I=B=R
INSTALLATION GUIDE
Number 6

Panel Heating for Small Structures

Forced circulation
hot water heating system

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Reg. U. S. Pat. Off.

THE INSTITUTE OF BOILER AND RADIATOR MANUFACTURERS
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SCOPE

THIS I=B=R Installation Guide No. 6 is intended for use in designing floor and ceiling panel heating systems for small residences. The data contained herein are based on conservative averages of information found in literature published by many industry groups and individual manufacturers.

The heating industry recognizes the need for continuing research in order to obtain more exact information on problems involved in panel heating. Such investigations are being carried out by The Institute of Boiler and Radiator Manufacturers as well as the American Society of Heating and Ventilating Engineers.

In the meantime the procedures outlined in this Guide will be found to be simple and practical for small residential buildings. For purposes of simplicity, this Guide is limited to one size and spacing of pipe or tube and one water temperature for floor and ceiling panel systems respectively.

HEAT LOSS CALCULATIONS

Accurate calculation of heat loss is the first essential step in determining the size of the heating plant. Modern residential construction tends to reduce heat losses. Thus, rule-of-thumb methods usually lead to overloading, with consequent costs of installation and operation which are unnecessarily high. The I=B=R Installation Guides have simplified the Btu per hour (Btu/Hr.) method of calculation and provide accuracy which is not inherent in more casual methods of determining heat losses.

The method for calculating heat losses in this and all other I=B=R Installation Guides is based on the factors found in the ASHVE Guide. By using Tables 1, 2 and 3, (pgs. 6-10), considerable time will be saved in the calculation of heat losses. The factors in I=B=R Installation Guides are based on a wind velocity of fifteen miles per hour, which is considered ample over the entire range of outdoor temperatures because, very rarely, is there excessive wind at the minimum temperatures for which systems are designed. No added allowance for infiltration for rooms facing the prevailing winds is considered necessary except for large structures, which are outside the scope of this Guide. For these larger structures, the method of determining heat losses found in the ASHVE Guide or the Engineering Standards of the Heating, Piping and Air Conditioning Contractors National Association may be used.

Btu EXPLAINED

British Thermal Unit (Btu) is used throughout this Guide because a Btu is a definite quantity of heat. A Btu is the quantity of heat required to raise one pound of water one degree Fahrenheit.

BOILER RATINGS

Cast iron boilers which have I=B=R Ratings may be depended upon to provide their full catalog ratings, expressed both as Gross I=B=R Output and Net I=B=R Rating. Net I=B=R Ratings contain ample allowance for piping and pickup as well as for domestic hot water load, except where unusual quantities of hot water are required. (See Step 3.)

CALCULATION SHEETS

Calculation sheets, I=B=R Form 6001 for panel heating systems, (see pg. 14), may be purchased from the Institute.

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FOR BOTH FLOOR AND CEILING PANEL SYSTEMS

1. Boilers should be automatically-fired. The control of water temperature in hand-fired installations is not close enough for panel heating.

2. Slab floors, whether or not they are used as a heating panel, must be provided with at least 1" waterproof edge insulation at least 24" deep or to the bottom of the frost line. The use of a waterproof membrane (vapor barrier) between the gravel fill and the slab is recommended. (See Figure D, pg. 16.)

3. All pits should be provided with drains.

4. Where panels do not cover the entire area of the ***floor or ceiling,*** the coil should be located near the exposed perimeter of the room.

5. All pipe ends should be reamed.

6. Connections between pump and boiler should be as close as possible.

7. Wherever the size of pipe changes in a horizontal run, use an eccentric reducer, keeping the top side level.

8. Drains should be installed at all low points.

9. All high points should be vented. Vents should also be installed where the plane of the system changes.

10. Balancing cocks or valves should be used on each coil. They should be installed below traffic plates for ***floor*** panels, and with extended stems, if necessary, for ***ceiling*** panels.

11. A mixing or tempering valve should be used to control the temperature of the water to the heating system if the boiler is used also to supply domestic hot water. This valve should be connected in accordance with the valve manufacturer's recommendations.

12. A flow control valve should be used when the heating panels are above the boiler and the boiler is used also to supply domestic hot water.

13. A pressure relief valve should be installed on the boiler.

14. The air cushion tank should be located above the boiler. (See Step 7, pg. 5.)

15. Coils should be filled with water very slowly in order to vent them properly.

16. The entire piping system should be tested to a hydrostatic pressure of 100 p.s.i. for a minimum of four hours before being connected to the boiler and before being concealed.

17. Because of variable conditions, controls should be selected and installed in accordance with control manufacturers' recommendations.

FOR FLOOR PANEL SYSTEMS:

18. Coils should not be laid on nor come in contact with cinders or other corrosive fill.

19. Coils should start 6" from the exposed perimeter of a floor slab.

FOR CEILING PANEL SYSTEMS:

20. All ceiling panels should be backed by insulation whether or not there is heated space above. When panels are exposed to unheated space, at least 3⅝" rock wool insulation or equivalent is recommended.

21. For ceiling panels it is advisable to design the coils so that the tube runs at right angles to the joists, which will give better support.

22. Coils should start 3" from the exposed perimeter of a ceiling.

23. Coils in ceiling panels should not be used to dry the plaster. The first time heat is applied in a new installation, the temperature of the coils should be raised only a few degrees each day.

CALCULATION AND DESIGN

Based on the common practice of a temperature drop through the system of 20 F

This Guide is limited to the use of serpentine coils directly connected to the main. The coils are designed as follows:

Floor Panels: ¾" tube or pipe on 12" centers with 120 F water.

Ceiling Panels: Nominal ⅜" tube on 6" centers with 140 F water

Note: No attempt has been made in this Guide to evaluate the effect on heat output of ***floor*** panels from the use of various types of floor covering. Frequently the builder does not know what the intention of the ultimate home owner is with respect to the type of floor covering. When floor coverings with great insulating effect are installed, it may be possible to obtain the required panel output by increasing the boiler water temperature.

PROCEDURE

STEP 1.	Determine the heat loss	(Tables 1, 2 and 3, pgs. 6-10)
STEP 2.	Determine the panel area required	
STEP 3.	Select the boiler	
STEP 4.	Determine the number of coils in each panel	
STEP 5.	Select the pump size	(Tables 4A and 4B, pg. 11)
STEP 6.	Determine the main size	(Tables 5A, 5B, 5C or 5D, pgs. 12 and 13)
STEP 7.	Select the air cushion tank.	

The examples which follow each of the steps refer to a one-story, basementless house shown in Figure A, (pg. 15). The heat loss is based on:

Exposed Walls: 4" brick, paper, sheathing, studs, lath and plaster
Windows: single, with storm sash
Ceiling: lath and plaster, no floor above, with 3⅝" rock wool
Floor: concrete on fill
Temperature Difference: 70 F indoors, —5 F outdoors = 75 F

All data concerning the calculation of the heating system appear in the calculation sheet on page 14. Piping plan for a ***floor*** panel is shown in Figure E, (pg. 17). Piping plan for a ***ceiling*** panel is shown in Figure I, (pg. 19).

STEP 1: Determine the heat loss ***from each room*** to be heated, in terms of Btu/Hr., as follows:

(a) Determine the areas, length and volume.

Gross Wall area: only walls exposed to the outdoors or unheated space, including exposed walls of closets opening into the room.

Window area: based on the outside measurements of the sash.

