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4.1. CRITICAL PARAMETERS OF AQUEOUS SOLUTIONS OF U^{235}

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The series of experiments to determine the critical parameters of aqueous solutions of UO_2F_2 highly enriched in U^{235} has continued.[1] In one set of the experiments reported below, the critical parameters of unreflected and water-reflected solutions in single vessels of varying size were determined. Both cylindrical and slab-type vessels were used. In another group of experiments, similar vessels were used under special reflector conditions. In a third set the critical parameters of arrays of interacting vessels were determined. For all the experiments the U^{235} enrichment of the solutions was 93.2%.

SET 1 ENRICHED U^{235} SOLUTIONS IN VESSELS OF SIMPLE GEOMETRY

A study of the conditions under which various enriched U^{235} solutions contained in aluminum and stainless steel cylinders become critical was initiated several years ago.[2] Results of experiments which extended this study to aluminum cylinders with diameters up to 30 in. were reported previously.[1] This work has now been supplemented with additional experiments performed with solutions contained in unreflected, partially water-reflected, and totally water-reflected, and totally water-reflected aluminum cylinders having diameters that ranged from 5.5 to 30 in. The solution concentrations varied from 0.532 to 0.0779 g of U^{235} per milliliter. The total water reflector was effectively infinite, while the partial water reflector was effectively infinite on the bottom and on the lateral surface to a height equal to the critical solution height. Experiments were also performed with solutions in an 8.5-in.-dia stainless steel cylinder and in an aluminum vessel that was rectangular (20 in.^{2}) in cross section. The containers used in this group of experiments had $\frac{1}{16}$-in.-thick walls, and the aluminum vessels were coated on the inside with Heresite.

All the results of the experiments in this series are presented in Table 4.1.1. It is to be noted that a few of the unreflected experiments were performed in a 9.5-ft-dia steel tank which acted as a neutron reflector.

A plot of the critical heights of the solutions in unreflected aluminum cylinders as a function of the $H:U^{235}$ atomic ratios of the solutions is shown in Fig. 4.1.1. In order to show more accurately the variation of critical height with concentration for values of concentrations near the minimum volume, the data for the 8.76- and 10-in.-dia unreflected cylinders have been replotted in Fig. 4.1.2 on an expanded scale. From these data it is seen that the concentration for a minimum critical volume of an unreflected enriched aqueous solution of UO_2F_2 in a cylindrical aluminum container is about 0.374 g of U^{235} per milliliter, corresponding to an $H:U^{235}$ atomic ratio of 66.

The data for solutions contained in totally water-reflected aluminum cylinders indicate that the minimum critical diameter for these conditions is between 5.5 and 6 in., since the solution concentrations used are near the concentration for minimum volume (for water-reflected cylinders). Also it was found that an unreflected 8.5-in.-dia stainless steel cylinder was not critical at a concentration near that for minimum volume. Then certainly an unreflected 8.5-in.-dia aluminum cylinder would not be critical; however, an unreflected 8.76-in.-dia aluminum cylinder was found to be critical. Since an unreflected 8.76-in.-dia stainless steel cylinder would also be critical, the minimum critical diameter for both unreflected stainless steel cylinders and unreflected aluminum cylinders is between 8.5 and 8.76 in.

The measured critical parameters of these experiments are obviously affected by the materials of the containing vessels, especially by the $\frac{1}{2}$-in.-thick bottom plate of the aluminum vessels. The effect of this bottom plate in unreflected systems was determined in an experiment reported below, and an appropriate correction (0.4 cm) was applied to all critical heights of unreflected aluminum cylinders reported here. The critical heights of totally water-reflected vessels were

[1] J. K. Fox and L. W. Gilley, *Appl. Nuclear Phys. Ann. Rep. Sept. 10, 1956*, ORNL-2081, p 61.

[2] C. K. Beck *et al.*, K-343 (April 19, 1949) (classified).

Table 4.1.1. Critical Parameters of Enriched U^{235} Solutions in Simple Geometry: With and Without Water Reflectors

Solution Container and Diameter (in.)	Solution Concentration		Critical Values		
	U^{235} (g/cc)	$H:U^{235}$ Atomic Ratio	Height (cm)	Volume (liters)	Mass (kg of U^{235})
Totally Water-reflected					
Aluminum cylinder					
5.5	0.532	44.7	*		
6	0.537	43.2	70.1	12.8	6.87
8	0.537	43.2	18.6	6.05	3.25
10	0.537	43.2	12.5	6.34	3.40
10	0.470	51.5	11.4	5.78	2.72
Partially Water-reflected					
Aluminum cylinder					
8	0.470	51.5	23.8	7.74	3.64
10	0.537	43.2	17.3	8.77	4.71
No Reflector					
Stainless steel cylinder					
8.5	0.385	63.7	*		
Aluminum cylinder					
8.76	0.532	44.7	175.0**	68.1	36.2
	0.480	50.1	202.2	78.7	37.8
	0.470	51.5	149.1	58.0	27.2
	0.437	55.4	171.6	66.8	29.2
	0.402	60.8	162.5	63.2	25.4
	0.373	66.1	159.8	62.2	23.2
	0.350	71.5	163.2	63.5	22.2
9.5	0.532	44.7	44.4**	20.3	10.8
	0.470	51.5	43.4**	19.9	9.35
10	0.537	43.2	34.9**	17.7	9.50
	0.532	44.7	34.7**	17.6	9.36
	0.480	50.1	34.8	17.5	8.40
	0.470	51.5	33.5**	17.0	7.99
	0.437	55.4	34.3	17.4	7.60
	0.402	60.8	34.1	17.3	6.96
	0.373	66.1	34.1	17.3	6.45
	0.350	71.5	34.1	17.3	6.06

*This cylinder was not critical at a height of at least 203 cm and probably could not have been made critical at any height.

**These experiments were performed inside a 9.5-ft-dia steel tank which acted as a neutron reflector; consequently, the values reported here are too low.

