-THICKNESS	CORE								DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Pu^{240} Content of Plutonium (wt%)	Specific Gravity of Solution	Solution Concentration					H/Pu Atomic Ratio	Diameter (in.)	Volume (litres)	Pu Mass (kgm)	
			Plutonium (gm/litre)	Hydrogen ION H^+ (gm ion/litre)	Total Nitrate ION NO_3^- (gm/litre)	Water (gm/litre)	Iron (gm/litre)					
0·049 in.	4·6	1·591 [a]	431 [a]	1·76 [a]	379 [a]	763 [a]	-	47·97	- [a]	13·75 [c]	5·93 [c]	5
		1·585 [a]	378 [a]	1·37 [a]	386 [a]	784 [a]	-	55·92	- [c]	13·50 [c]	5·10 [c]	5
		1·517 [a]	310 [a]	0·86 [a]	319 [a]	823 [a]	-	71·14	- [c]	13·05 [c]	4·05 [c]	5
		1·492 [a]	295 [a]	0·78 [a]	303 [a]	850 [a]	-	71·12	- [c]	12·96 [c]	3·82 [c]	5
		1·469 [a]	275 [a]	0·76 [a]	293 [a]	863 [a]	-	83·96	- [c]	12·85 [c]	3·53 [c]	5
0·089 in.		1·469 [a]	275 [a]	0·76 [a]	293 [a]	863 [a]	-	83·96	- [c]	13·09 [c]	3·60 [c]	5
0·125 in.		1·458 [a]	281 [a]	0·74 [a]	290 [a]	879 [a]	-	83·67	- [a]	13·11 [c]	3·68 [c]	5
0·304 in.		1·448 [a]	278 [a]	0·98 [a]	286 [a]	860 [a]	-	82·96	- [c]	13·51 [c]	3·76 [d]	5
		1·429 [b]	210 [b]	2·8 [b]	378 [b]	809 [b]	-	105·5	- [a]	13·44 [c]	2·81 [c]	6
		1·395 [b]	183 [b]	2·6 [b]	354 [b]	855 [b]	-	127·4	- [a]	13·27 [c]	2·43 [c]	6
		1·347 [b]	169 [b]	2·3 [b]	312 [b]	861 [b]	-	138·5	- [c]	13·10 [c]	2·21 [c]	6
		1·307 [b]	140 [b]	2·2 [b]	284 [b]	882 [b]	-	171·0	- [c]	12·97 [c]	1·82 [c]	6
		1·293 [b]	132 [b]	2·3 [b]	281 [b]	875 [b]	-	180·1	- [c]	12·97	1·71 [c]	6
		1·270 [b]	119 [b]	2·0 [b]	245 [b]	908 [b]	-	206·6	- [c]	12·93	1·54 [c]	5
0·089 in.		1·272 [b]	118 [b]	2·05 [b]	250 [b]	903 [b]	-	207·3	- [c]	13·12 [c]	1·55 [c]	5

Table 6.3 (Cont'd)

Spheres of Aqueous Solutions with Water Reflector - Unpoisoned

SPHERE WALL-THICKNESS	CORE								DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Pu^{240} Content of Plutonium (wt%)	Specific Gravity of Solution	Solution Concentration					H/Pu Atomic Ratio	Diameter (in.)	Volume (litres)	Pu Mass (kgm)	
			Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)	Iron (gm/litre)					
0·125 in.		1·278 [b]	119 [b]	2·01 [b]	249 [b]	905 [b]	-	205·9	- [c]	13·26 [c]	1·58 [c]	5
0·304 in.		1·279 [b]	120 [b]	2·05 [b]	252 [b]	903 [b]	-	203·8	- [c]	13·60 [c]	1·63 [c]	5
0·049 in.		1·184 [b]	101·6 [b]	0·60 [b]	143 [b]	957 [b]	-	251·5	- [c]	12·33 [c]	1·25 [c]	5
		1·219 [b]	96 [b]	1·67 [b]	203 [b]	919 [b]	-	258·3	- [c]	12·99 [c]	1·25 [c]	5
0·304		1·225 [b]	98 [b]	1·65 [b]	205 [b]	916 [b]	-	252·2	- [c]	13·70 [c]	1·34 [c]	5
0·049 in.		1·165 [b]	93·5 [b]	0·38 [b]	120 [b]	967 [b]	-	275·5	- [c]	12·45 [c]	1·16 [c]	5
		1·146 [b]	84·0 [b]	0·86 [b]	141 [b]	967 [b]	-	308·0	- [c]	12·69 [c]	1·07 [c]	5
		1·140 [b]	79·4 [b]	0·31 [b]	102 [b]	963 [b]	-	322·9	- [c]	12·77 [c]	1·01 [c]	5
		1·135 [b]	76·2 [b]	0·61 [b]	117 [b]	947 [b]	-	331·8	- [c]	12·85 [c]	0·98 [c]	5
		1·130 [b]	73·0 [b]	0·15 [b]	86 [b]	953 [b]	-	345·9	-	12·94 [c]	0·94 [c]	5
		1·130 [b]	54 [b]	1·03 [b]	121 [b]	953 [b]	-	473·0	- [c]	13·98 [c]	0·75 [c]	5
0·05 in. [d]	3·12	1·2695	77·2	4·72	359	822·7	0·237	-	12·0 (nominal)	15·19	1·176	4
		1·2412	70·22	4·07	322	843·6	0·218	-			1·070	4
		-	64·16	-	-	-	0·190	-			0·973	4
		1·2152	63·75	3·62	270	860·9	0·204	-			0·961	4
		-	60·35 [e]	- [e]	- [e]	- [e]	0·184 [e]	- [e]			0·911	4
		1·1898	59·93 [e]	3·20 [e]	237 [e]	879·8 [e]	0·199 [e]	- [e]			0·911	4
		- [e]	56·75 [e]	- [e]	- [e]	- [e]	0·286 [e]	- [e]			0·860	4
		1·1682 [e]	56·20 [e]	2·49 [e]	207 [e]	899·2 [e]	0·203 [e]	- [e]			0·854	4
		1·1482	51·80	2·20	163	920·0	0·272	-			0·786	4
		1·1318	50·39	1·57	138	922·8	0·178	-			0·763	4
		1·1306	50·25	1·61	139	941·3	0·199	-			0·761	4

Table 6.3 (Cont'd)

Spheres of Aqueous Solutions with Water Reflector - Unpoisoned

SPHERE WALL-THICKNESS	CORE								DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Pu^{240} Content of Plutonium (wt%)	Specific Gravity of Solution	Solution Concentration					H/Pu Atomic Ratio	Diameter (in.)	Volume (litres)	Pu Mass (kgm)	
			Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)	Iron (gm/litre)					
0·050 in.[d]	1·76	1·1006	34·81	1·46	116·0	940·1	0·121	-	13·0 (nominal)	18·94	0·654	4
		1·1012	34·59	1·44	117·0	939·8	0·113	-			0·656	4
		1·0858	34·06	1·04	87·1	955·6	0·124	-			0·640	4
		1·0848	33·17	1·02	86·2	962·4	0·123	-			0·631	4
	3·12	1·1905	44·64	3·71	269	865·2	0·269	-			0·846	4
		1·1910	44·12	3·63	270	868·3	0·262	-			0·834	4
		1·1548	41·10	2·90	205	908·6	0·266	-			0·777	4
		1·1547	40·69	2·90	205	906·2	0·248	-			0·773	4
		1·1279	38·83	2·01	156	926·7	0·141	-			0·727	4
		1·1107	38·11	1·67	128	-	0·110	-			0·712	4
		1·1106	37·99	1·64	132	-	0·095	-			0·716	4
b		1·1106	37·11	1·66	125	942·5	0·128	-		18·04	0·669	4
b		1·0910	36·27	1·15	93·1	955·1	0·114	-			0·654	4
0·050 in.[d]	0·54	1·1321	28·63	2·72	188	915·0	0·165	-	14·0 (nominal)	23·64	0·666	4
		1·1300	28·50	2·70	187	914·8	0·163	-			0·671	4
		1·1030	27·91	1·85	138	936·6	0·160	-			0·648	4
		1·1040	27·39	1·90	137	945·0	0·152	-			0·647	4
		1·0869	26·77	1·42	107	955·5	0·147	-			0·631	4
		1·0695	26·69	0·97	78·3	967·2	0·146	-			0·627	4
		1·0692	26·33	0·99	77·3	967·6	0·143	-			0·625	4
		1·0858	26·23	1·41	107	954·9	0·150	-			0·622	4
	1·76	1·0885	27·95	1·44	109	939·4	0·092	-			0·652	4

Table 6.3 (Cont'd)

Spheres of Aqueous Solutions with Water Reflector - Unpoisoned

SPHERE WALL-THICKNESS	CORE								DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Pu^{240} Content of Plutonium (wt%)	Specific Gravity of Solution	Solution Concentration					H/Pu Atomic Ratio	Diameter (in.)	Volume (litres)	Pu Mass (kgm)	
			Plutonium (gm/l)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)	Iron (gm/litre)					
		1·0885	27·92	1·42	110	938·4	0·096	-			0·661	4
	3·12	1·2508	39·62	5·75	408	799·7	0·147	-			0·935	4
		1·1993	35·82	4·39	308	844·7	0·144	-			0·841	4
		1·2001	35·53	4·32	311	852·4	0·146	-			0·840	4
		1·1460	31·79	2·90	208	898·6	0·120	-			0·752	4
		1·1087	30·33	1·92	143	925·4	0·113	-			0·713	4
		1·0918	30·15	1·39	109	951·8	0·129	-			0·708	4
		1·0931	29·74	1·51	115	941·4	0·113	-			0·701	4
		1·0914	29·61	1·40	110	948·2	0·127	-			0·699	4
		1·0769	28·78	1·02	87·4	957·7	0·110	-			0·681	4
	3·43	1·0923[e]	29·75[e]	1·46[e]	111 [e]	944·7[e]	0·129[e]	-[e]			0·698	4
		1·0916[e]	29·55[e]	1·46[e]	112 [e]	947·4[e]	0·148[e]	-[e]			0·699	4
		1·0925	29·60	1·51	111	948·3	0·142	-			0·695	4
	4·05	-[e]	41·19[e]	-[e]	-[e]	-[e]	0·126[e]	-[e]			0·973	4
		1·2405[e]	41·12[e]	5·40[e]	384·9[e]	811·9[e]	0·126[e]	-[e]			0·971	4
		1·2172	38·72	5·46	335·2	833·4	0·126	-			0·915	4
		-	37·84	-	334	-	0·115	-			0·892	4
		1·1826	36·38	3·69	272·4	865·7	0·104	-			0·857	4
		1·1496[e]	34·07[e]	2·92[e]	210·7[e]	890·1[e]	0·093[e]	-[e]			0·801	4
		-[e]	33·81[e]	-[e]	-[e]	-[e]	0·100[e]	-[e]			0·795	4
		1·1117	31·72	1·88	146·8	-	0·086	-			0·748	4
		-[e]	30·79[e]	-[e]	-[e]	-[e]	0·083[e]	-[e]			0·727	4

