EG&G Idaho, Inc.
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ENGINEERING DESIGN FILE

Project/Task ISV Treatability Study
Subtask Large-Scale Demonstration Test

Subject : Time Required to Vitrify TRU-Contaminated Pits and Trenches at the SDA

Abstract :

An estimate is obtained for the time required to vitrify the contents of the pits and trenches at the SDA containing TRU waste (trenches 1-10, pits 1-6, 9,10). The following assumptions are made:

- Electrode separation = 10 feet for trenches, 16 feet for pits
- Width of melt = 18 feet for trenches, 30 feet for pits
- Average excavated depth, overburden depth, and dimensions are as given by reference (1).
- Underburden depth = 3 feet
- Run time per melt as a function of total melt depth is given by reference (2).
- overlap between melts = 2 feet
- Calculated process unit times includes 24 hours between melts for moving equipment and 10% for maintenance.

Results

The following table shows the calculated values of the process unit days required for vitrification of trenches 1-10 and pits 1-6,9,10 along with the values of parameters employed in the calculations and other associated calculated quantities (calculations attached). The melt depth denotes the average value of the maximum melt depth (includes overburden, contaminated soil and underburden). The surface area is the estimated actual surface area of the pits and trenches (1). The time/melt is the time required for one melt (does not include the time required to move the equipment or maintenance time). The # of melts is the number of melts required for vitrification, allowing for sufficient overlap between melts and sufficient extra melt around the boundaries (rounded up to nearest multiple of 10). The area vitrified is the actual area vitrified (effective area per melt multiplied by the number of melts). The volume vitrified is the actual volume vitrified (area vitrified multiplied by the melt depth). The process unit days required is the number of days required for vitrification (includes 24 hrs between melts for moving equipment and maintenance time of 10%).

Distribution (complete package) J.L. Landon, B.L. Charboneau

Distribution (cover sheet only): Project EDF file log, EDF serial no. log

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TABLE 1 ISV PROCESS CALCULATIONS FOR TRU-CONTAMINATED PITS AND TRENCHES AT THE SDA

Trench, pit #	Melt Depth, ft.	Surface Area, sq. ft.	Time/ melt hrs	# of melts	Area vitrified, sq. ft.	melt vol. cu. ft./ 10^6	Process unit days required
tr.'s 1,5,7,9	18	29,050	62	300	74,700	1.34	1,183
tr.'s 2,3,4, 6,8,10	24	47,313	90	490	121,662	2.92	2,560
pit 1	23	30,824	210	60	40,560	0.932.	644
pit 2	25	99,064	300	180	121,680	3.04	2,673
pit 3	18	47,230	150	100	67,600	1.22	798
pit 4	22	104,979	210	200	135,200	2.97	2,145
pit 5	22	66,952	210	110	74,360	1.64	1181
pit 6	22	54,575	210	90	60,840	1.34	966
pit 9	20	42,802	210	80	54,080	1.08	858
pit 10	24	112,015	300	190	128,440	3.08	2,822
total		634,804		1,800	879,122	19.56	15,830 (44 yrs)

A similar calculation (attached) shows that the time required to vitrify the entire SDA (including the areas between pits and trenches) would be approximately 169 process unit years (includes 24 hours between melts and maintenance time of 10%).

REFERENCES

1. "History of Buried Transuranic Waste At The INEL", March 1977, D.H. Card, EG&G Idaho, Inc.

