DOE/ET/27256--T31

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# GEOTHERMAL GREENHOUSE-HEATING FACILITIES FOR THE KLAMATH COUNTY NURSING HOME,

Klamath Falls, Oregon

February 1982

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# GEOTHERMAL GREENHOUSE-HEATING FACILITIES
# FOR THE KLAMATH COUNTY NURSING HOME
## Klamath Falls, Oregon

The following is the result of a request for Technical Assistance.

## INTRODUCTION

The Klamath County Nursing Home, located in Klamath Falls, Oregon, was constructed in 1976. The building of 55,654 square feet currently houses care facilities for approximately 120 persons. During the initial planning for the Nursing Home, the present site was selected primarily on the basis of its geothermal resource. This resource (∿190°F) currently provides space and domestic hot water heating for the Nursing Home, Merle West Medical Center and the Oregon Institute of Technology.

This report explores the feasibility of installing a geothermal heating system in a planned greenhouse for the Nursing Home. The greenhouse system would be tied directly to the existing hot water heating system for the Nursing Home.

## SUMMARY OF CONCLUSIONS

Based on the assumptions as to size and location contained in this report, it appears that a greenhouse heating system could be tied into the existing Nursing Home heating system with minimal impact. An increase in total heating water flow requirements of 4.5% would result. The cost of attaching the greenhouse heating system to the existing building would amount to approximately $8,200. This figure assumes that all items relating to greenhouse heat distribution except the finned coil heat exchanger would be supplied as part of the greenhouse package.