Table 6.3 (Cont'd)

Spheres of Aqueous Solutions with Water Reflector - Unpoisoned

SPHERE WALL-THICKNESS	CORE								DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Pu^{240} Content of Plutonium (wt%)	Specific Gravity of Solution	Solution Concentration					H/Pu Atomic Ratio	Diameter (in.)	Volume (litres)	Pu Mass (kgm)	
			Plutonium (gm/l)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)	Iron (gm/litre)					
		1·0967 [e]	30·75 [e]	1·44 [e]	119·3 [e]	940·3 [e]	0·074 [e]	- [e]			0·726	4
		1·0777	29·94	1·01	87·49	959·8	0·128	-			0·706	4
		-	29·82	-	-	-	0·104	-			0·706	4
	4·40	1·1205	32·41	2·22	158	926·3	0·102	-			0·758	4
		1·1021	31·04	1·71	127	930·8	0·110	-			0·727	4
		1·1016	30·79	1·63	126	944·0	0·105	-			0·729	4
0·044 in.	4·6	1·303 [b]	63·0 [b]	6·64 [b]	477 [b,g]	760 [b]	-	345·4	- [h]	21·45 [h]	1·35 [h]	7
		1·295 [b]	58·5 [b]	6·51 [b]	465 [b,g]	770 [b]	-	376·0	- [h]	21·69 [h]	1·27 [h]	7
		1·276 [b]	57·0 [b]	6·00 [b]	431 [b,g]	777 [b]	-	387·0	- [h]	21·20 [h]	1·21 [h]	7
		1·280 [b]	53·6 [b]	6·27 [b]	445 [b,g]	770 [b]	-	409·3	- [h]	22·35 [h]	1·20 [h]	7
		1·285 [b]	52·3 [b]	6·47 [b]	455 [b,g]	775 [b]	-	387·0	- [h]	21·20 [h]	1·21 [h]	7
		1·277 [b]	53·0 [b]	5·95 [b]	424 [b,g]	790 [b]	-	422·5	- [h]	21·51 [h]	1·14 [h]	7
		1·268 [b]	49·5 [b]	6·01 [b]	424 [b,g]	786 [b]	-	450·5	- [h]	23·21 [h]	1·15 [h]	7
		1·268 [b]	49·2 [b]	5·96 [b]	421 [b,g]	794 [b]	-	457·4	- [h]	22·55 [h]	1·11 [h]	7
		1·268 [b]	49·2 [b]	5·96 [b]	421 [b,g]	794 [b]	-	457·4	- [h]	22·86 [h]	1·13 [h]	7
		1·294 [b]	47·9 [b]	6·70 [b]	465 [b,g]	775 [b]	-	462·9	- [h]	23·13 [h]	1·11 [h]	7
		1·284 [b]	46·8 [b]	6·62 [b]	459 [b,g]	770 [b]	-	470·6	- [h]	23·38 [h]	1·09 [h]	7
		1·261 [b]	44·5 [b]	5·49 [b]	386 [b,g]	825 [b]	-	521·6	- [h]	23·24 [h]	1·03 [h]	7
		1·203 [b]	42·1 [b]	4·22 [b]	302 [b,g]	850 [b]	-	559·9	- [h]	22·0 [h]	0·93 [h]	8
		1·199 [b]	40·4 [b]	4·07 [b]	295 [b,g]	856 [b]	-	586·5	- [h]	22·6 [h]	0·91 [h]	8
		1·198 [b]	39·2 [b]	4·20 [b]	313 [b,g]	843 [b]	-	596·5	- [h]	23·1 [h]	0·91 [h]	8
0·124 in.		1·199 [b]	39·9 [b]	4·12 [b]	297 [b,g]	857 [b]	-	594·9	- [h]	23·1 [h]	0·92 [h]	8

Table 6.3 (Cont'd)

Spheres of Aqueous Solutions with Water Reflector - Unpoisoned

SPHERE WALL-THICKNESS	CORE								DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Pu^{240} Content of Plutonium (wt %)	Specific Gravity of Solution	Solution Concentration					H/Pu Atomic Ratio	Diameter (in.)	Volume (litres)	Pu Mass (kgm)	
			Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)	Iron (gm/litre)					
		1·194 [b]	38·8 [b]	4·14 [b]	311 [b,g]	845 [b]	-	603·6	- [h]	23·7 [h]	0·92 [h]	8
0·160 in.		1·199 [b]	40·3 [b]	4·13 [b]	298 [b,g]	857 [b]	-	589·0	- [h]	23·3 [h]	0·92 [h]	8
0·044 in.		1·196 [b]	38·4 [b]	4·06 [b]	292 [b,g]	854 [b]	-	615·6	- [h]	23·3 [h]	0·89 [h]	8
		1·126 [b]	36·6 [b]	2·01 [b]	136 [b,g]	924 [b]	-	683·3	- [h]	21·37 [h]	0·78 [h]	7
		1·121 [b]	34·4 [b]	2·08 [b]	165 [b,g]	926 [b]	-	729·1	- [h]	22·57 [h]	0·78 [h]	7
		1·124 [b]	34·0 [b]	2·06 [b]	163 [b,g]	930 [b]	-	740·6	- [h]	22·52 [h]	0·77 [h]	7
0·124 in.		1·121 [b]	34·4 [b]	2·09 [b]	165 [b,g]	918 [b]	-	722·9	- [h]	22·99 [h]	0·79 [h]	7
0·160 in.		1·121 [b]	34·4 [b]	2·09 [b]	165 [b,g]	916 [b]	-	721·4	- [h]	23·45 [h]	0·81 [h]	7
0·044 in.		1·123 [b]	33·5 [b]	2·07 [b]	163 [b,g]	920 [b]	-	743·8	- [h]	22·96 [h]	0·77 [h]	7
		1·1409	27·05	3·07	212	900·7	0·096	-			0·787	4
0·050 in. [d]	3·12	1·1068	25·83	2·08	147	927·1	0·094	-	15·0 (nominal)	28·99	0·746	4
		1·0899	25·10	1·60	116	946·5	0·092	-			0·722	4
		1·0899	25·02	1·60	116	947·0	0·084	-			0·726	4

a. Plutonium said to be partly in hexavalent form $PuO_2(NO_3)_2$ and partly in tetravalent form $Pu(NO_3)_4$

b. Plutonium said to be in tetravalent form $Pu(NO_3)_4$

c. These experiments were performed in a sphere of fixed volume 12·95 litres and with supporting necks attached to top and bottom (see Figure 6.1). The critical parameter of larger systems are estimated by extrapolation of reciprocal multiplication curves. No correction is applied for the change in geometry which would be required to contain the extrapolated volume. Similarly no correction to complete sphere geometry is made for systems which are critical below 12·95 litres. Subsidiary experiments show correction for supporting necks is within the uncertainty of the experiments

d. Type 347 stainless steel sphere with $\frac{3}{8}$ in. O.D. solution feed pipe attached to the bottom and supporting neck to the top. Subsidiary experiments show correction for supporting neck = 5 gm plutonium

e. Duplicate samples of the same fissile solution

f. 20 gauge type 2S aluminium sphere

g. gm per litre

h. These experiments were performed in a sphere of fixed volume 23·22 litres and with supporting necks attached to top and bottom (see Figure 6.1). The critical parameters of larger systems are estimated by extrapolation of reciprocal multiplication curves. No correction is applied for the change in geometry which would be required to contain the extrapolated volume. Similarly no correction to complete sphere geometry is made for systems which are critical below 23·22 litres. Subsidiary experiments show correction for vessel neck is within the uncertainty of the experiments

Table 6.4

Spheres of Aqueous Solutions with Water Reflector - Cadmium Clad

Reference: 7

Fissile Solution: Plutonium (4·6 wt % Pu^{240}), dissolved in excess aqueous nitric acid; said to be in the tetravalent form $Pu(NO_3)_4$.

Spheres: 0·044 in. thick stainless steel clad in 0·03 in. thick cadmium.

Reflector: Effectively infinite thickness.

These experiments were performed in a single sphere of fixed volume 23·22 litres. The critical parameters of larger systems are estimated by extrapolation of reciprocal multiplication curves. No correction is applied for the change in geometry which would be required to contain the extrapolated volume. Similarly, no correction to complete sphere geometry is made for systems which are critical below 23·22 litres.