2. "In Situ Vitrification of Transuranic Waste: An Updated Systems Evaluation and Applications Assessment", March 1987, J.L. Buelt, C.L. Timmerman, K.H. Oma, V.F. FitzPatrick, and J.G. Carter, Pacific Northwest Laboratory, PNL-4800 Suppl. 1, page 116

Calculations of Time Required to Vitrify TRU Waste at the INEL

Assume: electrode separation = 5 m.
melt width = 30 ft.
run time given as a function of melt depth by Figure 57, supp. 1
time between melts = 24 hours
pits considered:
trenches considered: 1-10
pits considered: 1-6, 9, 10
overburden, underburden vitrified

Trench 1, 5, 7, 9 — 3 ft. underburden, 2 ft. overlap between settings
maintenance time not included here

Total length = 4150
width = 7 ft.
overburden depth = 5 ft.
excavated depth = 10 ft.
underburden depth = 3 ft.
→ melt depth = 18 ft. ≅ 6 m.
run time ≅ 150 hrs.
Assume 2 ft. overlap between settings.
→ # of settings ≅ $\frac{4150}{(30-4)\text{ft}}$ = 160 settings

total run time =
(160)(150) + (160)(24) = 27,840 hrs. = 1160 days

Trench 2, 3, 4, 6, 8, 10

width = 7 ft.
overburden = 5 ft.
exc. depth = 16 ft.
underburden = 3 ft.
→ melt depth = 24 ft. ≅ 7.3 m.
→ run time ≅ 210 hrs.
Assume 3 ft. overlap between settings.
→ # of settings = $\frac{6,759}{26}$ = 260

Lengths = 1114, 1124, 1132, 1130, 1132, 1127 ft.
total length = 6,759 ft.

total run time = (260 (210 + 24) = 60,840 hrs. = 2535 days

Assume Instead 3 m. electrode c.o.
melt width = 18 ft.

→ Trenches 1, 5, 7, 9

run time ≅ 62 hrs. total length = 1161 + 2,989 = 4,150 ft.

# of settings = $\frac{4150}{18-4}$ = 300

total run time = 300 (62 + 24) = 25,800 hrs. = 1,075 days

Trenches 2, 3, 4, 6, 8, 10

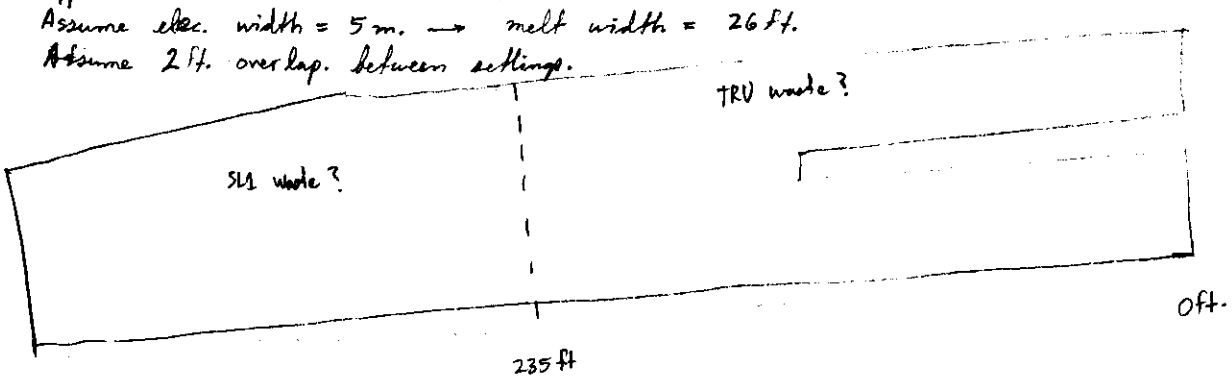
run time ≅ 90 hrs.

# of settings $\frac{6,759}{14}$ = 490

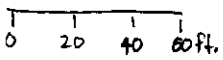
total run time = 490(90+24) = 55,860 hrs. = 2,328

Pit 1. surface area = 30,824 ft²

Approximate length = 235 ft. + 120 = 455 ft.
Approximate width = (30,824 ft²)/455 ft. = 68 ft.
Assume elec. width = 5 m. → melt width = 26 ft.
Assume 2 ft. overlap. between settings.



→ 3 settings widthwise to cover width and allow extra space on sides.