Door area: based on the actual size of the door.

Net Wall area: gross wall area minus the area of the windows and doors.

Ceiling area: ceiling exposed to unheated space, including the ceilings of closets opening into the room.

Floor area: wood floor exposed to unheated space and concrete floors on ground ***below grade,*** including the floors of closets opening into the room. No heat loss is calculated for floors over a basement.

Floor, ft. of edge: concrete floor on ground or fill at ***grade level.*** Linear feet of edge of floor exposed to the outdoors, including the exposed edge of the floor of closets opening into the room.

Infiltration: based on the volume of the room, including the volume of closets opening into the room.

(b) From Table 1, (pgs. 6 and 7), determine the factors for walls, ceilings, floors, windows and infiltration for the appropriate construction.

(c) From Table 2, (pgs. 8 and 9), determine the heat loss in Btu/Hr. for each item.

(d) Total the Btu/Hr. heat loss for all items to determine the total Btu/Hr. heat loss for the room at 70 F temperature difference.

(e) From Table 3, (pg. 10), convert item (d) above to Btu/Hr. heat loss at the required temperature difference.

Note: It is common practice to increase the ***corrected*** Btu/Hr. heat loss of a bathroom by 20% to provide extra radiation.

Example: Bedroom No. 1. 15′ x 12′ x 8′, having one long and one short wall exposed, four 2′8″ x 4′2″ windows with storm sash. Cold attic above. 3⅝″ rock wool in ceiling. Closet 2′ x 7′.

CALCULATION OF QUANTITIES		FROM TABLE 1 (pgs. 6 and 7)		FROM TABLE 2 (pgs. 8 and 9)
		Item	Factor	Btu/Hr. Required
Gross Wall	(15′ + 12′ + 2′) x 8 = 232 sq. ft.			
Window	(2′8″ x 4′2″) x 4 = 44 sq. ft.	19b (pg. 7)	0.45	1,400
Net Wall	232 — 44 = 188 sq. ft.	3g (pg. 6)	0.27	3,600
*Ceiling	15′ x (12′ + 2′) = 210 sq. ft.	13f (pg. 7)	0.08	1,200
Floor	15′ + 12′ + 2′ = 29 ft.	18a (pg. 7)	0.69	1,400
*Infiltration (Room Volume)	8′ x 15′ x (12′ + 2′) = 1680 cu. ft.	22b (pg. 7)	0.017	2,000
			Total for 70 F Indoor — Outdoor Temperature Difference	9,600

For a 75 F Temperature Difference, refer to Table 3, (pg. 10). In the column headed 70 F move down to 9600; then horizontally to column headed 75 F and read the heat loss as 10,290 Btu/Hr.

*In this case it is sufficiently accurate to assume closet extends full length of room.

STEP 2: Determine the panel area required for each room. Divide the room heat loss by the heat emission in Btu/Hr. per square foot of panel.

Floor Panel: An uncovered concrete slab floor panel having ¾″ pipe or tube on 12″ centers with a mean water temperature of 120 F will deliver 50 Btu/Hr. per square foot of panel.

Ceiling Panel: A ceiling panel with nominal ⅜″ tube on 6″ centers with water at 140 F will deliver 60 Btu/Hr. per square foot of panel.

If the required panel area for any room as determined by this Step is greater than the panel area available, the panel output may be supplemented by the use of some other form of radiation, or the heat loss of the room may be reduced by using storm sash or increasing the amount of insulation.

Example (*a*): The living room shown in Figure A, (pg. 15), has a heat loss of 15,320 Btu/Hr. The available panel area (length x width of room) is 364 sq. ft. (See calculation sheet, pg. 14). For a ***floor*** panel, 306 sq. ft. are required (15,320 ÷ 50). For a ***ceiling*** panel, 255 sq. ft. are required (15,320 ÷ 60).

Example (*b*): Bedroom No. 2 shown in Figure A (pg. 15) has a heat loss of 6,750 Btu/Hr., with an available panel area (length x width of room) of 110 sq. ft. (See wavy line on calculation sheet, pg. 14). For a ***floor*** panel, 135 sq. ft. would be required (6750 ÷ 50), which is in excess of the available panel area of 110 sq. ft. Therefore, 3⅝″ rock wool insulation has been added to the exposed walls of this room, reducing the heat loss from 6,750 Btu/Hr. to 5,040 Btu/Hr. This reduces the required ***floor*** panel area to 101 sq. ft. (5040 ÷ 50).

STEP 3: Determine the boiler size. Total the corrected Btu/Hr. heat loss of each room to find the total heat loss of the building. From manufacturer's catalog, select a boiler having a Net I=B=R Rating for water in Btu/Hr. equal to or greater than the total heat loss of the building.

Allowance for domestic hot water need only be made in the selection of a boiler if there are more than two bathrooms to be served, or if the use of domestic hot water exceeds 75 gallons in twenty-four hours, in which case the following allowances should be made:

Storage Type Heater: 120 Btu/Hr. for each gallon of storage tank capacity.

Tankless Heater: 12,000 Btu/Hr. for each bathroom in excess of two.

Example: The house used as an example in this Guide has one bathroom and a heat loss of 58,750 Btu/Hr. (See calculation sheet, pg. 14). A boiler with a Net I=B=R Water Rating equal to or in excess of 58,750 Btu/Hr. should be used.

STEP 4: Determine the number of coils for each panel.

Floor Panel: Divide the Btu/Hr. heat loss of the room by 10,000. No coil should be longer than approximately 200 linear feet.

Ceiling Panel: Divide the Btu/Hr. heat loss of the room by 3000. No coil should be longer than approximately 100 linear feet.

Note: If the number of coils so determined ends in a fraction less than half, drop the fraction; if one-half or over, add an additional coil.

Example: The living room shown in Figure A (pg. 15) has a heat loss of 15,320 Btu/Hr. For a ***floor panel***, two coils are required. For a ***ceiling panel***, five coils are required.

STEP 5. Select the pump size and determine pressure head. From manufacturer's catalog, select a pump which is capable of delivering one gallon per minute for each 10,000 Btu/Hr. total heat loss of the house. Tables 4A and 4B (pg. 11) represent conservative averages and may be used until the manufacturer's data can be consulted.

Example: 58,750 Btu/Hr. total load on system. Table 4A indicates that either a 1¼″ standard pump or a 1″ high head pump may be used. Table 4B for a total load of 50,000 Btu/Hr. (closest to 58,750) shows 6.00 feet of water for a 1¼″ standard pump. (Head for a 1″ high head pump is 8.25 ft. of water.)

STEP 6: Determine from Table 5A, 5B, 5C or 5D, (pgs. 12 or 13), the size of the trunk and circuits forming the main. The "trunk" is the section of the main in a multiple circuit system carrying the combined capacity of the circuits. A "circuit" is that portion of the main carrying only a part of the total capacity of the system.

Lay out the piping to scale on floor plan. (See Figure E (pg. 17) for ***floor*** panel system, and Figure I (pg. 19) for ***ceiling*** panel system.) On the plan, assign letters to the connections on the boiler, at the end of each circuit, and at all points where there is a division of the flow of water. Record on the piping layout the length of each circuit (measured length of main from the boiler to the farthest coil and back of the boiler). ***Do not include the length of the coil itself.*** If supplemental radiation is used, add to the measured length of the circuit an allowance of 12 feet for each radiator or baseboard connected to the circuit by means of a one-pipe fitting.