CORE						DELAYED CRITICAL CORE PARAMETERS		
SPECIFIC GRAVITY OF SOLUTION	Solution Concentration (gm/litre)				H/Pu Atomic Ratio	Diameter	Volume (litres)	Pu Mass (kgm)
	Plutonium	Hydrogen Ion H^+	Total Nitrate Ion NO_3	Water				
1·242	70·4	3·32	279	888	346·1	-	22·77	1·61
1·244	70·1	3·47	290	883	346·2	-	22·94	1·61
1·240	69·4	3·74	304	858	341·1	-	23·10	1·60
1·151	60·2	1·35	147	946	422·5	-	21·88	1·32
1·148	56·7	1·27	137	957	453·4	-	22·02	1·25
1·144	55·0	1·49	150	942	461·1	-	22·28	1·23
1·122	50·1	1·39	138	932	500·4	-	22·87	1·14
1·123	50·2	1·39	139	938	502·6	-	22·91	1·15
1·126	46·9	1·41	136	947	543·2	-	23·25	1·09

Table 6.5

Spheres of Aqueous Solutions with Water Reflector - with Added Lithium or Bismuth

Reference: 4

Fissile Solutions: Plutonium dissolved in excess aqueous nitric acid
Lithium added as lithium nitrate and bismuth as bismuth nitrate
Small amounts of iron contamination also present

Spheres: 0·05 in. thick Type 347 stainless steel; ⅜ in. O.D. solution feed pipe attached to bottom and a supporting neck to top.
Subsidiary experiments show correction for supporting neck <5g.m. plutonium

Reflector: Effectively infinite thickness

CORE									DELAYED CRITICAL CORE PARAMETERS			REMARKS
Pu^{240} Content of Plutonium (wt %)	Density of Solution (gm/cc)	Solution Concentration: Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)	Lithium or Bismuth (gm/litre)	Iron (gm/litre)	H/Pu Atomic Ratio	Diameter (in.)	Volume (litres)	Pu Mass (kgm)	
Solutions Poisoned with Lithium												
3·43	1·0968	31·19	1·49	118	946·1	0·206	0·157	-	14·0 (nominal)	23·64	0·736	Samples of the same solution
	1·0966	31·42	1·49	117·6	943·5	0·206	0·187	-			0·742	
	1·0984	31·66	1·50	119	944·2	0·235	0·151	-			0·749	Samples of the same solution
	-	30·84	-	-	-	-	0·165	-			0·730	
	1·1008	32·82	1·53	122	943·9	0·362	0·147	-			0·775	
	1·1030	33·92	1·54	125	943·8	0·441	0·154	-			0·799	Samples of the same solution
	-	32·40	-	-	-	-	-	-			0·763	
	1·1086	34·70	1·38	131	927·4	0·661	0·168	-			0·820	
	-	34·39	-	-	-	-	0·161	-			0·813	
	1·1243	39·94	1·84	147	921·5	1·31	0·162	-			0·944	
	1·1566	41·34	2·77	206	900·7	1·17	0·192	-			0·973	Samples of the same solution
	-	40·99	-	-	-	-	0·259	-			0·964	
	1·1599	42·98	2·75	-	895·2	103·3	0·188	-			1·012	Samples of the same solution
		43·31	-	-	-	-	0·171	-			1·020	

Table 6.5 (Cont'd)

Spheres of Aqueous Solutions with Water Reflector - with Added Lithium or Bismuth

CORE									DELAYED CRITICAL CORE PARAMETERS			
Pu^{240} Content of Plutonium (wt %)	Density of Solution (gm/cc)	Solution Concentration						H/Pu Atomic Ratio	Diameter (in.)	Volume (litres)	Pu Mass (kgm)	REMARKS
		Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)	Lithium or Bismuth (gm/litre)	Iron (gm/litre)					
Solutions Poisoned with Bismuth												
3·12	1·1693	31·21	1·36	153	932·1	49·8	0·139	-	14·0 (nominal)	23·64	0·739	Samples of the same solution
	1·1753	31·05	1·42	154	924·7	49·8	0·159	-			0·735	
	1·2245	32·22	1·54	187	899·7	83·65	0·141	-			0·763	
	1·2854	33·46	2·37	220	894·6	121·6	0·142	-			0·792	Samples of the same solution
	1·2957	33·36	2·35	227	894·4	121·6	0·160	-			0·790	
	1·4103	35·75	2·2	315	856·7[a]	196·7	0·169	-			0·846	
	1·4795	37·37	2·3	260	838·9[a]	241·0	0·230	-			0·880	

a. Questionable values due to interference of bismuth in the analysis

Table 6.6

Spheres of Aqueous Solutions with Paraffin Reflector

Fissile Solution: Plutonium (4·6 wt % Pu^{240}) dissolved in excess aqueous nitric acid: said to be in the tetravalent form $Pu(NO_3)_4$

Spheres: Stainless steel: supporting necks attached to top and bottom (see Figure 6.1).

These experiments were performed in a single sphere of fixed volume 23·22 litres. The critical parameters of larger systems are estimated by extrapolation of reciprocal multiplication curves. No correction is applied for the change in geometry which would be required to contain the extrapolated volume. Similarly no correction to complete geometry is made for systems which are critical below 23·22 litres.

SPHERE WALL-THICKNESS	CORE						REFLECTOR THICKNESS	DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Specific Gravity of Solution	Solution Concentration (gm/litre)				H/Pu Atomic Ratio		Diameter	Volume (litres)	Mass (kgm)	
		Plutonium	Hydrogen Ion H^+	Total Nitrate Ion NO_3^-	Water						
0·044 in.	1·475	220·6	3·83	461·0	798·0	100·2	0·5 in.	-	24·0	5·268	2, 3
	1·502	220	4·41	552	734	93·4		-	24·8	5·46	3, 9
	1·502	220	4·41	552	734	93·4	a	-	24·9	5·48	3, 9
	1·450	200·4	3·84	459·0	800·0	110·5		-	24·0	5·268	2, 3
	1·443	191·2	3·84	485·0	801·0	116·0		-	24·2	4·627	2, 3
	1·407	178·2	4·16	439·5	776·5	121·3		-	22·0	3·920	2, 3
	1·405	164·6	3·88	433·0	839·4	141·0		-	23·6	3·884	2, 3
	1·399	164·0	3·92	400·0	790·0	133·6		-	23·0	3·77	2, 3
	1·282	97·4	3·70	342	845	239·4		-	22·0	2·14	3, 9
	1·297	96·7	4·35	353·0	832·0	239·1		-	23·5	2·272	2, 3
0·044 in.	1·517	238·0	5·21	531·0	745·0	88·3	1·0 in.	-	22·5	5·36	2, 3
	1·516	228·9	5·31	551·0	742·0	91·6		-	22·6	5·17	2, 3
0·124 in.	1·514	233·0	5·55	527·0	738·0	89·8		-	22·7	5·29	2, 3
	1·514	233·0	5·55	527·0	738·0	89·8		-	22·7	5·29	2, 3
	1·515	230·0	5·62	560·0	735·0	90·7		-	22·8	5·24.	2, 3
0·044 in.	1·503	221	4·46	548	729	88·8		-	22·0	5·06	3, 9
	1·506	219	4·45	501[b]	731	93·5	c	-	23·2	5·08	3, 9
	1·506	219	4·45	501[b]	731	93·5	d	-	23·1	5·06	3, 9
	1·402	150·1	5·11	476·0	764·0	143·2		-	21·8	3·27	2, 3
	1·407	133·4	6·41	552·0	726·0	155·9		-	23·0	3·07	2, 3
	1·394	130·0	5·21	502·0	746·0	161·9		-	22·6	2·94	2, 3
	1·393	128·6	5·91	482·0	774·0	170·8		-	22·7	2·92	2, 3
0·124 in.	1·393	128·6	5·91	482·0	774·0	170·8		-	22·8	2·93	2, 3
0·044 in.	1·391	127·4	6·43	514·0	750·0	168·3		-	22·9	2·92	2, 3
0·124 in.	1·391	127·4	6·43	514·0	750·0	168·3		-	22·6	2·88	2, 3
0·044 in.	1·388	126·1	6·04	500·0	750·0	169·3		-	22·2	2·80	2, 3
0·124 in.	1·388	126·1	6·04	500·0	750·0	169·3		-	22·5	2·84	2, 3

Table 6.6 (Cont'd)

Spheres of Aqueous Solutions with Paraffin Reflector

SPHERE WALL-THICKNESS	CORE						REFLECTOR THICKNESS	DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Specific Gravity of Solution	Solution Concentration (gm/litre)				H/Pu Atomic Ratio		Diameter	Volume (litres)	Mass (kgm)	
		Plutonium	Hydrogen Ion H^+	Total Nitrate Ion NO_3^-	Water						
0·044 in.	1·400	126·4	6·27	512·0	743·0	167·8	e	-	22·6	2·86	2, 3
	1·322	85·1	6·18	459·0	766·0	256·3		-	22·8	1·94	2, 3
	1·206	53·6	3·49	290	851	437·9		-	22·2	1·19	3, 9

a. 5 in. dia. section of reflector moved $\frac{1}{2}$ in. away from core

b. Unreliable values

c. 10 in. dia. top section of reflector removed

d. 10 in. dia. side section of reflector removed

e. Sphere neck mockup adjacent to sphere

Table 6.7

Spheres of Aqueous Solutions with Concrete Reflector
(Includes cadmium shielded systems)

Fissile Solution: Plutonium (4·6 wt % Pu^{240}) dissolved in excess aqueous nitric acid, said to be in the tetravalent form, $Pu(NO_3)_4$.

Spheres: 0·044 in. thick stainless steel.

These experiments were performed in a single sphere of fixed volume 23·22 litres. The critical parameters of larger systems are estimated by extrapolation of reciprocal multiplication curves. No correction is applied for the change in geometry which would be required to contain the extrapolated volume. Similarly no correction to complete sphere geometry is made for systems which are critical below 23·22 litres.

