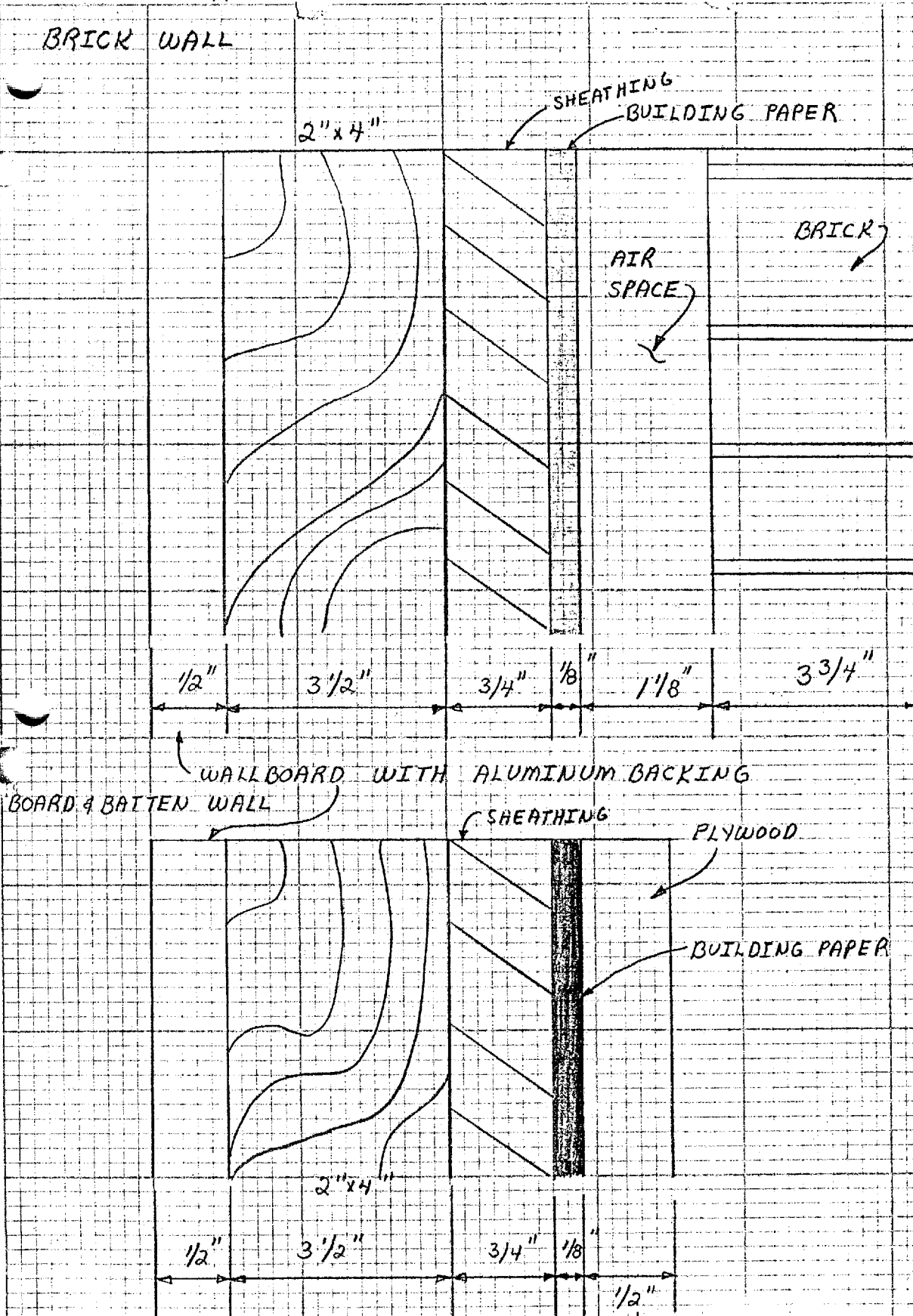


Attachment 2



STAT. *Heat Loss Calculations*

median of annual extremes	99%	97 1/2%	coincident w. velocity
18°	20°	23°	M
10°	15°	18°	L
10°	14°	18°	L

winter design temperature = 10° with light winds

for winds:

V _L	=	5	MPH
L	=	8	MPH
M	=	12	MPH
H	=	15	MPH

Indoor conditions	winter	75°F	30% relative humidity
	summer	75°F	50% relative humidity

$$t_i = 75^\circ$$

$$t_o = 10^\circ$$

$$\Delta t = 75 - 10 = 65$$

$$t_{avg} = \frac{75 + 10}{2} = 42.5^\circ$$

① outside surface films

V = 15	R = .17
8	4
V = 7.5	R = .25

$$\frac{15 - 7.5}{.17 - .25} = \frac{8 - 7.5}{4 - .25}$$

$$\frac{7.5}{-.08} = \frac{.5}{4 - .25}$$

$$7.54 - 1.875 = -.04$$

$$7.54 = 1.835$$

$$4 = .244$$

R value for brick veneer wall as constructed

① outside surface film with 8 MPH winds	R values
② brick veneer	.244
③ 1 1/8" air space E = 0.82	.417
④ 1/8" building paper = .06 x 2 =	.910
⑤ 3/4" sheathing	.120
⑥ 3 1/2" air space E = 0.20	1.979
⑦ 1/2" wallboard	1.76
⑧ inside air film f = 1.46 R = 1/1.46 =	.450
	.6849
	R = 6.56

② brick veneer $R = 4/K, K = 9 \quad 4 = 3.75'' \quad R = \frac{3.75}{9} = .41667$

③ 1 1/8" air space

$t_i = 75^\circ$

$t_o = 10^\circ$

thickness

R

.75"

.95

1.125

4

1.5"