# of settings = 3 × $\frac{455 \text{ ft.}}{26 \text{ ft.}}$ = 60

overburden = 6 ft.
exc. depth = 14 ft.
underburden = 3 ft.
→ melt depth = 23 ft. ≅ 7 m.
→ run time ≅ 210 hrs.
total run time = 60(210 + 24) = 14,040 hrs. = 585 days

Pit 2

Surface Area = 99,064 ft^2 Assume Elect. Sep. = 5 m.

"Length" = $L_1 + L_2$ = 1000 ft. + 150 = 1,150

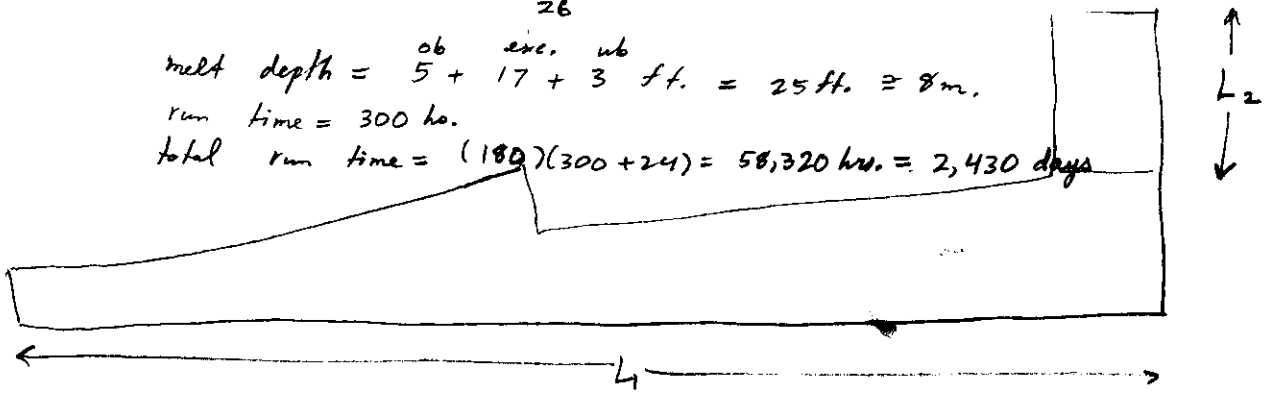
"Width" = (99,064)/1150 = 88 ft. → 4 settings to cover width