SPHERE WALL-THICKNESS	CORE						REFLECTOR		DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Specific Gravity of Solution	Solution Concentration				H/Pu Atomic Ratio	Geometry	Thickness (in.)	Diameter	Volume (litres)	Pu Mass (kgm)	
		Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)							
0·044 in.	1·508	232·0	4·86	546	738	89·5	Sphere	4	- [a]	21·6 [a]	5·01 [a]	3,9
	1·201	50·9	3·88	294	849	461·0			- [a]	22·7 [a]	1·16 [a]	3,9
	1·201	50·9	3·88	294	849	461·0			- [a]	22·6 [a]	1·15 [a]	3,9
	1·258	46·9	5·62	416	788	474·7			-	22·8	1·07	3,9
0·124 in.	1·258	46·9	5·62	416	788	474·7			-	23·0	1·08	3,9
	1·252	46·4	5·62	404	804	488·9			-	23·2	1·03	3,9
	1·252	46·4	5·62	404	804	488·9			-	23·2	1·08	3,9
0·160 in.	1·258	46·9	5·62	416	788	474·7			-	23·2	1·09	3,9
	1·248	43·7	5·66	410	808	521·8			-	23·6	1·03	3,9
0·044 in.	1·150	36·5	2·78	213·0	902·0	673·2			-	22·9	0·84	2,3
	1·146	36·3	2·94	218·0	890·0	665·8			-	22·6	0·82	2,3
	1·093	32·9	1·17	118	949	774·2			-	22·9	0·75	3,9
	1·093	32·9	1·17	118	949	774·2			-	22·9	0·75	3,9
	1·093	32·7	1·08	118	947	776·7			-	23·1	0·75	3,9
	1·091	32·6	1·20	120	948	779·1			-	22·9	0·75	3,9

Table 6.7 (Cont'd)

Spheres of Aqueous Solutions with Concrete Reflector
(includes cadmium shielded systems)

SPHERE WALL-THICKNESS	CORE						REFLECTOR		DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Specific Gravity of Solution	Solution Concentration				H/Pu Atomic Ratio	Geometry	Thickness (in.)	Diameter	Volume (litres)	Pu Mass (kgm)	
		Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)							
0·044 in.	1·288	118	1·88	239	927	212·8	Hemisphere 4 in. air-gap between core and reflector	6	-	22·4	2·62	6
	1·266	115	1·95	240	912	214·6			-	22·23	2·56	6
	1·251	106	2·01	234	906	231·4			-	22·27	2·36	6
	1·230	92·8	1·83	215	915	251·8			-	22·38	2·20	6
	1·217	88·3	1·98	214	915	280·4			-	22·57	1·99	6
	1·205	81·7	2·07	214	906	300·4			-	22·78	1·86	6
	1·189	73·4	2·11	207	905	334·2			-	22·37	1·72	6
0·044 in.	1·259	69·0	4·34	341	845	340·1	Sphere 4 in. air-gap between core and reflector	6	-	23·09	1·59	6
	1·250	67·9	4·29	336	843	344·7			-	23·20	1·58	6
	1·170	54·2	2·55	214	901	452·5			-	22·52	1·22	6
	1·163	52·1	2·31	197	909	473·8			-	22·96	1·20	76
	1·172	49·6	2·27	193	926	506·6			-	23·25	1·16	76
0·044 in.	1·157	52·4	2·07	183	921	475·8	Hemisphere	10	-	22·07	1·16	76
	1·147	47	2·05	176	920	530·0			-	23·08	1·08	76
0·044 in.	1·281	47·9	6·46	450	773	460·6	Sphere	10	-	22·22	1·06	76
	1·279	44·8	6·46	447	780	496·7			-	22·84	1·02	76
	1·286	43·3	6·37	445	791	520·1			-	23·25	1·01	76
	1·214	40·5	4·40	315	850	583·1			-	21·93	0·89	76
	1·205	38·4	4·46	315	844	611·2			-	22·52	0·86	76

Table 6.7 (Cont'd)

Spheres of Aqueous Solutions with Concrete Reflector
(Includes cadmium shielded systems)

SPHERE WALL-THICKNESS	CORE						REFLECTOR		DELAYED CRITICAL CORE PARAMETERS			REFERENCES
	Specific Gravity of Solution	Solution Concentration				H/Pu Atomic Ratio	Geometry	Thickness (in.)	Diameter	Volume (litres)	Pu Mass (kgm)	
		Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)							
	1·200	36·8	4·42	312	848	640·4			-	22·96	0·84	76
	1·213	36·5	4·38	309	864	657·0			-	23·27	0·85	76
	1·096	33·3	1·11	119	944	760·5			-	21·5	0·72	73
	1·095	32·8	1·11	120	938	767·2			-	21·5	0·71	73
	1·092	31·5	1·09	121	935	796·2			-	22·0	0·69	73
	1·087	30·0	1·07	123	933	834·1			-	22·9	0·69	73

a. Sphere clad in 0·03 in. thick cadmium

Table 6.8

Unreflected Cylinders of Aqueous Solutions

Reference: 10

Fissile Solution: Plutonium dissolved in excess aqueous nitric acid; said to be in the tetravalent form, except for solutions containing > 150 gm/litre plutonium where up to 25% of the plutonium may be in the hexavalent form $PuO_2.(NO_3)_2$

Cylinders: 18-8-1 Stainless Steel; see also Figure 6.2

SPECIFIC GRAVITY OF SOLUTION	SOLUTION CONCENTRATION		H/Pu ATOMIC RATIO	DELAYED CRITICAL PARAMETERS				
	Plutonium (gm/litre)	Total Nitrate [a] Ion NO_3 (gm mol./litre)		Diameter (in.)	Height (cm)	Height / Diameter	Volume	Pu Mass
Plutonium Containing 4·88 wt% Pu^{240}								
1·415	226	5·22	106	13·4	31·25	-	-	-
1·317	165	4·02	151		28·9	-	-	-
1·253	133	3·25	189		28·1	-	-	-
1·182	91·4	2·37	280		28·0	-	-	-
1·153	73·5	2·01	351		28·7	-	-	-
1·125	60·4	1·61	429		30·2	-	-	-
1·090	43·3	1·21	602		34·9	-	-	-
1·104	50·7	1·40	514	17·9	21·95	-	-	-
1·078	35·1	1·05	746		24·4	-	-	-
1·061	26·9	0·86	975		27·65	-	-	-
1·048	21·0	0·74	1219		34·05	-	-	-
1·044	17·5	0·68	1396		41·25	-	-	-
Plutonium Containing 13·74% Pu^{240} [b]								
1·284	169	3·32	134	13·4	41·83	-	-	-
1·204	114	2·45	197		37·95	-	-	-
1·156	80·2	1·87	286		38·26	-	-	-
1·132	65·6	1·60	352		40·25	-	-	-
1·120	58·6	1·48	395		42·02	-	-	-
1·392	215·5	5·03	95·9	17·9	27·3	-	-	-
1·323	174·5	4·17	124		35·84	-	-	-
1·250	135	3·3	161		24·86	-	-	-
1·195	102·5	2·59	218		24·3	-	-	-
1·141	73·0	1·92	310		24·54	-	-	-
1·098	53·5	1·48	425		25·85	-	-	-
1·090	43·6	1·27	517		27·7	-	-	-
1·065	28·5	1·03	811		36·4	-	-	-
1·053	22	0·85	1·061		52·0	-	-	-

a. Analytical results amended to give a reasonable fit with the recorded history of solutions preparation

Table 6.9

Cylinders of Aqueous Solutions with Water Reflector

Fissile Solution: Plutonium dissolved in excess aqueous nitric acid
Certain of the solutions were contaminated with small quantities of iron

Cylinders: Stainless Steel

Reflector: Effectively infinite thickness (except where shown in Table)

CORE								REFLECTOR THICKNESS	DELAYED CRITICAL CORE PARAMETERS					REFERENCES
Pu^{240} Content of Plutonium (wt%)	Specific Gravity of Solution	Solution Concentration					H/Pu Atomic Ratio		Diameter	Height (m)	Height / Diameter	Volume (litres)	Pu Mass (kgm)	
		Plutonium (gm/litre)	Hydrogen Ion H^+ (gm ion/litre)	Total Nitrate Ion NO_3^- (gm/litre)	Water (gm/litre)	Iron (gm/litre)								
2·85	1·175	77·40	1·41[d]	152 [d]	-	0·644	-	Effectively[a] Infinite	8·01in.[b]	19·01[c]	-[c]	15·66[c]	1·212 [c]	4
2·85	1·2110	109·16	1·68[d]	166 [d]	-	0·395	-	Effectively[a] Infinite	9·01in.[b]	11·76	-	12·25	1·337	4
	1·1997	99·09	1·37	136·5	-	0·378	-	[a]	[b]	12·09	-	12·60	1·249	4
	1·1859	85·14	1·29[d]	151 [d]	-	0·321	-	[a]	[b]	12·73	-	13·26	1·128	4
	1·1592	73·92	1·78[d]	125·6[d]	-	0·231	-	[a]	[b]	13·94	-	14·52	1·073	4
	1·1441	61·49	1·34[d]	134 [d]	-	0·303	-	[a]	[b]	15·78	-	16·44	1·011	4
	1·1329	54·53	1·36[d]	119·8[d]	-	0·257	-	[a]	[b]	17·55	-	18·29	0·997	4
2·85	1·175	77·40	1·41[d]	152 [d]	-	0·644	-	Effectively[a] Infinite	10·01in.[b]	9·93	-	12·78	0·989	4
	1·165	76·93	1·41[d]	152 [d]	-	0·327	-	[a]	[b]	9·74	-	12·53	0·964	4
	1·146	62·47	1·52[d]	146 [d]	-	0·269	-	[a]	[b]	10·73	-	13·79	0·860	4
	1·130	49·26	1·63[d]	142 [d]	-	0·260	-	[a]	[b]	12·87	-	16·56	0·816	4
	1·130	49·26	1·63[d]	142 [d]	-	0·260	-	[a]	[b]	12·82	-	16·50	0·813	4
	1·110	39·10	1·70[d]	138 [d]	-	0·172	-	[a]	[b]	16·44	-	21·16	0·827	4
2·85	1·1329	54·43	1·36	120	-	0·257	-	Effectively[a] Infinite	11·01in.[b]	10·08[e]	-[e]	15·69[e]	0·856[e]	4
2·85	1·1202	47·21	1·38	117	-	0·275	-	[a]	[b]	11·09[e]	-[e]	17·27[e]	0·8151[e]	4

Table 6.9 (Cont'd)