.92

$\frac{.75 - 1.5}{.95 - .92} = \frac{1.125 - 1.5}{4 - .92}$

$\frac{-.75}{.03} = \frac{-.375}{4 - .92}$

$1.5'' = .90 + \frac{2}{12} (1.02 - .90) = .92$

$-.754 + .69 = .01125$

$.75'' = .94 + \frac{2}{12} (1.01 - .94) = .95$

$4 = \frac{.69 - .01125}{.75} = .91$

⑤ 1/2" impregnated or coated sheathing 1/2" = 1.32

$25/32 = 2.06$

$\frac{.781 - .5}{.74} = \frac{.031}{.74}$

$R = 2.06 - .031 = 1.979$

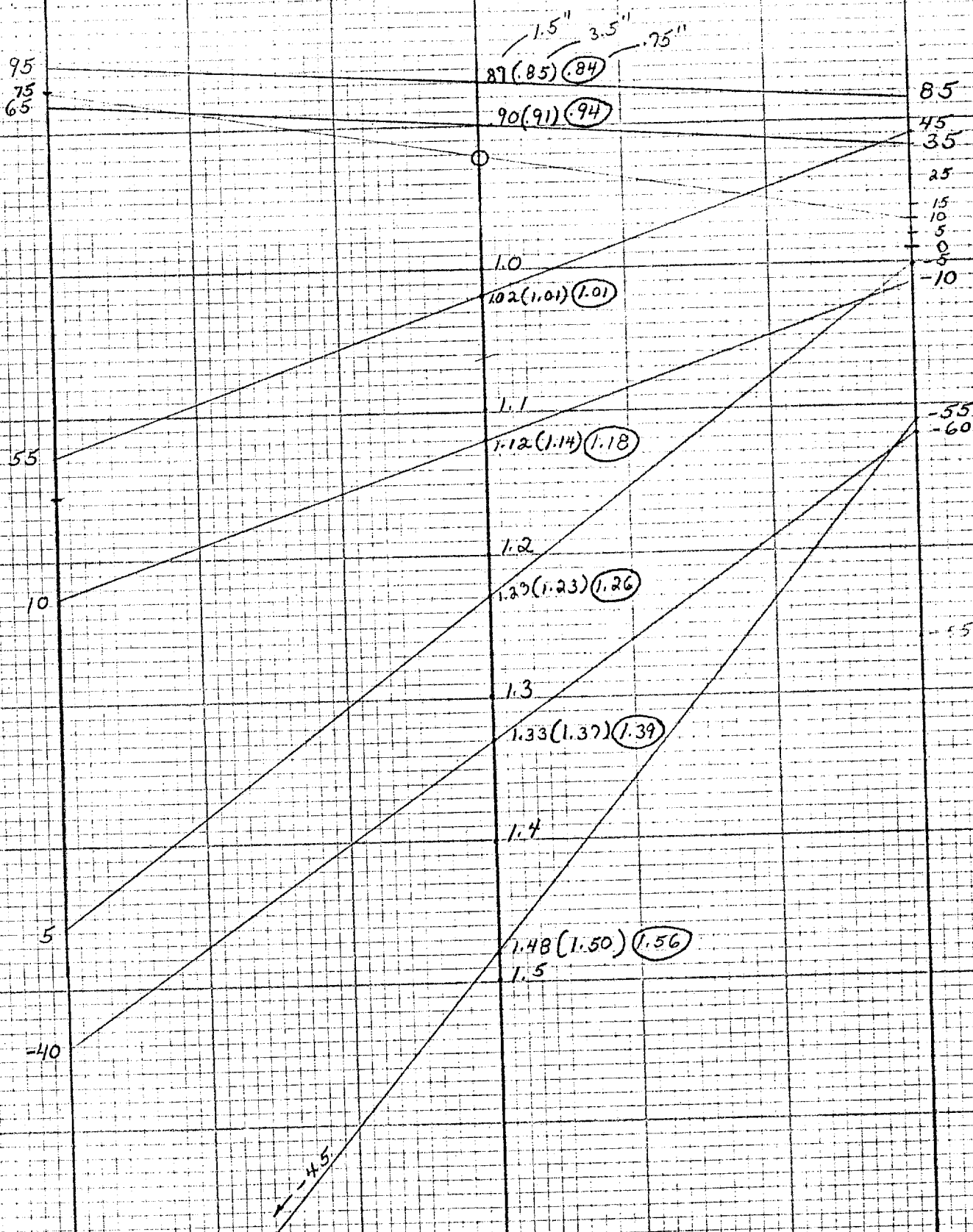
HORIZ HEAT FLOW

AIR SPACE = 1.5"

