

TABLE II

TABULATION OF AVERAGE BREATHING ZONE SAMPLES - AWES

Operation	Avg. Concentration (d/m ³)		No. of Samples
	Thorium	Thoron	
<u>Thorium Extraction</u>			
1. Unloading 190# Fibre Pak carton of TNT in hopper	1170	16,000	3
2. Loads up correct weight TNT in 3 small cartons	3000	73,000	3
3. Dumps Cartons containing TNT into tank	0	15,000	2
4. Discharging thorium Oxylate into 30 gal. drums	7	52,000	3
<u>Thorium Calcination & Hydrofluorination</u>			
1. Loading (1) tray(s) thorium oxylate (in hood) from 30 gal. drum (outside hood) & conveying to drier	250	0	4
2. Unloading 2 trays from drier, conveying to hood & dumping trays	1770	10,000	3
3. Loading thorium oxylate into 2 trays for calcining	1730	7,000	3
4. Transporting thorium Oxylate trays from load hood to storage area	0	25,000	2
5. Sweeping up thorium oxylate and thorium oxide in hood using broom and vacuum cleaner	4000	0	1
6. Unloading calcining furnace removing & trays thorium oxide	6000	100,000	2

~~SECRET~~

TABLE II (Cont'd)

Operation	Avg. Concentration (d/m ³)		No. of Samples
	Thorium	Thoron	
7. Loading calcining furnace with 4 trays thorium oxybate	4800	30,000	2
8. Unloading 2 trays thorium oxide in hood (weighs trays and then dumps in hood)	10800	125,000	2
9. Unloading one drum thorium oxide in large hood	7450	360,000	2
10. Loading 4 trays with thorium oxide in large hood	5800	117,000	3
11. Weighing 4 trays, making up weight and transporting to open storage area	1070	27,000	3
12. Levelling off thorium oxide in 6 trays	12000	120,000	2
13. Sweeps up thorium oxide and thorium oxybate	4000	0	1
14. Removing 12 thorium oxide trays from cooling area (Bench) and inserting trays in furnace. Sealing furnace.	132	9,400	3
15. Unloading 4 large trays thorium oxide into large hood. Weigh & dump.	16800	0	1
16. Unloading thorium fluoride furnace. Opening 3 furnaces.	270	33,000	1
17. Unloading 12 trays thorium fluoride in sets of 4 onto buggy carts	78	19,000	3
18. Transporting 12 trays on 3 buggies from HF furnace room to calcining room for cooling. Unloading buggy.	730	19,000	2

TABLE II (Cont'd)

Operation	Avg. Concentration (d/m/M ³)		No. of Samples
	Thorium	Thoron	
19. Sweeping off thorium fluoride cooling table with fox tail	5400	215,000	2
20. Unloading 3 trays thorium fluoride from cooling rack, weighs & dumps into loading hood, hammering back of tray	3720	440,000	3
21. Loading thorium fluoride into 5 gal. lined cans, weighs & seals can	7300	180,000	3
<u>Thorium Crude</u>			
1. Dumping 1 5-gal. drum of thorium fluoride into grinder	4400	100,000	3
2. Emptying hopper into 30 gal. drum	0	0	3
3. Loading mixer with zinc chloride, thorium fluoride & calcium fluoride charge	7600	130,000	3
4. Unloading zinc chloride, thorium fluoride & calcium fluoride from mixer	7400	150,000	3
5. Loading bomb-liner with ThF ₄ , Zn Cl and CaF ₂ charge	5200	80,000	3
6. Transporting bomb to topping area, top, add graphite plug, lines & seals bomb	2130	10,000	3
7. Opening 1 bomb and unloading line from top of bomb	0	0	3
8. Drilling out crucible from bomb	0	0	3

~~SECRET~~

TABLE II (Cont'd)

Operation	Avg. Concentration (d/m ³)		No. of Samples
	Thorium	Thoron	
9. Tamping & dumping slag from bomb	0	0	3
10. Chipping slag from billet with hammer & chisel	0	5,000	3
11. Removing slag with air hammer	0	0	3
12. Cleaning work area	0	0	3

Metal Casting

A. Unloading Desinced Billet

1. Removing furnaces by cart to hoist, removing quartz cover tube & insulation bricks	0	43,000	3
2. Remove 2 graphite pots containing 2 desinced billets. Unloads by dumping on floor, weighs & removes to chipping area	220	80,000	3
3. Chips 2 billets & blows off dust with air hose	0	0	3

B. Loading Desinced Billets

1. Inserting 2 desinced billets into Be crucible, adds thorium scrap and places top on crucible	463	10,300	3
2. Placing quartz tube around Be crucible. Adds graphite between quartz tube & crucible. Places quartz cover tube on furnace. Air hoisting unit.	0	17,000	3

~~SECRET~~

TABLE II (Cont'd)

~~SECRET~~

Operation	Avg. Concentration (d/m ³)		No. of Samples
	Thorium	Thoron	
3. Removing furnaces to remelt areas. Secures cover tube with sealer	0	0	3
4. Removes quartz furnace top, graphite top & vacuums furnace	0	3,500	2
5. Removes quartz inner tube graphite. Blows off furnace	0	3,000	2
6. Unloading furnace insulation & thorium metal casting	0	16,000	2
7. Cleaning off furnace parts brick insulation	250	76,500	2
8. Cleaning out inside furnace cover tube with scraper, brush & air hose	0	0	2
9. Cleaning graphite heater pots that hold crude biscuit	0	17,000	2
10. Loading 2 crude biscuits into pots, place insulation brick around pots, place quartz tubes on furnace. Air hoses.	19	1,600	2
<u>Machining</u>			
1. Milling or cropping thorium metal pieces	79	6,100	3
2. Sawing thorium billet	310	1,700	3

~~SECRET~~

~~SECRET~~

TABLE III

TABULATION OF AVERAGE GENERAL AIR SAMPLES - AMES

<u>Location</u>	<u>Avg. Concentration d/m/M³</u>		<u>No. of</u>
	<u>Thorium</u>	<u>Thoron</u>	<u>Samples</u>
<u>Thorium</u>			
Extraction Area (Rm. 203)	9	17,500	8
Drying & Calcining Area (Rm 303)	1780	1,700	4
Hydrofluorination Area (Rm 307)	34	0	5
Thorium Crude Area (Rm 33)	95	3,600	11
Bomb Storage Area (Rm 33)	195	8,500	2
Metal Casting Room (Rm 29)	1	1,600	6
East Control Panel (Rm 29)	0	600	2
West Control Panel (Rm 29)	0	700	2
Furnace Cleanout Area (Rm 22)	0	6,800	3
Corridor outside Rm 203	0	1,400	2
Seminar Room (Lunch Area)	0	2,800	2
Jolting Area (Rm 33)	38	3,300	2
Line Packing & Tapping Area (Rm 33)	195	8,500	2

Beryllium

Be Furnace & Preparation
Area (Rm 28)

0.4 ug/m³

7

TABLE IV

~~SECRET~~ RADIATION MEASUREMENTS

Area	Location	Radiation Measurement*		
		Alpha d/s/100 cm ²	Beta mreps/hr	Gamma mr/hr
Thorium Ex- traction (Rm 203)	General Bkgd. Radiation (Room)	0	0.1	0.35
	TNT Weigh Scale	34,000	0.6	1.9
	TNT Drum Storage Area			
	Top Drum	2,000	0	15.0
	Side Drum	3,000	1.5	17.0
	Floor	5,000	0	2.0
	TNT Lead Hopper (on TNT)	50,000	6	14
	Floor	24,000	0	0.95
	** TNT Tank #1 (Empty)			
	Inside	0	0.3	0.5
	Outside	0	0	0
	TNT Tank #1 (Full)			
	Inside	0	1.0	6.0
	Outside	0	0	5.5
	Step in front of 3 Slurry Tanks	32,000	0.1	0.6
Binco Filter (ThOx) material	50,000	2.5	1.5	
55 gal. Drum ThOx Half Full	0	0	4.5	
55 gal. Drum ThOx Full	50,000	5.0	7.0	
Filter Press				
Top	3,000	0	0.1	
Side	3,000	0.8	0.7	
Process Floor				
Avg. Reading at Filter Press, Binco & Slurry Tank Areas	34,000	0.1	0.75	
Work Bench	3,000	0.05	0.1	
Sink	15,000	0	1.5	

* B-γ2610A & Juno used for all measurements
 ** Same measurements for Tanks #2 and #3

TABLE IV (Cont'd)

Area	Location	Radiation Measurement		
		Alpha d/n/100cm ²	Beta mreps/hr	Gamma mr/hr
Thorium Ex- traction (Rm 203)	Corridor Outside Th. Extraction Room	5,000	0.02	0.11
Calcining & Hydrofluorina- tion	General Bkgd. Radiation Room	0	0.3	0.5
	Floor	30,000	0.05	1.8
	ThO ₂ Tray (6½ x 11 x 23)			
	Inside	-----***	3.0	8.5
	Outside	-----	0	5.0
	ThF ₄ Tray (Fresh from Furnace) (11 x 1¼ x 30)			
	Top	-----	10	4.0
	Bottom	-----	0.3	4.0
	ThF ₄ Tray (cooled for 17 hrs)			
	Top	-----	4	3.0
	Bottom	-----	0.75	2.0
ThOX Tray (6½ x 11 x 23)	Top	-----	2.0	6.5
	Bottom	-----	0.1	3.0
Thorium Crude (Room 33)	General Room Bkgd.	-----	0	0.2
	Floor around Mixer	-----	0	1.0
	5-gal. can ThF ₄			
	Cover off-Top Material	100,000	9.5	9.8
	Cover on-Top material	2,000	0	11.5
	ThF ₄ Can Storage Area			
	Side - 7 cans	2,000	0	22
Crude Billet	100,000	4.5	5.5	
Crude Billet Storage Area (Floor)	20,000	2.0	1.0	