CORE								REFLECTOR THICKNESS	DELAYED CRITICAL CORE PARAMETERS					REFERENCES
Pu^{240} Content of Plutonium (wt%)	Specific Gravity of Solution	Solution Concentration: Plutonium (gm/litre)	Solution Concentration: Hydrogen Ion H^+ (gm ion/litre)	Solution Concentration: Total Nitrate Ion NO_3 (gm/litre)	Solution Concentration: Water (gm/litre)	Solution Concentration: Iron (gm/litre)	H/Pu Atomic Ratio		Diameter	Height (m)	Height/Diameter	Volume (litres)	Pu Mass (kgm)	
	1·202	47·21	1·38	117	-	0·275	-	a	b	10·66	-	16·60	0·784	4
	1·1604	41·73	2·77	215	-	0·255	-	a	b	12·85	-	20·01	0·835	4
	1·110	39·10	1·70	138	-	0·172	-	a	b	12·28	-	19·12	0·747	4
	1·2022	36·90	4·28	300·0	-	0·263	-	a	b	16·93	-	26·36	0·973	4
	1·099	33·54	1·76[d]	137[d]	-	0·193	-	a	b	15·57	-	24·24	0·813	4
	1·098	30·81	1·78[d]	136[d]	-	0·173	-	a	b	13·55	-	28·88	0·839	4
2·9	1·1483	63·99	1·17	121·1	-	0·298	-	a	b	8·98	-	13·98	0·895	4
	1·1360	48·98	1·38	139·0	-	0·238	-	a	b	10·22	-	15·91	0·780	4
	1·2110	109·16	1·68[d]	166[d]	-	0·395	-	a	b	6·82	-	12·64	1·380	4
2·9	1·1260	48·75	1·27	116·3	-	0·223	-	Effectively Infinite[a]	12·0in.[b]	8·80	-	16·31	0·799	4
	1·1152	42·29	1·36	126·6	-	0·174	-	a	b	9·94	-	18·42	0·779	4
	1·1077	36·52	1·39	107·1	-	0·161	-	a	b	11·21	-	20·77	0·758	4
	1·1028	31·14	1·44	114·0	-	0·153	-	a	b	13·16	-	24·39	0·759	4
	-	26·45	1·09[d]	134[d]	-	0·154	-	a	b	17·50	-	32·43	0·858	4
-	-	62·86	1·73	-	-	-	397	9 in. (Radial reflector only.)[f]	30·5cm[g]	-	-	-	1·182[h]	11, 12
-	-	38·63	1·73	-	-	-	655	f	g	-	-	-	0·920[j]	11, 12
-	-	28·55	1·73	-	-	-	892	f	g	-	-	-	0·944[j]	11, 12

a. Top reflection provided by a close-fitting, 12 in. water-filled piston in 0·062 in. stainless steel. Piston penetrated by a straight, ¾ in. dia. central tube and by a ½ in. dia. spirit tube

b. Cylinder wall thickness 0·062 in. A solution feed pipe was attached to the centre base of each cylinder

c. This cylinder was sub-critical by an unknown amount

d. Estimates based on log-book entries

e. 0·065 in. layer of stainless steel was placed round the radial surface only of the cylinder

f. Two counters filled with natural BF_3 and two filled with enriched BF_3 were placed in a ring just outside the core in the reflector

g. Cylinder wall thickness 1/16 in., base thickness ½ in. A counter filled with BF_3 was placed in a tube along the axis of the core. The effect of this is said to be equivalent to < 2gm charge in critical Pu mass

h. Effect of absorption in Pu^{240} said to be equivalent to 55gm charge in critical Pu mass

j. Effect of absorption in Pu^{240} said to be equivalent to 22gm charge in critical Pu mass

Table 5.10

Cylinders of Aqueous Solutions with Beryllium Oxide/Graphite Reflector

References: 13, 14

Fissile Solutions: Plutonium dissolved in excess aqueous sulphuric acid (free acidity ~0·5N). The solutions were contaminated with small amounts of iron

Cylinders: 25 cm dia. x 30 cm, wall thickness 1 mm[a]. A 6 mm x 8 mm solution feed pipe was attached to the centre base of the cylinder and the top was closed by a cover surmounted by two 20 mm dia and one 10 mm dia access tubes. The cylinder, including the feed pipe, was wrapped in a layer of blotting paper and then enclosed within a close-fitting aluminium jacket. A gap of 1-2 mm then intervened between the aluminium jacket and the reflector.

Reflector[b]: A parallelepiped of beryllium oxide (average density 2·95 gm/cc) giving a minimum thickness in any direction of 27·5 cm enclosed in a layer of graphite (average density 1·65 gm/cc) 50 cm thick. The portion of the reflector located in the upward projection of the tank was a removable plug resting on an aluminium plate 2 cm thick.

CORE						DELAYED CRITICAL CORE PARAMETERS				
Pu^{240} Content of Plutonium (wt %)	Specific Gravity of Solution	Solution Concentration			H/Pu Atomic Ratio	Diameter (cm)	Height (cm)	Height / Diameter	Volume (litres)	Pu Mass (gm)
		Plutonium (gm/litre)	Hydrogen Ion H^+	Iron						
65%Fe, 14% Ni, 17%Cr, 2·5%Mo Steel Cylinder										
1·78	-	32·172	-	-	-	25	18·69	-	9·174	295·15
	-	31·550	-	-	-		19·17	-	9·410	294·11
	-	30·449	-	-	-		19·612	-	9·627	293·13
	-	29·684	-	-	-		20·05	-	9·842	292·15
	-	28·995	-	-	-		20·485	-	10·055	292·54
	-	28·331	-	-	-		20·94	-	10·279	292·21
	-	27·668	-	-	-		21·43	-	10·519	291·04
	-	27·035	-	-	-		21·94	-	10·770	291·17
In Zirconium Cylinder										
1·78	-	30·650	-	-	-	25	18·0	-	8·475	259·70
	-	28·970	-	-	-		19·0	-	8·940	258·99
	-	27·598	-	-	-		19·856	-	9·347	257·96
	-	27·040	-	-	-		20·238	-	9·527	257·62
	-	26·650	-	-	-		20·519	-	9·659	257·41
	-	25·971	-	-	-		21·035	-	9·902	257·17
	-	25·393	-	-	-		21·524	-	10·132	257·28
	-	25·014	-	-	-		21·848	-	10·285	257·27
	-	24·716	-	-	-		22·126	-	10·416	257·44
	-	23·991	-	-	-		22·9	-	10·780	258·6
	-	23·511	-	-	-		23·32	-	10·977	258·1
1·06	-	21·71	-	-	-		24·86	-	11·720	254·5
	-	20·80	-	-	-		26·175	-	12·310	256·2
	-	20·36	-	-	-		26·870	-	12·680	258

a. This reflector is shown by calculation to be equivalent to a 60 cm thick beryllium oxide reflector, increasing the critical mass by only 1% relative to the infinite beryllium oxide reflector

b. The thickness of the cylinder cover and base is different from that of the walls. An "effective uniform thickness" of 1·4-2·1 mm is evaluated by calculation

Table 6.11

Rectilinear Parallelepipeds of PuO_2/Polyethylene Mixture

Reference: 10

Fissile Mixture: Pu^{240} content of plutonium 3·24 wt %

Specific Gravity -

Plutonium density 2·88 gm/cc

Core Temperature: 50-65°C

Reflector: Thick polyethylene (density 0·92 gm/cc)

In these experiments the cores were assembled from tablets 2 in. x 2 in. x 1 in. and submultiples of this size

DELAYED CRITICAL CORE PARAMETERS					
H/Pu Atomic Ratio [a]	Area	Thickness (in.)	$\frac{\text{Thickness}}{\sqrt{\text{Area}}}$	Volume	Pu Mass (kgm)
5·5	9 in. x 9 in.	4·94	-	-	18·9
5·6	6 in. x 6 in.	11·5	-	-	19·6
	8 in. x 8 in.	5·95	-	-	18·0
7	6 in. x 6 in.	9·8	-	-	16·7
	7 in. x 7 in.	6·8	-	-	15·7

a. The change in the H/Pu ratio occurs because of the release of hydrogen gas by radiolysis of the polyethylene under the α activity of the plutonium

Table 6.12

Rectilinear Parallelepipeds of PuO_2/Polystyrene[a] Mixture

References: 15, 16

Fis e Mixture:

Pu^{24} content of plutonium	2·2 wt %
Specific Gravity	-
Plutonium Density	1·14 gm/cc
H/Pu Atomic Ratio	15
Particle Mesh Size	100

Reflector Material: 6 in. thick lucite

In these experiments the cores were assembled from 2 in. x 2 in. x 2 in. tablets of the fissile mixture (a few 1 in. and ½ in. thick tablets were also available for final mass adjustments). All tablets were coated with a thickness of about 0·001 in. of aluminium paint and then with rubberized plastic.

Each 2 in. cube tablet of fissile mixture generated about 0·3 watts of heat as the result of α emmission. Hence the core temperature was elevated above ambient as shown by the core centre temperatures given in the table. The core surface temperatures were about 34°C. The temperature coefficients of reactivity for core centre temperatures in the range 55-72°C are shown by subsidiary experiments to be ~-3 cents/°C for the unreflected assemblies and ~-0·25 cents/°C for the reflected assemblies.

Control and safety rods were of the fuel bearing type, penetrating the core horizontally from opposite directions. The safety rod contained 274·5 gm plutonium and penetrated the core to a depth of 8 in., occupying the space normally filled by four 2 in. cubes. The control rod contained 127·5 gm plutonium and occupied the space normally filled by two 2 in. cubes. Both rods were clad in a 0·051 in. thick steel jacket which fitted a 0·051 in. thick steel sleeve contained in the core.

The cores were assembled on a 12 in. thick, low density aluminium honeycomb table which subsidiary experiments showed to be equivalent to about a 0·07 in. charge in critical thickness for unreflected systems.