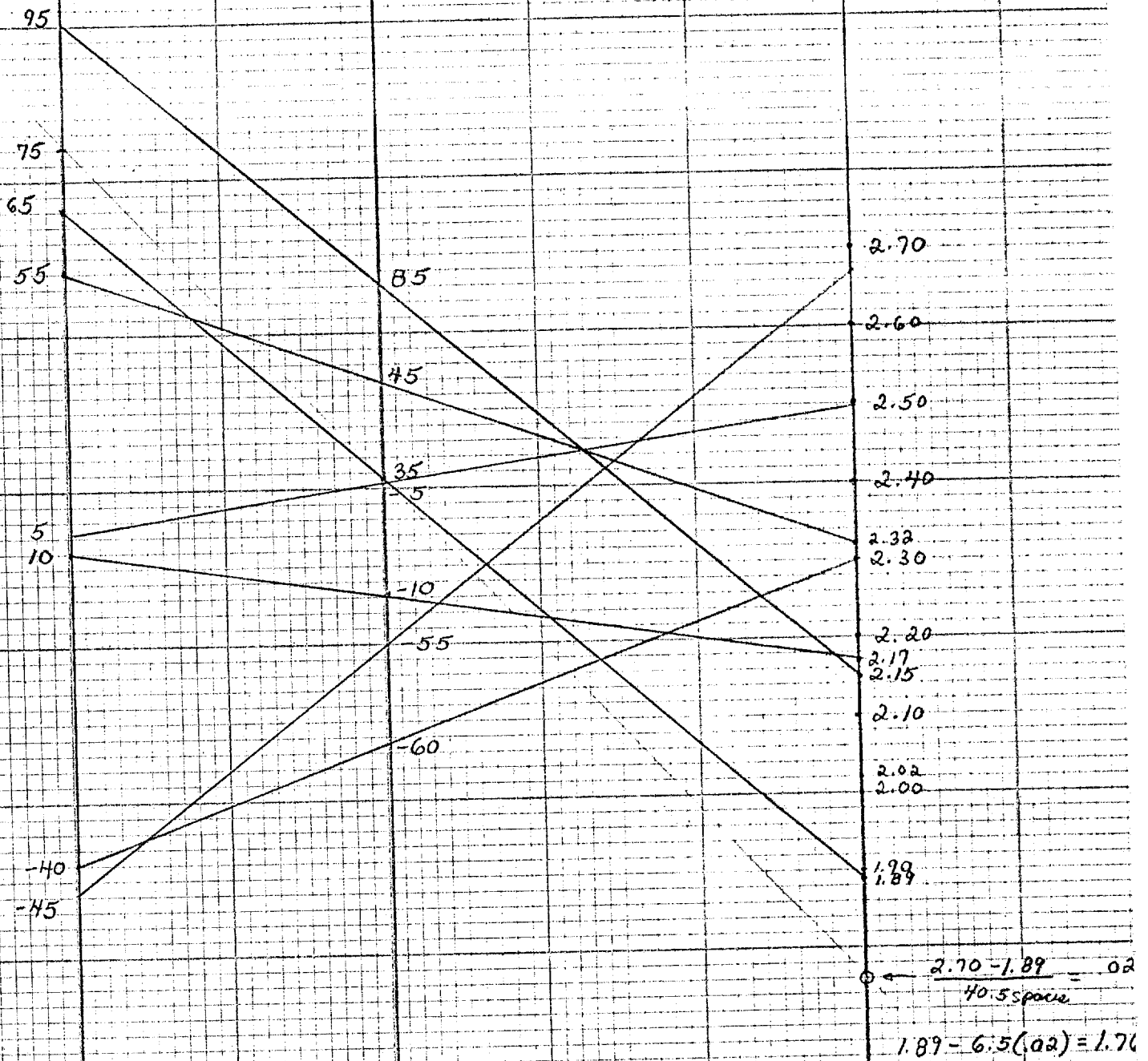
R GOOD FOR 3.5" AIR SPACE

ALSO 3.5" VALUES ()

.75" VALUES ()



VERT. AIR SPACE
HORIZ. HEAT FLOW



for board & watten wall

① outside surface film	.244
② 1/2" plywood	.630
③ 1/8" building paper	.120
④ 3/4" sheathing	1.979
⑤ 3 1/2" air space $E = .20$	1.760
⑥ 1/2" wallboard	.450
⑦ inside surface film	.6849
	<u>5.87</u>

As a check on approach determine Btuh for the house
using original parameters

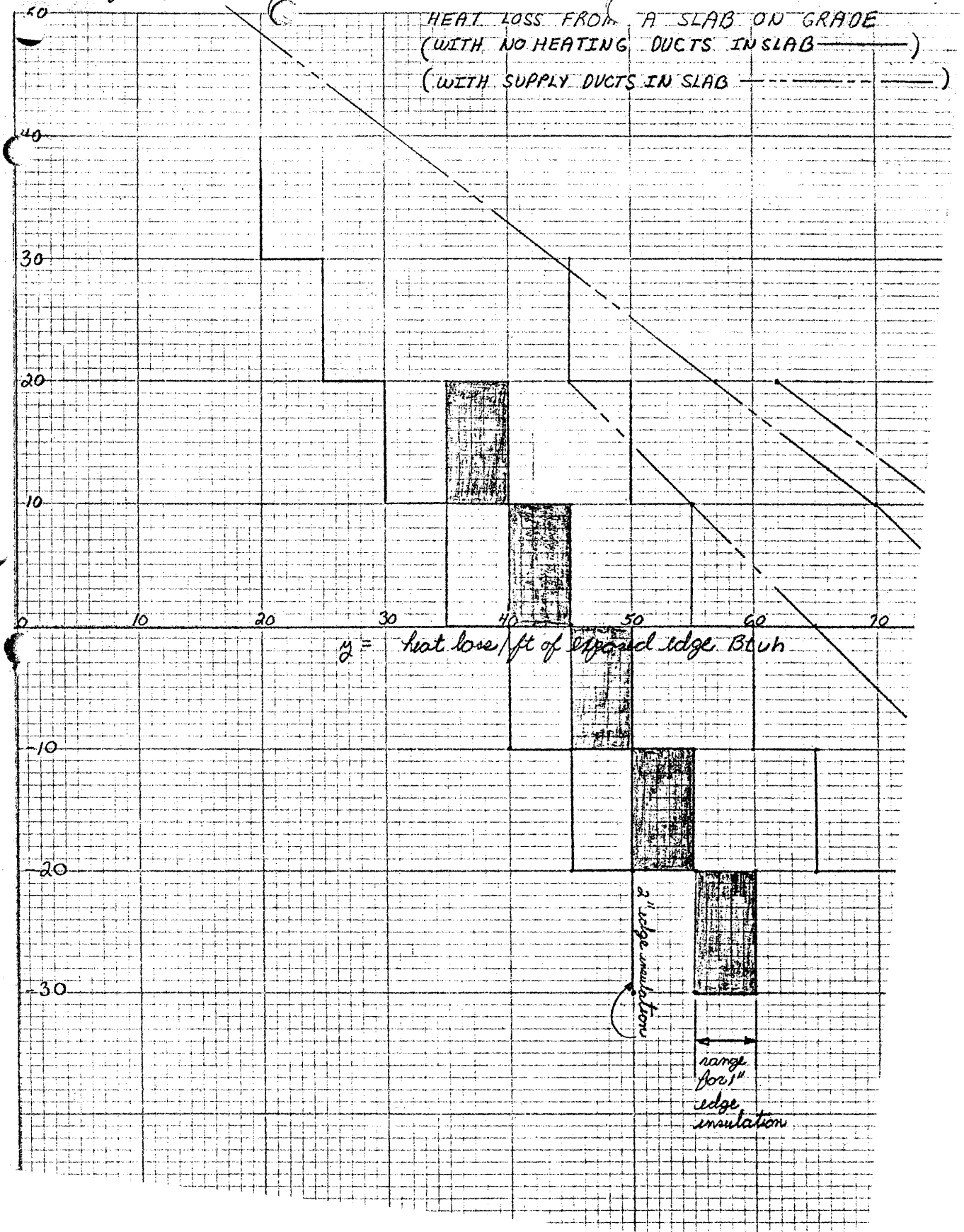
$$Q = \text{ft}^3/\text{hr} \times \frac{.018 \text{ Btu}}{\text{ft}^3 \text{ } ^\circ\text{F}} \times \Delta t \text{ } ^\circ\text{F}$$