Table 4.1.1 (continued)

Solution Container and Diameter (in.)	Solution Concentration		Critical Values		
	U^{235} (g/cc)	$H:U^{235}$ Atomic Ratio	Height (cm)	Volume (liters)	Mass (kg of U^{235})
		No Reflector			
Aluminum cylinder					
10	0.300	83.1	34.4	17.4	5.22
	0.291	85.7	34.9	17.7	5.15
	0.0785	328	147.8	74.9	5.83
	0.0779	331	170.1	86.2	6.72
12	0.480	50.1	22.6	16.5	7.92
	0.470	51.5	22.6**	16.5	7.76
	0.437	55.4	22.7	16.6	7.25
	0.402	60.8	22.7	16.6	6.67
	0.0779	331	32.8	23.9	1.86
15	0.480	50.1	17.9	20.4	9.79
	0.0779	331	22.9	26.1	2.03
20	0.480	50.1	15.4	31.0	14.9
	0.402	60.8	15.3	31.0	12.5
	0.0791	325	18.7	37.9	2.97
20 × 20 square cross section	0.0779	331	17.9	46.2	3.60
30	0.480	50.1	13.8	62.9	30.2
	0.470	51.5	13.3**	60.0	28.2
	0.0779	331	16.3	74.3	5.79

*This cylinder was not critical at a height of at least 203 cm and probably could not have been made critical at any height.

**These experiments were performed inside a 9.5-ft-dia steel tank which acted as a neutron reflector; consequently, the values reported here are too low.

corrected by –0.7 cm, a correction which was determined in earlier experiments.

CRITICAL PARAMETERS OF ENRICHED U^{235} SOLUTIONS IN VESSELS OF SIMPLE GEOMETRY WITH SPECIAL REFLECTOR CONDITIONS

A number of experiments have been performed with enriched aqueous solutions of UO_2F_2 contained in aluminum vessels of simple geometry under a variety of reflector conditions. In particular, an evaluation was made of the effect of the 0.5-in.-thick bottom plates on the critical heights of solutions in unreflected aluminum cylinders having $\frac{1}{16}$-in.-thick walls. The procedure used was to determine the critical height as a function of bottom plate thickness (0.5 to 1.75 in.), to plot the results, and to extrapolate linearly to a bottom plate thickness of zero. The difference between the extrapolated critical height and the critical height corresponding to a 0.5-in. thickness is a measure of the effect of the bottom plate on unreflected aluminum cylinders used in these experiments. This procedure was used with 10-, 15-, 20-, and 30-in.-dia cylinders containing solutions of various concentrations. All the critical parameters for these experiments are given in Fig. 4.1.3. It is felt that there is not sufficient data to justify usual curve-fitting techniques, and, therefore, only linear curves representing the limits of the data have been drawn by inspection along with an "averaged" curve representing the data as a whole. This averaged curve indicates that a correction of 0.4 cm should be applied to the measured critical heights. This is obviously an approximation and is subject to a relatively large percentage of error.

The effect of the $\frac{1}{8}$-in.-thick walls of an aluminum containing vessel on the critical height of a 6-in.-thick slab of solution was also determined. In these experiments the thickness of the aluminum on the two faces was varied. The data are presented in Fig. 4.1.4.

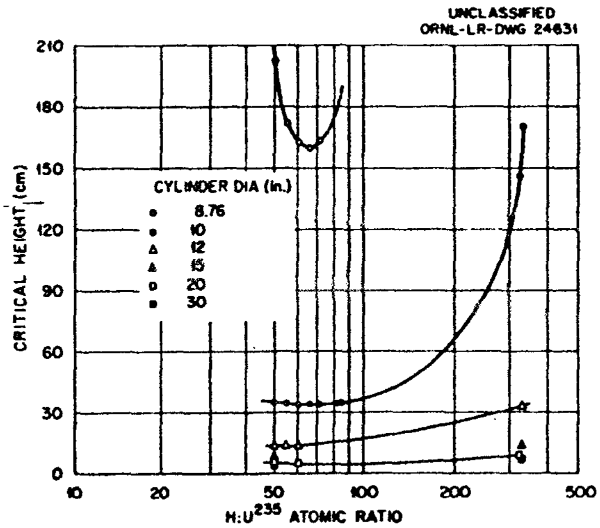

Fig. 4.1.1. Critical Height of Unreflected Enriched U^{235} Solutions Contained in Aluminum Cylinders as a Function of the $H:U^{235}$ Atomic Ratio of the Solutions.

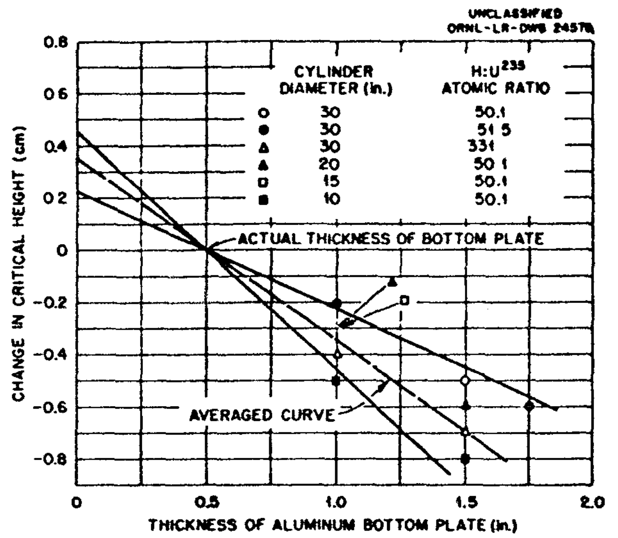

Fig. 4.1.3. Change in Critical Height of Unreflected Enriched U^{235} Solutions Contained in Aluminum Cylinders as a Function of the Thickness of the Bottom Plate of the Cylinders.

