UCRL-MI-135701-PH-2-VOL-1

# Array Experiments
# Phase 2
# Volume 1

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*U.S. Department of Energy*

Lawrence
Livermore
National
Laboratory

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# ARRAY EXPERIMENTS PHASE II

VOL. 1

BEAD CHAIN SOURCE HOLDER COUNTER

26" / 100 AND 110 IS MID POINT

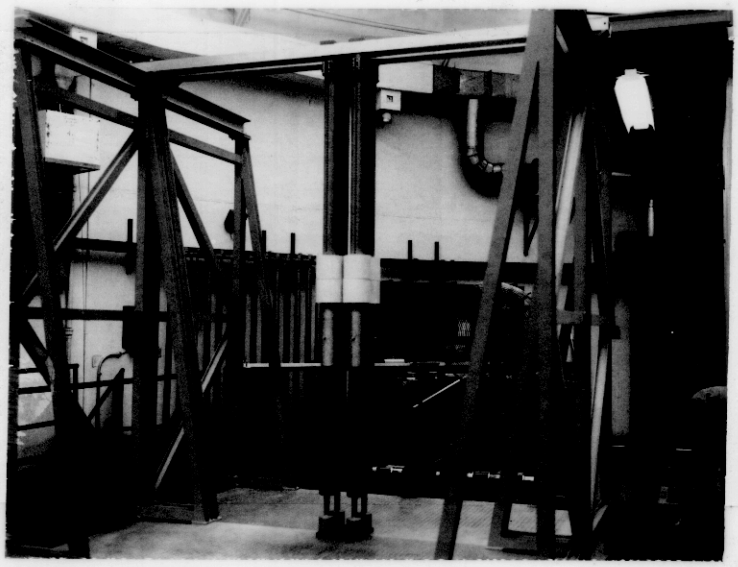
See Page 25, this Vol.

# Array Experiments Phase II Vol. 1

## Index

| Page No. | Exp. No. | Notes |
|---|---|---|
| 12 | A-1 | Wall Storage Safety Exp. |
| 14 | B-1 | $3^3$, 3 kg bare Repeat |
| 15 | B-2 | |
| 16 | B-3 | |
| 17 | B-4 | |
| 18 | B-5 | |
| 19 | B-6 | |
| 20 | B-7 | |
| 21 | B-8 | |
| 22 | B-9 | |
| 32 | C-1 | $4^3$, 6 kg, 1/2" mod. Safety Exp. |
| 33 | C-2 | " |
| 33 | C-3 | " |
| 36 | C-4 | " |
| 36 | C-5 | " |
| 37 | C-6 | " |
| 38 | C-7 | Full Array |
| 41 | C-8 | " |
| 42 | C-9 | " |
| 42 | C-10 | " |
| 43 | C-11 | " |
| 45 | C-12 | Safety Exp. |
| 46 | C-13 | " |
| 47 | C-14 | " |
| 48 | C-14' | " |
| 49 | C-15 | $4^3$, 6 kg, 1/2" mod. Full Array |
| 50 | C-16 | " |
| 53 | C-17 | " |
| 54 | C-18 | " |
| 55 | C-19 | " |
| 56 | C-20 | Safety Exp. |
| 57 | C-21 | " |
| 59 | | Dead Time Study |

| Page No. | Exp. No. | Notes | |
|---|---|---|---|
| 83 | D-1 | $4\frac{3}{4}$, 6 kg, 1" mod. | Safety Exp. |
| 87 | D-2 | | " |
| 88 | D-3 | | " |
| 90 | D-4 | | " |
| 92 | D-5 | | Full Array |
| 95 | D-6 | | " |
| 96 | D-7 | | " |
| 99 | D-8 | | " |



$2^3$ Moderated Array
$STS_c = 7.00$ cm

2-20-67

Start of pre-operational training for Phase II plutonium array studies using D-38 slugs.

The first setup will be the $2^3$ bare array with $STS_c = 0.75$ cm. For this spacing it is not possible to use the hose clamps for the tops of the columns. The clamps were replaced by drilling and tapping the top plugs and using screws. The safety pins also had to be left out as well as three of the top plug pins (Cols. 2, 3, 4). Safety wire was used in place of the safety pins. The east-west dimension was within a few mils of correct dimension (.75 cm) Dimension for base to base = .024 in and for can to can (vert) = .261 in

2-21-67

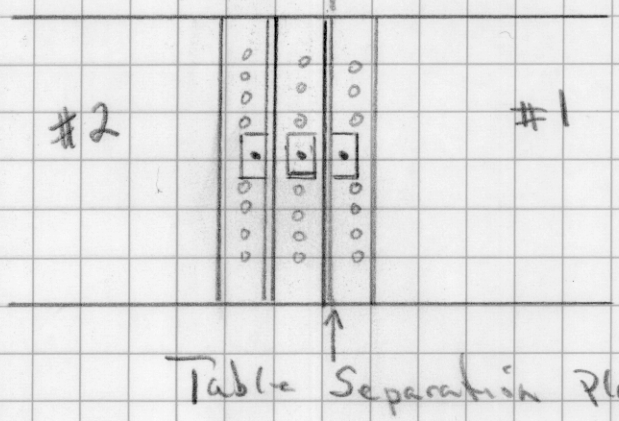
The tables were closed to check the north-south dimension. This dimension was off by ~.025 in. This was determined to be due to the fact that the top shoes could not be placed at the edge of the top beams. This was corrected by enlarging the bolt slot in the top shoes. The dimension will be checked again.

This modification helped but there is still about .010 - .015 in difference in dimensions. It was decided for the $2^3$ array that the setup dimension between cols 2 and 3 be decreased .010 in and the dimension between cols. 1 and 4 be decreased .015 in. The final dimension will be check when and if the $2^3$ array is assembled again.

The $2^3$ moderated array will be checked next with $STS_c = 7.00$ cm with mock HE = 2.54 cm. Dim. for base to base = 2.484 in and for can to can (vert.) = 2.722 in.

3-1-67

We began the $3^3$ array. Using the center holes in the top beams it was impossible to setup the $3^3$ array with $STS_c = 3.00$ cm. The only way possible to setup this array is to use the off center holes in the upper beam. This was checked with Bill O'Neal and Art Williams and was found to be okay for any array. ∴ the following is the way the beams are set for the $3^3$ array $STS_c = 3.00$ cm




The 3 columns on the center beam had to be attached to the top shoes with the screw system instead of clamps.

3-2-67

Measurements were made between columns to determine the spacings we are able to accurately setup. A sketch is made on the next page showing the variations in dimensions from the desired dimension. We attempted a col. to col. separation of .900 in. The variations given are in the order of top, center, and bottom column measurements.

# $3^3$ Bare Array Dimension Variations

| | | |
|---|---|---|
| 7 | 1 | 4 |
| T = .001<br>C = .005<br>B = .003 | T = -.005<br>C = -.002<br>B = -.004 | |
| Top = -.001<br>Center = -.003<br>Bottom = -.004 | T = .005<br>C = .000<br>B = -.001 | T = .004<br>C = .009<br>B = -.003 |
| 8 | 2 | 5 |
| T = -.003<br>C = -.001<br>B = .000 | T = -.002<br>C = .009<br>B = .002 | |
| T = -.001<br>C = -.010<br>B = -.003 | T = -.002<br>C = -.005<br>B = -.005 | T = -.002<br>C = -.005<br>B = .001 |
| 9 | 3 | 6 |
| T = -.001<br>C = .007<br>B = .006 | T = -.005<br>C = -.010<br>B = .004 | |

North →

↑ Table Separation Plane

RMS for top = $\sim \pm .003''$ in

RMS for center = $\sim \pm .006''$ in

RMS for bottom = $\sim \pm .003''$ in

The base to base separation for STS = 3.00cm is .900 in. (H. Finn)

We will now set up the $3^3$ moderated (3.81 cm) array. $STS_c$ = 8.00 cm. Base to base = 3.262 in.

It is shown here as before as long as the array is located at the top or bottom the dimensions are within $\pm .005$ in.

3-3-67

We will continue the setup of the $3^3$ Mod. Array.

3-6-67 We found that the datum blocks were not closing when we closed the table. It appears that when we torque the top clamps, we force the support structure apart. This distance was ~.002 in on the west and .008 in. on the east. By loosening the clamps on the east side the datum blocks came together. We will investigate this.

3-6-67

We will attempt to reproduce the effect we saw 3-3-67.

We placed a 15 mil shim in the east side while the west side was torqued and then removed it and torqued the east side. This gave us the opposite effect. We now saw the datum blocks on the east side come together .007 in before the table. The datum blocks were set so they led the table by .002 in.

3-7-67

It appears the problems we have been having here been due to the way the top beams are put in place and torqued down. If both ends of the beam is held in placed while torque is applied then everything is okay. It was also determined that if the top and bottom shoes are not aligned then this would also give us the effect we saw. By being off about $\frac{1}{8}$ - $\frac{1}{4}$ in. at the top the datum blocks were off a few mils.

We will now begin the $4^3$ Mod. with 1.27cm with $STS_c$ = 21.00 cm. Base to base =

3-8-67

The problem with the top datum blocks is back. The datum bloks have gaps of .001 in (east) and .003 (west). We don't know what the problems is, so we will have to live with it.

3-9-67

The $4^3$ is on the table and the datum blocks are separated by .003 in (east) and .002 in (west)

Spacing between columns was checked and the RMS = ~ ± .010 in from the Aug.

The base to base separation = 17.719 in

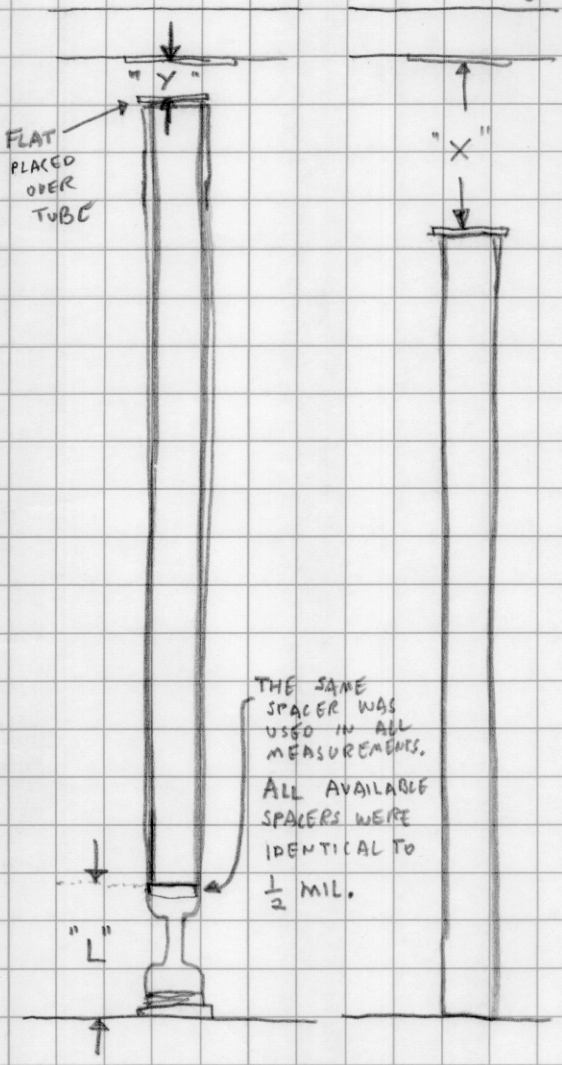
3-10-67

It was decided that the pins would be used for the Mock HE. We need 100 more. We will try to leave the Mock HE in place on the column during the loading and unloading of the table. It appears we may use Gordon's way for changing separations since it will cut down the exposure time.

3-13-67



Measurements were made do determine the height from the table top to the plane where the spacers begin inside a column (Above the taped bottom support/puck/spacer.). The measurements were made by inserting a long tube inside a column, fastening the column to its matching base, and measuring up to a fixed overhead beam. The distance from the tube to the beam without a column/base combination was also measured, and the difference gave the dimension in question "X" = 13.234"



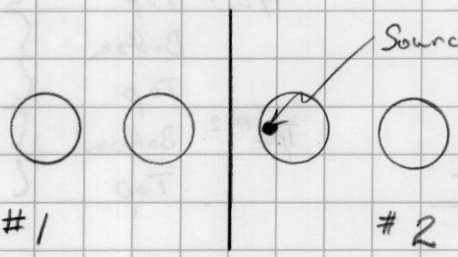

| COLUMN NO. | "Y", INCHES | ΔY | "L", INCHES | "L", cm |
|---|---|---|---|---|
| 1 | 2,331 | .001 | 10,903 | 27,694 |
| 2 | 2,329 | .003 | 10,901 | 27,689 |
| 3 | 2.333 | .001 | 10.905 | 27,699 |
| 4 | 2,331 | .001 | 10,903 | 27,694 |
| 5 | 2.333 | .001 | 10,905 | 27,699 |
| 6 | 2.332 | - | 10,904 | 27,696 |
| 7 | 2,332 | - | 10.904 | 27,696 |
| 8 | 2,332 | - | 10.904 | 27.696 |
| 9 | 2,332 | - | 10,904 | 27.696 |
| 10 | 2.332 | - | 10,904 | 27.696 |
| 11 | 2.332 | - | 10,904 | 27.696 |
| 12 | 2.332 | - | 10,904 | 27,696 |
| 13 | 2.329 | .003 | 10,901 | 27,689 |
| 14 | 2.334 | .002 | 10,906 | 27,701 |
| 15 | 2.331 | .001 | 10,903 | 27,694 |
| 16 | 2.334 | .002 | 10,906 | 27,701 |
| | ↓ | | ↓ | ↓ |
| | 2.332 ± .0014 | | 10,904 ± .002 | 27.696 ± .005 |

3-14-67

We will begin experiments again!

## START PHASE II

We will determine the eff. factors for the bare safety array as shown below. STS = 11.00cm



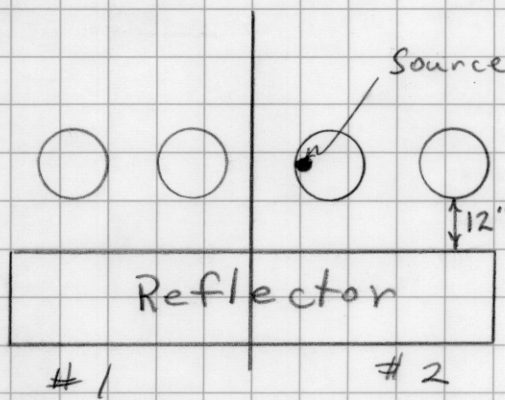

Count Rates :

| | T-1 | T-2 |
|---|---|---|
| c/m | 14699/3 | 10861/3 |
| c/s | 81.66 | 60.34 |
| Eff. | $6.28 \times 10^{-6}$ | $4.64 \times 10^{-6}$ |
| Eff. Factor | $1.579 \times 10^{5}$ | $2.16 \times 10^{5}$ |

3/15/67

| Background check | | | |
|---|---|---|---|
| | cts | 15/10 min | 9/10 min |
| | c/m | 1.5 | 1 |

We will determine the eff. factors for the reflected safety array as shown below. STS = 11.00cm




Count Rates :

SEE PAGE 13

| | T-1 | T-2 |
|---|---|---|
| c/m | 64727/5* | 10938/5 |
| c/s | 215.76 | 36.46 |
| Eff. | $1.66 \times 10^{-5}$ | $2.80 \times 10^{-6}$ |
| Eff. Factor | $.60 \times 10^{5}$ | $3.57 \times 10^{5}$ |

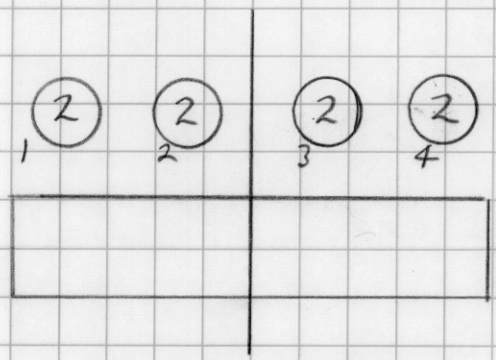
Assembly A-1 : Pu to Pu = 11.00 cm

Lateral Spacing : 0.69 fixed + 10.315 = 11.005 cm

Vertical Spacing :

Parts : 1, 2, 4, 5, 6, 8, 9, 12

Base Rate : 16.25 $\times 10^{-5}$ n/s




| Position | Cts T-1 | Eff. Factor | $10^{-5}$ n/s | M | CTS T-2 | Eff. Factor | $10^{-5}$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.824 | 2436 | $.60 \times 10^{-5}$ | 24.4 | 1.50 | 1005 | $3.57 \times 10^{-5}$ | 60.0 | 3.69 |
| | 40.6 | | | | 16.8 | | | |
| 3.998 | 2410 | $.60 \times 10^{-5}$ | | | 948 | $3.57 \times 10^{-5}$ | | |
| 2.998 | 2309 | $.60 \times 10^{-5}$ | | | 996 | $3.57 \times 10^{-5}$ | | |
| | T/C's | #1 = 87 °F | | | #2 = 84 °F | Room = 70 °F | | |
| 2.003 | 2305 | $.60 \times 10^{-5}$ | | | 1023 | $3.57 \times 10^{-5}$ | | |
| -0.002 | 64198/10 | $.6 \times 10^{-5}$ | | 3.95 | 10,176/10 | | | 3.69 |

There seems to be problems, so we will look at this assembly again.

| Position | CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.820 | 2401 +0.0 | $1.59 \times 10^{-5}$ | 63.6 | 3.91 | 1012 | $3.57 \times 10^{-5}$ | | 3.69 |
| 4.003 | 7285/3 | | | | 2561/3 | | | |
| 3.002 | 7210/3 | | | | 2979/3 | | | |
| 2.002 | 7139/3 | | | | 2956/3 | | | |
| 1.002 | 7306/3 | | | | 2860/3 | | | |
| .500 | 7325/3 | | | | 3098/3 | | | |
| .000 | 23852/10 | | | 3.91 | 10066/10 | | | 3.69 |

The problem was found to be in the scaler. It is now corrected. This was also going on when we took eff. factors for the assembly. We will correct our eff. factor now.

From page 11 T-1 should be 24727/s-

| | |
|---|---|
| c/s | 82.42 |
| Eff. | $.63 \times 10^{-5}$ |
| Eff. Factor | $1.59 \times 10^{-5}$ |

We again checked the fixed lateral dimension. Parts #1, 9, and 126 were measured as shown below.

#1 : 2.599 in
2.599 in

#9 : 2.599
2.597
2.598

#126 : 2.598
2.597 5
2.597

We took 2.598 in as the dia. of a typical billet.

2.850 in. (OD ~~Old Tube~~) Avg. Base Dim.
2.598
.252 in = .640 cm

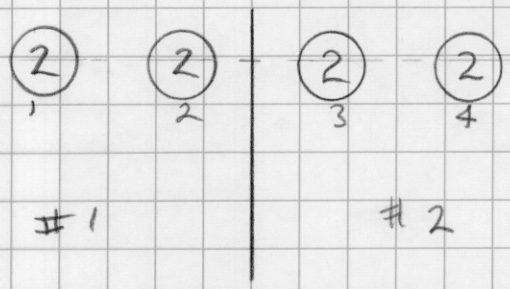
.010 in (can wall thickness) x 2 = .020 in ≈ .051 cm

∴ .640 cm
.051
.691 cm as the fixed dimension

but we found that the can wall is .0145 in* thick ∴ the fixed dimension should have been **.714 cm**

* CANS

We will now do the assembly without the reflector.




| Position | CTST-1 | Eff. Factor | $10^5$ n/s | M | CTST-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 4.000 | 9352/4 | $1.59 \times 10^{-5}$ | 62.00 | 3.82 | 6807/4 | $2.16 \times 10^{-5}$ | 61.3 | 3.77 |
| | 38.97 | | | | 28.36 | | | |
| 2.002 | 7043/3 | | | | 5120/3 | | | |
| | 39.13 | | | | 28.49 | | | |
| -.002 | 23822/10 | | 63.1 | 3.88 | 17557/10 | | 63.2 | 3.89 |
| | 39.7 | | | | 29.26 | | | |

3-17-67

We will begin the $3^3$ bare array. The loading of the columns are as shown on the back side of page 41 of Vol. 3 Phase I.*

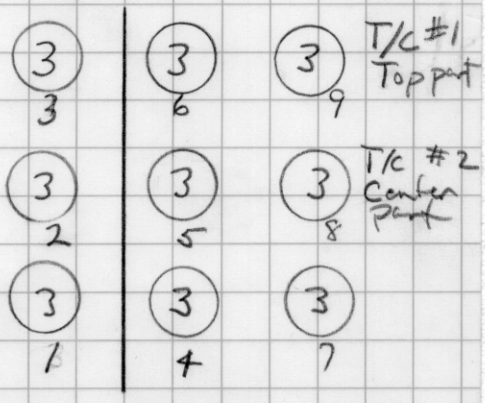
Assembly B-1: Pu to Pu = 8.000 cm

Lateral Spacing: 0.69 fixed + 7.310 = 8.000 cm

Vertical Spacing: 0.086 fixed + 7.914 = 8.000 cm

Parts: as shown above*

Base Rate: $55.78 \times 10^{-5}$ n/s



| Position | Cts T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.820 | 5839 | $1,892 \times 10^5$ | 184.1 | 3.30 | 4565 | $2,487 \times 10^5$ | 189.3 | 3.39 |
| | 97.3 | | | | 76.1 | | | ($\bar{m} = 3.35$) |

T/C's Room = 69 °F #1 = 90 #2 = 89

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0.000 | 12,677/2 | $1,89 \times 10^5$ | 199.8 | 3.58 | 9595/2 | $2.49 \times 10^5$ | 199.0 | 3.57 |
| | 105.6 | | | | 80.0 | | | ($\bar{m} = 3.58$) |

We will determine the eff. factors for the 33 array.

| | T-1 | T-2 |
|---|---|---|
| Bkg | 9745/5 | 11009/5 |

| Count Rates: | T-1 | | T-2 | |
|---|---|---|---|---|
| c/m | 30,361/5 | 20,616/5 | 26,693/5 | 15,684/5 |
| c/s | 68.72 | | 52.28 | |
| Eff. | $5.286 \times 10^{-6}$ | | $4.022 \times 10^{-6}$ | |
| Eff. Factor | $1.892 \times 10^5$ | | $2,487 \times 10^5$ | |

Assembly B-2: Pu to Pu = 6.000 cm

Lateral spacing: 0.69 fixed + 5.319 = 6.009 cm

Vertical spacing: 1.066 fixed + 4.934 = 6.000 cm

Parts same as B-1, Base rate $55.78 \times 10^5$ n/s

| Position | Cts T-1 | Eff Fact | $10^5$ n/s | M | Cts T-2 | Eff Fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.820 | 6789/1 | $1.892 \times 10^5$ | 214.1 | 3.84 | 5277/1 | $2.487 \times 10^5$ | 218.7 | 3.92 |
| | 113.15 cps | | | | 87.95 cps | | | |

T/C's Room = 70 °F #1 = 98 °F #2 = 93 °F

70 92 87

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| -.002 | 7856/1 | | 247.7 | 4.44 | 6077/1 | | 251.9 | 4.52 |
| | 130.93 cps | | | | 101.28 cps | | | $\bar{m} = 4.48$ |

3-20-67

ASSEMBLY B-3 : $P_n$ to $P_w$ = 4.000 cm

Lateral spacing : 0.69 fixed + 3,310 cm = 4.000

Vertical spacing : .086 fixed + 3.914 = 4.000 cm

Part zones as B-1, Base rate 55,78 x $10^5$ m/s

$\frac{1}{5}$ 5.78 = .017928

| POSITION | T-1 | EFF FACT | $10^5$ m/s | M | T-2 | EFF FACT | $10^5$ m/s | M |
|---|---|---|---|---|---|---|---|---|
| 7,822 | 9463/1 | $1.892 \times 10^5$ | 298.4 | 5,350 | 7271/1 | $2.487 \times 10^5$ | 301,4 | 5,403 |
| | 157,72 | | | | 121,19 | | | |
| -.002 | 12783/1 | | 400,56 | 7,181 | 9887/1 | | 409,8 | 7,347 |
| | 211.71 | | | (.1392) | 164.78 | | | (.1361) |

Room 70°F T#1 = 91°F T#2 = 104°F

at closure $\bar{n}$ = 7,264

At START OF SET-UP FOR B-4 ARRAY, IT WAS DISCOVERED VERTICAL SPACING MISTAKENLY SET-UP AS 5.000 cm INSTEAD OF 4.000 cm. ∴ $\bar{n}$ = 7,264 SHOULD APPLY TO $\overline{5T5} = 4\frac{1}{2}$

B-3' AGAIN WITH SPACING AS ADVERTISED ABOVE

| POSITION | T-1 | EFF FAC | $10^5$ m/s | M | T-2 | EFF FAC | $10^5$ m/s | M |
|---|---|---|---|---|---|---|---|---|
| 7,817 | 10,447/1 | $1.892 \times 10^5$ | 329.4 | 5,905 | 8228/1 | $2.487 \times 10^5$ | 340.97 | 6,113 |
| | 174.11 | | | | 137.10 | | | |
| -.002 | 16,120 | | 508,3 | 9,095 | 12,527 | | 519,24 | 9,309 |
| | 268,67 | | | | 208,78 | | | |

T#1 = 95°F T#2 = 96°F

$\bar{n}$ = 9,202

[$\bar{n}$ on old table = 9,26]

3-21-67

Assembly B-4 : Pu to Pu = 3.400 cm

Lateral Spacing: .69 fixed + 2.710 = 3.400 cm

Vertical Spacing: .086 fixed + 3.314 = 3.400 cm

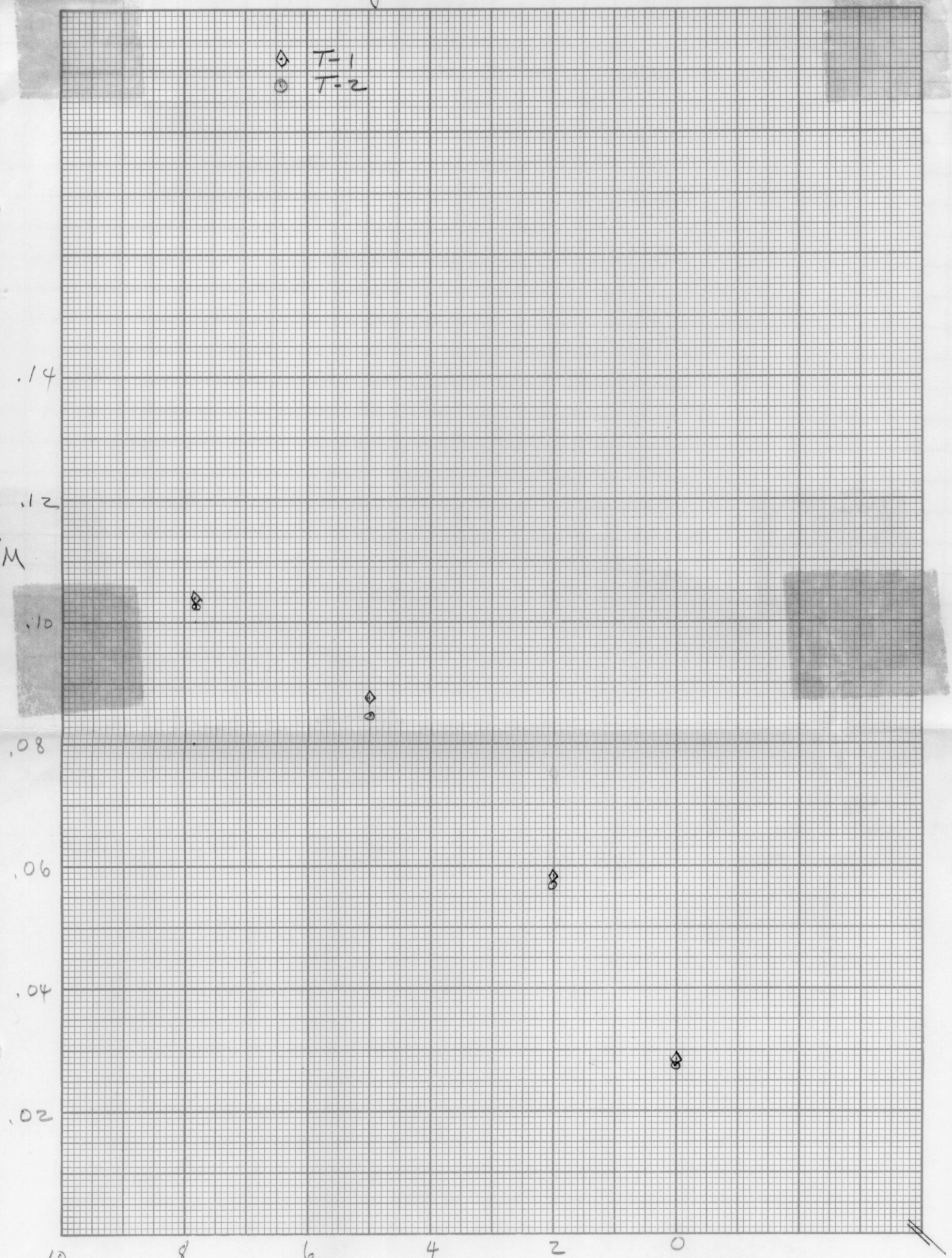
Parts: Same as B-1

Base Rate: 55.78 $\times 10^{-5}$ g/s

| Position | CTST-1 | Eff Factor | $10^{-5}$ g/s | M | CTST-2 | Eff. Factor | $10^{-5}$ g/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.820 | 19315<br>238.54 | $1.892 \times 10^{-5}$ | 451.4 | 8.09 | 11300<br>188.33 | $2.487 \times 10^{-5}$ | 468.4 | 8.40 |
| | T/C's | Room = 70 °F | | | #1 = 96 | | #2 = 95 | |
| 0.094 | 33102<br>551.7 | $1.892 \times 10^{-5}$ | 1043.8 | 18.7 | 25784<br>429.7 | $2.487 \times 10^{-5}$ | 1068.7 | 19.2 |
| | T/C's | Room = 70 | | | #1 = 91 | | #2 = 92 | |
| -0.002 | 34015<br>566.9 | $1.892 \times 10^{-5}$ | 1072.6 | 19.2 | 26541<br>442.4 | $2.487 \times 10^{-5}$ | 1100.2 | 19.7 |

$\bar{M} = 19.45$

3/21/67 Assembly B-5




K&E 20 X 20 TO THE INCH KEUFFEL & ESSER CO. 358-10½ MADE IN U.S.A.