For each lettered section, list the rooms served and the Btu/Hr. requirements.

Using Table 5A, 5B, 5C or 5D, select the size of piping for each section of the trunk and circuits and record on the plan. In ***floor*** panel systems, no section of the main shall be less than ¾" pipe or tube.

Note: The size of the trunk is always selected for the longest circuit. It is not necessary that main size and pump size be the same.

*Example — **Floor Panel:*** The use of a 1¼" standard pump (6.00 ft. of water) was determined under Step 5. Therefore, in this example, Table 5A is applicable because it covers pressure heads between 4.8 and 6.7 feet of water.

The lettered sections of the main shown in Figure E (pg. 17) are given in the following table, with the pipe sizes as taken from Table 5A.

Measured length of circuit AE + KM = 102 feet
Measured length of circuit AJ + KM = 98 feet
(In both cases, use 100 feet in Table 5A).

Sections of Main	ROOMS SERVED	Btu/Hr. from Calculation Sheet	Pipe or Tube Size from Table 5A
AB	All	58,750	1¼"
BC	Living room, Study, Bedroom No. 2, Hall	28,070	¾"
CD	½ Living room, Study, Bedroom No. 2, Hall	20,410	¾"*
DE	Study, Bedroom No. 2, Hall	12,750	¾"*
BF	Utility, Kitchen, Dining, Entrance, Bath, Bedroom No. 1	30,680	¾"
FG	Kitchen, Dining, Entrance, Bath, Bedroom No. 1	25,270	¾"*
GH	Dining, Entrance, Bath, Bedroom No. 1	19,910	¾"*
HI	Entrance, Bath, Bedroom No. 1	17,020	¾"*
IJ	Bath, Bedroom No. 1	14,020	¾"*
KL	All except Kitchen and Utility	47,980	1"
LM	All	58,750	1¼"

*Because all ***floor*** coils are ¾", no supply or return piping of a smaller size is used.

*Example — **Ceiling Panel:*** The use of a 1¼" standard pump (6.00 ft. of water) was determined under Step 5. Therefore, in this example, Table 5A is applicable because it covers pressure heads between 4.8 and 6.7 feet of water.

The lettered sections of the main shown in Figure I, (pg. 19), are given in the following table, with the tube sizes as taken from Table 5A.

Measured length of circuit AD + EJ = 122 feet
(Use 120 ft. in Table 5A).

Measured length of circuit AK + FJ = 43 feet
(Use 50 ft. in Table 5A).

Sections of Main	ROOMS SERVED	Btu/Hr. from Calculation Sheet	Tube Size from Table 5A
AB	All	58,750	1¼"*
BC	Study, Bedroom No. 2, Bath, Bedroom No. 1, Entrance, Dining Room, Hall	32,660	1"
CD	Bedroom No. 1, Bedroom No. 2	15,330	⅝"
EF	Bedroom No. 2, Bedroom No. 1, Bath, Study, Hall	26,770	¾"
FG	Bedroom No. 2, Bedroom No. 1, Bath, Study, Hall, Living Room	42,090	1"
GH	Bedroom No. 2, Bedroom No. 1, Bath, Study, Hall, Living Room, Entrance, Dining Room	47,980	1"*
HI	All except Utility room	53,340	1"*
IJ	All	58,750	1¼"*
BK	Living Room, Kitchen, Utility	26,090	⅝"

*Portions of piping common to more than one circuit are sized for the longest circuit.

STEP 7: Select air cushion tank. If a closed tank is used, allow one gallon of tank capacity for each 5,000 Btu/Hr. If an open tank is used, allow one gallon per 10,000 Btu/Hr.

*Example — **Closed Tank:*** 58,750 Btu/ Hr. heat loss of house. 58,750 ÷ 5,000 = 11.75 gallons. Select a 12 gallon tank or the next larger available size.

*Example — **Open Tank:*** 58,750 Btu/Hr. heat loss of house. 58,750 ÷ 10,000 = 5.87 gallons. Select a 6 gallon tank or the next larger available size.

TABLE I

HEAT LOSS FACTORS

EXPOSED WALLS

No. 1. Frame, Not Insulated

(*a*)	Clapboards or wood siding, studs, lath and plaster or plaster board (no sheathing)	0.35
(*b*)	Same as (*1a*) with composition siding over wood siding	0.28
(*c*)	Wood siding, paper, sheathing, studs, lath and plaster or plaster board	0.25
(*d*)	Same as (*1c*) with composition siding over wood siding	0.21
(*e*)	Same as (*1c*) substituting asphalt or asbestos shingles for wood siding	0.30

No. 2. Frame, Insulated

(*a*)	Wood siding, paper, sheathing, studs, ½" rigid insulation, plaster or plaster board	0.19
(*b*)	Wood siding, 25/32" rigid insulation, studs, lath and plaster or plaster board	0.19
(*c*)	Wood siding, paper, sheathing, ½" flexible insulation in contact with sheathing, studs, lath and plaster or plaster board	0.17
(*d*)	Same as (*2c*) with air space on both sides of insulation	0.15
(*e*)	Same as (*2c*) substituting 3⅝" rock wool or equivalent for ½" flexible insulation	0.08
(*f*)	Same as (*2c*) substituting 2" rock wool or equivalent for ½" flexible insulation	0.10

No. 3. Brick, Not Insulated

(*a*)	8" Brick, plaster or plaster board one side	0.46
(*b*)	8" Brick, furred, lath and plaster or plaster board one side	0.30
(*c*)	12" Brick, plaster or plaster board one side	0.35
(*d*)	12" Brick, furred, lath and plaster or plaster board one side	0.24
(*e*)	4" Brick, 8" hollow tile, plaster or plaster board one side	0.33
(*f*)	4" Brick, 8" hollow tile or cinder block, furred lath and plaster or plaster board	0.24
(*g*)	4" Brick, paper, sheathing, studs, lath and plaster or plaster board	0.27
(*h*)	4" Brick, 4" light weight aggregate block, furred, lath and plaster or plaster board	0.21

No. 4. Brick, Insulated

(*a*)	8" Brick, furred, ½" rigid insulation, plaster or plaster board one side	0.22
(*b*)	12" Brick, furred, ½" rigid insulation, plaster or plaster board one side	0.19
(*c*)	4" Brick, 8" hollow tile, ½" rigid insulation, plaster or plaster board one side	0.18
(*d*)	4" Brick, 4" light weight aggregate block, ½" rigid insulation, plaster or plaster board one side	0.16
(*e*)	4" Brick, paper, sheathing, studs, rigid insulation, plaster or plaster board	0.20
(*f*)	4" Brick, 25/32" rigid insulation, studs, lath and plaster or plaster board	0.21
(*g*)	4" Brick, paper, sheathing, 3⅝" rock wool or equivalent, studs, lath and plaster or plaster board	0.08
(*h*)	Same as (*4g*) substituting 2" blanket for 3⅝" blanket insulation	0.10

EXPOSED WALLS

No. 5. Hollow Tile

(*a*)	8" Tile, stucco exterior, furred, lath and plaster or plaster board	0.26
(*b*)	Same as (*5a*) substituting ½" rigid insulation for lath	0.20

