BOOK51R

Notes:

10148 on spine

Blank pages: page opposite page 1, 1, 10, 13, 14, 16, 24, 45, 59, 61, 81, 146-152, inside back cover sheet

Scanned by:
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14-2-2

SECRET

F-05

COMPUTATION BOOK

NAME	Number
Solution Experiments 1 thru 36	23

data book #1.

Course .....

Used from 9/3/47 19..., to 11/21/47 19...

HARVARD COOPERATIVE SOCIETY
Cambridge, Massachusetts

RESTRICTED DATA

[redacted] Book # 23

Solution Experiments, Data Book #1

Fall 1947

10148

[redacted]

"This document consists of 152 pages.
No. 1 of 1 copies, Series A."

[redacted]

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Index –

Areas of cylinder bases.

Reactor	Area of Bottom: cm^2	Height * to be added (Tamped Mass in elbow)
6"	182.4	3.50 cm.
6 1/2	214.4	2.97
7	248.3	2.57
8	324.3	1.97
9	410.7	1.55
10	506.7	1.26
12	729.7	

Volume of Tamped Mass
637.31 cm^3
~~Correction in Vol.~~

Mass to be added from elbow. *	N_H/N_X ratio	% X by wgt.	ρ of soln. g/cm^3	* Vol. to be added from elbow.
593.7	24.35	46.12	2.02	293.9 g.
494.1	31.12	41.45	1.87	264.2
370.4	43.87	34.86	1.667	222.2
252.5	62.6	26.39	1.501	168.2
193.9	86.30	22.79	1.353	143.3
127.8	127.45	~~16.04~~ 15.94	1.250	102.2
250.6	61.2	26.76	1.47	170.5

N_H/N_X	g X/cc soln
24.35	.9316
31.12	.7751
43.87	.5811
62.6	.3961
86.3	.3083
127.45	.1993
61.2	.3934

Area Ratio
9" cyl 81.07

* Based on 5.5" height (tamped) in 3" section.

Recorder chart speeds

#3 50 sec/div

#4 40 sec/div.

#5 10 sec/div.

Reed electrometer calibration: 0.001 gm Ra at 14 cm from center of chamber gives 1/2 scale on 1000 mv range. Assuming 8hr daily tolerance to be at point 25 cm from 1 mg source, the radiation giving 1/2 scale deflection on 1000 mv range is 3.2 x 8hr daily tolerance.

9/3/47.

Experiment 1. (See Exp 11).

Callihan
Morfitt
Williams
Fox
Quinn
Beck

6" Reactor. Tamped

UO_2F_2 - aqueous solution

H/x ratio $\cong$ 23.* H/X = 24

2:01 P.M. With check list satisfied, Storage Cylinder Control Valves on cylinders 1, 2, 3 opened, and air pressure applied.

2:15 Solution entered bottom of Reactor, after filling "dead volume" from Cylinders 1, 2 & 3.

2:30 Admitting Solution from Cylinder 9.

2:40 – Solution level in reactor – 6.1 cm – (This value is probably ca 4cm large ~~because~~ as indicated)
Cd Control rod all in – "0" on scale – Cd rod 3.9 cm from top of solution

Counts	#I	81.8 / 2min	80.8 / 2min
	#II	37 / 2 min	37 / 2min

At this point it was observed that the apparent solution level in the reactor as indicated by the gage glass was ca 4cm higher than the position of the bottom of the movable tamper at liquid contact. The movable tamper was removed after the liquid note was returned to zero on the gage glass. Upon examination the liquid meniscus was several centimeters below the grid in the reactor. Air pressure was applied to the top of the gage glass & air bubbles were blown from gage glass line – this procedure equalized the liquid level zeros. It is proposed that future experiments be started with the movable tamper removed and the zero of gage glass checked against zero of solution level at grid of reactor.

It was found desirable to apply vacuum to T Work vent valve in order to expedite the return of solution to storage cylinder.

The solution in the "dead volume" drained into #1 cylinder. VC 8/31/47

11/20/48 * Y-12 analyses of solution as shipped = 46.39 % U by wt. } See Book 22
K-25 " " " " received = 46.41 % U } pg 23 + 24.
Corresponding to H/X = 24.0
$\rho_{UO_2F_2}$ = 2.16 (see pg 6, this book).
Wt % X = 43.3 = 0.935 gm/cc.

Solution density - 1.12
Manometric fluid density 2.96
Area b reactor
Area storage cylinder 3.95

9/4- Solution inventory -

	Sh - manometer	6" equiv
#1	52.3 cm	18.15 cm ✓
2	12.1	4.2 ✓
3	2.1	0.73 ✓
4	22.6	7.84 ✓
5	26.3	9.12 ✓
6	23.6	8.20 ✓
7	28.3	9.80
8	30.1	10.45
9	21.0	7.28 ✓
	218.4	

Experiment #1 (Cont'd)

9/4/47

[redacted]
Morfitt
Vioner
Fox
Quinn
Callihan

12:15P - Started solution flow into b'reactor from Cylinder #1 [air pressure = 7.5 p.s.i.].

12:25 Flow interrupted to admit Murray + lunch -

12:55 Resumed experiment - Instrument check.
1:15 Closed #1, opened #9 - suspecting #1 may be empty.
1:20 Sol level 0. (air in line to right glass - blowing back with N_2 did not help much)
1:50. Closed #9 opened #8.
Count: liquid level 2.5 cm above bottom of reactor. Level checked by tamper.

Counter	CO rod in - Control	Control out.
#I	83	85
#II	32	32

2:25P Liquid level - 9.8 cm.

	Count. CO rod in	CO rod out.
#I	83	86
#II	34	32

82:40P Liquid level - 20.0 cm.

	Count CO rod in	CO rod out.
#I	90	91
#II	39	37

305P Liquid level - 29.9 cm

	Count. CO rod in	CO rod out
#I	108	110
#II	61	63

9/4/47

with Cd control in

Soln. height	$(c/2min)_{\#1}$	$\frac{83}{(c/2min)_1}$	$(c/2min)_{\#2}$	$\frac{32}{(c/2min)_2}$
2.5	83	1.000	32	1.00
9.8	83	1000	34	.940
20.0	90	.922	39	.821
29.9	108	.768	61	.524
35.1	137	.606	94	341
40.3	172	.482	140	.229
41.0	178	.466	148	.216
43.0	195	.426	167	.192
45.5	215	.386	190	.168
50.0	252	.329	230	.139
52.5	263	.315	253	.126

plotted on fig 1, Exp. 1

Conclusion from graph: 6" cylinder with thus N_θ/N_x probably safe at indefinite extension.

9/4/47

Experiment I (Cont).

3:25P Solution level: 35.1 cm.

	Count. Content rod in	Content rod out.
#I	137	137
#II	94	95

3:35P Solution level: 40.3 cm.

	Count. Content rod in	Content rod out.
#I	172	180
#II	140	142

3:55P Solution level: 41.0 cm.

#I	178	181
#II	148	148

4:05P Solution level 43.0 cm.

#I	195	198
#II	167	173

4:25P Solution level 45.5 cm

#I	215	216
#II	190	191

4:35P Solution level 50.0 cm

#I	252	254
#II	230	237

4:50P Solution level 52.5 cm

#I	263	267
#II	253	252

5:15P Solution level 2.4 cm

#I	~~#485~~
#II	34

9/8/47

Measurement of cylinder contents preparatory to dilution

	#1	#2	#3	#4	#5	#6	#7	#8	#9
Manom. h_2	56.3	57.0	55.7	Too full to measure	63.5	65.3	84.4	64.4	68.6
(h_1	54.5	53.8	55.1		46.7	44.7	23.3	45.6	41.0
Cm Hg. Oh	1.8	3.2	0.6		16.8	20.6	61.1	18.8	27.6

Ck. 56.4
53.9
3.6

Transferred from #2 to #5 & #9

56.6
54.3
2.3

Transferred from #2 & #4 to #5 & #9.

Ck	56.6	58.4	66.8	~~74.7~~ 75.2	~~70.7~~ ~~74.9~~ 39.0 ~~34.5~~ 34.7
	54.5	52.4	43.2	~~34.5~~	
	2.1	~~6.0~~	23.6	40.2	31.7

Value to manometer found partly closed.

56.3	56.4	79.0	72.0	68.7
54.7	54.7	29.9	37.3	40.9
1.6	1.7	49.1	34.7	27.8

Transfer from #7 to #8 & #9

						78.6	~~70.3~~	68.8	
						30.2	39.6	41.1	
1.6	1.7	0.6	49.1	34.7	20.6	48.4	30.7	27.7	Cm red manometer fluid $\Sigma = 215.1$
$\times \frac{2.96}{2.17}$ 2.2	2.3	0.8	67.0	47.3	28.1	66.0	41.9	37.8	Cm solution in storage cylinder.

Present H/x ratio = 23.8; Proposed $H/x = 30$

$H/x = \frac{2m_w}{M_w} \Big/ \frac{0.934\, m_u}{M_u} = \frac{2m_w}{0.934 m_u} \frac{M_u}{M_w}$ where m_w and m_u are the masses of water and UO_2F_2 in the present solution and M_w and M_u are their molecular wkt.

$= 23.8$

$= 36.3 \frac{m_w}{m_u}$

$m_u = \frac{2m_w}{0.934 \times 23.8} \frac{M_u}{M_w}$

Total mass of solution $= M = m_w + m_u = m_w\left(1 + \frac{2}{0.934 \times 23.8} \frac{305}{18}\right) = 2.52\, m_w$; $m_w = \frac{M}{2.52}$

In proposed solution $H/x = 30 = \frac{2(m_w + x)}{0.934\, m_u} \frac{M_u}{M_w}$

$\frac{m_w + x}{m_w} = \frac{30}{23.8}$

$x = m_w\left(\frac{30}{23.8} - 1\right) = 0.26\, m_w$.

$= \frac{0.26}{2.52} M_w \simeq 0.104\, M$.

So 10.4% of the total solution weight must be added to it to reduce H/x to 30.

9/8/47.

Cylinder Weights Prior to Dilution; ~~Weights~~ Diluent added.

	#9	#8	#7	#6	#5	#4
Gross	17.443 (438) Kg	17.906	20.631	16.421	18.440.	20.321
Tare	13.608	13.770	14.106	13.553	13.875	13.600
Net	3.830	4.136	6.525	2.868	4.565	6.721
X 0.104 = wt H_2O added	398gm.	430	678	298	475	699
Beaker Tare	345	345	345	345	345	345
	743	775	1023	643	820	1044

9/16/47 Measurement of cylinder contents preparatory to distillation

	#9	#8	#7	#6	#5	#3
h_1					73.5	81.3
h_2					35.4	26.9
					38.1	54.4

9/9/47 Experiment #2 (See Exp 36).

To test Critical height UO$_2$F$_2$ aqueous solution, H/X (≅ 30), in a 6" reactor. Fully reflected.
= 31.0

Underwood
Williams
Fox
Callihan

Estimated increase in 6" level upon filling from storage cylinder 4

# 4	22.3 cm	
5	15.2 cm	×
6	9.5	× (2.4)
7	21.7	× 2.4
8	13.7	×
9	12.7	×

H/X = 31.0

1:12P Started filling dead volume from cylinder #7.

1:34P Background Count #I 70 /2 min
#II 33

				Co/C Cd rod out.
1:43	liquid appears in sight glass – (9¾ psi – not quite enough).			
1:47	Back liquid level 2.4 cm. (No bubble trouble).			
	Count	#I	69	1
		#II	33	1

1:59 liquid level 7.8 cm.

Counts	Cd rod in	Cd rod out.	
#I	72	72	1
#II	33	32	1

2:15P liquid level 14.9 cm

Counts	Cd rod in	Cd rod out	
#I	73	75	0.934
#II	35	35	0.943

2:25P liquid level 22.9 cm.

Counts	Cd rod in	Cd rod out.	
#I	80	83	0.844
#II	41	42	0.786

2:32P liquid level 27.7 cm

#I	93	93	0.753
#II	55	54	0.611

9/9/47

{Safety rod displaces 1 cm in 6" cylinder at 50 cm level}

Co/e

2:48P Liquid level 36.1 cm

Counts	Cyl in	Cyl out.	
#I	139	142	0.493
#II	109	109	0.305

3:08 P Liquid level 40.1 cm

Counters			
#I	175	178	0.393
#II	151	151	0.220

3:24P Liquid Level 45.0 cm

#I	227	225	0.312
#II	205	213	0.155

3:45 Liquid Level 50.2cm -

Safety rod in 5 top thumps 1½ cm above.

#I	276	~~282~~	#I 205	0.248
#II	271	~~279~~	#II 186	0.118

4:12 Liquid Level 55.1 cm

#I	326	330	0.212
#II	325	331	0.108

4:27P Liquid Level - 60.0 cm. (Red light on & meter on).

263 - Scale 3 - Through Water window 7 0.184
" Wall 5 0.184
outside wall shadow 12 0.08

#I	367	381	
#II	374	387	

4:48P Liquid Level 65.1 cm.

#I	417	429	0.163
#II	413	439	0.075

3 scale

263 - outside wall shadow 18

inside " - 5

5:02P Liquid level 70.0 cm.

#I	464	482	
#II	447	495	

Zero counts		
#I	71	0.140
#II	35	0.067

5:12 Started to drain back into cylinder - 4, 5, 6, 7, 8 & 9

NOTE: It was found that the rate of drain of solution from reactor & storage cylinders could be markedly increased by first blowing air in the normal operating direction. Presumably this removes air locks from the line. Especially true when the line immediately preceding operation was a depth measurement

Measurements on solutions -

Some solution in reactor line

	#9	#8	#7	#6	#5	#4	#3
Manometer h_2	81.0 cm	66.1	67.5	79.2	75.8	66.9	
Manometer h_1	27.0	43.8	42.2	29.4	33.1	42.9	
"Red liquid" Δh	54.0	22.3	25.3	49.8	42.7	24.0	
Cylinder depth $\ell = 1.75$	91.3	37.8	42.8	84.4	72.2	40.6	

Drained line into #8

73.9
35.4
38.0

Δh.

Depth. 64.7

Transferred from #9 to #7

81.0
27.3
53.7 Too much transferred.

Returned from #7 to #9.

74.9	73.9
34.2	35.2
40.7	38.7

Transferred from #6 to #8

74.9	77.3	73.6
34.2	31.4	35.8
40.7	45.9?	37.8
	79.9	

28.6
51.3

Transferred from #8 to 6 + 7.

	75.0	73.2	76.4	77.0	75.7
	34.2	36.2	32.7	31.8	33.4
Δh Corrected Liquid	40.4	37.0	43.7	45.2	42.3 cm 24.0
Depth in cylinder, $\ell = 1.90$	63.6 cm	52.6 64.6	68.1	70.4	65.9	37.4	

Sample:

Cyl. #9 Dish # 25

10.1530
8.9448 gm
1.2082

From Cylinder #5
Dish # 34

9.2896
8.3454 8.3453
0.9442 gm

A sample was taken from #9 cylinder and its sp gr measured with an hydrometer -

Sp. gr = 1.90

9/10/47

Cylinder Weights - Dilution

	#9	#8	#7	#6	#5
Gross	19.042 Kg.	18.783	20.029	19713 ~~19.547~~	19.453
Tare	13.608 Kg	13.770	14.106	13.553	13.875
~~X/06=H2O~~ Net	5.434 Kg	5.013	5.923	~~5.944~~ 6.160	5.578
~~Beaker tare~~					
~~Hydrogen~~					
X/06=H2O Wt	536 gm	532	628	653	592
Beaker tare	345	345	345	345	345
H2O gross	921	877	973	998	937
Wt of dilution sol.	6.010	~~647~~ 6.100 5.515	6.551	6.813	6.170
~~Height of sol~~					
height of sol.*	74.3	68.6	81.0	84.2	76.3

After this dilution sample from #5 had $\rho = 1.75$

Note 158 g of orig soln added to this one

$$* \quad h = \frac{W}{\rho A} = \frac{W}{(1.75)(16.21)} = 1.236 \times 10^{-2} W$$

To dilute solution having an H/X ratio of 30 to one having H/X = 37 add water in amount determined as follows: (See pg 11, this book).

mass water per unit total mass at H/X = 30 is $\frac{m_w}{M_s} = \frac{1}{1 + \frac{2}{0.932 \times 30}\frac{30}{18}} = \frac{1}{2.195}$

Water to be added for required dilution

$X' = \left(\frac{37}{30} - 1\right) m_w = \frac{0.233}{2.195} M_w = 0.106\ M_w$, i.e. water in the amount of 10.6% of present cylinder content allowed be added to give H/X = 35.

Cylinder contents 10^{30} A[redacted] 9-11-47

#1, 2, 3 small amounts of orig. soln $N_H/N_X = 24$
#4 ≃ 37 cm of 1st dilution " = 30
#5, 6, 7, 8, 9 2nd dilution " ≃ 37

Measurement of liquid heights

	#9	#8	#7	#6	#5
h_2	76.5	75.6	78.3	79.3	77.9
h_1	32.4	33.3	30.1	29.1	30.8
Δh	44.1	42.3	48.2	50.2	47.1
$\times \frac{2.96}{1.75} = 1.69$	74.6	71.5	81.5	~~84.9~~	79.6
Δh inverted	18.9	18.1	20.6	21.5	20.2

differences due to amounts added in working operations.

20 H/X = 38.1

See also Exp 37.

Experiment # 3.

H/X ~ 37

Water lumped. To determine critical height of TO, Fe aqueous solution 6" reactor 9/11/47

12[25] Background on counters (2 min)

Murray - chief. exp.
Fox.
Morfit
Visnier.

	#1	#2
	213	48
changed gain	208	48
	190	—
moved counter	178	—

Note: main source moved about 6" away from the reactor.

1:10 PM. Instrument Check.

1:18. Started filling dead volume from cyl 5. Background count while filling dead volume. (2 min.

	#1	#2
	176	50
1:25	174	50
	177	52

1:55 Apparently valve on cyl 5 is stuck closed. Valve repaired (increased tension on valve stem spring).

2:15. Background

#1
200

2 PM. Enter: Callahan and Cronin

#1	#3
177	51

Boso County (Co).

2:40 Hg. 2.2 cm above zero. #5 empty. equivalent to 8.7 + 24 cm of cyl 5

2:42 Closed #5 opened #6

2:47. Liq. level. 12.1 cm

	Cd. rod in recip.		Cad. rod out.	
#1	176	508	175	1.01
#2	52	192.	51	1.00

2:58 Liq. level. 22.4 #6 Empty

#1	178	181	.98
#2	52	53	.96.

3:05	closed cyl # 6		opened # 7.	
3:15.	Liq. Level. 41.8		#7 Empty.	
		Cd. in	Cd. out.	c/c
	# 1	188	192	.92.
	# 2	63	68.	.75
3:18	Instr. Check.			
3:20	closed # 7		opened # 8	
3:25	Liquid Level. 50.0 cm			
	# 1	192	200	.89
	# 2	76	78.	.65.
3:37	Liq. Level	56.0	Source jerk.	
3:39	Liq Level.	58.0	# 8 empty	
	# 1	196	204	.87.
	# 2	79	90	.57.
3:48	Open # 9.			
3:51	Liq. Level	67.0.		
	# 1	204	220	.81
	# 2	86.	103	.50.
4:04	Liq. Level.	72.0		
	# 1	210	225	.79
	# 2	88	113.	.45

Conclusion: a 6" diameter cylinder water tamped, with a $H/\lambda \sim 37$ d is probably supercritical safe.

Note. Cyl. #4 has concentration of Exp 2. Reactivity weaker than previous experiments.

9/16/47 Sampling H/X ≈ 37

Wgt Pt. dishes

	cyl. # 6	cyl # 8
	I	II
#	35	37
orig. wgt	11.1122	11.2470
	8.9734	8.8367
wgt sol.	2.1388	2.4103

Density (measured before dilution) = 1.73 at 82.°

9/16/47

Measurement of Cylinder Contents Preparatory to Dilution

	#9	#8	#7	#6	#5	#4	#3	
h_1	72.3	72.6	72.8	74.9	73.5		~~84.3~~	70.4
h_2	34.6	34.8	34.5	34.0	35.4		~~46.9~~	37.3
	37.7	37.8	38.3	40.9	38.1		~~37.4~~	33.1
Corrected Height	63.8 ~~63.8~~	64.0	64.7	69.2	~~68.4~~ 64.5		~~92.1~~	56
net area =	46.215 cm							
Calc. Volume	2945			3198	~~3160~~ 2980		~~4255~~ cc	2585
Density =	~~1.73~~ 1.73							
mass	5090			5533	~~5466~~ ~~5442~~ 5151 ~~gms~~		~~7440~~ gms	4470
Water added								
M(.109)	555			603 gms.	~~596~~ ~~602~~ 562 gms.			not diluted ~~487~~ gms

9/16/47 Check Measurement of Cylinders before dilution.

h_1	72.8	72.6	72.9	73.7	73.1	70.0
h_2	34.2	34.4	34.1	33.1	33.7	37.0
	38.6	38.2	38.8	40.6	39.4	33.0
	Conversion factor = 1.692					
Corrected Height	65.2	64.6	65.6	68.7	66.7	55.8
	Effective Area = 46.215 cm^2					
Calc. Vol.	3015	2985	3031	3175	3085	2580
	Density = 1.73					
Mass	5215	5160	5240	5490	5330	4460
Water added						
M(109)	568	562	571	598	581	486

These values obtained after allowing material to stand overnight, and were checks on values obtained on date 9/15.

note = added approx 200 cc of diluted dimpsonig to #9

9/16/47

Expt. # 4

See also Exp 37

H/x = 46.2

Measurement of liquid heights after dilution

(H/x = 45 grams)

	#9	#8	#7	#6	#5
	76.2	74.7	74.7	76.1	75.5
	30.4	32.4	32.2	30.7	31.4
	~~45.8~~ 45.8	42.3	42.5	45.4	44.1
Conv. factor:	~~1.62~~ $\frac{2.96}{1.59}$ = 1.862				
height =	~~77.5~~	~~77.6~~	~~79.0~~	~~76.8~~	
calc =	85.2	78.8	79.2	84.6	82.1

Density of diluted sol. = 1.59 at 77°

Eqiv. Height in Reactor: 21.6 | 19.95 | 20.05 | 21.4 | 20.8

Experiment # 4 H/x = 45

Water jacket

To determine critical height of TO_2F_2 aqueous solution in 6" reactor.