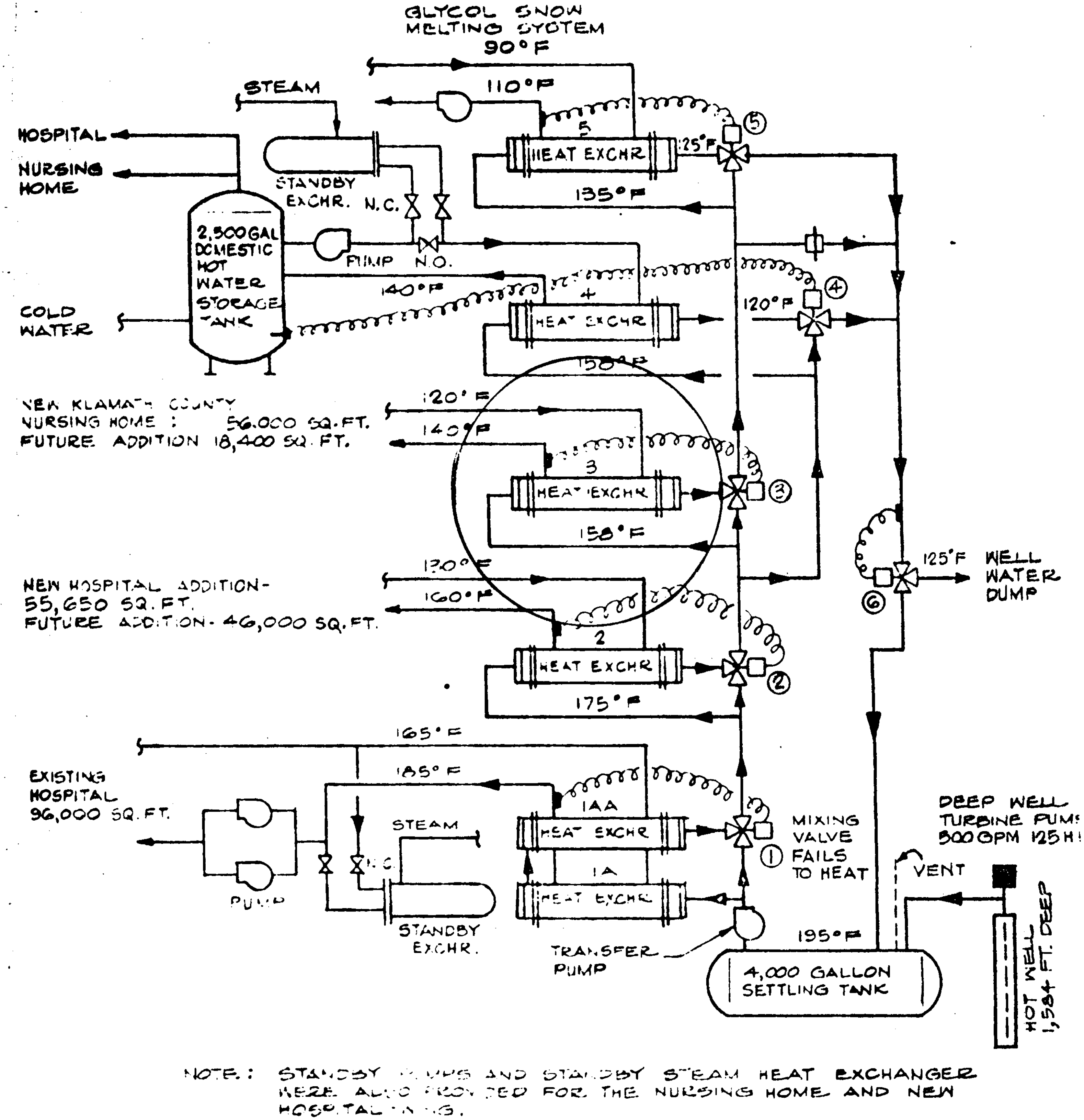
## AVAILABILITY OF GEOTHERMAL

As mentioned earlier, the Nursing Home is currently heated with geothermal. As a result, ready access to the resource is provided. Figure 1 shows the layout of the primary geothermal system. The equipment is located in the mechanical room of the Merle West Medical Center. Piping from the hospital's heat exchanger (circled) is routed, through a buried tunnel, to the Nursing Home mechanical room. Design supply water temperature for the Nursing Home system is approximately 140°F. This water temperature was used for determining the characteristics of the greenhouse terminal equipment.

## EXISTING MECHANICAL SYSTEM

The Nursing Homes' mechanical system is tied to that of the Merle West Medical Center (MWMC), indicated by Figure 1. A heat exchanger in the MWMC generates 140°F hot water which is supplied to the Nursing Home. The system was designed for a 20 $\Delta t$ and as a result 120°F return water flows back to the heat exchanger at the hospital. The main circulating pump is located at the hospital.