No. 6. Hollow Concrete Block, Gravel Aggregate

(*a*)	8" Block, plain, above grade	0.56
(*b*)	Same as (*6a*) plaster or plaster board one side	0.51
(*c*)	Same as (*6a*) furred, lath and plaster or plaster board	0.32
(*d*)	Same as (*6c*) substituting ½" rigid insulation for lath	0.23
(*e*)	Same as (*6a*) basement wall below grade	0.06
(*f*)	12" Block, plain, above grade	0.49
(*g*)	Same as (*6f*) basement wall below grade	0.06

No. 7. Hollow Concrete Block, Cinder Aggregate

(*a*)	8" Block, plain	0.42
(*b*)	Same as (*7a*) plaster or plaster board one side	0.39
(*c*)	Same as (*7a*) furred, lath and plaster or plaster board	0.27
(*d*)	Same as (*7c*) substituting ½" rigid insnlation for lath	0.20

No. 8. Hollow Concrete Block, Light Weight Aggregate

(*a*)	8" Block, no interior finish	0.37
(*b*)	Same as (*8a*) plaster or plaster board one side	0.35
(*c*)	Same as (*8a*) furred, lath and plaster or plaster board	0.26
(*d*)	Same as (*8c*) substituting ½" insulating board for lath	0.19
(*e*)	Same as (*8c*) plus 1" insulating blanket	0.13

No. 9. Poured Concrete

(*a*)	8" Wall, above grade	0.69
(*b*)	8" Wall, below grade	0.06
(*c*)	12" Wall, above grade	0.56
(*d*)	12" Wall, below grade	0.06

No. 10. Limestone or Sandstone

(*a*)	8" Stone, furred, lath and plaster or plaster board	0.37
(*b*)	Same as (*10a*) substituting ½" rigid insulation for lath	0.25
(*c*)	12" Stone, furred, lath and plaster or plaster board	0.33
(*d*)	Same as (*10c*) substituting ½" rigid insulation for lath	0.23
(*e*)	12" Stone below grade	0.06
(*f*)	16" Stone below grade	0.06

No. 11. Glass Block

(*a*)	3⅝" Block, corrugated surface	0.49

TABLE I

HEAT LOSS FACTORS

PARTITIONS

No. 12. Frame

(*a*)	With lath and plaster or plaster board one side only	0.31
(*b*)	Same as (*12a*) substituting ½" rigid insulation for lath	0.18
(*c*)	Same as (*12a*) with ½" rigid insulation on exposed side	0.13
(*d*)	With lath and plaster or plaster board both sides	0.17
(e)	Same as (*12d*) substituting ½" rigid insulation for lath	0.10
(*f*)	Same as (*12d*) with 3⅝" rock wool or equivalent	0.04
(*g*)	Same as (*12d*) with 2" rock wool or equivalent	0.06

CEILINGS

No. 13. Attic Space Above

(*a*)	Lath and plaster or plaster board, no floor above	0.32
(*b*)	Lath and plaster or plaster board, tight floor above	0.20
(*c*)	Same as (*13a*) substituting ½" rigid insulation for lath	0.23
(*d*)	Same as (*13b*) substituting ½" rigid insulation for lath	0.16
(*e*)	Same as (*13a*) with ½" rigid insulation on top of joists	0.18
(*f*)	Same as (*13a*) or (*13b*) with 3⅝" rock wool or equivalent	0.08
(*g*)	Same as (*13f*) except with 2" rock wool or equivalent	0.13

No. 14. Part of Shingle Roof — No Attic Space

(*a*)	Lath and plaster or plaster board, rafter, sheathing, shingles	0.29
(*b*)	Same as (*14a*) substituting ½" rigid insulation for lath	0.21
(*c*)	Same as (*14a*) with 3⅝" rock wool or equivalent	0.08
(*d*)	Same as (*14a*) with 2" rock wool or equivalent	0.10

No. 15. Part of Built-up Roof — No Attic Space

(*a*)	Lath and plaster or plaster board, rafter, sheathing, built-up roofing	0.31
(*b*)	Same as (*15a*) substituting ½" rigid insulation for lath	0.23
(*c*)	Same as (*15a*) with 3⅝" rock wool or equivalent	0.08
(*d*)	*Same as* (*15a*) with 2" rock wool or equivalent	0.10

No. 16. Part of Metal Roof — No Attic Space

(*a*)	Lath and plaster or plaster board, joists, metal roof	0.46
(*b*)	Same as (*16a*) substituting ½" rigid insulation for lath	0.27
(*c*)	Same as (*16a*) with 3⅝" rock wool or equivalent	0.08
(*d*)	Same as (*16a*) with 2" rock wool or equivalent	0.13

FLOORS

No. 17. Wood, Over Exposed or Unheated Space

(*a*)	Double floor on joists over enclosed, unheated space	0.17
(*b*)	Same as (*17a*) over exposed space	0.35
(*c*)	Same as (*17a*) with ½" rigid insulation on bottom of joists	0.10
(*d*)	Same as (*17b*) with ½" rigid insulation on bottom of joists	0.18
(*e*)	Same as (*17a*) with 2" rock wool or equivalent between joists	0.06
(*f*)	Same as (*17*b) with 2" rock wool or equivalent between joists	0.13
(*g*)	Same as (*17a*) with 3⅝" rock wool or equivalent between joists	0.04
(*h*)	Same as (*17b*) with 3⅝" rock wool or equivalent between joists	0.08

No. 18. Concrete

(*a*)	On ground or fill — per linear foot of exposed edge — NOT per square foot	0.69
(*b*)	Floor on ground, below grade — per square foot of area — NOT edge loss	0.04

WINDOWS

No. 19. Windows

(*a*)	Single (no storm sash)	1.13
(*b*)	With storm sash or double glazed	0.45
(*c*)	Double glazed with ¼" air space	0.60

EXTERIOR DOORS

No. 20. With or Without Glass
Same as Windows

INFILTRATION

(Based on volume of room in cubic feet)

No. 21. Windows and Doors Without Weatherstripping or Storm Sash

(*a*)	Rooms with windows or exterior doors on one side only	0.017
(*b*)	Rooms with windows or exterior doors on two sides	0.027
(*c*)	Rooms with windows or exterior doors on three sides	0.036
(*d*)	Entrance Halls	0.036
(*e*)	Sun Rooms with many windows on three sides	0.054

No. 22. Windows and Doors Weatherstripped or with Storm Sash

(*a*)	Rooms with windows or exterior doors on one side only	0.011
(*b*)	Rooms with windows or exterior doors on two sides	0.017
(*c*)	Rooms with windows or exterior doors on three sides	0.027
(*d*)	Entrance Halls	0.027
(*e*)	Sun Rooms with many windows on three sides	0.036