Counter #1

Callibration Chief Exp. For Monsit Metabolic Uranium

2:45 PM Started filling dead Vol. from cyl #8 2 min. all #8 and

2:47 closed #8 open #7 to finish filling dead Vol. read 1 cm from #7

2:55 Background Count

	#1	#2
before filling dead Vol.	101	102
	98	103
	100	108

2:58 Control rod raised 24 cm: 101 | 106

3:00 Height cm filled from #7 control rod ~~Sin~~ #5 emptied drained into #5 from reactor to get rid of air bubbles. Height now in reactor 17.8 cm

3:17

#1	#2
105	107

Control rod out

3:21 103 | 108

9/16/47

Experiment #4

3:25 Fill from #5 to 29.8 cm in reactor

Cd rod in — Cd rod out 40cm

	#1	#2	#1	#2
3:28	104	111	107	112

Filled to 39.4 from #5

	Cd. rod in		Cd rod out	
	#1	#2	#1	#2
3:37	109	117	112	118

#5 empty

3:52 Instrument check

3:55 Filling from #6 cyl. to 49.6 cm

		Control rod in		Control rod out	
		#1	#2	#1	#2
4:00	Counts	116	124	120	130

4:07 Filled from #6 cyl to Height of 59.8 cm

Control rod in		control rod out	
#1	#2	#1	#2
121	132	129	140

4:20 Filling from #9 to 64.9 cm

Control rod out		control rod in
#1	#2	
137	152	none

4:25 Liquid level 71.9

Control rod ~~out~~ in		Control rod out	
#1	#2	#1	#2
128	140	144	154

Ratio's Control Rod out

Height	Counts #1	Counts #2	Ratio's #1	Ratio's #2
0	101	106		
17.8	103	108	.981	.982
29.8	107	112	.944	.947
39.4	112	118	.902	.898
49.6	120	130	.842	.815
59.8	129	140	.773	.758
64.9	137	152	.738	.698
71.9	144	154	.709	.689

4:40 Re-check on counts at 64.9 cm
draining into #1 & 8
Control rod out
#1 #2
136 151

4:45 Control rod out to 86 cm
#1 #2
135 151
Control rod in
Draining into #2, 5, 6, 7, 8, 9 cylinders so that they have $N_4/N_x \simeq 45$

5:00 #4 has conc. of Expt. #2 ie $\frac{N_4}{N_x} \simeq 30$
#3 " " " " #3 " " $\simeq 37$
#1 empty (except for residue of $N_4/N_x \simeq 23$)

9/17/47

Experiment #5

probably 6"

8:30 AM

Sampling (See also Exp. 9).

Back Fox Cronin

#3 / dish 10.9630

#36 12.0734

8.1401

8.8816

#9 cyl. 2.8229

#7 cyl. 3.1818

Measurement of Liquid Heights in Cylinders Preparatory to Dilution.

	#1	#2	#3	#4	#5	#6	#7	#8	#9
h_1	70.6	73.6	70.5	66-3	68.6	67.5	69.3	68.1	69.0
h_2	36.6	33.4	36.8	41.7	37.9	40.2	38.2	39.6	38.5
	34.0	40.2	33.7	24.6	31.7	27.3	31.1	28.5	30.5
Conversion factor $\frac{2.96}{1.62} = 1.826$			Conv. fact. $\frac{2.96}{1.73} = 1.692$	factor $\frac{2.96}{1.90} = 1.556$					
Calc. Height	62.1	73.2	57.7	38.3	58.0	49.9	56.8	52.1	55.8
Effective Area = 46.215									
Calc. Volume.	2870	3385	2662	1771	2680	2308	2625	2409	2580
Density re-determined = 1.62									
Mass water added $M(0.18438)$	465 x5.	548 x1.	~~X~~	~~X~~	434 x1.	379 x1.	426 0	3900	4180
	858.2	1010.58	~~X~~	~~X~~	800.4	689.7	785.5	719.1	770.7

not diluted but calculated.

Density of diluted Solution = 1.47

9/17/47

$H/X = 61.2$

Measurement of Liquid Heights in Cylinders After Dilution

H/X approx 60

Personnel
Beck chief Experimenter
Fox
Olsen
Cronin

	#9	#8	#7	#6	#5	#4	#3	#2	#1
l_1	72.6	70.6	71.9	70.1	73.0				
l_2	34.4	36.8	35.4	37.5	34.3				
	38.2	33.8	36.5	32.6	38.7				
Count $\frac{2.96}{1.47} = 2.0136$									
Calc Height	77.0	68.1	73.5	65.7	78.0	38.3	57.7	73.2	62.1
$\div 3.95$ Equiv. Height in Reactor	19.46	17.21	18.60	16.63	19.75				
$N_H/N_X \simeq$	60	60	60	60	60	30	37	45	45

1:55 Equipment Checks.

2:25 Instrument Checks

2:45 Background Count

#1	#2
22	24

2:47 Filling dead Volume from #5 cyl.

2:55 Dead Volume filled

Background Count

#1	#2
24	25

Height on glass #5 empty is 2.6 cm

3:00 #5 closed filling from #6

3:05 Liquid Level 10.2 cm

	#1	#2
rod in	25	25
rod out	25	24

30
9/17/47

3:10 Filling from rest of #6 cyl. to 18.8 cm

3:12 Counters

	#1	#2
Control Rod in	25	25
Control Rod out	26	25

3:26 Liquid level 36.9 From #7 emptied

	#1	#2
Control Rod in	30	30
Control Rod out	30	31

3:35 Filling from #8 liquid level 44.2

	#1	#2
Control Rod in	32	35
Control Rod out	36	36

3:45 52.5 cm liquid level #8 cyl closed off.

	#1	#2
Control Rod in	37	39
Control Rod out	42	44

3:50 Filling from #9 to 60.2 cm

3:52

	#1	#2
Control Rod in	39	44
Control Rod out	48	50

4:00 Filling from #9 to 70.9 cm #9 empty

	#1	#2
Control Rod in	45 46	49
Control Rod out	58	64

9/12/47

Ratio's Control Rod Out

Height	Counts		Ratios	
0	#1	#2	#1	#2
0	24	25	1	1
10.2	25	24	1	.961
18.8	26	25	.962	~~.962~~ 1
36.9	30	31	.800	.807
44.2	36	36	.666	.694
52.5	42	44	.571	.568
60.2	48	50	.500	.500
70.9	58	64	.414	.391

4:10 Draining into Cyl # 5, 6, 7, 8, 9

4:25 Cylinders filled - & leveled.

4:28 Recheck on Background Counts

#1 #2

25 26

All liquid drained out.

9/18/47

Experiment #6

$N_H/N_X = 61.2$ *

Persons present Callihan
Murray (C.E.)
Morfitt
Cronin
Fox
Lykins
Macklin

Spent time until 11 AM in reviewing previous results and arriving at decision to test 7" reactor with following in mind:

1. To attempt to obtain a critical point, to check estimate made theoretically; thus giving some additional indications of validity of 6" data.
2. To make tests on the effect of source position on the gamma detector, to try to use its data.

11 00 Started to change cylinders and to check solution levels for dilutor.

11 35 Found that #2 valve was stuck, apparently partly open; tested level height to see if some of its contents had escaped during experiment of previous day. No difference, however. Note: when valves open, leave loose!! Rechecked density on #2 to ensure that solution did not drain into #2. No difference again. OK.

* 11/24/48 RE: This N/X value based on:
$\rho_H/\rho_X = 1.47$ see pg 62 this book.
analyses - see book 22, pg 40 gave 28.75% U by wht.
$N/X = 61.1$.

9/18/47

Measurement of Liquid Height in Cylinders.

	#1	#2	#3	#4	#5	#6	#7	#8	#9
h_1	72.3	75.0	~~~		77.2	70.3	Full	64.0	72.0
h_2	34.7	32.1	~~~		29.5	37.3		44.3	35.2
	37.6	42.9	~~~		47.7	33.0		19.7	36.8
corrected $\frac{2.96}{1.47}=2.0137$									
actual H_1	75.8	86.5	~~~		96.2	66.5	~91	39.7	74.2
H/x	60	60	37	30	60	60	60	60	60
$\times 0.186$									
ΔH in 7" reactor	14.1	16.1			17.9	12.4	~16.9	7.4	13.8

Note: Cylinders #1 + #2 should be used first to fill the dead volume and first portion of reactor

Experiment was not run because of mechanical difficulties with 7" cylinder alignment.

Recommend that data be taken with Strong source located in the two relative positions for exp. 1-3 and 4-5 to try to correct multiplication readings.

9/22/47

Water tamped
VO_2F_2 sol

Experiment # 6

7" Reactor H/X = 60

Persons Present Callihan CE
Machalec air values, gas flow, temps.
McPherson observer
Top values on solution storage cylinders -
Visner instruments
Cronin note.

Morning spent adjusting safety rod and tampers in 5" reactor

2:15 Instrument checks.

2:25 PM Background Count } tanks filled with H_2O and Control rod in.

#1	#2
24	25

Instrument check.

2:55 Started filling dead Volume from #1 & 2 cylinders

3:20 Dead Volume filled - values on #1 & 2 had been studs.

3:22 Background count

#1	#2
26	27

3:25 Filled to 10.1 cm from #1 & 2 cyl ½ cm diff between liquid in sightglass & tamper indicator.

Cd. rod out.

#1	#2
26	25

Height by
sight glass 10.1 cm
tamper 9.6 cm.

3:30 #2 cyl empty
3:30.5 #1 cyl empty

3:31 Filling from #8 cylinder to 21 cm - #8 emptied
0.6 cm diff between liquid level & tamper level.

Cd. rod in		Cd rod out		Height by	
#1	#2	#1	#2	sight glass	21.1 cm
29	28	28	28	tamper	20.5 cm

3:44 Instrument check.

3:45 Filling from #6 cylinder to 27.9 cm liquid level — 27.3 to complete

Cd rod in		Cd rod out			
#1	#2	#1	#2	Height by	
47	49	50	50	sight glass	27.9 cm
				temp.	27.3.

3:50 Filling from #6 cyl.

3:50 ~~Instrument check~~ ~~(from jeep?)~~ Source jerk } Recorder charts show these two operations reversed. DC

3:51 31.3 cm liquid level from #6 cyl. (by sight glass measurement).

Dump valve tripped ; surge on sight gauge = 33 cm approx

#3 nickel trip valve.

3:57 Used detector to enter Exp room. not dangerous after 5 min.

4:00 Started draining dump pan and returning filtered sol to storage tanks - all tanks have some material in them.

Some solution drained slowly into Cylinder # 1 & #2.

Remainder removed by suction from pan, in small quantities, into flask - then filtered into stainless steel beakers and returned, by suction, to Cylinders # 6 & 8.

Summary of data:

① Cd control rod out.

② heights of liquid measured by sight glass -

h/	Counter 1	C_0/C_1	Counter 2	C_0/C_2
0	26	-	27	-
10.1cm	26	1	25	[1.08]
21.1	28.	0.93	28	0.96
27.9	50	0.52	50	0.54

Cont'd pg 36.

9/24/47

Solution Analysis

From Cyl. #6

dish #32	10.1424	dish #33	10.9683
	8.5223		8.7154
sample wgt	1.6201		2.2527

dish # L-5	10.5116	ignited U_3O_8	7.8659
	6.5015		6.5015
	4.0101	wgt U_3O_8 =	1.3644

From Cylinder #2

dish #19	11.1096	dish # 29	16.7713
	8.2909		9.0320
	2.8187		1.7393

dish # L-4	9.7784	ignited to U_3O_8	7.8547
	6.8599		6.8599
	2.9185	wgt U_3O_8	.9948

Cont from pg 35 – Summary of Exp 6A:

① H/X ≥ 60, 7" reactor; discussion + early RLM paper predicts lengthed Critical h_f = 56 cm –

② Safety mechanism set to trip at about 80 x 100 on recorder; checked after experiment.

③ During entire experiment #4 on 10 scale, #5 on 1 scale, #3 chg° from 10 to 20 scale immediately preceding operation of dump valve.

④ Source in normal operating position throughout experiment

⑤ Solution taken to ca 20 cm level from cylinders 1, 2 + 8 in three steps. Little reactivity.

⑥ Frequent instrument checks were made.

⑦ Level raised to 27.5 ± 2 cm, multiplication ca 2, Control rod negligible effect. Sol cyl. #6.

⑧ " " " ca 31 cm, some increase in reactivity – source jerk – level fell below background, i.e. level with source present but no solution. Control rod not removed

⑨ Started to raise level further from #6 which apparently immediately emptied, air in line causing surge to ~33 on gage glass. Before sol. could be drained back safety mechanisms tripped. Predicted that #6 would empty at 34.5 cm.

9/25/47

Solution Analysis by Direct Ignition to Oxide.

Cyl #6	Cyl # 2
wgt Oxide 1.3644 gm	0.9948 gm
wgt Sample 4.0101 gm	2.9195
0.3401 gm U_3O_8 / gm oxide	
$\frac{U_3}{U_3O_8} \rightarrow 0.8463$	
.8463 X 1.3644 = 1.1546 gm U	.8463 x 0.9948 = 0.8419 gm U
$\frac{1.1546}{4.0101} =$ 28.79% U	28.84% U.
0.2879 x 0.934 = .2689 gm X/gm oxide	2884 X.934 = .2698 gm X/gm oxide
	.2693 x 2.9195 = 0.7862 gm X
.2689 X 4.0101 = 1.0783 gm X in sample	
$\frac{1.0783}{235} = 0.04589$ moles X in sample	$\frac{.7862}{235} = 0.03346$ moles X
Converting U to UO_2F_2	
$\frac{305}{235} = 1.298 \times 1.1546 = 1.4987$ gm UO_2F_2	$1.298 \times .8419 = 1.0927$ gm UO_2F_2
4.0101	2.9195
1.4987	1.0927
2.5114 gms H_2O in sample	1.8268 gms water
$\frac{2.5114}{9} = 0.2790$ moles H_2O	$\frac{1.8268}{9} = 0.20298$ moles
$\frac{0.2790}{0.04589} = 60.79 = \frac{H}{X}$	$\frac{H}{X} = \frac{.20298}{.03346} = 60.66$

(10) Three ion chamber recorders went off scale.
Y-12 process monitor recorder deflected momentarily 2½" above background, ("red light" level = 4½, action is slow).
Read electrometer - deflected about 5" above background for instant (1000 mr scale) = 8hr tolerance
~~No~~ one block pocket dosimeter (RL Macklin) showed few div. deflection (these are notorious leakers). [at 4' from reactor]
Film Badge type showed no deflection.

(11) Tamper position at time of trip: probably near surface after dump.

(12) 263 measurements in operating room 3' after dump: ½ scale on medium range. 263 monitoring showed immediate admittance & reactor possible

(13) Chart above radiation surge lasted ~20 sec, i.e. from background deflection to return. This includes time for instrument & response.

(14) ~~Background~~

Cont 43

Criticisms & Suggestions:

(1) Experiment was done too rapidly; insufficient time allowed for neutron levels to settle
(2) Worth of Cd Control rod not known at high n levels.
~~(3) Not enough counts taken for calculation of multiplication at~~
(3) Multiplication not determined at sufficiently small solution level increments.
(4) One recorder should be left always on lowest sensitivity.
(5) 263 survey meter should be kept in operating room.
(6) Experimenting group should, on the average, be more experienced.
(7) The difference between values of level shown by tamper & gage glass, though only a few millimeters should have been investigated
(8) Cd control rod should have been removed to investigate its worth at 31 cm level even though source jerk gave severe n drop
(9) Subsequent experiment shows dump values would have operated with this source before criticality was reached, because of multiplication of source neutrons.
(10) Response of ion chambers' recorders, rather lack thereof, not understood.
~~(11) [illegible]~~. DC
(11) When in uncertain region leave at least 5 cm in storage cylinder

Calculated EM

9/24/47

Experiment #6 (B) (Cont).

H/X = 61.2

Measurement of Solution in Storage Cylinder

	#1	#2	#3	#4	#5	#6	#7	#8	#9
h_1	68.5	67.1			77.2	~~69.3~~	Full	69.9	72.0
h_2	38.8	40.0			29.5	~~37.6~~		37.2	35.2
	29.7	27.1			47.7	31.7		32.7	36.8
factor 2.96 = 2.0137 / 1.47									
actual Ht.	58.8	54.6			96.2	63.8		65.8	74.1
H/X =	60	60	37	30	60	60	60 [9]	60	60
by .186									
actual Reactor Ht	10.94 cm	10.15 cm			17.9 cm	11.86 cm	11.16.9	12.25	13.77

Note: Dripping from sampling, sp. gr. reading etc. were returned to storage in #3 cyl. approx. 400 cc.

To retest 7" tamped reactor with solution having H/X = 60.

Morfitt - air
Fox - valves (left at 4:30 P).
William - dust
Callihan - Rotex etc

12:20P Background count -
#I 26 c/2mm -
#II 26

12:27 Instrument check.
12:37 Filling dead volume from #1 + 2. to - 3 cm (#1).
12:45 Filled to 0.9 from #2. #2 empty.

Background count #I 26
#II 28

1:00 5.6 cm from #1, #1 empty.
Filling from #6.

1:02 Level 10.0 cm (from #6). (Tamper check).

40 Expt Brook

Cd rod "out" when bottom is 10cm above solution level

$C_{o\,I}'$ 26

$C_{o\,II}$ 28

1:02P 10.0cm level —

Count.	Cadmium rod in	cd rod out	Co/C
#I	26	26	1
#II	27	28	1

1:12 P Filled to 15.0 cm from #6 - #6 practically empty
Instrument check.

Count			
#I	27	26	1
#II	29	28	1

1:25 P Raised level to 16.0 with small amount of solution from each cylinder 5, 7, 8 & 9 to test positive action of their valves

1:26 Filling from #8

1:30 Level 20.0 cm.

Count			
#I	28	29	0.897
#II	31	31	0.904

1:38 Still filling from #8

1:41 Level 23.5 cm.

Count			
#1	32	33	0.788
#2	34	34	0.824

(Check between counts ca 1:43).

1:50 Still filling from #8

1:52 Level 25.2 cm #8 empty.

Counts			
#I	36	36	0.722
#II	39	39	0.718

2.03P Source Jerk.
Filling from #7

2:10P Level 26.4 cm (from #7)

Count	Cd rod in	Cd rod out	Co/C (Cd in)	Co/C (Cd out)
#I	41	40		0.65
#II	42	44		0.637

2:22P Level 27.2 cm (from #7).

Count			
#I	46	46	0.565
#II	49	52	0.539

Cd rod removed 15 cm additional & count repeated.

#I	46
#II	52

2:35 } Raised stamper ca 2 cm, & level dropped.
2:43 } lowered safety rod to bottom —
Repositioned stamper. — Surface at 27.0 cm

Counts			
#I	34		0.765
#II	37		0.756

2:53P Level at 27.9 (from #7)

Counts				
#I	49	52	0.531	0.500
#II	55	60		0.467

3:12P Level at 28.4 (from #7).

Counts				
#I	55	60	0.477	0.433
#II	63	71		0.395

Cd up 15 cm from surface

3:28P Level at 28.8 (from #7).

Counts				
#I	59	70	0.440	0.372
#II	68	81		0.346

Chg'd #3 to 20 scale (from 10).

Cd up 10 cm from surface of paraffin as from on

3:45 Safety rod in for Cd change —
3:58 Level at 29.2 cm (from #7).

Counts				
#I	71	88	0.360	0.295
#II	81	100		0.280

Chg'd scales: V.R. - 50→100, #5 1→2

24p 6B Count. $C_{oI} = 26$
$C_{oII} = 28$

				c/c cd out.	c/c cd in
4:14P	Level 29.6 cm (from #7)				
4:15	Source jerk Count	cd rod in	cd rod out		
	#II	81	109	0.238	0.322
	#IV	95	123	0.228	
4:30	Safety rod in — for left.				
4:40P	Level 29.9 cm (from #7)				
	Counts				
cd rod 30 cm above solution level	#I	102	153	0.170	0.255
	#II	119	188	0.149	
4:58					
4:48	Source jerk, Control rod out.				
4:59	Safety rod in — level 30.3 cm Control rod in				
	Counts				
	#I	44		0.591	
	#II	48		0.584	
5:07	Safety rod out				
					Scale chgs #3 20→50, 5 2→5
5:14	Level 30.2 cm (from #7).				
cd rod above 40 cm liquid surface	Counts				
	#I	104	158	0.165	0.25
			160	0.163	
			191	0.147	
	#II	124	+40	0.150	
			186		
5:39	Level 30.5 cm (from #7)				
5:42	Count				→ 0.164
	#I	155			5:45 chg scale V,R 100→200
	#II	168			5:54 #5 5→10, #3 50→100
6:00	Control rod 7 cm in solution — Source jerk —				
6:06	Control rod 4 cm in solution Source jerk.				
6:08	Control rod 3 cm — Source jerk				
6:10	Source jerk — Control rod 4 cm out of solution				
6:15	Control rod 52 cm above solution				
	#I		323 326 380 378	0.079 0.094	

Cd Control rod in

6:37 Level at 30.6 cm – Hampers in Contact.
Control rod in.

6:40P

	Counts	Cd rod in		
# I	204 / 207		0.129	6:50P chg° scale
# II	stepmotor out of order			VP 200 - 500 -

At this solution level it was impossible to completely remove the Cd control rod when the source was in the operating position which it had occupied up to this point. However, the Cd control rod could be completely removed by placing the source further (higher) from the counters & reactor. It was thereby shown that the system was not critical with no Cd control. With source in operating position the power level would have been ~~to~~ high enough to drop the dump valve.

7:30 Following the above:
Solution level set at 30.8 cm & fully Hampered –
Source placed in new operating position and Cd control rod removed –
Reactor critical with Cd control rod ~~position~~ indicator at 22 cm. (Source out). i.e. ~~8.6~~ 8.6 cm of control rod in solution.

7:37 Draining back into 1, 2, 6 & 8 storage cylinders.

7:43 Liquid level '0' –
Background count
I 27
II 28

Conclusions:

① Reactor critical with solution 30.7 cm high. This is uncorrected for bottom 3" section – see below –

② Near Critical:
a) Safety rod ≡ 3 cm of solution
b) Control " ≡ 3 mm of solution
c) Tamper = ≡ 0.75 – 1.5 mm solution.