REFLECTOR GEOMETRY	DELAYED CRITICAL CORE PARAMETERS					
	Area	Thickness	Thickness/√Area	Volume	Pu Mass[b] (kgm)	Centre Temperature °C
Unreflected	12·21 in. x 12·21 in.	12·76 in.	-	-	33·73	60·2
All surfaces	9·16 in. x 9·16 in.	8·52 in.[c]	-[c]	-[c]	12·68[c]	54·1
	23·92 in. x 7·12 in.	6·11 in.	-	-	19·94	51·6
	16·36 in. x 16·28 in.	4·07 in.	-	-	19·22	54·2
Top and bottom surfaces	12·21 in. x 12·21 in.	9·51 in.	-	-	24·13	52·4
Top, bottom and side surfaces	27·36 in. x 7·12 in.	6·11 in.	-	-	21·10	50·3
Top, bottom and end surfaces	10·02 in. x 12·21 in.	8·14 in.	-	-	17·66	55·1

a. Atomic composition CH

b. Average stack density of plutonium 1·105 gm/cc

c. In this experiment the combined effect of the control and safety rod sleeves and the absence of reflector behind the control rod channels was determined to be ~10% in critical mass

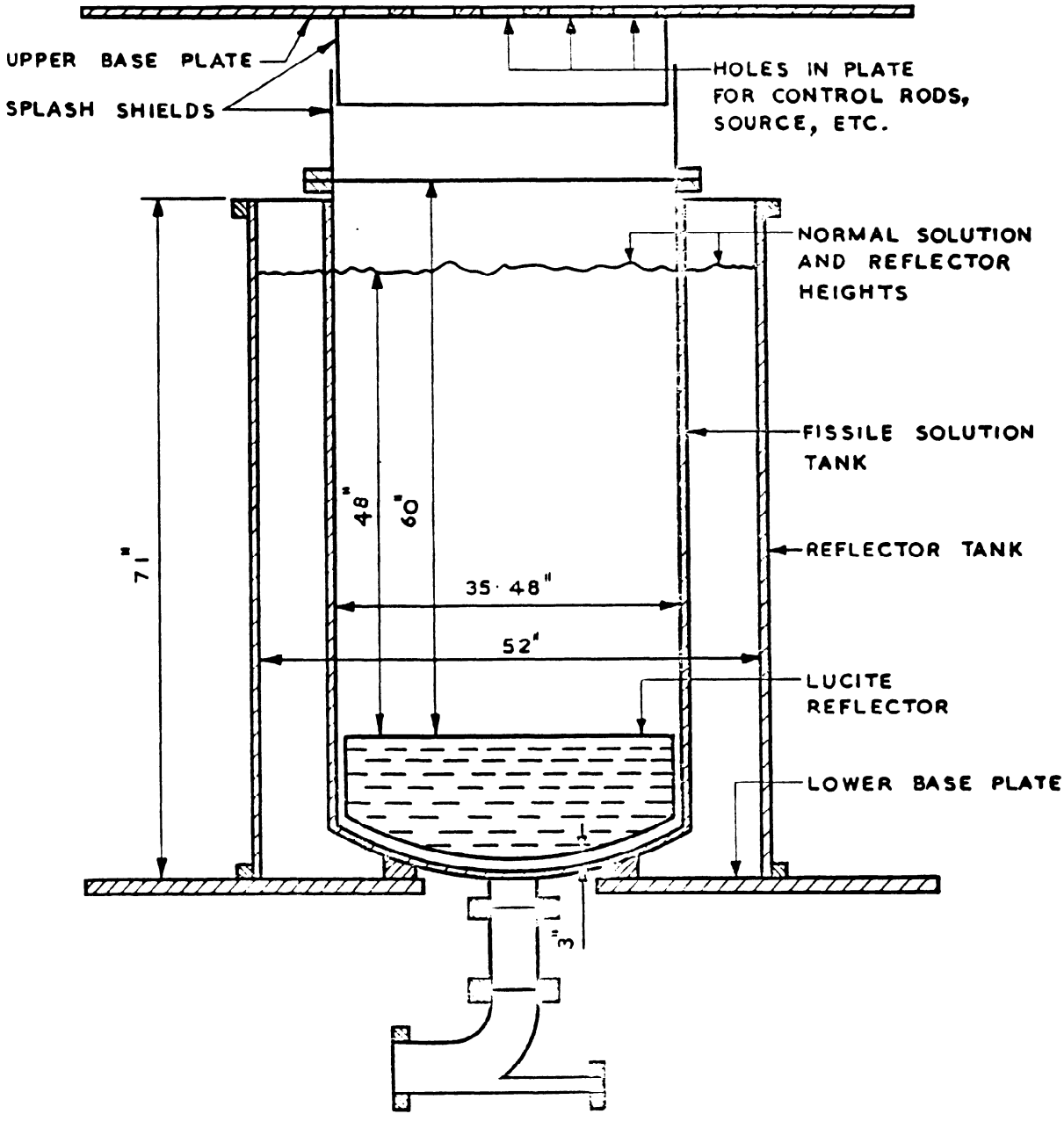


FIG. 5·1 (SEE TABLES 5·13 (b) (d))

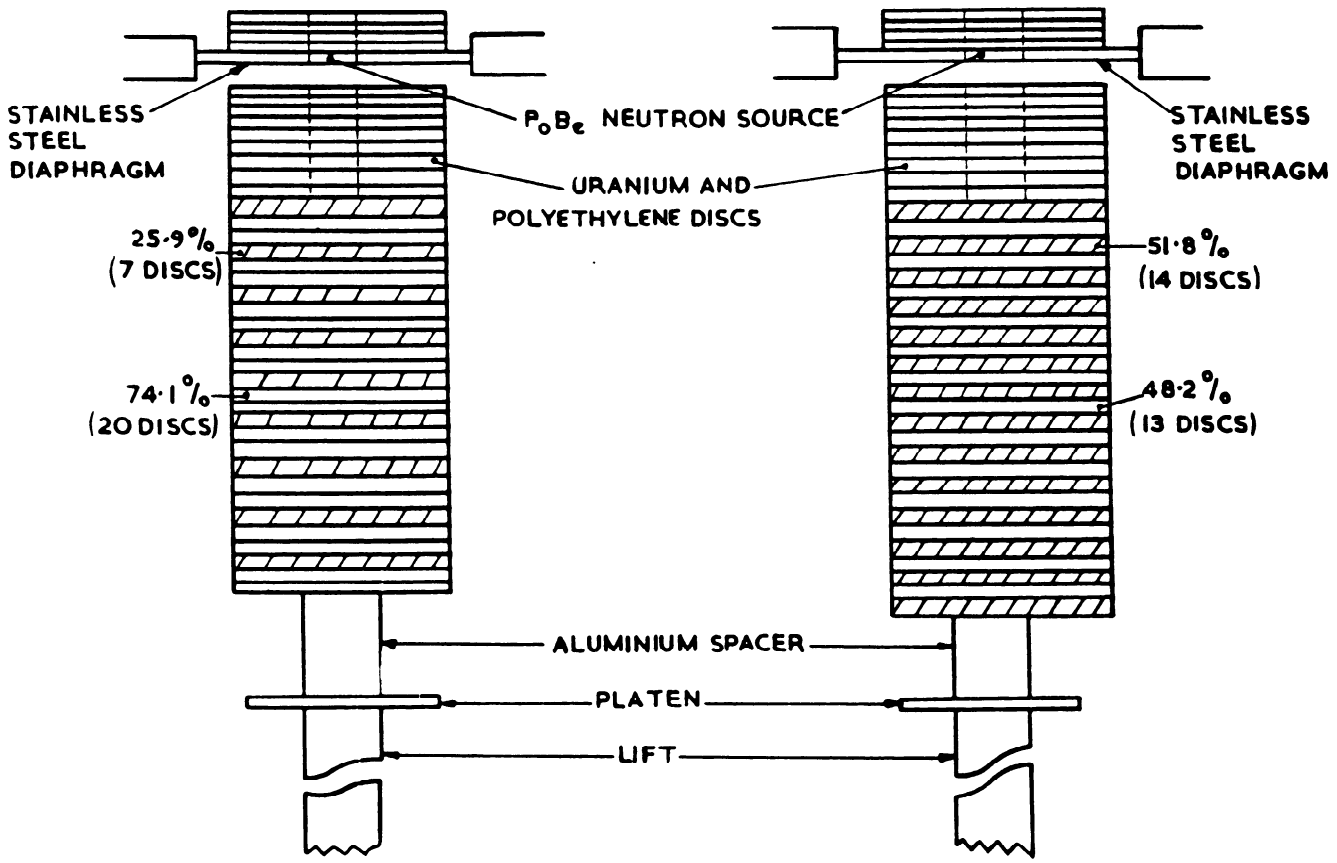


FIG. 5·2 (SEE TABLE 5·21)