3/21/67

Assembly B-5 : Pu to Pu = 3.200 cm

Lateral spacing: 0.690 fuel + 2.535 = 3.225) cm
(Lateral spacing ~ 0.010 in overlap)

Vertical spacing: 0.086 fuel + 3.115 = 3.201 cm

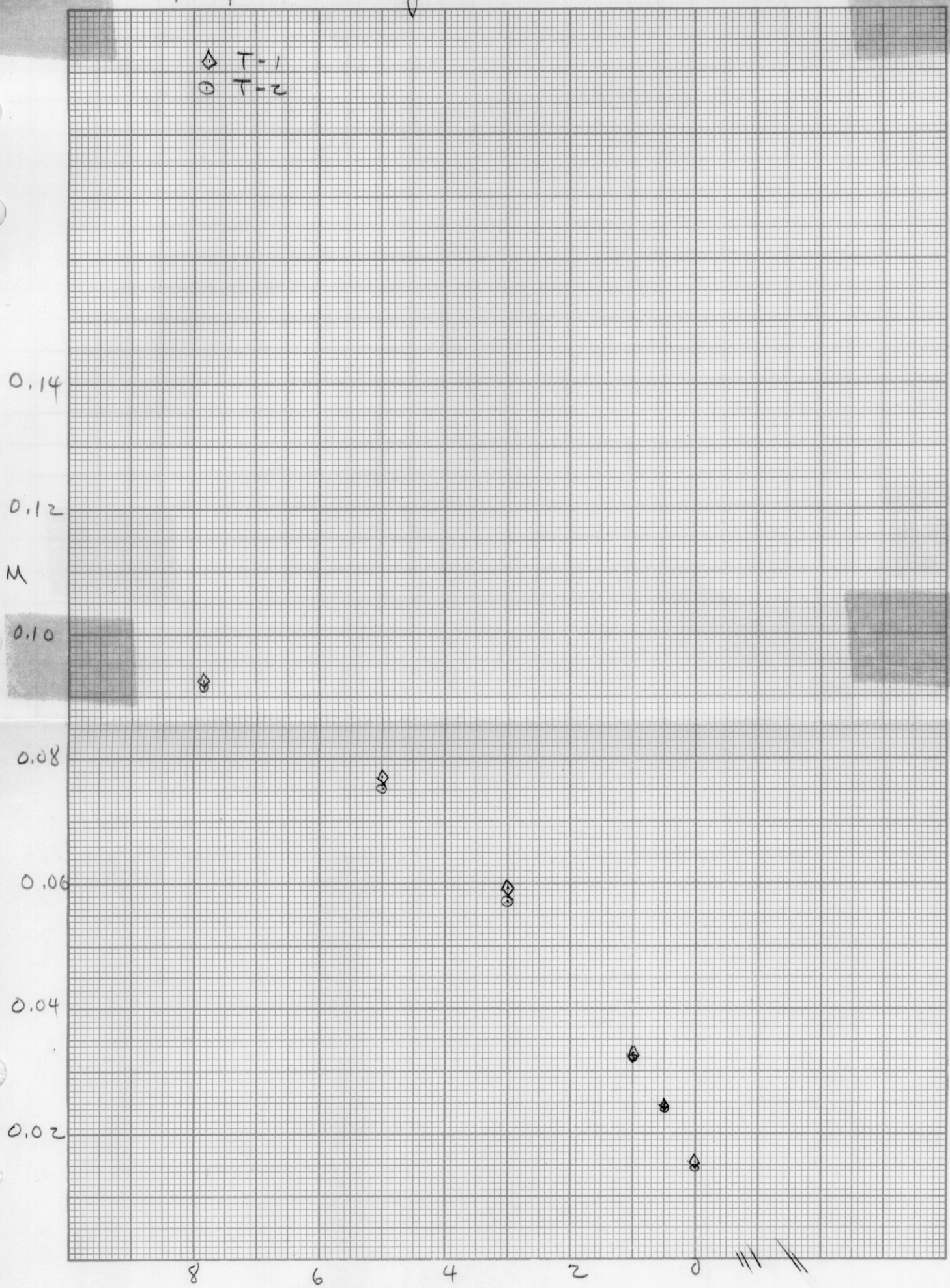
Pads: same as B-1

Base rate: $55.78 \times 10^{5}$ n/s

| Position | Cts T-1 | Eff. Fast | $10^5$ n/s | M | Cts T-2 | Eff. Fast | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.821 | 16938<br>282.3<br>T/C's | $1.892 \times 10^5$<br>Room = 70 °F | 534.1 | 9.58 | 13116<br>218.6<br>#1 - 102 | $2.487 \times 10^5$<br>#2 - 96 | 543.7 | 9.75 |
| 5.00 | 20248<br>337.5<br>T/C's | "<br>Room = 70 °F | 638.6 | 11.4 | 15807<br>263.4<br>#1 - 95 | "<br>#2 - 91 | 655.1 | 11.8 |
| 1.998 | 30374<br>506.2<br>T/C's | "<br>Room = 70 °F | 957.7 | 17.2 | 23737<br>395.6<br>#1 - 91 | "<br>#2 - 87 | 983.9 | 17.6 |
| -0.002 | 62531<br>1042<br>T/C's | "<br>Room = 70 °F | 1971 | 35.3 | 49021<br>817.0<br>#1 - 90 | "<br>#2 - 86 | 2032 | 36.4 |

$\overline{M} = 35.9$

3/22/67 Assembly B-6




358-10½ MADE IN U.S.A.
20 X 20 TO THE INCH
KEUFFEL & ESSER CO.

3/22/67

Assembly B-6: Pu to Pu = 3.100 cm

Lateral spacing: 0.690 fixed + 2.410 = 3.100

Boring spacing: 0.086 fixed + 3.010 = 3.096

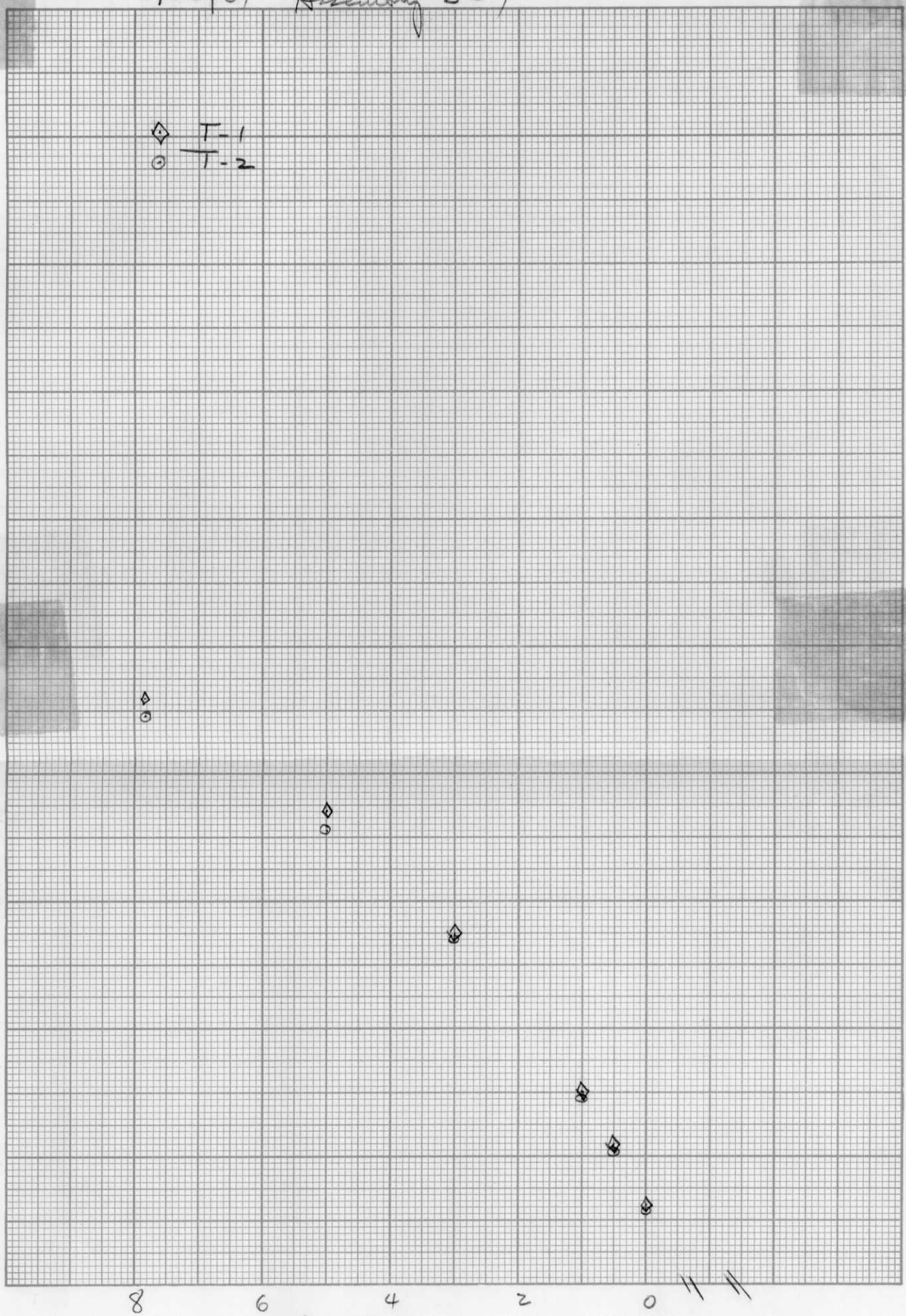
Parts: Same as B-1

Base rate: $55.78 \times 10^5$ n/s

| Position | cts T-1 | Eff fast | $10^5$ n/s | M | cts T-2 | Eff fast | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.825 | 19040 | $1.892 \times 10^5$ | 600.3 | 10.8 | 14671 | $2.487 \times 10^5$ | 608.1 | 10.9 |
| | 317.3 | | | | 244.5 | | | |
| | T/C's Room - 70 | | | | #1 - 88 | | #2 - 98 | |
| 5.000 | 22,929 | " | 722.9 | 12.9 | 17,963 | " | 744.6 | 13.3 |
| | 382.1 | | | | 299.4 | | | |
| | T/C's R - 70 | | | | #1 - 86 | | #2 - 96 | |
| 3.001 | 30,115 | " | 949.6 | 17.0 | 23,462 | " | 972.4 | 17.4 |
| | 501.9 | | | | 391.0 | | | |
| | T/C's R - 70 | | | | #1 - 84 | | #2 - 94 | |
| 1.000 | 53,492 | " | 1686.7 | 30.2 | 42,000 | " | 1740.9 | 31.2 |
| | 891.5 | | | | 700 | | | |
| | T/C's R - 70 | | | | #1 - 83 | | #2 - 93 | |
| .500 | 71,532 | " | 2255.6 | 40.4 | 55,721 | " | 2309.7 | 41.4 |
| | 1192.2 | | | | 928.7 | | | |
| | T/C's R - 70 | | | | #1 - 83 | | #2 - 93 | |
| -.002 | 114,589 | " | 3613.3 | 64.8 | 90,285 | " | 3742.2 | 67.1 |
| | 1909.8 | | | | 1504.7 | | | |
| | T/C's R - 70 | | | | #1 - 83 | | #2 - 93 | |

$\overline{M} = 66.0$

3/22/67 Assembly B-7




KE 20 X 20 TO THE INCH KEUFFEL & ESSER CO. 358-10½ MADE IN U.S.A.

## Assembly B-7: Pu to Pu = 3.080

Lateral spacing: 0.690 fuel + 2.390 = 3.080

Vertical spacing: 0.086 fuel + 3.000 = 3.086

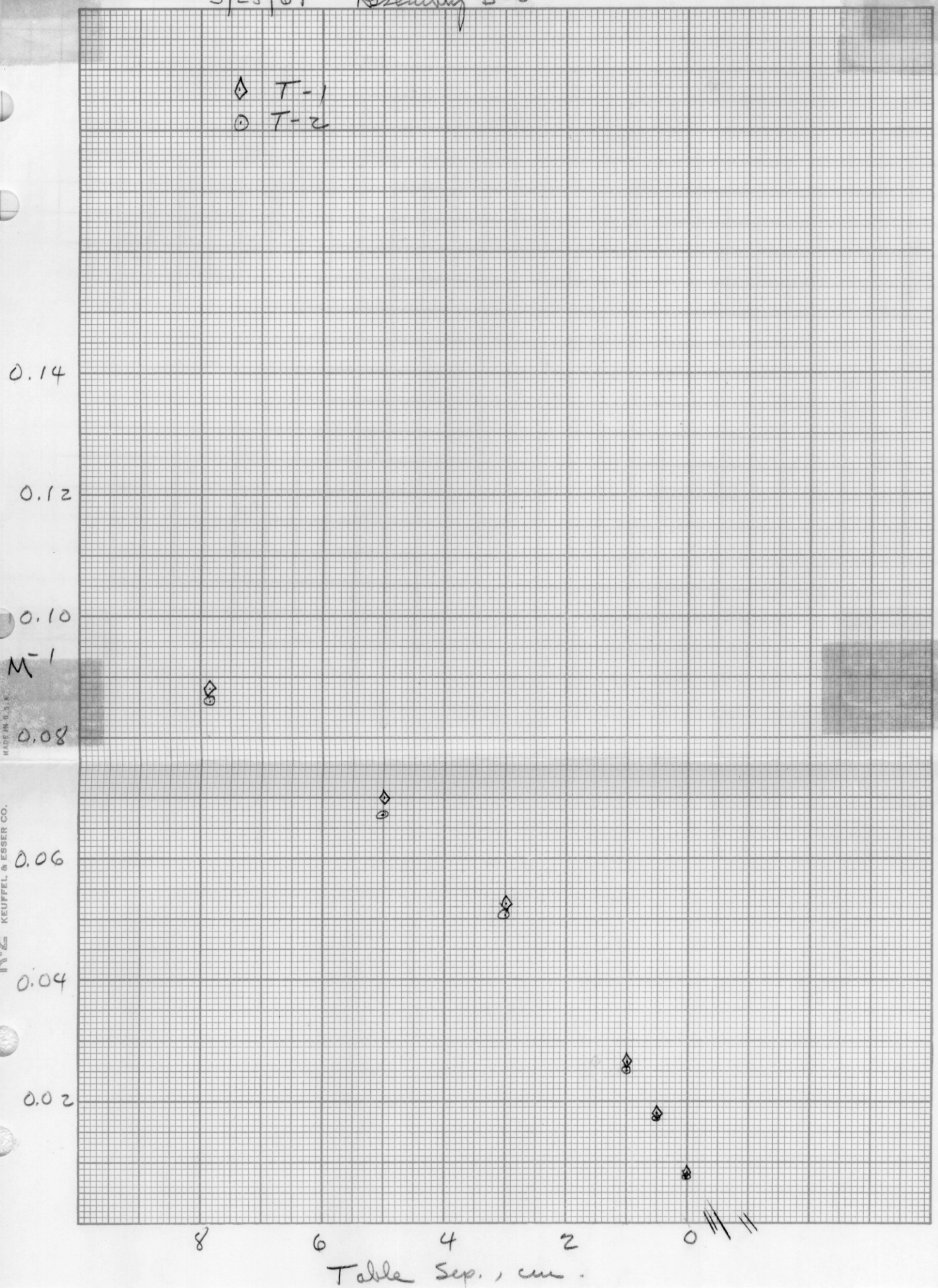
Parts: Same as B-1

Base rate: $55.78 \times 10^5$ n/s

| Position | Ctr T-1 | Eff. fact. | $10^5$ n/s | M | Ctr T-2 | Eff. fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.825 | 19,290 | $1.892 \times 10^5$ | 608.3 | 10.9 | 15,015 | $2.487 \times 10^5$ | 622.4 | 11.2 |
| | 321.5 | | | | 250.3 | | | |
| | T/C's R- 70 | | | #1- 95 | | #2 - 90 | | |
| 5.001 | 23,905 | " | 753.8 | 13.5 | 18831 | " | 780.7 | 14.0 |
| | 398.4 | | | | 313.9 | | | |
| | T/C's R- 70 | | | #1- 91 | | #2 - 87 | | |
| 3.001 | 31,649 | " | 998.0 | 17.9 | 24713 | " | 1024.4 | 18.4 |
| | 527.5 | | | | 411.9 | | | |
| | T/C's R- 70 | | | #1 - 91 | | #2 - 86 | | |
| 0.998 | 58589 | " | 1847.5 | 33.1 | 46489 | " | 1926.9 | 34.5 |
| | 976.5 | | | | 774.8 | | | |
| | T/C's R- 70 | | | #1- 90 | | #2 - 85 | | |
| 0.500 | 81,336 | " | 2564.8 | 46.0 | 64,130 | " | 2658.1 | 47.7 |
| | 1355.6 | | | | 1068.8 | | | |
| | T/C's R- | | | #1- 89 | | #2 - 84 | | |
| -0.002 | 144818 | " | 4566.5 | 81.9 | 115,090 | " | 4770.6 | 85.5 |
| | 2413.6 | | | | 1918.2 | | | |
| | T/C's | | | #1 - 89 | | #2 - 84 | | |

TM = 83.7

3/23/67 Assembly B-8




358-10½ MADE IN U.S.A.
KE 20 X 20 TO THE INCH KEUFFEL & ESSER CO.

3/23/67 Assembly B-8: Pu to Pu = 3.050 cm

Lateral spacing: 0.690 fuel + 2.360 = 3.050 cm

Vertical spacing: 0.086 fuel + 2.965 = 3.051 cm

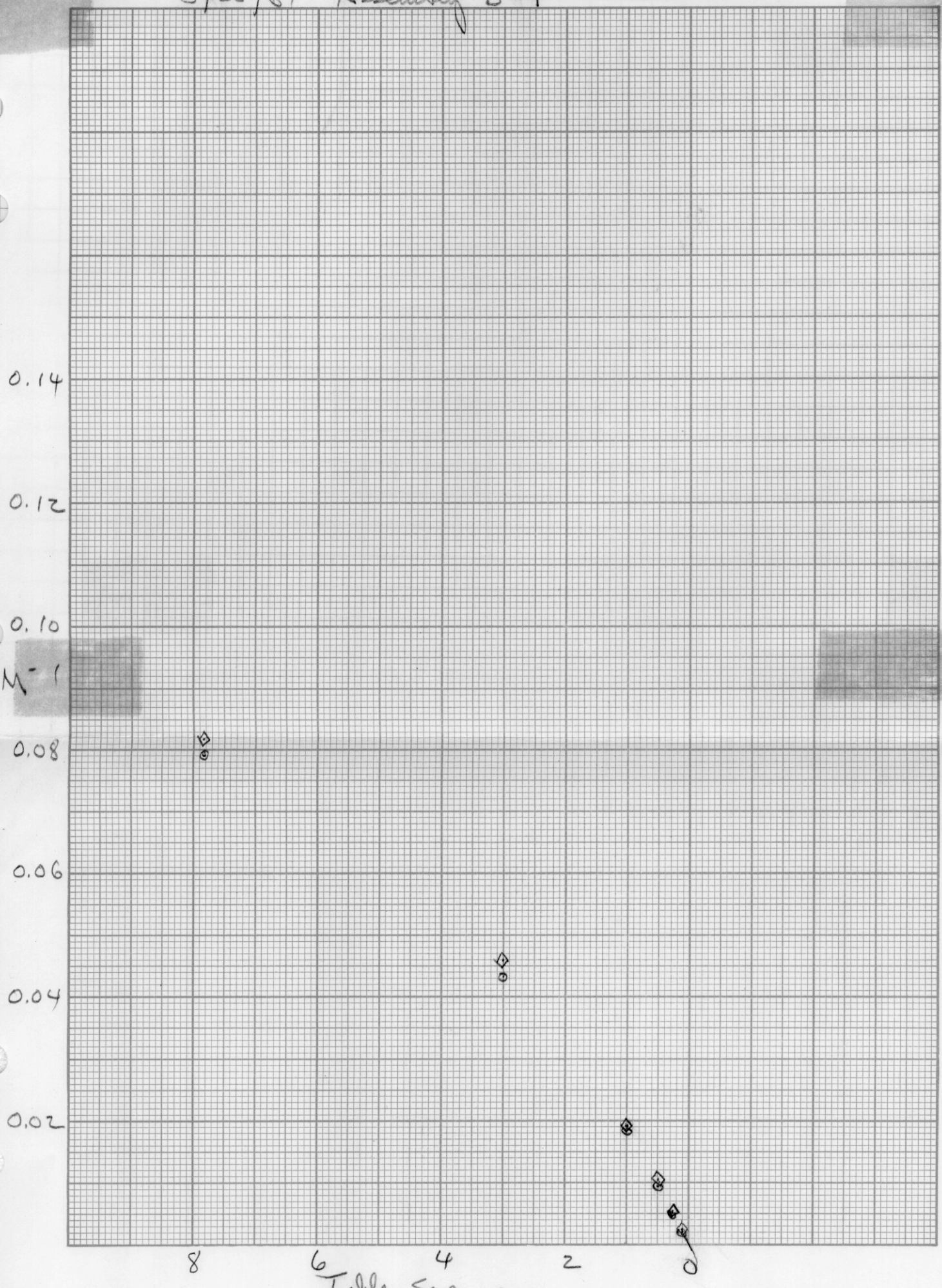
Pads: Same as B-1

Base rate: $55.78 \times 10^5$ n/s

| Position | Cts to T-1 | Eff. fact. | $10^5$ n/s | M | Cts to T-2 | Eff fact. | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.830 | 20,007<br>333.4<br>T/C's | $1.892 \times 10^5$<br>R-68 | 630.8 | 11.3 | 15,749<br>262.5<br>#1-88 | $2.487 \times 10^5$<br>#2-81 | 652.8 | 11.7 |
| 5.001 | 24926<br>415.4<br>T/C's | "<br>R-68 | 785.9 | 14.1 | 19885<br>331.4<br>#1-88 | "<br>#2-81 | 824.2 | 14.8 |
| 3.001 | 33731<br>562.2<br>T/C's | "<br>R-68 | 1063.7 | 19.1 | 26689<br>444.8<br>#1-90 | "<br>#2-81 | 1106.2 | 19.8 |
| 1.001 | 66560<br>1109.3<br>T/C's | "<br>R-68 | 2098.8 | 37.6 | 53015<br>883.6<br>#1-92 | "<br>#2-82 | 2197.5 | 39.4 |
| 0.500 | 97943<br>1632.4<br>T/C's | "<br>R-68 | 3088.5 | 55.4 | 78101<br>1301.7<br>#1-92 | "<br>#2-82 | 3237.3 | 58.0 |
| -0.002 | 208,844<br>3480.7<br>T/C's | "<br>R-68 | 6585.5 | 118.1 | 168468<br>2807.8<br>#1-92 | "<br>#2-82 | 6983.0 | 125.2 |

$\bar{M} = 121.6$

3/23/67 Assembly B-9




358-10½ MADE IN U.S.A.
20 X 20 TO THE INCH KEUFFEL & ESSER CO.

3/23/67 Assembly B-9: Pu to Pu 3.000 cm

Lateral spacing: 0.690 fixed + 2.310 = 3.000

Vertical spacing: 0.086 fixed + 2.915 = 3.001

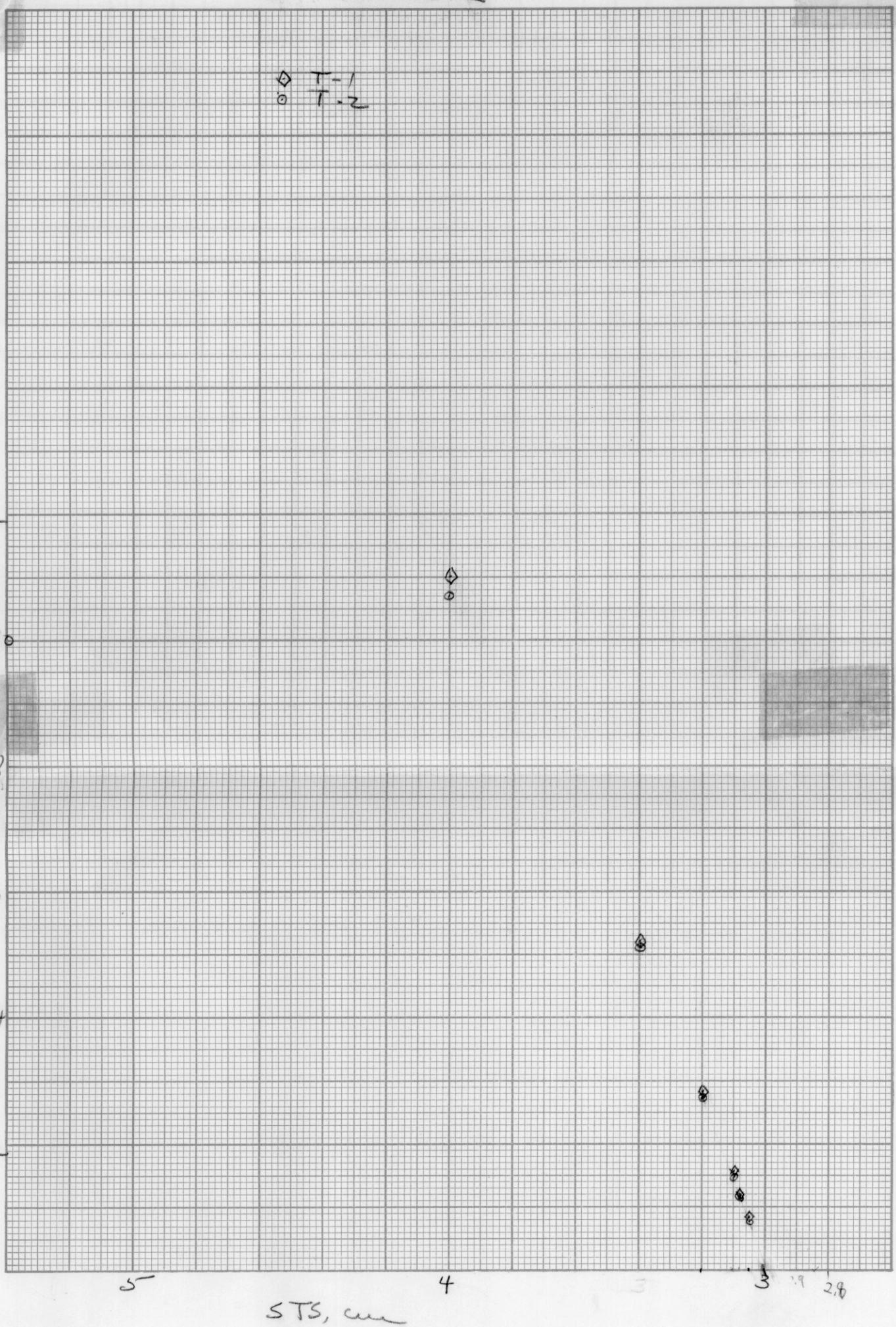
Pads: Same as B-1

Base Rate: $55.78 \times 10^5$ n/s

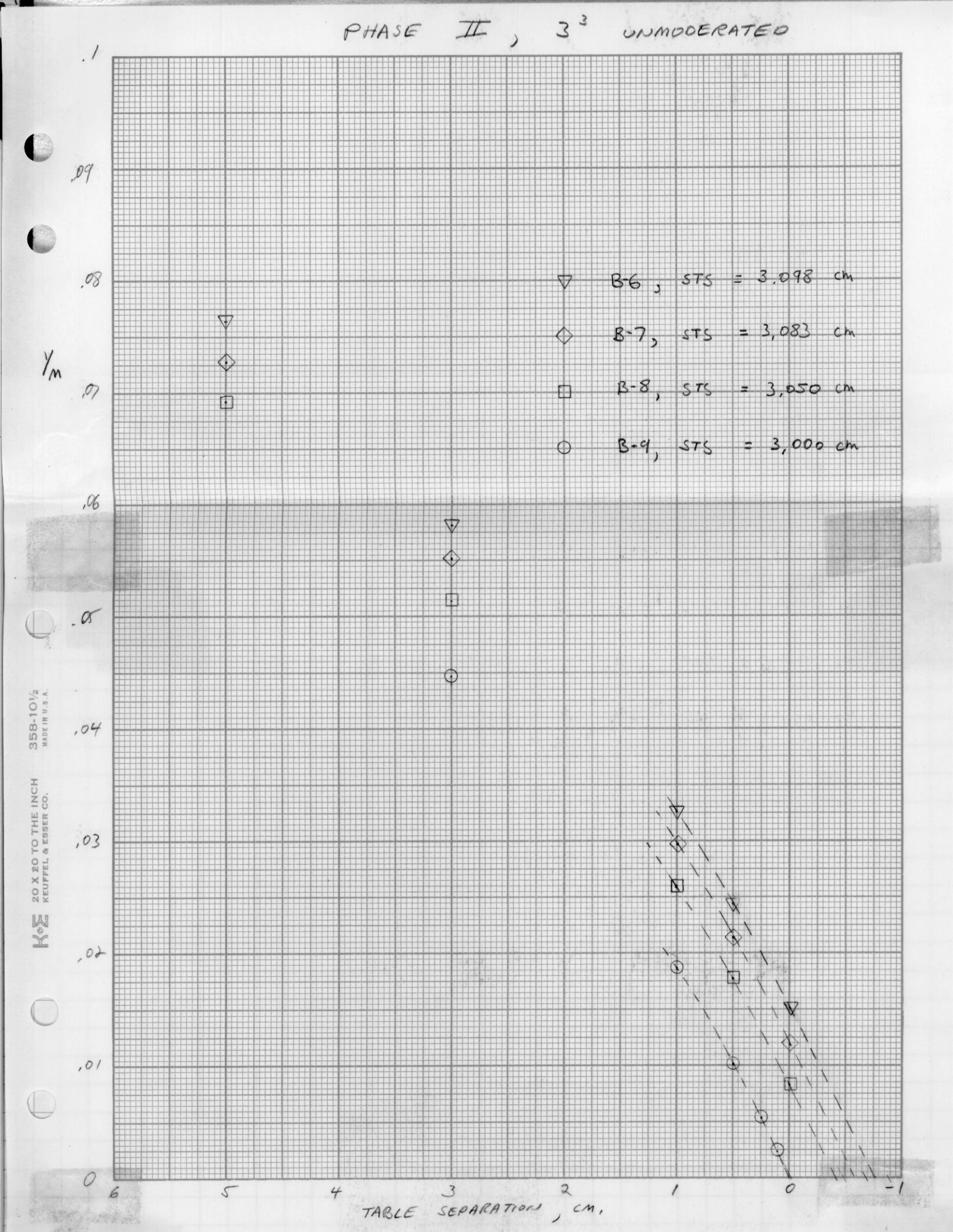
| Position | Cts T-1 | Eff. fact. | $10^5$ n/s | M | Cts T-2 | Eff. fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.814 | 21547 | $1.892 \times 10^5$ | 679.4 | 12.2 | 17050 | $2.487 \times 10^5$ | 706.8 | 12.7 |
| | 359.1 | | | | 284.2 | | | |
| | T/C's | R-69 | | | #1-85 | | #2-97 | |
| 3.001 | 38535 | " | 1215.2 | 21.8 | 30911 | " | 1281.3 | 23.0 |
| | 642.3 | | | | 515.2 | | | |
| | T/C's | R-69 | | | #1-85 | | #2-97 | |
| 0.997 | 92576 | " | 2919.4 | 52.3 | 74103 | " | 3071.7 | 55.1 |
| | 1543.0 | | | | 1235.1 | | | |
| | T/C's | R-69 | | | #1-83 | | #2-89 | |
| 0.497 | 170301 | " | 5370.3 | 96.3 | 138024 | " | 5721.1 | 102.6 |
| | 2838.4 | | | | 2300.4 | | | |
| | T/C's | R-69 | | | #1-83 | | #2-89 | |
| 0.246 | 321788 | " | 10,147 | 181.9 | 259441 | " | 10,754 | 192.8 |
| | 5363.1 | | | | 4324.0 | | | |
| | T/C's | R-69 | | | #1-83 | | #2-89 | |
| 0.102 | 730533 | " | 23,037 | 413 | 598580 | " | 24810 | 445 |
| | 12176 | | | | 9976 | | | |
| | T/C's | R-69 | | | #1-83 | | #2-89 | |

Could not complete closure of table

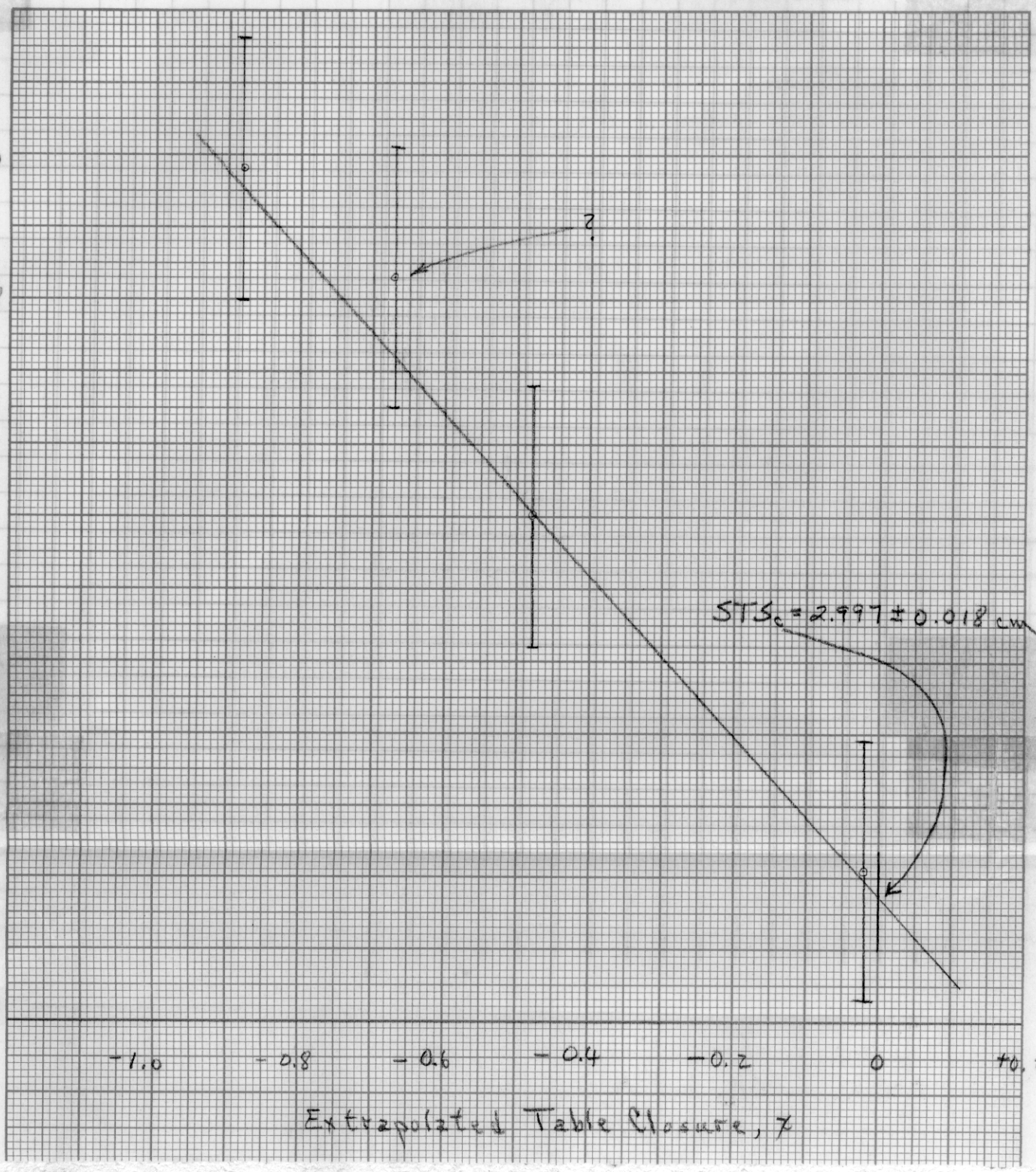
3³ Phase II




K&E 20 X 20 TO THE INCH KEUFFEL & ESSER CO. 358-10½ MADE IN U.S.A.