CM → Calculated Crit. Mass 3018 gm X in reactor
709 gm X in $1\frac{5}{2}$" section of 3" section below
(elbow ignored, bottom assumed flat)

11/17/48 BE 30.7 + 1.9 = ~~33.8~~ 32.6 cm corrected for bottom – Critical Height.
H/x = ~~61.~~ 61.1
7" Stainless – Tamped.
Area = 248.2 cm²
Wt % x = ~~2.680~~ ≡ 0.3940 gm X / cc
V_c = ~~8.094~~ 8091 cm³
Sp. gr. = 1.47
~~Mc~~ =
Mc = 3188 gm X

9/29/47

Solution Measurement

2:13 PM	#1	#2	#3	#4	#5	#6	#7	#8	#9
h_1	73.2	58.1	75.5	66.1	76.0	75.4	78.8	75.9	66.3
h_2	33.2	49.9	30.8	41.3	35.0	31.1	39.4	30.5	41.0
Δh	40.0	8.2	44.7	24.8	41.0	44.3	28.4	45.4	25.3
Sol. Ht.	80.6	16.5	~~80.4~~ X	X	82.6	89.3	+5.72	91.5	51.0
H/X	60	60	>37	30	60	60	60	60	60
heater Ht.	14.98	3.14	X	X	15.38	16.60	10.63	17.00	9.48

Test of delay time in trip circuits.

4 (a.) #4 Ion chamber set to trip at 92 x 100 under steady N flux. Strong source was removed and brought rapidly to slightly beyond above position 2 trip point (steady). Av. time required to function 8 sec.

4 (b.) Using weak source, set background steady flux at 64 x 100 ~~& strong source~~ ~~ground of 90 x 100 on recorder~~. Mark same delay time: 8 sec.

4 (c.) Using weak source, a background of 60 x 100 was set. Then strong source was brought to position 2 of pt. (a) above. There ±.5 sec. elapsed between the positioning of large source and the tripping of the relay.

4 (d) (No small source) Large source brought rapidly to approx. 1" of ion chamber. Tripping delay time: 2 sec.

Repeat of above experiments using #3 Inst.

3 (a) (b). Steady state set trip point: 82 x 100

Strong source removed and brought rapidly to slightly beyond steady state trip point
Trip delay time: 5 sec.

3 (c) (d) Weak source steady state background 60 x 100
Strong

3(d) Conditions are = 4(d) above. Delay time 1½ sec.

Sept 30 Callihan Underwood ~~Taylor~~ for Cronin

Testing effect of changing location of source — reactor empty 3 positions used — (A) operating position (B) plummet touching reactor on outside (C) in center of reactor — height kept same in all instances 5.9 cm ± 1 cm below top of reator — Experiments run with 2 sources 1 curie and 10 curie — also with tamper empty and full of water

Position	A		B		C		
	I	II	I	II	I	II	
1C source	68 / 2 min	82 / 2 min	79 / 2 min	92 / 2 min	96 / 2 min	117 / 2 min	tamper empty
1C source	3 / 2 min	3 / 2 min	6 / 2 min	7 / 2 min	11 / 2 min	13 / 2 min	tamper full H_2O
10C source	32 / 2 min	32 / 2 min	51 / 2 min	62 / 2 min	108 / 2 min	136 / 2 min	tamper full H_2O

9 Oct

Oct. 1 Beck
for
Cronin

8:30 Removed 7" reactor and inserted the male fitting of a Hoke needle valve into the solution line as a means of limiting the flow-rate of active solution. Considerable difficulty encountered.

12:00 Reinstalled the 7" reactor and checked both water and solution flanges for leaks.

3:10 Measured time of inflow with orfice installed in elbow – 4 min at 4 a

Drain back – line vented 1st cm = 20 sec
2nd cm = 22 sec
3rd cm = 23 sec

When vacuum applied to line approx. 1½ min for final drainage from zero gauge to cylinder

3:15 Solution Measurements

	#1	#2	#3	#4	#5	#6	#7	#8	#9
h_1	73.9	58.6			76.4	75.5	68.2	75.3	71.7
h_2	32.7	49.4			29.8	30.8	39.2	31.4	35.0
factor 2.0137	41.2	9.2			46.6	44.7	29.0	43.9	36.7
net ht.	83.1	18.5			93.9	90.2	58.4	88.4	74.0
factor .186 reactor ht	15.4	3.4			17.4	16.7	10.8	16.4	13.7
H/X 4	60	60	37	45	60	60	60	60	60

Oct 2, 1947 Exp. 7 Top

Probably 7" reactor

Fox Critical Height with Tamper removed Source in Reactor
Morfitt
Lykins
Cronin
Callahan
Murray C.E.

#4 u 60 X

Using a 1 curie source in the reactor approx 17 cm from bottom, to check shape of curve obtained in previous experiments. The top tamper was removed for this experiment, but outside tamper was filled. Further experiment with no tamping is planned.

Count with source at operating position 17 cm

#I	#II
16	19

With source at 0 on bottom of reactor

#1	#2
32	38

Source at top of Reactor (Source jet Jerks position) 100 cm.

#1	#2
4	4

#4 Brown recorder was initially set on 100 scale

10:00 AM Checks List checked.
10:05 Instrument Checks.
~~(Stop watch to be used for timing)~~
~~Stop watch started~~

10:09 Repeat Background Count Source at Operating Position 17 cm

#1	#2	
16.0	19.5	(Interpolating values from neon bulbs)

10:12 Experiment started Cotter pin removed from S & 4
Air pressure 4½# filling from #9
timed to fill from visible in Pt. 10 tubing to sight glass
10:30 #9 value only slightly cracked at beginning. approx 6½ min

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Oct. 2

10:30 Count with dead Volume filled
#1 #2
16.5 26.5

10:37 Mechanical diffiulty with #3 causing dump valve to trip.
On 10 scale #3 seems to trip without reason-
Chart motor repaired + #4 set on 10 scale, #3 set on 100 scale
#5 on 1 scale Reed on #25 scale

12:20 Instrument checks

12:25 Background count retaken to start Experiment again.
#1 #2
16.5 20.2 source at 17cm above bottom.

12:27 Air pressure on 5# filling from #9

12:36 #9 emptied - air off.

12:38 Fill from #8 5# air.

12:40 Dead Volume filled - approx 8¼ min total.

12:43 Geo level checked by direct observation

12:44 Checking for surge at 7# air Rise appears to be slower about 2 cm/min rise.

12:48 at 2 cm Count. Control rod in
#1 #2
17.5 21

12:54 ~~filling from #8 — 7#~~
at 2.4 cm Control rod out
#1 #2
18.0 22.0

1:00 Filling from #8 7½# air.

1:05 Control Rod out 5.1 cm
#1 #2
17.0 21
17.5 21.8

10/2

1:12 7 # air filling from #8

1:15 7.5 cm Control rod out.
#1 17.0 #2 20.0 Drops in count due to tamping effect of solution

1:19 Filling from #7 7½# air press

1:24 10 cm Air off.
Sidney Visits in. Green light

1:26 Control Rod out Red light on
#1 17.0 #2 21.0

1:30 Fill from #7

1:32 12.5 cm Control Rod out.
#1 19.0 #2 20.0

1:45 To keep surges to minimum due to emptying cylinder draining back 5 cm into #2 cylinder leaving 3.4 cm of liquid in it. Then to empty #7 within range of any possible surge (approx 2 cm)

1:50 Drained back to 7.6 cm

1:52 Emptying #7 ~~with surge of 4 cm max~~

2:00 #7 empty max surge rise was about 1 cm
NL = 12.5 cm

2:02 #6 used to fill line empty.

2:09 15.0 cm Height Control rod out.
#1 17.5 #2 23.0

2:14 15.0 cm (some drained to zero) some bound slowly — scale on Vib. Reed changed to 50

Control Rod in		Control Rod out	
#1	#2	#1	#2
59.0	~~74.5~~	60.5	74.0

54
10/2

2:24 With source at zero filling from #6
2:27 17.1 cm Control rod out
#1 #2 source at zero
665 830

2:32 17.1 cm source at 17 cm Control rod out
#1 #2
19 24

2:42 Filling from #6 Control rod in. to 20 cm

2:47 Control Rod out source at 0
#1 #2
72.5 91.0

2:51 Source at 17 Control rod out
#1 #2
31.5 38.5

2:56 Source at zero filling from #6

3:02 22.4 cm Control rod out Source at zero
#1 #2
87.0 111.0

3:07 22.4 cm Rod out source at 17 cm
#1 #2
49.0 61.0

3:12 Filling from #5

3:17 24.9 cm Control Rod seems to account for approx 2 cm of sol.
#1 #2 Source at zero.
102 123

3:23 24.9 cm Source at 17 cm
#1 #2
68.5 85.0 Cl Rod in
79.0 98 Cl Rod out.

10/2

3:30 Safety Rod in — (displaced 2½ mm of coal)
Contrl Rod equal to about 6 scale div on 100 scale on Vib. Recd
Addition of 2.49 cm of coal equiv. to 7 scale div.
Safety Rod equiv to 10 scale div.

Sidney Visors out & Green light for Guard change

3:43 Red Light.
Cole effect of Contrl + Safety Rod together = approx 3.5 cm
Contrl Rod = 3 millimeters. Safety Rod = 3 cm+

3:52 Filling from #5 starting at 24.9 cm

3:57 27.0 approx 10 scale div. on Vib. Recd Elect. for 2 cm coal.
#1 #2
Contrl Rod out
10 scale div for Contrl Rod on Vib. Recd Elect. (100 scale.

3:58 Somme jerks.
Evidently a max point at about 10 cm off bottom
so if somme is at zero to start, a somme jerk goes thru the max point.

4:07 Somme at zero 27.0 cm
#1 #2
137.5 164 Contrl Rod out

4:17 Somme at 17 cm 27.0 cm
#1 #2
128 167.5

4:22 Filling from #5 to 28.1
#1 #2 Somme at zero
170 210.5 Contrl rod out

4:30 Somme at 17 cm ht = 28.6
#1 #2
185.0 229.0

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10/2

4:39 Filling From #5 Control Rod in
29.5 cm sonne at 17 cm

4:44 Control Rod out changed to 500 scale on Red Electronics.
#1 #2
242 297.5

4:57 Sonne lowered to zero
#1 #2 Control Rod out.
207 254.5

5:07 Sonne raised to 28 cm

5:12 Filled to 30.2 cm from #5
Sonne lowered to 17 cm.

5:15 Control Rod out.

5:22 Counts Rod out
#1 #2
300 373.5

5:27 Sonne jerk

5:28 Sonne replaced to 40 cm

5:29 Sonne to 30 cm.
5:30 Sonne at 24 cm
5:40 Sonne jerks sol. at 31.25 cm.
5:42 Sonne returned to 24 cm ht.
5:43 adding sol.
5:46 Solution at 31.9 — sonne jerks.

5:55 Sonne piped at 30.5 cm

5:57 Sonne piped to give reading of about 20 on #3 Brown (trip at 80)
Sonne ht = 32 cm
6:05 Sonne jerks at 32.3 cm.

10/2

6:06 Source lowered to about 28 cm reading of 80 on #3 Brown
6:07 Cd rod lowered
6:13 Liquid level 32.3 cm not critical.

6:16 Draining back into cylinders #6, #7, #8, #9

6:25 Liquid level 10.3 cm source at zero
Control Rod out

#1	#2
~~57~~ 45	57

6:32 Liquid Ht. 5.1 cm source at zero
Control Rod out

#1	#2
33	41

6:37 Draining to zero liquid level.

6:40 Background — Source at zero

#1	#2
29	38

#1	#2	
18.5	22.5	Source at 17 cm

Comments: Cylinder close to critical at 32.3 cm, estimate that 0.2 cm more would be critical. Location of a source at 17 cm above the bottom of the reactor leads to a less steep 1/M curve, in fact concave upwards. With the source at the bottom the curve was quite linear. Noted that the greatest reactivity occurred (with a given solution height) when the source was up several cm above the bottom. The end tamper seems to correspond to about 32.5 - 30.8 = 1.7 cm of soln.

11/29/48 DC
H/X = 61.1
A.T.g = 1.47
Wt% X = 26.80
= 0.394 gm X/cc
NOT CRITICAL.
H = 32.3 + ~~6.2~~
= 34.2 cm
V = 8.49 l
M = 3.35 kg

Calculated Ratio's

Source at 17 cm in Center of Reactor

Sol. Ht.	Counts #1	Counts #2	Ratio #1	Ratio #2
0	16.5	20.2	1.0	1.0
2	17.5	21	.942	.962
2.4	18.0	22	.891	.919
5.1	17.0	21		
	17.5	21.5	.944	.942
7.5	17.0	20.0	.971	1.01
10.0	17.0	21.0	.971	.962
12.5	19.0	20.0	.868	1.01
15.0	17.5	23.0	.944	.88
17.1	18.0	24.0	.868	.842
20.0	31.5	38.5	.524	.531
22.4	49.0	61.0	.336	.331
24.9	79.0	98	.209	.206
27.0	128.0	157.5	.129	.128
28.6	185.0	229.0	.089	.083
29.5	242	292.5	.068	.068

With Source at 0 cm

0	32.0	38.0	—	—
5 cm	39.1	34.4	.970	.930
10 cm	45.0	57.5	.710	.662
15 cm	60.5	74.0	.529	.513
17.1	66.5	83.0	.483	.458
20.0	72.5	91.0	.441	.417
22.4	89.0	111.0	.359	.342
24.9	102	123	.314	.309
27.0	137.5	164X	.233	.231
28.6	170	210.5	.188	.180
29.5	207	254.5	.154	.149

60

19/3/47

Measurement of Soln. Heights

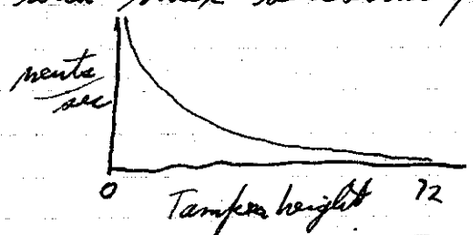
#1	#2	#3	#4	#5	#6	#7	#8	#9
73.6	67.1	75.5	66.5	634	75.3	63.3	72.3	72.4
33.0	40	30.8	41.0	49.2	30.9	44.3	34.4	34.3
40.6	27.1	44.7	15.5	19.2	44.4	19.0	37.9	38.1

3:30 PM — Liquid and washings from dump pan drained back into #3, and #4 cylinders. both are now full.

10/6/47 — Background neutron counts vs tamping

Source mounted in top tamper latter to be run both with and without water filling at positions on tamper scale 0.5, 10, 25, 50, 72 with counters in standard positions.

Preliminary run with H_2O in top tamper recording on ion chambers in counter positions gave smooth curve with max sensitivity at bottom.



(Outer tamper full for all expts)

2 min counts

Tamper position	With no water in top tamper #1	With no water in top tamper #2	Top Tamper filled #1	Top Tamper filled #2
1.0	290	318	195	215
10	185	203	121	139
25	89	99	59	67
50	35	41	39 23	4029
72	31	35	24	26

62

10/8/47

Sample for "Spec" analysis from Cyl #3 after dilution to H/X = 60 sp. gr. = 1.47

dish #36
13.4363
8.8918
4.5445 gms wt.

10/20 by phase from Lueke:
Ni: 100 M—
Cu: 30 "
Fe: W
Mn: trace.

4:00 pm — Measurement of Soln Heights.

	#1	#2	#3	#4	#5	#6	#7	#8	#9
	73.7	70.8	57.2	69.0	76.5	75.8	75.3	72.4	72.7
	32.9	36.0	51.1	38.1	29.8	30.8	31.2	34.4	34.0
	40.8	34.8	6.1	30.9	46.7	45.0	44.1	38.0	38.7
Cylindric Depth. ρ=1.47	82.2	70.1	12.3	62.2	94.1	90.6	88.7	76.5	77.9
N_H/N_X	60	60	sp.G= 1.63	sp.G= 1.58	60	60	60	60	60
Equiv. Read. Ht. factor = .186	15.3	13.3	~~[illegible]~~	~~[illegible]~~	17.8	16.9	16.5	14.2	14.5

Note: Solution from cylinder 3 + 4 was diluted to an H/X = 60 and transfered to cylinder 2, 5, and 7, Dilution was by measuring the specific gravity and slowly adding water to correspond to a sp. gr. of 1.47 (measured on other cylinder which had an H/X = 60)

10/9/47

Exp. 8

H/x = 61.2

7" Reactor Untamped (Source inside Reactor) H/X 60

Calliham CE
Morfit
McFarlane
Cronin

8:00 - 10:30	Equipment checked	
10:30	Instrument check.	
10:35	Badges + Dosimeter issued Personel checked	

Background count

#1	#2	
27	20	Source at extreme height (source fish position).
131	129.5	Source at 17cm above bottom of reactor
161.5	177.0	Source at 0 cm
159.5	165.5	" at 5 cm

11:35 AM. Source 5cm from bottom of reactor - Start filling dead volume from #1.

11:44AM. Dead volume ~~filled~~ filled - Background count - Cd control rod in (cmd bottom ~~of~~ on reactor bottom).

#I	156.5
#II	164.0

11:51 0.7 cm - #1 emptied. Filling from #2.

11:55 5.0 cm - Source now just in solution source - Removal of Cd rod caused no observable chg in level.

Count.	Cd rod in	Cd rod out.
#I	99.0	96.0
#II	95.0	94.0

12:02P Continuing filling from #2.

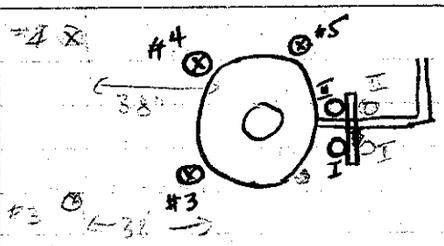
12:11P Solution 8.7 cm rod in
" 8.7 - rod out.

Count	~~#1~~ Rod out.	~~Rod in~~
#I	115.0	
#II	110.5	

It became apparent that, in the absence of danger the general neutron level is high enough to ~~[illegible]~~ probably preclude an approach to critical by withdrawing volume. Decided to move rod chambers away from reactor in order to increase level to which reactor can be taken. Draining back to H=0 into #2.

Extn: Vernier

N.



Counters I & II, Chambers 4 & 3 moved to positions shown at left. #5 not moved.
Reed electrometer moved to table in corner (SE) of room.

12:47P	Solution 0 -	Counts:		1:11P	(Flow checked by observing
	# I	115.0		115.5	solution to be at zero).
	# II	115.0		113.0	
					C/c
1:26P	Filling from #2				
1:37	H = 5.0cm -	Counts	Rod in	Rod out.	
		# I	65.0	67.0	1.72
		# II	68.0	~~66.0~~ 65.5	1.73
1:43P	H = 10.0	Counts			
		# I		86.0	1.34
		# II		87.5	1.29
1:50	Filling from #2				
1:53	H = 14.2 cm	Counts			
		# I		111.0	1.04
		# II		113.0	1.00
~~2:09~~ 2:00	H = 18cm #2 empty, filling from #5				
2:09	H = 20.0 cm	Counts			
		# I		134.0	0.86
		# II		137.5	0.82
2:14	filling from #5				
15	H = 23.1 cm	Counts			
		# I		141	0.82
		# II		145.5	0.78
2:25	H = 27.0 cm				
		# I		148.	0.78
		# II		152.5	0.74
2:35	H = 29.8 cm				
		# I		153.5	0.75
		# II		155.5	0.73
	#5 empty.				
2:45	H = 34.1 cm	# I		158.5	0.73
		# II		160.0	0.71

			Counter.	Rod in c/c	Rod out	c/c.
2:50	Filling from # 9					
3:00	H = 39.7 cm	I		159.5	0.72	
		II		167.0	0.68	
3:03	H = 40.0 cm	I		153.0	0.75	
		II		161.0	0.70	
	Control and Safety rods in.					
3:15	H = ~ 45.5	I		147.0	0.79	
				148.5	0.76	
	Same just Safety rod up.					
3:25	H = 44.7	I		146.0	.79	
		II		150.5	.75	
	Repositioned source - partially returned to its original position -					
		I		154.0	.75	
		II		159.0	.71	
	# 9 empty.					
3:50	H = 48.4	I		151.0	.75	
		II		161.0	.70	
	Filling from # 8.					
4:03	H = 54.5	I		152.0	.76	
		II		161.0	.70	
	# 8 empty.					
4:23	H = 60.0	I		153.5	.75	
		II		159.0	.71	
	Filling from # 7.					
4:30	H = 69.3	I		150.5	.77	
		II		159.0	.71	
	Filling from # 6.					
4:40	H = 79.3	I		150.5	.77	
		II		158.5	.71	
	Fill from # 7					
	H = 83.0					
	Fill from # 6					
4:50	H = 85.2	I		156.0	.74	
		II		160.0.	.71	
	Drain lock.					
	H = 0.5	I		106.0.		
	Background	II		106.5.		

10/9/42 Exp 8 (Cont)

Summary of Counting Rates

Sol Height	C_I	C_{II}	C_0/C_I	C_0/C_{II}	Remarks —
0 cm	115.0	114.0	—	—	Beginning of Experiment
0.5	106.0	106.5	—	—	End of Experiment
	110.5	110.5	—	—	Average. Difference probably due to source not returning to exactly same position after source pick. This caused by hitting of control rod by source with.
5.0	67.0	65.5	1.65	1.69	
10.0	86.0	87.5	1.28	1.26	
14.2	111.0	113.0	1.00	0.98	
20.0	134.0	137.5	0.83	0.80	
23.1	141.0	145.5	0.78	0.76	
27.0	148.0	152.5	0.75	0.73	
29.8	153.5	155.5	0.72	0.71	
34.7	158.5	160.0	0.70	0.69	
39.7	159.5	167.0	~~0.66~~ 0.69	0.66	
"	153.0	161.0	0.72	0.69	Control Rod in
44.7	147.0	148.5	0.75	0.74	Control & Safety Rods In
"	154.0	159.0	0.72	0.69	Safety & Control Rods out.
48.4	154.0	161.0	0.72	0.69	
54.5	152.0	161.0	0.73	0.69	
60.0	153.5	159.0	0.72	0.70	
69.3	150.5	159.0	0.73	0.70	
79.3	150.5	158.5	0.73	0.70	
85.2	152.0	160.0	0.71	0.69	

In this experiment the 1c PoBe source was used in the reactor 5cm from bottom. The 10c source was in its paraffin-Cd tank & contributed about 16 counts to the background. These were not subtracted off.

The plot of height vs C_0/C has a peak at 5cm due to lack of H$_2$O shielding of source at ground level — at 40cm, multiple curvature = 1/3 curve becomes parallel to height axis and remains so to greatest height, 85.2cm tested. Therefore, at this moderation, H/X = 60, 7" dia cylinder would be safe at ∞ length. At 85.2cm the 7" reactor contains ~ 8.91 kg U = 8.32 kg 25

SW corner of reactor room

10/10/47 Solution levels measured.