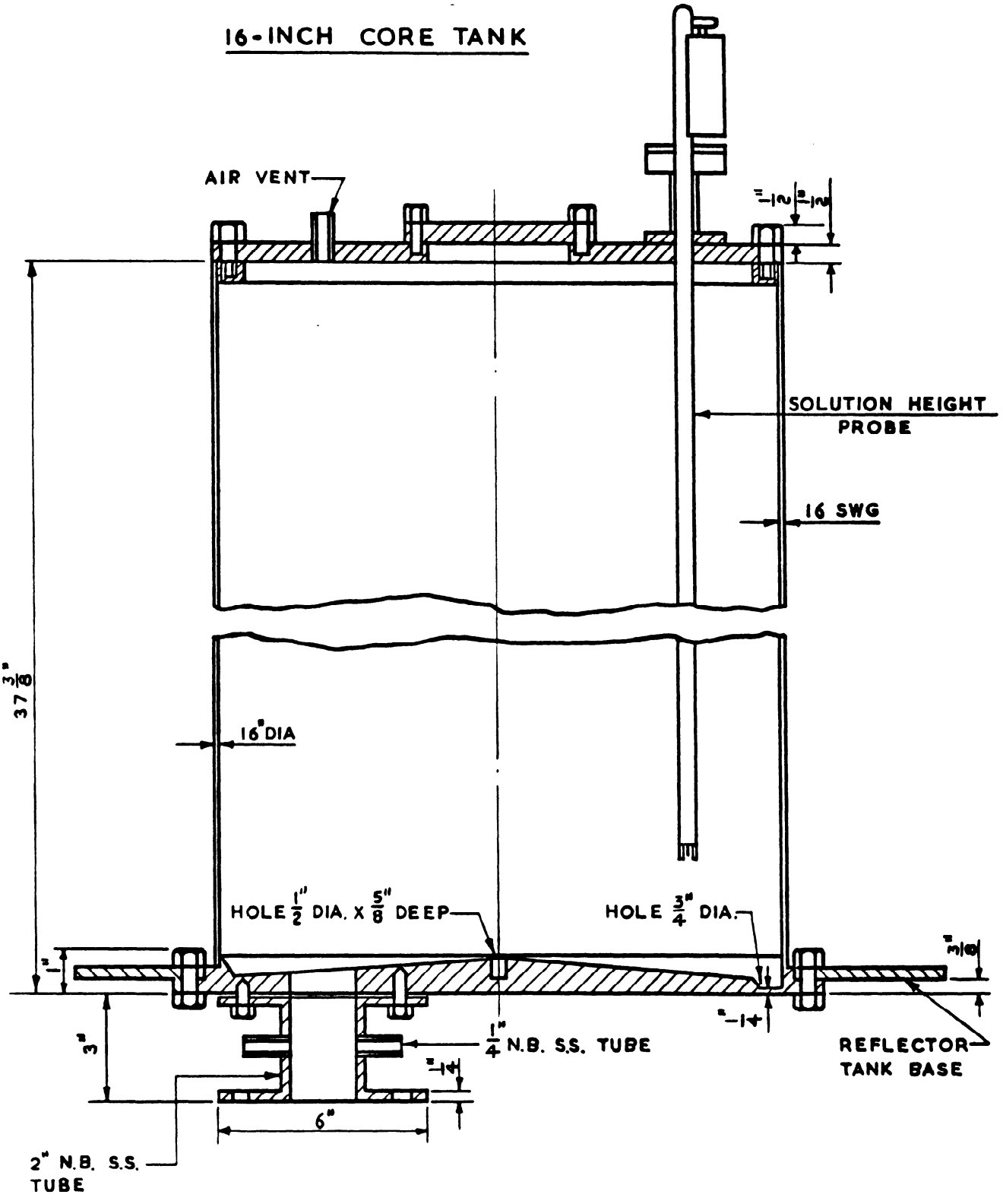
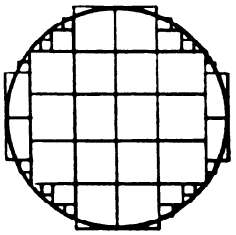
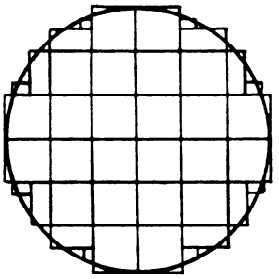


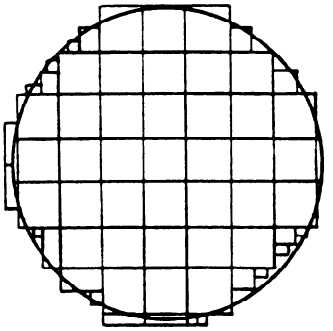
FIG 5·3 (SEE TABLE 5·37)



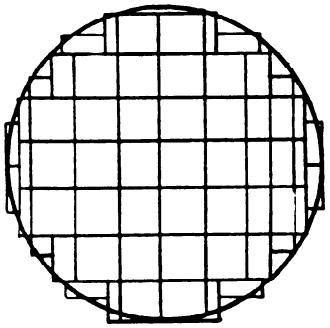
20-IN. DIA CYLINDER



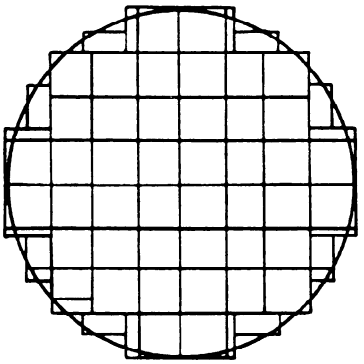
24-IN. DIA CYLINDER



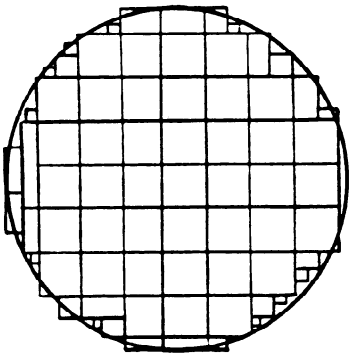
29-IN. DIA CYLINDER



28-IN. DIA CYLINDER

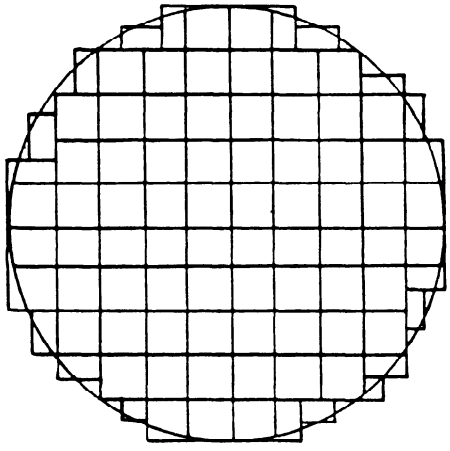


32-IN. DIA CYLINDER

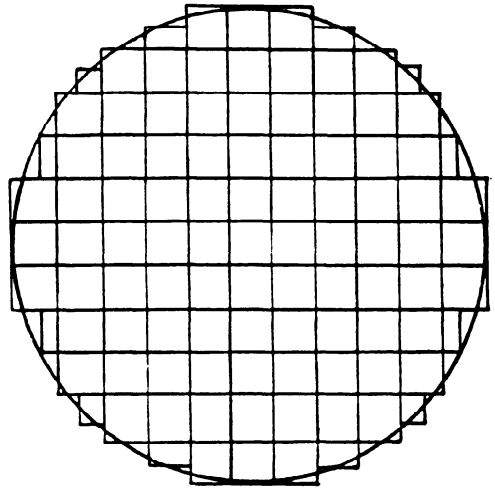


31-IN. DIA CYLINDER

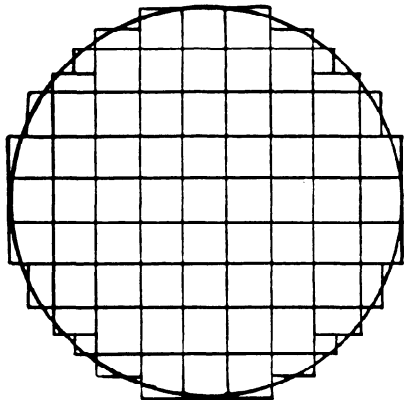
FIG 5·4 (SEE TABLE 5·43)