PHASE II, $3^3$ UNMODERATED
.1
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
$Y_m$
B-6, STS = 3.098 cm
B-7, STS = 3,083 cm
B-8, STS = 3,050 cm
B-9, STS = 3,000 cm
6
5
4
3
2
1
0
-1
TABLE SEPARATION, CM.
358-10½ MADE IN U.S.A.
20 X 20 TO THE INCH KEUFFEL & ESSER CO.

Phase II, $3^3$ unmodulated




K+E 10 X 10 TO THE ½ INCH 359-11 MADE IN U.S.A. KEUFFEL & ESSER CO.

From graph on p 23 we get schedule

| STS, cm | Extrapolated Table Closure, cm |
|---|---|
| 3.098 | 0.88 |
| 3.083 | 0.67 |
| 3.050 | 0.48 |
| 3.005 | 0.02 |

Discussion of the uncertainties in result:

We have the following components in the uncertainties in STS:

(1) STS(x, y): lateral clearances of fillets in tubes: ± 0.010 in ± 0.025 cm

(2) STS(x, y): lateral precision in tube positioning: ± 0.010 in ± 0.025 cm

(3) STS(z) has the weakest accuracy ± 0.001 in ± 0

Then the uncertainty in STS(x) = STS(y) is gotten by rule for summation of random fluctuations:

$$\sigma = \sqrt[2]{x_{(1)}^2 + x_{(2)}^2} = \sqrt[2]{2 \times 0.025^2} = (0.00125)^{1/2} = 0.035 \text{ cm}$$

We then get $\bar{\sigma}$ for STS(x, y, z) by averaging, taking into account the relative worth of STS(z)

| | |
|---|---|
| $\sigma_x$ : | 0.035 |
| $\sigma_y$ : | 0.035 |
| $2 \times \sigma_z$ : | 2 × 0 |
| | 4 \| 0.070 |
| $\bar{\sigma}$ STS(x, y, z) = | 0.018 cm ~ (0.007 in) |

This is wrong

JRM

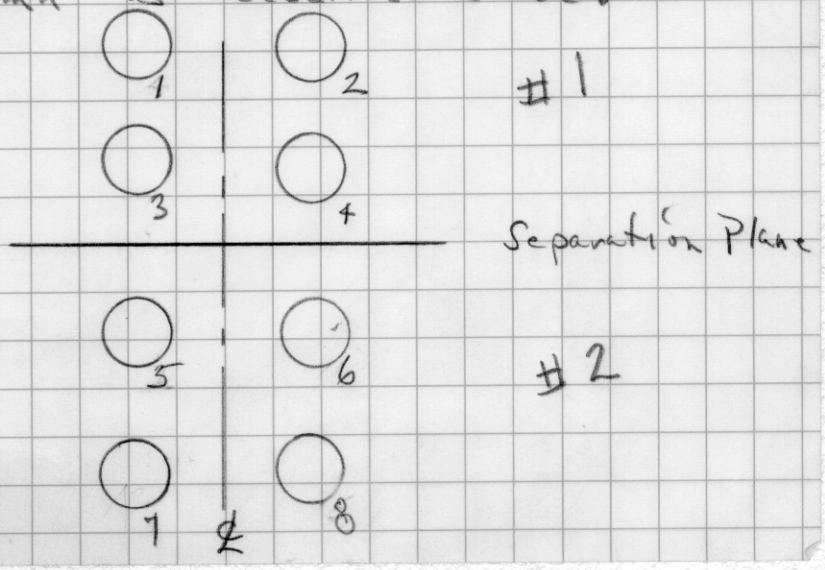
ASIDE ON SOURCE HOLDER:
SOURCE NOW ATTACHED TO BALL CHAIN WHICH RUNS THROUGH CENTERING FIXTURE (WHICH FITS IN TOP OF COLUMN) COMPLETE WITH GEARED COUNTER. AT 00000 COUNTER SETTING, SOURCE HANGS DOWN $10\frac{1}{2}$", AND COUNTER "CALIBRATION" IS 26"/100. TO SET SOURCE HALF WAY DOWN WE HAVE CHOSEN

$110 = 10\frac{1}{2} + 28.6 = 39.1$" FROM TOP.

3-28-67

The source of our error in the top datum blocks as described on pages 4, 8 & 9 was found to be our safety beam used for column support while loading the table. When clamping the safety beam the datum blocks separated by about 5-6 mils. We will have to modified our clamping of this beam.

We will now do an eff. factor determination for the array as shown below with the source located in the column as described above.



## Eff. Factor Determinations (Source: MRC 8-7, $1.3 \times 10^7$ n/s)

| | | T-1 | T-2 |
|---|---|---|---|
| Col. 1 | Count Rates: | | |
| | c/m | 17448/4 | 13899/4 |
| | c/s | 72.70 | 57.91 |
| | Eff. | $5.59 \times 10^{-6}$ | $4.45 \times 10^{-6}$ |
| | Eff. Factor | $1.79 \times 10^5$ | $2.25 \times 10^5$ |
| Col. 2 | Count Rates: | | |
| | c/m | 18566/4 | 12894/4 |
| | c/s | 77.36 | 53.7 |
| | Eff. | $5.95 \times 10^{-6}$ | $4.13 \times 10^{-6}$ |
| | Eff. Factor | $1.68 \times 10^5$ | $2.42 \times 10^5$ |
| Col. 3 | Count Rates: | Assume same as 5 | |
| | c/m | | |
| | c/s | | |
| | Eff. | | |
| | Eff. Factor | $1.98 \times 10^5$ | $2.43 \times 10^5$ |
| Col. 4 | Count Rates: | Assume same as 6 | |
| | c/m | | |
| | c/s | | |
| | Eff. | | |
| | Eff. Factor | $1.89 \times 10^5$ | $2.58 \times 10^5$ |
| Col. 5 | Count Rates: | | |
| | c/m | 15724/4 | 12844/4 |
| | c/s | 65.52 | 53.52 |
| | Eff | $5.04 \times 10^{-6}$ | $4.12 \times 10^{-6}$ |
| | Eff. Factor | $1.98 \times 10^5$ | $2.43 \times 10^5$ |

Col. 6 Count Rates:

| | T-1 | T-2 |
|---|---|---|
| C/m | 16487/4 | 12083/4 |
| C/s | 68.70 | 50.35 |
| Eff. | $5.28 \times 10^{-6}$ | $3.87 \times 10^{-6}$ |
| Eff. Factor | $1.89 \times 10^{5}$ | $2.58 \times 10^{5}$ |

Col. 7 Count Rates:

| | | |
|---|---|---|
| C/m | 16722/4 | 14086/4 |
| C/s | 69.68 | 58.69 |
| Eff. | $5.36 \times 10^{-6}$ | $4.51 \times 10^{-6}$ |
| Eff. Factor | $1.87 \times 10^{5}$ | $2.22 \times 10^{5}$ |

Col. 8 Count Rates:

| | | |
|---|---|---|
| C/m | 18799/4 | 13290/4 |
| C/s | 78.33 | 55.38 |
| Eff. | $5.88 \times 10^{-6}$ | $4.26 \times 10^{-6}$ |
| Eff. Factor | $1.70 \times 10^{5}$ | $2.35 \times 10^{5}$ |
| Avg. = | $1.85 \times 10^{5}$ | $2.41 \times 10^{5}$ |

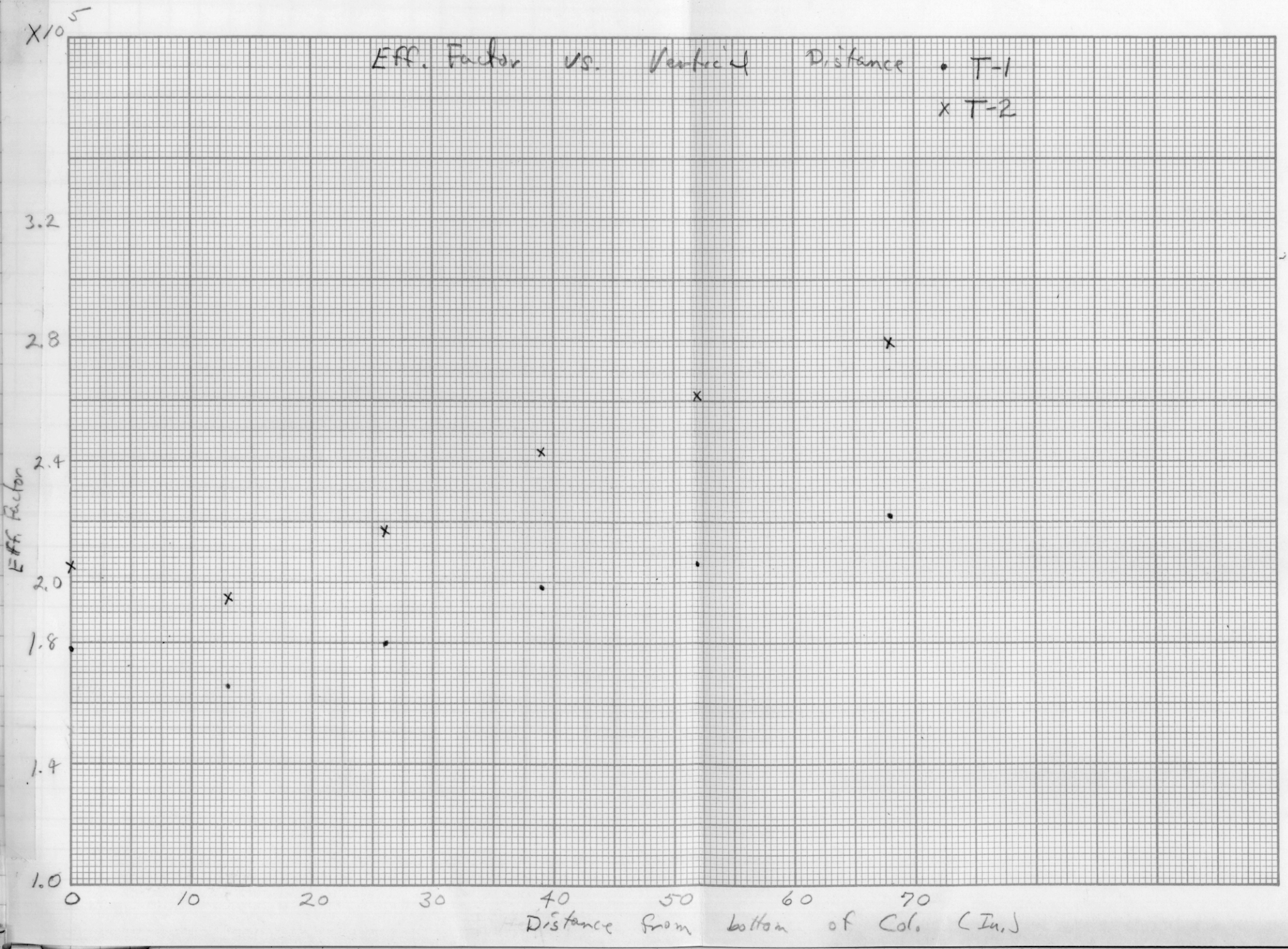
We will now check the vertical variations in the eff. factors. We will place the col. in position 5.

Vertical Position = 00262 (Bottom of tube)
(Indicator)

Count Rates:

| | T-1 | T-2 |
|---|---|---|
| C/m | 17549/4 | 15185/4 |
| C/s | 73.12 | 63.27 |
| Eff. | $5.62 \times 10^{-6}$ | $4.87 \times 10^{-6}$ |
| Eff. Factor | $1.78 \times 10^{5}$ | $2.05 \times 10^{5}$ |

K+E 20 X 20 TO THE INCH KEUFFEL & ESSER CO. 358-10½ MADE IN U.S.A.



Vertical Position = 00212 ≈ 13" from bottom of column

| | T-1 | T-2 |
|---|---|---|
| Count Rates: | | |
| C/m | 18755/4 | 15990/4 |
| C/s | 78.15 | 66.6 |
| Eff. | $6.01 \times 10^{-4}$ | $5.12 \times 10^{-6}$ |
| Eff. Factor | $1.66 \times 10^{5}$ | $1.95 \times 10^{5}$ |

Vertical Position = 00162 ≈ 26" from bottom of column

| | | |
|---|---|---|
| Count Rates: | | |
| C/m | 17310/4 | 14350/4 |
| C/s | 72.13 | 59.79 |
| Eff. | $5.55 \times 10^{-4}$ | $4.60 \times 10^{-6}$ |
| Eff. Factor | $1.80 \times 10^{5}$ | $2.17 \times 10^{5}$ |

Vertical Position = 00060 ≈ 52" from bottom of column

| | | |
|---|---|---|
| Count Rates: | | |
| C/m | 15142/4 | 11913/4 |
| C/s | 63.09 | 49.64 |
| Eff. | $4.85 \times 10^{-6}$ | $3.82 \times 10^{-6}$ |
| Eff. Factor | $2.06 \times 10^{5}$ | $2.62 \times 10^{5}$ |

Vertical Position = 00000

| | | |
|---|---|---|
| Count Rates: | | |
| C/m | 13828/4 | 11196/4 |
| C/s | 57.62 | 46.65 |
| Eff. | $4.43 \times 10^{-6}$ | $3.59 \times 10^{-6}$ |
| Eff. Factor | $2.26 \times 10^{5}$ | $2.79 \times 10^{5}$ |

We will now measure multiplication for a pair of 3 kg billets at center of column in location 5 (page 25). We are using parts 1 & 2

Base Rate = $4.08 \times 10^{5}$ n/s

| CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|
| 11204/25 | $1.98 \times 10^{5}$ | 14.79 | 3.62 | 9266/25 | $2.43 \times 10^{5}$ | 15.02 | 3.68 |
| 7.47 | | | | 6.18 | | | |

We will now enclose the 6 kg unit with 1.27 cm of mock HE.

| CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|
| 13579/25 | $1.95 \times 10^{5}$ | 17.65 | 4.32 | 11106/25 | $2.39 \times 10^{5}$ | 17.69 | 4.32 |
| 9.05 | | | | 7.40 | | | |

An Eff. Factor check for the previous system will be made with the source inside the mock HE.

Count Rates:

| | T-1 | T-2 |
|---|---|---|
| c/m | 12036/3 | 9778/3 |
| c/s | 66.87 | 54.32 |
| Eff. | $5.14 \times 10^{-6}$ | $4.18 \times 10^{-6}$ |
| Eff. Factor | $1.95 \times 10^{5}$ | $2.39 \times 10^{5}$ |

This is same eff. factors as determined for the bare column. We will now place a column with moderator at position 6. To see what effect if any more moderator has on the eff. factors.

Count Rates:

| | | |
|---|---|---|
| c/m | 10879/3 | 9837/3 |
| c/s | 60.44 | 54.65 |
| Eff | $4.65 \times 10^{-6}$ | $4.20 \times 10^{-6}$ |
| Eff. Factor | $2.15 \times 10^{5}$ | $2.38 \times 10^{5}$ |

Columns with centered mock HE were placed at positions 7 and 8 and there was no change in eff. factors.

A cell of mock HE was placed below and above the center cell on column 6 at a spacing of ~ 6 in. and there was no effect on eff. factors

I will take the avg. eff. factors for the bare annay* and increase them 5% to account for the effect of added mock HE.

∴ our eff. Factors for the moderated annay safety experiments will be as shown below.

* T-1 = $1.95 \times 10^5$ T-2 = $2.43 \times 10^5$

| | T-1 | T-2 |
|---|---|---|
| Eff. Factor = | $2.08 \times 10^5$ | $2.55 \times 10^5$ |

An new $STS_c$ for the 4" mod. has been received from G. Petley. For STS = 20. cm, K = .90 ∴ $\$ = \frac{\Delta K}{K\beta} \simeq \frac{\Delta K}{\beta} = \frac{0.1}{.002} = 5^-0$

For $STS_x = STS_y = 20$ cm and $STS_z = 14$ cm, K = .93 and if we assume $(x) = (y) = {}^3(z)$

$$\$ = \frac{\Delta K}{\beta} = \frac{.07}{.002} = 35^-$$

ERROR HERE

$$\therefore \frac{\$35^-}{6\text{ cm}} \simeq 6\,\$/\text{cm}$$

$$\therefore \frac{\$5^-0}{3} \simeq \$17. \text{ in } x, y \text{ and } z \text{ which will be}$$

$\simeq$ 3 cm ∴ $STS_c$ = 17 cm.

But through mutual agreement(?) we will set up STS = 16.0 cm for our safety experiments

We will now look at 2 6kg units moderated with 1.27 cm of mock HE centered in col. 5. Parts 1, 3, 3, +4. Base Rate = $8.12 \times 10^5$ n/s

| CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|
| 11169/10 | $1.95 \times 10^5$ | 36.31 | 4.52 | 8882/10 | $2.39 \times 10^5$ | 35.37 | 4.40 |
| 18.62 | | | | 14.80 | | | |

We will now look at 3 6 kg units moderated with 1.27 cm of mock HE centered in Col. 5. Parts 1, 2, 3, 4, 5, +6
Base Rate = $12.11 \times 10^5$ n/s

| CTS T-1 | Eff Factor | $10^5$ n/s | M | CTS T-2 | Eff Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|
| 16466/10 | $1.95 \times 10^5$ | 53.51 | 4.43 | 12586/10 | $2.35 \times 10^5$ | 51.77 | 4.29 |
| 27.44 | | | | 21.66 | | | |

3-30-67

The previous assembly was counted again.

T-1 = 16466/10 T-2 = 13269/10

We will now look at 4 6 Kg units moderated with 1.27 cm of mock HE centered in Col. 5 Parts 1, 2, 3, 4, 5, 6, 8, +9
Base Rate = $16.15 \times 10^5$ n/s

| CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|
| 22120/10 | $1.95 \times 10^5$ | 71.90 | 4.45 | 17807/10 | $2.35 \times 10^5$ | 70.94 | 4.39 |
| 36.87 | | | | 29.68 | | | |

$\bar{M} = 4.42$

We will now move Col. 5 to position 6

| CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|
| 23584/10 | $1.89 \times 10^5$ | 74.30 | 4.60 | 16766/10 | $2.58 \times 10^5$ | 72.09 | 4.46 |
| 39.31 | | | | 27.94 | | | |

$\bar{M} = 4.53$

We will now move to position 8.

| CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|
| 25618/10 | $1.70 \times 10^{-5}$ | 72.59 | 4.50 | 18374/10 | $2.35 \times 10^{-5}$ | 71.96 | 4.46 |
| 42.70 | | | | 30.62 | | | |

$\bar{M} = 4.48$

We will now move to position 2

| CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|
| 12716/5 | $1.68 \times 10^{-5}$ | 71.22 | 4.41 | 9239/5 | $2.42 \times 10^{-5}$ | 74.57 | 4.62 |
| 42.39 | | | | 30.80 | | | |

$\bar{M} = 4.51$

Avg. Mult. for 1 Col. $\Sigma\bar{M} = 4.49$

Assembly C-1: Pu to Pu = 16.02 cm

Lateral Spacing: 0.714 cm fixed + 15.286 cm = 16.00 cm

Vertical Spacing: 0.108* cm fixed + 15.914 cm = 16.022 cm

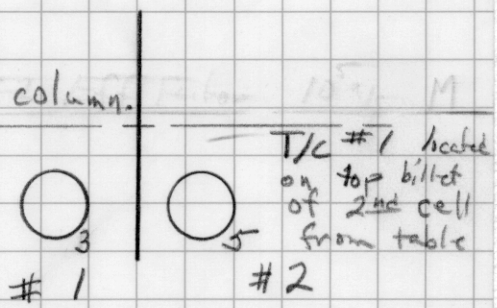
Moderator Thickness per 6 Kg cell = 1.27 cm

Parts: 1, 2, 3, 8, 5, 6, 8, 9, 10, 11, 12, 13, 18, 15, 16, 17

Base Rate = $32.47 \times 10^5$ n/s

2 columns of 4 6Kg units per column.

* FROM THIS POINT ON THE CORRECTED VALUE OF .108 cm



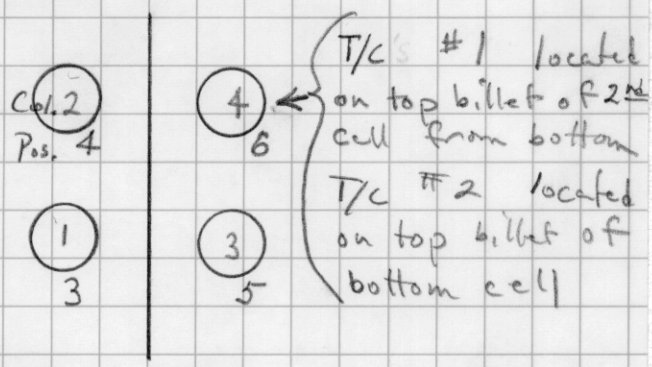

| Position | CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| Fast Stop | 19665/3 | $1.95 \times 10^{-5}$ | 158.87 | 4.89 | 11229/3 | $2.39 \times 10^{-5}$ | 149.09 | 4.59 |
| | 81.47 | | | | 62.38 | | | |
| | T/C's | # 1 = 105° F | | | Room = 68 | | | |
| -.004 | 15084/3 | $1.95 \times 10^{-5}$ | 163.41 | 5.03 | 11791/3 | $2.39 \times 10^{-5}$ | 156.28 | 4.81 |
| | 83.80 | | | | 65.39 | | | |
| | T/C's | #1 = 105 | | | Room = 69 | | | |

3-31-67

Assembly C-2: Pu to Pu = 16.01 cm

4 columns of 4 6Kg units per column

table #1




Lateral Spacing: 0.714cm fixed + 15.286 cm = 16.000 cm

Vertical Spacing: 0.108 cm fixed + 15.914 cm = 16.022 cm

Moderator Thickness per 6Kg cell = 1.27 cm

Parts: 1 – 33 with the exclusion of part #7

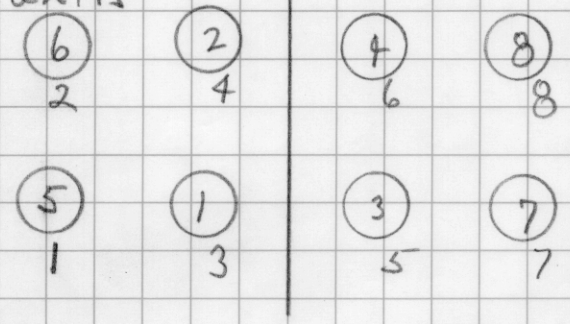
Base Rate = 65.19 $\times 10^{-5}$ n/s

| Position | CTBT-1 | Eff. Factor | $10^{-5}$ n/s | M | CTBT-2 | Eff. Factor | $10^{-5}$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.810 | 10680 | $2.04 \times 10^{-5}$ | 363.1 | 5.57 | 8184 | $2.64 \times 10^{-5}$ | 360.1 | 5.52 |
| | 178.0 | | | | 136.4 | | | |
| | T/C's | Room = 69 °F | | | #1 = 105 | | #2 = 105 | |
| +.004 | 11228 | $2.04 \times 10^{-5}$ | 381.7 | 5.85 | 8699 | $2.64 \times 10^{-5}$ | 382.8 | 5.87 |
| | 187.1 | | | | 145.0 | | | |

Assembly C-3: Pu to Pu = 16.01 cm

8 columns of 4 6Kg units

Table #1




T/C's same as for C-2

Lateral Spacing: 0.714cm fixed + 15.286 cm = 16.000 cm

Vertical Spacing: 0.108cm fixed + 15.914 cm = 16.022 cm

Moderator Thickness per 6 kg cell = 1.27 cm

Parts: 1 – 65 with the exclusion of part #7

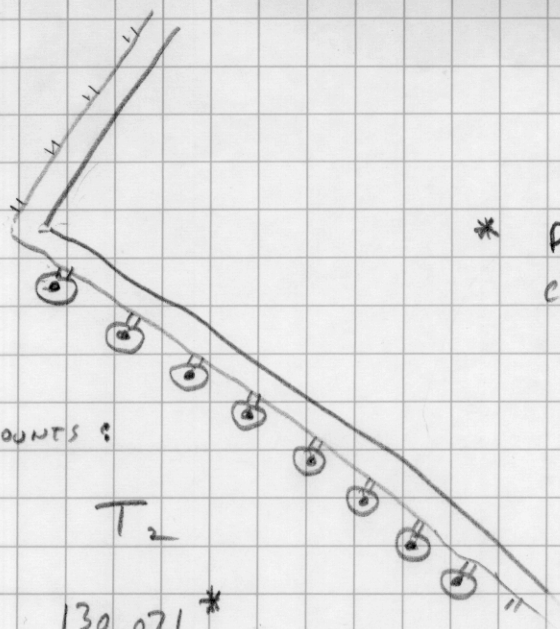
Base Rate = $129.11 \times 10^{-5}$ n/s

The temp. of the parts went to ~ 132 °F while we were loading the other columns with the fans off. We want to keep the fans on if columns with moderator are stored.

| Position | CtsT-1 | Eff. Factor | $10^{-5}$ n/s | M | CtsT-2 | Eff. Factor | $10^{-5}$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.810 | 27096 | $2.08 \times 10^{-5}$ | 939.3 | 7.28 | 21098 | $2.55 \times 10^{-5}$ | 896.6 | 6.94 |
| | 451.6 | | | | 351.6 | | | |
| | T/C's | Room = 69 | | | #1 = 128 | | #2 = 121 | |
| -.004 | 29078 | $2.08 \times 10^{-5}$ | 1008. | 7.80 | 22637 | $2.55 \times 10^{-5}$ | 962.1 | 7.45 |
| | 484.6 | | | | 377.3 | | | |

---

AT THIS STAGE, IT APPEARS A GOOD BET THAT STS = 16.00 cm FOR THE FULL ARRAY IN QUESTION WILL BE SUBCRITICAL AND A SECOND SAFETY EXPERIMENT WILL BE NEEDED. TO SAVE A GREAT DEAL OF TIME, EFFORT, & DOSE, WE WILL DO THE SECOND SET OF EXPERIMENTS NOW, WITHOUT UNLOADING ANY TUBES. TO THIS END, WE WILL TAKE SOME LONG BACKGROUND COUNTS WITH 8 COLUMNS IN THE STORAGE RACK



* DOOR OPEN THIS COUNT

10 MINUTE COUNTS:

| $T_1$ | $T_2$ |
|---|---|
| 97,820 * | 130,071 * |
| 97,867 | 130,183 |

4-3-67

Repeat on Monday Morning

| | |
|---|---|
| 97,800 | 130,931 |

∴ 6 COLUMN BACKGROUND IS: (assuming symmetric removal)

| $T_1$ | $T_2$ |
|---|---|
| 7,335 /min | 9,820 /min |

We now want to re-do the safety experiment with $STS_z = 16.00$, $STS_{xy} = 15.00$ $\quad STS_{xyz} = 15.33$

Based on the graph of K vs $\overline{STS}$ obtained from 05R calculations we can conservatively estimate the change in multiplication due to a small change in part spacing. From the above mentioned graph,

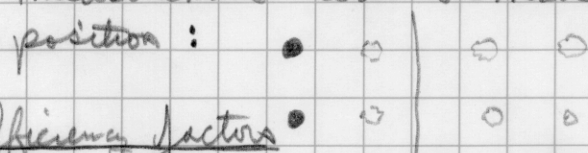
$$\Delta\, {}^{1}/_{m} \,/_{cm} = .036$$

∴ for 2/3 cm change $\Delta\, {}^{1}/_{m} = .024$

the change in multiplications expected are then:

| | | |
|---|---|---|
| 2 | parts | 4.92 → 5.56 |
| 4 | parts | 5.86 → 6.82 |
| 8 | parts | 7.63 → 9.34 |

We had intended to load 1 column on each table at the 15.0 cm (closed) spacing to check the 1st multiplication change, but found that the two operators had already started to load the table (without being instructed to do so) and columns were already in positions 1 and 2 (see page 25). It was felt that there is more hazard involved in moving columns than leaving them in position (representing an estimated multiplication of 5.56) so a measurement will be made with the columns in this position:



The estimated efficiency factors for this position are T-1 = $1.83 \times 10^5$, T-2 $2.45 \times 10^5$

Assembly C-4: $P_1$ to $P_2$ (Base rate for 2 columns was $32.47 \times 10^5$) 15.00 x,y and z. for 35

| Position | CTS 1 | $10^5$ n/s | M | CTS 2 | $10^5$ n/s | M |
|---|---|---|---|---|---|---|
| -.0045 | 61,370/5 | 150.6 | 4.64 | 66,763/5 | 144.3 | 4.44 |
| | 12,274 c/m | | | 13,353 | | |
| | - 7,335 | | | 9,820 | | |
| | 4,939 c/m | | | 3,533 c/m | | |
| | 82.3 c/s | | | 58.9 | | |

$\bar{M} = 4.54$

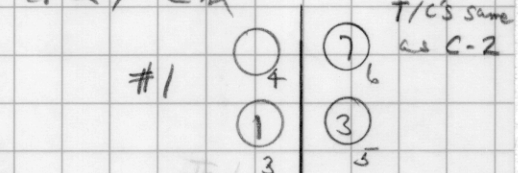
Assembly C-5: Pu to Pu = 15.00 cm in x & y, 16.02 cm in z

Lateral Spacing: 0.718 cm fixed + 14.286 cm = 15.000 cm

Vertical Spacing: 0.108 cm fixed + 15.914 cm = 16.022 cm

Moderator Thickness per 6 kg cell = 1.27 cm

Parts:




Base Rate = Assume $65.15 \times 10^5$ n/s

| Position | CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.810 | 15730 | $2.04 \times 10^5$ | 368.6 | 5.65 | 14596 | $2.64 \times 10^5$ | 354.3 | 5.43 |
| Bkg | - 4890 | | | Bkg | - 6547 | | | |
| | 10840 | | | | 8049 | | | |
| | 180.7 | | | | 134.2 | | | |

T/C's 5 Room = 69 #1 = 118 #2 = 118

| Position | CTS T-1 | Eff. Factor | $10^5$ n/s | M | CTS T-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| -.005 | 16089 | $2.04 \times 10^5$ | 380.9 | 5.84 | 15124 | $2.64 \times 10^5$ | 377.5 | 5.79 |
| | -4490 | | | | -6547 | | | |
| | 11199 | | | | 8577 | | | |
| | 186.7 | | | | 143.0 | | | |

T/C's Room = 69 #1 = 110 #2 = 112

Assembly C-6 : Pu to Pu = 15.00 cm in x, y, 16.02 cm in z

Lateral Spacing: 0.718 cm fixed + 14.286 cm = 15.000 cm

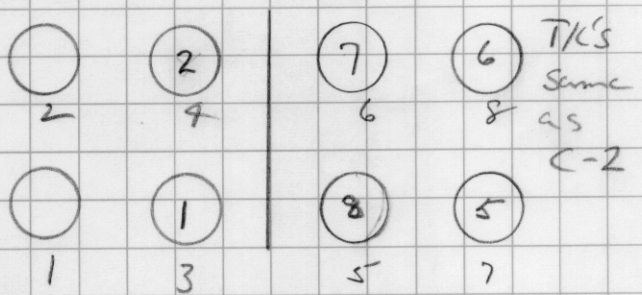
Vertical Spacing: 0.108 cm fixed + 15.914 cm = 16.022 cm

Moderator Thickness per 6 Kg Cell = 1.27 cm

Parts : 1-65 with the exclusion of part #7

Base Rate = $129.11 \times 10^5$ n/s

& column of 4 6 Kg units #1

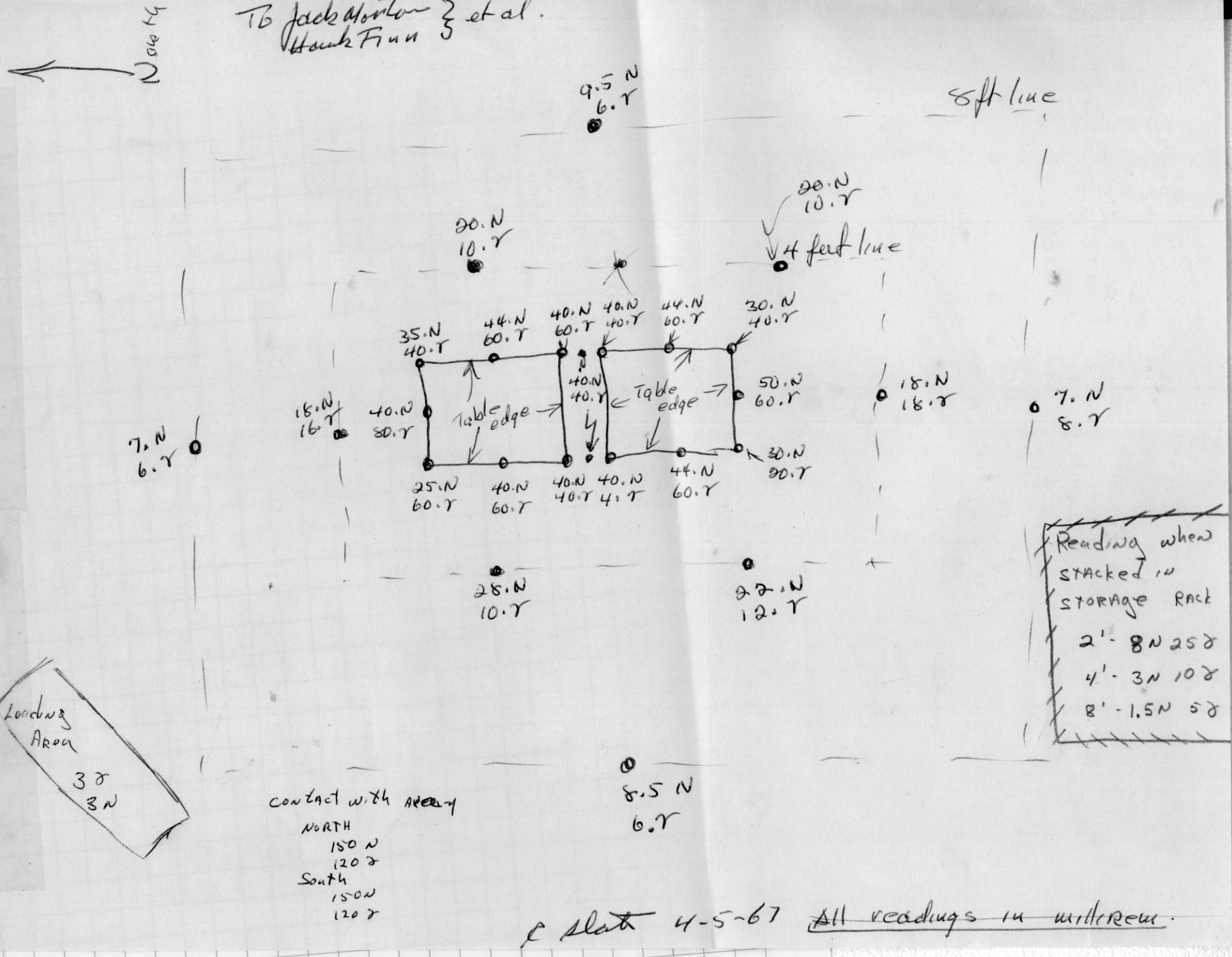



| Pos | CTS1 | Eff Fact | $10^5$ n/s | M | CTS-2 | Eff Fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.816 | 28071/1 | $2.08 \times 10^5$ | 973.1 | 7.54 | 21902/1 | $2.55 \times 10^5$ | 930.8 | 7.21 |
| | 467.85 | | | | 365.03 | | | |

| | #1 | #2 | room |
|---|---|---|---|
| Temps | 112°, | 114°, | 69° |

| Position | CTS-1 | Eff Fact | $10^5$ n/s | M | CTS-2 | Eff Fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| -.005 | 30,010 | $2.08 \times 10^5$ | 1040.3 | 8.06 | 23,249 | $2.55 \times 10^5$ | 988.07 | 7.65 |
| | 500.16 | | | | 387.48 | | | |

$\bar{M} = 7.86$


To Jack Morton & et al.
Hawk Finn
Lake
9.5 N
6.Y
8ft line
20.N
10.Y
4 feet line
20.N
10.Y
35.N
40.Y
44.N
60.Y
40.N
60.Y
40.N
40.Y
44.N
60.Y
30.N
40.Y
18.N
16.Y
40.N
80.Y
Table edge
40.N
40.Y
Table edge
50.N
60.Y
30.N
80.Y
25.N
60.Y
40.N
60.Y
40.N
40.Y
40.N
4.Y
44.N
60.Y
18.N
18.Y
7.N
8.Y
7.N
6.Y
28.N
10.Y
22.N
12.Y
Reading when stacked in storage rack
2'- 8N 25Y
4'- 3N 10Y
8'- 1.5N 5Y
Loading Area
3Y
3N
8.5 N
6.Y
contact with Area
North
150 N
120 Y
South
150N
120 Y
Slate 4-5-67 All readings in milliRem.