The basic system at the Nursing Home is composed of central air handlers delivering air to terminal reheat coils. Based on the original construction plans supplied by Nursing Home personnel, the design flow rate for the system is 244 gpm. This water is supplied to the various reheat coils through insulated piping installed in the space between




NOTE: STANDBY PUMPS AND STANDBY STEAM HEAT EXCHANGER WERE ALSO PROVIDED FOR THE NURSING HOME AND NEW HOSPITAL WING.

# GEOTHERMAL HEATING

PRESBYTERIAN INTERCOMMUNITY HOSPITAL

BALZHISER & COLVIN ENGINEERING
EUGENE, OREGON
DATE: 1976

the interior ceiling and the roof.

## PROPOSED GREENHOUSE HEATING SYSTEM

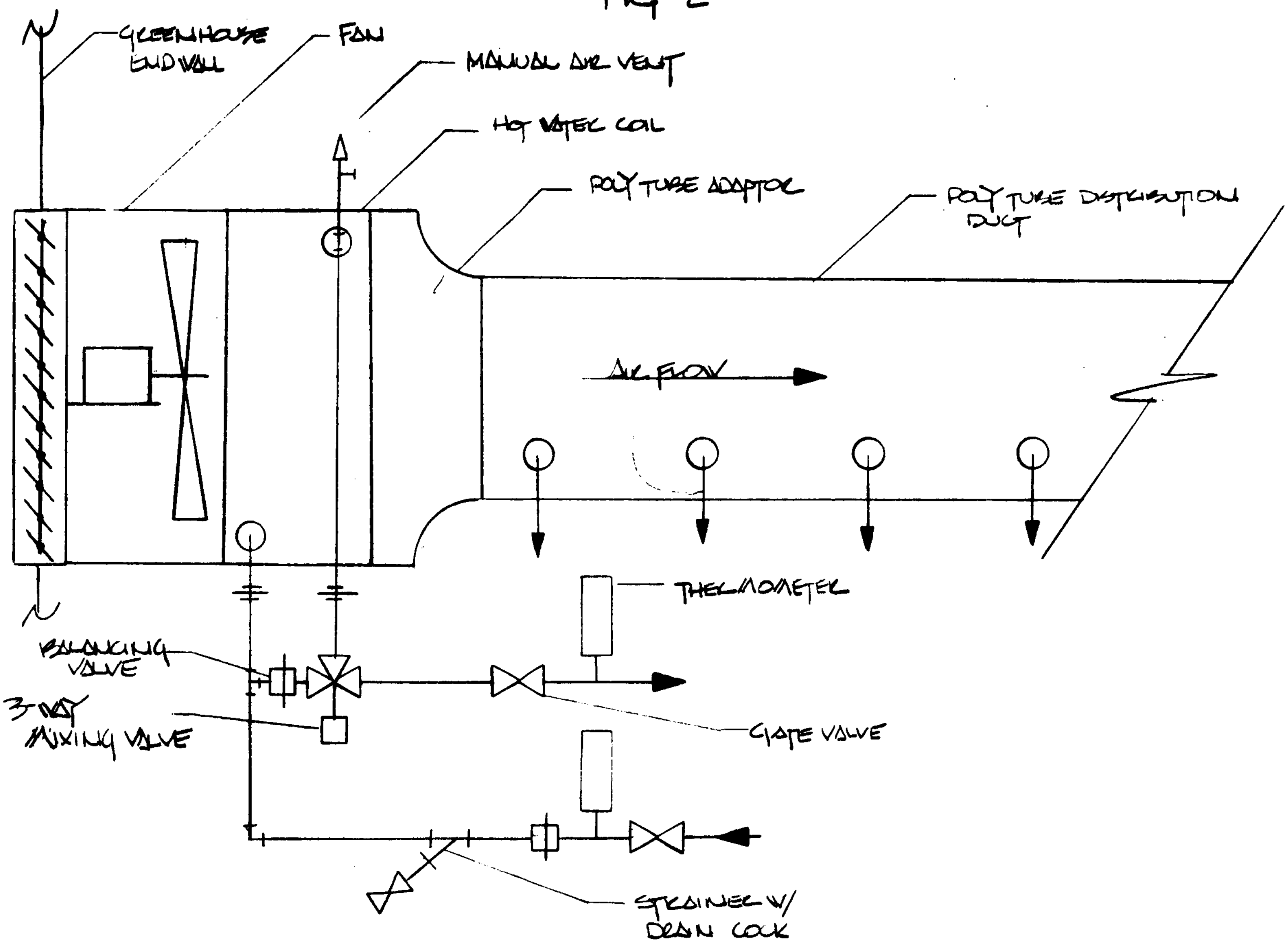
For purposes of this study, a 30' X 96' double poly type greenhouse was considered for heat loss purposes. This type of structure is characterized by much lower heating requirements per square foot of area than single glazed greenhouses. In addition, heat losses for the double layer structure are much less influenced by wind velocity than that for single glazing. The location considered is characterized by 10+ mph winds a large portion of the time. Peak heat loss for this structure was calculated to be 228,700 Btu/hr. A plot of heat loss per square foot for various types of greenhouse structures is included in the appendix. Details of the calculation are also to be found in the appendix.