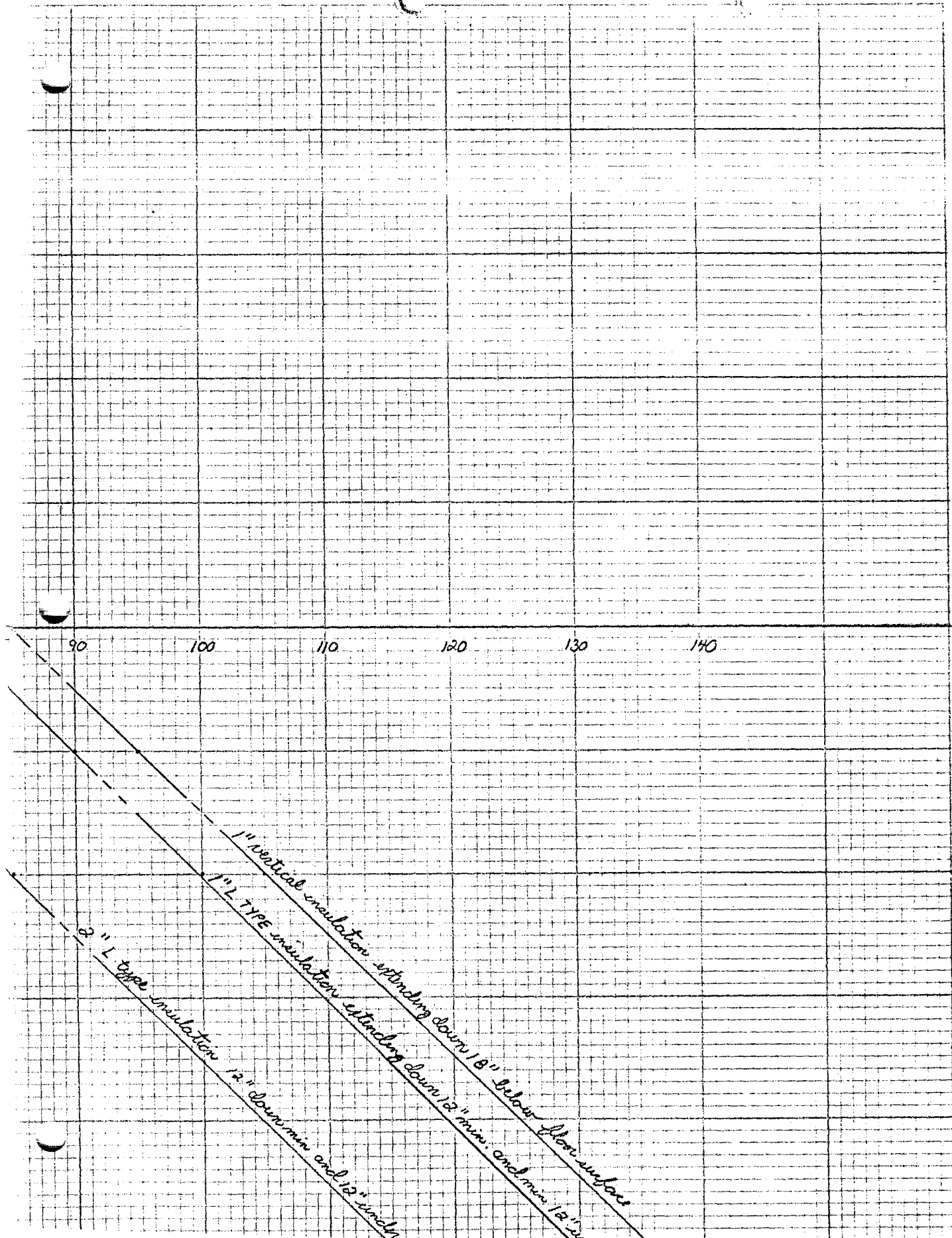
heat loss due to transmission $Q = AU(t_i - t_o)$