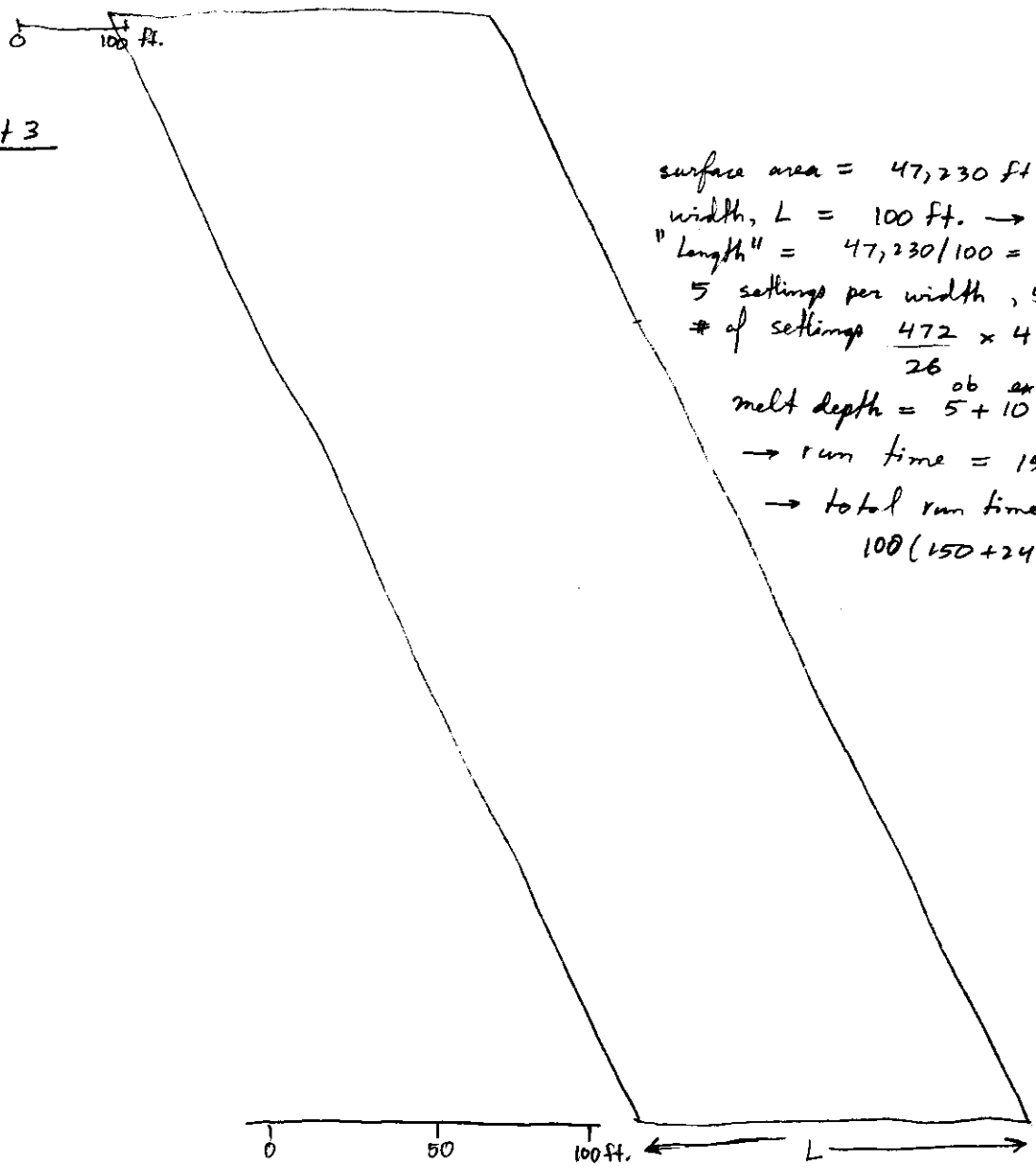
# of settings = $4 \times \frac{1150}{26}$ = 180

melt depth = $\overset{ob}{5} + \overset{exc.}{17} + \overset{ub}{3}$ ft. = 25 ft. ≅ 8 m.

run time = 300 hr.

total run time = (180)(300 + 24) = 58,320 hrs. = 2,430 days





Pit 3

surface area = 47,230 ft^2

width, L = 100 ft. →

"Length" = 47,230/100 = 472 ft.

5 settings per width, 5 m. elec. sep.

# of settings $\frac{472}{26} \times 4$ = 100

melt depth = $\overset{ob}{5} + \overset{exc.}{10} + \overset{ub}{3}$ = 18 ft. ≅ 6 m.

→ run time = 150 hrs.

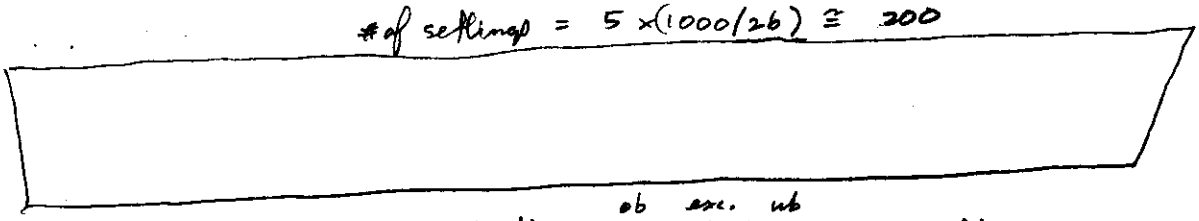
→ total run time =

100 (150 + 24) = 17400 hrs.