		#1	#2	3	4	5	6	7	8	9
Manometer levels	h_1	76.6	75.5			~~78.~~ 75.9	72.2	73.9	74.6	74.0
	h_2	29.4	31.8			30.6	34.6	32.7	31.0	32.6
	Δh	47.2	43.7			45.2	37.6	41.2	43.6	41.4
H/X		60	60			60	60	60	60	60
Height of Sol. in Cylinder $\ell = 1.47$		95.1	88.2			91.3	76.0	83.3	86.1	83.7
									16.0	~~15.6~~
~~Δy 0.186~~		~~17.7~~	~~16.4~~			~~17.0~~	~~14.1~~	~~15.5~~	~~16.0~~	~~15.6~~
Equivalent 6" ht.		24.1	22.3			23.1	19.2	21.1	21.8	21.1

Calculated mass of X at 85.2 cm is 8350 gm plus 709 gm X in $15\frac{1}{2}$" section of 3" pipe below reactor (neglecting elbow in pipe and assuming a flat bottom at the elbow)

11/29/48 7" Stainless, Unstamped

$H/X = 61.1$ $\rho_{sol} = 1.47$

— NOT CRITICAL —

With $\%X = 26.8 = 0.394$ gm X/cc

$H = 85.2 + 1.9 = 87.1$ cm

$V = 21.62$ ℓ

$M = 8.52$ kg.

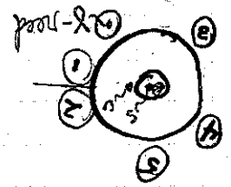
$V_c = M_c = \infty$ est.

10/13/47. Experiment 9 (Repetition of #5)

6 inch reactor. H/X ~ 60 H/X = 61.2

Water Lamped
No top lamper.

Source inside reactor (1 Curie)
5 cm from bottom
slightly west of center.



N

Personnel.
Callahan Fox.
Mechlin Visner
Cronin.

2:40 Counters #1 23.5 } C_o
#2 24.0 }

2:50 Filling from #9.

3:00 0.2 cm = H Counts/2min
#1 23.5
#2 25.0

Filling from #8 Rd on Y.

			C	C/C.
3:15.	H = 5.0 cm			
		#1	18.5	1.27
		#2	20.5	1.17
	~~Char~~ Raised and lowered source		20.5	
	to it original position.		20.0	
3:30	H = 10.0	#1	23.5	1.0
		#2	24.0	1.0
3:37	H = 15.0	#1	30.0	.78
		#2	30.5	.79
3:50	H = 20.0	#1	36.5	.64
		#2	36.5	.66.

Filling from #7.

4:05	H = 24.9	#1	40.0	.59
		#2	41.5	.58
4:15	H = 30.1	#1	43.0	.55
		#2	44.5	.54

11/29/48 H/X=
ρ ρgr = 1.47
Wt % U = 26.80
6" stainless
Not Crit
H = 85.0
V = 15.98
m =
Hc = Mc = ∞

			Rd in.		Rod out	
			C.	c/c.	c	c/c
4:25	H = 35.0 cm	I			46.5	.51
		II			48.5	.50
4:35	H = 40.0	I			48.5	.48
		II			52.5	.46
	Filling from #6					
4:45	H = 45.0	I			51.0	.46
		II			54.5	.44
4:57	H = 50.0	I	48.5	.48	51.5	.46
		II	49.5	.48	55.0	.44
5:10	H = 57.4	I			54.5	.43
		II			59.5	.40
	Filling from #5.					
5:23	H = 65.0	I			55.5	.42
		II			59.5	.40
5:40	H = 74.9	I			60.5	.39
	74.9	II			63.0	.38
	Filling from #2					
5:53	H = 85.0	I			63.5	.37
		II			69.5	.35
		I			63.5	
		II			70.6	
5:05	H = 80.0	I			62.5	.38
	80.1	II			68.0	.35
5:25	H = -1.0	I	Background.		25.0	
		II			26.0	

Comments & Conclusions: ① Comparison of 1/M vs height curves with that of #5 exp. of which this is a repetition, shows the same position within solution gives results more easily interpretable.

② The solution level was taken to 85 cm with continually increasing reactivity, but at a decreasing rate. ($\frac{1}{M} \geq 0.35$).

③ 6" duke pipe, H/k ~ 60, water-reflected, except top, probably safe at infinite length.

④ Control rod, just without reactor, ≅ 5 cm solution.

Calculated mass of X at 85.0 cm is 6120 gm with 709 gm X in a 1 1/2" section of 3" pipe below the reactor (neglecting the elbow & assuming a flat bottom at that point).

61.1
=0.394 gm/cc
Temp'd
ICAL-
+2.6 = 87.6 cm
&
6.30 kg
est.

10/6

Solution Measurements

#1	#2	#3	#4	#5	#6	#7	#8	#9
78.5	75.4	56.7	69.5	62.5	66.6	74.5	72.7	71.4
18.7	31.1	51.5	35.6	45.2	40.8	32.0	34.0	35.4
49.8	44.3	5.2	33.9	17.3	25.8	42.5	38.7	36.0

10/17 With drew sol from #3 & #4 for evap.
Sol evap to sp. gr. of 2.14 approx.

Com sol returned to cyl #3

Sol withdrawn from #1, evap to sp gr. 2.14 and returned to #3 cylinder

10/20/47 Sol withdrawn from cyl's #2 + 5 for evap.

Ht of sol in #3 cyl: $\frac{77.9}{27.5} \times \frac{50.4 \times 2.96}{2.14} = 69.8$ cm in 3" cyl. approx

Returned sol approx 2.10 sp-gr. to #2 cylinder *

H/X ~60 in cyl's # 7, 8, 9 only.

#2 + #3 cyl H/4 (20-25) roughly.

* This Concentration gave:
H/X = 24.4 (see pg 74 + 80 this book)
sp gr - 2.02
wt% X = 43.01 = 0.8688 gm/cc -

10/20/47 Samples sent to laboratory

dish #37 9.7655
8.8367
.9288 gms of purified Opide from recovery process.

dish #41 9.8645
8.8255 gms of purified Opide from recovery process
1.0390

dish #27 11.7827
8.7347
3.0480 gms of sol from cylinder H/H approx 60.

10/21/47 Evap sol. returned to cylinders 1, 2, 3 and 9
all available H/H ~ 60 evap to ~ 25 H/H

#1	#2	#3	78.4	#9	
75.6	78.0		27.6	73.0	all others empty.
31.0	28.4		50.8	34.1	
44.6	49.6			38.9	

density approx 2.10
ratio = 1.41

62.9	69.9	71.6		54.8 cm in 3" cylinder
15.86	16.84	18.05		13.82

in 6" reactor → 18.81 cm required to fill dead vol.

10/22/47 – Wednesday — Experiment 10.

6" untamped; H/X ~ ~~22~~ 24.4

C. Beck
J. Fox
F. Cronin
J. Moffitt

Quinn, ~~McFadden~~, Olsen } 8:30 – 10:30

Source inside solution, 5½ inches from bottom

1) arranged with D. Williams to insert another re-entrant tube through top tanglers. beginning with 6".

2) 10:00 AM. Beginning untamped experiment on 6" cylinder.

Background counts:

# I	# II	
147.5	150.0	Source on bottom in contact with grill no solution. No tamper. 2 minute count. Safety rod in contact with grill; control rod up.
134.5	138.	} Source 12.5 cm from bottom, No solution; no tamper. 2 minute count. Safety rod in contact with grill; control rod up.
133.5	140	}
134.0	134.0	Source 12.5 cm from bottom, no solution, no tamper, control rod down, safety rod up. (operating position)

(#3 is on 100 scale throughout experiment; #4 ~~was~~ started on scale of 10. Reed electrometer on scale of 25, #5 on scale of 1, Process monitor operating).

135	135	same as last above.

10:35 – 10:48 all of cylinder #3 emptied into dead volume.

136	140	Solution ½ cm above grill, no tamper; Control ~~Safety~~ rod down (inside the cylinder), Safety rod up. Source 12.5 cm above grill, inside cylinder.

2 minute counts

Time	Solution Level	# I	# II	
11:06	0.7 cm	136	141	same as last above.
	(adding solution from cylinder #2).			
	10.0 cm.	89.	91.	Source is slightly (2.5 cm) above ~~below~~ solution level.
	10.0 "	90	91.	Same, except control rod out.
	(adding from cylinder #2)			
11:22	20.0	88	79	Source is now covered with solution, control rod ~~with~~
	19.8	91	80	Control rod out.
11:40	(emptying the #2 cylinder (empty at 24.8); adding from #9).			
	30.2	113	100	control rod in.
	29.9	112.6	102.5	Control rod out.

11/29/48 DC

H/X = 24.4, 6" stainless untamped
Not Critical

H/X = 24.4   Sp gr = 2.02
wt % X = 43.01 = 0.8688 gm X/cc
H = 60.5 + 2.6 = 63.1 cm
V = 11.51 L, M = 10.00 kg
$M_c - V_c = \infty$ est.

11:50 The ionization chambers showed considerable change in level at two or 3 places after the source was supposed to be covered. A check revealed that the source was floating upward inside its counterweight. The source was ~~[illegible]~~ hung on the bottom of the counter-weight, and being of less sp.gr. than the solution, tended to float. After complete submersion – at about 25 cm. no further trouble due to change in position of source should occur.

11:52 – (adding from cylinder #9: empty at ~~40.0~~ cm).

Solution Level	Counter I	Counter II	Remarks.
40.0 cm	129.5	119.5	Control rod in solution
39.6	133.0	124.0	Control rod out.
40.0	134.0	119.0	Control rod in

12:11 (adding from cylinder # 1.)

50.1	138.5	126.0	Control rod in solution
49.6	139.0	129.0	Control rod out
50.1	135.	127.2	Control rod in

12:29 (adding remainder of cylinder 1.)

max. → 60.5 – at this point the neutron source slipped from the counterweight hook and floated on the solution surface. It was replaced and the hook closed with pliers.

Source 12.5 cm from grill; inside solution.

60.5	165.5	181	control rod in solution
59.7	168.0	179	control rod out

12:51 (Returning solution to cylinder # 1)

49.9	169.	180.5	Control rod out.

1:01 (Returning to cylinder # 1)

39.9	165	172.5	control rod out

1:09 (Returning to cylinder # 2)

29.8	138	150.	Control rod out

1:15 (Returning to cylinder # 2).

20.1	113	112.5	control rod out.

most reliable data I felt.

1:24 (Returning to cylinder #3). at zero gauge level Control Rod out

#1	#2
138	142
136	143

1:30 Returning to Cyl. #9)

2 40 PM Sample removed for H/x & sp. gr.

Drink #31

15.2779
8.1404
7.1375 sp. gr.

sp gr. = 2.02

10.8864
8.1404
2.7460 → UO_2F_2 sol.

H/x sample

9.6404
8.1404
1.5000 wt. U_3O_8

$$H/x = 33.01 \times \frac{2.746}{1.50} = 36.28$$

$$= 29.15^{*} \checkmark$$

Conclusion: 1) 6" untamped cylinder, H/x = 22, at a hight of 60 cm is not critical.
2) Extrapolation of the reciprocal multiplication curve indicates that criticality would not be achieved at much greater expansion.

* With this are averaged two values from pg 80 to give 24.4 = H/x.

10/23/47

Experiment 11

6" tamped $\frac{N_H}{N_x} = 22$

Present: Cronin
Fox
Morfitt
Murray

Center Source 125cm from bottom

1) Added conical end to source weights to facilitate smooth removal from funnel in end tamping. Restrung Source to eliminate knot. Fastened dumping spring.

trip point: #3, 87 on 100 scale
#4, 90 on 100 scale.

9[12] AM Ready to go

Scales used: #5 on 2 Reed on 25
#4 on 10
#3 on 100

Background, counters: #1 16 ~~60~~ first test 17 2nd test
#2 18. " 17 "

9[38] AM Air On. Source centr 12.5 cm off bottom.
Filling from #9 containing dead Volume only.

Soln Depths	Gage Reading	Height @ which soln. cylind. goes MT.
#9	52.3 cm.	19.5 (dead Vol.)
#3	50.4 "	18.7
#2	53.4 "	19.9
#1	48.9 "	18.2

(Ratio densities) 2.96/2.02 = 1.466
(Ratio Volumes) 3.94/1
Factor = 1.466/3.94 = 0.3725

Height rose to 1 cm in cyl. on emptying #9
1 cm drained back into #3.

Background

#1 19.5 #2 19.0

9[58] Hgt. 0. Feeding from #3

			Count #1	Count #2
10 04 AM	H = 10.2 cm.	Rod in Rod out	18.0, 19.0,	18.0 19.0
10 21 AM	H = 19.0 cm #3 Empty	Rod out	33.0 33.5	
	Source Pulled - Dead			
10 30 A	Filling from #2			
10 39 A	H = 24.2	Rod Out	36.5 38.0	
	Scale on Reed changed to od.			
10 42	H = 30.2	Rod Out	44.5 47.5	
10 53	Trouble with bubble in Sight Glass			
10 59	H = ~~35.1~~ 34.9		~~48.5~~ 52.0	
	Source Pulled - Dead.			
11 02	#2 Empty @ 36.1 cm. Filling #1	Rod out	~~52.5~~ ~~57.5~~	
11 15	H = 40.0		52.5 57.5	
11 27	H = 47.6	Rod Out	55.0 61.0	
11 26	H = 54.3 cm.	Rod Out.	#1 56 #2 60,	61.5
11 34	Draining ~~Back~~ 20 cm into #9 Height 34.2 on sight glass Count taken to verify curve.			
11 45	H = ~~47.5~~ 34.2		#1 45.5 #2 47.5	
11 50	Draining back 20 cm into #3. Height 14.0 cm on sight glass			
	H = 14.0		#1 18.5 #2 19.5	
11 55	Draining back 14 cm into #2. Height 0.0 on sight glass			

Inter-war time 10/23/47

1. Removed 6" Cylinder
2. Installed 7" Cylinder
3. Decontaminated 7" Tamper & transferred to Williams for source tube.
4. Washed 6" Tamper for storage.
5. Chipped Cd spray from all 9 cylinder so valves could be safely welded.
6. Washed 4 of the new cylinders with 1:1 HNO_3, tap water, distilled water.
7. Installed 7" Tamper in cylinder to align it.
8. Tested all position of Tamper & safety rod for concentricity & alignment.
9. Retested tip point & instruments for afternoon run
10. Completed set up for untamped system, change of control rod etc.
11. **Fastened dump valve spring to lever with string. !!**

Conclusions; experiment 11

6" tamped cylinder with $N_H/N_X \simeq 22$ not critical at 54.3cm. Maximum multiplication $\simeq 3$. Flattening out, so looks like it is reasonably safe.

PM

$H = 54.3 + 2.6 = 56.9$ cm
$H/X = 24.4$; $\rho_H = 1.0$
$N_H/N_X = 43.0$; $\simeq 0.8688$ gm x/cc
$V = 10.38$ l
$M = 9.02$ kg.
$H_c = V_c = M_c = \infty$ est.

10/23/47 Untamped 7" Reactor N_{16}/U_{25} (20-30) Experiment 12

Background with No Soln.
#1 - 134
#2 - 135

2:54 P Ready to Go.

Present Cronin, Fox, Martin, Murray

Soln. Hgts. In terms on centimeters of gage glass.

#1 Dead Volume
#2 10 cm.
#3 14.5 cm
#9 14.5 cm.

Trip point: ~~85~~ 82 on #3 100 scale
88 on #4 "

Operating Scales.
#5 on 2 scale
#4 on 10 scale
#3 on 100 scale
Read on 50 scale

3:00 PM Filling from #1

Source is located 12.5 cm off bottom.

3:15 PM Soln. @ 0.2 cm Background (G) Readings #1 133
#2 135

3:16 PM #1 Empty @ 1.5 cm.

Filling from Number 9.

3:28 PM. H = 7.5 Rod Out
Blow out line twice -
Gage Glass (GB) 74
75

3:30 H = 12.5 Rod In → 69
68
Rod Out → 69
65

3:38 H = 16.6 Rod Out 101
Number 9 Empty 100

3:48. Filling from 3

3^{22} P	H = 19.8 Rod Out	122 120.5
3^{50} P	29.0 H = ~~24.8~~ Rod Out Blew out line again. #3 Empty @	143, 147.
	H = 31.1	159 161
4^{05} P	H = 35.0 Rod out	163. 164
4^{17} P	H = 41.6 Rod out.	172.5 176.0

Putting soln Back.
#1 15 cm (in the 7" reactor)
#2 10 cm "
#3 17 cm "
#4 dead volume.

4^{40} Background count with soln. at grid. #1, 132
#2, 145, 134

↑ with Moffett & Fox as tamping.

Conclusions, Experiment 12

Shut amped 7" reactor with $N_H/N_X \simeq 22$ not critical with 41.6 cm height, the maximum available solution. Curve flattening, but not as rapidly as Exp. 11. Still looks infinitely safe, though. Maximum multiplication 1.3.

H = 41.6 + 1.9 = 43.5 cm
H/x = 24.4; k_{pq} = 2.0 ✓
Wt % x = 43.01; = 0.8688 gm/cc.
V = 10.80 ℓ
M = 9.38 kg
$H_c = M_c = V_c$ = ∞ estimated.

Inter. Rec Time 10/23/47

I Cd Control Rod Cleaned & Reinstalled in Unstamped Position.

H/X Determination
(By direct Ignition of UO_2F_2 solu to U_3O_8)

Sample #1
3.0643 gms sample
1.6672 gms Oxide

$$33.01 \times \frac{3.0643}{1.6672} - 36.28 = 24.39 \qquad \frac{H}{X} = 24.52$$ 11/19/47 JM DC

Sample #2
1.7300 gms Sample
0.9427 gms Oxide

$$33.01 \times \frac{1.7300}{0.9427} - 36.28 = 24.30 \qquad = 24.52$$ 11/19/47 JM DC

$\therefore \frac{H}{X} = 24.3$ approx.

10/24/47 — 7" Reactor Tamped H/X ~~(24.5)~~ 24.5 =24.3 Experiment 13

1 curie source ~~24.5~~ 7.5 cm from bottom of reactor.

1:15 Instruments checked – Tamper installed and checked.
Personnel: Callihan – C.E
Morfitt – Valves
Malblin – Instru.
Cronin – Records

Solution available:	#1	#2	#3	#9
	15cm	10cm	17cm	Dead Vol.

Values from Drain back 10/23/47

Instruments: #3 – 10 scale
#4 – 100 scale
#5 – 1 scale
Red Electrometer = 25 scale

Counts	#1	#2	no solution
	32.5	34.5	

1:38 Filling dead vol from #9

1:58 Dead Volume filled from #9 now empty. Note: Solution has considerable inertia giving a time lag between actual level and reading on sight glass.

2:01 Background taken at 1.5 cm sol ht.

#1	#2
29.5	30.0

2:04 Filling from #3 cyl to 5.2 cm
2:08 Counts

#1	#2
34.5	34.0

2:11 Source moved to 7.5 cm. bottom weight should now be touching bottom.
Counts

	#1	#2
2:13	39.5	40

2:14 Draining back to 0 cm into #3
2:17 Leveled off at 0.2 cm Counts:

#1	#2
32.0	34.0

2:21 Filling from #3 to 10cm. Reed Electrometer very sensitive.

Note: Tamper has been at 10.7cm since beginning of Exp. limit switch set at this value to prevent breaking some loose.

2:25 Counts #1 #2 10.2 cm
~~60~~ ~~70~~
57.0 56.5

2:30 Filling from #3 to 11cm

2:35 11.20 cm CRI Tamper level agrees with liquid level.

2:37 Filling from #3 to 12.5 cm

Counts #1 #2
2:39 67.0 65.0 12.8 cm

2:45 Fill from #3 to approx 17 cm available.

2:47 Sol. Ht = 15.0 Counts #1 #2
70 72.5

2:55 Fill from #2 to avoid surge on emptying #3

2:58 Reading = 17.6 cm Counts #1 #2
82.5 83

Note: all counts have been made with Control 10 cm from surface of Sol.

3:09 Filling to 20cm

3:11 20.1 cm Counts #1 #2

3:25 Source pull – all instrument OK – came back to operating level.

3:26 Filling from #2 to 22.5 cm

3:27 Soln Ht = 22.6cm #1 #2
112 110

3:35 Draining backs into #1 cyl preparatory to blowing #2, 3, + 9 dry. adding approx 2.8 cm into #1 cyl.

3:50 Guard Change, Soln at 22.8.

3:55 Filling from #1 cyl to 25

3:56 Soln Ht = 25.2 #1 #2
Cd Rod out 20 cm 129.5 121

4:00 Cd Rod In. Filling to 27.5 cm from #1
#1 #2

4:06 Soln Ht = 27.6 cm 173 179.5
Cd Rod out 20 cm

4:13 Source pull shows a max at 18 cm Ht.

Safety Rod lowered giving about 3 cm of soln as value.

Counting #1 #2 } Control Rod In
106 109 } Safety " "
Temper In

4:20 Safety Rod only In } #1 #2
Temper In } 116.5 118.5

4:24 Safety Rod out. Control Rod In.
#1 #2
137.5 143.0

4:30 ~~Refilling~~ Adding 1 cm from #1 cyl

4:31 28.6 cm sol. #1 #2 } Control Rod out 20 cm
181.5 191

4:40 29.5 cm sol #1 #2 } Control Rod Out 20 cm
206 219

	Soln. Ht.	Counts #1	Counts #2	Cd. Rod out. Ratio c/c #1	Cd. Rod out. Ratio c/c #2	
	—	32.5	34.5	—	—	
Background	1.5 cm	29.5	30.0	—	—	
	5.2 "	84.5	34.0	.855	.883	
Source mound + 7.5 cm	5.2 cm	39.5	40.0	.811	.851	
	0.2 cm	32.0	34.0	~~.811~~	~~.851~~	
#3 cyl.	10.1 cm	57.0	56.5	.561 ~~.694~~	~~.861~~ .704	.601
#3 cyl.	12.8 cm	67.0	65.0	.477 ~~.585~~	~~.646~~	.523
	15.0	70.0	72.5	.457 ~~.565~~	~~.592~~	.469
#2 cyl	17.6	82.5	83.0	.388		.409
#2 cyl	20.1	92.0	94.5	.348		.360
#2 cyl	22.6	112.0	110	.286		.308
#1	25.2	129.5	121.5	.247		.281 Cd Rod out 20 cm
#1	27.6	173.	179.5	.185		.189
#1 Control Rod in Safety Rod in		106	109	.302		.312 *
Safety Rod only in Tamper In				.275		.287 *
Safety Rod out Control Rod In		137.5	143.0	.238		.233 *
	28.6	181.5	191.0	.176		.178
	29.5	206	219	.155		.155
	30.8	274.5	291	.1161		.1167
	31.2	313.5	327.5	.102		.104
	31.9	409.5	440.5	.0784		.0772
Control Rod In		258	273.5	.124		.124 *
	32.2	478	509.5	.067		.066

86
10/24/47

Exp 13

4:48 Sol Ht. 29.5 adding from #1 cyl

4:47 Sol Ht. 30.8 cm

#1	#2	
274.5	291	Control Rod Out 30 cm

5:07 31.2 cm

#1	#2	
313.5	327.5	Control Rod out 40 cm

Note: Solution added so that total addition equivalent to about 7/8 of control rod value.