TABLE 2

Btu/Hr. REQUIREMENTS FOR AREAS AND VOLUME

70 F Indoor Minus Outdoor Temperature Difference

Btu/Hr. Required	WINDOW AND DOOR AREAS Sq. Ft.			INFILTRATION Room Volume, Cu. Ft.					WALL, CEILING AND FLOOR AREAS, SQ. FT.										
	FACTORS			FACTORS					FACTORS										
	0.45	0.60	1.13	0.011	0.017	0.027	0.036	0.054	0.04	0.06	0.08	0.10	0.13	0.15	0.16	0.17	0.18	0.19	0.20
100	3.2	2.4	1.3	130	84	52.9	39.7	26.5	35.7	23.8	17.9	14.3	10.9	9.5	8.9	8.4	7.9	7.5	7.1
200	6.4	4.8	2.5	260	168	106	79.4	52.9	71.4	47.6	35.7	28.6	21.9	19.0	17.8	16.8	15.9	15.0	14.3
300	9.5	7.1	3.8	390	252	159	119	79.4	107	71.4	53.6	42.9	32.9	28.5	26.7	25.2	23.8	22.6	21.4
400	12.7	9.5	5.1	519	336	212	159	106	143	95.2	71.4	57.1	43.9	38.1	35.7	33.6	31.7	30.1	28.6
500	15.9	11.9	6.3	649	420	265	198	132	179	119	89.3	71.4	54.9	47.6	44.6	42.0	39.7	37.6	35.7
600	19.0	14.3	7.6	779	504	317	238	159	214	143	107	85.7	65.9	57.1	53.6	50.4	47.6	45.1	42.9
700	22.2	16.7	8.8	909	588	370	278	185	250	167	125	100	76.9	66.7	62.5	58.8	55.6	52.6	50.0
800	25.4	19.0	10.1	1039	672	423	317	212	286	190	143	114	87.9	76.1	71.4	67.2	63.5	60.1	57.1
900	28.6	21.4	11.4	1169	756	476	352	238	321	214	161	129	98.9	85.7	80.3	75.6	71.4	67.7	64.3
1000	31.7	23.8	12.6	1299	840	529	397	265	357	238	179	143	110	95.2	89.3	84.0	79.4	75.2	71.4
1100	34.9	26.2	13.9	1429	924	582	437	291	393	262	196	157	121	105	98.2	92.4	87.3	82.7	78.6
1200	38.1	28.6	15.1	1558	1008	635	476	317	429	286	214	171	132	114	107	101	95.2	90.2	85.7
1300	41.3	31.0	16.4	1688	1092	688	516	344	464	310	232	186	143	124	116	109	103	97.7	92.8
1400	44.4	33.3	17.7	1818	1176	741	556	370	500	333	250	200	154	133	125	118	111	105	100
1500	47.6	35.7	18.9	1948	1260	794	595	397	536	357	268	214	165	143	134	126	119	113	107
1600	50.8	38.1	20.2	2078	1345	846	635	423	571	381	286	229	176	152	143	134	127	120	114
1700	53.9	40.5	21.5	2208	1429	899	675	450	607	405	304	243	187	162	152	143	135	128	121
1800	57.1	42.9	22.7	2338	1513	952	714	476	643	429	321	257	198	171	161	151	143	135	129
1900	60.3	45.2	24.0	2468	1597	1005	754	503	679	452	339	271	209	181	170	160	151	143	136
2000	63.5	47.6	25.2	2597	1681	1058	794	529	714	476	357	286	220	190	179	168	159	150	143
2100	66.7	50.0	26.5	2727	1765	1111	833	556	750	500	375	300	231	200	187	176	167	158	150
2200	69.8	52.4	27.8	2857	1849	1164	873	582	786	524	393	314	242	210	196	185	175	165	157
2300	73.0	54.8	29.0	2987	1933	1217	913	608	821	548	411	329	253	219	205	193	183	173	164
2400	76.2	57.1	30.3	3117	2017	1270	952	635	857	571	429	343	264	229	214	202	190	180	171
2500	79.4	59.5	31.6	3247	2101	1323	992	661	893	595	446	357	275	238	223	210	198	188	179
2600	82.5	61.9	32.8	3377	2185	1376	1032	688	929	619	464	371	286	248	232	218	206	195	186
2700	85.7	64.3	34.1	3506	2269	1429	1071	714	964	643	482	386	297	257	241	227	214	203	193
2800	88.9	66.7	35.3	3636	2353	1481	1111	741	1000	667	500	400	308	267	250	235	222	211	200
2900	92.0	69.0	36.6	3766	2437	1534	1151	767	1036	690	518	414	319	276	259	244	230	218	207
3000	95.2	71.4	37.9	3896	2521	1587	1190	794	1071	714	536	429	330	286	268	252	238	226	214
3100	98.4	73.8	39.1	4026	2605	1640	1230	820	1107	738	554	443	341	295	277	260	246	233	221
3200	101	76.2	40.4	4156	2689	1693	1270	847	1143	762	571	457	352	305	286	269	254	241	229
3300	105	78.6	41.6	4286	2773	1746	1310	873	1179	786	589	471	363	314	295	277	262	248	236
3400	108	81.0	42.9	4416	2857	1799	1349	899	1214	810	607	486	374	324	304	286	270	256	243
3500	111	83.3	44.2	4545	2941	1852	1389	926	1250	833	625	500	385	333	312	294	278	263	250
3600	114	85.7	45.4	4675	3025	1905	1429	952	1286	857	643	514	396	343	321	303	286	271	257
3700	117	88.1	46.7	4805	3109	1958	1468	979	1321	881	661	529	407	352	330	311	294	278	264
3800	121	90.5	48.0	4935	3193	2011	1509	1005	1357	905	679	543	418	362	339	319	302	286	271
3900	124	92.9	49.2	5065	3277	2063	1548	1032	1393	929	696	557	429	371	348	328	310	293	279
4000	127	95.2	50.5	5195	3361	2116	1587	1058	1429	952	714	571	440	381	357	336	317	301	286
4100	130	97.6	51.7	5325	3445	2169	1627	1085	1464	976	732	586	451	390	366	345	325	308	293
4200	133	100	53.0	5455	3529	2222	1667	1111	1500	1000	750	600	461	400	375	353	333	316	300
4300	136	102	54.2	5584	3613	2275	1706	1138	1536	1024	768	614	472	409	384	361	341	323	307
4400	140	105	55.5	5714	3697	2328	1746	1164	1571	1048	786	629	483	419	393	370	349	331	314
4500	143	107	56.7	5844	3781	2381	1786	1190	1607	1071	804	643	494	429	402	378	357	338	321
4600	146	110	58.1	5974	3866	2434	1825	1217	1643	1095	821	657	505	438	411	387	365	346	329
4700	149	112	59.3	6104	3950	2487	1865	1243	1679	1119	839	671	516	448	420	395	373	353	336
4800	152	114	60.6	6234	4034	2540	1905	1270	1714	1143	857	686	527	457	429	403	381	361	343
4900	156	117	61.8	6364	4118	2593	1944	1296	1750	1167	875	700	538	467	437	412	389	368	350
5000	159	119	63.1	6494	4202	2645	1984	1323	1786	1190	893	714	549	476	446	420	397	376	357
	0.45	0.60	1.13	0.011	0.017	0.027	0.036	0.054	0.04	0.06	0.08	0.10	0.13	0.15	0.16	0.17	0.18	0.19	0.20

TO USE THIS TABLE

Enter at top under factor determined from Table 1.
Read down to nearest value in sq. ft. or cu. ft.
Read to left to determine the Btu/Hr. required.