*** Juno Contaminated.

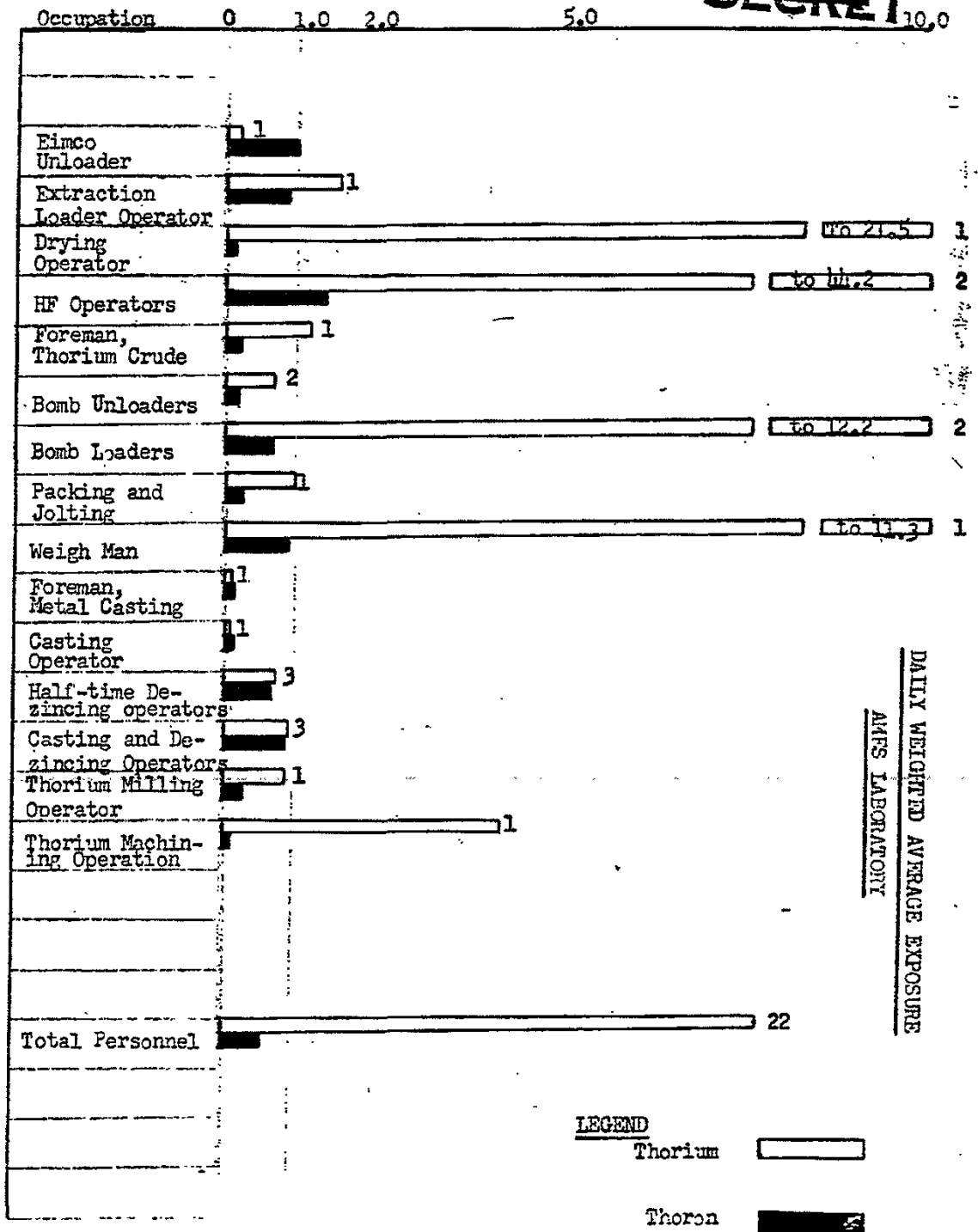
~~SECRET~~

TABLE IV (Cont'd)

Area	Location	Radiation Measurement		
		Alpha d/m/100cm ²	Beta mreps/hr	Gamma mc/hr
Th. Metal Reduction & Casting	Average Desined Billet			
	Bottom	----	3.5	9.5
	Top	----	Off Scale	10.5
	Side	----	2.5	5.0
	Average Cast Billet (Fresh)			
	Bottom	----	1.0	5.0
	Middle	----	1.0	4.0
	Top	----	6.0	7.0
	Average Cast Billet (20 hrs old)			
	Bottom	----	4.0	4.0
	Middle	----	3.0	1.0
	Top	----	1.0	3.5
	Generator	General Room Bkgd.	----	0
Thorium Mach- ining Shop	Finished Billet Storage Area			
	12 Boxes (billets) <u>1 wk old</u>			
	Length (Contact)	----	2.0	16
	End (Contact)	----	0	12
	Length (6")	----	2.0	9.0
	End (6")	----	0	7.0
	Length (1')	----	2.0	6.5
	End (1')	----	0	4.0
	12 Boxes (billets) <u>3 wks old</u>			
	Length (Contact)	----	1.0	Off Scale
	End (Contact)	----	1.0	11
	Length (6")	----	1.0	16
	End (6")	----	1.0	8.0
	Length (1')	----	1.0	9.5
End (1')	----	1.0	6.5	
Corridor	Floor between Crude & Metal Machining (after washing)	15,000	0.5	0.05
	Steps to Locker	3,000	---	---

WEIGHTED AVERAGE EXPOSURE (MAC)