5:17 adding from #1 cyl to 31.8

5:20 31.9 cm tamper worth about 1/8 of control rod

#1	#2	
409.5	440.5	Control Rod 45 cm out

Control Rod effect levelled off at 40 cm off surface.

5:33 Control In and Counts:-

#1	#2
258	273.5

5:36 Control Rod In adding 3 mm from #1

5:37 32.2 cm (3 mm equivalent to tamper motion

Control Rod 45 cm out

#1	#2
478	509.5

5:58 33.3 cm (Equivalent to 1/2 control Rod

#1	#2

5:59 33.3 Tamper down

Control Rod at 14.5 cm Red light of Prom monitor is on.

Exp 13 (Cont).

6:06	Source pull. With Safety Rod In Showed max at 24 cm equal to level before pulling at 30 cm.
6:15	Safety Rod out Source at 30 cm Control Rod In.
6:17	Tamper down part way
6:18	Source pull to compensate for lowering tamper
6:20	Tamper lowered down to within 1mm.
6:22	Source moved to 37.5 C rod pulled out slowly
6:23	Source at 47.5 C rod to
6:24	Control rod out Source at 50 – level falling
6:26	Tamper Raised Control Rod In Adding 1mm sol
6:28	33.~~4~~cm = Soln Ht.
6:32	Tamper down
6:40	Source pull – gradual drop in power level.
6:42	Adding 2mm sol.
6:43	Soln Ht. 33.6 cm
6:47	Tamper down
6:56	Control Rod 30.8 } continue to rise Source Out
6:59	Control Rod 30.6 } Slightly Supercritical Source Out very gradual rise Soln = 33.6 cm

Exp 13 (cont)

7:00 PM	Draining back into #2 cyl	15.0 cm equivalent in 7" reactor
7:15 P	" " " #3 "	15.1 " " " 7" "
	" " " #1 "	(Height to be measured 10/27)

7:27 P Counts.
Solution level = −0.1 cm

#I	28.0
#II	29.0

These values are suspect since stirring may have been started during return of the source ~~rod~~ through top tamper.

Dead Volume in #9

Exp. 13 (Cont)

Conclusions:

① 7" reactor, completely tamped, H/X ratio [redacted] = 24.3 was critical with 33.6 cm solution height with 3.6 cm of Cd control rod in tamper below surface of solution in reactor.

② This reactor, etc. was slightly subcritical at 33.4 cm solution height with Cd control rod completely removed.

③ Best estimate of height at criticality = 33.5 cm. (plus 3" bottom connection)

④ During part of experiment ~~for~~ in which multiplication data were taken source was 7.5 cm from bottom. It was found ~~as before~~ that the counting rate ~~reactivity~~ was a maximum (~~at near critical~~ at height ~ 32 cm) ~~at about 24~~ with source about 24 cm from bottom.

⑤ This reactor with H/X = 61 was critical at 30.6 cm - this H/X gives higher ~~to~~ solution depth at criticality -

11/17/48 DC

33.5 + 1.9 = 35.4 cm = H_c corrected for bottom -
H/U-235 = ~~24.35~~ ~~24.5~~ 24.4.
7" Stainless - Tamped
% X wtd - ~~0.4301~~ 43.01%
Sp. Gr. = 2.02
V_c = 8786 cm^3
= 0.8688 gm X / cm^3
M_c = 7633 gm.

Inter-Rees 10/27/47 Experiment 14

8" untamped.
$N_H/N_X = 29$

Solution Meas.

#1	#2	#3	#4	#5	#6	#7	#8	#9
70.1	82.6	81.8	M.T.	M.T.	M.T.	M.T.	M.T	78.2
36.6	22.6	23.5						27.5
33.5	60.0	58.3						50.7

#9 will fill dead volume
#1 will fill in the 8" cylinder ~~#1~~ ~~cm~~ 6.70 cm
#2 " " " " " " ~~#2~~ ~~cm~~ (11.56 / 11.56) 12.00 cm
#3 " " " " ~~#3~~ 11.65 cm
~~2+3=5~~ 30.3

8:00 Beck, Macklen McLendon, Fox.

Began removing 7" reactor and inserting 8" reactor.

Chamber #3 showed transients when other equipment was cut on and off the line.

9:00 Quinn and Lykins came in to check #3. a condenser was placed across the output which seemed to remedy the difficulty.

11:00 Visner came in, to complete the working quots.

11:30 Lunch

12:00 Quinn and Lykins left.

12:50. Check list completed. 8" reactor in place. Control rod in Safety rod out. Source 3" from bottom, No Tamper. #3 on scale of 100, #4 on scale of 10, #5 on scale of 5.

12:55

Solution Level	Counts/2 minutes Counter I	Counter II	Remarks.
Everything empty.	132. Co	138.	Source 3" from bottom. Safety
Recheck	132.	139.	rod out. Control rod in.

1:12 Emptying #9 into lead volume.

1:20 #9 empty. Check for zero solution level, leaks. Both OK.

		S/C.		
0.1 cm.	123.0	1.07	121.5	
1:34 5.0	70.5	1.87	69.5	From cylinder #1.
1:47 10.0 control rod in.	99.5	1.33	96.5	Cylinder #1 empty at 6.0. Adding from 2.
10.0 control rod out.	99.0		96.0	Source covered at 7.5 cm.
1:56 12.0 rod in	121.0		168.5	adding from #2.
2:01 rod out	119.0	1.11	112.0	
2:05 ~~14.1~~ 14.1 Rod out	133.0	.992	130.0	adding from 2.
2:11 16.0 Rod out	149.5	.882	142.0	adding from 2.
2:19 17.7 Rod out	159.0	.83	158.5	#2 empty at 17.7 cm.
2:27 20.0 Rod out	174.		162.5	adding from #3.
19.2 Rod in	171.		166.0	
19.2 Rod out	172.5	.765	165.5	
2:41 22.9 Rod out	185.0	.712	180.	adding from #3.
2:50 25.9 Rod out	200	.66	195	adding from #3.
26. Rod in	198.5		193.5	
3:03 29.5 Rod in	259.		250.5	three emptied.
Rod out	268	.492	250.0	here, after emptying appeared settled and steady,
3:16 Rod out	265		256.	the counting rate suddenly rose rapidly, and settled
3:27 Rod in.	307		303	at a new level. All instrument phones clicked.
Rod in.	312		312	The source appears to have shifted. This will be
in.	303		302	checked.
3:35 Rod out	302		306.5	

	Soln Level	#1	#2	
3:50	200 Rodact	238	557 240	10cm of solution withdrawn into #1. The high counts here indicate that the source — or something — has definitely shifted.
				Source was checked. No apparent shift could be seen
4:03	9.9 Rodact	111.5	118 108.0	material withdrawn into # 2.
4:13	9.9	113.5	109.0	
	Source raised 1 cm — Now 8 cm from bottom.			Repeating experiment
4:17	9.9. Rodact.	99.0	1,33 91.5	
4:20	15.0	163.5	808 155.0	adding from #2.
4:32	20.1	212.0	622 205.0	" " "
4:45	25.0	251.0	525 243.0.	adding from 1.
4:49	27.7	266.0	491 258.	"
4:54	~~29.7~~ 29.6	274.5	483 274.5	"
		276.5	272.0.	

5.01. Withdrawing Solution: 10cm (reactor level) into 1, 2, and 3 respectively.

5:20	0.1	131.	131.5
5:30	empty	135.0	134.5

1

Conclusion: 1) 29.6 cm of H/X = 24.3 in an 8" untamped cylinder does not become critical.

2) Extrapolation of the reciprocal multiplication curve leaves considerable uncertainty as to eventual criticality of long, untamped 8" reactor at this concentration. Shifting of the source to give a higher reading on the highest (most critical) point showed a dip toward the axis and criticality at maybe 40 cm Ht. But recheck showed this to be an error. Criticality may be achieved with higher levels, — or the curve may level off and fail to become critical at any extension.

C. Beck

11/30/48 DC

H/X = 24.4; δ_{49} = 2.02

$N_{Pu^{239}}$ X = 43.01 = 0.8688 gm/cc

H = 29.7 + 1.5 = 31.2 cm

V = 10.12 ℓ.

M = 8.79 kg.

NOT Critical ←

Estimated ∴ $M_c = V_c = H_c = \infty$

Experiment 15 10/28/47

8" tamped, N_H/N_x = ~~24.3~~

Personnel Cronin, Fox, Murray, Olson, Williams.

9:00 Installed end tamper and aligned.

Interchanged counters #3 and #4 with supplies.

Trip circuits: #3 set to trip at 88 on 100 scale
#4 " " " " 91 " " "

Instrument #3 on 100 scale
#4 on 10 scale
#5 on 2 scale
Red Electrometer on 25 scale
} at start of Exp.

10:02 Background Count (system empty) (source approx. 8.5 cm from bottom of reactor.)

(50). Level)	#1	#2
0	~~30~~28	~~30.5~~29

10:10 Start filling dead vol from #4

Filled to 1 cm in 10 min. at 10 #psi

10:25 Drained back to 0 level into cyl. #3

10:32	50). Level) -2 mm	32 31.5 31.0 } 31.5 Av.	~~28~~ 31 30.5 (rechecks)	30.5 Av.

10:44 Filling from #3 B/C

10:55	5.0 cm.	29.5 (1.067)	27.0	(1.13)
11:05	11.0 #3 empty	65.5 Rod out 45.5	60.0 60.0 rechecks.	

11:15 Filling from #2

9/10/28/47

	Sol. Level	#1 counts	B/L	#2 counts	B/L
11:25	13.0 cm	91.0	(.346)	85.5	(.357)
11:40	14.5	113.5	(.278)	110.5	(.276)
11:50	16.0	159.0	(.198)	155.6	(.197)

Vibrating Reed Electrometer shows a Downward Drift. (Inst. instability ?)

12:12	17.0 cm	199.5	(.158)	191.5	(.159)

~~(Value of control R. = .6 cm 30).~~

12:18 Filling from #1 storage Cyl.

12:24	17.9	269.0	(.119)	254.5	(.120)

Value Cont. R. = .6 cm.

12:38	19.0				
	Value Cont. R. .6 cm.	379	(.088)	382.0	(.080)
1:04	19.9	690 approx.	(.046)	735.5	(.041)

Value of Cont. Rod .5 cm

Raised source to lower power level. (no max)

1:25 20.5 Raised control rod slowly to 45 cm. Not critical. source at 24. cm from bottom.

1:40 20.8 Raised control Rod slowly to 55 cm. Not critical. Source varied in Height — stopped at ~~24~~ 26 cm.

1:53 20.95 cm. Sol. Raised control rod slowly to 60 cm. not Critical. Source at 37 cm.

2:03 21.0 cm. Critical with control rod at 16 cm. Source out to 100 cm.

Conclusions:

Best estimate of Critical height of 24.3 N_4/N_x solution in 8" tamped reactor = 20.95 cm. Extrapolation of curve with last point at 20 cm leads to 21.2 cm; curve very straight for last 5 cm or so.
Instruments worked well except for #1, which failed to turn over 100's, late in experiment.

Drained back:

~~#0~~

#1 Had 5 cm, now 10 cm in it.

#2 " 7 cm now 10 cm in it.

#3 ~~11 cm~~, now 11 cm in it

#4 dead volume less 1 cm on gage drained it to it

11/17/48 dc*

20.95 + 1.45 = 22.4 cm = H_c corrected for bottom-

H/x = ~~24.35~~ 24.4

8" Stainless, tamped

Sp gr = 2.02

Wt % X = ~~0.4301~~ 43.01 ≡ 0.8688 gm X/cc

V_c = 7264 cm^3

M_c = 6310 gm

5:00 Cd shuting wrapped around outside of 8" reactor and securely fastened with bolted straps. (aluminum straps)

5:35 Nickel evaporating pan pickled in dilute acids until clean after Ni Value had been installed.

* 3/3/49 - dc Assuming the 8" short S.S. cylinders to have been in error due to short 3" section of pipe, a 1 cm slight glass correction is being made -

∴ 20.95 + 1.45 + 1.0 = 23.4 cm = bottom corrected Height.

V_c = 324.2 × 23.4 = ~~7588~~ 7586 cc

M_c = 6590 gm

Experiment 16.

8:10 Beck, Cronin, Fox, Moffitt.

10/29/47

8" tamper with Cadmium Shelf.
Top tamper contains — gms cadmium shot. No cadmium on bottom except as end of shelf folded under to the 3" connection

Preparations for 8" tamped, shielded.

Instrument check:

Outside tamper full	Counter	#1	#2	Source 8 cm from
Top tamper at 10.5 cm		28	25	bottom.
		28	28	

Instrument #4 on 10 scale; #3 on 100 scale, #5 on 2 scale, Reed on 25 scale.

Top tamper at 10.5 cm.

storage
Top on, Values
Cronin on instruments
Moffitt on solution controls
Beck, Chief - recorder.

10:32 Filling ~~top~~ lead volume from #9.

	Solution level	Counter 1	Counter 2.		
	Everything empty	28	25		Source 8 cm. from bottom
		28	28		
10:46	0.6 cm.	25	26	b/c	
		27.5	25	1.21	
10:49	adding from #1.	~~21.5~~	~~21.5~~		~~#1 empty at 9.0 cm. adding~~
	5.0 cm	21.5	21.5	1.18	
10:59.	adding from 1 - empty at 9.0. adding to 10 from #2.				Source covered by solution at
	10.0 cm.	25.0	22.0	1.16	~ 8.5 cm.
11:07	adding from 2.				Solution reached top tamper
	14.3 cm.	33.0	31.0	.823	at 10.5 cm and thereafter
					remained in contact.
	17.0	39.5	37.0	.69	
11:24 ~~13~~	#2 empty at 19.3, adding from #3				
	20.0	44.0	44.0	.58	
				.55	
		50.0			
11:31	22.5	~~50.~~	48.0	.53	

11/30/48 DL - 8" Stainless Tamped, Cd shielded -
H/X = 24.4; ρ_H/ρ_X = 2.02
With ρ_H/ρ_X = 43.01 = 0.8688 $ in/cc.
H = 29.3 + 1.5 = 30.8 cm
V = 9.99 ℓ.
M = 8.68 Kg
→ Not CRITICAL ←
Estimated: H_c = 47 cm.
V_c = 15.24 ℓ.
M_c = 13.24 Kg

	Solution level	Counter #1	Counter #2	B/c
11:44	25.0 cm	56.0	52.0	.492
11:50	27.3	63.0	60.0	.425
11:58	29.3	65.5 / 65.0	64.0 / 64.5	.398
	0.0	27.5	27.0.	(solution filling dead volume
	Everything empty.	28	27.5	

Solution Drain-back:
Cyl #1 - 9 cm
" #2 - 10 cm
#3 9.3 - Dead vol into #9

Conclusion.
1) The data appear to be entirely consistent and reliable.
2) at H/X = 24, 29.3 cm height, in tamped cadmium enclosed 8" cylinder doesn't become critical
3) Extrapolation of the curve indicates criticality would not be achieved at infinite, or at least much beyond 30 cm, extension.

G. Beck.

Lunch

Beck & Crompton removing 8" cylinder installing 9" cylinder — Cadmium covered, with the idea that this will be the first experiment tomorrow
Fox & Norfitt installing a 4" storage cylinder in place of #7 tank.

9" cylinder cadmium sheathed installed, top tamper cleaned and positioned for operation.

Cadmium strips removed from 8" top tamper and washed
8" top tamper washed with dilute nitric acid.

Dump pan cleaned and rinsed out with distilled water — rinsings to be reserved due to possibility of Cadmium determination
3 Curie source removed from its present holder, and tried in the new source holder
New source holder to be returned to shop to enlarge inside hole.

Experiment 17 10/30/47 9" cylinder, tamped, $N_4/N_x \approx 24, 35$

Cd shielded on sides, top (by shot) and some on bottom by virtue of folding.

8:20 Murray, Cronin, Olson, Fox, Morfitt

Williams procured Cd shot and had new source holder drilled out to accomodate source. New source assembly weighed 425 gms. (wax sealed into 8 steel torpedo)
End tamper removed; Cd shot, washed in nitric to remove smaller particles, put in; tamper replaced. – 750 gm used

Infra-red heat lamps put near soln. cylinders 1, 2, 3 to reduce solution viscosity.

9:40 Olson working on instruments

Source fixed position 7 cm above bottom.

Heights at which cylinders go empty (approx.)

#1	7.1	cm.
#2	7.9	"
#3	7.3	
#9	Dead Vol.	

11:00 Inst. Check: Trip points:
#3 – 88 on 100 scale
#4 – 84 " " "

11:05 Zero count #1 25.5 – no sol. in.
#2 26.5

11:10 Instr. #3 on 100 scale
#4 on 10 "
#5 on 2 "
Reed on 25 "
Process mon. on.

Min. End Tamper Position 12 cm.

11:17 Started filling dead Vol. from #9

Solution level	#1 counter	#2 counter	B/c
11:35 0	28	27	1
Filling from #3			
11:45 5.1	21	1.33 20.5	1.32

#3 empty at approx. 7cm switched to #2 cyl.

	Sol. level	#1 counter	B/C	#2 counter	B/C
11:55	8.0	21.5	1.30	20	1.35
12:03	10.0	26	1.08	25.5	1.06
12:14	12.5 (Tamper now in contact with sol)	35.5	.790	33.5	.806
12:23	14.5	42.5	.66	42.0	.693

#2 Empty at approx. 15.3 cm. changed to #1 cyl.

12:35	17.0	54.0	.52	54.5	.99
12:43	18.5	62.0	.45	61.0	.44
12:48	20.1	73.0	.384	76.0	.355

Gamma activity high relative to neutron activity due to presence of cadmium.

12:57	21.0	81.5	.344	81.5	.352
1:00	22.0	~~88.0~~	~~.320~~ .318	92	.294
1:08	23.5	104	.270	109	.248
1:25	22.7 Drawing	94.5	~~.300~~ .296	~~94.5~~ 97.0	~~.280~~ .278

With sol. level at about 22 cm a test was made of the effect of moving the source up and down. A wide plateau was found to exist over which moving the source had no effect. Only near the top and bottom was there any falling off in multiplication. 7 cm from the bottom seems to be near the center of the plateau.

1:40 Drawing:

#1 — 7 cm
#2 7.7 cm
#3 8.0 cm

~~[redacted]~~

1:45 Background Count on drain tracks

zero level of sol.

#1	#2
25.5	27.0
25.0 (26) av	26.5 (27) av.
27.0	27.0

Conclusions on Experiment 17.

1. Not critical at 23.5 cm height.
2. Instruments good, reproduced background.
2. Linear extrapolation indicates that 9" tamped, Cd shielded reactor would be critical at around 30.5 cm. $n_H/n_x \simeq 24$.

11/17/44 JC 31.5 + 1.15 = 32.7 cm = Hc corrected for bottom — Estimated, Reported as >32 cm.

9" Stainless. Tamped + shielded. by Cd.

H/x = ~~24.35~~ 24.4

$\rho_H/\rho_x = 2.02$

Wt % X = ~~0.4301~~ $\frac{43.0}{}$ ≡ 0.8688 gm^x/cm^3

V_c = ~~13420 cm^3~~ > 13.1 ℓ.

M_c = ~~11659 gm~~ > 11.4 kg.

Actual measurements Not Critical

H = 23.5 + 1.2 = 24.7 cm.

V = 10.13 ℓ.

M = 8.80 kg.

(10/30/09 ?
DC-

Experiment 18 H/x = 24.35

Untamped 9" Reactor

Personnel: same as Expt 17

Background- #1 #2 Sol. at zero level
141 149.5
(140) 139.5 147.5 (149)
140 149.5 Source at 7 cm.

Instr: #3 on 100 scale, #4 on 20 scale
#5 on 2 scale. Int. Read on 100 scale
Control Rod not used because of result of Expt. 17

2:29 Start filling from #3

	Sol Level	#1 Counter	B/c	#2 Counter	B/c
2:33	5.0	87.5	1.60	93.5	1.59
2:38	7.6	101	1.385	104.	1.432

#3 Empty at 8.9 cm Filling from #2

2:43	10.0	152	.922	155	.962
2:50	12.5	212.5	.660	220	.678
2:56	13.9	294	.574	254	.586
3:01	16.2	301	.965	310	.480
3:06	18.0	339	.414	351	.425
3:11	19.1	361	.388	380.5	.392
3:16	20.0	389.5	.360	399.5	.373
3:21	21.0	405.5	.346	428.0	.348
3:25	22.0	425	.330	450	.331
3:30	22.9	446.5	.314	475	.314

Time	Height	#1 counter	B/C	#2 counter	B/C
3:37	23.7	961	.304	993.5 997	.304

Conclusions on exp 18

1. Not critical at 23.7 cm height
2. Less reactive untamped than with Cd shielding; extrapolation (which is not especially accurate) leads to a critical height of about 40 cm.
3. Next test should be 9" Tamped.

Drawback: #1 — 8 cm of 9" reacta vol.
#2 — 8 cm of 9" reacta vol.
#3 — 7.8 cm of 9" reacta vol.
#9 — Dead Vol.

Final Background.

#1 139.5
#2 198.0

→ 9" Untamped — Not critical —

11/30/48 H/X = 24.4, $\mu\rho$ = 2.02
Wt% X = 43.01 ≡ 0.8688 gm X/cc
H = 23.7 + 1.2 = 24.9 cm
V = 10.22 ℓ.
M = 8.88 Kg
Estimated — probable ∞ slab
Hc > 45
Vc = 18.5 ℓ.
Mc = 16.1 Kg.