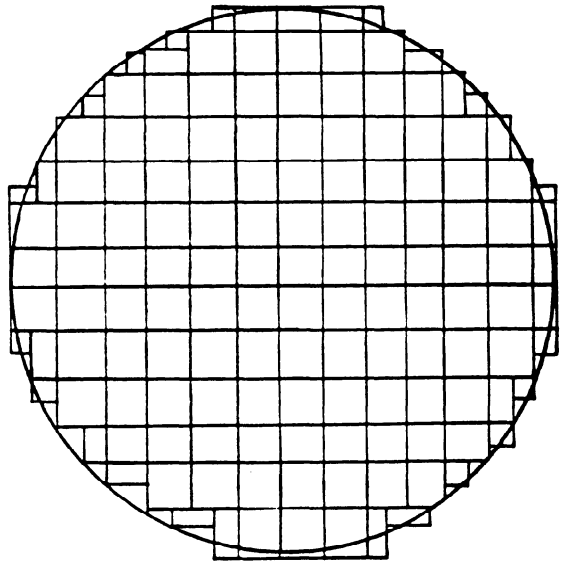
40-IN. DIA CYLINDER



40-IN. DIA CYLINDER

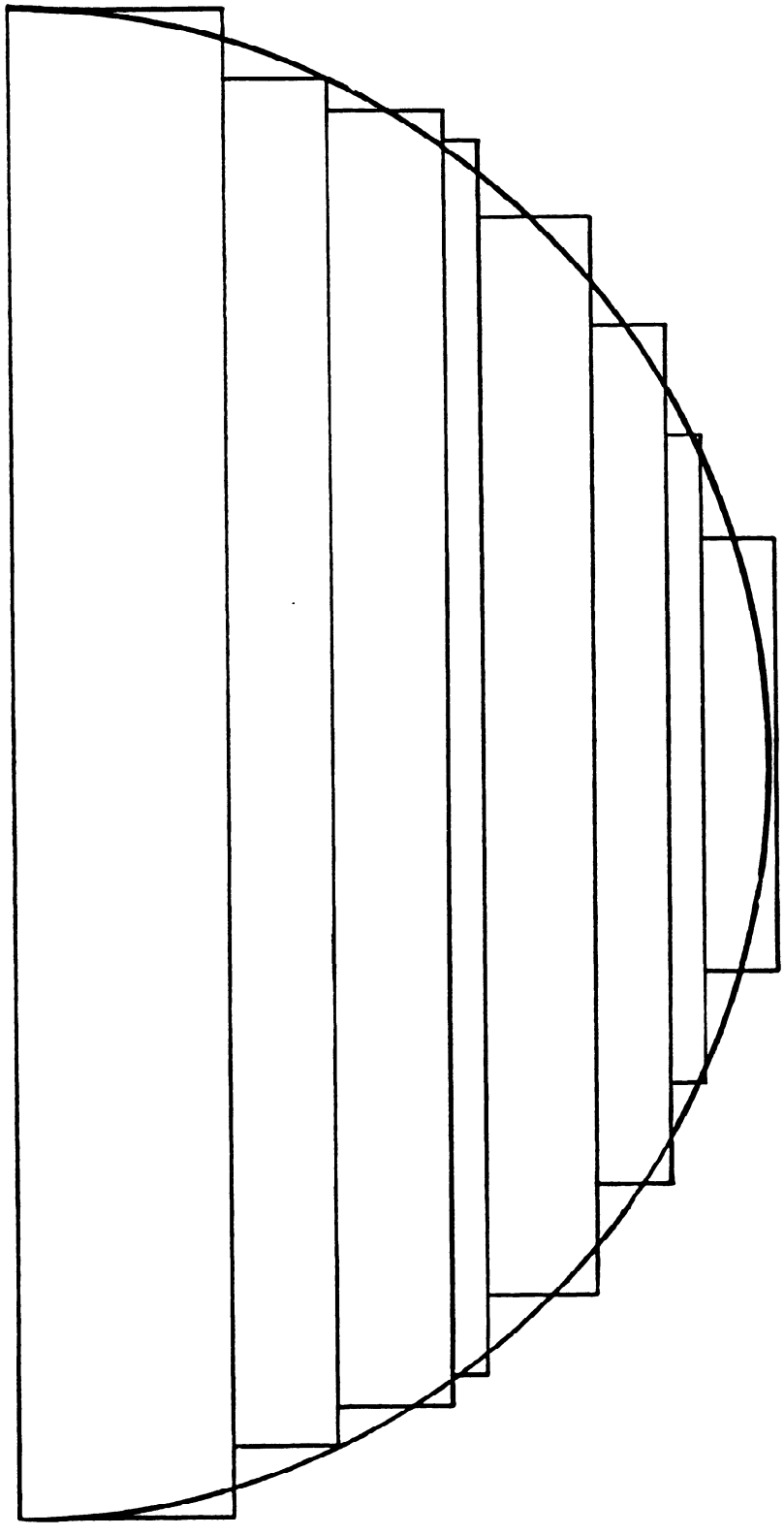


36-IN.-DIA CYLINDER



50-IN. DIA CYLINDER

FIG 5·4. (CONT.) (SEE TABLE 5·43)



HALF SECTION OF 107.1cm DIAMETER PSEUDO-CYLINDER

FIG 5·5 (SEE TABLE 5·45)

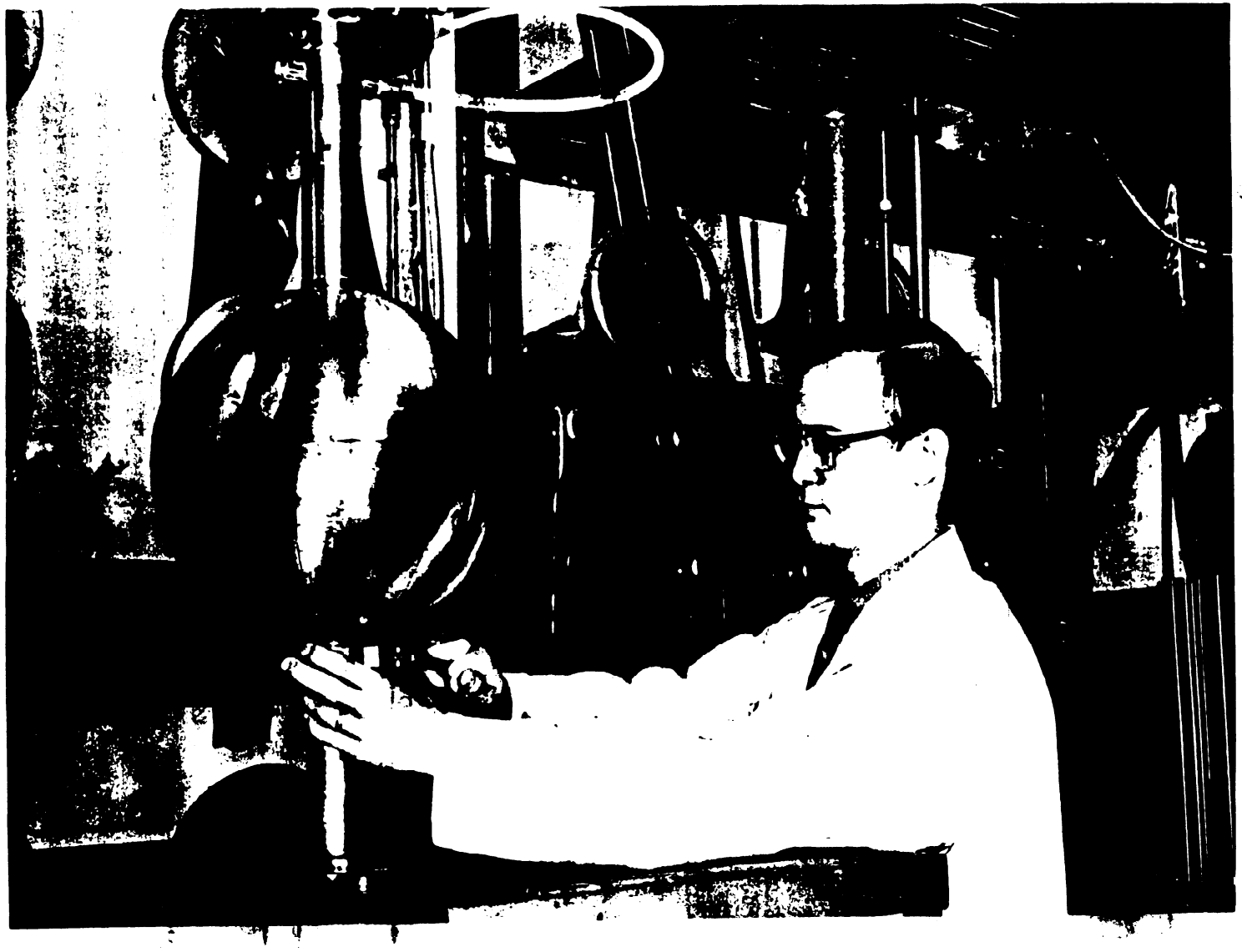


Figure 6.1 - (See Table 6.1)

A	13·4"	17·9"
B	6·75"	9·0"
C	20"	24"

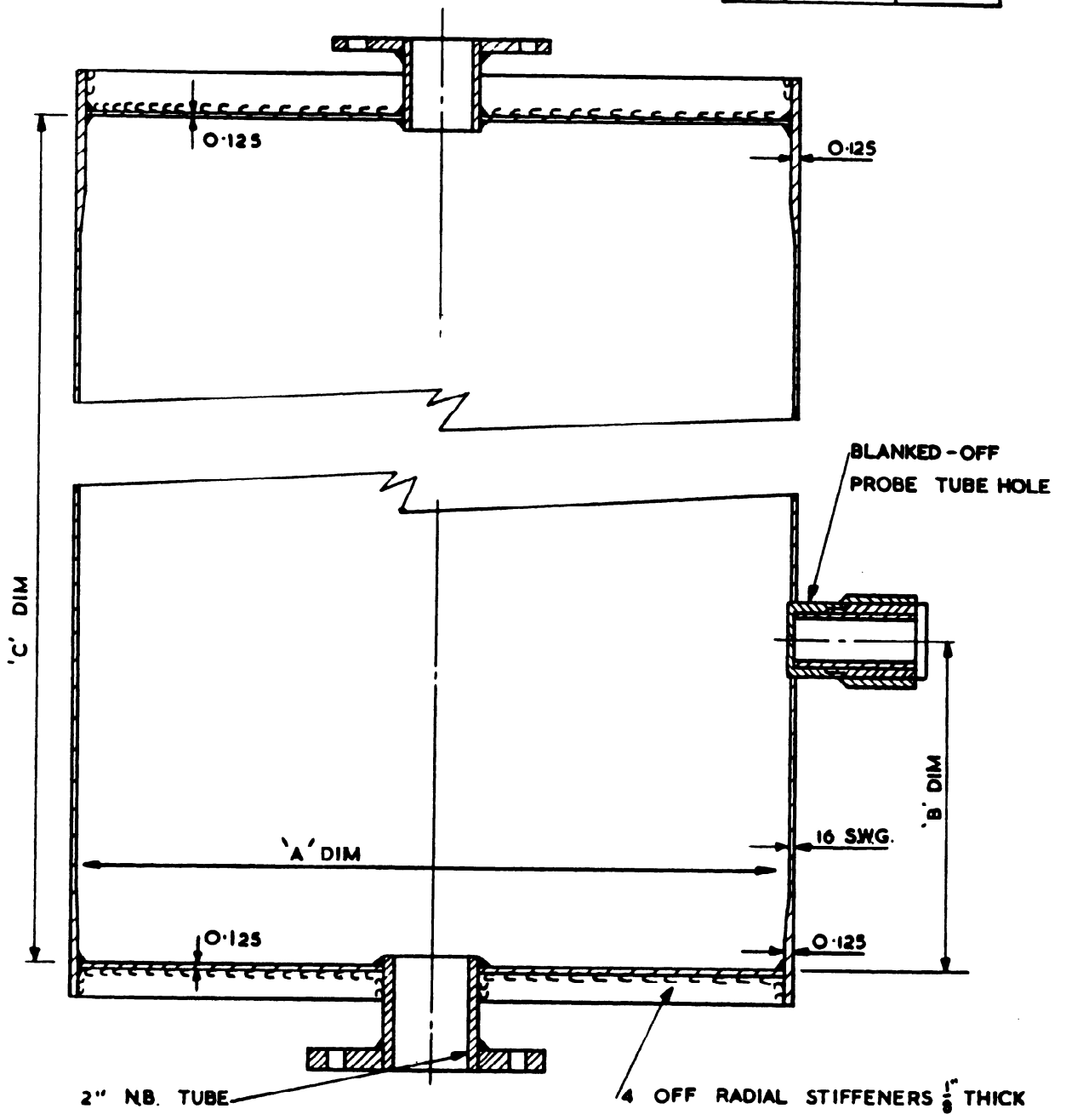


FIG. 6·2 (SEE TABLE 6·8)