= 725 days

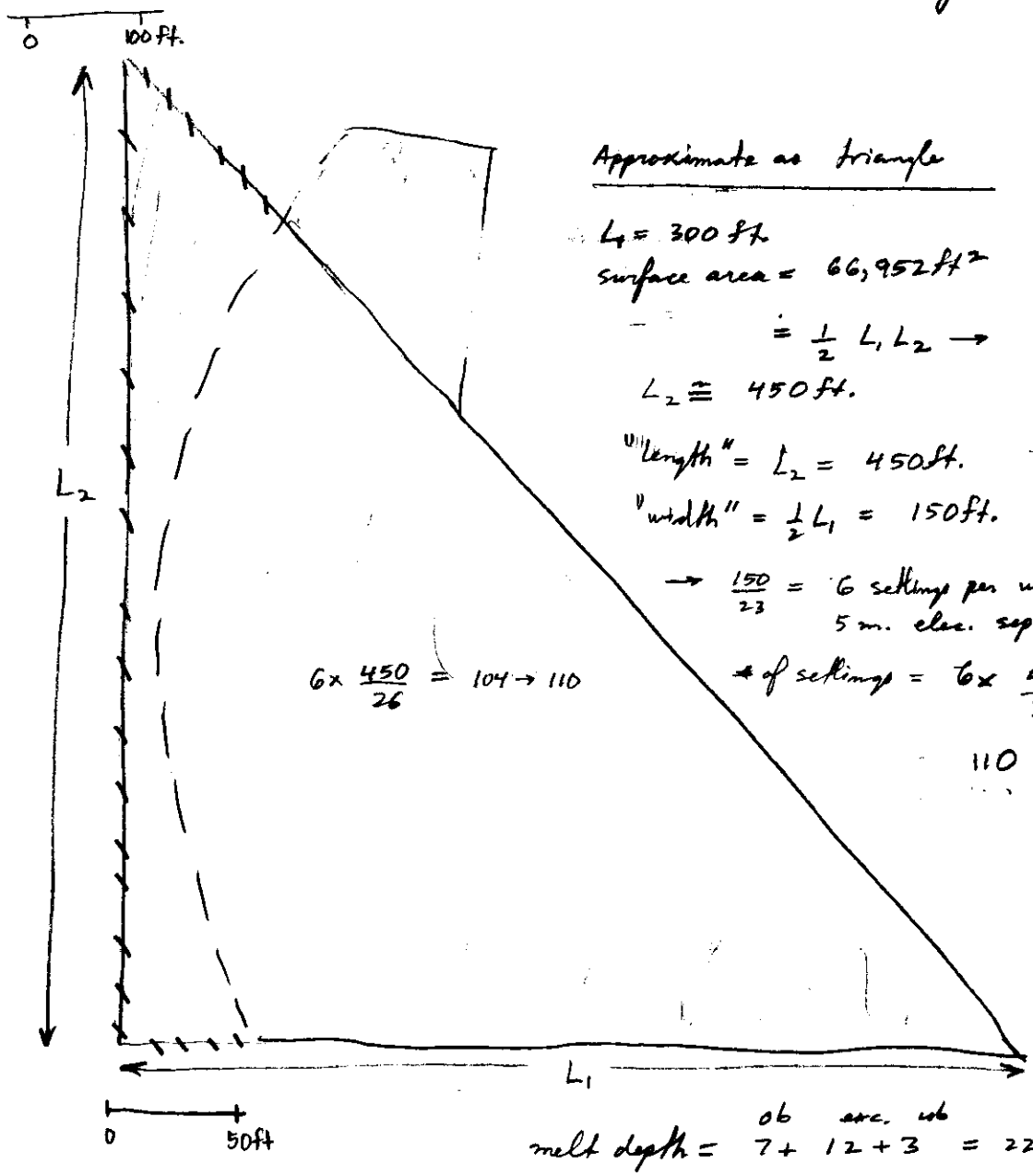
Pit 4

Surface area = 104,979 ft²
"length" = 1000 ft.
→ "width" = 104 ft. → 5 settings per width 5 m. elec. sep.
# of settings = 5 × (1000/26) ≅ 200