SECRET 10.0



DAILY WEIGHTED AVERAGE EXPOSURE
AMPS LABORATORY

LEGEND

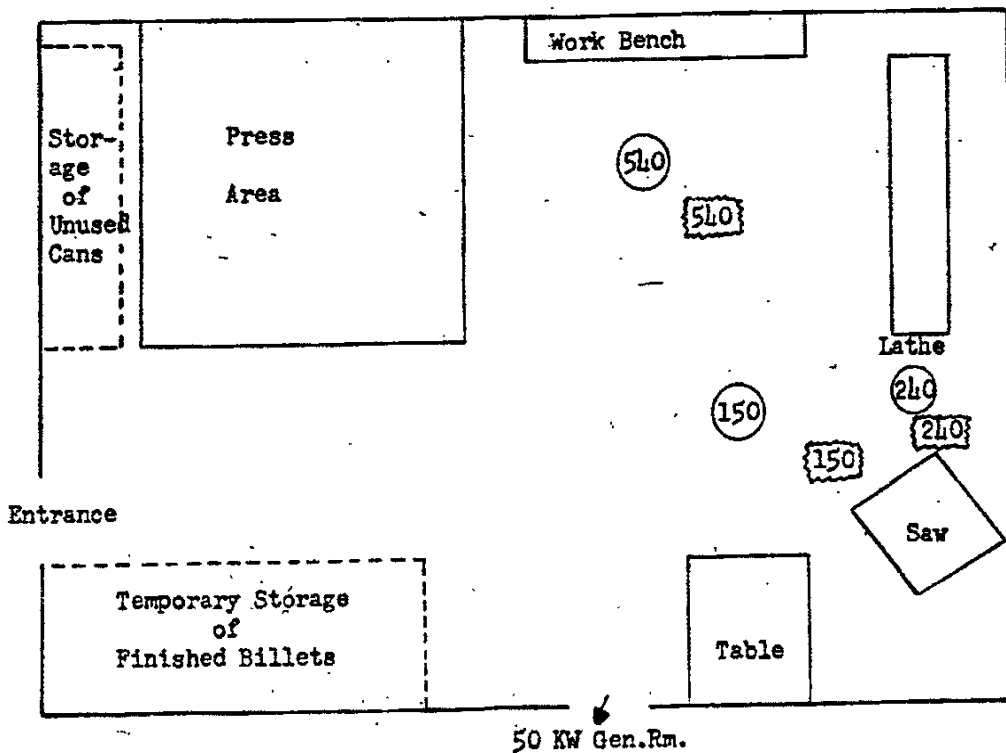
Thorium
Thoron

Fig. **SECRET**

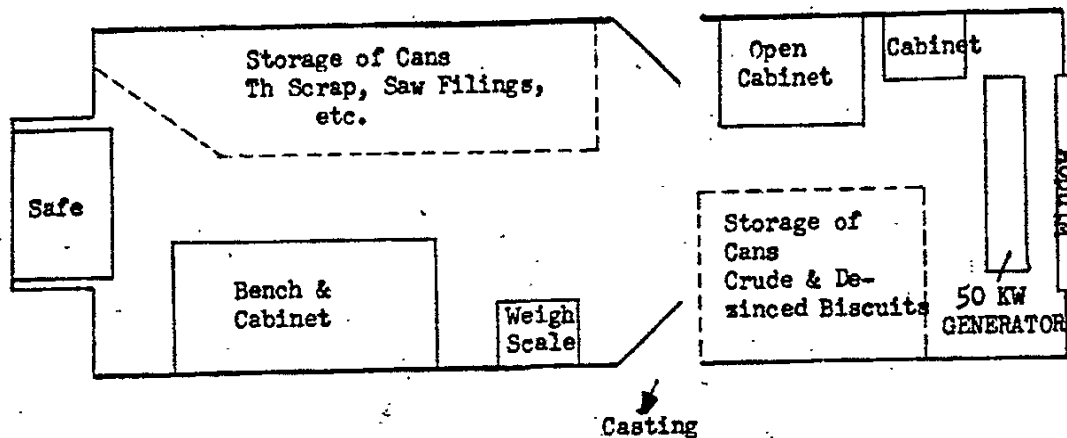
USA 012533

FINISHING ROOM 15

~~SECRET~~



50 KW GENERATOR ROOM & STORAGE



- - G.A. Thorium
- ▭ - Breathing Zone
- - G.A. Thoron

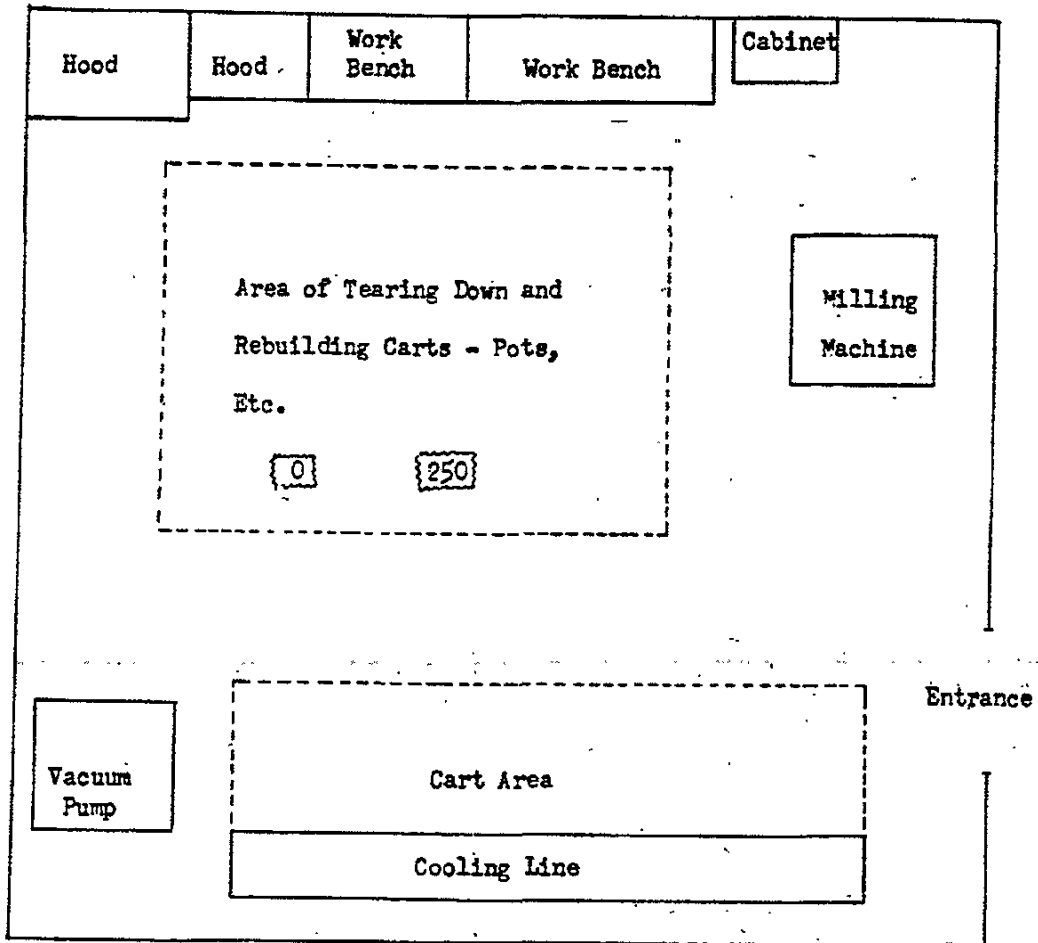
~~SECRET~~

Fig. 2

~~SECRET~~

CARTS SET UP & TORN DOWN FOR INGOTS
& COOLING LINE

ROOM 22



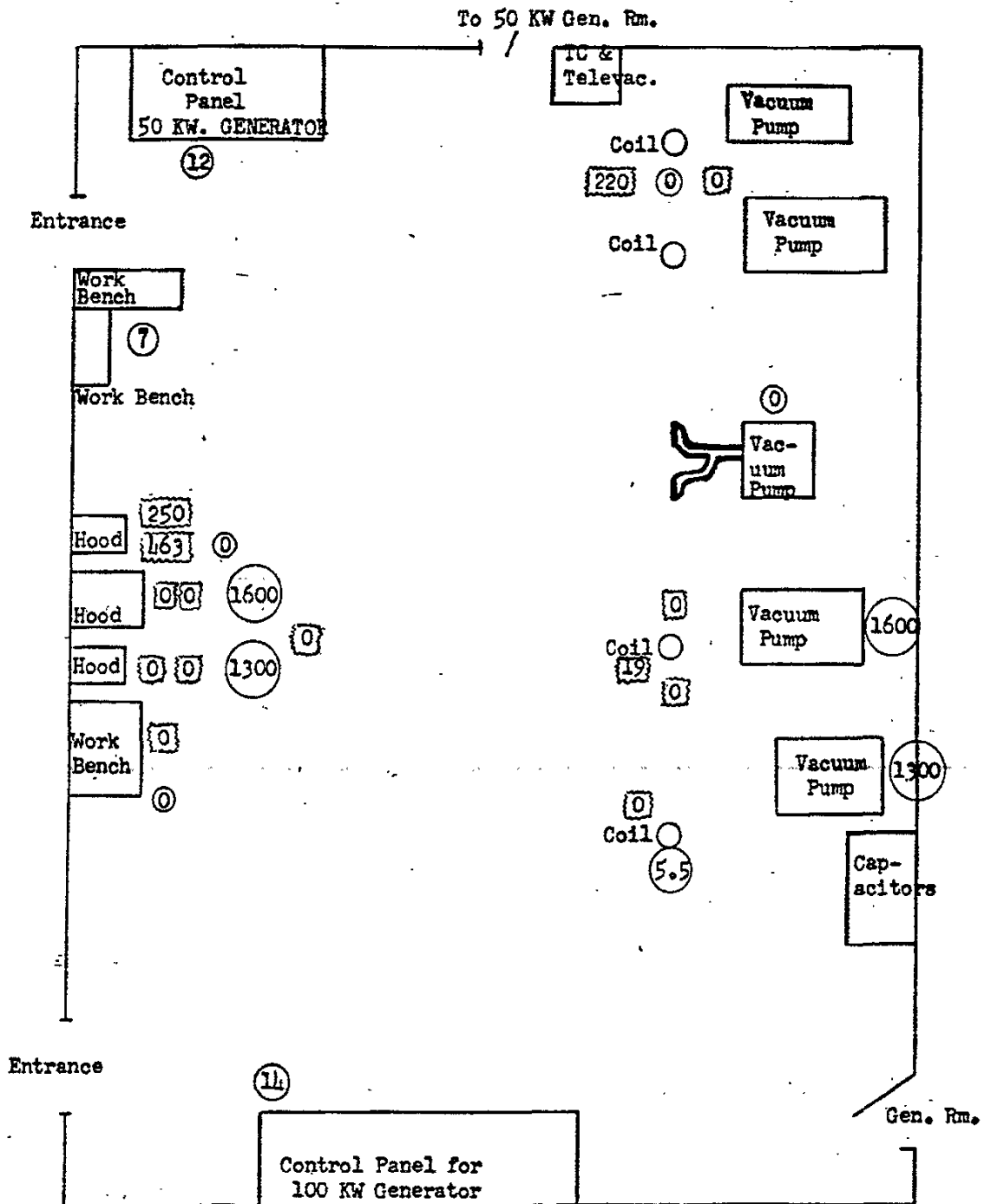
 - Breathing Zone

Fig. 3

~~SECRET~~

USA 012535

~~SECRET~~
CASTING AND LEZINGING - ROOM 29



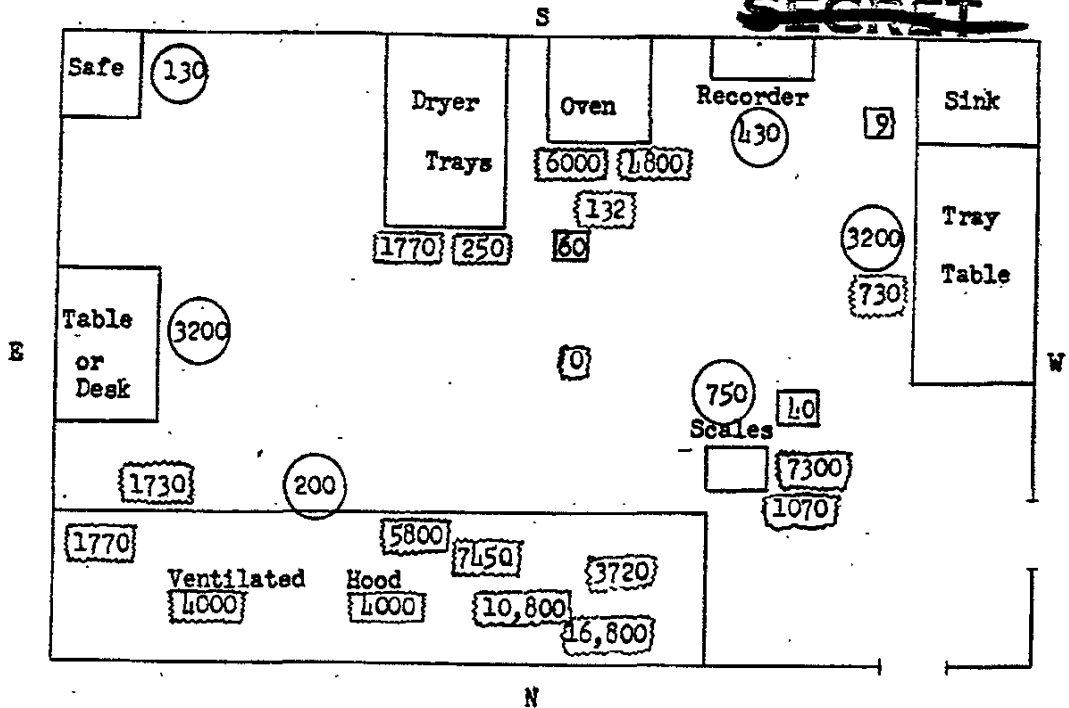
- - Thorium G.A.
- - Thoron G.A.
- ▤ - Breathing Zone