TABLE 2—Continued

Btu/Hr. REQUIREMENTS FOR AREAS AND VOLUME

70 F Indoor Minus Outdoor Temperature Difference

Btu/Hr. Required	WALL, CEILING AND FLOOR AREAS, SQ. FT. (See Note Below)																					
	FACTORS																					
	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.35	0.37	0.39	0.42	0.46	0.49	0.51	0.56	0.69*
100	6.8	6.5	6.2	5.9	5.7	5.5	5.3	5.1	4.9	4.8	4.6	4.5	4.3	4.1	3.9	3.7	3.4	3.1	2.9	2.8	2.6	2.1
200	13.6	12.9	12.4	11.9	11.4	10.9	10.5	10.2	9.9	9.5	9.2	8.9	8.7	8.2	7.7	7.3	6.8	6.2	5.8	5.6	5.1	4.1
300	20.4	19.5	18.6	17.9	17.1	16.5	15.8	15.3	14.8	14.3	13.8	13.4	13.0	12.2	11.6	10.9	10.2	9.3	8.7	8.4	7.7	6.2
400	27.2	25.9	24.8	23.8	22.8	21.9	21.1	20.4	19.7	19.0	18.4	17.9	17.3	16.3	15.4	14.7	13.6	12.4	11.7	11.2	10.2	8.3
500	34.0	32.4	31.0	29.7	28.5	27.5	26.4	25.5	24.6	23.8	23.0	22.3	21.6	20.4	19.3	18.3	17.0	15.5	14.6	14.0	12.8	10.4
600	40.8	38.9	37.2	35.7	34.2	32.9	31.7	30.6	29.6	28.6	27.6	26.8	26.0	24.5	23.1	22.0	20.4	18.6	17.5	16.8	15.3	12.4
700	47.6	45.4	43.4	41.6	39.9	38.5	37.0	35.7	34.5	33.3	32.3	31.2	30.3	28.6	27.0	25.6	23.8	21.7	20.4	19.6	17.9	14.5
800	54.4	51.9	49.6	47.6	45.7	43.9	42.3	40.8	39.4	38.1	36.9	35.7	34.6	32.6	30.9	29.3	27.2	24.8	23.3	22.4	20.4	16.6
900	61.2	58.4	55.8	53.5	51.4	49.4	47.6	45.9	44.3	42.8	41.5	40.2	39.0	36.7	34.7	33.0	30.6	27.9	26.2	25.2	23.0	18.6
1000	68.0	64.9	62.1	59.5	57.1	54.9	52.9	51.0	49.3	47.6	46.1	44.6	43.3	40.8	38.6	36.6	34.0	31.1	29.1	28.0	26.0	20.7
1100	74.8	71.4	68.3	65.4	62.8	60.4	58.2	56.1	54.2	52.4	50.7	49.1	47.6	44.9	42.5	40.3	37.4	34.2	32.1	30.8	28.1	22.8
1200	81.6	77.9	74.5	71.4	68.5	65.9	63.5	61.2	59.1	57.1	55.3	53.6	52.0	49.0	46.3	44.0	40.8	37.3	35.0	33.6	30.6	24.8
1300	88.4	84.4	80.7	77.3	74.2	71.4	68.9	66.3	64.0	61.9	59.9	58.0	56.3	53.1	50.2	47.6	44.2	40.4	37.9	36.4	33.2	26.9
1400	95.2	90.9	86.9	83.3	79.9	76.9	74.1	71.4	69.0	66.7	64.5	62.5	60.6	57.1	54.0	51.3	47.6	43.5	40.8	39.2	35.7	29.0
1500	102	97.3	93.1	89.2	85.7	82.4	79.4	76.5	73.9	71.4	69.1	67.0	65.0	61.2	57.9	54.9	51.0	46.6	43.7	42.0	38.3	31.0
1600	109	104	99.3	95.2	91.4	87.9	84.7	81.6	78.8	76.2	73.7	71.4	69.3	65.3	61.8	58.6	54.4	49.7	46.6	44.8	40.8	33.1
1700	116	110	106	101	97.1	93.3	89.9	86.7	83.7	80.9	78.3	75.9	73.6	69.4	65.6	62.3	57.8	52.8	49.5	47.6	43.4	35.2
1800	122	117	112	107	103	98.8	95.2	91.8	88.7	85.7	82.9	80.4	77.9	73.5	69.5	65.9	61.2	55.9	52.5	50.4	45.9	37.3
1900	129	123	118	113	109	104	100	96.9	93.6	90.5	87.6	84.8	82.3	77.5	73.3	69.6	64.6	59.0	55.4	53.2	48.5	39.3
2000	136	130	124	119	114	110	106	102	98.5	95.2	92.1	89.3	86.6	81.6	77.2	73.3	68.0	62.1	58.3	56.0	51.0	41.4
2100	143	136	130	125	120	115	111	107	103	100	96.8	93.7	90.9	85.7	81.1	76.9	71.4	65.2	61.2	58.8	53.6	43.5
2200	150	143	137	131	126	121	116	112	108	105	101	98.2	95.2	89.8	84.9	80.6	74.8	68.3	64.1	61.6	58.7	45.5
2300	156	149	143	137	131	126	122	117	113	110	106	103	99.6	93.8	88.8	84.2	78.2	71.4	67.0	64.4	61.2	47.6
2400	163	156	149	143	137	132	127	122	118	114	111	107	104	97.9	92.6	87.9	81.6	74.5	69.9	67.2	63.8	49.7
2500	170	162	155	149	143	137	132	127	123	119	115	112	108	102	96.5	91.6	85.0	77.6	72.9	70.0	66.3	51.8
2600	177	169	161	155	149	143	138	133	128	124	120	116	113	106	100	95.2	88.4	80.7	75.8	72.8	68.9	53.8
2700	184	175	168	161	154	148	143	138	133	129	124	121	117	110	104	98.9	91.8	83.8	78.7	75.6	71.4	55.9
2800	190	182	174	167	160	154	148	143	138	133	129	125	121	114	108	103	95.2	86.9	81.6	78.4	74.0	58.0
2900	197	188	180	173	166	159	153	148	143	138	134	129	126	118	112	106	98.6	90.0	84.5	81.2	76.5	60.0
3000	204	195	186	179	171	165	159	153	148	143	138	134	130	122	116	110	102	93.2	87.4	84.0	79.1	62.1
3100	211	201	193	185	177	170	164	158	153	148	143	138	134	127	120	114	105	96.3	90.3	86.8	81.6	64.2
3200	218	208	199	190	183	176	169	163	158	152	147	143	139	131	124	117	109	99.4	93.2	89.6	84.2	66.2
3300	224	214	205	196	189	181	175	168	163	157	152	147	143	135	127	121	112	102	96.2	92.4	86.7	68.3
3400	231	221	211	202	194	187	180	173	167	162	157	152	147	139	131	125	116	106	99.1	95.2	89.3	70.4
3500	238	227	217	208	200	192	185	179	172	167	161	156	152	143	135	128	119	109	102	98.0	91.8	72.5
3600	245	234	223	214	206	198	190	184	177	171	166	161	156	147	139	132	122	112	105	101	94.4	74.5
3700	252	240	230	220	211	203	196	189	182	176	170	165	160	151	143	136	126	115	108	104	96.9	76.6
3800	258	247	236	226	217	209	201	194	187	181	175	170	165	155	147	139	129	118	111	106	99.5	78.7
3900	265	253	242	232	223	214	206	199	192	186	180	174	169	159	151	143	133	121	114	109	102	80.7
4000	272	260	248	238	229	220	212	204	197	190	184	179	173	163	154	147	136	124	117	112	105	82.8
4100	279	266	255	244	234	225	217	209	202	195	189	183	177	167	158	150	139	127	119	115	107	84.9
4200	286	273	261	250	240	231	222	214	207	200	194	187	182	171	162	154	143	130	122	118	110	86.9
4300	292	279	267	256	246	236	228	219	212	205	198	192	186	175	166	158	146	134	125	120	112	89.0
4400	299	286	273	262	251	242	233	224	217	209	203	196	190	180	170	161	150	137	128	123	115	91.1
4500	306	292	279	268	257	247	238	230	222	214	207	201	195	184	174	165	153	140	131	126	117	93.2
4600	313	299	286	274	263	253	243	235	227	219	212	205	199	188	178	168	156	143	134	129	120	95.2
4700	320	305	292	280	269	258	249	240	232	224	217	210	203	192	181	172	160	146	137	132	122	97.3
4800	326	312	298	286	274	264	254	245	236	229	221	214	208	196	185	176	163	149	140	134	125	99.4
4900	333	318	304	292	280	269	259	250	241	233	226	219	212	200	189	179	167	152	143	137	128	101
5000	340	325	311	298	286	275	265	255	246	238	230	223	216	204	193	183	170	155	146	140	130	104
	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.35	0.37	0.39	0.42	0.46	0.49	0.51	0.56	0.69*