10/3/47 Experiment 19- 9" Reactor - tamped.

H/x = 24-35

Personnel: Macklin
Visnes
Fox
Mclendon
Callihan.

J.C - 201
S.V - 22,
D.M. 16.
J.M. - 19.2

8:30a No record found of activities of 10/31 - also no personnel contamination - inside of tamper tank found very active so is being decontaminated.

9:00 Instrument checked

9:15 on 100 scale # 3 trips at 85
4 " " 83

Top tamper limit switches set so: ① upward motion is limited when tamper is ca 1" above top of reactor
② downward motion allows source to be surrounded by tamper for better background counts.

Top tamper alignment tested at one complete range of motion for face plate of safety rod - It was found that horizontal angle, as usually clamped at top of tamper, should not be so clamped.

a steel horizontal rod was attached top tamper indicator connector to act as a guide for source to insure its return through tamper.

Re: location of source in new source holder - Williams estimates source is 1/3 of length from bottom - length is 13 cm. ∴ source is ca 4 cm from bottom -

Source positioned so its bottom is 2 cm from from reactor bottom, i.e. at 9.3 on scale - therefore source is 6 cm from reactor bottom.

12 noon Step motor for counter no 2 repaired by Barthen.
V-263's tested - Calibration of two - OK - #263-19 found inoperative. To be sent to Y-12.

12:10 Exit Fox.

12:20 Background. I - 17.0 II - 18.0

12:21 Filling from cylinder # 9
Chamber pressure by: 431 / 100 #4 X 10

12:37. Emptied # 9.

	Liquid Heights cm.	#1 c/2 m.	$\frac{C_o}{C}$	#2 c/2 m	$\frac{C_o}{C}$
		Cd control rod out			
12:42	0.8	20.0		19.5	Background.
		20.0		20.5	
12:50	Filling from #3.				
12:55	1.9	Position of top tamper checked with liq. level. OK			
		21.0	0.95	22.0	0.91
1:03	5.0	32.0	0.63	29.0	0.69
1:13	6.6	37.0	0.54	39.0	0.54
	Filling from #2	about 1.2 cm worth left in #9			
1:25	7.6	44.0	0.45	43.0	0.47
1:35	9.0	54.0	0.37	53.5	0.37.
1:42	10.0	62.5	0.32	61.0	0.33.
1:53	11.0	73.5	0.27	74.0	0.27
2:03	12.0	92.5	0.22	89.0	0.22
2:13	13.0	113.5	0.18	110.5	0.18
	Filling from #1	about 1.6 cm left in #2			
2:22	14.2	153.5	0.13	156.5	0.13
	Safety Rod marked;	For admitted also control rod in.			
2:37		123	.16	126	.16.
	control rod out.	safety rod in.			
2:40		129.5	.15	131.5	.15
	control rod in	safety rod out			
2:45		143.0		144.6	
2:50	15.2	206.0	0.10	208.5	0.1
	Source line found on W side of quick rod & corrected by placing on E side				
3:10	16.2	Process Monitor light on ~ 9.2 on Microvolt.			
		358.5	.06	373.0	
		357.5		371.0	.05

	Liquid Height cm	# 1 c/2m	# 1 $\frac{C_o}{C}$	# 2 c/2m	# 2 $\frac{C_o}{C}$
3:20	16.7	537.5	0.04	561.5	0.035

Source raised ~ 6 inches, and reactivity fell. Original position apparently gave higher reactivity. Solution level is 16.5 cm. due to displacement of source added two nos.

3:53 16.7 source jerk. rdout n.g.

4:01 16.9 source jerk. rdout n.g.

The procedure is as follows at this pt: Cd control rod inserted, top tamper raised, solution added, top tamper lowered, control rod withdrawn,

410 17.2 Bottom ∇ control rod, 0.3 cm. above solution level.

This is critical

11/17/48 DC

17.2 + 1.15 = ~~18.35~~ 18.4 cm = Ho corrected for bottom -

H/x = ~~24.~~ 24 ~~25~~ 4

9" stainless, tamped.

Wt% X = 0.4301 = 0.8688 gm x/cm³

Sp gr = 2.02

Vc = 7551 cm³

Mc = 6560 gm.

Conclusion:

① The 9" cylinder, water tamped, is critical at a height ∇ 17.2 cm with solution ∇ H/x = 24 with the bottom of control rod almost even with the top of the solution

② a height ∇ 16.9 cm. was not critical with the control rod all the way out.

③ Lowering the top tamper one inch & the portion ∇ fissile with top ∇ solution is equivalent to adding 2 cm ∇ solution

Drain back. # 1 - 8 cm ∇ 9" reactor vol.

2 - 8.1 cm ∇ " " "

3 - 8.5 cm 8.5 " " "

9. - Full dead volume.

0.8 cm. Background. # 1 - 20.5 # 2 - 20.0

21.5

Filled 10" top tamper with water after adding 900 gm cd shot.

11/4/47

Experiment #20

10" Reactor. Cd shielded, H_2O tamped, $H/X \tilde{=} 24$.

Personnel: Fox
Williams
Callihan

AM: Installed 10" reactor, Cd sheet. Cd shot in top tamper. Some difficulty with alignment - corrected, top tamper had to be filled to allow free motion of safety rod.

Instrument Man has wired chart drive recorder #3 by-pass clutch.

Trip levels set - #3 85 on 100 scale
#4 92 " 100 "

Source placed with bottom of container 2cm from bottom of reactor i.e. source is 6 cm from bottom of reactor.

Zero count to be taken with top tamper surrounding source.

Re solution in storage cylinders: #9 Has dead volume
#3 " 6.8 cm in 10" reactor
#2 " ~~6.5~~ 6.5 " " " "
#1 " 6.4 " " " "

Control rod in H_2O - of little value - but may be used as indicator of completeness of shielding.

1:40P Instruments checked
#3 - 100 scale
#4 - 10 scale
#5 - 1 scale
Rec. - 25 ma scale.

1:55 Background counts - #I 13.5 13.0 @/2 m
#II 13.0 13.5

2:10
~~2:07~~P Started filling dead volume from tg (10# air). (Renew paper - recorder #4).
2:15 Dead volume filled.
CK's for leaks - bottom of reactor.

Exp #20 (cont).

		Counts #I	Counts #II	C/c #I	C/c #II	
2:20 P	H = 0.7 cm	15.0	14.5			tamper at bottom & reactor surrounding source
		14.5	14.5			
2:28 P	H = 2.0 cm	15.0	15.5	1	0.94	
	tamper - 32 mm.					
2:35 P	Back in.					
2:43 P	H = 5.0	19.5	19.0 +8.	0.14	0.76	
2:48	#3 empty at H = 5.9 cm					
	Filling from #2.					
2:55	H = 7.5 cm.	25.5	25.0	0.57	0.58	
3:04	H = 9.0 cm.	30.0	31.0	0.48	0.47	
3:13 P	H = 10.5 cm -	37.5	37.5	0.39	0.39	
	Filling from #1.					
3:24	H = 11.5 cm.	42.0	42.0	0.35	035	
3:35	H = 13.0 "	52.0	52.0	0.28	0.28	
3:45	H = ~~5~~ 14.5 cm.	64.5	66.5	0.22	0.22	
3:55	H = 16.0	80.5	84.5	0.18	0.17	
	Back left					
4:10	H = 16.0 -	75.0	80,0	0.19	0.18	Safety rod in.
	Filling from #2.					
4:20	H = 17.5 cm	111.0	114.0	0.13	0.13	
4:27	H = 17.8 #2 empty.					
	Filling from #1					
4:35	#1 empty					
	H = 18.7	145.0	154.0	0.10	0.09	
4:50	"	118.5	129.0	0.12	0.11	Safety rod in
4:55	"	142.0	153.0			Control rod out
4:57	Drain back -					
	Data #1 — 6.5 cm equivalent 10" reactor					
	" #2 — 6.4 " " " "					
	" #3 — 5.7 " "					
	" #9 - Dead volume -					
5:40	H = 0.6	15.0	14.5			

Exp 20 (Crit)

Conclusions:

10" reactor - H$_2$O tamper - Cd shield -

① Not critical with max. amount of solution available - i.e. 18.7 cm.
② Multiplication curve appears to extrapolate to a critical height ≅ 22.5 cm.
③ At maximum reactivity ('/hr = 0.1) safety rod ≅ 0.8 cm solution.
④ Cd control rod in tamper outside shield has no value -
⑤ Top tamper fairly valuable - makes effect of Cd shield questionable. DC 11/4/47

It was decided to not use new 4" storage cylinder because to do so would require additional solution to fill its "dead volume" whereas those of #1, 2, 3 + 9 are already filled.

Things done:

① Cd removed from reactor + tamper - tamper cleaned + filled for use with in tamped 10" Exp.
② Control rod reposition - into reactor -

11/17/48 DC $\cancel{22.5}\ \cancel{27.5} + 0.9 = \cancel{23.4}\ \cancel{28.4}$ cm = Hc corrected for bottom - estimated

10" Stainless, tamper, shielded by Cd.

H/8 = ~~24.35~~ 24.4

Wbl % U = ~~0.4301~~ ≡ 0.8688 gm U/cm^3

Δρ gm = 2.0 ~

Vc = ~~14387~~ cm^3 11.9 ℓ

Mc = ~~12499~~ gm 10.3

Actual measurements

H = 18.7 cm + 0.9 = 19.6 cm.
V = 9.93 ℓ.
M = 8.63 kg.

Experiment 21. Nov. 5, 1947. 10" $H/x = 24$.

Beck for Moffitt — Untamped

8:15 Beginning check list.
Trip points #3, 85 on scale 100
#4, 90 on scale 100.

Quatrument settings
#3 on 100 scale
4 " 10 scale
5 " 2 "
Reed " 25.

8:50:	Solution Levels	#1	#2	C/S.		
	Background"	133	126.		Source within 2 cms of bottom	
		126	128		Untamped. No solution.	
		124	128.		Control rod in.	
		126.5				
9:02	Filling dead volume from #9.					
	"Zero count"					
	1.0 cm	110.	111.0		Control rod out on all readings.	
	adding from #1.			I	II	
	4.0	80.	79.5	1.38	1.39	
	#1 dry at 6.1. Adding from #2.					
9:28	8.0	101	99.0	92 ~~1.09~~	.89	Source covered w 6.5 cm.
9:35	10.0	142	143	78.	.77	
	#4 to scale of 20. adding from 2.					
9:48	12.0	194.5	193.5	.57	.67	
9:55	#2 dry at 12.5 Adding from #3					
10:00	#4 to scale of 50	#5 to scale of 5		Reed to 50 scale.		
	14.0	252	252	.44	.44	
10:10	16.0	310.5	313	.36	.36	
	17.5	365.0	377.	.31	.295	
10:21	18.5	401.5	409.	.275	.270	
		403.5	~~4~~			
		396.	387	.280	285	Rod in (Control)
	1 ⊙ Background	111	107	OK		

Conclusions:

1. 10" reactor, at height 18.5 cm, H/x ratio of 24, Untamped is not critical
2. 10" Untamped is less critical than when Cadmium coated and tamped

Drain Bath:

Auto #1 6.5 cm from 10" reactor.
#2 6.5" " "
#3 6.

11/30/48 DC

H/x = 24.4, δ_{ff} = 2.02

What % x = 43.01; ≡ 0.8688 gm x/cc

H = 18.5 + 0.9 = 19.4 cm

V = 9.83 ℓ

M = 8.54 kg } Not Critical —

Estimated: Hc = 28 cm

Vc = 14.2 ℓ

Mc = 12.36 kg —

17

Experiment # 22. 10" Reactor — Tamped.

H/x ≅ 24

Back
For
Moffett.

#5 on 2 scale
#4 on 10
#3 on 100.
Reed on 25.

Top Tamper in position. Check list complete

	Solution Levels	# 1	# 2	Ratio #1	Ratio #2	Comments
11:24	0.0 "Background"	15.0	15.5			Top Tamper down, Source 1.5 cm from bottom
11:31	adding from #1.					
	2.9	21.5	19.5	.70	.80	Control rod out for counting
	5.8 (#1 empty).	31.0	31.0	.48	.50	
11:49	adding from #2.					
	8.0	47.5	47.5	.32	.32	
	Reed changed to 50 scale.					
11:58	adding from #2					
	10.0	77.0	76.0	.20	.20	
12.08	adding from 2.					
	11.0	98.0	99.5	.155	.15	
	#4 changed to 20 scale.					
12.16.	adding from #3					
	12.0	154.5	155.5	.097	.1	
	Change 5 to 5 scale. change 4 to 50.					
12.28	adding from 3					
	12.8	205.0	206.5	.073	.07	
	Reed on 200 scale					
12:42	13.5	345.5	349.0	.043	.044	
	#5 on 10 scale,					
12:50	13.85	545.0	558.	.027 ~~.035~~	.027	
	#4 on 100 scale. Reed on 500. #5 out of paper.					
		457	461	.033	.033	Control rod in.
		118.5	120.	~~.084~~ .127	.129	Top tamper at 33.5 — 20 cm control rod in from Soln level.
		126	129.	.119		" " " " Control rod out
12:58	Best estimate of Criticality = 14.4 ±.1 cm.					
1:30	"Zero" 0.0 level	15.5	15.0 — OK.			

Conclusion:

10" Tamped reactor H/x = 24 is critical at 14.4 ± .1 centimeters

Drain back.

#3 has equivalent of 6. cm on 10" reactor
#2 " " " 6.5 " "
#1 " " 6.5 " "

Final Background Count #1 - 14 #2 14.5

Measurement of solution height preparatory to dilution: (entered by DC 11/7).

	#1	#2	#3	#4	#9	
h_1						
h_2						
Δh	45.3	37.0	43.8	44.7	28.3	cm manometer liquid
$\times \frac{2.96}{2.02}$	66.4	54.2	64.2	65.5	41.4	cm solution — H/x = 24.
H$_2$O added to give H/x=30	690	560	670	680	430	cc. (= 0.22 cc H$_2$O/cc sol).

11/17/48 DC

14.4 + 0.9 = 15.3 cm - Hc corrected for bottom.
10" stainless tamped.
H/x = ~~24.35~~ 24.4
Wt % x = ~~0.4301~~ $\frac{43.0}{}$ = 0.8688 gm x/cm^3
Spg = 2.02
V_c = 7751 cm^3
M_c = 6734 gm

Exp #23a 10" reactor $N_H/N_x \stackrel{?}{\simeq} 30$ tamped 11/6/47

Personnel – Fox
Moffett
Murray

8:10 Checking instruments, etc.

8:40 Tamper water level went too high (drain hose blocked with air).
Siphoned out water in reactor, dumped valve and rinsed reactor.

		Scale
9:20 trip # 3 – 87 on 100	#5	2
#4 – 82 on 100	#4	10
	#3	100
	reed	25

9:23 Count – no. soln #1 – 18.0
#2 – 14.0

#1 – 14.0
#2 – 14.0

Check of soln heights:

Cylinder	L	H	ΔH	depth in 3" ($=\Delta H \frac{2.96}{3.90}$)	depth in 0"
1	77.4	28.3	49.1	76.6	6.9
2	77.1	28.6	48.5	75.6	6.8
3	77.3	28.6	48.7	75.9	6.8
4	78.2	27.5	50.7	79.0	7.1
9	68.5	37.7	30.8	48.0	4.3

9:30 Filling dead vol. from #2

time	reactor level	#1	#2	B/c #1	B/c #2	comments
9:45	0.3 cm.	15.5	15.5			
		16.0	16.0			
		16.5	16.0			
	ave	16.0	16.0	1.0	1.0	
9:54	filling from #2 yet. found bubbles in sight line. so recheck zero					
9:57	0.0	17.0	16.0			
		16.0	15.0			
		16.5	15.5	1.0	1.0	
	filling again from #2					
10:05	1.0	#2 empty				
	filling from #9					
10:17	2.6	19.5	17.5	.85	.89	
10:20	Dump valve accidentally opened - soln. dropped. The catch on the valve is not very tight because of gasket compression being less than originally. Should be repaired. Did so by putting in additional gasket. ("Pg Moffett says these washers were put into #2 & #9). (also about 2 L distilled H2O were added) DC					
12:00	Ready to go again, after getting solution back in storage cylinders.					
12:10	no soln	22.5	23.0			
		21.5	22.5			
12:13	filling from #2					
12:30	0.0	15.5	14.5			
		15.0	15.0			
	assume	15.0	15.0	1.0	1.0	
12:40	filling from #2					
	1.1	#2 empty				
12:41	filling from #9					
	Trouble with tamper - soln. level. Drained back to zero, looked in.					
2:20	Back at it again. Filling from #9.					
	0.0	15.0	15.0	1.00	1.00	
2:30	2.4	17.5	18.0	.86	.83	
2:35	4.9	26.5	26.5	.57	.57	
2:40	6.5	35.5	35.5			
	7.6	#9 empty				

time	reactor level	#1	#2	B/C #1	B/C #2	
2:50	7.8	49.5	51.0	.30+	.295	
2:54	Filling from #3.					
256	9.0	64.0	66.0	.234	228	
3.02	9.95	73.5	78.5			
		74.0	80.0			
		ave 74	79	.203	.190	
	Added a little soln, level rose to 108cm. Count on #3 did not seem to correspond, so blew through, found level at 10.0 only. Apparently, levels as indicated on # 256 and 302 are actually					
325		~~97~~	~~92.0~~			
	10.0	92.0	97.0	.163	.155	
	dropped soln back to 9.0 to recheck points					
328	9.0	67.5	69.0	.222	.217	tamper hits soln when pointer is 0.4 above level on sight glass
335	~~10.0~~ 9.9	87.0	91.0	.172	.165	"
350	10.8	102	107	.147	.140	
4.15	11.1	107.5	107.5	.139	.139	
4 25	10.5	84	84.5	.179	.177	
~~4~~ 30	10.9	98	99	.153	.151+	
4 37	11.7	120	126.5	.125	.119-	
~~4.38~~	Feeding from #1 (#3 not empty, but to avoid bubble)					
~~4.45~~	12.6	163.5	168	.092	.089	
455	13.2	184	195	.081+	.077	
510	13.9	271	281	.055	.053+	
520	14.3	335	356	.045	.042+	
530	14.9	417	449	.036	.0358	tamper hits soln when pointer is 1.9 below level on sight glass
555	Draining into #1.					
	Stopped at 11.0					
6:05	Draining into #2.					
	stopped ~~4.0~~ 3.9					
620	Draining into #3					
	Stopped at 6					
620	Draining dead vol. into #9.					

Data on discrepancy between pointer and liquid height in sight glass:

h_s	h_t	$\Delta = h_s - h_t$
14.9	13.2	1.7
13.5	12.3	1.2
12.5	11.7	0.8
11.5	11.0	0.5
10.0	9.6	0.4
7.5	7.1	0.4
3.9	3.5	0.4

Conclusions: Critical height probably 16-17 cm. 10" tamped at $NH/N_x \simeq 30$, but progressive discrepancy noted between tamper position and sight glass. Question validity of data.

11/24/47

Macklin
Morfitt
Callihan

Examination of reactor showed
① Reactor cylinder vertical
② Top tamper rigidly attached to its support.
③ Bottom surface of top tamper plane but not horizontal by about 2cm across diameter – this corrected by making connecting tube at top ⊥ to top surface (which, incidentally was the cause of the trouble).

Sp. gr of solution from #9 storage cylinder = 1.66
" " " " " " #2 " " = 1.69

2 Samples for HX determination taken from #2:

	Dish L6	Dish L1
Gross	12.0736 gm	12.5365 gm
Tare	6.0791 "	6.8455
	5.9945 gm	5.6890 gm

Measured solution heights in storage cylinder:

	#1	#2	#3	#4	#9
h_1	80.2cm	75.3	76.4	78.6	74.2
h_2	25.2 "	31.0	29.4	27.2	32.2
Δh	55.0	44.3	47.0	51.4 81cm	42.0
$\times \frac{2.96}{1.66}$ =	~~60.8~~ 97.0	~~48.9~~ 78.0	~~54.8~~ 91.2	~~56.8~~ 90.6	~~46.4~~ 74.0
$\times \frac{46.9}{(5)^2(2.54)^2\pi}$ =	~~5.6~~cm 9.2	~~4.9~~ 7.4	4.9 8.7	~~5.4~~ 8.6	~~4.4~~ 7.1 cm in 10" reactor

—

On 11/5 it was desired to dilute the solution. When at HX ≅ 24 to an HX ≅ 31. This was done by adding 0.22 gm H_2O to each cc of solution – However at HX = 31.0, sp gr = 1.90 (see pg 15-18) Therefore present HX = 40-45. (See next page →).

Calibration of tamper position indicator & its zero were checked.

NG [illegible]

11/7/47 Experiment 23 b- $H/X \cong 40$ (same as 23a).

Macklin — Completely tamped.

Moffitt — 10" reactor-

Callihan. To redo Ex 23a which was uncertain because of apparent difference between levels measured with sight glass + tamper position —

2P. #3 strip chart 86 on / #4 " 84 — #3 100 scale / #4 10 " / #5 2 " / Rod 25 "

2:20 Instruments checked, red light - etc. — #I Counter - 14.5 / #II " - 13.0

Fill dead volume from #9

Time		Counter #I	Counter #II	C/c I	C/c II
~~2:34~~	Dead vol				
2:39	H = 0.3 cm	15.0	14.0		
	H = 0.8 #9 empty.				
	= 0.7 after blowing out sight glass.				
2:46	Filling from #1				
2:59	H = 2.4 (glass) [= 2.1 tamper]	22.0 (?).	15.5		
		17.0	16.0	0.88	0.88

Ck of level indicated by glass + tamper poor — blew back through sight glass very energetically. Levels agree to 1 mm (bottom of miniscus). Observation of contact point through source hole confirms tamper position value of level.

Time		Counter #I	Counter #II	C/c I	C/c II
3:49P	H = 4.5 cm (tamper ✓) ✓ after blowing	25.5	25.0	0.59	0.56
3:59	= 7.5 cm (6.2 by tamper).				

These differences could be caused by density variations in sight glass column + reactor or decided to measure density of solution from Cylinder #1 which is now being added:

Cylinder #1 - sp gr = 1.89 which is what whole lot was supposed to be

[illegible] Sp Gr #3 [illegible] 1.80 ([illegible])
" #4 " 1.88 (" " ")

On 11/6 no solution #4 was ~~not~~ used —
all " #2 + #9 was removed therefrom —
from #3 about 2.7 cm (10" reactor) was used.
" #1 " 3.2 " " "
(Cont.)