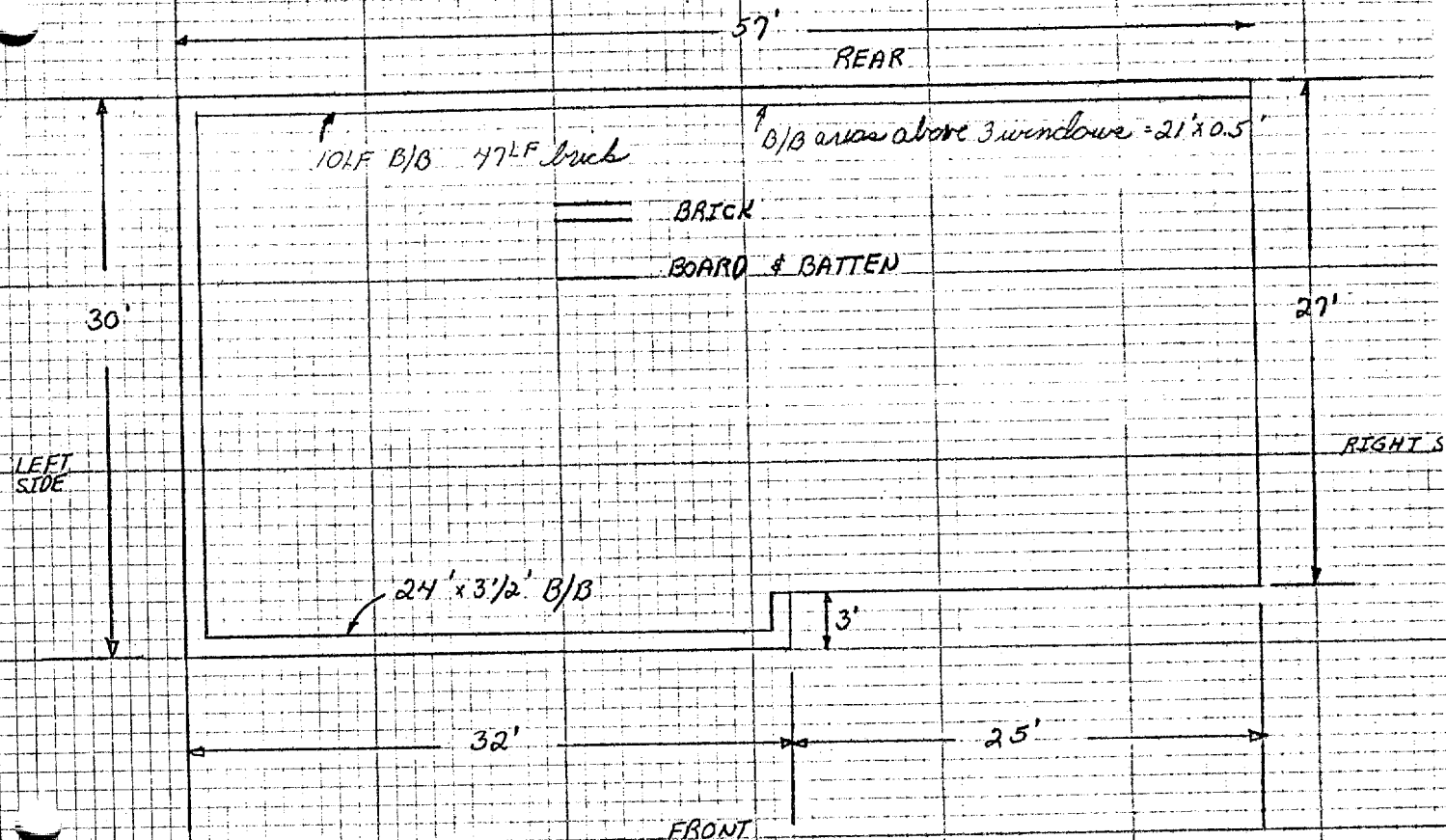
infiltration $Q = \text{ft}^3/\text{hr} \times .018 \times \Delta t$

BTUH for 4 bedroom unit (from plans) = 69095 BTUH

outdoor design temp







		LF infiltration
rear Windows	7'x3' in brick	29
	7'x3' in brick	29
	7'x4 1/2' in B/B	36.5
	7'x4 1/2' in brick	36.5
	3'x7' door in B/B	20
front	7'x3' in B/B	29
	7'x3' in B/B	29
	4'x3' in B/B	17
	13.5'x6.75' in B/B	73.5
	3'x7' door in B/B	20
L.S.	4'x3' in brick	17
	4'x3' in brick	17
R.S.	3'x7' door in B/B	20
		<u>Σ = 373.5</u>

rear wall brick = $(57 \times 9) - 90 - (21 \times 1/2) - 21 - 21 - 31.5 =$ 339 S.F.

* include doors in B/B area

board & batten = $90 + (21 \times 1/2) - (7 \times 4.5) =$ 69 S.F.

glass = $21 + 21 + 31.5 + 31.5 =$ 105 S.F.

513 ✓

front brick = $(32+3) \times 9 - (24 \times 3.5) =$ 231

B/B = $(24 \times 3.5) + (25 \times 9) - 21 - 21 - 12 - 91.125 =$ 163.875

glass = $21 + 21 + 12 + 91.125 =$ 145.125

540

L.S. brick = $(30 \times 9) - 12 - 12 =$ 246

glass = $24 =$ 24

270

R.S. B/B = $27 \times 9 =$ 243

Heat losses due to transmission

brick = $(339 + 231 + 246) \times 1/6.56 \times 55 =$ 6842 BTuh

board/batten = $(69 + 164 + 243) \times 1/5.87 \times 55 =$ 4460

glass = $(105 + 145.1 + 24) \times 1.13 \times (55) =$ 11036

ceiling $[(57 \times 27) + (3 \times 32)] \times .11 \times 55 =$ 9892

slab $[(57 \times 2) + (30 \times 2)] \times 68.5 \text{ BTuh/FT} =$ 11919

50149

Heat loss due to infiltration

$\frac{373.5}{2} \times 35 \times .018 \times 55 =$ 6471

56620

Loss due to fireplace drawing out warm air assume 10% 5662

6228.2

6228

10% misc losses: poor construction

future deterioration

opening of doors

windows left opened unintentionally or due to poor fit

68510 BTuh = total heat loss of house

* original design heat loss = 69095

① Determine heat losses for each room in the house

brick walls $U = .057$

board/batten walls $U = .060$

windows

$U = .55$ (actual value Solar Seal Co. = .58

2.5mm glass 1/4" space panh

ceiling

$U = .052$ min.

② size supply ducts (abandon ducts in slab and use picks of furnace to supply air to the system)

③ size furnace

assume attic temp = outside design temperature = 10°
 ← legitimate assumption because of louvered ends of attic

$\Delta t = 75^{\circ} - 10^{\circ} = 65^{\circ}F$

slab loss / L.F. = 45 Btu/h (max) with 1" edge insulation with no edge insulation = 60
 ← no ducts in slab