Fig. 1

~~SECRET~~

ROOM 303

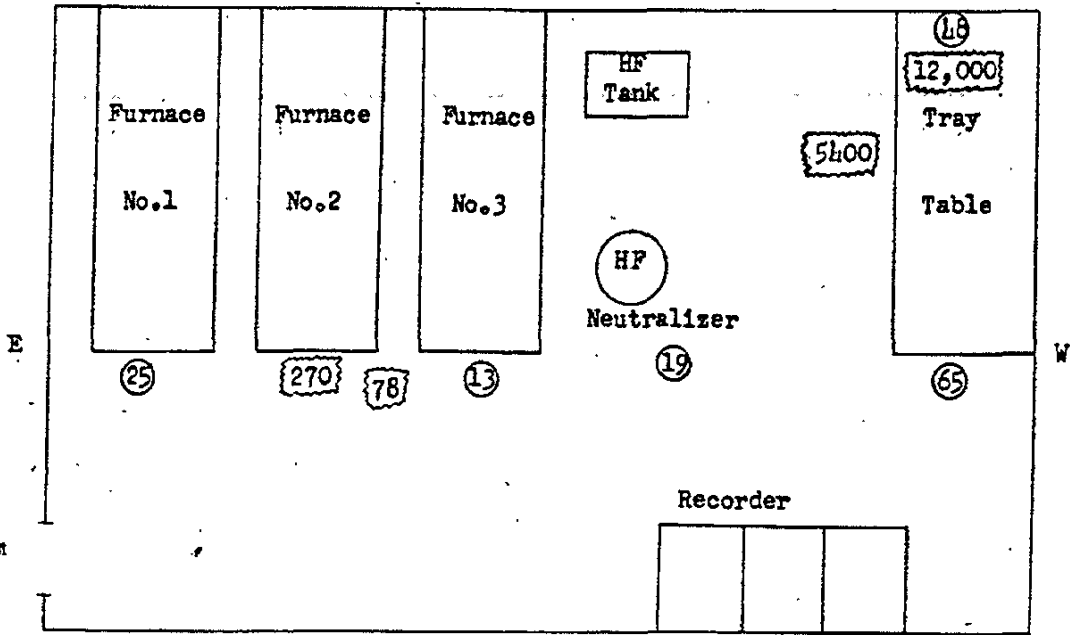
~~SECRET~~



ROOM 307

- - G.A. Thorium
- - G.A. Thoron
- ▭ - Breathing Zone

S



Room 303

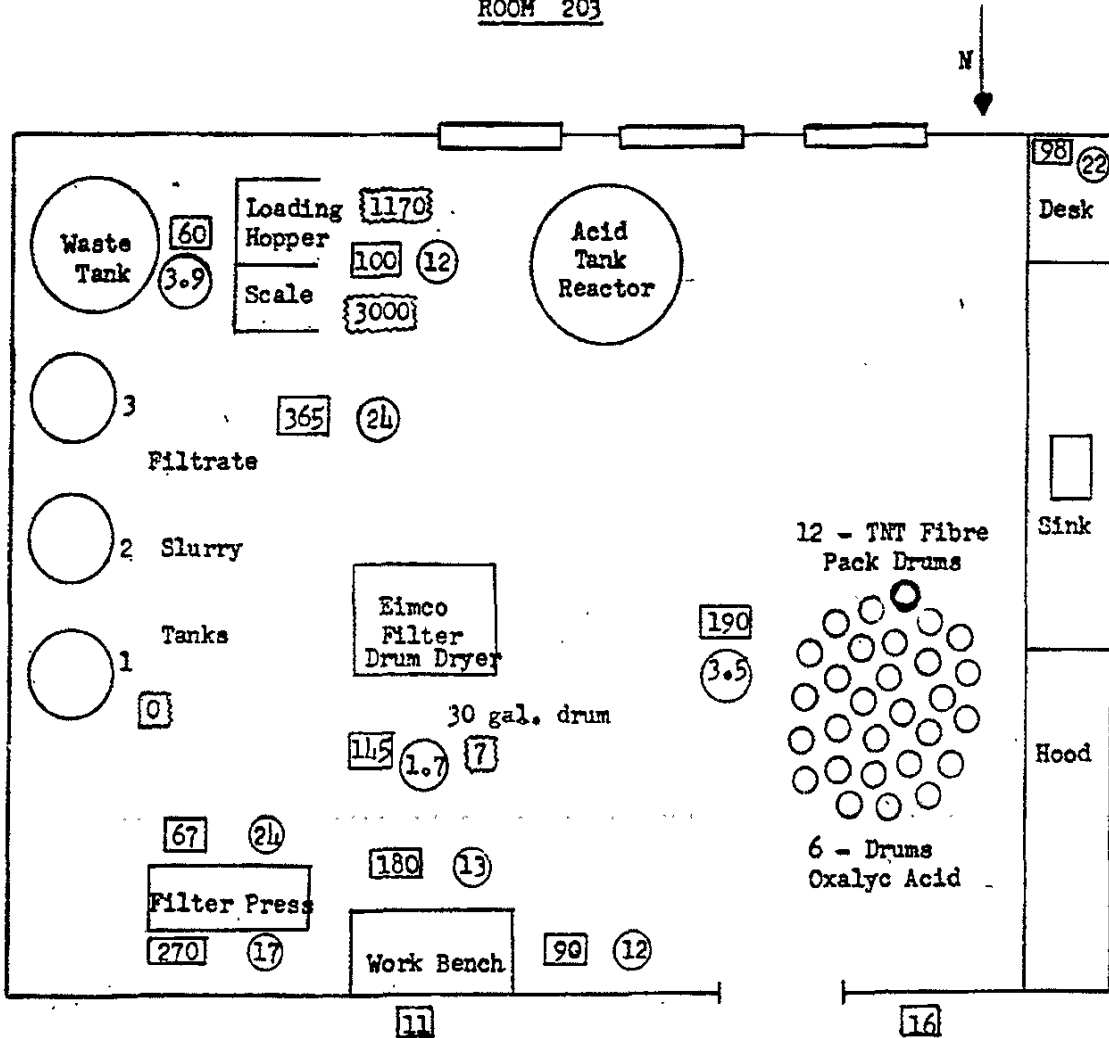
Fig. 5

~~SECRET~~

~~SECRET~~

THORIUM EXTRACTION

ROOM 203



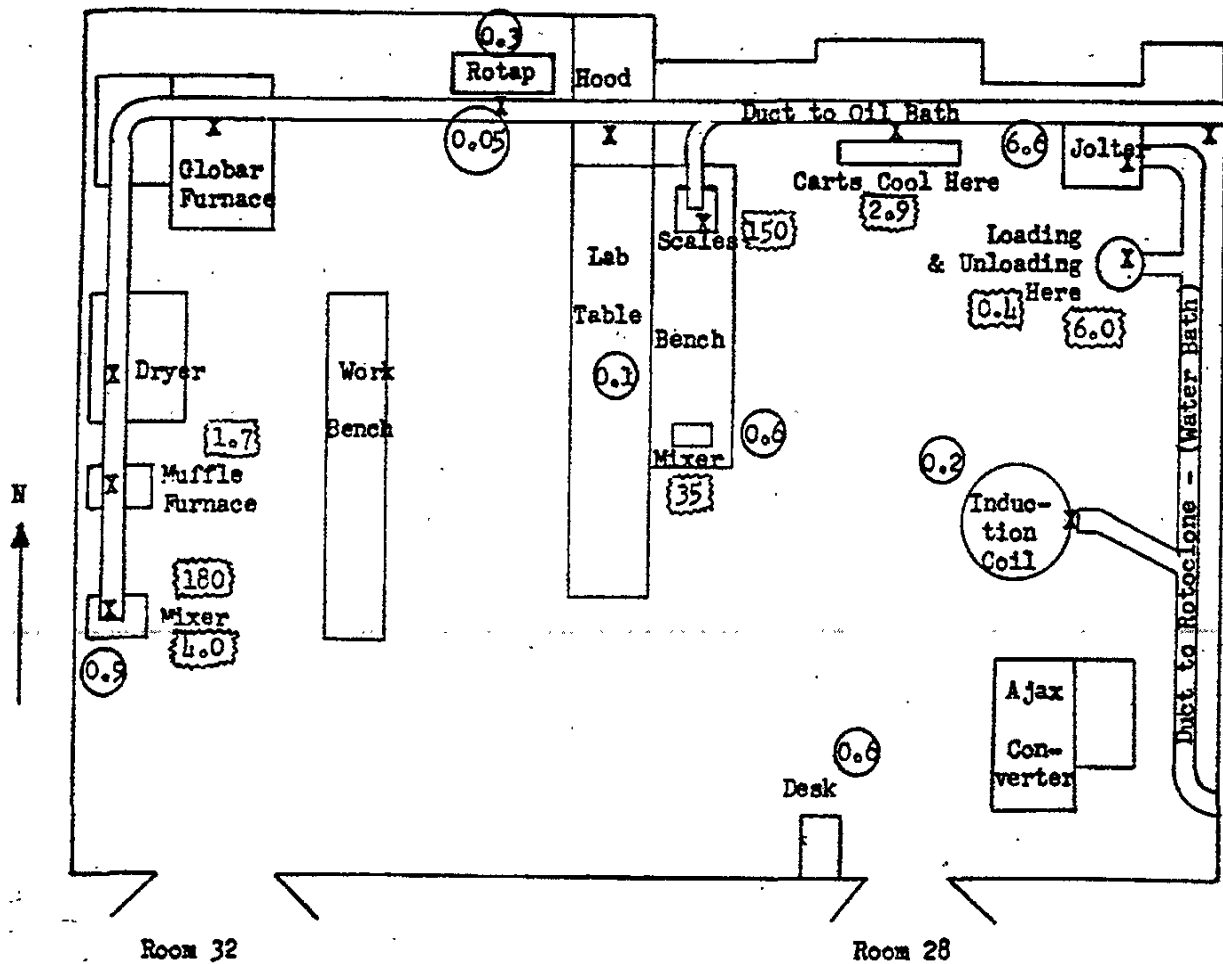
- - G.A. Thoron
- - G.A. Thorium
- ▭ - Breathing Zone

Fig. 6

~~SECRET~~

~~SECRET~~

BERYLLIUM OPERATION



- - G.A. Thorium
- - G.A. Thoron
- ▣ - Breathing Zone

X - Inlets to Ducts

Fig. 7

~~SECRET~~

- - G.A. Thorium
- - G.A. Thoron
- ☒ - Breathing Zone

THORIUM CRUDE

ROOM 33

B

~~SECRET~~

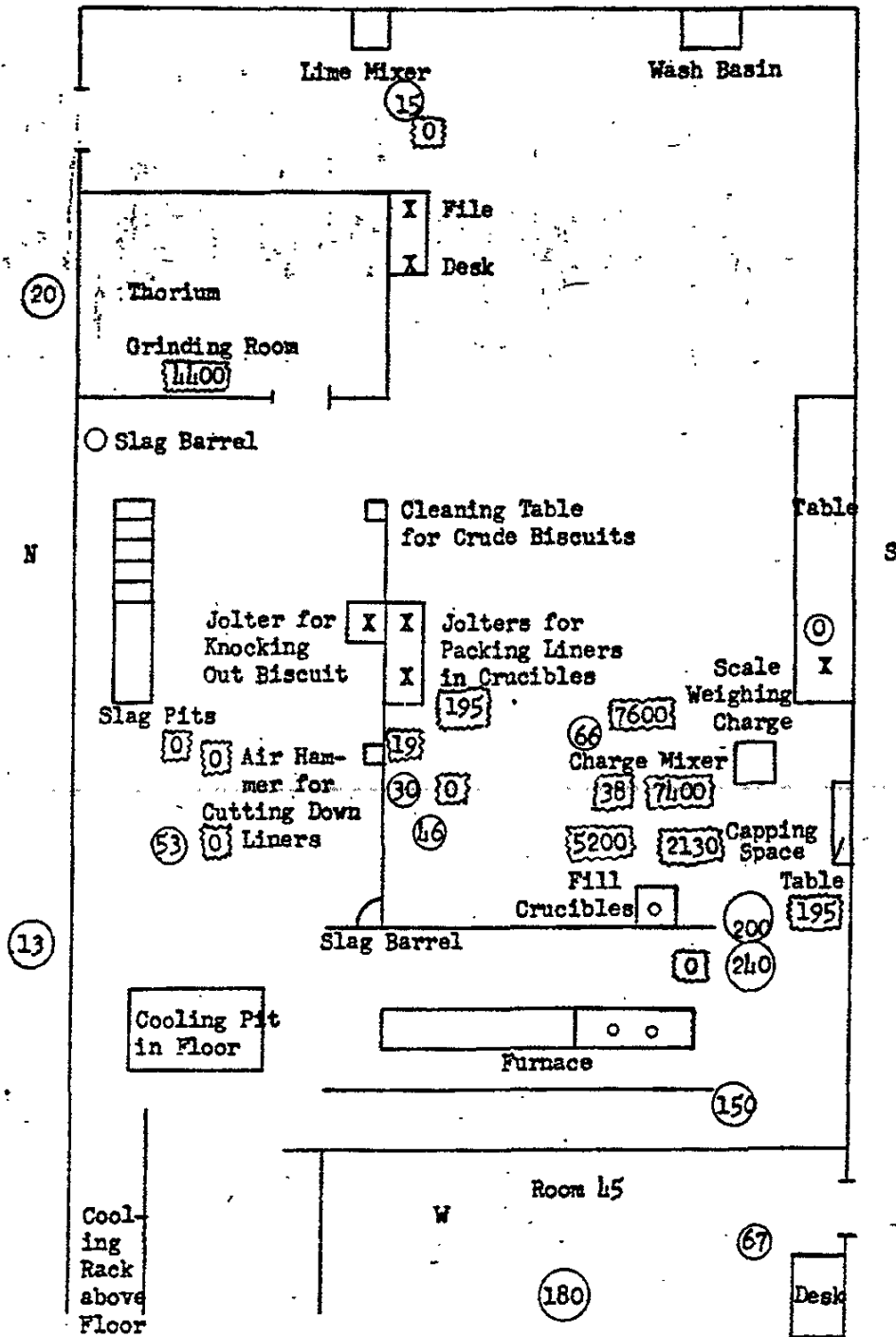


Fig. 8

~~SECRET~~

~~SECRET~~

APPENDIX A

~~SECRET~~

USA 012541

~~SECRET~~

OPERATOR: Drying Operator 1 men/shift; 1 shifts/day; 2 men/day

THORIUM- ROOM 303

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (Min)(T)	No. of Samp- les	Concentration d/m/m ³			Avg Con'c. * Times Total Time (T X C)
					Low	High	(C) Avg	
<u>Unload Drying Furnace</u>								
4 small trays removed from dryer to load. hood. and dumped (ThOX)	2	10	20	3	620	2400	1770	35,000