A "fan jet" finned hot water coil, poly tube type heating system was chosen for the greenhouse. This type of heating system was chosen for several reasons. In view of the relatively low temperatures involved, an excessive amount of surface area would be required for a radiant type system. In addition, since a number of the people working in the greenhouse will be confined to wheel chairs the overhead system will minimize the amount of interference to their mobility. Finally, this type of system provides for a lower first cost.

Based on the available temperature of 140°F and a 40 $\Delta t$, a three row 9 square foot coil is required. This size coil corresponds well to the available greenhouse heating equipment (poly tube, mixing dampers, etc). Figure 2 shows a detail of the heating coil installation. De-

NATIONAL 42-381 50 SHEETS 5 SQUARE
42-382 100 SHEETS 5 SQUARE
42-389 200 SHEETS 5 SQUARE

COUNTY NURSING HOME - GREENHOUSE
FORCED AIR COIL DETAIL
FIG 2

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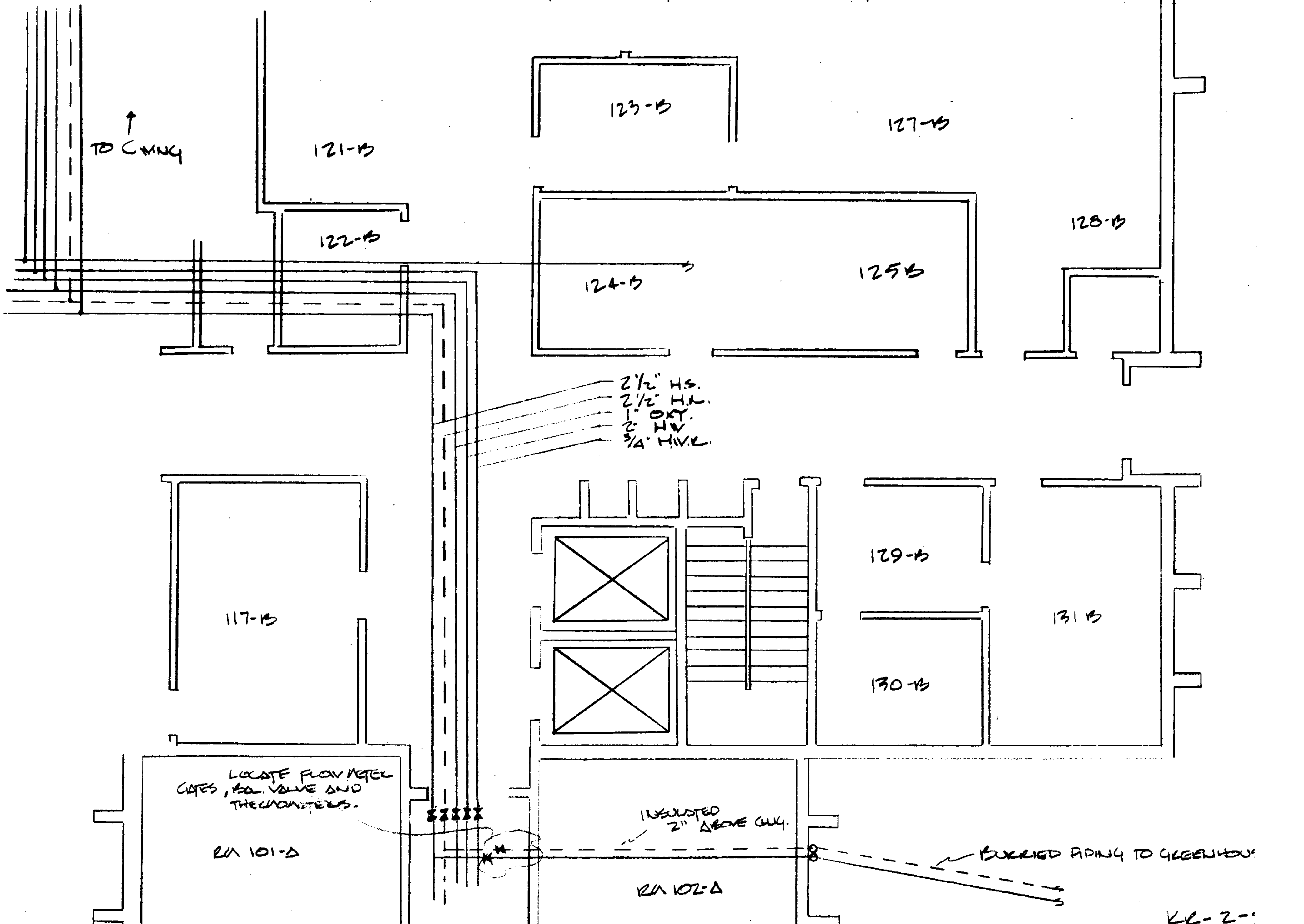
tails of the coil configuration are shown in the appendix.

As mentioned earlier, hot water for the greenhouse would be supplied for the existing building heating system. Several points were considered as options for piping tie ins. However, the final choice was made, based on access to existing piping, room for new pipe routing, and minimum impact on the existing system. Figure 3 shows the tie in points and associated piping. This point, in Building section C, is close to the main distribution point of the hot water system. In addition, the mechanical space is relatively free of ductwork and other obstructions.

From the tie in point, the piping would proceed to the edge of the building (insulated) and down the outside wall (see Figure 3). From the edge of the building, the piping (2") would proceed, buried, to the greenhouse. The 2 inch line sizes were assumed in view of the plans for future expansion of the greenhouse area. At the terminal point (at the new greenhouse), a concrete valve box would be provided with supply and return lines capped off for future expansion. One inch line would then enter the greenhouse. If the supply and return lines are buried in a three foot trench, it is possible to use uninsulated steel piping. Under worst conditions (wet heavy soil, 140° water temp, 10° air temp), heat loss from the piping would amount to only about 3°F based on 200 feet (length). This temperature loss should not effect the performance of the heating system to any great extent.

The design flow rate for the greenhouse, 11.5 gpm, should not pose a great balancing problem when brought on line. The increase in flow

FIGURE 3 GREENHOUSE PIPING TIE-IN.



compared to existing design amounts to only 4.5%. A flow meter would be provided at the tie in to the existing system to insure accurate flow balancing.

## GREENHOUSE LOCATION

The greenhouse location, for this report, was assumed to be approximately 40 feet from the north entrance at Building section C (see Figure 4). The 40 foot figure results from the building orientation and local solar characteristics. In order to assume full solar exposure from 10 am to 3 pm, on the north side of the building, a 40 foot shadow buffer was required.

The north side of the building was chosen to insure access to the greenhouse for residents confined to wheelchairs.

## CAPITAL COSTS

Table 1 outlines the capital costs necessary for the heating system proposed. Also included are budget type estimates of the major items necessary for the construction of the 30' X 96' double poly type greenhouse. The estimated figures are from IBG International for a Minute Man II type structure.