Assembly C-7: Pu to Pu = 40.00 cm in x, y, 16.02 in z

$4^3$ Moderated 6 Kg array.

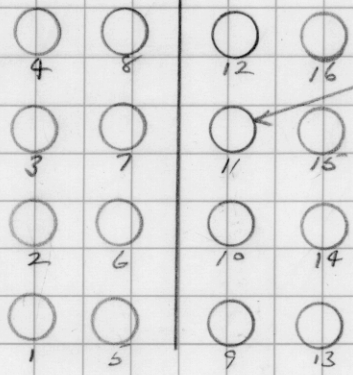
Lateral Spacing: 0.714 cm * 39.286 cm = 40.000 cm

Vertical Spacing: 0.108 m * 15.918 cm = 16.022 cm

Moderator Thickness per 6 Kg cell = 1.27 cm

Parts: 1 - 129 with the exclusion of # 7

Base Rate = 259.38 $\times 10^{-5}$ n/s




#1

T/C #1 located on top part 2nd cell from bottom. T/C #2 located on top part of bottom cell.

| Position | Cts T-1 | Eff. Factor | $10^{-5}$ n/s | M | Cts T-2 | Eff. Factor | $10^{-5}$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.826 | 48286 | $2.08 \times 10^{-5}$ | 1678. | 6.45 | 38078 | $2.55 \times 10^{-5}$ | 1618.23 | 6.24 |
| | 804.8 | | | | 634.6 | | | |

$\bar{M} = 6.35$

T/C's Room = 69 °F #1 = 110 #2 = 109

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| -.004 | 48537 | $2.08 \times 10^{-5}$ | 1683. | 6.49 | 38617 | $2.55 \times 10^{-5}$ | 1641. | 6.33 |
| | 809.0 | | | | 643.6 | | | |

$\bar{M} = 6.41$

T/C's Room = 69 °F #1 = 107 #2 = 107

$\left(\bar{M} = 6.41, \frac{1}{\bar{M}} = .1560\right)$

4-6-67

We will check eff. factors for the previous assembly. The source MRC 8-7 will be located at indicator position 110 in the column for this check. We will first do the check with one bare column at different locations on table # 2 as shown on page 38.

BKg: T-1 = 19513 T-2 = 55193

Position # 13

| Count Rates: | T-1 | T-2 |
|---|---|---|
| | 69358/3 | 179078/3 |
| C/m + BKg | 23119 | 59693 |
| BKg. | 19513 | 55193 |
| C/m | 3606 | 4500 |
| C/s | 60.1 | 75.0 |
| Eff. | $4.62 \times 10^{-6}$ | $5.77 \times 10^{-6}$ |
| Eff. Factor | $2.16 \times 10^{5}$ | $1.73 \times 10^{5}$ |

Position # 9

| Count Rates: | T-1 | T-2 |
|---|---|---|
| | 68965/3 | 178633/3 |
| C/m + BKg | 22988 | 59544 |
| BKg | 19513 | 55193 |
| C/m | 3475 | 4351 |
| C/s | 57.92 | 72.5 |
| Eff. | $4.46 \times 10^{-6}$ | $5.58 \times 10^{-6}$ |
| Eff. Factor | $2.24 \times 10^{5}$ | $1.79 \times 10^{5}$ |

Position #10

| Count Rates: | 70357/3 | 177998/3 |
|---|---|---|
| C/m + BKg | 23452 | 59333 |
| BKg | 19513 | 55193 |
| C/m | 3939 | 4140 |
| C/s | 65.65 | 69.00 |
| Eff. | $5.05 \times 10^{-6}$ | $5.31 \times 10^{-6}$ |
| Eff. Factor | $1.98 \times 10^{5}$ | $1.88 \times 10^{5}$ |

Position # 11

Count Rates

| | T-1 | T-2 |
|---|---|---|
| | 72855/3 | 176092/3 |
| G/m + BKg | 24265 | 58697 |
| BKg | 19513 | 55193 |
| G/m | 4752 | 3504 |
| G/s | 79.20 | 58.40 |
| Eff. | $6.09 \times 10^{-6}$ | $4.49 \times 10^{-6}$ |
| Eff. Factor | $1.64 \times 10^{5}$ | $2.23 \times 10^{5}$ |

Position # 12

Count Rates

| | T-1 | T-2 |
|---|---|---|
| | 74021/3 | 175892/3 |
| G/m + BKg | 24677 | 58497 |
| BKg | 19573 | 55193 |
| G/m | 5164 | 3304 |
| G/s | 86.07 | 55.07 |
| Eff. | $6.62 \times 10^{-6}$ | $4.24 \times 10^{-6}$ |
| Eff. Factor | $1.51 \times 10^{5}$ | $2.36 \times 10^{5}$ |

Position # 14

Count Rates:

| | T-1 | T-2 |
|---|---|---|
| | 70820/3 | 178149/3 |
| G/m + BKg | 23607 | 59380 |
| BKg | 19513 | 55193 |
| G/m | 4094 | 4187 |
| G/s | 68.23 | 69.78 |
| Eff. | $5.25 \times 10^{-6}$ | $5.37 \times 10^{-6}$ |
| Eff. Factor | $1.90 \times 10^{5}$ | $1.86 \times 10^{5}$ |

Position # 15

Count Rates:

| | T-1 | T-2 |
|---|---|---|
| | 72199/3 | 176234/3 |
| G/m + BKg | 24049 | 58741 |
| BKg | 19513 | 55193 |
| G/m | 4536 | 3548 |
| G/s | 75.60 | 59.13 |
| Eff. | $5.82 \times 10^{-6}$ | $4.55 \times 10^{-6}$ |
| Eff. Factor | $1.72 \times 10^{5}$ | $2.20 \times 10^{5}$ |

Position #16

| Count Rates: | | I-1 | I-2 |
|---|---|---|---|
| | g/m + BKg | 73907/3 | 175882/3 |
| | BKg | 24636 | 58627 |
| | g/m | 19513 | 55193 |
| | g/s | 5123 | 3434 |
| | Eff. | 85.38 | 57.23 |
| | Eff. Factor | $6.57 \times 10^{-6}$ | $4.40 \times 10^{-6}$ |
| | Avg. | $1.52 \times 10^{5}$ | $2.27 \times 10^{5}$ |
| | | $1.83 \times 10^{5}$ | $2.09 \times 10^{5}$ |

It seems there is a problem with T-2 due maybe to the coh stored in the storage rack on the west wall.

ASSEMBLY C-8 Pu to Pu = 28.654 cm in X, 16.02 in Z

$4^3$ Moderated, 6 Kg array

Lateral Spacing: .714 cm + 27.940 = 28.654 cm

Vertical Spacing: .108 cm + 15.914 = 16.022 cm

Moderator Thickness per 6 Kg cell = 1.27 cm

Parts: 1 — 129 w/o #7

Base Rate = 259.38 $\times 10^{5}$ n/s

T/C's Same as C-7

| Position | CTS T-1 | Eff Factor | $10^5$ n/s | M | CTS T-2 | Eff Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.809 | 52686 | $2.08 \times 10^{-5}$ | 1826.4 | 7.04 | 42242 | $2.55 \times 10^{-5}$ | 1795.2 | 6.92 |
| | 878.1 | | | | 704.0 | | | |

T/C's Room = 69 #1 = 98 #2 = 101

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| -.005 | 53652 | $2.08 \times 10^{-5}$ | 1860. | 7.17 | 43369 | $2.55 \times 10^{-5}$ | 1843.1 | 7.11 |
| | 898.2 | | | | 722.8 | | | |

T/C's Room = 69 #1 = 99 #2 = 104

($\bar{m} = 7.14$, $\frac{1}{m} = .1401$)

7-10-67

Assembly C-9, Pu to Pu = 21.987 cm in x-y, 16.02 in z

$4^3$ Moderated, 6 Kg Array

Lateral Spacing : .714 cm + 21.273 = 21.987 cm
Vertical Spacing : .108 cm + 15.914 = 16.022 cm

Moderator Thickness per 6 Kg cell = 1.27 cm

Parts : 1-129 less # 7

Base Rate : 259,38 $\times 10^5$ n/s

T/C's Same as C-7

| Pos. | Cts T-1 | Eff Fact | $10^5$ n/s | M | Cts T-2 | Eff Fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.813 | 59683/1 → 994.7 | $2.08 \times 10^5$ | 2069.0 | 7.98 | 47467/1 → 791.1 | $2.55 \times 10^5$ | 2017.3 | 7.78 |

($\bar{M} = 7.88$)

TC's:

(#1 - 104, #2 - 109, Room = 70)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| -.005 | 62650/1 → 1044.2 | $2.08 \times 10^5$ | 2171.9 | 8.37 | 49766/1 → 829.4 | $2.55 \times 10^5$ | 2115.0 | 8.15 |

($\bar{M} = 8.26$, $\frac{1}{M} = .1211$)

Assembly C-10 Pu to Pu = 18.494 in x-y, 16.02 in z

Everything same as above except:

Lateral Spacing : .714 cm + 17.780 cm = 18.494 cm

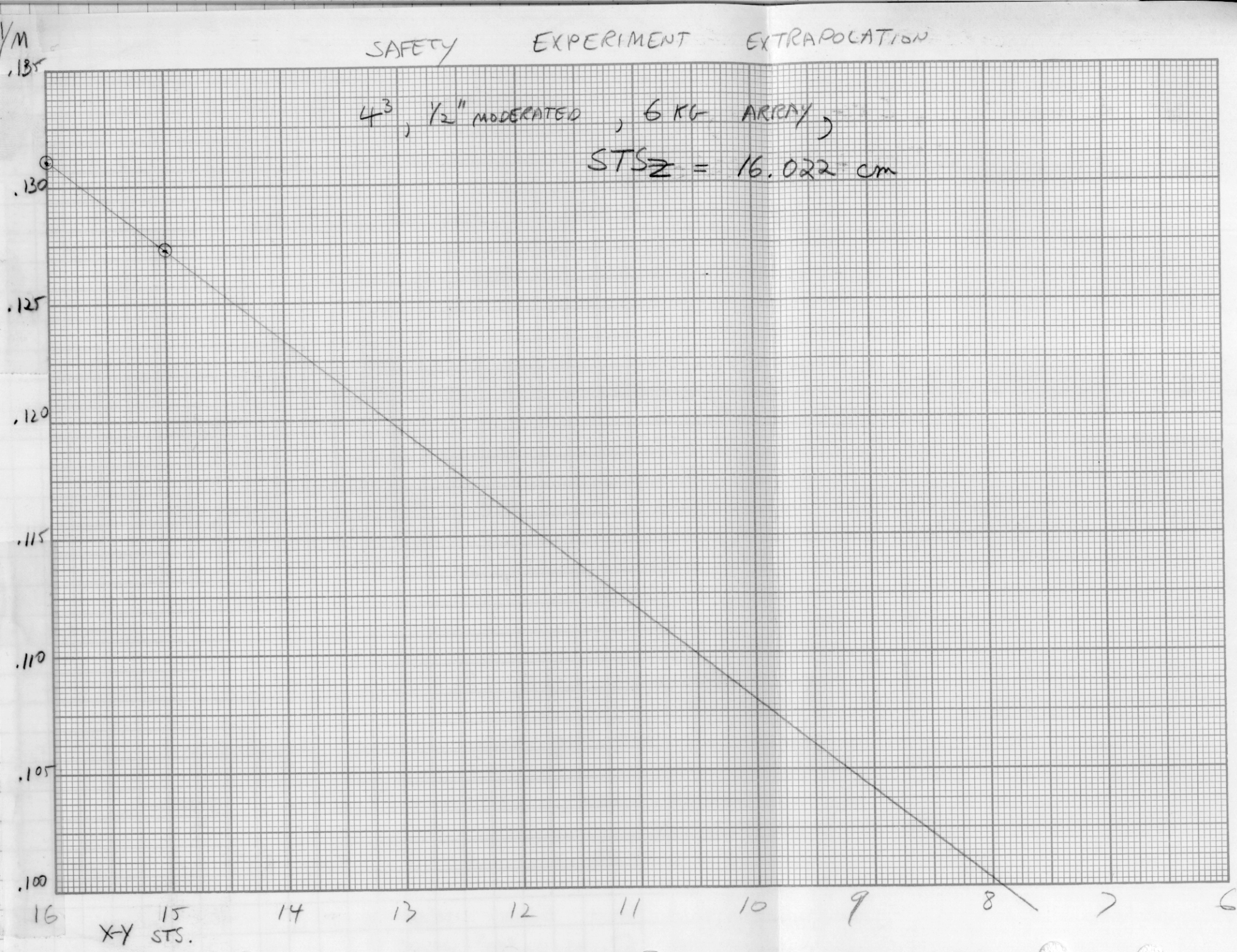
T.C.'s: #1 113°F, #2 115°F, Room 69°F

| Position | Cts-1 | Eff Fact | $10^5$ n/s | M | Cts-2 | Eff Fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.819 cm | 67,121 → 1,118.7 | $2.08 \times 10^5$ | 2326.9 | 8.97 ↓ | 53,753 → 895.9 | $2.55 \times 10^5$ | 2284.5 | 8.81 ↓ |

$\bar{M} = 8.89$

TC's #1 105°F, #2 110°F

SAFETY EXPERIMENT EXTRAPOLATION




K&E 20 X 20 TO THE INCH KEUFFEL & ESSER CO. MADE IN U.S.A. 358-10½

(Base Rate = 259.38 $\times 10^5$ n/s)

| Pos | Cts-1 | Eff Fact | $10^5$ n/s | M | Cts-2 | Eff Fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| -.004 | 73 099 | $2.08 \times 10^5$ | 2534.1 | 9.77 | 58 683 | $2.55 \times 10^5$ | 2494.2 | 9.62 |
| | 1,218.3 | | | | 978.1 | | | |

($\bar{M} = 9.69$ $1/\bar{M} = .1032$)

4/11/67

ASSEMBLY C-11 Pu to Pu 15 cm x-y, 16 cm z

$4^3$ MODERATED (½") 6 KG ARRAY

LATERAL SPACING: .714 cm + 14.288 = 15.002 cm
VERTICAL SPACING: .108 cm + 15.914 = 16.022 cm

BASE RATE: 259.38 $\times 10^5$ n/s

| Pos: | Cts-1 | Eff Fact | $10^5$ n/s | M | Cts-2 | Eff Fac | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.824 | 87,057 | $2.08 \times 10^5$ | 3017.8 | 11.63 | 70,638 | $2.55 \times 10^5$ | 3002.1 | 11.57 |
| | 1,450.9 | | | | 11,773 | | | |

[T.C.'S = #1-98°F, #2-97°F, Room 69°F]

$\bar{M} = 11.60$
$1/\bar{M} = .08621$

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| -.005 | 104,514 | | 3567.0 | 13,75+ | 84,476 | | 3590.1 | 13.84+ |
| | 1,714.9 | | | | 1,407.9 | | | |

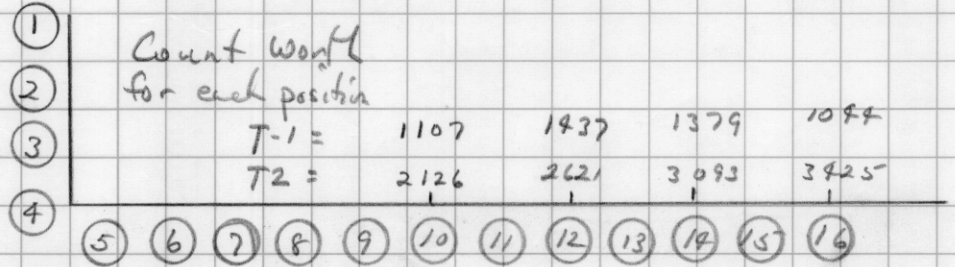
$\bar{M} = 13.80$
$1/\bar{M} = .07246$

At this point we are forced to come to a temporary halt to the 16 column array proceedings because we have reached the limit of what our safety experiments permit us to do. (It is readily apparent that the calculations by the Theoretical group were greatly in error and we are now proceeding on our own.) The next step is to determine the spacing for a new set of safety experiments. The safety experiments previously completed ($z = 16.02$, $x\text{-}y = 16.000, 15.000$) allow us to extrapolate to $x\text{-}y = 7.95$ for $M = 10$. Further, The 1st 5 points in the 16 column (FUEL) array experiments allow us to confidently predict that the critical x-y STS will be greater than 7 cm. (probably greater than 8 cm). Still further, CSM # 60 restricts the range of desired x-y STS to $32 \leq \leq 8$. For these reasons, We will do our next safety experiment at $STS_{xy} = 8.000$ cm.

We fully expect to achieve a multiplication of greater than 10 on this 1/2 array, but we can very confidently interpolate back to that 1/2-array which does have a multiplication of 10 + which we can 'safely' load on one table.

4-11-67

A counting experiment will be performed to determine the backgrounds to be used during the safety experiments for x = y = 8.000 cm, z = 16.020 cm. All 16 columns will be stored in the storage rack and counted, then one column will be removed from the vault. Another count will be made and by changing the location of the empty storage position some feel for the background from the columns in the storage rack may be obtained.




| | T-1 | T-2 |
|---|---|---|
| All Tubes: Count Rates: | 17619 | 27579 |
| Col. 16 out: | 16575 | 24158 |
| Col. 14 out: | 16240 | 24486 |
| Col. 12 out: | 16182 | 24958 |
| Col. 10 out: | 16512 | 25453 |

$\sum_{15-16}$ CTST-1 = 2255 $\quad$ $\sum_{15-16}$ CTST-2 = 6684

$\sum_{13-16}$ CTST-1 = 5042 $\quad$ $\sum_{13-16}$ CTST-2 = 12634

$\sum_{9-16}$ CTST-1 = 9800 $\quad$ $\sum_{9-16}$ CTST-2 = 21733

| | T-1 | T-2 |
|---|---|---|
| ∴ BKg for 2 member array | 15364 | 20895 |
| BKg for 4 member array | 12577 | 14945 |
| BKg for 8 member array | 7819 | 5846 |

4-12-67

We will now continue safety experiments for the 43 6 Kg Moderated (1.27cm) Array.

Assembly C-12:

Lateral Spacing: 0.718cm fixed + = 8.00 cm

Vertical Spacing: 0.108cm fixed + 15.918 = 16.02 cm

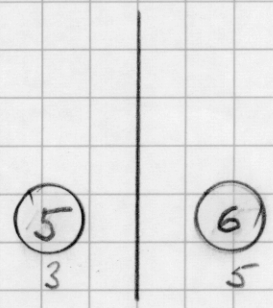
Moderator Thickness per cell = 1.27 cm

Parts: deduce from drawing, next page

Base Rate: Assume same as for col. 1 & 2
= $32.47 \times 10^5$ n/s

2 columns of 4 6 Kg units per col.

| | T-1 | T-2 |
|---|---|---|
| BKg = | 15364 | 20895 |




| Position | CJST-1 | Eff. Factor | $10^5$ n/s | M | CJST-2 | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.819 | 20280 | $1.95 \times 10^5$ | 159.7 | 4.92 | 25284 | $2.39 \times 10^5$ | 178.9 | 5.39 |
| | - 15364 | | | | - 20895 | | | |
| | 4916 | | | | 4389 | | | |
| | 81.9 | | | | 73.2 | | | |
| -.006 | 20930 | Assume same ∴ | | 4.92 | 20773 | | | 5.39 |

$\bar{M} = 5.15$

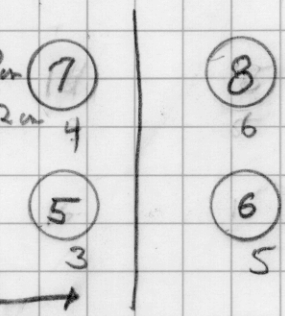
Assembly C-13 Spacing same as C-12 but now four columns in the array instead of 2

Lateral Spacing: .714 cm fixed + 7.286 cm = 8.000 cm
Vertical Spacing: .108 cm fixed + 15.914 cm = 16.022 cm

Moderator Thickness: 1/2" = 1.27 cm

Pairs can be deduced from column #5 →

Eff. Fact's same as in C-5




Bare Rate assumed to be $65.19 \times 10^5$ n/s

| Poo | T-1 | Eff Fac | $10^5$ n/s | M | T-2 | Eff Fac | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.805 | 25,504 | $2.04 \times 10^5$ | 439.6 | 6.74 | 25,975 | $2.64 \times 10^5$ | 485.2 | 7.44 |
| | - 12,577 | | | | - 14,945 | | | |
| | 12,927 | | | | 11,030 | | | $\bar{M} = 7.09$ |
| | ↓ 215.5 | | | | ↓ 183.8 | | | |
| -.005 | 28,446 | | 539.6 | 8.28 | 28,227 | | 584.5 | 8.97 |
| | - 12,577 | | | | - 14,945 | | | |
| | 15,869 | | | | 13,282 | | | $\bar{M} = 8.62$ |
| | ↓ 264.5 | | | | ↓ 221.4 | | | |

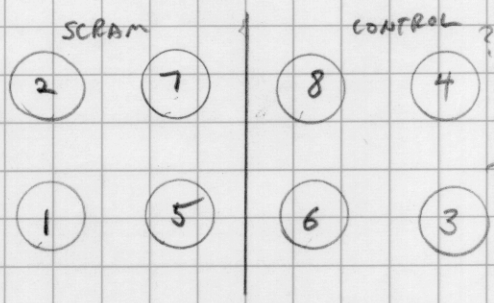
# ASSEMBLY C-14

Spacing as before, but now eight columns in the safety area instead of 4

Lateral Spacing: .714 fixed + 7.286 cm = 8.000 cm
Vertical Spacing .108 fixed + 15.914 = 16.022 cm

Mod. Thickness: ½" nom = 1.27 cm

Parts #'s can be deduced from diagram →

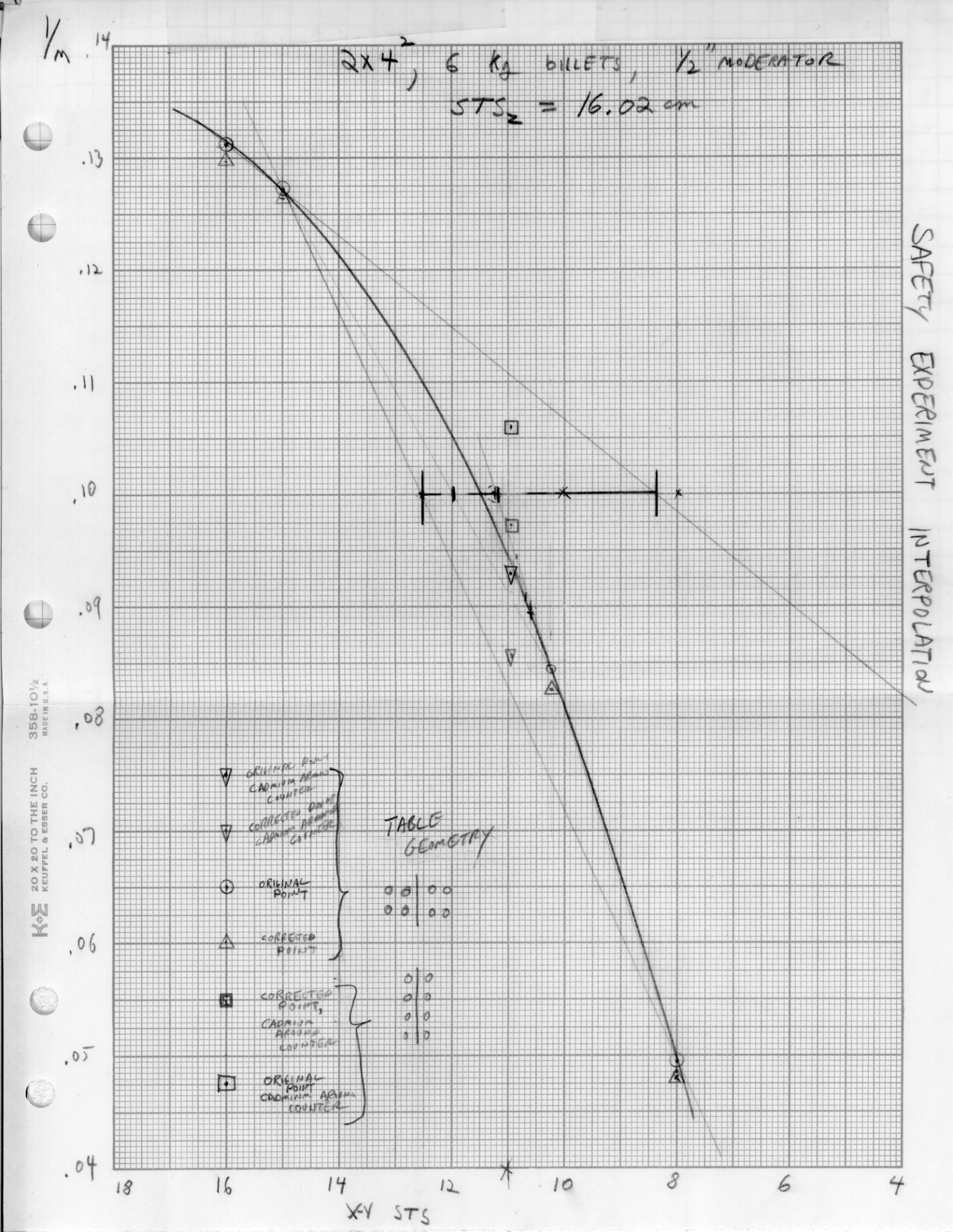



Eff Fact same as in C-6

Base Rate assumed to be: $129.11 \times 10^5$ n/s (same as C-6)

| Pos: | T-1 | Eff Fac | $10^5$ n/s | M | T-2 | Eff Fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.811cm | 56,295 | $2.08 \times 10^5$ | 1680.5 | 13.02 | 46,544 | $2.55 \times 10^5$ | 1729.7 | 13.40 |
| | - 7819 | | | | - 5846 | | | |
| | 48476 | | | | 40,698 | | | $\bar{m} = 13.41$ |
| | 807.93 | | | | 678.3 | | | |
| 2.998cm | 66805 | | 2044.8 | 15.84 | 55369 | | 2104.8 | 16.30 |
| | - 7819 | | | | - 5846 | | | |
| | 58,986 | | | | 49,523 | | | $\bar{m} = 16.07$ |
| | 983.1 | | | | 825.4 | | | |
| 1.000 | 75,937 | | | | 61760 | | | |
| | - 7,819 | | | | -5846 | | | |
| | 68,118 | | | | | | | |
| | 1135.3 | | | | | | | |
| -.006 | 82793 | $2.08 \times 10^5$ | 2599.2 | 20.1 | 67362 | $2.55 \times 10^5$ | 2618.5 | 20.3 |
| | - 7819 | | | | - 5846 | | | |
| | 74974 | | | | 61516 | | | $\bar{m} = 20.191$ |
| | 1249.6 | | | | 1025.3 | | | |

$1/\bar{m} = .0495$

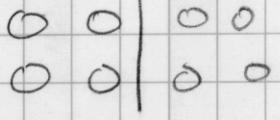

1/M
.14
.13
.12
.11
.10
.09
.08
.07
.06
.05
.04
18
16
14
12
10
8
6
4
X-Y STS
2x4", 6 Kg billets, 1/2" moderator
STS2 = 16.02 cm
SAFETY EXPERIMENT INTERPOLATION
ORIGINAL POINT CADMIUM AROUND COUNTER
CORRECTED POINT CADMIUM AROUND COUNTER
ORIGINAL POINT
CORRECTED POINT
CORRECTED POINT, CADMIUM AROUND COUNTER
ORIGINAL POINT CADMIUM AROUND COUNTER
TABLE GEOMETRY
20 X 20 TO THE INCH
KEUFFEL & ESSER CO.
358-10½
MADE IN U.S.A.

ASSEMBLY C-14

New Safety Experiment: Full 8-member array as before but with longer X-Y Spacing.

Lateral Spacing: .714 fixed + 9.525 cm = 10.239 cm
Vertical Spacing: .108 fixed + 15.914 = 16.022 cm

Mod Thickness = ½" Nom.