Loads Th OX in 2 large trays for calcining	3.6	6	20	3	1100	2300	1730	34,6000
Transporting ThOX trays from load hood to storage hood	0.5	12	6	2	0	-	0	0
Loads 1 tray ThOX in hood from 30 gal. drum (outside hood), conveys to dryer (drying)	3.0	12	36	4	0	520	250	9,000
Unloads 2 trays from dryer to load hood and dumped	2	6	12	3	620	2400	1770	21,200
Sweeps up ThOX and ThO ₂ in hood using broom and vacuum cleaner	3.5	2	7	1	4000	-	4000	28,000
G.A. Room 303	-	-	379	4	0	3200	1800	682,000
Lunch (Seminar Room)	-	-	60	2	0	-	0	0

*Adjusted to two significant figures.

Σ T 510 ~~SECRET~~ Σ (T x C) 810,000

$$\Sigma \frac{(T \times C)}{\Sigma(T)} = \frac{1500}{\gamma/m^3} = 21$$

Times the Maximum Allowable Concentration.

USA 012542

OPERATOR: Steve Holston ~~SECRET~~ / shift: 1 shifts/day; 1 men/day

THORIUM

ROOM 203

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samp- les	Concentration $\mu\text{g}/\text{m}^3$ (C)			Avg Con'c.* Times Total Time (T X C)
					Low	High	Avg	
Discharging Th oxylate with 30 gal. drums	12	6	72	3	2	10	7	54
Thorium extraction Room 203	-	-	108	8	0	24	9	3670
Lunchroom	-	-	60	2	-	-	0	-

* Adjusted to two significant figures.