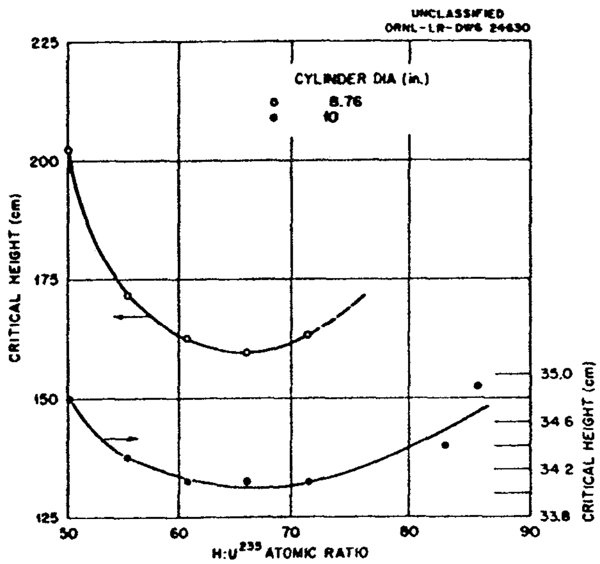

Fig. 4.1.2. Critical Height of Unreflected Enriched U^{235} Solutions Contained in Aluminum Cylinders as a Function of the $H:U^{235}$ Atomic Ratio of the Solutions. Ratios from 50 to 86.

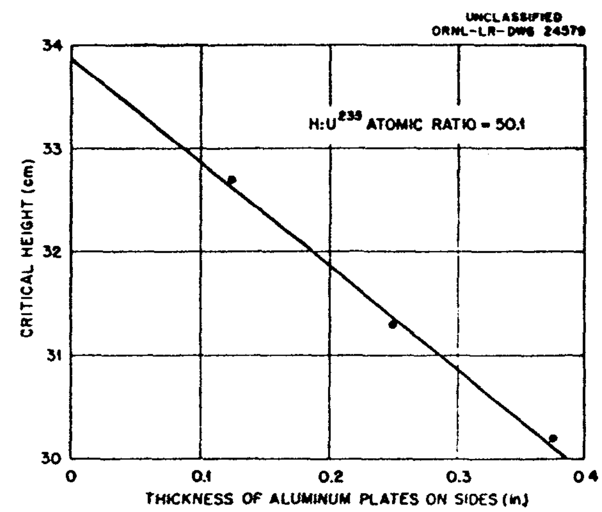

Fig. 4.1.4. Critical Height of a 6-in.-Thick Slab of Enriched U^{235} Solution Contained in an Aluminum Vessel as a Function of the Thickness of Aluminum on the Two Faces of the Slab.

A group of experiments also was performed to determine the relative neutron-reflecting properties of Plexiglas and water. A 30-in.-dia aluminum cylinder ($\frac{1}{16}$-in.-thick walls) was placed in a 9.5-ft-dia steel tank in which water could be raised to any desired height. The level of the water was adjusted to the same height as the bottom of the solution, and critical heights were measured for various thicknesses of Plexiglas replacing the water immediately beneath the cylinder. The data, presented in Table 4.1.2, indicate that, to within the accuracy of these experiments, Plexiglas and water have the same neutron-reflecting properties; however, it was discovered in later experiments (see "Critical Parameters of Arrays of Interacting Enriched U^{235} Solutions," below), in which more sensitive measurements were taken, that Plexiglas is more effective than water.

A few rather specialized experiments were performed to determine the critical height of solutions in partially water-reflected aluminum cylinders ($\frac{1}{16}$-in.-thick walls). The critical height of an otherwise totally water-reflected 10-in.-dia cylinder was measured as a function of the thickness of a void immediately above the solution. These data are presented in Fig. 4.1.5. Experimental results were also obtained from which a comparison of the critical heights of an unreflected and a one-half water-reflected 10-in.-dia cylinder could be made. In addition, data were obtained for comparing an 8-in.-dia cylinder water-reflected on one-half the lateral surface (one-half shell reflector). One experiment was performed in which the critical height was measured for an 8-in.-dia cylinder surrounded by a 6-in.-thick annular void on the lateral surface and an effectively infinite water reflector on the lateral surface outside the void. All these data are shown in Table 4.1.3.

The critical parameters of a 6-in.-thick slab of solution contained in an aluminum vessel ($\frac{1}{8}$-in.-thick walls) were determined for several

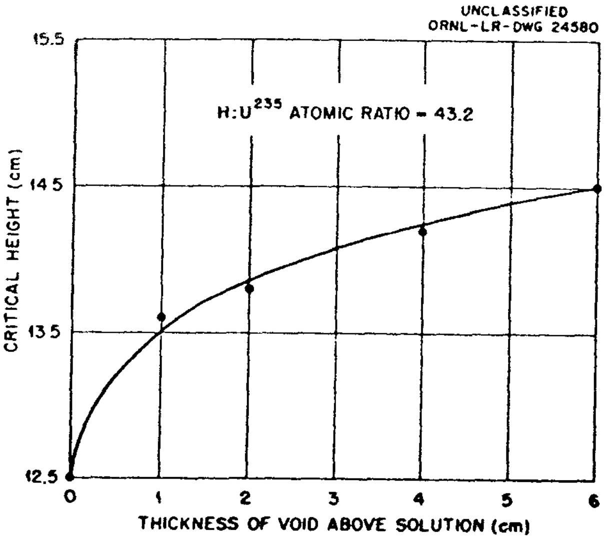

Fig. 4.1.5. Critical Height of Water-reflected Enriched U^{235} Solutions Contained in 10-in.-dia Aluminum Cylinders as a Function of the Thickness of a Void Immediately Above the Solution.

Table 4.1.2. Critical Parameters of Enriched U^{235} Solutions Contained in 30-in.-dia Aluminum Cylinders Reflected on the Bottom by Plexiglas and/or Water

Solution concentration: 0.470 g of U^{235} per cc
$H:U^{235}$ atomic ratio = 51.5

Bottom Reflector	Critical Values		
	Height (cm)	Volume (liters)	Mass (kg of U^{235})
None	13.3	60.0	28.2
Infinite water	9.8	44.6	21.0
0.5-in.-thick Plexiglas + infinite water	9.8	44.6	21.0
1.5-in.-thick Plexiglas + infinite water	9.8	44.6	21.0

reflector conditions. In one group of experiments the critical height was measured for the following reflector conditions: (1) unreflected, (2) 3-in.-thick water reflector on one face of the slab, (3) 6-in.-thick water reflector on one face of the slab, and (4) 6-in.-thick water reflector on one face of the slab plus a 6-in.-thick Plexiglas reflector on one end and the bottom of the slab. These data are presented in Table 4.1.4.