***NOTE:** When calculating the heat loss of a house where the floor corresponds to Item 18 (a) of Table 1, the figures used under the factor of 0.69 represent linear feet of exposed edge—not the square feet of floor area.

TABLE 3

EQUIVALENT Btu/Hr. HEAT LOSS

For Various Indoor Minus Outdoor Temperature Differences

70 F	50 F	55 F	60 F	65 F	75 F	80 F	85 F	90 F	70 F	50 F	55 F	60 F	65 F	75 F	80 F	85 F	90 F
1000	710	790	860	930	1070	1140	1210	1290	7000	5000	5500	6000	6500	7500	8000	8500	9000
1100	790	860	940	1020	1180	1260	1340	1410	7100	5070	5580	6090	6600	7610	8120	8620	9130
1200	860	940	1030	1110	1290	1370	1460	1540	7200	5140	5660	6170	6690	7710	8230	8740	9260
1300	930	1020	1110	1210	1390	1490	1580	1670	7300	5210	5740	6260	6780	7820	8340	8860	9390
1400	1000	1100	1200	1300	1500	1600	1700	1800	7400	5290	5810	6340	6870	7930	8460	8990	9510
1500	1070	1180	1290	1390	1610	1710	1820	1930	7500	5360	5890	6430	6960	8040	8570	9100	9640
1600	1140	1260	1370	1490	1710	1830	1940	2060	7600	5430	5970	6510	7060	8140	8690	9230	9770
1700	1210	1340	1460	1580	1820	1940	2060	2190	7700	5500	6050	6600	7150	8250	8800	9350	9900
1800	1290	1410	1540	1670	1930	2060	2190	2310	7800	5570	6130	6690	7240	8360	8920	9470	10030
1900	1360	1490	1630	1760	2040	2170	2310	2440	7900	5640	6210	6770	7340	8460	9030	9590	10160
2000	1430	1570	1720	1860	2140	2290	2430	2570	8000	5710	6290	6860	7430	8570	9140	9710	10290
2100	1500	1650	1800	1950	2250	2400	2550	2700	8100	5790	6360	6940	7520	8680	9260	9840	10410
2200	1570	1730	1890	2040	2360	2510	2670	2830	8200	5860	6440	7030	7610	8790	9370	9960	10540
2300	1640	1810	1970	2140	2460	2630	2790	2960	8300	5930	6520	7110	7710	8890	9490	10080	10670
2400	1710	1890	2060	2230	2570	2740	2910	3090	8400	6000	6600	7200	7800	9000	9600	10200	10800
2500	1790	1960	2140	2320	2680	2860	3040	3210	8500	6070	6680	7290	7890	9110	9720	10320	10930
2600	1860	2040	2230	2410	2790	2970	3160	3340	8600	6140	6760	7370	7990	9210	9830	10440	11060
2700	1930	2120	2310	2510	2890	3090	3280	3470	8700	6210	6840	7460	8080	9320	9940	10560	11190
2800	2000	2200	2400	2600	3000	3200	3400	3600	8800	6290	6910	7540	8170	9430	10060	10690	11310
2900	2070	2280	2490	2690	3110	3310	3520	3730	8900	6360	6990	7630	8260	9540	10170	10810	11440
3000	2140	2360	2570	2790	3210	3430	3640	3860	9000	6430	7070	7710	8360	9640	10290	10930	11570
3100	2210	2440	2660	2800	3320	3540	3760	3990	9100	6500	7150	7800	8450	9750	10400	11050	11700
3200	2290	2510	2740	2970	3430	3660	3890	4110	9200	6570	7230	7890	8540	9850	10520	11170	11830
3300	2350	2590	2830	3060	3540	3770	4010	4240	9300	6640	7310	7970	8640	9960	10630	11290	11960
3400	2430	2670	2910	3160	3640	3890	4130	4370	9400	6710	7390	8060	8730	10070	10740	11420	12090
3500	2500	2750	3000	3250	3750	4000	4250	4500	9500	6790	7460	8140	8820	10180	10860	11540	12210
3600	2570	2830	3090	3340	3860	4110	4370	4630	9600	6860	7540	8230	8910	10290	10970	11660	12340
3700	2640	2910	3170	3440	3960	4230	4490	4760	9700	6930	7620	8310	9010	10390	11090	11780	12470
3800	2710	2990	3260	3530	4070	4340	4610	4890	9800	7000	7700	8400	9100	10500	11200	11900	12600
3900	2790	3060	3340	3620	4180	4460	4740	5010	9900	7070	7780	8490	9190	10610	11320	12020	12730
4000	2860	3140	3430	3710	4290	4570	4860	5140	10000	7140	7860	8570	9290	10710	11430	12140	12860
4100	2930	3220	3510	3810	4390	4690	4980	5270	10100	7210	7940	8660	9380	10820	11540	12260	12990
4200	3000	3300	3600	3900	4500	4800	5100	5400	10200	7290	8010	8740	9470	10930	11660	12390	13110
4300	3070	3380	3690	3990	4610	4910	5220	5530	10300	7360	8090	8830	9560	11040	11770	12510	13240
4400	3140	3460	3770	4090	4710	5030	5340	5660	10400	7430	8170	8910	9660	11140	11890	12630	13370
4500	3210	3540	3860	4180	4820	5140	5460	5790	10500	7500	8250	9000	9750	11250	12000	12750	13500
4600	3290	3610	3940	4270	4930	5260	5590	5910	10600	7570	8330	9090	9840	11360	12120	12870	13630
4700	3360	3690	4030	4360	5040	5370	5710	6040	10700	7640	8410	9170	9940	11460	12230	12990	13760
4800	3430	3770	4110	4460	5140	5490	5830	6170	10800	7710	8490	9260	10030	11570	12340	13110	13890
4900	3500	3850	4200	4550	5250	5600	5950	6300	10900	7790	8560	9340	10120	11680	12460	13240	14010
5000	3570	3930	4290	4640	5360	5720	6070	6430	11000	7860	8640	9430	10210	11790	12570	13360	14140
5100	3640	4010	4370	4740	5460	5830	6190	6560	11100	7930	8720	9510	10310	11890	12690	13480	14270
5200	3710	4090	4460	4830	5570	5940	6310	6690	11200	8000	8800	9600	10400	12000	12800	13600	14400
5300	3790	4160	4540	4920	5680	6060	6440	6810	11300	8070	8880	9690	10490	12110	12920	13720	14530
5400	3860	4240	4630	5010	5790	6170	6560	6940	11400	8140	8960	9770	10590	12210	13030	13840	14660
5500	3930	4320	4710	5110	5890	6290	6680	7070	11500	8210	9040	9860	10680	12320	13140	13960	14790
5600	4000	4400	4800	5200	6000	6400	6800	7200	11600	8290	9110	9940	10770	12430	13260	14090	14910
5700	4070	4480	4890	5290	6110	6520	6920	7340	11700	8360	9190	10030	10860	12540	13370	14210	15040
5800	4140	4560	4970	5390	6210	6630	7040	7460	11800	8430	9270	10110	10960	12640	13490	14330	15170
5900	4210	4640	5060	5480	6320	6740	7160	7590	11900	8500	9350	10200	11000	12750	13600	14450	15300
6000	4290	4710	5140	5570	6430	6860	7290	7710	12000	8570	9430	10290	11140	12860	13720	14570	15430
6100	4360	4790	5230	5670	6540	6970	7410	7840	12100	8640	9510	10370	11240	12960	13840	14690	15560
6200	4430	4870	5310	5760	6640	7090	7530	7970	12200	8710	9590	10460	11330	13070	13940	14810	15690
6300	4500	4950	5400	5850	6750	7200	7650	8100	12300	8790	9670	10540	11420	13180	14060	14940	15810
6400	4570	5030	5490	5940	6860	7320	7770	8230	12400	8860	9740	10630	11510	13290	14170	15060	15940
6500	4640	5110	5570	6040	6960	7430	7890	8360	12500	8930	9820	10710	11610	13390	14290	15180	16070
6600	4710	5190	5660	6130	7070	7540	8010	8490	12600	9000	9900	10800	11700	13500	14400	15300	16200
6700	4790	5260	5740	6220	7180	7660	8140	8610	12700	9070	9980	10890	11790	13620	14520	15420	16320
6800	4860	5340	5830	6310	7290	7770	8260	8740	12800	9140	10060	10970	11890	13710	14630	15540	16460
6900	4930	5420	5910	6410	7390	7890	8380	8870	12900	9210	10140	11060	11980	13820	14740	15660	16590
70 F	50 F	55 F	60 F	65 F	75F	80 F	85 F	90 F	70 F	50 F	55 F	60 F	65 F	75 F	80 F	85 F	90 F