50
~~SECRET~~

$\Sigma (T \times C)$ **4170**

$$\Sigma \frac{(T \times C)}{\Sigma (T)} = \underline{7.7} \quad \mu\text{g}/\text{m}^3 =$$

Times the Maximum Allowable Concentration.

OPERATOR: Packing and Jolting 1 men/shift; 1 shifts/day; 1 men/day

THORIUM- Grade

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samp-les	Concentration $\mu\text{g}/\text{m}^3$			Avg Con'c.* Times Total Time (T X C)
					Low	High	Avg (C)	
Line packing and tamping area	-	-	360	2	30	46	38	13,700
Jolting area	-	-	120	2	150	240	195	23,400
Lunch Area	-	-	60	2	-	-	0	0

* Adjusted to two significant figures.

ΣT 540

$\Sigma (T \times C)$ 37,100

$$\Sigma \frac{(T \times C)}{\Sigma (T)} = \frac{37,100}{540} \mu\text{g}/\text{m}^3 = 0.99$$

Times the Maximum Allowable Concentration.

OPERATOR: CASTING OPERATOR 1 men/shift; 1 shifts/day; 1 men/day

THORIUM

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samp- les	* Concentration <i>dlm/m³</i>			Avg Con'c.* Times Total Time (T X C)
					Low	High	(C) Avg	
G.I. West Control Panel			150	2	-	-	0	-0
G.I. Th. Casting Area (Room 29)			30	6	0	7	1	30
Lunch (Seminar Room)			60	2	0	-	0	-0

* Adjusted to two significant figures.

ΣT

540

$\Sigma (T \times C)$

30

$$\Sigma \frac{(T \times C)}{\Sigma (T)} =$$

~~0.1/m³~~

Times the Maximum Allowable Concentration.

~~SECRET~~

OPERATOR: Foreman 1 men/shift; 3 shifts/day; 3 men/day

THORIUM

Thorium Metal Casting

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samp- les	Concentration $\mu\text{g}/\text{m}^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	(C) Avg	
S.A. Thorium metal casting room	*	*	60	6	0	7	1	60
C.A. Lunch room	*	*	60	3	0	-	0	0

* Adjusted to two significant figures.

ΣT 540

$\Sigma (T \times C)$ 60

$$\Sigma \frac{(T \times C)}{\Sigma (T)} = \frac{0.60}{540} \mu\text{g}/\text{m}^3 = 0.11$$

Times the Maximum Allowable Concentration.

~~SECRET~~

USA 012546

~~SECRET~~

OPERATOR: BOMB LOADERS 2 men/shift; 2 shifts/day; 2 men/day

THORIUM

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samp- les	Concentration /m ³			Avg Con'c.* Times Total Time (T x C)
					Low	High	(C) Avg	
Loading bomb-lined with ThO ₂ , EnGI and Gel charge	6	10	60	3	2100	9300	5300	312,000
Transporting bomb to topping area, top, add graphite plug, lines and seals bomb	5	10	50	3	0	6200	2130	106,500
Bomb load storage area	-	-	60	2	150	210	195	11,700
QA- Room 33 (Thorium Crude)	-	-	310	11	0	210	95	29,500
Lunch	-	-	60	2	0	-	0	0

* Adjusted to two significant figures.

Σ T 50

~~SECRET~~

Σ (T x C) 460,000

$$\Sigma \frac{(T \times C)}{\Sigma (T)} = \frac{460}{50} = 9.2 \text{ } \mu\text{g}/\text{m}^3 = 12$$

Times the Maximum Allowable Concentration.

~~SECRET~~

OPERATOR: Bomb Unloaders

2 men/shift; 1 shifts/day; 2 men/day

THORIUM

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (Min)(T)	No. of Samp- les	Concentration d/m/m ³			Avg Con'c. * Times Total Time (T X C)
					Low	High	Avg	
Opening 1 bomb and unloading line from top of bomb	2.5	10	25	3	0	-	0	0
Drilling out crucible from bomb	3.7	10	37	3	0	57	29	703
Tamp and dump slag from bomb	3.9	10	39	3	0	-	0	0
Chipping slag from billet with hammer and chisel	1.7	10	17	3	0	-	0	0
Removes slag with air hammer	3	10	30	3	0	-	0	0
Clean up	2	3	6	3	0	-	0	0
G.A. Room 33-Thorium crude	-	-	326	11	0	210	95	31,000
Lunch	-	-	60	2	0	-	0	0

*Adjusted to two significant figures.

~~SECRET~~ $\Sigma(T \times C) = 24,000$

$$\Sigma \frac{(T \times C)}{\Sigma(T)} = \frac{24}{44} \gamma/m^3 = 0.63$$

Times the Maximum Allowable Concentration.

USA 012548

OPERATOR: WITCHMAN ~~_____~~ Shift: 1 shifts/day; 1 men/day

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samp- les	Concentration			Avg Con'c.* Times Total Time (T x C)
					d/m ³			
					Low	High	(C) Avg	
Dumping 1-5 gal. drum ThF ₄ into grinder	1.3	10	13	3	3200	5100	4100	57,200
Emptying hopper into 30 gal. drum	.5	10	5	3	-	-	0	0
Loading mixer with ZnCl ₂ , ThF ₄ and CaF ₂ charger	3.4	10	34	3	5700	8500	7600	258,000
Unloading ZnCl ₂ , ThF ₄ and CaF ₂ from mixer	1.3	10	13	3	2900	16,000	7400	96,200
G.I. Room 33 (Thorium crude)	-	-	435	11	0	240	95	39,400
Lunch	-	-	60	2	-	-	0	0

* Adjusted to two significant figures.

ΣT 510

$\Sigma (T \times C)$ 451,000

$$\Sigma \frac{(T \times C)}{\Sigma (T)} =$$

721

$d/m^3 = 11$

Times the Maximum Allowable Concentration.

OPERATOR: Thorium Extraction 1 men/shift; 1 shifts/day; 1 men/day
Loading Operator

THORIUM

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samples	Concentration $d/a/m^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	(C) Avg	
Unloading 190# Fibre Pak carton of THF in hopper	2	6	12	3	0	2100	1170	14,000
Loads up correct weight THF into 3 small cartons	2.3	6	14	3	1300	5600	3000	42,000
Dumps Cartons containing THF into tank	1	6	6	2	0	-	0	-
G.I. Thorium extraction (Room 203)	-	-	418	18	0	24	9	3160
Hallway (Corridor)	-	-	30	2	-	-	0	-
Lunch (Seminor Room)	-	-	60	2	-	-	0	-

* Adjusted to two significant figures.

ΣT

~~SECRET~~

$\Sigma (T \times C)$ 60,000

$$\Sigma \frac{(T \times C)}{\Sigma (T)} =$$

111

$$d/a/m^3 = 1.6$$

Times the Maximum Allowable Concentration.

USA 012550

OPERATOR: Lowman Crude Dept. 1 men/shift; 1 shifts/day; 1 men/day

TABLE

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samp- les	Concentration $\mu\text{g}/\text{m}^3$			Avg Con'c.* Times Total Time (T X C)
					Low	High	Avg	
G.A. Thorium crude area- Room 33	-	-	130	11	0	250	95	15,600
Lunch Room	-	-	60	2	0	-	0	0

* Adjusted to two significant figures.

ΣT 540

$\Sigma (T \times C)$ 15,600

~~SECRET~~

$$\frac{\Sigma (T \times C)}{\Sigma (T)} =$$

84

$$\mu\text{g}/\text{m}^3 = 1.2$$

Times the Maximum Allowable Concentration.

OPERATOR: 2b Machining Operator 1 men/shift; 1 shifts/day; 1 men/day

THORIUM

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Sample (min)(T)	No. of Samp- les	Concentration $\mu\text{Ci}/\text{m}^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	Avg	
Sanding Thorium Billet	-	-	180	3	150	210	310	119,000
Lunch (Senior Room)	-	-	60	2	0	-	0	0

* Adjusted to two significant figures.

ΣT 540

$\Sigma (T \times C)$ 119,000

$$\Sigma \frac{(T \times C)}{\Sigma (T)} = \frac{276}{540} \mu\text{Ci}/\text{m}^3 =$$

Times the Maximum Allowable Concentration.

SECRET

USA 012552

OPERATOR: Th Milling Operator

1 men/shift; 1 shifts/day; 1 men/day

THORIUM

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Shift (min)(T)	Samp- les	Concentration $\mu\text{g}/\text{m}^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	(C) Avg	
Milling or Cropping Thorium pieces	*	*	180	1	-	*	79	33,200
S.A. Room 22	*	*	60	1	0	*	0	0
Lunch (Sealiner Room)	*	*	60	2	0	*	0	0

* Adjusted to two significant figures.

ΣT

$\Sigma (T \times C)$

$$\Sigma \frac{(T \times C)}{\Sigma T} = \underline{61} \text{ } \mu\text{g}/\text{m}^3$$

Times the Maximum Allowable Concentration.