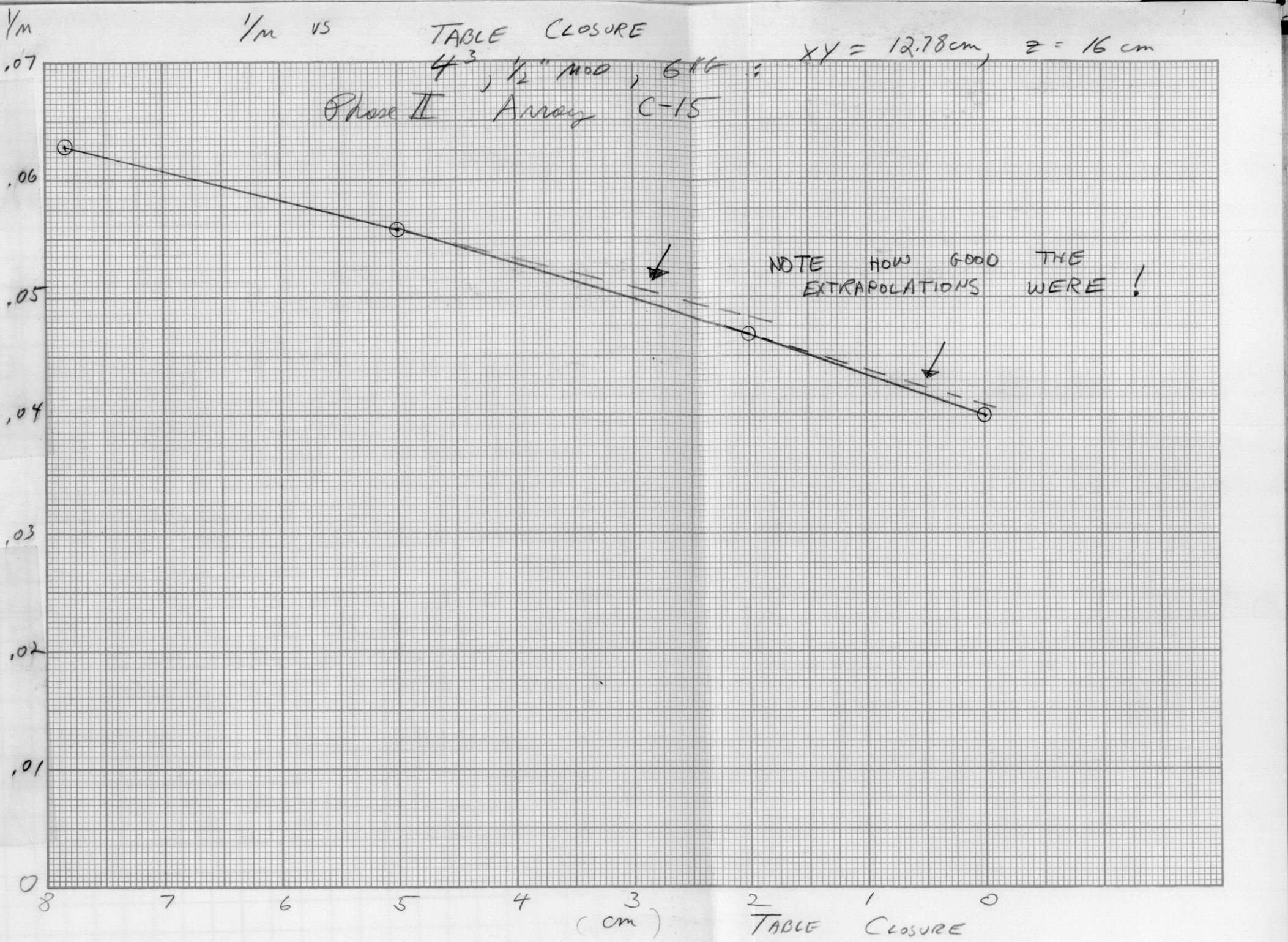
Base Rate: 129.11 $\times 10^5$ n/s

| $P_{00}$ | T-1 | Eff Fac | $10^5$ n/s | M | T-2 | Eff Fac | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7,812 cm | 44,010 | $2.08 \times 10^5$ | 1254.6 | 9.72 | 36,884 | $2.55 \times 10^5$ | 1319.1 | 10.22 |
| | 7,819 | | | | 5,846 | | | |
| | 36,191 | | | | 31,038 | | | $\bar{M} = 9.97$ |
| | 603.2 | | | | 517.3 | | | |
| −.005 | 51,310 | | 1507.7 | 11.68 | 42,295 | | 1549.1 | 12.00 |
| | 7,819 | | | | 5,846 | | | |
| | 43491 | | | | 36,449 | | | $\bar{M} = 11,838$ |
| | 724.85 | | | | 607.48 | | | |
| | | | | | | | | $1/\bar{M} = .08448$ |

We now have 4 ½ ARRAY safety experiment points to graph; 2 over M=10 and 2 under. We can, with a very high degree of confidence, graphically interpolate to that X-Y SPS at which each table has a multiplication of 10 — the limit to where we can load without a special procedure.

That extrapolated spacing is 11.50 cm

At this time, the 'suggested' X-Y spacing for the next 16 column array is 12.779 cm (Frank sets up 4 3/4")


1/m
1/m vs TABLE CLOSURE
4³, ½" MOD, 6 RG ; XY = 12.78cm, Z = 16 cm
Phase II Array C-15
NOTE HOW GOOD THE EXTRAPOLATIONS WERE !
.07
.06
.05
.04
.03
.02
.01
0
8
7
6
5
4
3
2
1
0
(cm)
TABLE CLOSURE

4/13/67

Assembly C-15 Back to the full array! (16 columns)
Columns in same relative spacing as before

$4^3$, 6 Kg, ½ MODERATED ARRAY X-Y ≈ 12¾ cm, Z = 16 cm

Lateral Spacing = .714 cm fixed + 12.065 cm = 12.779 cm
Vertical Spacing = .108 cm fixed + 15.914 cm = 16.022 cm

Base Rate 259.38 $\times 10^5$ n/s
[T.C.'s #1-107°; #2-101°; Room-69°]

| $P_\infty$ | T-1 | Eff Fac | $10^5$ n/s | M | T-2 | Eff Fac | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.821 | 120,449 | $2.08 \times 10^5$ | 4,175.6 | 16.10 | 96,411 | $2.55 \times 10^5$ | 4097.3 | 15.78 |
| | 2,007.5 | | | | 1606.8 | | $\bar{m}$ = 15.94 | |
| | 1 | | | | | | $1/\bar{m}$ = .0627 | |
| 5.000 | 134,883 | | 4,676.0 | 18.05 | 108,920 | | 4620.6 | 17.83 |
| | 22,481 | | | | 1,812.0 | | $\bar{m}$ = 17.94, $1/\bar{m}$ = .0557 | |
| 2.000 | 160,509 | | 5564.4 | 21.47 | 129,867 | | 5510.8 | 21.27 |
| | 26752 | | | | 2161.1 | | $\bar{m}$ = 21.37 $1/\bar{m}$ = .0468 | |
| -.006 | 187,811 | | 6510.8 | 25.13 | 152,069 | | 6,442.9 | 24.93 |
| | 3,130.2 | | | | 2,534.5 | | $\bar{m}$ = 25.03 $1/\bar{m}$ = .03995 | |

Re-computed/dead time corr.: $\bar{m}'$ = 26.79, $1/\bar{m}$ = .03732

TC's : #1 101°F, #2 95°F, Room 69°F

At this point the straight-line extrapolation is to 10 cm, the curvilinear extrapolation is to $STS_{x-y}$ = 11¼ cm.

We will reduce our spacing to 12.000 cm for the next array

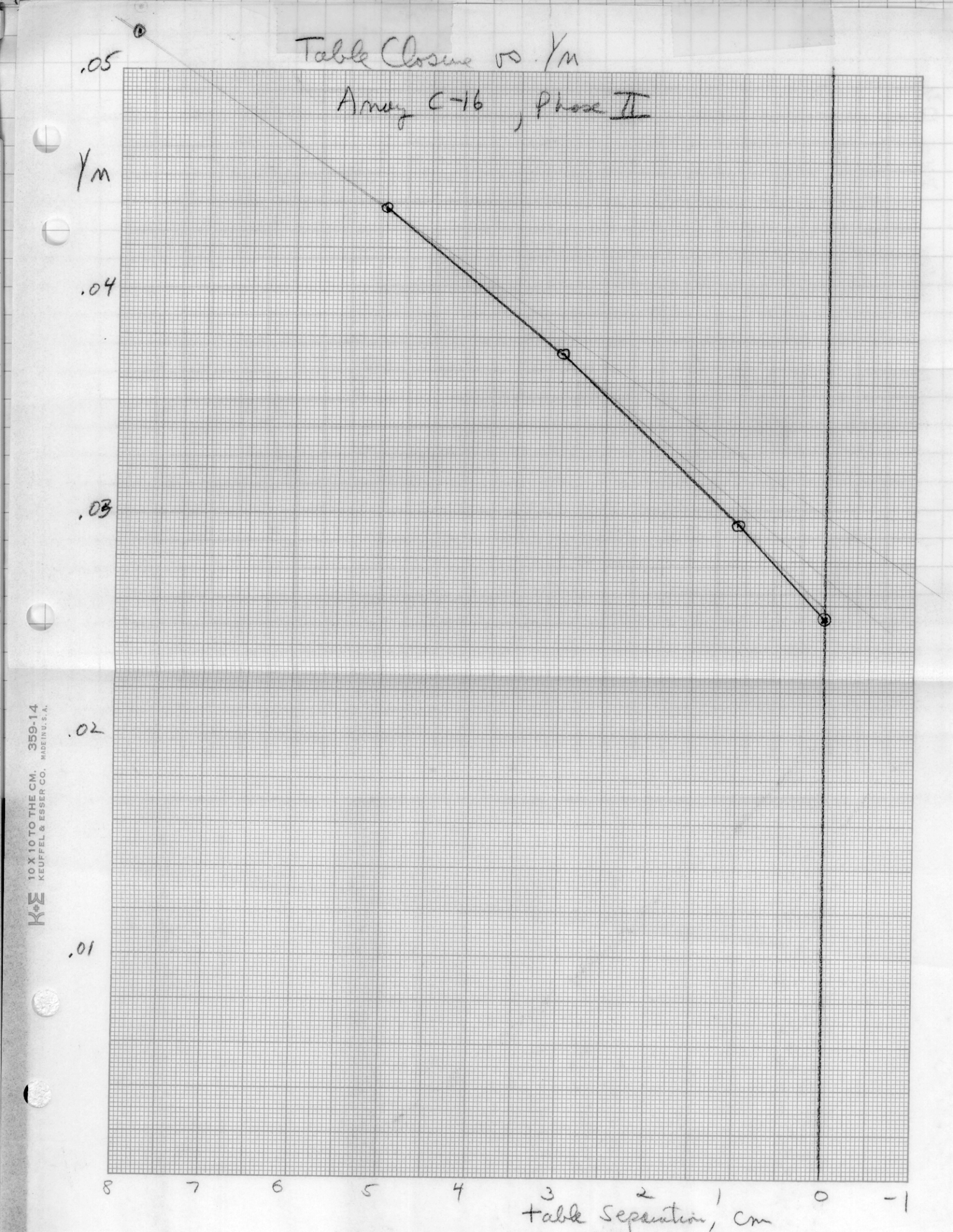


Table Closure vs. Ym
Array C-16, Phase II
Ym
.05
.04
.03
.02
.01
8
7
6
5
4
3
2
1
0
-1
table separation, cm

Assembly C-16 Full (16 column) array continued
Columns in same relative spacing

$4^3$, 6 Kg, ½" moderator, x-y = 12.00 cm, z = 16.02 cm

Lateral Spacing = .714 fixed + 11.286 made-up = 12.000 cm
Vertical Spacing = .108 cm fixed + 15.914 cm = 16.022 cm

Base Rate 259.38 $\times 10^5$ n/s

TC's #1 - 111°F, #2 - 115°F, Room - 69°F

| Poo | T-1 | Eff Fact | $10^5$ n/s | M | T-2 | Eff Fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7,818 | 146,397 | $2.08\times10^5$ | 5075.0 | 19.59 | 117,442 | $2.55\times10^5$ | 4991.4 | 19.26 |
| | 2,439.9 | | | | 1,957.4 | | $\bar{m}$ = 19.43, $1/\bar{m}$ = .0515 | |
| 5,001 | 171,258 | | 5936.9 | 22.91 | 138,653 | | 5892.8 | 22.74 |
| | 2,854.3 | | | | 2,310.9 | | $\bar{m}$ = 22.83, $1/\bar{m}$ = .0438 | |

Note: on T-1
$M$ = Counts/min $\times$ $1.3379\times10^{-4}$

on T-2
$M$ = Counts/min $\times$ $1.6402\times10^{-4}$

| Poo | T-1 | M | T-2 | M |
|---|---|---|---|---|
| 3.000 | 201,331 | 26.936 | 162,393 | 26.636 |
| | | | | $\bar{m}$ = 26.786 $1/\bar{m}$ = .0373 |
| 1.000 | 253,792 | 33.955 | 204 946 | 33.615 |
| | | | | $\bar{m}$ = 33.78 $1/\bar{m}$ = .0296 |
| -.006 | 295,340 | 39.513 | 239,115 | 39.220 |
| | | | | $\bar{m}$ = 39.37, $1/\bar{m}$ = .02540 |
| | | | | $\bar{m}'$ = 43.66, $1/\bar{m}'$ = .02290 |

T#1 - 96°F, T#2 - 105°F, Room 69°F

note: T'c's are on
Column # 16
#1 on top can of bottom Cell, #2 on top can of next cell up.

At this point, We want to reduce our count rate to the scalers (+ counters) so that we can proceed beyond a multiplication of ~100.

To this end we will add cadmium to the area between the counters ($BF_3$) + Poly Moderator. With no changes and the tables open, we record the following counts:

| T-1 | T-2 |
|---|---|
| 74,750 | 61,056 |

Adding 3/4" DIA X 12" LONG X .020" thick Cd Tubes to each of the 8 holes in the Poly Moderator, we get the following counts:

| | |
|---|---|
| 25,072 | 18,752 |

Adding a 2" DIA X 12" long x .020" thick Cd tubes around the <u>outside of the Counter</u>, we get the following counts:

| | |
|---|---|
| 35,928/5 | 24/342/5 |
| + 7,186/1 | + 4,868/1 |

Thus the efficiency factors should be increased by factors of:

| | |
|---|---|
| 10.402 | 12.542 |

to:

| | |
|---|---|
| $2.1636 \times 10^6$ | $3.1982 \times 10^6$ |

---

With the table at 7.812", counts are:

14,268 (old count 146,397) 10,127 (old count 117,442)

a decrease of:

| | |
|---|---|
| 10,260 | 11.596 |

implying efficiency factors of:

| | |
|---|---|
| $2.134 \times 10^6$ | $3.957 \times 10^6$ |

---

With table at -.00, counts are:

29,527 (old count 295,340), 20,872 (old count 239,115)

decreases + efficiency factors of:

T-1: 10.002; T-2: 11.456;

Recounts:

Fast Stop

29,156/2 → 10.042

20,903/2 → 11.237

Fall Out:

36,472/5 → 10.248

27,760/5 → 11.00

Note How Tub 2 is changing with time
We will take more counts Monday Morning.

---

Monday Morning 4/17/67

Now That Electronics has stabilized, we will re-check factors.
On Table is still Assembly C-16 (X-Y = 12.00, Z = 16.02)

| Pos. | T-1 | T-2 |
|---|---|---|
| 7.810 | 14,842 (Old 146,397) | 10,161 (Old 117,442) |
| | Ratio: 9.864 | 11,558 |
| 5.001 | 17,261 (Old 171,258) | 12,092 (Old 138,653) |
| | Ratio: 9,922 | 11,467 |
| 3.000 | 20,312 (Old 201,338) | 14,353 (Old 162,393) |
| | Ratio: 9,912 | 11,314 |
| 1.000 | 25,920 (Old 253,792) | 18,134 (Old 204,946) |
| | 9,791 | 11,302 |
| -.005 | 30,668 (Old 295340) | 21,398 (Old 239,115) |
| | 9,630 | 11,175 |

TC's 88-#1 96 #2 69-Room

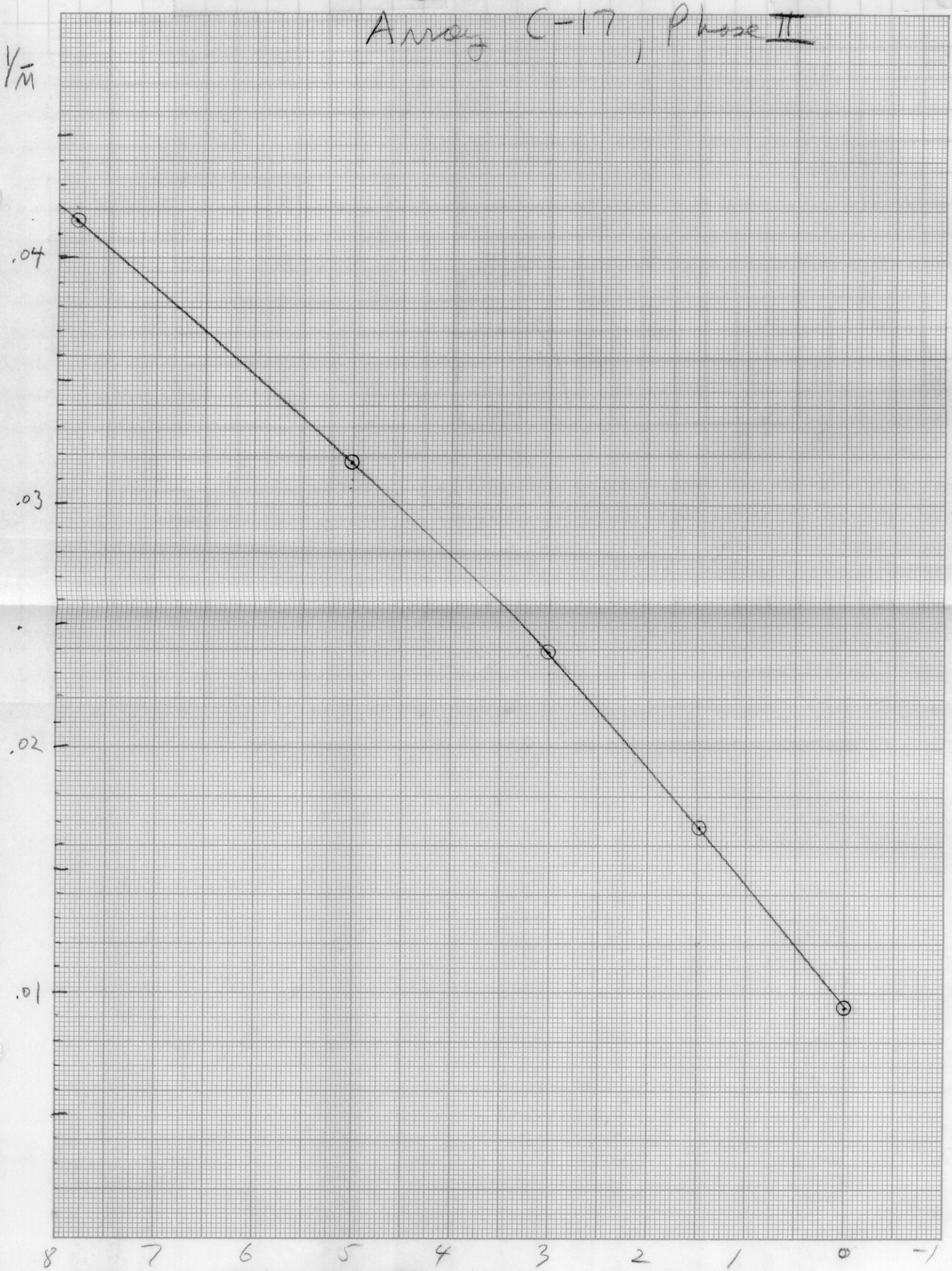
We will Choose the Following Ratios:

T-1 : 9.86

11.40

Table Closure vs $1/M$

Array C-17, Phase II




K&E 10 X 10 TO THE CM. 359-14 KEUFFEL & ESSER CO. MADE IN U.S.A.

This leads to the following change in efficiency factors:

NOTE: THE ABOVE DATA CAN BE ANALYZED

T-1: $2.051 \times 10^6$ up from $2.08 \times 10^5$

T-2: $2.907 \times 10^6$ up from $2.55 \times 10^5$

---

Assembly C-17 X-Y STS = 11.3, Z = 16.02

Lateral Spacing: .714 + 10.587 = 11.301 cm
Vertical Spacing: .108 + 15.914 = 16.022 cm

Base Rate 259.38

| Poo | T-1 | | | | T-2 | | | |
|---|---|---|---|---|---|---|---|---|
| 7.815 | 18,865 | Eff Fact | $10^5$ n/s | $\eta$ | 12,914 | Eff Fact | $10^5$ n/s | M |
| | 302.75 | $2.051 \times 10^6$ | 6209.4 | 23.96 | 215.23 | $2.907 \times 10^6$ | 6256.7 | 24.15 |
| | | | | | $\bar{m} = 24.06$ | | $1/\bar{m} = .04156$ | |

TC's: #1 112°F, #2 107°F, Room 69°F

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5.000 | 24.247 | 8288.5 | 31.99 | 16,625 | 8054.7 | 31.09 |
| | 404.12 | | | 277.08 | $\bar{m} = 31.54$, | $1/\bar{m} = .03171$ | |
| 2.997 | 31,812 | 10874.4 | 41.97 | 22,442 | 10873.1 | 41.96 |
| | 530.20 | | | 374.03 | $\bar{m} = 41.96$ | $1/\bar{m} = .02383$ | |
| 1.470 | 45,397 | 15517.9 | 60.13 | 31,617 | 15316.0 | 59.11 |
| | 756.6 | | | 526.87 | $\bar{m} = 59.62$ | $1/\bar{m} = .01677$ | |
| +.003 | 80,391 | 27480.3 | 106.06 | 57,712 | 27961.6 | 107.91 |
| | 1339.85 | | | 961.87 | $\bar{m} = 106.99$ | | |
| | | $\bar{m}' = 109.77$, | $1/\bar{m}' = .00911$ | | $1/\bar{m} = .00935$ | | |

Note:

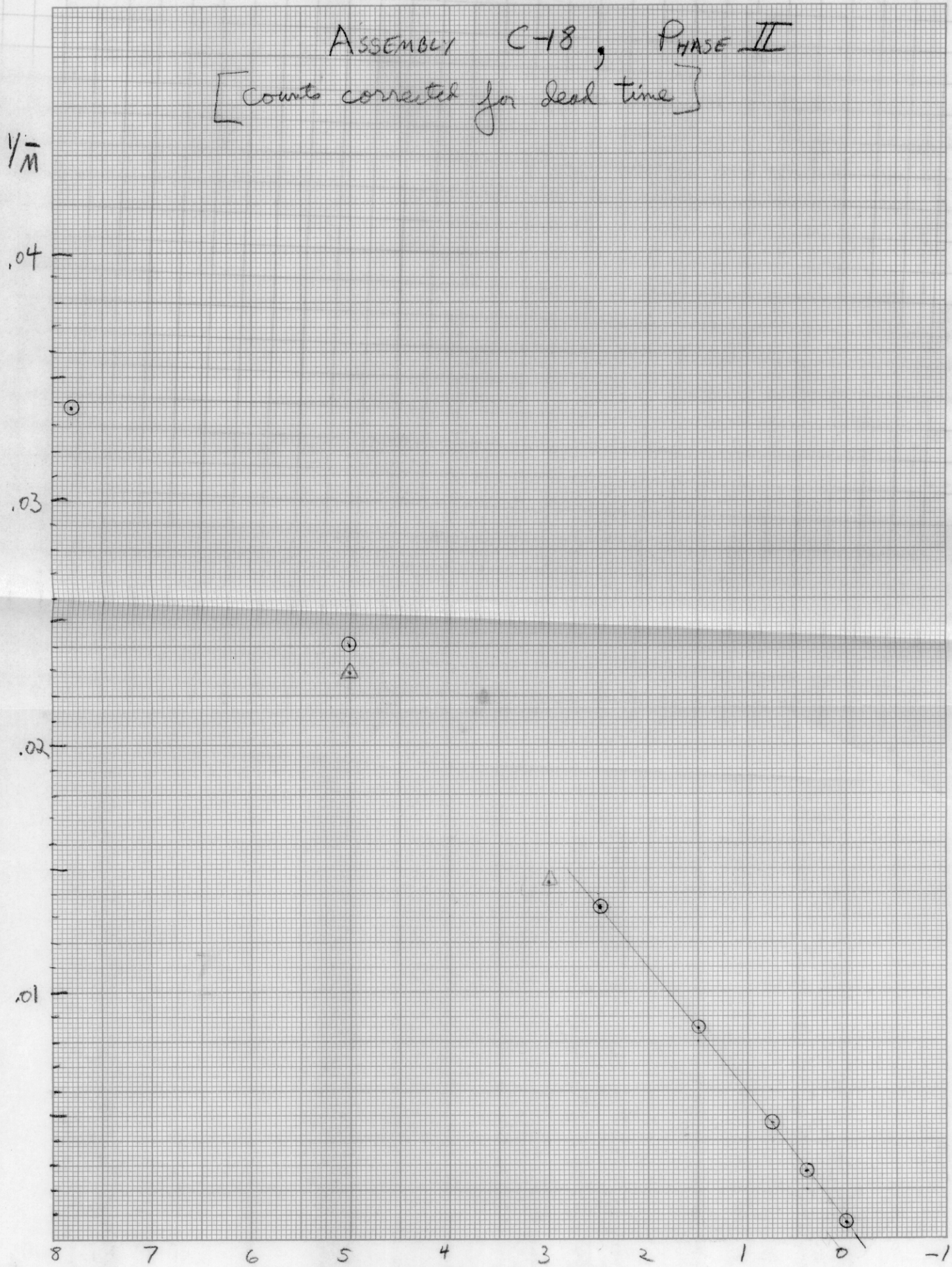
On Tub #1, $M = 1.3193 \times 10^{-3} \times$ Counts/min

On Tub #2, $M = 1.8698 \times 10^{-3} \times$ Counts/min

# TABLE CLOSURE vs $\sqrt{M}$

## ASSEMBLY C-18, PHASE II

[counts corrected for dead time]




K+E 10 X 10 TO THE CM. 359-14 KEUFFEL & ESSER CO. MADE IN U.S.A.

4/18/67

Assembly C-18 : $STS_{x-y} = 11.00$ cm, $STS_z = 16.02$ cm

Lateral: .714 cm Fixed + 10.287 cm spaced = 11.001 cm

Vertical: .108 cm Fixed + 15.914 cm spaced = 16.022 cm

[$4^3$, 6 Kg, ½" (1.27 cm) MODERATED ARRAY]

BASE RATE : $259.38 \times 10^5$ n/s

EFFICIENCY FACTORS T-1 : $2.051 \times 10^6$, T-2 $2.907 \times 10^6$

We will correct for dead time by the relation $N = \frac{m}{1-pm}$

| POSITION | T-1 | M | T-2 | M |
|---|---|---|---|---|
| 7.817 | 22389 | 29.79 | 15666 | 29.45 |
| | ↓ 22587 corrected for dead time | | ↓ 15748 corrected for dead time | |

$\bar{M} = 29.62$, $1/\bar{m} = .03376$

POSITION TC's #1 99°F #2 99°F, Room 69°F

New format for this Run:
list 1st counts, then correction divide $1-mp$,
($p_1 = .39316 \times 10^{-6}$, $p_2 = .33373 \times 10^{-6}$)

then corrected count, then Multiplication as per page 53 bottom

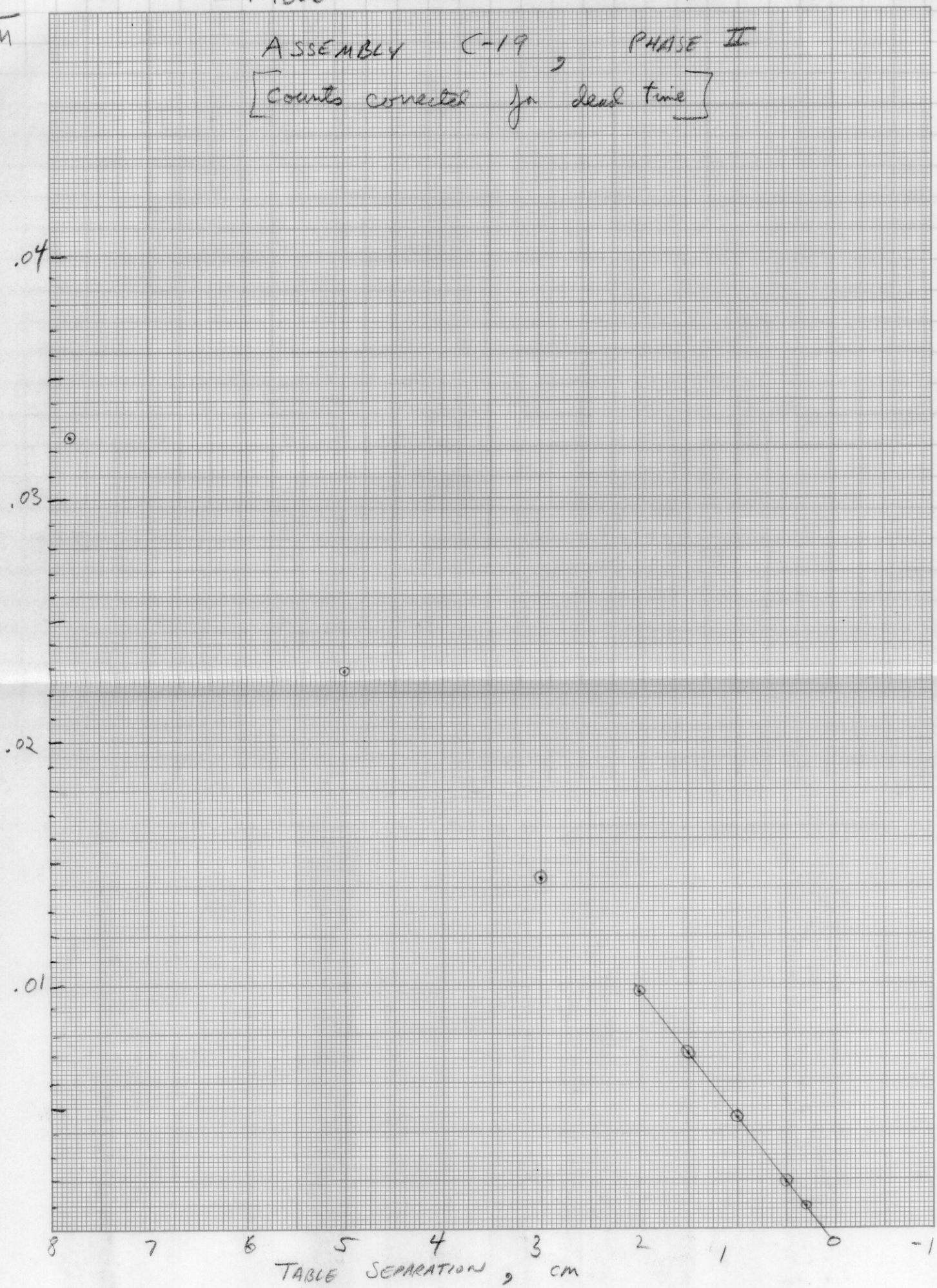
| Pos | T-1 | FACTOR | T-1' | M | T-2 | FACTOR | T-2' | M |
|---|---|---|---|---|---|---|---|---|
| 5.001 | 31442 | .98764 | 31,835 | 42.00 | 21944 | .99268 | 22,106 | 41.33 |
| | | | | $\bar{M} = 41.66$ | | | $1/\bar{m} = .02400$ | |
| 2.486 | 55,291 | .97826 | 56,519 | 74.56 | 39,449 | .98683 | 39,975 | 74.74 |
| | | | | $\bar{M} = 74.65$ | | | $1/\bar{m} = .01340$ | |
| 1.500 | 84,841 | .96664 | 87,769 | 115.79 | 61,262 | .97555 | 62,797 | 117.42 |
| | | | | $\bar{M} = 116.55$ | | | $1/\bar{m} = .00858$ | |
| .750 | 150,517 | .94082 | 159,985 | 211.07 | 111,750 | .96271 | 116,079 | 217.04 |
| | | | | $\bar{M} = 214.06$ | | | $1/\bar{m} = .004671$ | |
| .399 | 242,097 | .90482 | 267,564 | 353.00 | 183,694 | .93869 | 195,692 | 365.90 |
| | | | | $\bar{M} = 360.45$ | | | $1/\bar{m} = .02774$ | |

TABLE CLOSURE vs $1/M$

$1/M$

ASSEMBLY C-19, PHASE II

[Counts corrected for dead time]




K&E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

| $P_{00}$ | T-1 | CORR | T-1' | M | T-2 | CORR | T-2' | M |
|---|---|---|---|---|---|---|---|---|
| -.006 | 836,789 | .671008 | 1,247,063 | 1645.24 | 679,554 | .776216 | 863,876 | 1615.27 |

$\bar{M} = 1630.25$, $1/\bar{M} = .000613$

4-19-67

Assembly C-19 : $STS_{x,y} = 10.950$ cm $STS_z = 16.02$ cm

Lateral Spacing: .714 cm fixed + 10.236 cm = 10.950 cm

Vertical Spacing: .108 cm fixed + 15.918 cm = 16.02 cm

[ $4^3$, 6 Kg, ½" Moderator Array ]

Base Rate = 259.38 $\times 10^{-5}$ A/s

Eff. Factors: T-1 = $2.057 \times 10^{-6}$ T-2 = $2.907 \times 10^{-6}$

Correction divider = $1 - \eta\rho$

$\rho_1 = .39316 \times 10^{-6}$, $\rho_2 = .33373 \times 10^{-6}$

| Position | T-1 | Factor | T-1' | Corr. $10^{-3}$ | M | T-2 | Factor | T-2' | Corr. $10^{-3}$ | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 7.811 | 23611 | .99072 | 23832 | 1.3193 | 31.4 | 16071 | .99464 | 16158 | 1.8698 | 30.2 |

$\bar{M} = 30.8$ $\frac{1}{M} = .0325$

T/C's Room = 69 #1 = 95 #2 = 97

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 5.000 | 33001 | | | | 43.5 | 23483 | | | | 43.8 |

$\bar{M} = 43.7$ $\frac{1}{M} = .0229$

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3.001 | 51519 | .9798 | 52581 | 69.4 | 36629 | .9878 | 37081 | | | 69.3 |

$\bar{M} = 69.4$ $\frac{1}{M} = .0144$

T/C's Room = 69 #1 = 98 #2 = 99

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.998 | 74998 | .9705 | 77278 | 101.9 | 54691 | .9818 | 55705 | | | 104.2 |

$\bar{M} = 103.1$ $\frac{1}{M} = .0970$

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.500 | 99795 | .9608 | 103867 | 137.0 | 73211 | .9756 | 75042 | | | 140.3 |

$\bar{M} = 138.6$ $\frac{1}{M} = .0072$

| Pos. | T-1 | Factor | T-1' | Corr. x10^3 | M | T-2 | Factor | T-2' | Corr. 10^3 | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 150446 | .9409 | 159896 | 1.319 | 210.9 | 113700 | .9621 | 118174 | 1.870 | 221. |
| | | | | | | | $\bar{M}$ = 216.0 | | $\frac{1}{M}$ = .0046 | |

T/C's  Room = 69  #1 = 100  #2 = 100

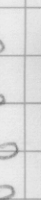
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| .500 | 328714 | .8708 | 377485 | 497.9 | 255580 | .9147 | 279414 | | | 522.5 |
| | | | | | | $\bar{M}$ = 510 | | $\frac{1}{M}$ = .00196 | | |
| .300 | 633763 | .8508 | 744902 | 982.5 | 505027 | .8315 | 607369 | | | 1136. |
| | | | | | | $\bar{M}$ = 1059 | | $\frac{1}{M}$ = .00094 | | |

Ion Chambers  #1 = .2 x 10^-8  #2 = .2 x 10^-8

4-20-67

Assembly C-20

8 column (in a 2 rows) ½ table multiplication experiment. [4" x 2, 6 Kg, ½" mod] →



Spacing same as C-19:

STS x-y = 10.950 cm, STS z = 16.022 cm

Base Rate = (Assumed) 129.11 x 10^5 n/s

With 8 columns around corner & no cadmium in counter tubes, Background for 8 columns was T-1: 7,819, T-2: 5,846

since we have reduced the efficiency of the counters by factors of: 9.86 on T-1 & 11.56 on T-2,

the backgrounds should be:

T-1 : 793 cpm, T-2 : 506 cpm

| $P_{oo}$ | T-1 | Eff Fact | $10^5$ n/s | M | T-2 | Eff Fact | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 7.811 | 3,557 | $2.051 \times 10^6$ | 944.9 | 7.32 | 4,406 | $2.907 \times 10^6$ | 1889.6 | 14.63 |
| | 793 | | | | 506 | | | |
| | 2,764 | | | | 3,900 | | | |
| | * 46.07 | | | | * 65.00 | | | |

HIGH MULTIPLICATION DUE TO SOURCE STILL IN CELL!