In another group of experiments, the results of which are given in Table 4.1.5, the critical height of the slab was determined as a function of the separation distance between one edge of the slab and a 48 × 48 × 6 in. slab of water placed perpendicular to and symmetrical with the edge of the solution slab. In a third group of experiments a study was made of the critical parameters of the slab as a function of the separation distance between the slab and a 5-ft-thick concrete wall parallel to the slab. In some of these experiments a sheet of boral (60 × 48 × ¼ in.) was placed adjacent to the concrete wall on the side facing the slab. In other experiments the boral sheet was placed adjacent to the slab on the

Table 4.1.3. Critical Parameters of Partially Water-reflected Enriched U^{235} Solutions Contained in Aluminum Cylinders

Water Reflector	Solution Concentration: U^{235} (g/cc)	Solution Concentration: $H:U^{235}$ Atomic Ratio	Critical Values: Height (cm)	Critical Values: Volume (liters)	Critical Values: Mass (kg of U^{235})
10-in.-dia Cylinders					
None	0.0785	328	147.8	74.9	5.88
4 in. thick on bottom and on one-half (180 deg) of lateral surface	0.0785	328	38.0	19.3	1.52
8-in.-dia Cylinders					
6 in. thick on one-half (180 deg) of lateral surface only	0.470	51.5	46.1	15.0	7.05
6 in. thick over entire lateral surface	0.470	51.5	25.3	8.2	3.85
Effectively infinite water reflector outside 6-in.-thick void over entire lateral surface	0.470	51.5	66.4	21.6	10.2

Table 4.1.4. Critical Parameters of a 6-in.-thick Slab of Enriched U^{235} Solution Under Various Reflector Conditions

UO_2F_2

Solution concentration: 0.779 g of U^{235} per cc
$H:U^{235}$ atomic ratio = 331

Reflector	Critical Values: Height (cm)	Critical Values: Volume (liters)	Critical Values: Mass (kg of U^{235})
None	121.5	221.1	17.2
3 in. of water on one face	34.5	62.8	4.89
6 in. of water on one face	33.7	61.3	4.78
6 in. of water on one face; 6 in. of Plexiglas on one end and bottom	30.5	55.5	4.32

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Table 4.1.5. Critical Parameters of a 6-in.-thick Slab of Enriched U^{235} Solution Perpendicular to and at Various Distances from a 6-in.-thick Slab Water Reflector

Solution concentration: 0.0791 g of U^{235} per cc
$H:U^{235}$ atomic ratio = 325

Separation Distance (in.)	Critical Values		
	Height (cm)	Volume (liters)	Mass (kg of U^{235})
1.1	100.8	183.5	14.5
5.1	105.6	192.2	15.2
15.6	109.6	199.5	15.8
42.6	111.3	202.6	16.0
∞	111.3	202.6	16.0

side facing the concrete wall. The critical height of the solution slab as a function of the separation distance from the concrete wall is plotted in Fig. 4.1.6. Placing the boral sheet adjacent to the concrete wall reduced the critical height somewhat, the difference becoming less as the separation increased. This was due, at least partly, to the smaller fractional solid angle subtended by the boral at larger separations.

CRITICAL PARAMETERS OF ARRAYS OF INTERACTING ENRICHED U^{235} SOLUTIONS

Interacting Parallel Slabs

The critical parameters of systems of parallel 3- and 6-in.-thick slabs of solutions contained in type 2S aluminum vessels 4 ft wide and 5 ft high were determined. The thickness of the lateral walls of the containers was 0.125 in., and wall distortion was minimized by $\frac{1}{4}$-in.-dia tie rods welded in place on 12-in. centers. In all plots of the data obtained in this series, the separation distances include the wall thicknesses of the containing vessels.

In one group of experiments three parallel 3-in.-thick slabs were separated equally, and the common critical height was measured for various distances between the slabs. The slab solution had an $H:U^{235}$ atomic ratio of 337. Both unreflected and water-reflected systems were used; however, it should be pointed out that the unreflected experiments were performed in a 9.5-ft-dia steel tank which, as is noted below, acted as a neutron reflector. The water-reflected slabs were reflected to the height of the fuel; that is, there was no top

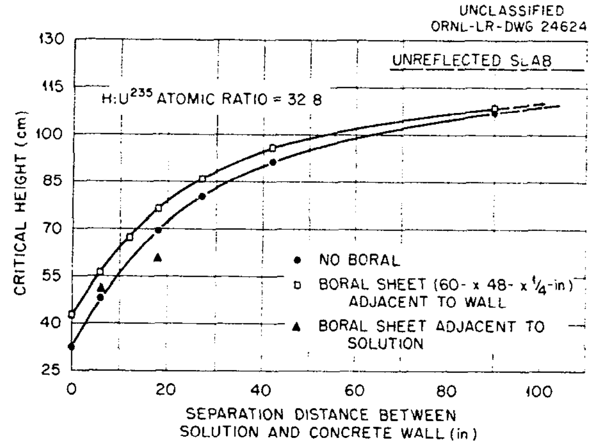

Fig. 4.1.6. Critical Height of a 6-in.-Thick Slab of Enriched U^{235} Solution Contained in an Aluminum Vessel as a Function of the Distance from a 5-ft-Thick Concrete Wall: With and Without Boral Adjacent to the Wall or Solution.

reflector. The critical heights measured in these experiments are plotted as a function of the separation distance between the slabs in Fig. 4.1.7. Corresponding data for two water-reflected slabs are also shown for comparison.

In another group of experiments the effect of replacing some of the water reflector in the two-slab system with Plexiglas was determined. In all cases the Plexiglas was placed adjacent to the inner or outer lateral faces of the slabs. Use of Plexiglas resulted in a lowering of the critical height, which indicates that Plexiglas is superior to water as a moderator or reflector. The results of these experiments are given in Table 4.1.6.