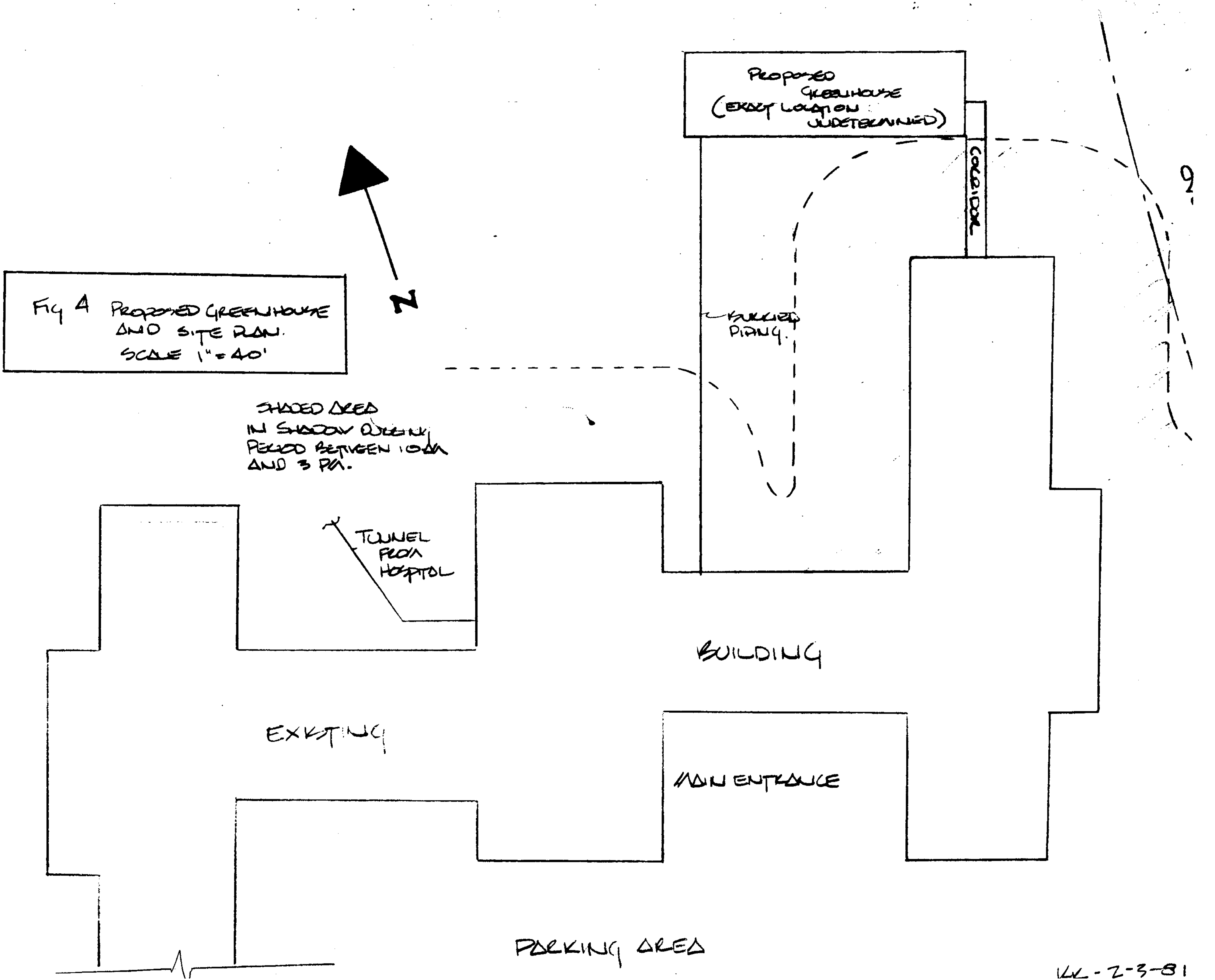



Fig 4 Proposed Greenhouse and site plan. Scale 1" = 40'

TABLE 1

Capital Costs:

| | | |
|---|---|---|
| **Greenhouse** - | | |
| Steel super structure | | 2,720 |
| Roof covering | | 2,160 |
| Ends (fiberglass and frame) | | 1,394 |
| Sides (figerglass and frame) | | 1,224 |
| Celdek Cooling System | | 1,056 |
| Exhaust fans (2) | | 1,340 |
| Circulating pump (for cooling system) | | 380 |
| Fan for heating | | 350 |
| Freight | | 800 |
| Labor (IBG Portland crew) | | 4,300 |
| Concrete | | 100 |
| | TOTAL | 15,824 |

| | | |
|---|---|---|
| **Heating System** - | | |
| Piping tie in (to outside wall) | | 1,820 |
| Buried piping (to greenhouse) | | 2,700 |
| Finned Coil | | 1,100 |
| Piping in greenhouse | | 1,500 |
| | Subtotal | 7,120 |
| | 15% engineering & contingency | 1,070 |
| | TOTAL | 8,190 |