We Will Remove Source (!) & continue in!

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| -.001 | 21,078/5 | 117.01 | 9.06 | 15,589 | 126.54 | 9.80 |
| | = 4,216/1 | | | = 3,118/1 | | |
| | - 793 | | | - 506 | $\bar{M} = 9.43$ | |
| | 3,423 | | | 2,612 | | |
| | * 57.05 | | | * 43.53 | $1/\bar{M} = .1060$ | |

Note: This Array was set up as follow:

4/21/67

| SCRAM TABLE | | CONTROL TABLE |
|---|---|---|
| (8) | (12) | |
| (7) | (11) | |
| (6) | (10) | |
| (5) | (9) | |

We will re-num the array rotated 90° as follows:

| | | SCRAM TABLE | | CONTROL TABLE | |
|---|---|---|---|---|---|
| (5) | (6) | | (7) | (8) | |
| (9) | (10) | | (11) | (12) | |

Assembly C-21

8 columns
4 x 4 x 2, 6 Kg, 1/2" mod.

Ky STS = 10.950 cm, Z STS = 16.022 cm

Assumed base Rate = $129.11 \times 10^5$ n/s

Assumed Background again

T-1 : 793 cpm T-2 : 506 cpm

| $P_{oo}$ | T-1 | Eff Fac | $10^5$ n/s | M | T-2 | Eff Fact | $10^5 N_2$ | M |
|---|---|---|---|---|---|---|---|---|
| -.007 | 23,995/5 | $2.051 \times 10^6$ | 1390.0 | 10.77 | 16939 | $2.907 \times 10^6$ | 1396.2 | 10.81 |
| | 4,799 | | | | 3,388 | | | |
| | - 793 | | | | - 506 | | | |
| | 4,006 | | | | 2,882 | | $\bar{M} = 10.79$ | |
| | 67.77 | | | | 48.03 | | $1/\bar{M} = .09268$ | |

An uncertainty has arisen concerning the proper $\frac{\text{NO CADMIUM}}{\text{WITH CADMIUM}}$ DETECTOR RATIO

We are going to take a 10 MIN COUNT (WITH THE TABLES APART) and remove the cadmium.

| $P_{oo}$ | T-1 | T-2 |
|---|---|---|
| Both Out | 35,859/10 | 26,000/10 |

We Have Removed Cd From T-1 !

| | | |
|---|---|---|
| Both Out | 358495/10 | 26,263/10 |

We Will Now Run the Tables closed:

[Assembly C-21 Continued!]

| $P_{oo}$ | T-1 |
|---|---|
| -.007 | 476,874/10 |
| | 47,687/1 |
| | - 7,819 |
| | 39,868/1 |

T-2 = 34002/10
3400/1
(Only 22 cpm different!)

With Cadmium was 4,006
$R_1 = 9.95$, different than the full table ratio listed on page 52.

Quick Dead Time Measurement shows $P_{T-1} = .199 \times 10^{-6}$ min

| Data: | | |
|---|---|---|
| | Bkgnd | 35,859/1 |
| | S-1 | 158,669/1 |
| | S-2 | 192,949/1 |
| | S-1+S-2 | 308,397/1 |

4/24/67

## Dead Time Study

From the with and without Cadmium data of assembly C-16 (pages 50-52) it was possible to deduce dead times based on the assumption that the change in Cadmium ratio between 0 cm + 1 cm, was due entirely to dead time losses. This analysis gave the following numbers:

$$\text{Assume: True Counts} = \frac{\text{observed counts}}{1 - \rho \cdot \text{observed counts}}$$

then:

$$\rho_{T-1} = .393 \times 10^{-6} \text{ min}, \quad \rho_{T-2} = .334 \times 10^{-6} \text{ min}$$

These were used to correct the data of Assemblies C-18 and C-19.

Assembly C-20 was run to check the 1/2 table multiplication of X-Y STS = 10.95 cm. The multiplications were lower than expected. This was believed due to the fact that the columns were like: ⁘|⁘ and were being compared with data taken when the columns were like: ⁘⁘|⁘⁘.

In Assembly C-21, the 8 columns were rotated. But after making the above dead time corrections, which include correcting the ratio measurements on pages 52 & 53 for dead time losses [these corrections are not shown in the log], the multiplication did not fall on the curve [facing page 48] as it should. This indicated that either a) there was something wrong with the dead time corrections, or b) The Cadmium ratio changed depending on whether 1/2 table or full table was loaded.

Thus we will do a series of source counts to check the dead time a little better.

The procedure will be to count 1 source, another source, & then both sources. But since the background is high enough to have to

be background corrected, the analysis will not be straight-forward, but rather trial & error.

[Once good dead time numbers are obtained, we will go back & correct all the data for this array]

No Source [Recall T-2 still has Cd]

T-1: 361,039/10 T-2: 25,953/10

Thin* source Near T-1 (SOURCE # 300045 nRC8-7, 1.3×10⁷ n/s Pu-238)

T-1: 332,549/3 T-2: 8,016/3

Add Thick Source Near T-1

T-1: 547,206/3 T-2: 8,725/3

Remove Thin Source, Just Thick Source (SOURCE # 300043 R-11 1.4×10⁷ n/s Pu-238)

T-1: 329,549/3 T-2: 8,187/3

This set leads to: $P_{TH} = .2200 \times 10^{-6}$ min

Repeat with Sources Farther Away (from T-1)

Thick Source:

T-1: 193,139/3 T-2: 8,308/3

Both Sources:

T-1: 262,256/3 T-2: 8,698

Just Thin Source:

T-1: 177,397 T-2: 8,137

THIS SET LEADS TO $P_{TH} < 0$

Now Bring Sources Close IN.

(Next Page)

* THE ONE WE GENERALLY USE FOR CALIBRATION

Just Thin Source:

T-1: 975,233/3 T-2: 8,096/3

Both Sources:

T-1: 1,861,496/3 T-2: 8,609/3

Just Thick Source:

T-1: 1,088,831/3 T-2: 8,315

THIS SET LEADS TO $P_{T-1} = .1726 \times 10^{-6}$ MIN

Thick Source Near T-2

T-1: 191,261/5 T-2: 310,289/5

Both Sources Near T-2

T-1: 202,111/5 T-2: 618,362/5

Just Thin Source:

T-1: 190,888/5 T-2: 321,015/5

THIS SET LEADS TO $P_{T-2} < 0$

Repeat with Closer Source (up on "support" tubes)

Thin Source Near T-2

T-1: 114,295/3 T-2: 784,722/3

Both Sources Near T-2

T-1: 121,070/3 T-2: 1,379,821/3

Thick Source Near T-2

THIS SET LEADS TO $P_{T-2} = .1375 \times 10^{-6}$ MIN

T-1: 114,391/3 T-2: 646,983/3

Background with Source Support Cans:

NOTE INCREASE:

T-1: 360,477/10 T-2: 28,978/10

Recount 10 MIN BACKGROUND WITHOUT SUPPORT TUBES.

T-1: 360,534/10 T-2: 28,709/10

T-1: 360,998/10 Repeat T-2: 27,816/10

Take Series of 4 min Counts to ck. T-2 Bkgd Variation

| | |
|---|---|
| 11,029 | 10,969 |
| 10,986 | 11,023 |
| 11,392 | 11,036 |
| 11,065 | 10,933 |
| 11,172 | 10,892 |

[2,762]

+ 1 10 MIN CT: 27,358/10 → 2,736

Conclusion is that Bkgd for T-2 as taken at top of page 60 is 1 bad point in a lot of good ones

4/25/67

G. Piece Data two more on T-2.

Overall Results:

| T-1 | T-2 |
|---|---|
| .173 | .119 |
| .199 | .138 |
| .220 | .183 |

$\times 10^{-6}$

$\overline{\rho}_{T-1} = .197 \times 10^{-6}$

$\overline{\rho}_{T-2} = .147 \times 10^{-6}$

FOR CONVENIENCE

$.20 \times 10^{-6}$ MIN

$.15 \times 10^{-6}$ MIN

4/26/67

This allows The ratio experiment to be re-calculated:

| | T-1 | T-2 |
|---|---|---|
| FULL TABLE | 10.218 → 10.22 | 11.592 → 11.59 |
| HALF TABLE | 10.042 → 10.04 | — NOT DONE — |

11:55

½ Pu unloaded + out of Vault.

Take 60 Min BKGD Count.

T-1: 467,399/60 = 7,790/1

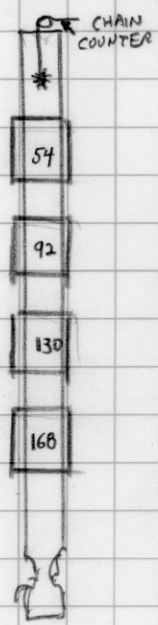
T-2: 50,290/60 = 838/1

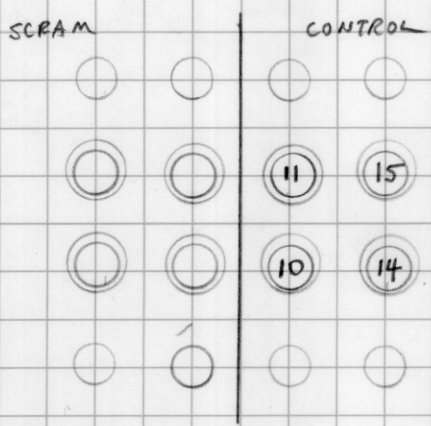
Remove Cd from T-2 + Recount Bkgnd

271,690/35 = 7,763/min → 7,775 corrected

280,802/35 = 8,023/min → 8,033 corrected

Source Positions to be studied:
54, 92, 130, 168 (Source chain position in column)




Re-Check of Efficiency Factor:

Moderator (except inner discs) as in Assembly C-2

(XY "STS" = 10.95 cm, Z "STS" = 16.02 cm)

| POSITION | T-1 | T-2 |
|---|---|---|
| 10-168 | 119,311/10 = 11,931 → 11,959 − 7,775 = 4,184 cpm corrected | 119,593/10 = 11,959 → 11,980 − 8,033 = 3,947 Cpm Corrected |
| 10-130 | 116,296/10 = 11,630 → 11,657 − 7775 = 3,882 | 117,217/10 = 11,722 → 11,743 − 8,033 = 3,710 |

ARROWS Represent dead time correction

Continue Source Counts in the Columns 4/27/67

(Repeat All Points:)

| Position | T-1 | T-2 |
|---|---|---|
| 10-168 | 119,420/10 | 119,458/10 |
| | 11,942 → 11,971 | 11,946 → 11,967 |
| | 7,775 | 8,033 |
| | 4,196 cpm | 3,934 cpm |
| | AVG OF 2 DAYS → 4,190 | → 3,941 |
| 10-130 | 117,465/10 | 115,899/10 |
| | 11,747 → 11,775 | 11,590 → 11,610 |
| | 7,775 | 8,033 |
| | 4,000 cpm | 3,577 cpm |
| | AVG OF 2 DAYS 3,941 cpm | 3,644 cpm |
| 10-92 | 115,751/10 | 114,572/10 |
| | 11,575 → 11,602 | 11,457 → 11,477 |
| | - 7,775 | - 8,033 |
| | 3,827 cpm | 3,444 cpm |
| 10-54 | 113,231/10 → 11,349 | 111,841/10 → 11,203 |
| | 11,323 → -7,775 | 11,184 → - 8,033 |
| | 3,574 | 3,170 |

Column 10 Averages:

| T-1 | T-2 |
|---|---|
| 3883 cpm = 64.72 cps | 3550 cpm = 59.16 cps |
| Eff. = $4.978 \times 10^{-6}$ | Eff. = $4.551 \times 10^{-6}$ |
| Eff. Factor = $2.01 \times 10^{5}$ | Eff. Factor = $2.20 \times 10^{5}$ |

| Position | T-1 | T-2 |
|---|---|---|
| 11-168 | 127,408/10 → 12,774 | 112,661/10 → 11,285 |
| | 12,741 → -7,775 | 11,266 → -8,033 |
| | 4,999 | 3,252 |
| 11-130 | 124,219/10 → 12,453 | 111,430/10 → 11,162 |
| | 12,422 → -7775 | 11,143 → -8033 |
| | 4,678 | 3,129 |

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 11-92 | 121893/10 → 12189 | 12219 − 7775 = 4444 | 109726/10 → 10973 | 10991 − 8033 = 2958 |
| 11-54 | 119,823 → 11,982 | 12,011 − 7775 = 4,236 | 108,209 → 10,821 | 10,839 − 8033 = 2806 |

Column 11 Averages:

T-1 = 4,589 = 76.49 cps
Eff. = $5.88 \times 10^{-6}$
Eff. Factor = $1.70 \times 10^{5}$

T-2 = 3034 cpm = 50.56 cps
Eff. = $3.89 \times 10^{-6}$
Eff. Factor = $2.57 \times 10^{5}$

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 15-168 | 131611/10 → 13161 | 13196 − 7775 = 5421 | 114527/10 → 11453 | 11473 − 8033 = 3440 |
| 15-130 | 128011/10 → 12801 | 12834 − 7775 = 5059 | 112398/10 → 11240 | 11259 − 8033 = 3226 |
| 15-92 | 123829/10 → 12383 | 12414 − 7775 = 4639 | 111055/10 → 11106 | 11125 − 8033 = 3092 |
| 15-54 | 118987/10 → 11899 | 11927 − 7775 = 4152 | 108992/10 → 10899 | 10916 − 8033 = 2883 |

Column 15 Averages:

T-1 = 4818 c/m = 80.30 cps
Eff. = $6.18 \times 10^{-6}$
Eff. Factor = $1.62 \times 10^{5}$

T-2 = 3160 cpm = 52.67
Eff. = $4.05 \times 10^{-6}$
Eff. Factor = $2.47 \times 10^{5}$

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 14-168 | 120601/10 → 12060 | 12089 − 7775 = 4314 | 120994/10 → 12099 | 12121 − 8033 = 4088 |
| 14-130 | 117778/10 → 11,778 | 11,806 − 7775 = 4,031 | 118560/10 → 11,856 | 11,877 − 8,033 = 3,844 |
| 14-92 | 116,923/10 → 11,692 | 11,719 − 7775 = 3,944 | 116479/10 → 11,648 | 11,668 − 8033 = 3,635 |
| 14-54 | 114,488/10 → 11,449 | 11,475 − 7775 = 3,700 | 112500/10 → 11,250 | 11,269 − 8033 = 3,236 |

COLUMN 14 AVERAGES:

T-1 3,997 cpm = 66.62 cps
Eff = $5.12 \times 10^{-6}$
Eff Fact = $1.95 \times 10^{5}$

T-2 3701 cpm = 61.68 cps
Eff = $4.74 \times 10^{-6}$
Eff Fac = $2.11 \times 10^{5}$

Total Averages for 4 Columns

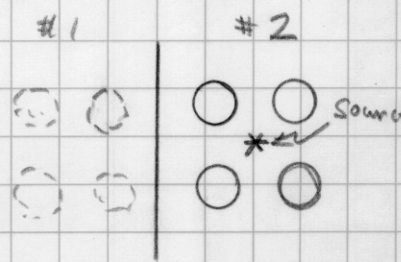
T-1 72.03 cps
$\overline{Eff} = 5.54 \times 10^{-6}$
T-1 Eff Fact = $1.805 \times 10^{5}$

T-2 56.02 cps
$\overline{Eff} = 4.31$
T-2 Eff Fact = $2.321 \times 10$

Note T-1 eff factor was 15.2 % Too High
T-2 eff factor was 9.9 % Too High

The source was placed as shown below and a count made.

| T-1 | T-2 |
|---|---|
| 126396/10 | 118211/10 |
| Eff Factor = $1.60 \times 10^{5}$ | $2.05 \times 10^{5}$ |
| 11% low | 12% low |



We now want to determine the effect of the inner Mock H.E. discs that were left out of the above measurements. To determine this effect we will remove all of the mock H.E. from the columns + recount the bare source. This will tell us the effect of just the outer moderator. The effect of TOTAL moderator is 1,194 times the effect of the outer moderator

| POS | T-1 | | T-2 | |
|---|---|---|---|---|
| 10-54 | 113802/10 | | 110344/10 | |
| 10-54 repeat | 114293/10 | 11331 | 110248/10 | 11048 |
| AVG | 114,047/10 | -7775 | 110,296/10 | -8033 |
| | 11,405 | 3556 | 11,030 | 3015 |
| 10-92 | 116207/10 | 11648 | 110984/10 | 11116 |
| | 11,621 | -7775 | 11,098 | -8033 |
| | | 3873 | | 3083 |
| 10-130 | 117638/10 | 11,792 | 113626/10 | 11,382 |
| | 11,764 | -7775 | 11,363 | -8,033 |
| | | 4017 | | 3,349 |
| 10-168 | 120,584 | 12,087 | 115,204 | 11540 |
| | 12,058 | -7775 | 11,520 | -8033 |
| | | 4,312 | | 3,507 |

COLUMN 10 AVERAGES

T-1 : 3939 cpm = 65.66 cps  T-2 : 3238 cpm = 53.98 cps

Eff = $5.051 \times 10^{-6}$  Eff = $4.152 \times 10^{-6}$

Eff Fac = $1.98 \times 10^{5}$  Eff Fac = $2.41 \times 10^{5}$

OLD MOD Eff Fac WERE: $2.01 \times 10^{5}$  $2.20 \times 10^{5}$

Note that ON THE AVERAGE, The Partial (outer only) Moderator case is +.090 (in Eff. Fac) from Bare Case. If it had been complete, the average efficiency factor would have been up .107, with an average efficiency of 2.212 instead of 2.195. ∴ All efficiencies should be increased by a factor of 1.0077

IN an attempt to understand what is going on with the Mock H.E., we will do the following experiments with the source in position 10 – 168

| | T-1 | T-2 |
|---|---|---|
| Recall: FULL MODERATED ARRAY | 4,196 cpm | 3,934 cpm |
| BARE ARRAY | 4,312 | 3,507 cpm |

1.) 1/2" DISC BETWEEN SOURCE AND T-2

121,233/10 → 12,123 → 12,152 − 7775 = 4,377 ← UP A LITTLE

112,870/10 → 11,287 → 11,306 − 8,033 = 3,273

DOWN 6.67 %

2.) 1/2" DISC BETWEEN SOURCE & T-1

117,752/10 → 11,776 → 11,804 − 7775 = 4,029

115,160/10 → 11,516 → 11,536 − 8033 = 3,503 ← UNCHANGED

DOWN 6.56 %

NOTE: 1/2" DISC DECREASES COUNTS BY ~ 6.62 %

3) 1/2" RING ALL AROUND SOURCE

120,723/10 → 12,072 → 12,101 − 7775 = 4,326

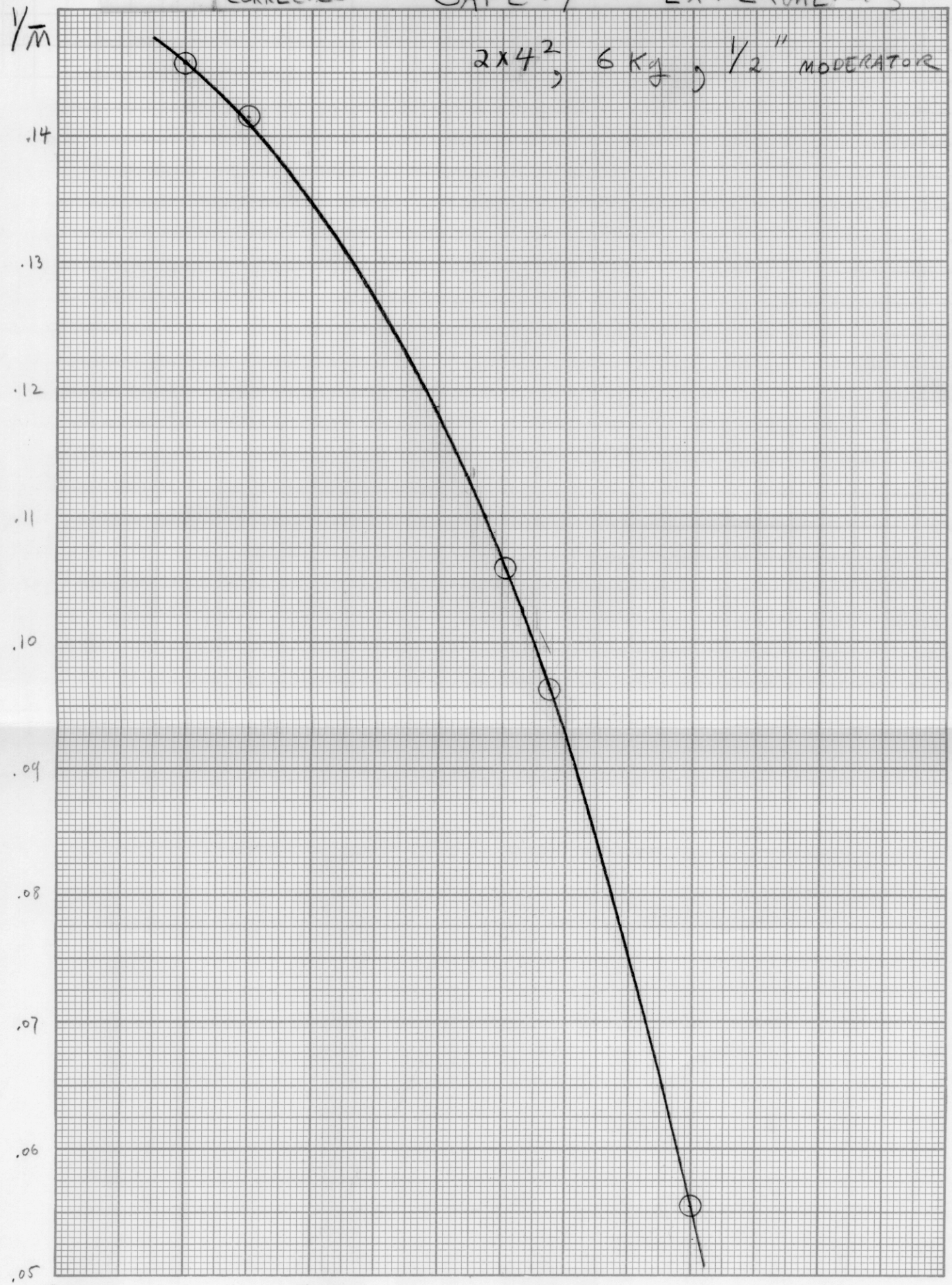
114,452/10 → 11,445 → 11,465 − 8033 = 3,432

NOTE: 1/2" RING LEAVES COUNTS CHANGED VERY LITTLE DUE TO BACK & SIDE SCATTER.

WE NOW CAN EXPLAIN ALL OUR OBSERVED COUNTS & WILL ACCEPT RESULTS AT BOTTOM OF PRECEEDING PAGE

4/28/07

CORRECTED SAFETY EXPERIMENTS




358-10½ MADE IN U.S.A.
20 X 20 TO THE INCH KEUFFEL & ESSER CO.

THE CORRECTED (FOR TOTAL MODERATOR) EFFICIENCY FACTORS ARE THEN

T-1 : $1.819 \times 10^{5}$ , T-2 : $2.339 \times 10^{5}$

AND IF WE WANT TO CONVERT COUNTS DIRECTLY TO MULTIPLICATIONS, FOR A BASE RATE OF 129.11

T-1 : $M = C \times 2.348 \times 10^{-4}$, T-2 : $M = C \times 3.019 \times 10^{-4}$ $(min^{-1})$

FOR A BASE RATE OF 259.38

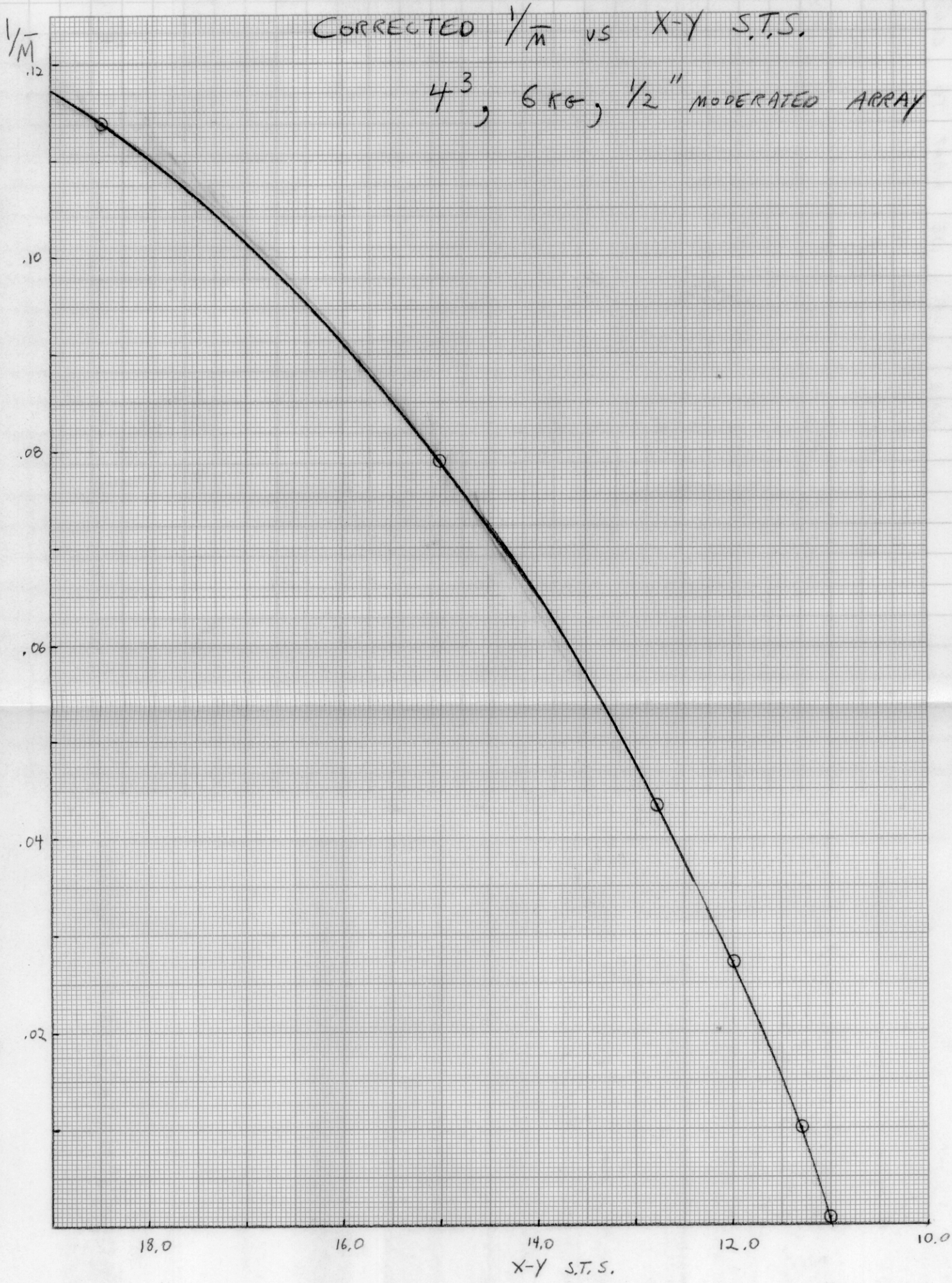
T-1 : $M = C \times 1.169 \times 10^{-4}$, T-2 : $M = 1.503 \times 10^{-4}$

[this assumes EFF FACTS GOOD FOR 16 COLUMNS !]

We Can Now Conect all Previous Arrays for Dead Time + Efficiency Factors.