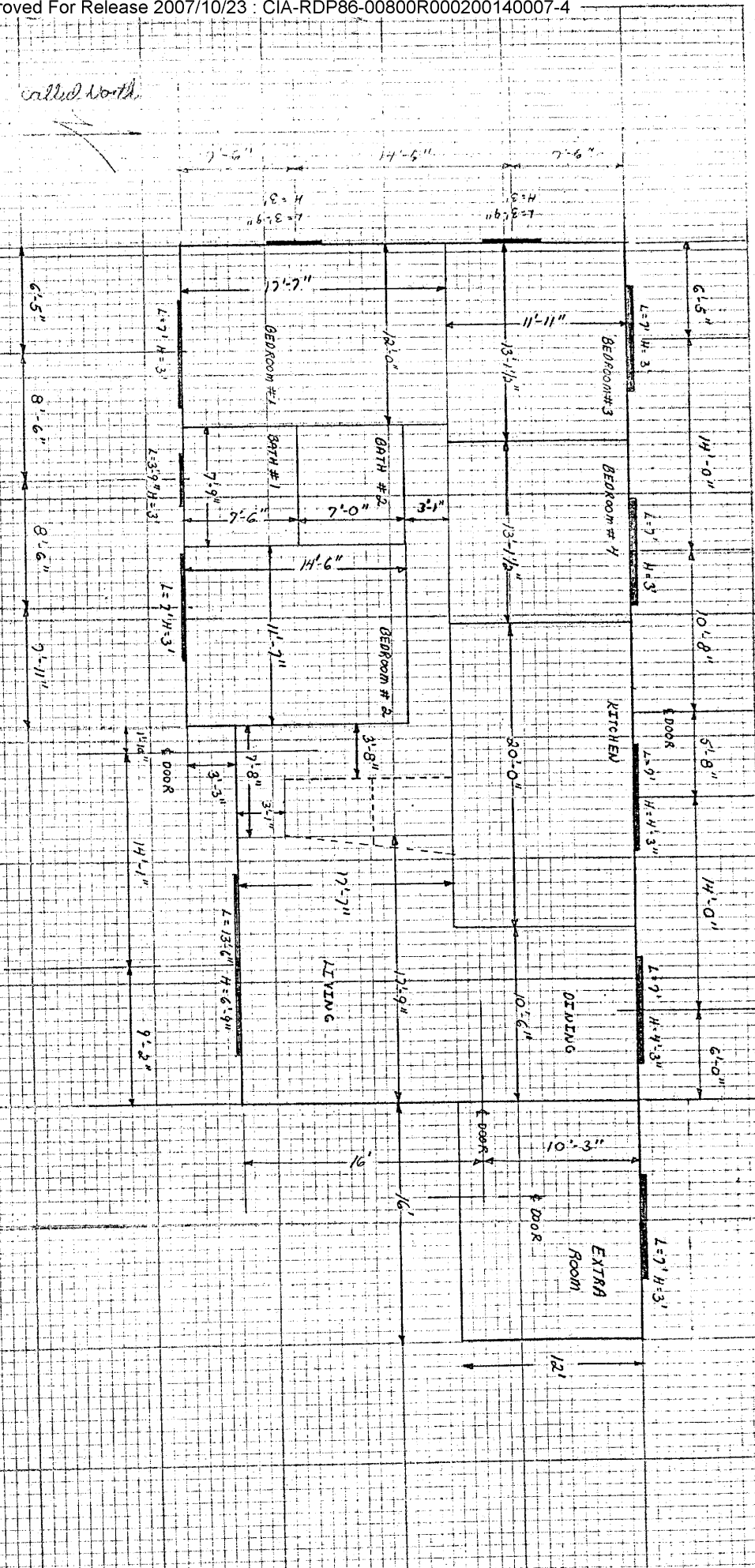
infiltration = 35 ft³/hr / L.F. of crack

losses from door being opened. assume 1 opening / 30 min = 2 per hour

$\frac{9}{15} \times 900 \text{ ft}^3/\text{hr} = 480 \text{ ft}^3/\text{hr}$

heat loss / door / hr = $480 \times 2 \times .078 \times 65 = 1124 \text{ Btu/h}$

called North.



ROOM	BRICK AREA	D/B AREA	CEILING AREA	GLASS AREA	LF EXPOSED SLAB	LF INFIL.
① BDRoom 3	+ 11.92 x 9 + 13.125 x 9 - 7 x 3 - 3.75 x 3 - 7 x 1 186.2 SF	7 x 1 7 SF	11.92 x 13.125 156.5 SF	7 x 3 3.75 x 3 32.3 SF	11.92 + 13.125 25.0 LF	7 + 7 + 18 for 1 wall = (3.75 x 2) + (3 x 3) for 2nd wall (outside walls) was 32
② BDRoom 4	13.125 x 9 - 7 x 1 - 7 x 3 90.1 SF	7 x 1 7 SF	11.92 x 13.125 156.5 SF	7 x 3 21 SF	13.125 13.1 LF	7 + 7 + 18 for 1 wall (outside wall) 32 LF
③ Kitchen	20 x 9 - 7 x 4.25 - 63.2 87.1 SF	+ 9 x 10.33 - 7 x 4.25 63.2 SF	20 x 11.92 238.4 SF	7 x 4.25 29.8 SF	20.0 20 LF	1 outside wall 7 + 7 + 3 + 3 (7 x 2) + 6(4.25) 59.5 LF
④ Dining Room	10.5 x 9 - 7 x 1 - 7 x 4.25 57.8 SF	0 0	10.5 x 11.92 125.2 SF	7 x 4.25 29.8 SF	10.5 10.5 SF	14 + 4.25(6) for 1 wall = 1 outside wall 39.5 LF
⑤ Living Room	0 0	17.75 x 9 14.25 x 9 - 13.5 x 6.75 197 SF	17.75 x 12.58 312 SF	13.5 x 6.75 91.1	17.75 + 14.25 32 LF	2 outside walls (4 x 13.5) + (7 x 6) + (2 x 3) for 0 for 2nd wall 102 LF
⑥ Entry/Hallway	0 0	7.67 x 9 62 SF	7.67 x 3.125 3.67 x 9.25 3.125 x 18.75 116.5 SF	0	7.67 7.67 LF	1 outside wall (7 x 2) + (3 x 2) 20 LF
⑦ Bedroom 2	11.67 x 9 3.25 x 9 - 7 x 1 - 1 x 4 - 7 x 3 102.3 SF	7 x 1 1 x 4 11 SF	11.67 x 14.5 169.2 SF	7 x 3 21 SF	11.67 + 3.25 14.9 LF	1 outside wall 14 + (3 x 6) 32 LF