# APPENDIX

SHADOW FROM BUILDING:

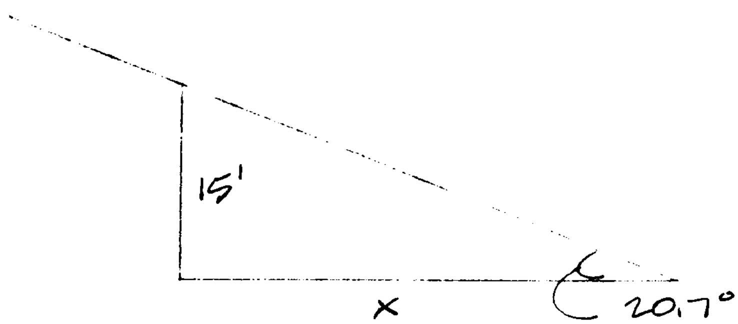
BUILDING FACES 18° WEST OF SOUTH
DEC 21 10 AM / 3 PM
FOR 42° N. LAT.

$\sin\beta = \cos L \cos\delta \cos H + \sin L \sin\delta$
$\sin\phi = \cos\delta \sin H / \cos\beta$

L - LOCAL LATITUDE - 42° 12' (SAY 42°)
δ - SOLAR DECLINATION
H - HOUR ANGLE

USE TABLE DATA FOR 40° N.
$\beta = 20.7°$
$\phi = 29.4°$

BUILDING HEIGHT

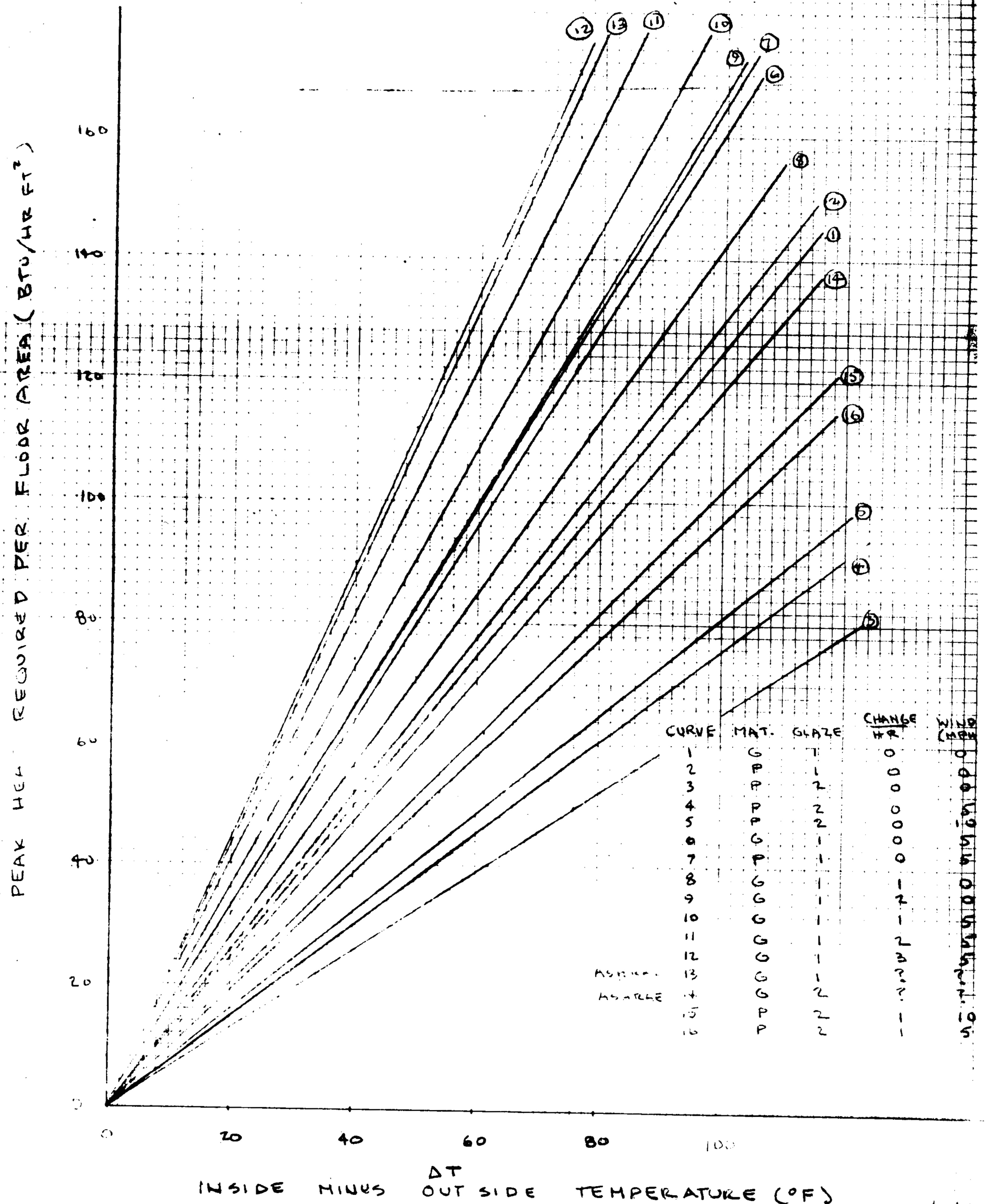



$\tan 20.7° = 15/x$
$\tan 20.7° = .3779$

$15 \div .3779 = 39.69'$ (SAY 40')

GREENHOUSE MUST BE A MINIMUM OF 40' FROM NORTH SIDE OF BUILDING.

# WALL/FLOOR OF 1.5/1




| | CURVE | MAT. | GLAZE | CHANGE/HR | WIND (MPH) |
|---|---|---|---|---|---|
| | 1 | G | 1 | 0 | 0 |
| | 2 | P | 1 | 0 | 0 |
| | 3 | P | 2 | 0 | 0 |
| | 4 | P | 2 | 0 | 5 |
| | 5 | P | 2 | 0 | 10 |
| | 6 | G | 1 | 0 | 5 |
| | 7 | P | 1 | 0 | 5 |
| | 8 | G | 1 | 1 | 0 |
| | 9 | G | 1 | 2 | 0 |
| | 10 | G | 1 | 1 | 5 |
| | 11 | G | 1 | 2 | 5 |
| | 12 | G | 1 | 3 | 5 |
| ASHRAE | 13 | G | 1 | ? | ? |
| ASHRAE | 14 | G | 2 | ? | ? |
| | 15 | P | 2 | 1 | 10 |
| | 16 | P | 2 | 1 | 5 |

PK 3/20/81

COUNTY NURSING HOME