On 11/5

Soln #1 was returned essentially what was removed. Balance of solution was then pulled into #2, #3, & #9 in that order.

It is apparent that the deviation of the density of each cylinder from the 1.90 expected from the dilution on 11/6 is ~~~~ is in the order & estimated from the amount of solution used from that ~~solution~~ cylinder.

Comparisons have been made of the volumes of solution at the following times:

① afternoon 11/5 prior to dilution (+H2O added).
② morning 11/6 after tamper overflow
③ " 11/7 " addition of pan washings on 11/6 after following dump valve accident –

These show ca 1.7 L of H2O added to solution inventory by dump pan washings and <100cc added by tamper overflow. The 1.7 L were put into #2 & #9. ~~~~ This reduced the concentration in #2 & #9 to H/U ≅ 40-45 & changed its density appreciably & cause the difference between sight glass & tamper values of level – due in turn to inhomogeneous solution. (1.7 L checked by recollection of amount of wash water used).

5:30P Drained back into #8 – 7.6 cm → 0.1 cm; ca 7.5 cm of 10" reads.
" " " #9 = dead volume.

Things to do next:

① Sample #8 & #9 for sp. gr.
② Boil down contents #8 & #9 to sp gr ≅ 1.92.
③ Mix all solutions for homogeneity.

DF 11/7/49

11/10/47

Sp. G. · Measurements

		Volume → ΔH
Cyl. #8	1.765	75.1 − 30.8 = 44.3 = 3470cc
#9	1.77	75.5 − 30.4 = 45.1 = 3540cc
#3	1.80	73.7 − 32.5 = 41.2 = 3180cc
#2	1.69	75.9 − 30.1 = 45.8 = 3760cc
#1		62.6 − 45.0 = 17.6

Solution from #8 and #9 boiled down to a density 1.89 and put back into [redacted] and #9. #2 solution reserved for boiling down. Solution from #2 boiled down.

Part (1180 cc) of the solution from #3 was boiled down to give max density (2.1) and mixed with remainder in #3 to give density near 1.89 measured as 1.91 by hygrometer

---

after Boildown to $d \doteq 1.89$

	77.6 − 28.4	=	49.2	@ $\frac{2.96}{1.95}$	75.0 cm	3520 cm³ added 1950 cc ← to #2
#1	79.1 − 26.8	=	52.3	81.8	$d = 1.895$	
#2	72.8 − 33.8	=	39.0	61.1	$d = 1.89$	
#3	73.5 − 33.0	=	40.5	62.8	$d = 1.91$	
#4	−	=	51.4	81 cm	$d = 1.88$ ← (11/7 measure)	
#9	74.9 − 31.6	=	43.3	67.8	$d = 1.89$	

4PM

In 3" cylinders as of 4PM 11/10/47

NB = for information on Concentration following this evaporation see Bk 24, pg 7

			equivalent in 10" reactor
#1	81.8	cm*	7.4 cm
#2	61.1	cm	5.5 cm
#3	62.8	cm	5.6½ cm
#4	81.0	cm*	7.3 cm
#9	67.8	cm	6.1 cm

*dead volume ≐ 74cm in 3" cyl.

Air Contamination Samples.

3:15 PM.	# 01000	Six inches over tray containing solution in experimental room.
3:20 PM	# 01001	Furnace room, one hour after evaporating solutions.
3:30 PM	# 01002	Experimental Room, over pit at nose level, above operation of returning evaporated solutions to storage cylinders.

11/11/47 Experiment 24 10" Reactor - Untamped.

For Cronin, Williams, Cullitan. Decided to do untamped in order to use a maximum plutonium as to get homogeneous H/X. H/X = 30 Source at about 8.8 cm 1.

9:50A Instruments checked Scales #3 - 100 #5-2
Trip - 88 x100 #3 #4 - 10 RE - 25 ms.
88 x100 #4.
Process monitor seems to have a high zero at about (8) on scale

10:05 Start of Experiment Background count

#1	#2	
197.5	113.5	no solution in line
189.0	115.5	" " " "
201.0	114.0	" " " "
208.5	108.0	" " " "
219.	109.0	" " " "

10:15 Some discrepancy in counts on #1 counter rechecking. When instruments were being checked top cover on G.M. tube was raised. This was replaced before counting.

10:30 #5 position changed moved away from counter # 5 container replaced

#1	#2
226.5	108.5
225.5	110.0
232.0	123.0
223.0	118.5
228.0	117.5
231.0	

10:40 Filling from #4 calc equiv of dead vol.

10:45 Background counts

#1	#2	
#233	116	Soln = zero sightglass reads 0.3 cm.
231	113	

10:55 To empty #4 + continue filling to 5 cm from #9

11:10 4.9 cm soln HH

#1	#2
136.5	73.5
130.5	74.0

11:22 #9 cyl empty at 7.2 cm
11:24 Filling from #3
11:29 Ht = 10.0 cm Cl red out

#1	#2
177.5	102.5
199.5	101.5

Exp 24

11/11/47

11:38	Filling from #3 cyl					
11:45	Cd rodout 11.6 cm Ht	#1	#2	c/c #1	#2	
		186.0	136.5	1.25	0.840	
11:54	Emptying #3 cyl. to 13.3 cm out Ht.					
11:57	13.3 cm out Ht.	#1	#2	c/c #1	#2	
	Cd Rod out	229	175	1.01	0.655	
12:11	14.9 cm Rodout	#1	#2	c/c #1	#2	
	from #2 cyl	267	219.5	.868	.522	
		283	222.0	.820	.516	
12:20	Filling from #2 cylinder.					
12:31	17.1 cm Rodout	#1	#2	c/c #1	#2	
		302.5	278.5	.768	.412	
		306.5	279.0	.757	.411	
12:48	#2 cylinder empty					
	18.9 cm Rod out	#1	#2	c/c #1	#2	
		396.5	340.0	.582	.337	
		409	345.5	.568	.333	
1:01	Filling from #1 cyl Process Monitor's light on.					
1:12	20.9 cm from #1 Rodout	#1	#2	c/c #1	#2	
		491	422	.473	.272	
		471.5	426.0		.269	
1:17	Filling from #1 to add 3 cm					
1:27	approx 3 cm from #1			c/c		
	Rod out	#1	#2	#1	#2	
	23 cm sol.	566	529	.410	.2165	
		572	535.5	.405	.214	
1:35	Adding 2 cm from #1			c/c		
		#1	#2	#1	#2	
1:52	Sol added Cd Rodout	665.5	665.0	0.349	0.172.	
	25 cm	655.0	666.5			

Exp #4

				Co/C	
		#1	#2	#1	#2
2:09	#1 cyl empty Rod out	751.5	758.5	.309	.151
	Soln Ht. = 26.2	754.5	756.		
2:14	Rod in - draining back to about 17.5-18.0 cm				
2:20	7.0 cm placed in #4 cyl Reactor Ht. = 19.2 cm.				
2:24	Stop at 17.2 cm to recheck counts			Co/C	
	Cd Rod out	#1	#2	#1	#2
		306.5	287.5	.757	.398
		314	285.0	.740	.402
2:32	Stopped at 16.0 cm	#1	#2	#1	#2
		287.5	276.0	.808	.465
		255.5	247	.801	
2:41	Stopped at 11.2 = 6.0 cm in #3 cm				
2:47	Stopped at 6.0 cm = 5.2 cm in #2 cm				
2:55	Recheck at H = 0	#1	#2		
		145	118		
		152.5	121.5		

11/17/48 DC 35 + 0.9 = 35.9 cm = Hc corrected for bottom reflector

Report H_c > 35 cm

10" Plexiglas cylinder.

H/x = ~~31.12~~ ~~31.06~~ 31.6

ρ_{Pu} = 1.88

~~What M_{Pu}~~ x = ~~38.5~~ = 0.724 gm/cc

12.7 < Vc = ~~18187 cm³~~ } ESTIMATED.

12.8 kg < Mc = ~~13.17 kg~~ }

H = 26.2 + 0.9 = 27.1 cm } actual measurements

V = 13.73 ℓ

M = ~~11.9 kg~~ 9.94

Soln Hts (in 10" reactor

#1	#2	#3	#4	#9
6.0	5.2 cm	6.0 cm	7.0 cm	dead volume

Conclusions: ① 10" reactor, H/x = 30, cylinder was not critical at maximum available height (with solution available) = 26.2 cm. (Multiplication) curve was not horizontal on this arrangement would probably go critical at ≥ 35 cm.

② above estimate based on curve obtained from Counter II which was operating satisfactorily throughout the experiment. "Zero" of #I was unsteady. If one uses the value for #I zero obtained at end of experiment (~150 c/2 min) instead of the earlier value (232) the "I multiplication curve lies very close to #II's.

③ Since all solution was used it is sufficiently well mixed to sample.

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11/11/47.

5P. Cylinder #1 Sp. Gr. = 1.88
" #4 " = 1.88
" #9 " = 1.85

Samples taken from #1 + #9 for H/X ratio – into Pt dishes #28, #27
(See pg 52 Book 22).
(Due to above variation it may be desirable to resample after more mixing).

Cd applied to outside 10" reactor.
850 gm Cd slat put into 10" top tamper + top water
Top tamper installed; control rod in position if wanted –
Safety rod + tamper motion OKd –
Chart drive + recorder repaired by Instrument Maintenance –
List of instrument difficulties kept for Dunn + Olsen.

→ 11/19/48 → These samples give H/X = 31.56 ave. by gravimetric – DC

11/12/47 Experiment 25 10" Reactor
H/x = 330
Tampers ~~with~~ plus Cd shielding

Cronin
Fox
Murphy
Calliha

① During morning Quinn and Olsen repaired instruments.
② Sp gr #2 = 1.88; #3 = 1.88

Trip points #3 = 87 + 100
#4 = 92 + 100

Scales #3 = 100
#4 = 10
#5 = 1
R.E = 25

		#1	#2		
1:34p	~~Background Count~~ Counts	26.0	24.0	(top tamper up).	
		12.0	11.0	(top tamper around corner).	
1:42	Filling from #4.				
1:45	Dead volume filled.				
	"Zero" Count"	16.5	14.5	$(M)^{-1}$ I	III
	#4 empty at ca 1 cm.				
1:59	Filling from #9.				
2:18	H = 4.3cm - after some bubble trouble (now tamper H = 3.9).				
		16.5	14.0	1.00	1.03
2:26	H = 7.5 (glass) = 7.1 (tamper).	23.0	21.5	.718	.674
	#9 empty, now filling from #3 - blew through #9 after it emptied in order to mix two lots of slightly different density.				
2:40	H = 10 - Blew through sight glass to ① Improve sight-glass - tamper level measurement ② Mix solutions.				
	H = 9.5 (glass) = 9.4 (tamper).	32.5	31.0	0.508	0.468
2:48	H = 9.7 (glass) = 9.5 (tamper).	32.5	29.0	0.508	0.500
2:58	= 10.9 " = 10.7 "	90.0	35.0	0.412	0.414
	Control rod out.	40.0	37.0		
	Safety rod in	36.5	33.0	.458	.439
3:10	H = 12.1 (glass) = 11.8 (tamper).	45.5	42.0	0.363	0.345
3:18	H = 13.1 " = 12.7 "	55.0	49.0	0.300	0.296
	Blew out sight glass lines = no sol. added				
	H = 12.8 (") = 12.7 ("). Stopped filling from #3, started from #2.				
3:37	H = 14.0 glass = 13.8 (")	59.5	60.0	0.278	0.242
3:43	Safety rod in for quant change.				
3:47	H = 14.0 = 13.8	68.0	62.0	0.239	0.242
		70.0	58.0		
4:00	H = 15.0 = 14.8	83.0	71.0	0.194	0.209
		83.5	74.0		

128 11/4/47 Exp 25 cont

		I	II	$(cm)^{-1}$ I	II
4:10P	H=16.1 (glass) =15.8 (tamper).	102.0	88.5	0.162	0.164
4:20P	H=17.1 (") =16.7 (")	This 1.1 cm from cylinder #3.			
		134.0	116.0	0.123	0.125
4:30P	H=18.0 " =17.7 (").	This 0.9 cm from cylinder #3; #3 empty.			
		176.5	154.5	0.093	0.094
	Safety rod in	137.0	117.0	0.120 ~~0.083~~	0.124 ~~0.~~
	Now filling from #2 again				
4:50	H=18.8 glass =18.4 tamper.	233.0	202.0	0.071	0.072
	Tamper up, safety rod in - blew out night glass.				
	H=18.5 glass =18.3 tamper.				
5:10	H=19.6 " =19.4 "	470.0	402.0	0.035	0.036
	Now filling from #1				

System once carried to criticality:
H = 20.2 (glass) = 20.0 (tamper) at this time top tamper was in contact with solution and lower end of safety rod was in top tamper 1 cm above solution surface.

~~3a~~	H=0 "Zero" count.	13.5	12.0
		13.5	13.0

Conclusions - ① 10" reactor, H/x = 30, tamped with Cd shield was critical at solution height of 20.25 cm.
② Top tamper, although containing Cd sheet, appears to be quite valuable, (3/4 cm Ad).
③ Some difficulty today with apparent level differences as measured by sight glass + tamper. This is probably due to slight ~~temp~~ density differences. When all solution except that in #1 was in reactor it was mixed by an air flow.
④ Final "Zero" count ca 15% lower than initial values; may be partly responsible for curve not extrapolating to critical point.

JC 11/17

Drain back to 19.5" into #1.
" " " 12.5 " #2.
" " " 6.0 " #3
" " " 0 " #4

#1 contains 6.1 equivalent cm in 10" reactor
#2 " 7.0 " " " " "
#3 " 6.5 " " " "
#4 " 6.0
#9 " dead volume.

11/17/48 JC 20.25 + 0.93 = ~~21.17~~ 21.1 cm - Hc corrected for bottom-
H/x = ~~21.17~~ 31.6
10" Stainless. Tamped and Cd shielded
Wt% U = ~~0~~ 38.5 = 0.734 gm U/cm³
Sp gr = 1.88
Vc = ~~10.7~~ 10.69 L.
Mc = 7.74 kg

Experiment 23c (~~26~~)
11/13/47

10" tamped reactor at $V_H/V_x \simeq 30$

Cronin
Fox
Moffitt
Murray

Scales
#5 - 2
#3 - 100
#4 - 10
Reed - 25

trip points
#3-88
#4-87

9[45] Ready to go, having removed Cd from tamper, reactor.

9[60] Background - no solution — #1 13.5, 13.0; #2 11.0, 11.5

9[55] Filling dead volume from #9

	Time	H (cm)	#1	#2	$(B/c)_1$	$(B/c)_2$	
	10[00]	0.35	(ave 15.5) 15.0, 16.0	(ave 14.0) 14.0, 14.0	1.00	1.00	
	10[20]	4.0	22.0	19.0	.705	.737	
Filling from 4	10[25]	6.1	30.0	28.5	.517	.491	#4 empty
Filling from 3	10[35]	7.6	41.5	38.5	.373	.364	
Filling from 3	10[45]	9.0	56.5	51.5	.274	.272	tamper at solution
			51.0	45.5	.304	.308	tamper 1/2 cm up
			64.5	57.5	.240	.243	tamper 1/4 cm down
Filling from 3	11[00]	10.2	78.0	68.5	.201	.264	
"	11[07]	11.0					stopped filling from #3
Filling from 2	11[10]	11.3	112	101	.138	.138	
"	11[20]	12.2	163.5	142	.095	.099	
"	11[30]	13.0	284	251	.055	.056	
"	11[40]	13.5	406.5	360	.039	.038	Stopped filling from #2
Filling from 1	11[58]	13.8	566	498	.027	.028	cd rod ~~out~~
	12[00]		468.5	418.5	.0335	.0331	cd rod in
	12[02]	13.8	Source position 19		with cd rod out		
	12[10]	13.9	" 22		"		
	12[15]	~~14.0~~	" 28				
		14.3	almost critical - Used simultaneous rod and source pull method				
		14.35	estimated criticality				

Draining Back into #1 0.8 cm — #1 Contains 6.1 cm in 10" reactor = 7.5 cm in 9" reactor
#2 2.5 cm — #2 " 7.0 " " = 8.6 " " "
#3 4.9 — #3 " 6.5 = 8.0 " "
#4 6.1 — #4 " 6.1 = 7.5 " "
#9 dead volume

14.3 ckd

Exp 23c

Conclusions:

1. Estimated best value of solution height for criticality with 10" tamped reactor, $N_H/N_X \simeq 30$ is 14.35 cm. This is about 0.15 cm lower than the reciprocal multiplication extrapolation with last point (at $^B/_C = .033$) There is a negligible difference in critical height with that for $N_H/N_X \simeq 24$

Installed 9" reactor, Cd shielded + shot in tamper. Practically ready to go in the A.M.

11/7/48 DC 14.35 + 0.93 = 15.3 cm = H_C corrected for bottom.

$H/N = 31.6$

10" Stainless, tamped.

$\rho_{sol} = 1.88$

Wt% U = 38.5 ≡ 0.724 gm U/cm³

$V_C = 7.75$ ℓ

$M_C = 5.61$ kg

11/17/47 Experiment #26 — 9" Reactor

H/V = ~~30~~ 31.12

For — tamper + Cd shielding.

McLendon
Calkhen

Storage Cylinder solution heights =
#1 - 7.5 cm in 9" reactor
#2 - 8.6 " " "
#3 - 8.0 " " "
#4 - ~~7.5~~ 7.5 " " "
#9 - dead volume.

Trip mechanism - #3 92×100 — Scales #3 - 100 — #5 - 1
#4 92×100 — #4 - 10 — RE - 50 mv (bedada).

9:33A Background Count I = 13.0 — no solution in line -
II = 12.5 — tamper + Cd surrounding source.

9:45 Filling from #9

9:50 Dead vol. filled. Ct's for leads - H = 1.0 cm, may be air in line. #9 empty -
"Zero" counts I 13.0, II 13.5 — Co/C I, II
14.0/13.5, 12.0/12.9

10:02 Filling from #1
H = 3.0 by sight glass; = 2.7 by tamper - blowing glass back produced no change, "Zeroed"

10:15A	H = 3.0	14.0	13.0			tamper with turnbuckle.
10:24A	H = 7.1 (both glass tamper).	17.5	16.5	0.77	0.78	" " (set)
10.27	Visuals in					
:32	H = 7.2 #1 empty - now filling from #2.					
34	H = 10.0	23.5	23.5	0.57	0.55	
43	H = 12.6	33.0	31.5	0.41	0.41	
52	H = 14.5	40.5	39.5	0.33	0.32	
59	~~H = 15.7~~	40.0	40.5			Cd control rod out.
11.02	H = 15.9	47.5	46.0	0.28	0.28	#2 empty, also line -
14	H = 18.5	~~53.0~~ 62.0	59.0	0.21	0.22	
19	H = 20.2	~~74.0~~ 74.5	73.0	0.17	0.18	
25	H = 22.0	100.5	96.5	0.13	0.13	
	H = 22.5					#4 empty - now filling from #3
32	H = 23.5	134.0	122.0	0.10	0.10	
40	"	103.5	96.0	0.13	0.13	Safety Rod in.
47	H = 25.0	183.5	174.0	0.074	0.072	8mm tamper motion = 1.5 cm solution
54	H = 27.0	405.5	381.0	0.033	0.034	
12:05P	H = 27.5	566.5	534.0	0.024	0.024	
~30	H = 27.75 - Critical with no safety rod.					

Drain back to 22.5 in #3; 15.5 into #5; 7.5 into #2, to zero into #1.

50 H = 0 — 12.5 — 12.5

11/17/47 Experiment 26 (Cont).

Conclusions ① H/X = 30, 9" reactor, tamped with Cd shielding
Critical at 27.75 cm.
② This value is lower than indicated by extrapolation of last two multiplication points, but agrees with value expected from earlier counts. May be due to missing counts at latest rate – ca 275 x 64/min ≅ 275/sec ≅ 4 millisec –
(High for resolving time of circuit). DC 11/17

11/17/48 DC
27.8 + 1.2 = 29.0
~~27.75 + 1.15 = 28.90~~ cm Hc Corrected for bottom –
9" Stainless, tamped and Cd shielded.
H/X = ~~31.2~~ 31.6

$\rho_{eff} = 1.88$
wt% X = $\frac{38.5}{0.365} \equiv 0.72$ gm X/cm³
$V_C = 11.90\ \ell$
$M_C = 8.62$ Kg

11/17/47 Experiment 27 — 9" Reactor
H/V ≈ ~~30~~ 31.12
Untamped.

Mehendor
Fox
Visner
Callihan

Storage cylinder solution height
#1 – 7.5 cm in 9" reactor
#2 8.0 " " " "
#3 ~~7.0~~ 8.0 " " " "
#4 7.0 " " " "

Scales #3 – 100
#4 – 10
#5 – 1
R.E. – out of order.

Dead volume had not been drained back from previous exp.

Time	H	I	II	I	II	Remarks
1:54 D	H = 0.1 cm	107.5	104.5			← C/c
	Filling from #1	112.0 / 110	101.5 / 103			
2:02 P	H = 5.0	65.0	62.0	1.69	1.66	Counting with C) rod out.
:08	H = 7.5 #1 Empty, Visner left, Filling #2.					
:13	H = 10.0	107.0	104.5	1.03	0.99	
:21	H = 13.5	153.5	148.0	0.72	0.70	
28	H = 15.6	183.0	174.5	0.60	0.59	#2 ~~Emp~~ Empty.
35	H = 19.0	230.5	215.5	0.48	0.48	Filling from #4
43	H = ~~23.0~~ 22.9	295.5	277.0	0.37	0.37	#4 Empty. – Blew out sight glass – no liquid ...
54	H = 25.9	344.5	320.0	0.32	0.32	
3:01	H = 28.0	371.0	350.5	0.297	0.294	Control rod has no effect.
3:07	H = 30.8	422.5	393.5	0.26	0.26	#3 Empty.
12	Draining back, to 22.5 into #3, to 15.5 into #4; to 7.5 into #2; to zero into #1.					
27	H = 0	110.0	105.5			

Conclusion: 9" Reactor, H/X ≈ 30, untamped was far from critical with all available solution, (30.8 cm – $(M)^{-1} \approx 4$). Probably would not be critical at infinite extension.
DC 11/17

11/30/48 DC
$H = 30.8 + 1.2 = 32.0$ cm
$H/X = 31.6$; $R_{g}q_{p} = 1.88$
Wht % X = 38.5 = 0.72 gm X/cc.
V = 13.13 L
M = 9.51 kg
} Not Critical.