~~SECRET~~

USA 012553

OPERATOR: HF OPERATORS 2 men/shift; 1 shifts/day; 2 men/day

THORIUM

ROOM 303

Operation or Operating Area	Time Per Oper. (min)	No. of Shifts	Time per Shift (min)(T)	No. of Samples	Concentration $\mu\text{g}/\text{m}^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	Avg (C)	
Unloading calcining furnace removing 4 trays ThO_2	1	2	2	2	6000	6000	6000	5,000
Loading calcining furnace with 4 trays Thorium Oxylate	2	2	2	2	2100	7500	4800	45,000
Unloading 2 trays ThO_2 in hood (weigh trays and then dump in Hood)	1	18	18	2	9500	23,000	10800	154,000
Unloading ThF_4 furnace opening 3 furnaces	4	1	4	1	270	270	270	1,000
Unloading 12 trays Th_2O_3 in sets of 4 onto buggy with carts	3.5	3	10.5	3	0	170	78	820
Transporting 12 trays on 3 buggies from HF Furnace room to Calcining room for cooling. Unloads buggy	2.9	2	6	2	360	1100	730	4,400
Sweeps off ThF_4 cooling tube with foxetail	1	2	2	2	2800	2000	500	10,800
Unloads 3 trays ThF_4 from cooling rack weighs and dumps into loading hood (dumpers back of tray)	3	12	36	3	2200	5000	3720	134,000

* Adjusted to two significant figures.

ΣT

$\Sigma (T \times C)$

$$\Sigma \frac{(T \times C)}{\Sigma (T)} =$$

$$\frac{\mu\text{g}}{\text{m}^3}$$

Times the Maximum Allowable Concentration.

~~SECRET~~

USA 012554

OPERATOR: 12 OPERATORS (Continued) men/shift; shifts/day; men/day

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samp- les	Concentration $\mu\text{g}/\text{m}^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	Avg (C)	
Load ThO_2 into 5 gal. lined drums, weigh and seal drums (hoppers cover)	3.5	12	42	3	1800	21000	7200	31000
Unload 1 drum of ThO_2 in large hood	1	3	3	2	5200	9700	7150	22100
Loading 4 trays with ThO_2 in larger hood	1.33	9	12	3	5200	7000	5300	69600
Weighting 4 trays; making up weight and transporting to storage (open) area	3.5	9	33	3	110	1900	1070	35300
Leveling off ThO_2 in 6 trays	6	6	36	2	10000	14000	12000	132000
Sweeps up ThO_2 and ThOx	40	1	40	1	4000	4000	4000	16000
Removing 12 ThO_2 trays from cooling area (bench) and inserting trays in furnace. Seal furnace	5.7	3	17	3	88	230	132	2240
Unloading 4 trays ThO_2 into large hood, weigh and dump.	1.5	2	3.0	1	16800	-	16800	50400
Gen. Air room 307			69	5	13	65	34	2350
Gen. Air Room 303			166	4	200	3200	1980	295200
Lunch (Seminar Room)	-	-	60	2	-	-	0	0

~~SECRET~~

* Adjusted to two significant figures.

ΣT 540

$\Sigma (T \times C)$ 1,680,000

$$\Sigma \frac{(T \times C)}{\Sigma (T)} = \frac{3100}{540} \mu\text{g}/\text{m}^3 = 5.74$$

Times the Maximum Allowable Concentration.

~~SECRET~~

USA 012555

OPERATOR: Casting and Desizing 3 men/shift; 2 shifts/day; 3 men/day
Operators

FUNCTION

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samples	Concentration $\mu\text{g}/\text{m}^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	Avg (C)	
Unloading Desized Billets								
Remove furnaces by cart to hoist remove quarts cover tube and insulation blocks.	2.2	4	9	3	0	-	0	0
Remove 2 graphite pots containing 2 desized billets unloads by dumping on floor, weighs, removes to shipping area	3.6	4	14.5	3	0	550	220	3,190
Chips 2 billets and blows off dust with air hose	3.3	4	13	3	0	-	0	0
Loading Desized billets								
Inserts 2 desized billets into Be crucible. Adds thorium scrap and places top on crucible	7.5	4	30	3	49	1100	463	13,890
Places quarts tube around Be crucible. Adds graphite between quarts tube and crucible. Places quarts cover tube on furnace. Air hoses unit	9.5	4	38.0	3	0	-	0	0
Removes furnaces to remelt areas. Secures cover tube with peeler	2	4	8	3	0	-	0	0

* Adjusted to two significant figures.

ΣT

$\Sigma (T \times C)$

$$\Sigma \frac{(T \times C)}{\Sigma (T)} = \frac{13,890}{38.0} = 365.5 \mu\text{g}/\text{m}^3$$

Times the Maximum Allowable Concentration,

~~SECRET~~

USA 012556

OPERATOR: Casting and Resinizing 3 men/shift; 2 shifts/day; 3 men/day
~~operators (continued)~~

THORIUM

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Opera. (min) (T)	No. of Samples	Concentration $\mu\text{g}/\text{m}^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	Avg (C)	
<u>Unloading Casting</u>								
Removes quartz furnace top, graphite top and vacuum furnace	3.0	h	12	2	0	-	0	0
Removes quartz inner tube graphite. Blows off furnace	2.7	h	11	2	0	-	0	0
<u>Unloading Furnace Room 22</u>								
Unloading furnace insulation and Thorium metal casting	3.7	h	15	2	0	-	0	0
Clean off furnace parts, brick insulation	17.5	h	70	2	170	390	250	17,500
Clean outside furnace cover tube with scraper, brush and air.	5.2	h	21	3	0	-	0	0
<u>Loading Crude Biscuits for desinizing</u>								
Cleaning graphite heater pots that holds crude biscuit.	2.9	h	12	2	0	-	0	0
Loading 2 crude biscuits into pots, place insulation brick around pots, place quartz tubes on furnace unit. Air hoses.	9	h	36	2	0	36	19	684
Gen. Air Room 29 (Thorium casting)	=	=	190	6	0	7	1	190

* Adjusted to two significant figures.

$\Sigma T = 50$

$\Sigma (T \times C) = 17,500$

$$\Sigma \frac{(T \times C)}{\Sigma (T)} =$$

$\mu\text{g}/\text{m}^3$
~~SECRET~~

Times the Maximum Allowable Concentration.

USA 012557

OPERATOR: ~~Casting and Boring~~ 3 men/shift; 2 shifts/day; 3 men/day
 Operators (continued)

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)	No. of Samp- les	Concentration μg/m ³			Avg Con'c.* Times Total Time (T x C)
					Low	High	Avg	
Lunch	•	•	60	2	0	•	0	

* Adjusted to two significant figures.

Σ T 540

Σ (T x C) 35,000

$$\Sigma \frac{(T \times C)}{\Sigma(T)} = \frac{35}{540} \mu\text{g}/\text{m}^3 = 0.065 \mu\text{g}/\text{m}^3$$

Times the Maximum Allowable Concentration.

USA 012558

OPERATOR: Half-Time Desinced 3 men/shift; 2 shifts/day; 3 men/day
Operators

THORIUM

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (Min)(T)	No. of Samp- les	Concentration d/m ³			Avg Con'c. * Times Total Time (T X C)
					Low	High	Avg (C)	
<u>Unloading desinced</u> <u>billet</u>								
Remove furnaces by cart to hoist, remove quartz cover tube and insulation bricks.	2.2	3	7.	3	0	-	0	0
Remove 2 graphite pots containing 2 desinced billets. Unloads by dumping on floor, weights and removes to chopping area	3.6	3	11	3	0	550	220	2,420
Chops 2 billets and blows off dust with air hose	3.3	3	10	3	0	-	0	0
<u>Loading Desinced billets</u>								
Inserts 2 desinced billets into Be crucible. Adds Thorium scrap and place top on crucible	7.5	3	22.5	3	19	1100	463	10,400
Places quartz tube around Be crucible. Adds graphite between quartz tube and cru- cible. Places quartz cover tube on furnace. Air Hoses unit.	9.5	3	28.5	3	0	-	0	0

*Adjusted to two
significant figures.

$$\frac{\sum T \times C}{\sum T} = \bar{C}$$

$$\frac{\sum (T \times C)}{\sum T}$$

$$C/m^3$$

Times the Maximum
Allowable Concen-
tration.

OPERATOR: Half-Time Desincing 3 men/shift; 3 shifts/day; 3 men/day
Operators (continued)

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Opera. (Min)(T)	No. of Opera. les	Concentration d/m ³ (C)			Avg Con'c. * Times Total Time (T X C)
					Low	High	Avg	
Removes furnaces to suit areas. Secures cover tube with sealer.	2	3	6	3	0	-	0	0
<u>Unloading Casting</u>								
Removes quartz furnace top, graphite top and vacuum furnace	3.0	3	9	2	0	-	0	0
Removes quartz inner tube graphite. Blows off furnace	2.7	3	8	2	0	-	0	0
<u>Unloading Furnace in Room 22</u>								
Unloading furnace in- sulation and Thorium Metal casting	3.7	3	11	2	0	-	0	0
Clean off furnace parts, Brick insulation	17.5	3	52.5	2	170	330	250	13,100
<u>Loading Crude Biscuit for desincing</u>								
Cleaning graphite heater pots that holds crude biscuit	2.9	3	8.5	2	0	-	0	0
Load 2 crude biscuit into pots, place in- sulation brick around pots, place quartz cover tube on furnace unit. Air Note	9	3	27	2	0	36	19	513

*Adjusted to two
significant figures.