melt depth = 8 (ob) + 11 (exc.) + 3 (ub) = 22 ft. ≅ 7 m.
→ run time = 210 hrs.
total run time = 200 (210 + 24) = 46800 hrs.
= 1950 days.

Pit 5



Approximate as triangle

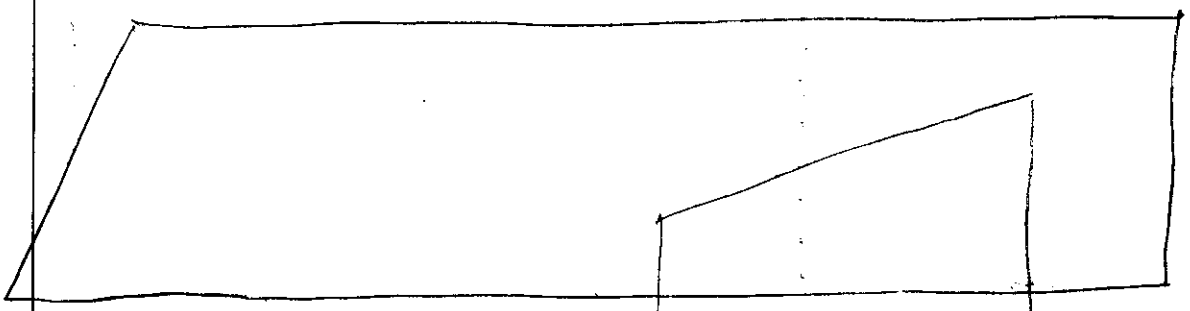
L_1 = 300 ft.
surface area = 66,952 ft²
$= \frac{1}{2} L_1 L_2$ →
$L_2 \cong$ 450 ft.
"length" = L_2 = 450 ft.
"width" = $\frac{1}{2} L_1$ = 150 ft.
→ $\frac{150}{23}$ = 6 settings per width, 5 m. elec. sep.

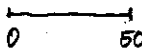
$6 \times \frac{450}{26} = 104 \rightarrow 110$

# of settings = $6 \times \frac{450}{26}$
110

melt depth = 7 (ob) + 12 (exc.) + 3 (ub) = 22 ft.
≅ 7 m.
run time = 210 hrs.
total run time = (110)(210 + 24)
= 25,740 hrs. = 1073 days

Pit 6 surface area = 54,575 ft²
Width ≅ 120 ft. → 6 settings per width, 5 m. elec. sep.
→ "length" = 54,575/120 = 455 ft.





# of settings = $5 \times \frac{455}{26} = 90$

melt depth = 8 (ob) + 11 (arc.) + 3 (und.) = 22 ft. ≅ 7m.

run time = 210 hrs.