ASSUMPTIONS

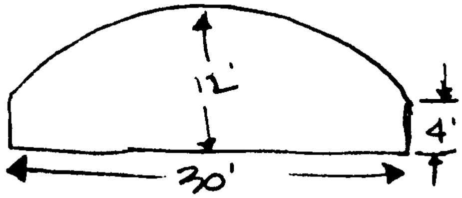
30 × 96 DOUBLE POLY GREENHOUSE

65° INSIDE

0° OUTSIDE

0 AIR CHANGE / HR

MINUTEMAN TYPE STRUCTURE




HEAT LOSS:

SURFACE AREA =

$(2\pi \cdot 15) \div 2$ = ARC LENGTH = 47.1'

| | | | FT² |
|---|---|---|---|
| | ROOF AREA = 47.1 · 96 | = | 4523 |
| | SIDES AREA = 4 · 96 · 2 | = | 768 |
| $\pi(15)^2 + 4 \cdot 30 \cdot 2$ = | END AREA = | = | 946 |
| | | TOTAL AREA | 6237 |

FLOOR AREA = 30 · 96 = 2880 FT²

SURFACE AREA : FLOOR AREA RATIO :

6237 ÷ 2880 = 2.166

GREENHOUSE HEAT LOSS CURVES BASED ON 1.5 : 1

2.166 ÷ 1.5 = 1.444

FROM CURVES FOR DOUBLE POLY 0 AIR CH/HR

10 MPH WIND VELOCITY

55 BTU / HR · FT² (FLOOR AREA)

55 · 1.444 = 79.4 BTU/HR · FT²

HEAT LOSS = 79.4 · 2880 = **228721 BTU/HR**

REQUIRED FLOW @ 40° Δt

228721 ÷ 498 ÷ 40 = 11.48 — 11.5 gpm

COIL CONFIGURATION:

| | | |
|---|---|---|
| EA | - | 65 |
| LA | - | 108 |
| EW | - | 140 |
| LW | - | 100 |
| CFM | - | 5270 |
| FA | - | 37.5 x 36 (9.375) |
| FEED | - | 3 |
| CODE | - | 1 |
| EL | - | 4500 |
| ROW | - | 3 |
| FPI | - | 1057 (11) |
| AIR ΔP | - | .37 |
| PASSES | - | 24 |
| WTR ΔP | - | 15.87' |