Estimated $H_c = V_c = M_c = \infty$

Experiment 28 — 9" Reactor

11/17/47

McLendon — H/x = 30. 31.1"

Fox — Tamped.

Vianen

Callihan

Storage cylinder liquid heights: #1 7.5 cm in 9" reactor — Scales #3 - 100

#2 8.0 cm " " — #4 - 10

#3 8.0 cm " " — #5 - 1

#4 7.0 " " — Read - nearest leg.

		I	II			
4:30P	H = 0 cm	14.5	14.0			
		14.5	14.0			
	Filling from #1			Factor c/c I	Factor c/c II	
4:37	H = 5.0 cm	23.0	23.5	0.63	0.60	
4:45	H = 7.3	34.0	32.0	0.43	0.44	#1 Empty.
4:53	H = 9.0	43.5	42.5	0.33	0.33	Filling from #2.
5:01	H = 10.6	59.0	56.5	0.25	0.25	
5:09	H = 12.5	89.5	82.5	0.16	0.17	
5:16	H = 14.0	135.5	124.0	0.107	0.111	
5:24	H = 15.2	210.0	198.5	0.069	0.070 0.700	#2 Empty.
5:31	H = 16.2	369.5	344.5	0.039	0.044	Filling from #3.
5:40	H = 16.8	714.0	694.0	0.019	0.020	
6:00	H = 17.0	Critical with 4cm Cd control rod below solution surface.				
	= 16.9+	Not quite critical with all Cd control rod out.				
6:03	Draining back to 15.5 into #3; to 7.4 into #2; to zero into #1; dead vol. in #9.					
6:14	H = -0.2 cm	15.0	15.0			

Location of solutions: #9 Dead volume

#4 7.0 cm in 9" reactor = 8.8 cm in 8" reactor

#3 8.0 cm " " " 10.1 " " "

#2 8.1 " " " " 10.2 " " "

#1 7.4 " " " " 9.4 " " "

Conclusion - 9" reactor, H/x = 30, completely tamped - critical at 16.95 cm solution height.

Dc = 17

11/17/48 16.95 + 1.15 = 18.1 cm = Hc corrected for bottom.

9" Stainless tamped

H/x = 31.6

Wt%x = 0.385 = 0.774 gm/cc

Sp. gr. = 1.88

Vc = 7.43 ℓ Mc = 5.38 Kg.

Experiment 29 — 8" Reactor

11/18/47 — Cronin, Fox, Williams, Calliham.

H/X = ~~30~~ 31.1~

Tamped with Cd.

3- V263 radiation meters checked -

Storage Cylinder height: #1 ~~9.4~~ 8.8 cm in 8" reacta; #2 ~~10.2~~ 10.1 " " " ; #3 10.1; #4 8.8; #9 dead volume

Scales: # 3 - 100; # 4 - 10; # 5 - 1; R.E - out of order.

Trip levels: #3 92×100; #4 89×100

		#I	#II			
11:02A	Background count.	13.0	36.0			
		13.5	25.5			
		14.0	24.5			
		13.5	23.0			
		13.0	21.0			

Counts taken with control rod in except as noted.

11:20	Filling dead volume from #9					
11:26	Dead volume filled	13.0/13	18.0			#9 empty.
11:31	H = 3.3 (glass) = 3.4 (tamper)		Blew back eight glass —			Filling from #I
11:35	H = 3.4 " = 3.5 "	13.5	18.0	I c/c 0.99	II 1.00	
43	H = ~~8.9~~ 9.1	19.5	26.5	0.68	0.68	# 1 empty.
55	H = 12.6	25.5	35.5	0.52	0.51	Filling from #2
12:04P	= 15.5	30.0	35.5	0.443		
~~+5~~	~~= 18.9~~	30.0	36.0		0.50	~~#2 empty.~~
15	= 18.7	36.0	40.5	0.370	0.445	#2 empty.
23	= 22.0	40.5	59.0	0.329	0.305	Filling from #4.
32	= 25.0	46.5	54.5	0.286	0.330	=
42	= 27.8	51.0	61.5	0.261	0.292	#4 empty.
49	= 31.0	56.0	72.5	0.238	0.248	Filling from #3.
55	= 31.0 ~~= 34.4~~ ~~= 34.2~~	58.0	71.5	0.229	0.252	Cd control rod out.
1:01P	= 34.4	64.5	74.5 ~~75~~	0.206	0.241	
1:20	= 0.2 cm	13.5	21.5!			
		12.5 OK	23.5! !!			

Conclusion:

Drain back: #1 has 10 cm, #2 has 9 cm, #3 has 10.3 cm, #4 has 8.5 cm all in 8" reacta.

① 8" reacta, tamped + Cd H/X = 30 not critical with solution available. ~~Height~~ Maximum height 34.4 cm. Height could have been ca 3 cm greater but assembly would not have had 6" tamping (as really the top limit switch was too low!) One more point would not have added much to data: at 34 cm, M = 5

② #II counter data undependable.

11/18/47 DC H = 34.4 + 1.5 = 35.9.
H/X = 31.6 ρe = 1.88
Wt % X = 38.5; = 0.724 for ρe
V = 11.642 } actual meas.
M = 8.43 Bg. }

Estimated Mc = Hc = Vc = ∞

DC 11/19

Experiment 30 — 8" Reactor

11/18/47 — 30Y — H/X ≅ ~~30~~ 31.1

Cranin — Untamped.

Williams — [Reed electrometer being worked on by Hopkins]

Callihan — [Quinn (Olsen repairs) #II].

Trip levels 92+100 #3
92+100 #4.

Scales: #3 – 100
#4 – 10
#5 – 1

		I	II	I Calc	II Calc	
5:10P	Background	116.0	107.0			# 9 empty
		122.0	109.5			All counts with Cd control out.
5:13	Filling from #9.					
5:23	H = 0.5 cm	113.5	105.5			
		114.0	106.5			
5:32	H = 4.9 cm	68.5	60.0	1.66	1.77	Filling from #1
:40	H = 10.8	113.0	104.5	1.006	1.014	#1 empty
:46	H = 12.5	136.0	124.0	0.84	0.85	Filling from #2
:53	H = 14.9	162.0	147.0	0.70	0.72	#2 empty.
6:04	H = 19.9	212.0	194.0	0.54	0.55	Filling from #3.
:09	H = 24.5	242.5	225.0	0.47	0.47	
:17	H = 29.8	269.5	245.0	0.42	0.43	#3 empty.
:22	H = 33.9	283.5	258.5	0.40	0.41	Filling from #4.
29	H = 37.8	295.0	270.0	0.39	0.39	#4 empty.
47	H = 0.0	126.5	116.5			
	Draining line	129.5	119.0			

Drain back — #4 contains 8.0 cm in 8" reactor.
#3 " 8.8 " " " "
#2 " 11.0 " " " "
#1 " 10.0 " " " "
#9 dead volume.

Conclusions: 8" reactor, untamped, H/X = 30 would not be critical at infinite height. 38 cm solution available, M = 2.5 + Curve was flat.

JC 11/18/47

H = 37.8 + 1.5 = 39.3 cm
H/X = 31.6; H/D = 1.8
Wt H/X = 38.5 = 0.724 gm/cc

V = 12.74 ℓ
M = 9.22 kg
} Actual meas.

Estimated
Hc = Vc = Mc = ∞

Experiment 31. 8" reactor Tamped

H/X = ~~30~~ 31.12

Back
Moffitt
~~Zet~~
Cronin

8:30 Trouble with #4 Instrument. Barkes from Lykins' group came down and replaced the "rough" potentiometer ~~with a~~ in the zero adjustment circuit with a 225 ohm fixed ~~resistor~~ resistor.

10:30 Testing #4 — seems ok. All other instruments good.

11:00 Check list complete
#4 on 10, #3 on 100, #5 on 1.

	Solution level	Counter #1	Counter #2	Co/C #1	Co/C #2	
	Background	13	13			Top Tamper down.
		13	13.5			
11:05	Filling dead volume from #9.					
	0.5 "zero"	17.	15			
		15.0	14.5			
11:20	5.0	23	22.	.652	.682	From cylinder #4.
11:30	10.0	94.5	46.	.337	.326	From cylinder #3
11:39	15.0	102.	100.	.147	.15	From " #2. #5 on 2; #4 on 20.
11:46	17.0	159	160	.0943	.0938	From cyl #1., #4 on 50; #5 on 5
11:55	18.0	221.5	213.5	.0677	.0702	" #4 on 100; #5 on 10.
12:03	19.0	359.5	348.5	.0417	.040	"
12:13	19.6	535.5	502.5	.028	.0288	"
	19.6	360	353.5	.042	.042	Control rod in.
12:26	19.8+ This point is not critical with control rod out.					From #3
12:34	20.0 This point is not critical with control rod out					From #3.
12:45	Critical at 20.15 ± .1 cm					

Drain back: Same as in #30.

	#1	#2
Count at zero level	15.5	15.0

Conclusion: Critical at 20.15 ± .1 cm.

11/17/48 DC 20.15 + 1.45 = 21.6 cm He corrected for bottom
H/X = ~~31.5~~ 31.6.
8" Stainless. Tamped.
Apg = 1.84 38.5
Wt% U = ~~38.5~~ = 0.726 gm X/cm³
Vc = 7.00 ℓ
Mc = 5.07 Kg

7/3/49 adding 1 cm zero correction for "about 8" cylinder
DC Hc' = 22.6
V' = 7.33 ℓ
M' = 5.31 Kg

Beck
Morfitt
Fox
Cronin

11/1/47

Experiment # 32.
7" Cadmium Coated Tamped.
H/x ≅ 30.

12:30 7" cylinder installed, cadmium coated. Instruments checked.
#4 on 10, #3 on 100, #5 on 2, Prec. mon. ok, rod not operating.

Storage cylinders.

#9 Dead volume
#4 cyl. contains 10.5 cm of ~~10.5cm~~ 7" cyl.
#3 " " 11.5
#2 " " 14.4 " " "
#1 13.0

pm	Solution Levels	Counter #1	Counter #2	C₀/C #1	C₀/C #2	
3:52	Background	11.0	11.0			
	Filling dead volume from #9.					
3:56	0.5 "Zero"	10.5	11.0			
4:07	10.4	16.0	17.0	.688	.648	Emptying cylinder #4.
4:09	16.1	20.5	23.0	.538	.479	from #3
4:19	21.8	26.0	25.0	.424	.44	Emptying #3.
4:29	30.0	28.5	27.0	.386	.407	out of #2.
4:37	35.5	28.5	29.	.386	.375	Emptying #2
4:52	48.4	28.5	29.0	.386	.375	Emptying #1

Drain Back :-
into #1 12cm from #7
" " 2 " " "
3 " " "
4 " " "
#9 Dead volume.

Conclusion 7" Cadmium coated tamped is not critical at 48.4 cm height; and would not become critical at indefinite extension.

11/30/47 xc
$H = 48.4 + 1.9 = 50.3$ cm
$H/x = 31.6$; $\rho_{fg} = 1.88$
wt H/x = ~~38~~ 38.5 = 0.726 gm/cc
V = 12.48 L } Actual
= 9.04 kg. } Meas.

Estimated — $H_c = V_c = M_c = \infty$

11/21/57

Exp. 33

7" untamped $N_H/N_X \simeq 30$

Cronin
Fox
Moffett
Murray

trip pts. #3 - 80
#4 - 83

8^{55} Initial counts. source way up
#1 10 1/4 10
#2 8½ 8½

9^{10} Source in place
#1 128, 127
#2 126, 126

Time	Height	#1	#2	$(B/C)_1$	$(B/C)_2$
9:15	filling dead vol. from #9				
9:30	dropped 1 cm into #4.				
9:35	zero	(127) 128 / 125.5	125 / 125 (125)	1.00	1.00
9:45	Filling from #4				
9:50	11.1	99.5	96.5	1.29	1.30
9:55	15.0	132.5	126	.97	.99
	Number 4 empty at 13.5, filling from #3.				
10^{00}	20.0	157	154.5	.815	.81
10^{05}	#3 empty at 24.7, filling from #2				
10^{08}	25.1	199.5	171.	.73	.71
10^{12}	30.0	186.	183.5	.69	.68
10^{18}	36.8 Number 2 empty				
10^{19}	36.8	188	181.0	.68	.69
10^{35}	46.0	195.5	187.	.655	.67

Drain Back 10cm in #1 makes ~ 12 cm.
12 " 2 "
12 " 3 "
12 " 4 "
dead vol in 9

Conclusion:

11/30/48 DC
$H = 46.0 + 1.9 = 47.9$ cm.
$H/X = 31.6$ $\phi\beta = 1.88$
wt% X = 38.5 = 0.724 gm/cc
V = 11.89 kg } Actual
M = 8.61 kg. } Meas.
Estimated He = $V_c = M_c = \infty$

Exp 34

7" tamped $N_H/N_x \simeq 30$

Fox
Moffett
Mumay

Scales: #3 - 100
#4 - 10
#5 - 1
Reed - not working

12⁰⁰ Sol'n at zero. #1 #2

	#1	#2	
12.75	11.5	13.0	12.75
	14.0	12.5	
	12.5	13.0	

	time -	Height	#1	#2	$(B/C)_1$	$(B/C)_2$	
Filling, #1 →	12⁰⁰	0	12.75	12.75	1.00	1.00	
	12²⁰	5	18.0	18.5	.71	.69	
	12²⁵	10	29.0	30.5	.44	.42	
	12³⁰	12.3	#1 empty				
Filling, #2 →	12³⁵	12.5	35.5	37.5	.36	.34	
	12⁴⁰	15.0	68 ± 45.5	44.0	.28	.29	* 3 min. count
	12⁴⁵	17.5	52.	51.0	.245	.25	
	12⁵⁰	22.5	79.5	78.5	.16	.16⁺	
	12⁵⁵	24.0	#2 empty				
Filling #3 →	12⁵⁸	26.0	115	114.5	.11	.11	
	1⁰⁰	28.0	159	157.5	.080	.081	
	1¹⁵	30.0	246.5	248.5	.052	.051	50 scale { soln 1cm = 7.5 div; cd rod = 17. div
Filling #4 →	1²⁵	30.9	353	349	.036	.0365	100 scale { soln 1cm = 6 div; cd rod = 16 div
	1⁴⁵	32.0	Power level @ 33, cd rod out, source at #1				
	1⁵⁵	32.3	" " cd rod @ 20 cm Source out				

Conclusion - Critical at 32.1 cm; 7" tamped $N_H/N_x \simeq 30$ on drain back - 12 cm in each of #1, 2, 3, 4
dead vol. in #9

Reed brought back, put into use

11/17/58 DC 32.1 + 1.9 = 34.0 cm - Hc corrected for bottom -
Hx = ~~31.~~ 31.6

7" Stainless, Tamped.
wt of x = 38.5 = 0.724 gm/cm³
of q_x = 1.88
V_c = 8.448
M_c = 6.11 kg.

11/14/47

Exp. 35

6½" tamped $N_H/N_X \simeq 30$.

Cronin
Fox
Morfitt
Murray

Height of soln in ~~storage~~ cylinders (in terms of 6½" reactor)

13.9 cm in each of #1, 2, 3, 4. Dead vol. in #9

Changed to 6½" cylinder. Holes in solution flange bored wrong location...!!!
Used C clamps.

3^05 No soln - Background #1, 11¾ #2, 13

Scales
#3 - 100
#4 - 10
#5 - 1
Reed - 25

	Time	Height	#1	#2	$(B/c)_1$	$(B/c)_2$
	3:28	0.3	14.5 (14.5) 14.5	14.0 (13.75) 13.5	1.00	1.00
Filling #1 →	3:35	1.0	#9 empty.			
	3 40	7.7	22.0	20.5	.66	.67
	3 45	12.5	30.0	30.0	.48	.46
Filling #2 →	3 48	13.8	#1 empty			
	3 52	17.5	40.5	42.0	.36	.33
	3 59	22.5	52.0	50.0	.28	.275
	4 08	27.5	65.0	61.5	.22+	.22+
Filling #3 →	4 10	28.0	#2 empty			
	4 15	32.0	82.0	78.5	.177	.175
	4 20	36.3	101.0	98.5	.143	.140
	4 32	40.0	137.5	135.5	.105	.101+
Filling #4 →	4 35	41.3	# 3 empty			
	4 40	44.0	228.5	220	.63+	.63
	4 50	46.0	369.0	355	.39	.39
	5 02	47.0	Source at 58 with rod about			
		46.8	with source out. Critical			

Conclusion: 6½" reactor, tamped, with $N_H/N_X \simeq 30$ is critical at 46.8 cm. per Source holder displaces 0.2 cm.

Drain back distribution - ?

11/17/47 ac 46.8 + 2.2 = 49.0 cm - Hc corrected for bottom

$H/X = 31.6$

6½" Stainless tamped.

$\rho_{H_2O} \times = 0.385 = 0.724$ gm/cm³

$\rho_{H_2O} = 1.88$

$V_c = 10.49\ell$

$M_c = 7.59$ Kg

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11/21/47

Crowin
Callahan
Moffett

Experiment # 36 — 6" Reactor
H/X: 30
Tamped.

Distilled 6" reactor.

Trip points: #3 - 95 X100
#4 - 94 X100
Reed ~ 4.5 X 100.

Solution levels #1
#2
#3
#4
} ?
#9 - Dead volume

11:40a Background count:

#I	#II
13.5	14.0
	14.0
13.0	13.0

Scales. #3 - 100
#4 - 10
#5 - 1
R.E. - 10 (not very stable.

11:55 Dead Volume filled from #9 - Blowing back.

12:00 Height - 0.5 cm Taking Background Count.

12:05 Second Background Count:

	#I	#II
Av 15.0	15.0	15.5
	15.0	14.0
	15.0	14.5

Av. 14.7

12:17 Filling from #2

Time	Height	#1	#2	(B/C)1	(B/C)2
12:33	5.1	18.5	17.0	.811	.865
12:37	10.2	25.5	25.0	.588	.588
12:45	15.1	32.0	31.0	.468	.474
12:48	#1 Empty @ 15.4 cm.	Filling from #2			
12:53	20.1	34.5	35.5	.435	.414
12:58	25.0	40.5	39.0	.371	.377
1:05	30.0	40.0	40.0	Rod In.	
1:10	30.0	45.5	43.5	.330	.338
1:13	#2 Empty @ 32.5	Filling from #3.			
1:20	35.0	48.0	47.0	.312	.312
1:25	42.5	53.0	50.5	.284	.292
1:29	#3 Empty @ 48.0	Filling from #4			
1:35	50.0	56.5	55.5	.266	.265
1:43	60.0	61.5	59.0	.244	.248
1:52	64.0	63.5	60.5	.236	.243

Drawback

#1	64.0	to	47.5	16.5 cm.
#2	47.5	"	31.0	16.5 cm
#3	31.6	"	12.5	18.5 cm
#4	12.5	"	~~2~~ - 3.0	≈ 15.0 cm
#9	Dead Vol. - 3 cm.			

Background Count

15.0 14.7

Conclusions: 6" reactor, H/X ≅ 30, completely tamped was not critical with available solution - Multiplication ≅ 4 at H = 64 cm. Apparently solution cannot be caused to diffuse height without going critical DC

11/24 Mckendree, Vieira, Fry, Callihan - Measured quantity solution each cylinder. (Sp_{fs} = 1.88)

	#1	#2	#3	#4	#9
Manometer h_1	73.2	75.4	76.2	70.9	75.7
Manometer h_2	33.3	30.8	29.9	35.9	30.5
Δh	39.9	44.6	46.3	35.0	45.2
$\times \frac{286}{194}$ 46.2 =	2900	3245	3368	2545	3287 cc
×1.88	5455	6095	6330	4783	6180 gm sol. - To change H/X from ≅ 32 to 45 add H_2O = 19% of total mass.
×0.19	1036	1158	1203	909	1174 cc of H_2O to be added.

During dilution of #1, valve to depth measuring manometer was inadvertently left open and ca 15cc of manometer fluid (probably acetylene tetrabromide) disappeared. Three or 4 cc were in manometer line volume. No significant amount was found in liquid handling. Bulk is probably in cylinder #1. Solution from #1 removed in 1500 cc lots, filtered in Buchner & put into #5. #1 to be replaced with a" because its volume is sketchy.

Dilution continued - mixes from #2, 3 & 9 put into #6. Trap installed in manometer line. { NB - for data on resulting solution see BK 2 V pg 13

11/25 #1 - 3" storage cylinder - removed & drained - small amount of manometer fluid found - Probably the missing amount was removed in filtering solution from #1 - or is more dispersed throughout the liquid volume -

#1 - 3" cylinder rinsed twice with distilled water.

11/30/68 DC

H = 64.0 + 2.6 = 66.6 cm

H/X = 31.6; Sp_{fs} = 1.88

wt% X = 38.5 ≅ 0.7N gm X/cc

V = 12.15 ℓ } Actual

M = 8.80 kg } Measured.

Estimated

$H_c = V_c = M_c = \infty$

Check List

Date →	10/24	10/27	1928	10/29	10/30	10/30	11/3	11/4	11/5 Exp 24	11/5 Ex 22	11/6	11/11/47	11/12/47	11/13/47	11/17/47	11/18/47	11/19/47 Exp 31	11/19/47 Exp 32	11/20/47 Exp 33	11/20/47	11/25/47
1. Storage Cylinders in Place & Properly Positioned.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Solution Levels Measured & Recorded	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Calculation of Heights at which cylinders go empty	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Correct Size Reactor in place & properly pos.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. All valves positioned.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6. Insert Hose & Stopper on Full Tamper Tank. Fill Tamper & Leaks.	✓	✓	✓	✓	✓	None	✓	✓	No	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓
7. Smooth Action: end Tamper, Limit Switches, Safety Rod	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓
8. Control rod guide, check for smooth action & zero.	✓	✓	✓	None	None	None	✓	✓	✓	✓	✓	✓	✓	None	✓	✓	None	✓	✓	—	✓	✓
9. Engage Cd Safety Rod. Energize Solenoids, Set Dump Spring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10. Trip safety devices with source, noting trip points. Check all instruments.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11. Reengage Safety devices. Move safety rod to Top & control rod to bottom.		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
12. Check to see if ALL SOURCES are in place. Check Source Pulleys.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
13. Make final check of safety devices & pulleys, including dumping bar.		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
14. Notify Guards, Close Closet door, Check personnel, badges, dosimeters.		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
15. Chain Up. Red Light.			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

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SECRET