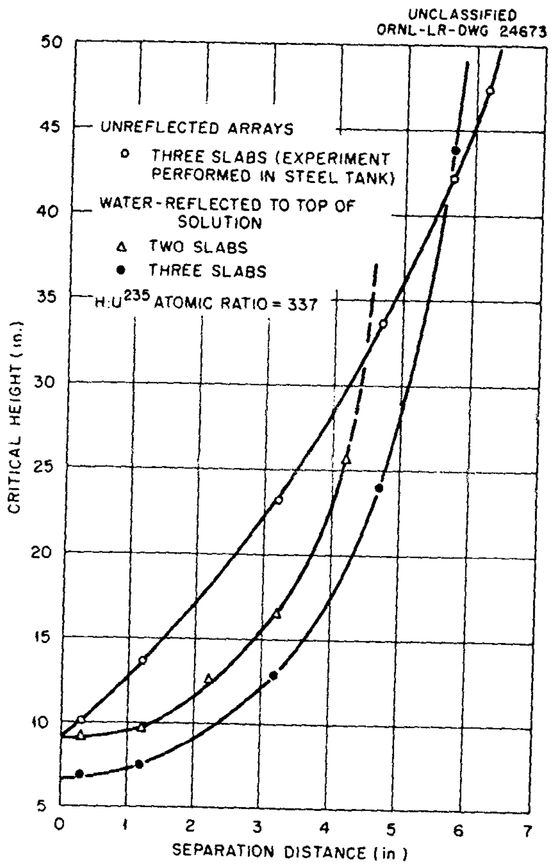

Fig. 4.1.7. Critical Height of Equally Spaced 3-in.-Thick Slabs of Enriched U^{235} Solution as a Function of the Distance Between the Slabs (Aluminum Vessels).

Since it was known that the 9.5-ft-dia steel tank in which the totally water-reflected experiments were performed would act as a neutron reflector and thus affect the results of unreflected experiments to some extent, it was decided to determine the magnitude of the effect. Thus a series of experiments was performed with two- and three-slab arrays, both in the reflector tank and outside the tank. The results, which are presented in Table 4.1.7, verified that the tank had an appreciable effect on the measured critical heights, and unreflected arrays were subsequently performed outside the tank.

A series of experiments was performed in which two parallel 3-in.-thick slabs were placed in water at an $H:U^{235}$ atomic ratio of 50.1. The data are presented in Fig. 4.1.8. The graph shows clearly that the interacting slabs are essentially isolated when separated by 12 in. of water, even though the solid angle between the reactors is large. This result agrees with earlier data obtained by using cylinders.[3] The critical height for two unreflected slabs is plotted in Fig. 4.1.9.

A group of unreflected experiments was performed with a nominally 6-in.-thick slab of solution ($H:U^{235}$ atomic ratio = 337) in various combinations with 3-in.-thick slabs. In one series, two 3-in.-thick slabs were placed adjacent to each other to mock up a 6-in.-thick slab, and the common critical height of the two 6-in.-thick slabs was studied as a function of their separation distance. The same experiment was performed by using a 6-in.-thick slab and one 3-in.-thick slab. In another experiment a 3-in.-thick slab was placed on each side of the 6-in.-thick slab at equal distances. The results of all these experiments are plotted in Fig. 4.1.10.

In order to investigate the dimensional uniformity of the nominally 3-in.-thick slabs, one series of experiments was performed in which some of the slabs were interchanged. Plots of the resulting critical heights in Fig. 4.1.10 show that the difference in thickness was sufficiently large to affect the data.

Two interacting 6-in.-thick slabs with a 6-in.-thick water reflector on the two outer faces only were studied at $H:U^{235}$ atomic ratios of 254 and 325. The data are plotted in Fig. 4.1.11. The variation of the common critical height with separation is roughly equivalent to that obtained for an unreflected system (see, e.g., the lower curve in Fig. 4.1.12), the effect of the outside reflector being mainly an increase in individual slab reactivity.

Interacting Nonparallel Slabs

The interaction of unreflected slabs was further studied in a series of experiments in which two slabs were used to form T- and L-shaped assemblies. The common critical height as a function of the separation distance between the two arms of each assembly is shown in Fig. 4.1.13. The data for two parallel 6-in.-thick slabs at an $H:U^{235}$ ratio of 337 are also plotted for purposes of comparison.

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[3] J. K. Fox and L. W. Gilley, *Critical Mass Studies, Part IX*, ORNL-2367 (to be published).

Table 4.1.6. Critical Parameters of Two 3-in.-thick Slabs Reflected by Plexiglas and/or Water

Solution concentration: 0.0763 g of U^{235} per cc
$H:U^{235}$ atomic ratio = 337

Reflector*	Separation Distance** (in.)	Critical Values		
		Height (in.)	Volume (liters)	Mass (kg of U^{235})
Water	2.2	12.63	59.1	4.51
	4.2	25.63	120	9.14
Water plus a 1-in.-thick Plexiglas plate (area = 12 × 48 in.) against inner surface of each slab	2.2	11.94	55.8	4.26
Water plus a 1-in.-thick Plexiglas plate (area = 22 × 48 in.) against inner surface of each slab	4.2	22.11	103	7.89
Water plus a 1-in.-thick Plexiglas plate (area = 22 × 48 in.) against outer surface of each slab	4.2	22.47	105	8.02

*Water reflector was always to the height of the fuel, with no top reflector.
**Includes wall thicknesses of containers.

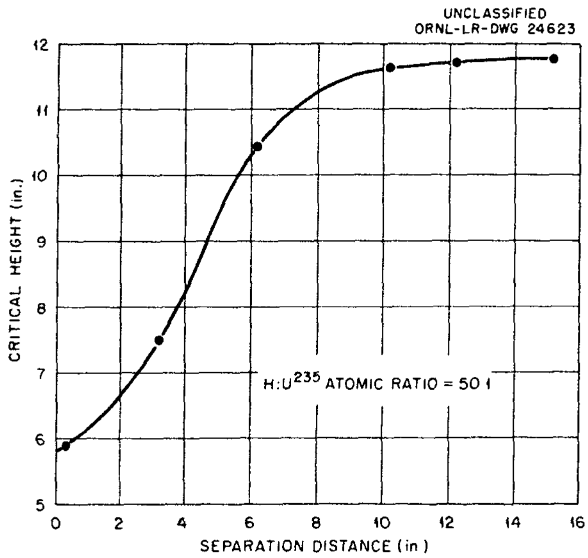

Fig. 4.1.8. Critical Height of Two Water-reflected (Except at Top), Parallel Slabs of Enriched U^{235} Solution as a Function of the Distance Between the Slabs (Aluminum Vessels).