ΣT

$\Sigma(T \times C)$

USA 012560

$$\frac{\Sigma(T \times C)}{\Sigma(T)}$$

γ/m^3

Times the Maximum
Allowable Concen-
tration.

OPERATOR: Half-time designing 3 men/shift; 1 shifts/day; 3 men/day
 operators (continued 3)

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (Min)(T)	No. of Sam- ples	Concentration d/m ³			Avg Con'c. * Times Total Time (T X C)
					Low	High	Avg	
Gen. Air Room 29 (Thorium casting)	-	-	100	6	0	7	1	100
GA. East Panel Board	-	-	180	2	0	-	0	0
Lunch	-	-	60	2	0	-	0	0

*Adjusted to two significant figures.

ΣT 540 ~~540~~ $\Sigma (T \times C)$ 26,500

$$\Sigma \frac{(T \times C)}{\Sigma(T)} = \frac{26,500}{540} \text{ } \mu\text{/m}^3 = 0.70$$

Times the Maximum Allowable Concentration.

USA 012561

OPERATOR: Drying Operator 1 men/shift; 2 shifts/day; 1 men/day

THORON

~~SECRET~~

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (Min)(T)	No. of Samp- les	Concentration d/m ³			Avg Con't. * Times Total Time (T X C)
					Low	High	(C) Avg	
<u>Unload Drying Furnace</u>								
4 small trays removed from dryer to loading hood, and dumped (ThOX)	2	10	20	3	0	300	100	2,000
Loads ThOX in 2 large trays for calcining	3.6	6	20	3	0	200	70	1,400
Transporting ThOX trays from load hood to storage hood	0.5	12	6	2	0	0	0	0
Loads 1 tray ThOX in hood from 30 gal. drum (outside hood), conveys to dryer (drying)	3.0	12	36	4	0	0	0	0
Unloads 2 trays from dryer to load hood and dumped	2	6	12	3	0	300	100	1,200
Sweeps up ThOX and ThO ₂ in hood using brush and vacuum cleaner	3.5	2	7	1	0	-	0	0
G.A. Room 303	-	-	379	4	0	-	0	0
Lunch (Seminar Room)	-	-	60	2	24	31	28	2,280

USA 012562

*Adjusted to two
significant figures.

ΣT 520

$\Sigma(T \times C)$ 6,500

$\Sigma \frac{(T \times C)}{\Sigma(T)}$

Initial Thoron Daughter - 1400 d/m³ at actual time of survey

Times the Maximum
Allowable Concen-
tration.

~~SECRET~~

OPERATOR: Packing and Jolting 1 men/shift; 1 shifts/day; 1 men/day

THORON- Crude

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (Min)(T)	No. of Samples	Concentration d/m/m ³ (C)			Avg Con'c. * Times Total Time (T X C)
					Low	High	Avg	
Line packing and tamping area	-	-	360	2	26	60	33	11,900
Jolting area	-	-	120	2	80	90	85	10,200
Lunch Area	0	-	60	2	24	31	28	1,680

*Adjusted to two significant figures.

$\Sigma T = 540$

$\Sigma(T \times C) = 23,800$

23,800

USA 012563

~~SECRET~~

$\Sigma \frac{(T \times C)}{\Sigma(T)}$

44

γ/m^3

0.63

Times the Maximum Allowable Concen-

Initial Thoron: Daughter - 1800 d/m/m³ at actual time of survey

OPERATOR: Freeman 3 men/shift; 3 shifts/day; 3 men/day

THORON

THORON THORIUM METAL CASTING

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (Min)(T)	No. of Samples	Concentration d/m/m ³ (C)			Avg Con'c. * Times Total Time (T X C)
					Low	High	Avg	
G.A. Thorium metal casting room	-	-	180	6	0	15	16	7,680
G.A. Lunch room	-	-	60	2	24	31	28	1,680

*Adjusted to two significant figures.

ΣT ~~240~~ $\Sigma(T \times C)$ **9,360**

$\Sigma \frac{(T \times C)}{\Sigma(T)}$ 37 γ/m^3 0.24 Times the Maximum Allowable Concentration

$\Sigma(T)$ Initial Thoron daughter 1900 d/m/m³ at actual time of survey

OPERATOR: ELCO UNLOADER 1 men/shift; 1 shifts/day; 1 men/day
 THORON
 THORIUM

Operation or Operating Area	Time Per Opera. (min)	Per Shift	Time per Shift (min)(T)	No. of Samp- les	Concentration $d/n/m^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	(C) Avg	
Discharging Th oxylate with 30 gal. drums	12	6	72	3	118	690	518	37,300
Thorium extraction- ra. 203	-	-	60	3	60	365	175	71,400
Lunchroom	-	-	60	2	24	31	28	1,680

* Adjusted to two significant figures.

$\Sigma T = 50$ $\Sigma (T \times C) = 110,000$

$\Sigma \frac{(T \times C)}{\Sigma T} = \frac{110,000}{50} = 2,200 \text{ } d/n/m^3 = 2.2$ Times the Maximum Allowable Concentration.

Initial Thoron daughter- 22,000 $d/n/m^3$ at actual time of survey

OPERATOR: BOMB LOADERS

2 men/shift; 1 shifts/day; 2 men/day

THORON

Operation or Operating Area	Time Per Opera. (min)	Oper. Per Shift	Time (min)(T)	No. Samples	Concentration d/m^3			Avg Con'c.* Times Total Time (T x C)
					Low	High	(C) Avg	
loading bomb-lined with Rn_2 , fuel and Cal charge	6	10	60	3	700	1700	800	48,000
transporting bomb to topping area, top, add graphite plug, lines and seals bomb.	5	10	50	3	0	260	100	5,000
bomb load storage area	-	-	60	2	80	90	85	5,100
L.A. Room 33 (Thorium trade)	-	-	110	11	0	90	36	11,800
lunch	-	-	60	2	21	11	28	1,680

* Adjusted to two significant figures.

ΣT 20

$\Sigma (T \times C)$ 71,000

$$\Sigma \frac{(T \times C)}{\Sigma (T)} = \frac{130}{20} \frac{d/m^3}{m^3} = 6.5$$

Times the Maximum Allowable Concentration.

Initial Thoron Daughter = 14,000 d/m^3 at the actual time of survey

OPERATOR: Bomb Unloaders 2 men/shift; 2 shifts/day; 2 men/day

TRKON

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)	No. of Samples	Concentration $\mu\text{r}/\text{m}^3$			Avg Con'c,* Times Total Time (T x C)
					Low	High	Avg	
Opening 1 bomb and unloading line from top of bomb	2.5	10	25	3	0	-	0	0
Drilling out crucible from bomb	3.7	10	37	3	0	-	0	0
Tape and dump slag from bomb	3.9	10	39	3	0	-	0	0
Chipping slag from billet with hammer and chisel	1.7	10	17	3	0	150	50	850
Removes slag with air hammer	3	10	30	3	0	-	0	0
Clean up	2	3	6	3	0	-	0	0
G.A. Room 13- Thorium grade	-	-	126	11	0	90	36	11,700
Lunch	-	-	60	2	24	31	28	1,680

* Adjusted to two significant figures.

ΣT 510

$\Sigma (T \times C)$ 11,200

$\Sigma \frac{(T \times C)}{\Sigma (T)}$ =

27

$\frac{\Sigma (T \times C)}{\Sigma (T)} = \frac{11,200}{510} = 22$

Times the Maximum Allowable Concentration.

Initial Thorium Daughter - 3100 $\mu\text{r}/\text{m}^3$ at actual time of survey

OPERATOR: WESLEY HAN

1 men/shift; 1 shifts/day; 1 men/day

THORON

Operation or Operating Area	Time Per Opera. (min)	Opera. Per Shift	Time Per Shift (min)(T)	No. of Samples	Concentration $\mu\text{Ci}/\text{m}^3$			Avg Con'c.* Times Total Time (T x C)
					Low	High	(C) Avg	
Dumping 1- 5 gal. drum ThO_2 into grinder	1.3	10	13	3	400	1800	1000	13,000
Emptying hopper into 30 gal. drum	.5	10	5	3	0	0	0	0
Loading mixer with ZnO , ThO_2 and CaF_2 charger	3.4	10	34	3	400	2000	1300	44,200
Unloading ZnO , ThO_2 and CaF_2 from mixer	1.3	10	13	3	0	4000	1500	19,500
Ca. Room 33 (Thorium grade)	-	-	115	11	0	90	36	41,500
Lunch	-	-	60	2	24	31	28	1,680

* Adjusted to two significant figures.

$\Sigma T = 330$ ~~SECRET~~ $\Sigma (T \times C) = 93,300$

$$\Sigma \frac{(T \times C)}{\Sigma T} = \frac{93,300}{330} = 283 \text{ } \mu\text{Ci}/\text{m}^3 = 2.8$$

Times the Maximum Allowable Concentration.

Initial Thoron Daughter: $19,500 \mu\text{Ci}/\text{m}^3$ at actual time of survey