total run time = 90(210+24) = 21,060 hrs. = 878 days

Pit 9

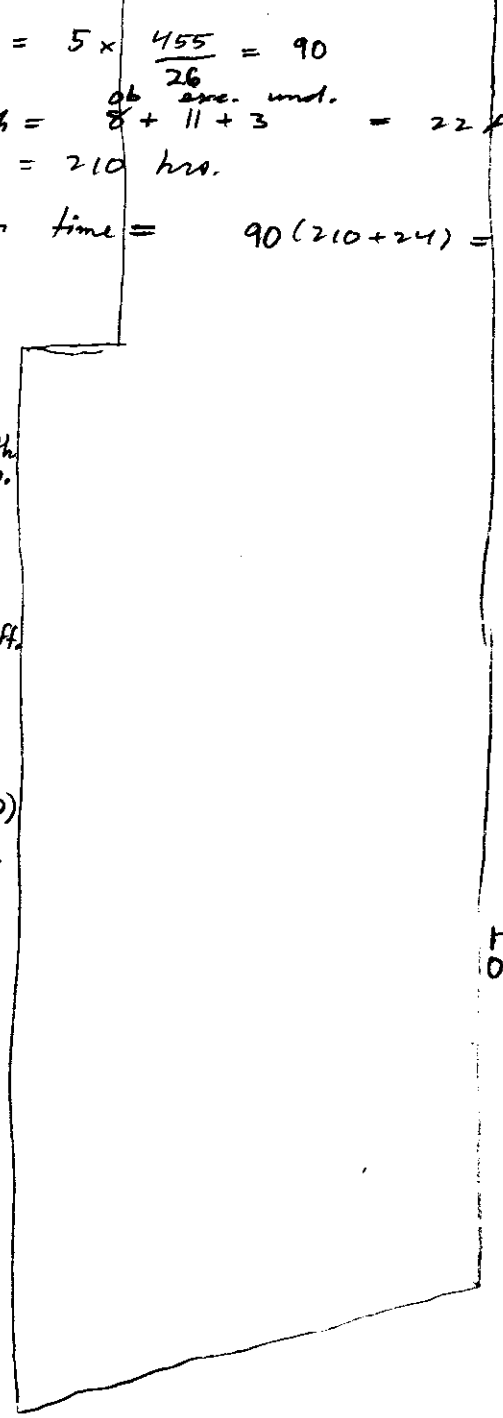
Surface area = 42,802 ft²
width ≅ 130 ft → 6 settings/width, 5 m. elec. sep.
length = 330 ft.

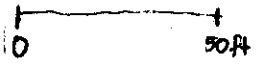
# of settings = $6 \times \frac{330}{26} \cong 80$

melt depth = 5 (ob) + 12 (arc.) + 3 (und.) = 20 ft.
≅ 7m.

run time = 210 hrs.

total run time = (210+24)(80)
= 18,720 hrs.
= 780 days





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Pit 10

0 100 ft.

surface area = 112,015 ft^2

width ≅ 120 ft. → 6 settings/width, 5 m. elev. sep.

length = $\frac{112,015}{120}$ = 940 ft.

# of settings = $\left(\frac{940}{26}\right)(5)$ = 190

melt depth = $\overset{ob}{8}$ + $\overset{exc.}{13}$ + $\overset{ub}{3}$ = 24 ft.

≅ 8 m.

run time = 300 hrs.

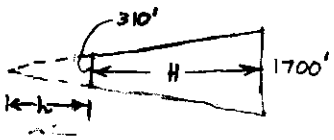
total run time = 190 (300+24)

= 61,560 hrs.

= 2,565 days.

Whole SDA : melt depth (average of above pits) : 22 ft. ≅ 7m (* average)
run time = 210 hrs.

Assume SDA is iso. triangle

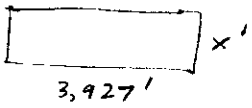


Total area = 88 acres = (43,560)(88) = 3,834,000 ft^2

$\frac{1}{2}(H+h)(1700) - \frac{1}{2}(310)(h) = 3,834,000$ h/H = 310/1700 h = .182H

850H + (850 − 155)h = 3,834,000 = 976.5H → H = 3,927 ft. h = 715 ft.

Approximate as rectangle



$$3{,}927\,x = 3{,}834{,}000$$
$$x = 976'$$

\# of settings per width $= \frac{976}{26} = 38$

\# of settings $38 \times \left(\frac{3927}{26}\right) \cong 5{,}740$

total run time $= 5{,}740\ (210 + 24)$ hrs.
$= 1{,}343{,}160$ hrs. $= 154$ years.

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