SAFETY EXPERIMENTS

| ARRAY # | STS x-1 | T-1 | T-1 CORR | M | T-2 | T-2 CORR | M | $\bar{M}$ | $1/\bar{M}$ |
|---|---|---|---|---|---|---|---|---|---|
| C-3 | 16,000 | 29,098 | 29,248 | 6,867 | 22,637 | 22,714 | 6.857 | 6.862 | .14573 |
| C-6 | 15.000 | 30,010 | 30,191 | 7,089 | 23,249 | 23,330 | 7,043 | 7,066 | .14152 |
| C-21 | 10,950 | 47,687 | 48,146 | 9,479 | 3,388 | 39,273<br>-8,033<br>31,124 | 9,396 | 9,438 | .10595 |
| C-14' | 10.239 | 51,310 | 51,842<br>-7,775<br>44,067 | 10,347 | 42,295 | 42,565<br>-8,033<br>34,532 | 10,425 | 10,386 | .09628 |
| C-14 | 8,000 | 82,793 | 84,187<br>-7,775<br>76,412 | 17,942 | 67,362 | 68,049<br>-8,033<br>60,016 | 18,119 | 18,031 | .05546 |




K&E 10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

# COMPLETE ARRAYS

| Array No. | X-Y STS | Table Pos. | T-1 | T-1 Corr | $M_1$ | T-2 | T-2 Corr | $M_2$ | $\bar{M}$ | $1/\bar{M}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| C-7 | 40.000 | -.004 | 48,537 | 49,013 | 5.730 | 38,617 | 38,842 | 5.838 | 5.784 | .17289 |
| C-8 | 28.654 | -.005 | 53,652 | 54,234 | 6.340 | 43,369 | 43,653 | 6.561 | 6.451 | .15501 |
| C-9 | 21.987 | -.005 | 62,650 | 63,445 | 7.417 | 49,766 | 50,144 | 7.537 | 7.477 | .13374 |
| C-10 | 18.494 | -.004 | 73,099 | 74,184 | 8.672 | 58,683 | 59,204 | 8.898 | 8.785 | .11383 |
| C-11 | 15.002 | -.005 | 104,514 | 106,745 | 12,478 | 84,476 | 85,560 | 12,860 | 12,669 | .07893 |
| C-15 | 12.797 | 5.001 | 134,883 | 138,623 | 16.205 | 108,920 | 110,729 | 16.643 | 16.424 | .06089 |
| | | 2.000 | 160,509 | 165,832 | 19.386 | 129,667 | 132,239 | 19.875 | 19.631 | .05094 |
| | | -.006 | 187,811 | 195,140 | 22.812 | 152,069 | 155,619 | 23.390 | 23.101 | .04329 |
| C-16 | 12.000 | 5.001 | 171,258 | 177,332 | 20.730 | 138,653 | 141,598 | 21.282 | 21.006 | .04761 |
| | | 3,000 | 201,331 | 209,786 | 24.524 | 162,393 | 166,448 | 25.017 | 24.771 | .04037 |
| | | 1.000 | 253,792 | 267,786 | 31.304 | 204,946 | 210,063 | 31.572 | 31.438 | .03181 |
| | | -.006 | 295,340 | 313,880 | 36.693 | 239,115 | 248,011 | 37.276 | 36.985 | .02704 |

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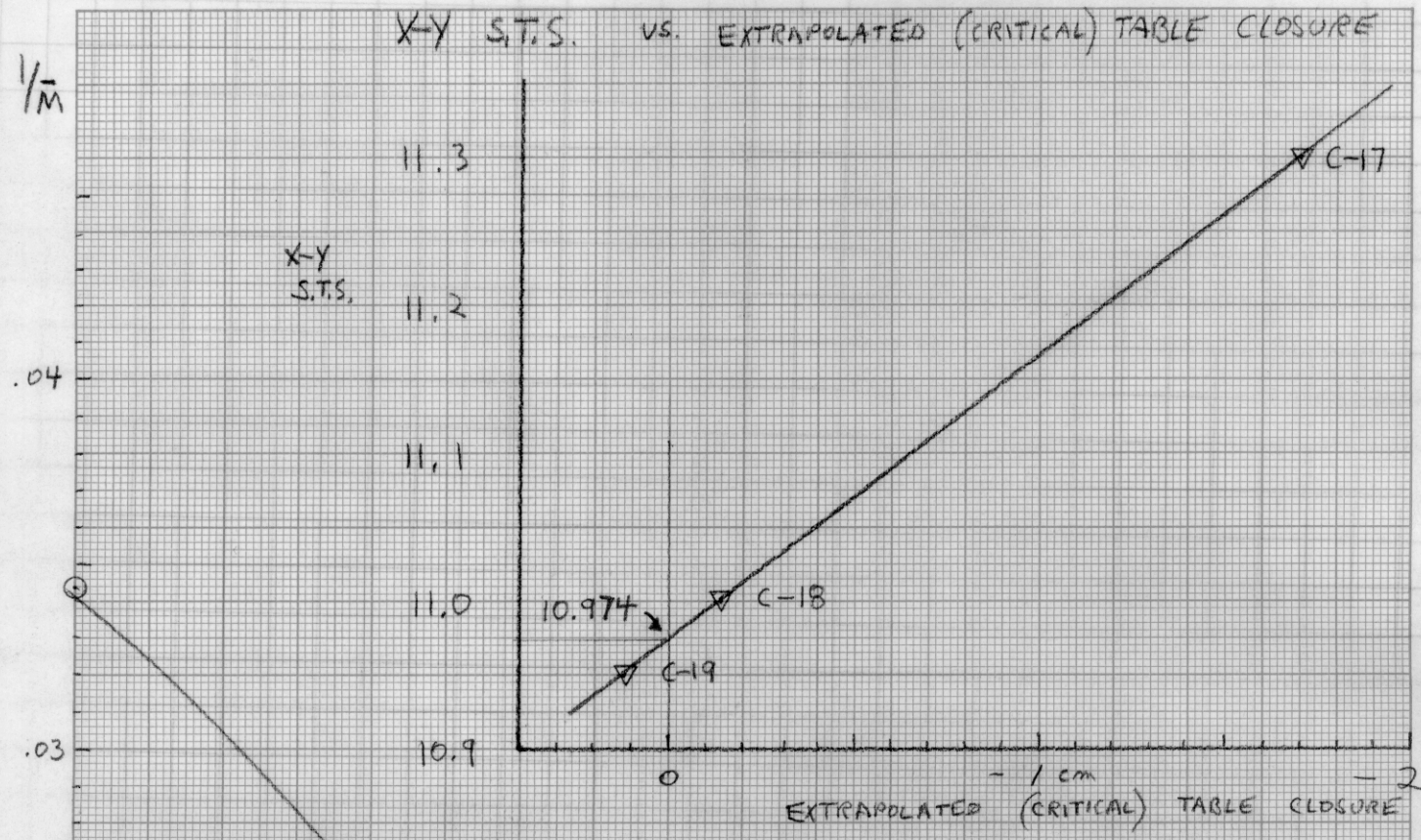
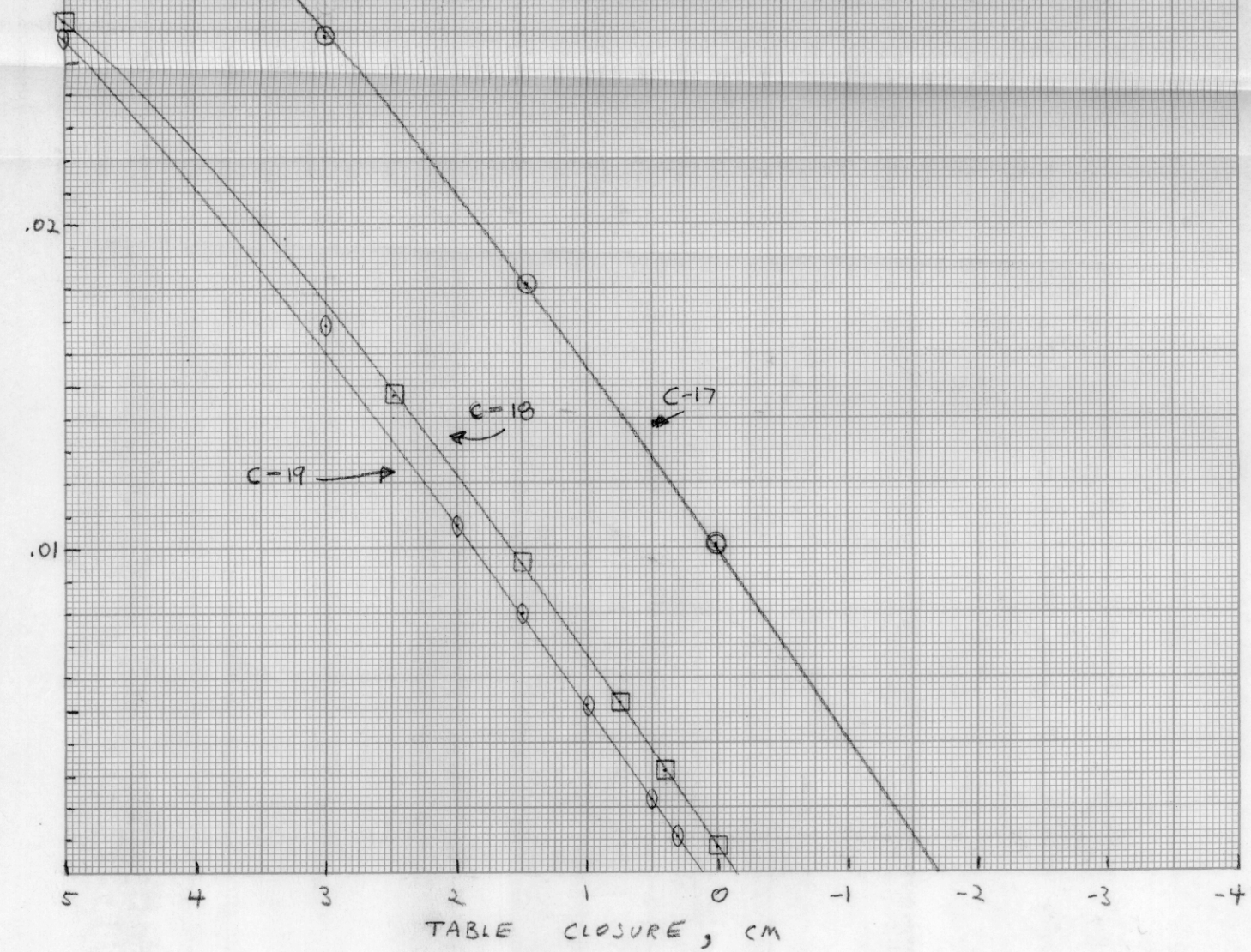
(continued on next page

# INVERSE MULTIPLICATION OF LAST THREE ARRAYS VS. TABLE SEPARATION




K&E 10 X 10 TO THE CM. 359-14 KEUFFEL & ESSER CO. MADE IN U.S.A.

# COMPLETE ARRAYS

| ARRAY No. | X-Y STS | TABLE POS | T-1 | T-1 CORR. | $M_1$ | T-2 | T-2 CORR. | $M_2$ | $\bar{M}$ | $1/\bar{M}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| C-17 | 11.301 | 5.000 | 24,247 | 248,962 | 29.104 | 16,625 | 16,625 | 29.037 | 29.071 | .03440 |
| | | 2.997 | 31,812 | 327,139 | 38.243 | 22,442 | 22,518 | 39.233 | 38.738 | .02581 |
| | | 1.470 | 45,397 | 468,117 | 54.723 | 31,612 | 31,763 | 55.340 | 55.032 | .01817 |
| | | +.003 | 80,391 | 834,862 | 97.595 | 57,712 | 58,216 | 101.428 | 99.512 | .01005 |
| C-18 | 11.001 | 5.000 | 31,442 | 323,308 | 37.795 | 21,944 | 255,209 | 38.358 | 38.077 | .02626 |
| | | 2.486 | 55,291 | 571,278 | 66.782 | 39,449 | 460,017 | 69.141 | 67.962 | .01471 |
| | | 1.500 | 84,841 | 881,875 | 103.09 | 61,262 | 716,733 | 107.72 | 105.41 | .00949 |
| | | .750 | 150,517 | 1,585,731 | 185.37 | 111,750 | 1,317,489 | 198.02 | 191.70 | .00522 |
| | | .399 | 242,097 | 2,599,614 | 303.90 | 183,694 | 2,189,706 | 329.11 | 316.51 | .00316 |
| | | -.006 | 836,789 | 10,268,916 | 1,200.4 | 670,554 | 8,642,300 | 1,298.9 | 1,249.7 | .00080 |
| C-19 | 10.950 | 5.000 | 33,001 | 339,442 | 39.681 | 23,443 | 272,713 | 40.989 | 40.335 | .02479 |
| | | 3.000 | 51,519 | 531,898 | 62.179 | 36,629 | 426,945 | 64.170 | 63.175 | .01583 |
| | | 1.998 | 74,998 | 777,999 | 90.948 | 54,691 | 639,218 | 96.074 | 93.511 | .01069 |
| | | 1.560 | 99,795 | 1,040,468 | 121.63 | 73,211 | 858,098 | 128.97 | 125.30 | .00798 |
| | | 1.000 | 150,446 | 1,584,945 | 185.28 | 113,700 | 1,340,870 | 201.53 | 193.41 | .00517 |
| | | .500 | 328,714 | 3,595,142 | 420.27 | 255,580 | 3,080,806 | 463.05 | 441.66 | .00226 |
| | | .300 | 633,763 | 7,415,734 | 866.9 | 505,027 | 6,334,008 | 952.0 | 909.5 | .00110 |

# Eff. Factor Determinations for $4^3$ Mod. (1.0") Array

BKg: T-1 = 7860 T-2 = 7813

This background was deduced from a 60 min. count.

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 10-168 | 116075/10 | 11635 | 117889/10 | 11810 |
| | 11608 | - 7860 | 11789 | - 7813 |
| | | 3775 | | 3997 |
| 10-130 | 114201/10 | 11446 | 115552/10 | 11575 |
| | 11420 | - 7860 | 11555 | - 7813 |
| | | 3586 | | 3762 |
| 10-92 | 113078/10 | 11334 | 113907/10 | 11411 |
| | 11308 | - 7860 | 11391 | - 7813 |
| | | 3474 | | 3598 |
| 10-54 | 110384/10 | 11062 | 110882/10 | 11106 |
| | 11038 | - 7860 | 11088 | 7813 |
| | | 3202 | | 3293 |

Column 10 Averages:

T-1 = 3509 cpm = 58.48 cps T-2 = 3663 cpm = 61.05 cps

Eff. = $4.50 \times 10^{-6}$ Eff. = $4.70 \times 10^{-6}$

Eff. Factor = $2.22 \times 10^{5}$ Eff. Factor = $2.13 \times 10^{5}$

Note: Average of above efficiency Factors is $2.175 \times 10^{5}$. Base column 10 Average efficiency Factor was $2.173 \times 10^{5}$. Therefore we will not correct for the moderator

| | | | | |
|---|---|---|---|---|
| 11-168 | 130100/10 | 13044 | 108670/10 | 10885 |
| | 13010 | - 7860 | 10867 | - 7813 |
| | | 5184 | | 3072 |
| 11-130 | 126558/10 | 12692 | 107385/10 | 10756 |
| | 12660 | - 7860 | 10739 | - 7813 |
| | | 4832 | | 2943 |
| 11-92 | 123487/10 | 12380 | 106280/10 | 10695 |
| | 12349 | - 7860 | 10628 | - 7813 |
| | | 4520 | | 2832 |

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 11-54 | 120103/10 | 12039 | 104253/10 | 10495 |
| | 12010 | -7860 | 10429 | -7813 |
| | | 4179 | | 2632 |

Column 11 Averages:

T-1 = 4679 cpm = 77.98 cps  T-2 = 2870 cpm = 47.83 cps
Eff. = $5.998 \times 10^{-6}$  Eff. = $3.679 \times 10^{-6}$
Eff. Factor = $1.67 \times 10^{5}$  Eff. Factor = $2.72 \times 10^{5}$

| | | | | |
|---|---|---|---|---|
| 15-168 | 131829/10 | 13217 | 108883/10 | 10901 |
| | 13183 | -7860 | 10888 | -7813 |
| | | 5357 | | 3088 |
| 15-130 | 128487/10 | 12882 | 107773/10 | 10794 |
| | 12849 | -7860 | 10777 | -7813 |
| | | 5022 | | 2981 |
| 15-92 | 125637/10 | 12555 | 106806/10 | 10698 |
| | 12568 | -7860 | 10681 | -7813 |
| | | 4735 | | 2885 |

5-1-67 We will re-count 15-92.
T-1 = 125782/10  T-2 = 107076/10

| | | | | |
|---|---|---|---|---|
| 15-54 | 120095/10 | 12039 | 105517/10 | 10569 |
| | 12010 | -7860 | 10552 | -7813 |
| | | 4179 | | 2756 |

Column 15 Averages:

T-1 = 4823 cpm = 80.38 cps  T-2 = 2928 cpm = 48.80 cps
Eff. = $6.183 \times 10^{-6}$  Eff. = $3.754 \times 10^{-6}$
Eff. Factor = $1.62 \times 10^{5}$  Eff. Factor = $2.66 \times 10^{5}$

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 14-168 | 118883/10 | 11917 | 115625/10 | 11982 |
| | 11888 | -7860 | 11963 | -7813 |
| | | 4057 | | 4169 |
| 14-130 | 114182/10 | 11441 | 117032/10 | 11722 |
| | 11414 | -7860 | 11703 | -7813 |
| | | 3581 | | 3909 |
| 14-92 | 113886/10 | 11416 | 115146/10 | 11533 |
| | 11389 | -7860 | 11515 | -7813 |
| | | 3556 | | 3720 |
| 14-54 | 111421/10 | 11169 | 111574/10 | 11175 |
| | 11142 | -7860 | 11157 | -7813 |
| | | 3309 | | 3362 |

Column 14 Averages:

T-1 = 3626 cpm = 60.43 T-2 = 3790 cpm = 63.17

Eff. = $4.698 \times 10^{-6}$ Eff. = $4.859 \times 10^{-6}$

Eff. Factor = $2.155 \times 10^{5}$ Eff. Factor = $2.06 \times 10^{5}$

Total Averages of 4 columns 1.0" mod.

T-1 = 69.32 cps T-2 = 55.21 cps

$\overline{Eff.} = 5.332 \times 10^{-6}$ $\overline{Eff.} = 8.297 \times 10^{-6}$

T-1 Eff. Factor = $1.875 \times 10^{5}$ T-2 Eff. Factor = $2.355 \times 10^{5}$

We will now check the eff. factors for the 1.5" moderator with a center to center spacing of 12". $STS_{x,4}$ = 10.950 cm

The new source locations are 180, 134, 88, 42

.9976 .9978

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 10-180 | 114192/10<br>11419 | 11446<br>-7860<br>3586 | 120798/10<br>12080 | 12099<br>-7813<br>4286 |
| 10-134 | 111334/10<br>11133 | 11160<br>-7860<br>3300 | 117937/10<br>11794 | 11813<br>-7813<br>4000 |
| 10-88 | 109213/10<br>10921 | 10947<br>-7860<br>3087 | 115163/10<br>11516 | 11534<br>-7813<br>3721 |
| 10-42 | 106766/10<br>10677 | 10703<br>-7860<br>2843 | 111389/10<br>11139 | 11157<br>-7813<br>3344 |

Column 10 Averages:

T-1 = 3209cpm = $S^{-3.80}$ T-2 = 3838cpm = 63.97

Eff. = $4.108 \times 10^{-6}$ Eff. = $4.921 \times 10^{-4}$

Eff. Factor = $2.43 \times 10^{5}$ Eff. Factor = $2.03 \times 10^{5}$

| | | | | |
|---|---|---|---|---|
| 14-180 | 113073/10<br>11307 | 11334<br>-7860<br>3474 | 122953/10<br>12295 | 12319<br>-7813<br>4506 |
| 14-134 | 110980/10<br>11098 | 11125<br>-7860<br>3265 | 119682/10<br>11968 | 11983<br>-7813<br>4170 |
| 14-88 | 110603/10<br>11060 | 11087<br>-7860<br>3227 | 116701/10<br>11680 | 11689<br>-7813<br>3876 |
| 14-42 | 106617/10<br>10662 | 10688<br>-7860<br>2828 | 111788/10<br>11179 | 11197<br>-7813<br>3384 |

Column 14 Averages:

T-1 = 3199 cpm = 53.32 cps  T-2 = 3988 cpm = 66.40 cps
Eff. = $4.102 \times 10^{-6}$  Eff. = $5.108 \times 10^{-6}$
Eff. Factor = $2.13 \times 10^{5}$  Eff. Factor = $1.96 \times 10^{5}$

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 15-180 | 134921/10 | 13524 | 107165/10 | 10734 |
| | 13492 | -7860 | 10717 | -7813 |
| | | 5664 | | 2921 |
| 15-134 | 129490/10 | 12980 | 106222/10 | 10639 |
| | 12949 | -7860 | 10622 | -7813 |
| | | 5120 | | 2826 |
| 15-88 | 124604/10 | 12490 | 105603/10 | 10577 |
| | 12460 | -7860 | 10560 | -7813 |
| | | 4630 | | 2764 |
| 15-42 | 120272/10 | 12056 | 103717/10 | 10389 |
| | 12027 | -7860 | 10372 | -7813 |
| | | 4196 | | 2576 |

Column 15 Averages:

T-1 = 4903 cpm = 81.72 cps  T-2 = 2772 cpm = 46.20 cps
Eff. = $6.284 \times 10^{-6}$  Eff. = $3.578 \times 10^{-6}$
Eff. Factor = $1.59 \times 10^{5}$  Eff. Factor = $2.81 \times 10^{5}$

| | | | | |
|---|---|---|---|---|
| 11-180 | 132179/10 | 13248 | 108425/10 | 10860 |
| | 13217 | -7860 | 10843 | -7813 |
| | | 5388 | | 3047 |
| 11-134 | 127929/10 | 12824 | 106562/10 | 10673 |
| | 12793 | -7860 | 10656 | -7813 |
| | | 4964 | | 2860 |
| 11-88 | 124530/10 | 12483 | 105015/10 | 10519 |
| | 12453 | -7860 | 10502 | -7813 |
| | | 4623 | | 2706 |

| Position | T-1 (.9996) | | T-2 (.9994) | |
|---|---|---|---|---|
| 11-42 | 119279/10 | 11957 | 102735/10 | 10290 |
| | 11928 | - 7860 | 10274 | - 7813 |
| | | 4097 | | 2477 |

Column 11 Averages:

| | T-1 | | T-2 | |
|---|---|---|---|---|
| | 4768 cpm = 79.47 cps | | 2773 cpm = 46.22 | |
| Eff. | $6.113 \times 10^{-6}$ | Eff. | $3.555 \times 10^{-6}$ | |
| Eff. Factor | $1.68 \times 10^{5}$ | Eff. Factor | $2.81 \times 10^{5}$ | |

Total Averages of 4 columns 1.5" mod.

| | | | |
|---|---|---|---|
| T-1 = | 66.98 cps | T-2 = | 55.70 cps |
| $\overline{Eff.}$ = | $5.152 \times 10^{-6}$ | $\overline{Eff.}$ = | $4.285 \times 10^{-6}$ |
| T-1 Eff. Factor = | $1.94 \times 10^{5}$ | T-2 Eff. Factor = | $2.33 \times 10^{5}$ |

We will now look at this vertical spacing (center to center = 12") for the bare column.

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 10-180 | 123212/10 | 12357 | 115617/10 | 11581 |
| | 12321 | - 7860 | 11562 | - 7813 |
| | | 4491 | | 3768 |
| 10-138 | 120452/10 | 12074 | 112909/10 | 11308 |
| | 12045 | - 7860 | 11290 | - 7813 |
| | | 4214 | | 3495 |
| 10-88 | 117271/10 | 11755 | 109790/10 | 10991 |
| | 11727 | - 7860 | 10973 | - 7813 |
| | | 3895 | | 3178 |
| 10-42 | 115518/10 | 11580 | 108280/10 | 10845 |
| | 11552 | - 7860 | 10828 | - 7860 |
| | | 3720 | | 2985 |

Column 10 Averages:

T-1 = 4080 cpm = 68.00 T-2 = 3357 cpm = 55.95
Eff. = 5.230×10⁻⁶ Eff. = 4.304×10⁻⁶
Eff. Factor = 1.91×10⁵ Eff. Factor = 2.32×10⁵

We will now look at the effect of the 1.5" Mock HE. @ Position 10-180

1) 1.5" Mock HE disc between source and T-2

12252/10 12255 109645/10 10983
12425 −7860 10965 −7813
4595 3170

2) 1.5" disc between source & T-1

115989/10 11627 115627/10 11582
11599 −7860 11563 −7813
3767 3769

5-3-67

3) 1.5" cell

121285/10 12158 119469/10 11864
12129 −7860 11946 −7813
4298 3651

4) Bare

123376/10 12368 115722/10 11530
12338 −7860 11572 −7813
4508 3717

We will now look at the eff. factors for 1.0" mod. at $STS_{xy}$ = 17.857cm $STS_z$ = 16.000cm.

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 10-168 | 118500/10 | 11878 | 118579/10 | 11877 |
| | 11850 | -7860 | 11858 | 7813 |
| | | 4018 | | 4064 |
| 10-130 | 115764/10 | 11604 | 115825/10 | 11602 |
| | 11576 | -7860 | 11583 | -7813 |
| | | 3744 | | 3789 |
| 10-92 | 115804/10 | 11608 | 113582/10 | 11376 |
| | 11580 | -7860 | 11358 | -7813 |
| | | 3748 | | 3563 |
| 10-54 | 112269/10 | 11254 | 109868/10 | 11005 |
| | 11227 | -7860 | 10987 | -7813 |
| | | 3394 | | 3192 |

Column 10 Averages:

| | T-1 | T-2 |
|---|---|---|
| | = 3726cpm = 62.10cps | = 3652cpm = 60.87cps |
| Eff. | = $4.777 \times 10^{-6}$ | = $4.682 \times 10^{-6}$ |
| Eff. Factor | = $2.09 \times 10^{5}$ | = $2.14 \times 10^{5}$ |

| | | | | |
|---|---|---|---|---|
| 11-168 | 129603/10 | 12991 | 110182/10 | 11032 |
| | 12960 | -7860 | 11018 | -7813 |
| | | 5131 | | 3219 |
| 11-130 | 126814/10 | 12711 | 108263/10 | 10843 |
| | 12681 | -7860 | 10826 | -7813 |
| | | 4851 | | 3030 |
| 11-92 | 124135/10 | 12414 | 107854/10 | 10802 |
| | 12414 | -7860 | 10785 | -7813 |
| | | 4584 | | 2989 |

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 11-54 | 119838/10 | 12013 | 105340/10 | 10551 |
| | 11984 | -7860 | 10534 | -7813 |
| | | 4153 | | 2738 |

Column 11 Averages

T-1 = 4680 cpm = 78.00 cps  T-2 = 2998 cpm = 49.80 cps
Eff. = 6.00 x 10^-6  Eff. = 3.838 x 10^-6
Eff. Factor = 1.69 x 10^-5  Eff. Factor = 2.61 x 10^-5

1.0022  1.0016

| | | | | |
|---|---|---|---|---|
| 15-168 | 133671/10 | 13396 | 111274/10 | 11146 |
| | 13364 | -7860 | 11127 | -7813 |
| | | 5536 | | 3332 |
| 15-130 | 128637/10 | 12895 | 108731/10 | 10890 |
| | 12864 | -7860 | 10873 | -7813 |
| | | 5035 | | 3077 |
| 15-92 | 124946/10 | 12525 | 109618/10 | 10979 |
| | 12495 | -7860 | 10961 | -7813 |
| | | 4665 | | 3166 |
| 15-54 | 120438/10 | 12073 | 106790/10 | 10796 |
| | 12044 | -7860 | 10679 | -7813 |
| | | 4213 | | 2983 |

Column 15 Averages:

T-1 = 4862 cpm = 81.03 cps  T-2 = 3140 cpm = 52.33 cps
Eff. = 6.233 x 10^-6  Eff. = 4.025 x 10^-6
Eff. Factor = 1.60 x 10^-5  Eff. Factor = 2.48 x 10^-5

5-9-67

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 14-168 | 119459/10 | 11975 | 120837/10 | 12103 |
| | 11946 | -7860 | 12084 | -7813 |
| | | 4115 | | 4290 |
| 14-130 | 118440/10 | 11872 | 118209/10 | 11839 |
| | 11844 | -7860 | 11820 | -7813 |
| | | 4012 | | 4026 |
| 14-92 | 116719/10 | 11700 | 115877/10 | 11617 |
| | 11672 | -7860 | 11598 | -7813 |
| | | 3840 | | 3804 |
| 14-54 | 113648/10 | 11392 | 111366/10 | 11155 |
| | 11365 | -7860 | 11137 | -7813 |
| | | 3532 | | 3342 |

Column 14 Averages:

T-1 = 3875 cpm = 64.58 cps  T-2 = 3866 cpm = 64.43 cps

Eff. = $9.968 \times 10^{-6}$  Eff = $4.956 \times 10^{-6}$

Eff. Factor = $2.01 \times 10^{5}$  Eff. Factor = $2.02 \times 10^{5}$

Total Averages of 4 columns, 1.0" mod. $SS_{xy} = 6.25$" = 12.85 cm

T-1 = 71.93 cps  T-2 = 56.88 cps

$\overline{Eff.} = 5.495 \times 10^{-6}$  $\overline{Eff.} = 4.375 \times 10^{-6}$

| T-1 Eff. Factor = $1.82 \times 10^{5}$ | T-2 Eff. Factor = $2.29 \times 10^{5}$ |
|---|---|

We will now begin the $4^3$, 1.0" Mod. Array safety experiments.

Bkg: T-1 = 162087/20 = 8104 cpm  T-2 = 137709/20 = 6885 cpm

We will look at 1 column of 4 6 Kg units moderated with 1.0" Mock HE located at position 6. (Page 38) The $STS_3$ = 16.062 cm. $STS_{x,y}$ = . Parts 66-703.
Base Rate = 15.76 $\times 10^5$ n/s
The scram table will be closed and the one column counted.

T-1 = 213830/20 T-2 = 203172/20

5-5-67

We will re-check the one column with only the scram table closed.

T-1 = 212885/20 T-2 = 204102/20

We will now close the control table and check its effect.

T-1 = 213210/20 → 10683 − 5105 = 2578 cpm
= 10661 cpm

T-2 = 205521/20 → 10291 − 6885 = 3356 cpm
= 10226 cpm

T-1′ = 42.98 cps T-2′ = 55.93 cps

| Position | T-1′ | Eff. Factor $10^5$ n/s | M | T-2′ | Eff. Factor $10^5$ n/s | M |
|---|---|---|---|---|---|---|
| 0.000 | 42.98 | $2.22 \times 10^5$ | | 55.93 | $2.13 \times 10^5$ | |

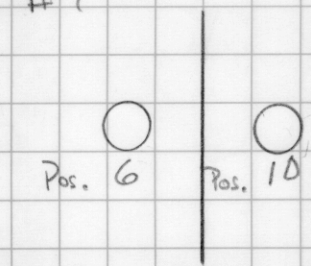
$\bar{M}$ =

We found trouble with the preamp for T-1. We don't know how long we have had this noise. We will have to look at our Eff. Factor data and see if we can determine when the trouble began. A tube was also changed in T-2.

5-8-67

We will do Assembly D-1 before we check our eff. factors since we have it already setup.

2 columns of 4 6Kg units




Assembly D-1: Pu to Pu $STS_{x,y}$ = 17.859 cm $STS_z$ = 16.062 cm

Lateral: .714 cm fixed + 17.145 = 17.859 cm

Vertical: .108 cm fixed + 15.954 cm = 16.062 cm

Moderator thickness per 6Kg cell = 1.0" = 2.54 cm

Parts: 66-81

Base Rate = 31.75 $\times 10^{-5}$ n/s

| Pos. | T-1 | T-1' | Eff. Factor* | $10^5$ n/s | M | T-2 | T-2' | Eff. Factor* | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 8.090 | 69239/5 = 13847 | 13886 − 8104 = 5782 | $1.95 \times 10^{-5}$ | 188.0 | 5.72 | 66826/5 = 13285 | 13314 − 6885 = 6429 | $2.37 \times 10^{-3}$ | 253.8 | 7.99 |
| | | 96.4 | | | | | 107.1 | | | |

Bad Background

* Deduced from data on .5" & 1.5" mod. & bare eff. factor work

We will now re-check the eff. factor for position 10 to see if there is any difference due to changing pre-amp of T-1 and tube of preamp of T-2

Pos.

10-180 T-1 = 153398/10 = 15339 → 15387 − 10825 = 4562

T-2 = 160580/10 = 16058 → 16097 − 12197 = 3900

10-134 T-1 = 149426/10 = 14943 → 14988 − 10825 = 4163

T-2 = 156389/10 = 15635 → 15671 − 12197 = 3474

8 Kg (10 cd. on wall, 2 with 1" mod.) T-1 = 648032/60 = 10801 → 10825

T-2 = 730521/60 = 12175 → 12197

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 10-88 | 146853/10 → 14685 | 14729<br>-10825<br>3904 | 153699/10 → 15370 | 15405<br>-12197<br>3208 |
| 10-42 | 144078/10 → 14408 | 14449<br>-10825<br>3624 | 151129/10 → 15113 | 15148<br>12197<br>2951 |

These numbers compare to the old ones page 77.

∴ There must be something wrong with the Eff. Factors. We will investigate this for Assembly D-1.

| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 10-172 | 153886/10 → 15389 | 15437<br>-10825<br>4612 | 159778/10 → 15978 | 16016<br>-12197<br>3819 |
| 10-134 | 151217/10 → 15122 | 15168<br>-10825<br>4343 | 156567/10 → 15657 | 15695<br>-12197<br>3498 |
| 10-96 | 148663/10 → 14866 | 14911<br>-10825<br>4086 | 154322/10 → 15432 | 15468<br>-12197<br>3271 |
| 10-57 | 145816/10 → 14582 | 14624<br>-10825<br>3799 | 151342/10 → 15134 | 15169<br>-12197<br>2952 |

Column 10 Averages:

T-1 = 4210 cpm = 70.17 cps  T-2 = 3385 cpm = 56.42 cps

Eff. = $5.398 \times 10^{-6}$  Eff. = $4.340 \times 10^{-6}$

Eff. Factor = $1.85 \times 10^{-5}$  Eff. Factor = $2.30 \times 10^{-5}$

5-9-67

It appears the background count for T-2 taken on page 81 was in error. Comparing with other and longer background counts it should be around 8000 /min. We will use the bkg. from page 72. T-1 = 7860 T-2 = 7813. We will now compute the mult. for the two previous safety assemblies.