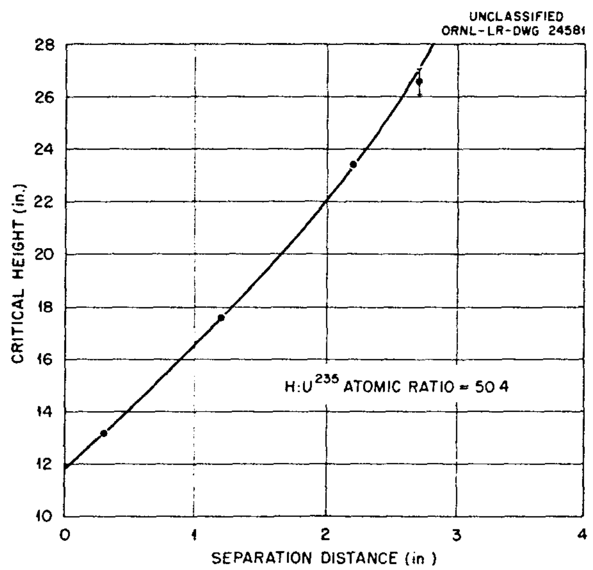

Fig. 4.1.9. Critical Height of Two Unreflected, Parallel 3-in.-Thick Slabs of Enriched U^{235} Solution as a Function of the Distance Between the Slabs (Aluminum Vessels).

Table 4.1.7. Comparison of Critical Parameters of Unreflected Slab Arrays of Enriched U^{235} Solutions to Show Effect of 9.5-ft-dia Steel Tank

Description of Array	Separation Distance (in.)	Solution Concentration: U^{235} (g/cc)	Solution Concentration: $H:U^{235}$ Atomic Ratio	Critical Values: Height (in.)	Critical Values: Volume (liters)	Critical Values: Mass (kg of U^{235})
Experiments Performed Inside Tank						
One 6-in.-thick[a] slab and one 3-in.-thick slab	6.2	0.0792	337	17.74	125	9.50
	12.2			22.91	161	12.3
	18.2			26.89	189	14.4
	30.2			32.72	229	17.5
	∞			39.80	279	21.2
Two 3-in.-thick slabs	0.3	0.480	50.1	12.54	58.7	28.2
	1.2			16.8	~79	~38
	3.2			[b]		
Experiments Performed Outside Tank						
One 6-in.-thick slab and one 3-in.-thick slab	2.2	0.0792	337	12.75	88.8	6.77
	6.2			17.55	122	9.32
	15.2			25.91	180	13.8
	30.2			36.41	254	19.4
	48.2			44.82	312	23.8
	∞			51.87	362	27.6
Two 3-in.-thick slabs	0.3	0.481	50.4	13.13	61.5	29.6
	1.2			17.53	81.9	39.4
	2.2			23.4	109	52.4
	2.7			26–27[c]	~124	~60

[a]One 6-in.-thick slab mocked up with two adjacent 3-in.-thick slabs.
[b]Subcritical; probably subcritical even at an infinite height.
[c]Extrapolated from an actual solution height of 24.7 in.

Interacting Cylinders

The data on interacting cylinders has been extended beyond those previously reported,[3] the interaction between two 10-in.-dia aluminum cylinders having been studied in some detail. A series of experiments was performed with unreflected cylinders containing solutions that varied in $H:U^{235}$ atomic ratios from 49.2 to 328. A series was also performed in which two interacting cylinders contained solutions that differed in concentrations. All these data are presented in Fig. 4.1.14, along with data reported earlier[4] for two unreflected cylinders containing a solution with an $H:U^{235}$ atomic ratio of 329. The data for solutions with $H:U^{235}$ atomic ratios of 325 and 328 are shown on the same curve, since the effect of the difference in concentration is probably within the experimental error. The difference between the new curve and that from K-406 is felt to be mainly due to the reflector tank present in the earlier experiments.

The data for two interacting cylinders, one of which contains a solution with an $H:U^{235}$ atomic ratio of 50 and the other a solution with a ratio of 328, show that the common critical height is very close to the critical height of two cylinders, each of which contains a solution with an $H:U^{235}$

[4]D. Callihan *et al.*, K-406 (Nov. 28, 1949) (classified).

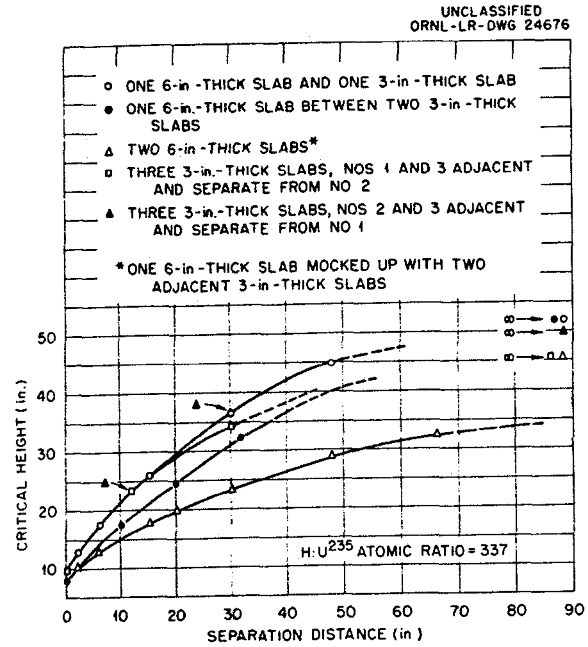

Fig. 4.1.10. Critical Height of Unreflected Arrays of Interacting Parallel 3-in.-Thick Slabs of Enriched U^{235} Solution as a Function of the Distance Between the Slabs (Aluminum Vessels).