	Brick	H/B	Ceiling	Joist	insulation	infiltration
⑧ Bath #1	7.75x9 -3.75x3 -3.75x1 -2.5x4 -2x4	3.75x1 2.5x4 2x4	7.75x7.5	3.75x3	7.75	10 outside wall (3.75x2)+9
	36.8 SF	21.8 SF	58.7 SF	11.3 SF	7.8 L.F.	16.5 L.F.
⑨ Bath #2	0	0	7.75x7	0	0	0
	0	0	69.8 SF	0	0	0
⑩ Bedroom #1	12x9 17.67x9 -7x1 -1.5x4 -7x3 -3.75x3	7x1 1.5x4	12x17.67	7x3 3.75x3	12+17.67	2 outside walls 1st wall = 7+7+18 = 2nd wall = (3.75x2)+9 =
	221.8 SF	13.0 SF	212 SF	32.3 SF	29.7 L.F.	32 L.F.
⑪ Extra room	0	16x9 16x9 12x9 -7x3	12x16	7x3	16+16+12 * slab has no edge insulation in the area	14+18 for 1 wall 7+7+3x2 for 2nd wall 3 outside walls 32 + ins 20
		375	192	21	44	302

Room	Brick UAAT UAAT = .057 x 65 Area x 3.705	Board/Battm .06 x 65 A x 3.9	Ceiling .052 x 65 A x 3.38	Glaze .58 x 65 SF x 37.7	Slab 45 Btuh 60 Btuh *	Infiltration 35 x .018 x 65 LF x 40.95	Σ
① Bedroom #3 Btuh	186.2 (690)	7 (28)	156.5 (529)	32.3 (1218)	25 (1125)	32 (1311)	4901
② Bedroom #4	90.1 (334)	7 (28)	156.5 (529)	21 (792)	13.1 (590)	32 (1311)	3584
③ Kitchen	87.1 (323)	63.2 (247)	238.4 (806)	29.8 (1124)	20 (900)	59.5 (2437)	5837
④ Dining Room	57.8 (215)	0 (0)	125.2 (424)	29.8 (1124)	10.5 (473)	39.5 (1618)	3854
⑤ Living Room	0 (0)	197 (769)	312 (1055)	91.1 (3435)	32 (1440)	102 (4177)	10876
⑥ Entry/Hall	0 (0)	69 (270)	116.5 (394)	0 (0)	7.67 (347)	20 (819)	1830
⑦ Bedroom #2	102.3 (380)	11 (43)	169.2 (572)	21 (792)	14.9 (671)	32 (1311)	3769
⑧ Bath #1	36.8 (137)	21.8 (86)	58.1 (197)	11.3 (427)	7.8 (351)	16.5 (676)	1874
⑨ Bath #2	0 (0)	0 (0)	69.8 (236)	0 (0)	0 (0)	0 (0)	236
⑩ Bedroom #1	221.8 (822)	13 (51)	212 (717)	32.3 (1218)	29.7 (1337)	32 (1311)	5456
⑪ Extra room *	0 (0)	375 (1463)	192 (649)	21 (792)	44 (2640)	32 (1311)	6855

Room	Btuh	loss due to door utilization	loss due to fireplace	% for substandard construction, lack of maintenance and misc. losses		# of registers (max am for 1 register 80)
① Bedroom #3	4901	0	0	5%	5147	1
② Bedroom #4	3584	0	0	5%	3763	1
③ Kitchen	5837	1124	2%	5%	7449	1
④ Dining room	3854	0	5%	5%	4240	1
⑤ Living room	10876	0	5%	5%	11963	2
⑥ Entry hall	1830	1124	2%	5%	3161	1
⑦ Bedroom #2	3769	0	0	5%	3957	1
⑧ Bath #1	1874	0	0	5%	1968	1
⑨ Bedroom #1 + Bath #2	5692	0	0	5%	5977	1
⑩ stor. room	6855	1124	0	5%	8378	2
	4907.2				Σ = 56003	

check $4907.2 \times 1.10 \times 1.10 = 5937.8$

front windows E = .8 x 42" = 33.6" avg stack line
 rear windows W = .8 x 42" = 33.6" " " "

right side N no overhang 25 Btuh/ft²

left side S no overhang 39 Btuh/ft²

front & rear windows:

Bedroom # 1 lower 9" in sun

Bath # 1 " " " "

Bedroom # 2 " " " "

Living room lower 4'-3" "

x tra rm lower 9"

Dining rm lower 24"

Kitchen lower 24"

Bedroom # 4 lower 9"

Bedroom # 3 lower 9"

infiltration / Btuh / gross exposed wall area

100	1.9
96	4
95	1.5

$$\frac{5}{.4} = \frac{1}{4-1.5}$$

$$.4 = 54 - 7.5$$

$$54 = 7.9$$

$$4 = 1.58$$

with mechanical ventilation

100°	27.0 Btuh/cfm
96°	4
95°	22.0

$$\frac{5}{5} = \frac{1}{4-2.2}$$

$$54 - 110 = 5$$

$$4 = 23$$

ROOM	LOCATION OF HEAT GAIN	DIMENSIONS	AREA OF L.F. CFM	TIME OF DAY	HEAT GAIN				
Kitchen	Brick Area		87.1 S.F.	1.288	113				
	B/B Area		63.2 S.F.	1.356	86				
	Ceiling		238.4	1.924	459				
	Glass	7x4.25	29.8 SF (W)	—					
	Infiltration	$\frac{20 \times 11.92 \times 9}{60}$	35.76 CFM	23	823				
		7x2 SUN (W)	14.0	74	1036				
		7x2.25 SHADE (N)	15.75	25	394				
					$\Sigma = 2911$				
Dining Room	Brick		57.8 SF	1.288	75				
	Ceiling		125.2 SF	1.924	241				
	Glass	7x2 SUN (W)			1036				
		7x2.25 SHADE (N)			394				
	Infiltration	$\frac{10.5 \times 11.92 \times 9}{60}$	18.8 CFM	23	433				
					$\Sigma = 2179$				
Living Room	B/B		197 SF	1.356	268				
	Ceiling		312 SF	1.924	601				
	Glass	13.5 x 6.75 (E)	—						
		13.5 x 4.25 (E)	57.4	74	424.8				
		13.5 x 2.50 (N)	33.8	25	845				
	Infiltration	$\frac{17.75 \times 11.58 \times 9}{60}$	46.8	23	1077				
					$\Sigma = 7039$				