One column of 4 6Kg units
Moderated with 1.8" Mock HE located at position 6 (page 38)
The $STS_3$ = 16,062cm. Parts 66-73
Base Rate = $15.76 \times 10^5$ n/s

T-1 = 213210/20 → 10660 − 7860 = T-1′ = 2822 (10682)

T-2 = 204521/20 → 10226 − 7813 = T-2′ = 2428 (10241)

| Pos. | T-1′ | Eff. Factor | $10^5$ n/s | M | T-2′ | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|
| 6.000 | 47.03 | $1.85 \times 10^{-5}$ | 87.00 | 5.52 | 40.47 | $2.30 \times 10^{-5}$ | 93.08 | 5.91 |

$\bar{M}$ = 5.71

Assembly D-1 : As described on page 83

| Pos. | T-1 | T-1′ | Eff. Factor | $10^5$ n/s | M | T-2 | T-2′ | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 69234/5 → 13847 | 13886 − 7860 = 6026 | $1.85 \times 10^{-5}$ | 185.7 | 5.85 | 66426/5 → 13285 | 13312 − 7813 = 5499 | $2.30 \times 10^{-5}$ | 210.8 | 6.64 |
| | | 100.4 | | | | | 91.65 | | | |

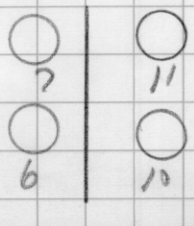
$\bar{M}$ = 6.25

$M_1$ = 5.94 $M_2$ = 6.37

If we use bkg from page 63 we get $\bar{M}$ = 6.16

We will now look at the eff. Factors for the 4 column safety experiment (1.1" Mock HE)

| | T-1 | T-2 |
|---|---|---|
| Bkg. | 107272/10 → 10727 | 121372/10 → 12137 |



| Position | T-1 | | T-2 | |
|---|---|---|---|---|
| 10-172 | 147270/10 | 14770 | 160205/10 | 16060 |
| | 14727 | -10825 | 16021 | -12197 |
| | | 3945 | | 3863 |
| 10-134 | 144283/10 | 14470 | 157811/10 | 15819 |
| | 14428 | -10825 | 15781 | -12197 |
| | | 3645 | | 3622 |
| 10-96 | 143593/10 | 14801 | 155361/10 | 15572 |
| | 14359 | -10825 | 15536 | -12197 |
| | | 3576 | | 3375 |
| 10-57 | 141496/10 | 14185 | 157978/10 | 15233 |
| | 14145 | -10825 | 15198 | -12197 |
| | | 3360 | | 3036 |

Column 10 Averages

T-1 = 3632cpm = 60.53 cps  T-2 = 3479 cpm = 57.98 cps

Eff. = $4.656 \times 10^{-4}$  Eff. = $4.957 \times 10^{-4}$

Eff. Factor = $2.15 \times 10^{5}$  Eff. Factor = $2.25 \times 10^{5}$

| | | | | |
|---|---|---|---|---|
| 11-172 | 157102/10 | 15759 | 152617/10 | 15297 |
| | 15710 | -10825 | 15262 | -12197 |
| | | 4934 | | 3100 |
| 11-134 | 154118/10 | 15459 | 150995/10 | 15085 |
| | 15411 | -10825 | 15050 | -12197 |
| | | 4634 | | 2888 |
| 11-96 | 151076/10 | 15154 | 150241/10 | 15059 |
| | 15108 | -10825 | 15024 | -12197 |
| | | 4329 | | 2862 |
| 11-57 | 147064/10 | 14749 | 147560/10 | 14789 |
| | 14706 | -10825 | 14756 | -12197 |
| | | 3924 | | 2592 |

Columns 11 Averages:

T-1 = 4455 cpm = 74.25 cps  T-2 = 2861 cpm = 47.68
Eff. = $5.712 \times 10^{-6}$  Eff. = $3.668 \times 10^{-6}$
Eff. Factor = $1.75 \times 10^{5}$  Eff. Factor = $2.73 \times 10^{5}$

Average Eff. Factors for the 4 column 1.0" mod. safety array. $STS_{xy}$ = 17.859 cm  $STS_z$ = 16.062 cm

$\overline{T-1}$ = 67.39 cps  $\overline{T-2}$ = 52.79 cps
Eff. = $5.184 \times 10^{-6}$  Eff. = $4.061 \times 10^{-6}$
Eff Factor = $1.93 \times 10^{5}$  Eff Factor = $2.46 \times 10^{5}$

Assembly D-2: Pu to Pu  $STS_{xy}$ = 17.859 cm  $STS_z$ = 16.062 cm

Lateral: .714 cm fixed + 17.145 cm = 17.859 cm

Vertical: .108 cm fixed + 15.954 cm = 16.062 cm

Parts: 66 - 97

Base Rate = $63.69 \times 10^{5}$ n/s

| (11) | (9) |
|---|---|
| 7 | 11 |
| (12) | (10) |
| 6 | 10 |

| Pos. | T-1 | T-1′ | Eff. Factor | $10^5$ n/s | M | T-2 | T-2′ | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| Fast Step | 20775 | 20863 | $1.93 \times 10^{5}$ | 418.2 | 6.57 | 17894 | 17992 | $2.46 \times 10^{5}$ | 415.2 | 6.52 |
| | | −7860 | | | | | −7813 | | | |
| | | 13003 | | | | | 10179 | | | |
| | | 216.7 | | | | | 168.8 | | | |

$\overline{M}$ = 6.55

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 21488 | 21592 | $1.93 \times 10^{5}$ | 441.8 | 6.94 | 18794 | 18887 | $2.46 \times 10^{5}$ | 452.4 | 7.10 |
| | | −7860 | | | | | −7813 | | | |
| | | 13732 | | | | | 11034 | | | |
| | | 228.9 | | | | | 183.9 | | | |

$\overline{M}$ = 7.02

5/12/67

Installation of $8 \times 10^6$ n/s source Holder near T-1 & T-2 :

1st Take 5-MIN BKGD COUNTS

T-1 : 136,790 → 27,508 ; T-2 : 111,446 → 22,364
27,358 22,289

Installed Holder Fixed to plate
Take 5-MIN COUNTS

T-1 : 509,195 → 103,957 ; T-2 : 507,790 → 103,129
101,839 101,558
27,508 -22,364
76,449 80,765

Source Counts for M-248 in Holder !!!

This will be our daily standard

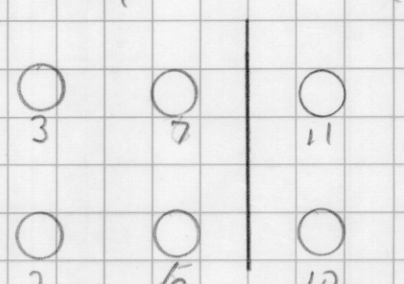
Assembly D-3 : Pu to Pu $STS_{x,y}$ = 17.859 cm $STS_z$ = 16.062 cm

Lateral : .718 cm fixed + 17.145 cm = 17.859 cm

Vertical : .108 cm fixed + 15.954 cm = 16.062 cm

Parts : 66 - 129

Base Rate = $130.22 \times 10^5$ n/s




| Pos. | T-1 | T-1' | Eff. Factor | $10^5$ n/s | M | T-2 | T-2' | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 7.816 | 42937 | 43309 | $1.82 \times 10^5$ | 1025.3 | 8.26 | 35232 | 35926 | $2.29 \times 10^5$ | 1073.1 | 8.24 |
| | | -2860 | | | | | -7813 | | | |
| | | 35449 | | | | | 28113 | | | |
| | | 590.8 | | | | | 468.6 | | | |

$\bar{M}$ = 8.25

| Pos. | T-1 | T-1' | Eff. Factor | $10^{5}$ n/s | M | T-2 | T-2' | Eff. Factor | $10^{5}$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 228563/5 | 46137 | $1.82 \times 10^{-5}$ | 1161.2 | 8.92 | 190836/5 | 38386 | $2.29 \times 10^{-5}$ | 1167.0 | 8.96 |
| | 45717 | -7860 | | | | 38167 | -7813 | | | |
| | | 38277 | | | | | 30573 | | | |
| | | 638.0 | | | | | 509.6 | | | |

$1/m_1 = .11214$

$1/m_2 = .11159$

$\bar{M} = 8.94$

$1/m = .1119$

5/11/67

---

Daily Source Counts

| T-1 | T-2 |
|---|---|
| 96,266 | 144,019 |
| -20,005 | -62,865 |
| 76,261 | 81,154 |

---

We are now halting temporarily to a) install new transit holder, b) transit guard rails and c) try out new locating screws.

5/12/67

We are going to change some of the old 1½" mod columns while we wait for completion of transit installation. 1st we will take 40 min BKgd count to get good measurement of BKgd. Any change in BKgd will be due to change in set-up of the 7 columns we are going to work on

T-1 740794/40
18,520 → 18,589

T-2 2483742/40
62,094 → 62,678

↑ Note decrease in bkgd from yesterday

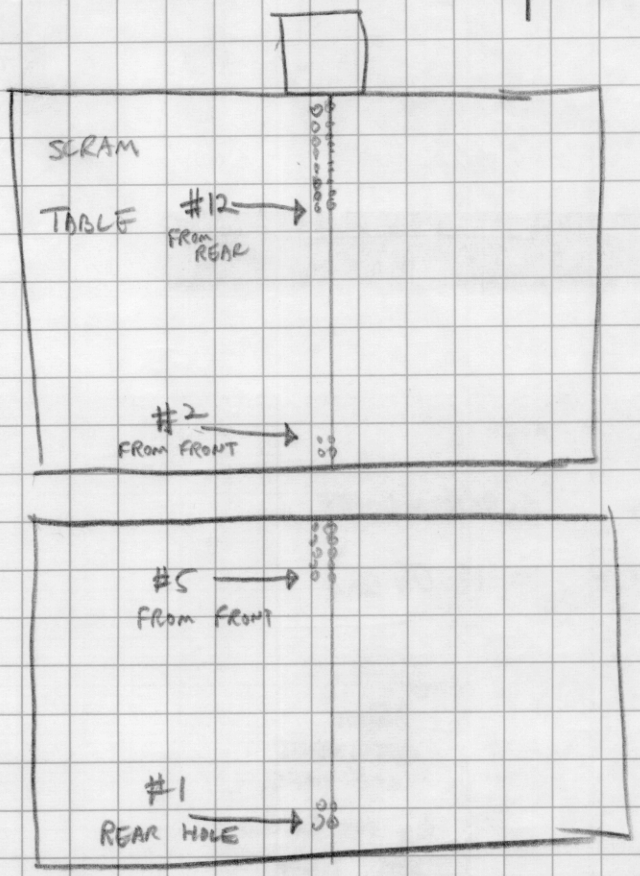
After change late Friday

T-1 602,290/29
20,769 → 20,856

$\Delta = 2,267$

T-2 1,863,933/29
64,274 → 64,900

$\Delta = 2,222$




Holes to be used for lining up table ℄ !

5-15-67

| | T-1 | T-2 |
|---|---|---|
| Bkg. | 629785/30 | 1944120/30 |
| | 20993 → 21082 | 64804 → 65439 |

We will assume our backgrounds for the 8 member safety array are the old one's (page 72) plus the Δ's (page 89) T-1 = 10127 T-2 = 10035

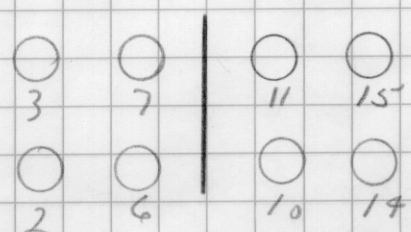
Assembly D-4: Pu to Pu $STS_{xy}$ = 18.494cm $STS_z$ = 16.062cm

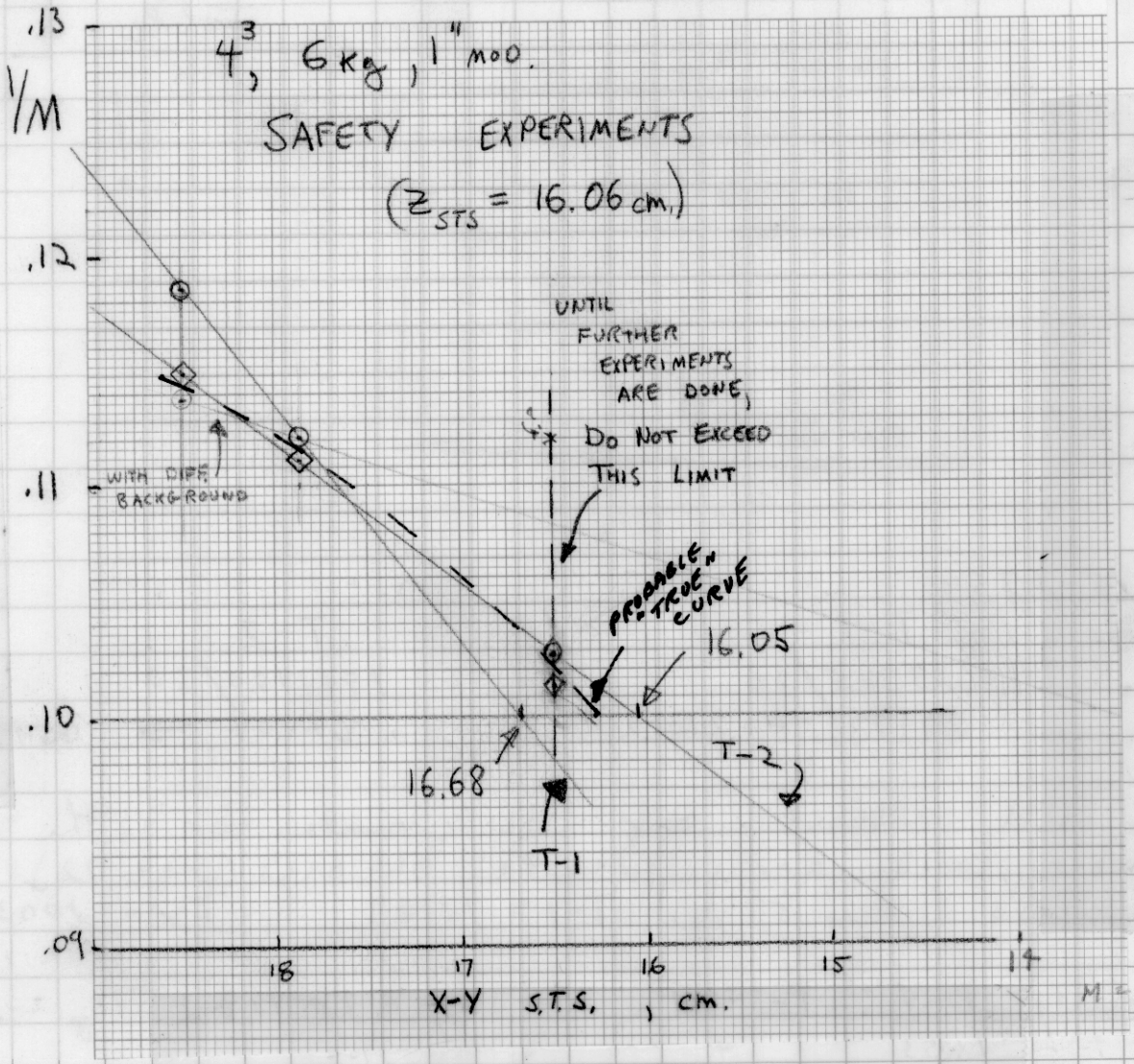
Lateral: .714cm + 17.780 cm = 18.494 cm

Vertical: .108cm + 15.954 cm = 16.062 cm

Parts: 66-129

Base Rate = $130.22 \times 10^5$ n/s



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| Pos | T-1 | T-1' | Eff. Factor | $10^5$ n/s | M | T-2 | T-2' | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 7810 | 43020 | 43393 | $1.82\times10^{-5}$ | 1009.0 | 7.75 | 37453 | 37666 | $2.29\times10^{-5}$ | 1054.5 | 8.10 |
| | | -10127 | | | | | -10035 | | | |
| | | 33266 | | | | | 27631 | | | |
| | | 558.4 | | | | | 460.5 | | | |

$\bar{M} = 7.93$

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 22958 n/s | 46344 | $1.82\times10^{-5}$ | 1068.6 | 8.44* | 39751 n/s | 39737 | $2.29\times10^{-5}$ | 1133.6 | 8.71 |
| | 45918 | -10127 | | | | 39503 | -10035 | | | |
| | | 36217 | | | | | 29702 | | | |
| | | 603.6 | | | | | 495.0 | | | |

$1/M_1 = .11853$ ; $1/M_2 = .11487$

$\bar{M} = 8.58$

$1/\bar{M} = .1166$

The purpose of the above two arrays (D-3 & D-4) was to allow us to extrapolate forward to the whereabouts of $M_{\frac{1}{2}} = 10.6$. However, the spread in the extrapolations of the individual counters is so wide as to be intolerable. However, we feel that the spread is due to a slightly erroneous background (see page 89, un-accountable decrease noted on T-1*) and that the T-1 curve is probably too conservative (using another background number for T-1, we can just as well extrapolate to less than 14 cm, as shown with red line on graph) (see graph).

We feel we can proceed, however, at least until the 16.5 cm point without doing further safety experiments.

If we have to proceed beyond that point with the full array we will pause for more ½ table experiments.

* on page 89 $\Delta_1$ could have been 851 and $Bkgd_1 = 8711$

Then $C-1 = 37633$ cpm $= 627.2$ cps $\rightarrow 1141 \times 10^5$ n/s $\rightarrow M_1 = 8.76$

$1/M_1 = .1142$

5-16-67 We will now begin the $4^3$ array (1" Mod)

Assembly D-5: Pu to Pu $STS_{xy} = 36.274$ cm $STS_z = 16.062$ cm

Lateral: .714 cm fixed + 35.560 cm = 36.274 cm

Vertical: .108 cm fixed + 15.954 cm = 16.062 cm

Parts: 1-129 less #7

Base Rate = 259.38 $\times 10^{-5}$ n/s

[$4^3$, 6 Kg, 1.0" Moderated Array]

T/C's located col. 16 parts #125 (#1) #123 (#2)

| Pos. | T-1 | T-1' | Eff. Factor | $10^5$ n/s | M | T-2 | T-2' | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 7.869 | 61223 | 61979 | $1.82\times10^{-5}$ | 1880.1 | 7.2 | 49013 | 49378 | $2.25\times10^{-5}$ | 1884.7 | 7.3 |
| | | 1033. | | | | | 823.0 | | | |

$\bar{M} = 7.25$

T/C's Room = 69 #1 = 107 #2 = 94

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 61278 | 62041 | $1.82\times10^{-5}$ | 1881.9 | 7.26 | 49730 | 50106 | $2.25\times10^{-5}$ | 1912.8 | 7.37 |
| | | 1034. | | | | | 835.1 | | | |

$\bar{M} = 7.31$

$M^{-1} = .1368$

T/C's Room = 69 #1 = 107 #2 = 83

We will close this assembly again and take a longer count before we place the Cd in the Tubes.

T-1 = 617216/10 T-2 = 498607/10

5-17-67

Source determination:

| | T-1 | T-2 |
|---|---|---|
| Bkg. | 290661/5<br>58132 → 58814 | 234879/5<br>46976 → 47307 |
| With Source | 664116/5<br>132823 → 136852 | 629322/5<br>125,864 → 126288 |
| Source Worth | 77638 | 80981 |

We will now place cadmium in the Tubs and do this source determination again.

| | T-1 | T-2 |
|---|---|---|
| Bkg (Cd) | 31299/5<br>6260 | 19769/5<br>3954 |
| With Source (Cd) | 134797/5<br>26959 | 111650/5<br>22330 |
| Source Worth (Cd) | 20699 | 18376 |

We will do this source determination again.

| | T-1 | T-2 |
|---|---|---|
| Bkg (Cd) | 31898/5<br>6369 | 19612/5<br>3922 |

| | T-1 | T-2 |
|---|---|---|
| With Source (Cd) | 136074/5<br>27214 | 107194/5*<br>21439 |
| Source Worth (Cd) | 20845 | 17517* |

* This is ~5% lower than the previous determination. We re-ran this 4 times and it repeated ∴ we will use this latter value for the Cd correction.

$T\text{-}1 = \frac{77638}{20845} = 3.725$ $\quad T\text{-}2 = \frac{89981}{17517} = 4.623$

New Eff. Factors for the Cd Tubs.

$T\text{-}1 = 1.82 \times 10^5 \times 3.725 = 6.780 \times 10^5$

$T\text{-}2 = 2.29 \times 10^5 \times 4.623 = 10.587 \times 10^5$

We will normalize the Eff. Factors using the Assembly D-5 numbers. * (Other page)

We will now run Assembly D-5 again with the Cd in place.

| Pos. | T-1 | T-1' | Eff. Factor | $10^5$ n/s | M | T-2 | T-2' | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.861 | 32505/5<br>6501* | 108.4 | 17.352 x $10^5$ | 1881. | 7.25 | 20456/5<br>4091* | 68.18 | 27.680 x $10^5$ | 1888.5 | 7.27 |

T/C's Room = 70 #1 = 109 #2 = 98

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 32774/5<br>6555 | 109.3 | 17.226 x $10^5$ | 1882.8 | 7.26 | 20773/5<br>4155 | 69.25 | 27.615 x $10^5$ | 1912.3 | 7.37 |

The corrected Eff. Factors for the Cd Tubs are

$T\text{-}1 = 17.226 \times 10^5$ $\quad T\text{-}2 = 27.615 \times 10^5$

5-18-67

Source determination

| | T-1 | T-2 |
|---|---|---|
| Bkg (Cd) | 33764/5<br>6753 | 20163/5<br>4033 |
| w.th Source (cd) | 137470/5<br>27494 | 103503/5<br>20701 |
| Source Wo.th (Cd) | 20741 | 16668 |

Tub 2 is not acting right again. It has again decrease about 5%. We will take more counts on T-2 with source.

17156

17316

17582

17510

There appears to be a problem with T-2 of some type. Looking at the pulses there is the double base line again which I don't understand. We will do the array and then check this out, since we can't check it out now.

Assembly D-6: Pu to Pu $STS_{x,y}$ = 27.384cm $STS_z$ = 16.062cm

Lateral: .718cm (fixed) + 26.670cm = 27.384

Vertical: .108cm (fixed) + 15.954cm = 16.062cm

Parts: 1-129 less #7

Base Rate = 259.38 X $10^{-5}$ 4/s

[9³, 6Kg, 1.0" Moderated Array]

T/C's located col. 16 parts #125 (#1) #125 (#2)

| Pos | T-1 | T-1' | Eff. Factor | $10^5$/S | M | T-2 | T-2' | Eff. Factor | $10^5$/S | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 7.859 | 14844/2 7421 | 123.7 | $17.352 \times 10^{-5}$ | 2146.4 | 8.28 | 9216/2 4638 | 77.3 | $27.680 \times 10^{-5}$ | 2136.6 | 8.24 |

$\bar{M} = 8.26$

T/C's Room = 70 #1 = 98 #2 = 107

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 15493/2 7747 | 129.1 | $17.352 \times 10^{-5}$ | 2240.1 | 8.64 | 9630/2 4815 | 80.3 | $27.680 \times 10^{-5}$ | 2219.5 | 8.56 |

$\bar{M} = 8.60$

$Y_M = .1163$

T/C's Room = 70 #1 = 97 #2 = 104

5-24-67

We have been unable to find out why the counts increase with counting time. We changed the $B^+$ supplies with no effect. We removed the Cd with no effect. We changed the $BF_3$ tubes with no effect. The effect we are having has the appearance* of something activating. We will return our system to the original condition and continue since this effect will not effect our $Y_M$'s very much. We will now do the next array.

* THE ACTIVATION HYPOTHESIS HAS BEEN PRETTY WELL BEATEN INTO THE GROUND

We will do the source determination check as shown on the adjacent page.

Assembly D-7 : Pu to Pu $STS_{x,y} = 22.304 cm$ $STS_z = 16.062 cm$

Lateral : .718 cm (fixed) + 21.590 cm = 22.304 cm

Vertical : .108 cm (fixed) + 15.954 cm = 16.062 cm

Parts : 1-129 less # 7

Base Rate = $259.38 \times 10^{-5}$ $Y_S$

[ $4^3$, 6 Kg, 1.0" Moderated Array ]

(Cd in)

| Pos. | T-1 | T-1' | Eff Factor | $10^5$ n/s | M | T-2 | T-2' | Eff Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 7.858 | 38862/s | 126.9 | $20.343 \times 10^5$ | 2202. | | 26767/s | 95.9 | 27.6 Factor | 2650.0 | |

T/C's Room = 71 #1 = 91 #2 = 97

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 41510/s | 138.4 | $20.343 \times 10^5$ | 2815.5 | 10.85 | 31709/s | 105.7 | $26.809 \times 10^5$ | 2833.2 | 10.92 |

$\bar{M}$ = 10.89

T/C's Room = 71 #1 = 92 #2 = 98

There is a problem with T-1 which may be due to wrong Eff Factor from the playing around with the detectors. We will remove the Cd and re-determine the new normalization factor for the Eff Factor.

(Cd out)

| Pos. | T-1 | T-1' | Eff Factor | $10^5$ n/s | M | T-2 | T-2' | Eff Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 7.896 | 41503/s | 84908 | $1.82 \times 10^5$ | 2560.4 | 9.87 | 333033/s | 67280 | $2.25 \times 10^5$ | 2567.8 | 9.90 |
| | 83007 | 1406.8 | | | | 66607 | 1121.3 | | | |

$\bar{M}$ = 9.89

T/C's Room = 70 #1 = 94 #2 = 100

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 45565/s | 92821 | $1.82 \times 10^5$ | 2815.5 | 10.85 | 367076/s | 74232 | $2.25 \times 10^5$ | 2833.2 | 10.92 |
| | 91132 | 1547.0 | | | | 73415 | 1237.2 | | | |

$\bar{M}$ = 10.89

$\frac{1}{M}$ = .09183

T/C's Room = 70 #1 = 94 #2 = 101

We will do some source determinations without Cd.

| | T-1 | T-2 |
|---|---|---|
| Bkg | 342017/s | 277178/s |
| | 68403 → 6930-3 | 55435 → 5-5899 |
| With Source | 657321/s | 670212/s |
| | 131464 → 135-014 | 134042 → 136792 |

| | T-1 | T-2 |
|---|---|---|
| Source Worth | 65761 | 80893 |

T-1 doesn't look right as compared to p. 93
We will count T-1 with source again.

T-1 = 712635/s⁻ , 712392/s⁻ , 712366/s⁻
Source Worth T-1 = 77353⁻
BKg T-1 = 341037/s⁻

We will check the array again without Cd.

Assembly D-7: Same as page 96

(Cd out)

| Pos. | T-1 | T-1' | Eff. Factor | $10^5$ n/s | M | T-2 | T-2' | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 7.896 | 415473/s⁻ | | | | | 337283/s⁻ | | | | |
| 0.000 | 405396/s⁻ | | | | | 368493/s⁻ | | | | |

Same As 1st Run without Cd p. 97

We will now put the Cd in and do the run again for normalization.

| Pos. | T-1 | T-1' | Eff. Factor | $10^5$ n/s | M | T-2 | T-2' | Eff. Factor | $10^5$ n/s | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 7.893 | 386479/s⁻ 7729 | 128.8 | $19.879 \times 10^{-5}$ | 2560.4 | 9.87 | 25916/s⁻ | 96.39 | $26.670 \times 10^{-5}$ | 2562.8 | 8.9 |
| 0.000 | 424784/s⁻ | 141.58 | $19.886 \times 10^{-5}$ | 2815.5 | 10.45 | 31824/s⁻ | 106.1 | $26.703 \times 10^{-5}$ | 2833.2 | 10.5 |

T/C's

T/C's Room = 70 #1 = 65⁻ #2 = 102

$\bar{M}$ = 10.89
$\frac{1}{M}$ = .09183

Therefore the Eff. Factors for this array work will be as follows:

| | T-1 | T-2 |
|---|---|---|
| Eff. Factor | $19.886 \times 10^{-5}$ | $26.703 \times 10^{-5}$ |

We will now do a source determination with the Cd in.

| | T-1 | T-2 |
|---|---|---|
| Bkg (Cd) | 31705/5<br>6341 | 23571/5<br>4714 |
| With Source (Cd) | 118305/5<br>23661 | 111621/5<br>22324 |
| Source Worth (Cd) | 17320 | 17610 |

5-25-67

We will do a source determination again before we take the assembly down.

| | T-1 | T-2 |
|---|---|---|
| Bkg (Cd) | 31652/5<br>6330 | 22588/5<br>4509 |
| With Source (Cd) | 118505/5<br>23701 | 109798/5<br>21960 |
| Source Worth (Cd) | 17371 | 17451 |

Assembly D-8 Pu to Pu $STS_{x-y} = 18.494$ $STS_z = 16.062$

Lateral: .714 cm (fixed) + 17,780 cm = 18,494 cm

Vertical: .108 cm (fixed) + 15,954 cm = 16,062 cm

Port: 1-R1 less #7

Base Rate = $259.38 \times 10^5$ n/s

[ $4^3$, 6 Kg, 1" Moderated Array ]

| Poo: | T-1 | T-1' | Eff Fac $10^5$ n/s | M, | T-2 | T-2' | E.F. $10^5$ n/s | $M_2$ |
|---|---|---|---|---|---|---|---|---|
| 7.847 | 20,303/2 | 10,173 | 19.886×10⁵ | 33 71.7 | 12.999 | 15,002/2 | 26,703×10⁵ | 3341.9 | 12,884 |
| | 10,152 | 169.55 | | | | 7,501 | 7509 / 125.15 | | |
| 0.000 | 25,590/2 | 12,828 | | 16.39 | | 18,564/2 | 9,295 | | 15.95 |
| | 12,795 | | | | | 9,282 | | $\bar{M}$ = 16.17 | |
| | | AGAIN | | | | | | | |
| 0.000 | 64,094/5 | 12,852 | | 16,42 | | 46,866/5 | 9,386 | | 16.10 |
| | 12,819 | | | | | 9,373 | | $\bar{M}$ = 16,26 | |
| | | | | | | | | $Y_M$ = .0615 | |

T.C. # 1, 116°F, #2: 108°F, Room = 70°F

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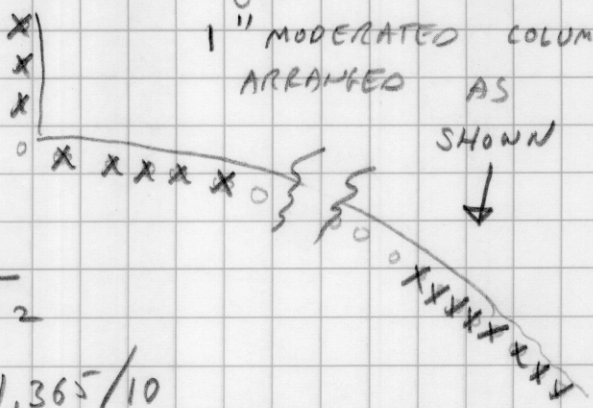
5/26/67

We are going to resume 1/2 Table experiments but need to know what the Cd Ratio is for 16 elements on wall racks (Cd Ratio seems to be geometry dependent). To this end we are going to duplicate the storage conditions of 5/15/65 a day with no cadmium in counters.




$T_1$

20,627/10

2,063 → 2064

used to be:

21,082

$T_2$

71,365/10

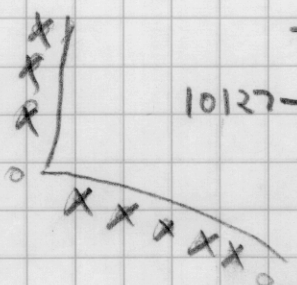
7,137 → 7,145

65,439

Ratios are:

10.214

9.159



Then the 8 column background is:

10127 → 991

10035 → 1,096

Eff. Factor Determination for C-2

| | T-1 | T-2 |
|---|---|---|
| Col. 3 | $2.16 \times 10^{-5}$ | $2.43 \times 10^{-5}$ |
| Col. 4 | $1.89 \times 10^{-5}$ | $2.84 \times 10^{-5}$ |
| Col. 5 | $2.18 \times 10^{-5}$ | $2.43 \times 10^{-5}$ |
| Col. 6 | $1.89 \times 10^{-5}$ | $2.84 \times 10^{-5}$ |
| Avg = | $2.04 \times 10^{-5}$ | $2.64 \times 10^{-5}$ |