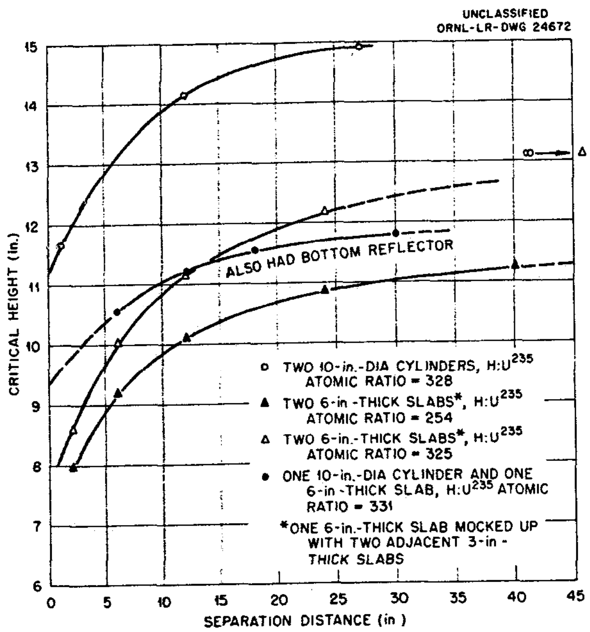

Fig. 4.1.11. Critical Height of Partially Water-reflected Arrays of Interacting Vessels of Enriched U^{235} Solutions as a Function of the Separation Distance Between the Vessels: Water Reflector on Sides Opposite the Interacting Surfaces.

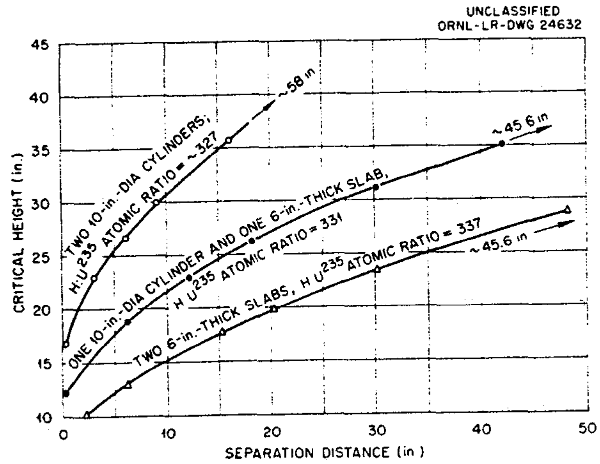

Fig. 4.1.12. Critical Height of Unreflected Arrays of Interacting Vessels of Enriched U^{235} Solutions as a Function of the Separation Distance Between the Vessels.

atomic ratio of 50. In one set of experiments, the two atomic ratios were 49 and 83. Data obtained in experiments with unreflected single 10-in.-dia cylinders (Table 4.1.1) indicate that the critical height of a solution having an $H:U^{235}$ atomic ratio of 49 is very nearly the same as in one having a ratio of 83, since the atomic ratio yielding a minimum critical volume is about 65.

Three experiments were also performed in which the cylinders had half shells of reflector water 3½ in. thick on the sides opposite the interacting surfaces. The results are shown in Fig. 4.1.11.

The study of arrays of seven interacting aluminum cylinders[3] also has been extended to include data for 5-in.-dia cylinders at an $H:U^{235}$ atomic ratio of 50. As shown in Fig. 4.1.15, unreflected hexagonal arrays become infinitely high cylinders at about a 2-in. separation. Water-reflected arrays require about a 4.6-in. separation. A line of seven water-reflected cylinders has an infinite height at about a 3.5-in. separation. Removal of one of the seven cylinders in line has little effect at a separation of 2 in. Hence an infinite plane of cylinders at a 3.5-in. separation probably would not be critical.

Interacting Slabs and Cylinders

The critical parameters for an interacting 6-in.-thick slab and a 10-in.-dia cylinder have been studied for two reflector conditions. The common critical heights of two unreflected 10-in.-dia