	HEAT GAIN			OR. L.F. OR. CFM	U x ETD VALUE	Btuh HTM x Area (U x ETD) x Area	
Bedroom #3	Brick wall		186.2	186.2 ft ²	.057(22.6)	240	
	B/B wall		7.0	7.0 ft ²	.06(22.6)	10	
	ceiling			156.5 ft ²	.052(37)	302	
	window S	3' x 3'-9"	32.3	11.25 ft ² S	S=39.8 Btuh/FT ²		
	W	7' x 3'		21.00 ft ² W			
		.75 x 7 SUN		5.25 ft ²	74	389	
		2.25 x 7 SHADE		15.75 ft ²	25	394	
	infiltration						
	Vol = 11.916 x 13.125 x 9						
	= 1407.6 ft ³ /hr						
	= 23.5 CFM				23	541	
						<u>Σ = 1876</u>	
Bedroom #4	Brick wall		90.1	90.1	1.288	117	
	B/B wall		7.0	7.0	1.356	10	
	ceiling		156.5	156.5	1.924	302	
	window W	7' x 3'		5.25	74	389	
		.75 x 7 SUN		15.75	25	394	
		2.25 x 7 SHADE					
	infiltration						
	Vol = 11.92 x 13.125 x 9			23.5 CFM	23	541	
	60					<u>Σ = 1753</u>	

			LF CFM	U x ETD	
Entry/Hallway	B/O Ceiling Infiltration	$\frac{116.5 \times 9}{60}$	69 SF 116.5 SF 17.5 CFM	1.356 1.924 23.0	94 225 403 Σ = 1722
Bedroom #2	Brick B/O Ceiling Glass	7' x 3' 7.5 x 7 SUN(E) 2.25 x 7 (D)	102.3 11.0 169.2 5.25 15.75	1.288 1.356 1.924 74 25	132 15 326 389 394 Σ = 1841
	Infiltration	$\frac{169.2 \times 9}{60}$	25.4 CFM	23	585
Bath #1	Brick B/O Ceiling Glass	3.75 x 3 7.5 x 3.75 SUN 2.25 x 3.75 SHADE	36.8 21.8 58.1 2.8 8.4	1.288 1.356 1.924 74 25	48 30 112 208 210 Σ = 809
	Infiltration	$\frac{58.1 \times 9}{60} =$	8.7	23	201
Bath #2	Ceiling Infiltration	$\frac{69.8 \times 9}{60}$	69.8 10.47	1.924 23	135 241 Σ = 376

			CFM		
Bedroom #1	Brick		221.8	1.288	286
	B/B		13.0	1.356	18
	Ceiling		212	1.924	408
	glass				
	7x3 (E)	7.5x7 (E)	5.25	74	389
		2.25x7 (N)	15.75	25	394
	3.75x3 (S)	3.75x3 (S)	11.25	39	439
	Infiltration	$\frac{212 \times 7}{60}$	31.8	23	73.2
				$\Sigma = 2666$	
Ctira Room	B/B		375	1.356	509
	ceiling		192	1.924	370
	glass 7x3 (W)	7.5x7 (W)	5.25	74	389
		2.25x7 (N)	15.75	25	394
	Infiltration	$\frac{192 \times 7}{60}$	28.8	23	66.3
				$\Sigma = 2325$	

Room	Heat Gain	Appliances	Occupants 1 = 225 Btu/h	5% misc losses		Final Heat Gain (Sensible)	Total Heat Gain Sensible
Bedroom #3	1876	-	-	94		1970	2561
Bedroom #4	1753	-	-	88		1841	2394
Kitchen	2911	1200	2 = 450	229		4790	6225
Dining Rm.	2179	-	450	132		2761	3596
Living Rm.	7039	-	4 = 900	397		8336	10833
Entry	722	-	-	37		759	987
Bedroom #2	1841	-	-	93		1934	2515
Bath #1	809	-	-	41		850	1105
Bath #2	376	-	-	19		395	514
Bedroom #1	2666	-	-	134		2800	3646
Extra room	2325	-	-	117		2442	3175
	24497	1200	1800	1381		28878	3751
			$\frac{37547}{12000} =$	3.13 Tons	use	$3\frac{1}{2}$ ton unit	= 42,000

Ceiling under naturally vented attic - light

100°	41
96°	4
95°	36

$$\frac{5}{5} = \frac{1}{4-36}$$

$$54 - 180 = 5$$

$$54 = 185$$

$$4 = 37$$

Front of #89 runs S-N

shade line factors

E 0.8

S 3.6 - 35°
2.6 - 40°

W 0.8

3.6	35°
4	36°-5'
2.6	40°

overhang = 3'-6"

$$\frac{3.6-2.6}{35^\circ-40^\circ} = \frac{4-2.6}{(36^\circ-5')-40^\circ}$$

$$\begin{array}{r} 39 \\ 40-60 \\ \hline 36 \\ 36-55' \end{array}$$

$$\frac{1.0}{-5^\circ} = \frac{4-2.6}{-3^\circ-55'}$$

$$\frac{1.0}{-300} = \frac{4-2.6}{-235}$$

$$-235 = -3004 + 780$$

$$3004 = 780 + 235$$

$$4 = 3.4$$

No awnings or inside shading Regular glass

N = 25 Btu/h/ft²

E & W = 74

S = 39

heat gain due to transmission
infiltration
solar radiation
heat produced in the space
latent heat

225 Btu/h/occupant (assume 2 occupants x # of bedrooms) Occupants
this heat is distributed in the living areas

appliances = 1200 Btu/h

latent heat = 30% of the sensible heat

STAT

wind	Dry bulb	range	Wet bulb	
M	94°	18°	79°	Lat = 36°-5'
L	96°	20°	80°	Lat = 37°-1'
L	96°	21°	79°	Lat = 37°-3'

use: L 96° 21° 79° 37°-3'
↑
Medium range

Equivalent Temperature Differences

Walls - window on frame

100°	28.6
96°	4
95°	23.6

$$\frac{100-95}{28.6-23.6} = \frac{96-95}{4-23.6}$$

$$\frac{5}{5} = \frac{1}{4-23.6}$$

$$54-118 = 5$$

$$57 = 113$$