WILL REQUIRE 1/2 HP MOTOR RATHER THAN STANDARD 1/3 HP

PIPING HEAT LOSS
FOR 2" LINES UNINSUL (ALLOWS FOR EXPANSION)

| | | | | | | |
|---|---|---|---|---|---|---|
| 01 | ID | - | 2.067 | | | |
| 02 | OD | - | 2.375 | | | |
| 03 | ID JKT | - | 2.375 | | | |
| 04 | OD JKT | - | 2.375 | | | |
| 05 | DEEP | | 5' | | | |
| 06 | k PIPE | - | 300 | | | |
| 07 | k INSUL | - | 9 | 6 | | 2.4 |
| 08 | h GRND. | - | 9 | | 5 | 9 |
| 13 | k JKT | - | 9 | 6 | | 2.4 |
| 10 | k SOIL | - | 9 | 6 | | 2.4 |
| 11 | tw | | 140 | | | |
| 12 | ta | | 10 | | | |
| | LOSS/FT | | 82.3 (HVY SOIL) | 56.9 (LT SOIL DAMP) | 75.4 (SHALLOW) | 23.9 (LT SOIL DRY) |

FOR PIPING OUT END OF BUILDING

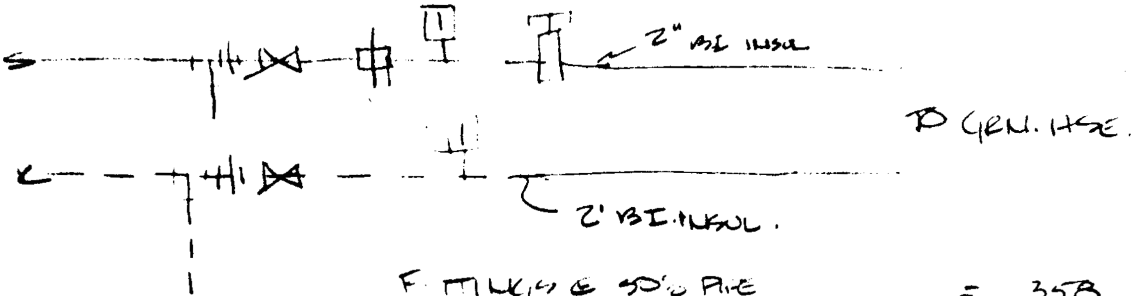
150' @ 82.3 = 12345 BTU/HR
12345 ÷ 500 · 11.5 = 2.15 °F LOSS

FOR PIPING OUT SIDE OF BUILDING

200' · 82.3 = 16460 BTU/HR
16460 ÷ 500 · 11.5 = 2.86 °F LOSS

ACTUAL LOSS WILL PROBABLY BE LESS DUE TO BOTH RETURN AND SUPPLY IN SAME TRENCH. ALSO HEAT LOSS CALCULATED FOR HVY. DAMP SOIL, ROUGH GRND SURF AND 15 MPH WIND

PIPING REQUIREMENTS:




| | | | | |
|---|---|---|---|---|
| | FITTINGS @ 50% PIPE | | = | 358 |
| 2-2" | UNION (INSULATING) | @ 33 | | 66 |
| 2-2" | GATE VLV | @ 64 | = | 128 |
| 1-2" | CIRC. SETTER | @ 120 | = | 120 |
| 1-2" | FLOW STATION | @ 135 | = | 135 |
| 2 - | THERMOMETERS | @ 20 | = | 40 |
| 2" 80 | PIPING ON HANGERS | @ 8.95 | = | 716 |
| 80 | INSULATION 2" | @ 2.58 | = | 206 |
| | TRN. WALL | | | 50 |
| | | | | 1819 |

150' BURRIED (3') 2" BI SUPPLY AND RT. WRAPPED

| | | | |
|---|---|---|---|
| MATERIAL | @ 3.89 l/F | = | 1167 |
| WRAP | @ 1.0 l/F | | 150 |
| TRENCH + BKFL | @ 5.00 l/F | = | 750 |
| INST | @ 2.0 l/F | = | 600 |
| | | | 2667 |

UNIT HEATER HOOK-UP

| | | | |
|---|---|---|---|
| | FINNED COIL 9 FT² 3 ROW | - | 1080 |
| | INSTALLATION | - | 150 |
| 1¼ | GATE 2 @ 39 | - | 78 |
| | THERM. 2 @ 20 | - | 40 |
| 1¼ | CIRC SETTER @ | - | 85 |
| 1¼ | FLOWMETER @ | - | 135 |
| 1¼ | STRAINER AND DRAIN COCK @ | - | 65 |
| 1¼ | UNION @ | - | |
| ½ | AIR VENT-MANUAL @ 20 | - | 20 |
| | CONTROL (T-STAT) @ | - | 60 |
| 1¼ | 3 WAY MIX VALVE. @ | - | 320 |
| 50' | 1¼ BI @ 6.15 | - | 308 |
| 50 | 1¼ INSUL @ 2.36 | - | 118 |
| | FITTINGS @ 50% PIPING | | 152 |
| | | | 2611 |