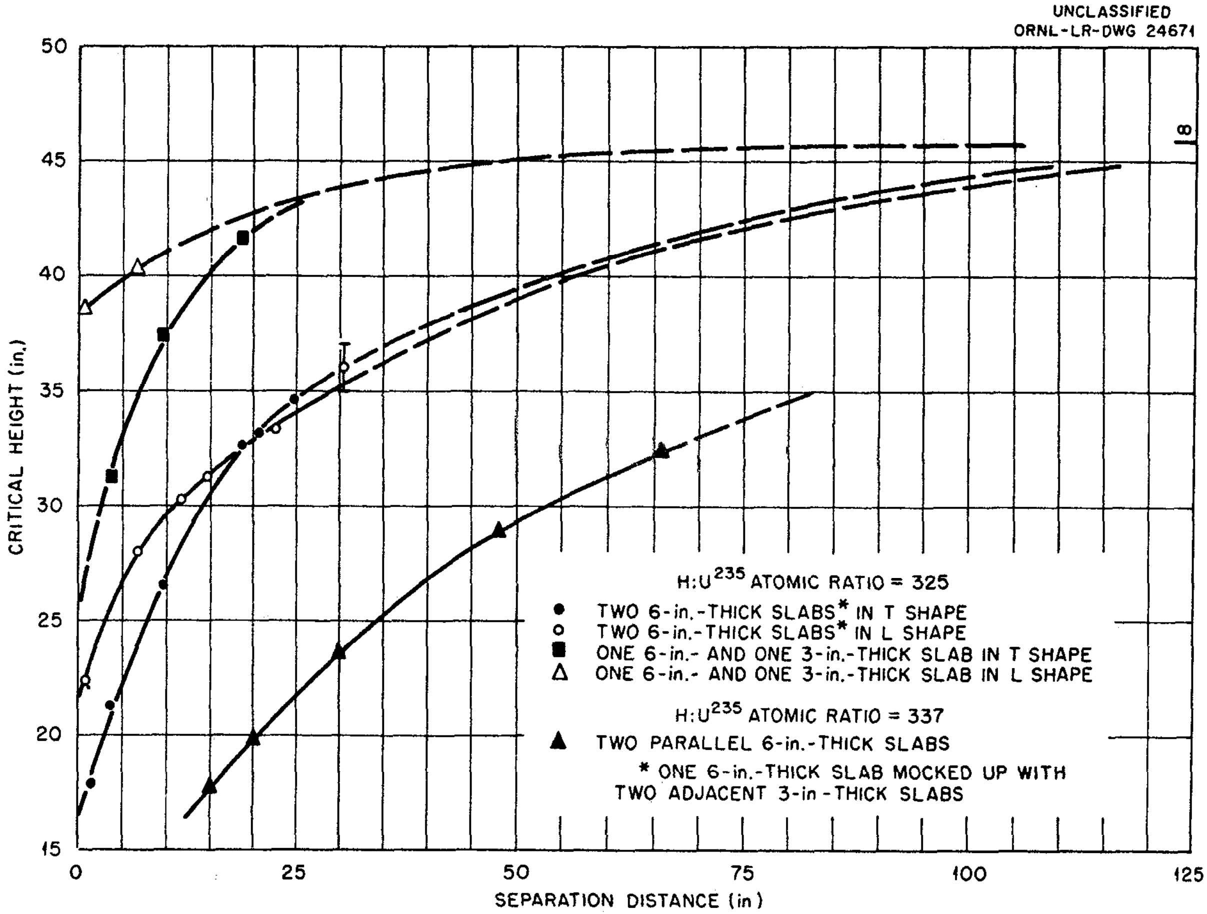

Fig. 4.1.13. Critical Height of Unreflected Arrays of Interacting Nonparallel 3-in.-Thick Slabs of Enriched U^{235} Solution as a Function of the Distance Between the Slabs (Aluminum Vessels).

cylinders, of two unreflected 6-in.-thick slabs, and of one unreflected 10-in.-dia cylinder combined with one unreflected 6-in.-thick slab, all containing solutions with approximately the same $H:U^{235}$ atomic ratio, are shown in Fig. 4.1.12. The curve for the cylinder-slab combination lies between the curves for the two other systems but is somewhat closer to that for the two slabs, since they are the more reactive vessels. Some data were obtained for the slab-cylinder combination reflected on the back sides and the bottom (see Fig. 4.1.11). For large separation distances the bottom reflector was sufficient to lower the critical height of the slab-cylinder combination below that for two slabs reflected on the back sides only (also shown in Fig. 4.1.11).

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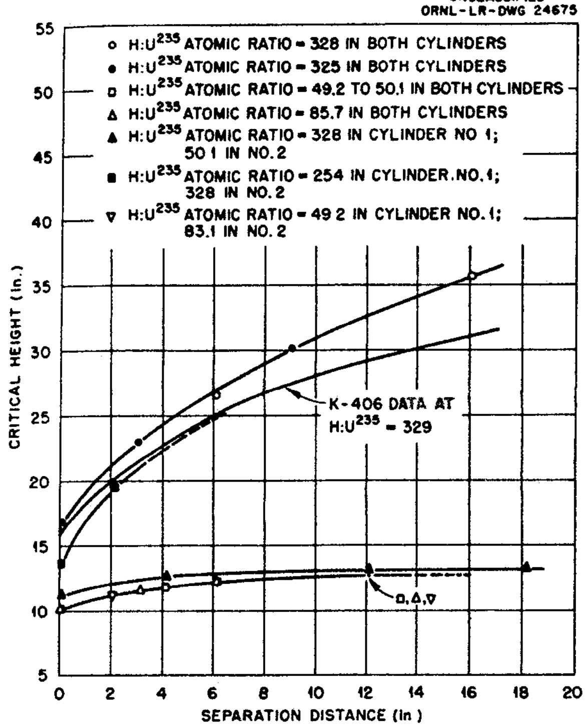

Fig. 4.1.14. Critical Height of Two Unreflected Interacting 10-in.-dia Cylinders Containing Enriched U^{235} Solution as a Function of the Distance Between the Cylinders.

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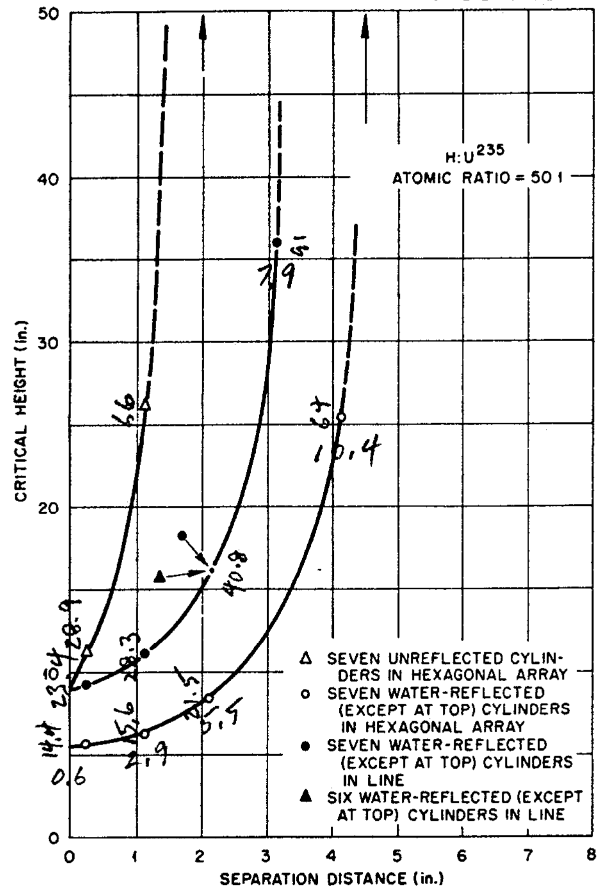

Fig. 4.1.15. Critical Height of Arrays of 5-in.-dia Cylinders Containing Enriched U^{235} Solution.