TO USE THIS TABLE

Enter under column headed 70 F.
Read down to Btu/Hr. determined from Table 2.
Read across to the column which represents the indoor minus outdoor temperature difference for which the system is designed.

TABLE 4A

PUMP SIZE

Total Load on System Btu/Hr.	PUMP SIZE	
	Standard Pump	High Head Pump
Up to 50,000	1"	1"
50,001 to 100,000	1¼"	1"
100,001 to 150,000	1½"	1¼"
Over 150,001	1½"	1½"

TABLE 4B

PRESSURE HEAD DEVELOPED BY PUMP

Note: This Table is based on conservative averages. Consult manufacturers' data for closer accuracy.

Total Load Btu/Hr.	PRESSURE HEAD IN FT. OF WATER					
	Standard Pump			High Head Pump		
	1"	1¼"	1½"	1"	1¼"	1½"
25,000	5.50	6.25	6.75	8.50	9.50	10.75
50,000	5.25	6.00	6.75	8.25	9.25	10.50
75,000	4.75	5.75	6.50	8.00	9.00	10.25
100,000	4.50	5.50	6.50	7.75	8.75	10.00
125,000	4.00	5.25	6.25	7.25	8.25	9.50
150,000		5.00	6.00	6.75	7.75	9.25
175,000		4.50	6.00	6.25	7.25	9.00
200,000		4.00	5.75	5.75	6.75	8.50
225,000			5.50	5.00	6.25	8.00
250,000			5.25	4.00	5.50	7.50
275,000			5.00		4.75	6.75

TO USE THIS TABLE

Enter left-hand column at figure closest to total load on system. Read across to the column representing the size and type of pump selected from Table 4A.

MAIN SIZES — IRON PIPE OR TYPE L COPPER TUBE

TABLE 5A
FOR PRESSURE HEADS BETWEEN
4.8 and 6.7 FT. OF WATER

Measured Length Ft.	CAPACITY IN Btu/Hr.					
	½" Tube	⅝" Tube	¾" Pipe or Tube	1" Pipe or Tube	1¼" Pipe or Tube	1½" Pipe or Tube
50	19,000	30,000	42,000	81,000	147,000	225,000
60	18,000	28,000	39,000	74,000	135,000	205,000
70	17,000	26,000	37,000	69,000	125,000	192,000
80	16,000	24,000	35,000	65,000	119,000	180,000
90	15,000	23,000	33,000	61,000	113,000	171,000
100	14,000	22,000	31,000	58,000	107,000	163,000
110	13,000	21,000	30,000	56,000	102,000	157,000
120	13,000	20,000	29,000	54,000	99,000	150,000
130	12,000	19,000	28,000	52,000	95,000	146,000
140	12,000	19,000	27,000	51,000	92,000	141,000
150	11,000	18,000	26,000	49,000	89,000	136,000
160	11,000	18,000	25,000	48,000	87,000	133,000
170	11,000	17,000	24,000	46,000	85,000	129,000
180	10,000	17,000	24,000	45,000	83,000	127,000
190	10,000	16,000	23,000	44,000	81,000	124,000
200	10,000	16,000	23,000	43,000	79,000	122,000
250	9,000	14,000	21,000	40,000	72,000	112,000
300	8,000	13,000	20,000	36,000	67,000	103,000
400	7,000	12,000	17,000	32,000	59,000	92,000
500	6,000	10,000	15,000	29,000	54,000	83,000

TABLE 5B
FOR PRESSURE HEADS BETWEEN
6.8 and 8.7 FT. OF WATER

Measured Length Ft.	CAPACITY IN Btu/Hr.					
	½" Tube	⅝" Tube	¾" Pipe or Tube	1" Pipe or Tube	1¼" Pipe or Tube	1½" Pipe or Tube
50	25,000	37,000	54,000	102,000		
60	23,000	34,000	49,000	93,000	171,000	
70	21,000	32,000	45,000	87,000	159,000	240,000
80	20,000	30,000	43,000	82,000	150,000	227,000
90	19,000	28,000	41,000	77,000	142,000	214,000
100	18,000	27,000	39,000	74,000	135,000	205,000
110	17,000	26,000	37,000	71,000	129,000	196,000
120	17,000	25,000	36,000	68,000	125,000	190,000
130	16,000	24,000	34,000	66,000	120,000	184,000
140	15,000	23,000	33,000	63,000	116,000	178,000
150	15,000	22,000	32,000	61,000	113,000	173,000
160	14,000	21,000	31,000	60,000	110,000	169,000
170	14,000	21,000	31,000	58,000	106,000	165,000
180	14,000	21,000	30,000	57,000	104,000	161,000
190	13,000	20,000	30,000	56,000	101,000	157,000
200	13,000	20,000	29,000	55,000	99,000	153,000
250	12,000	18,000	26,000	50,000	91,000	140,000
300	10,000	16,000	23,000	46,000	85,000	130,000
400	9,000	14,000	21,000	40,000	75,000	115,000
500	8,000	12,000	19,000	36,000	68,000	105,000

TO USE THESE TABLES

Enter left-hand column at figure nearest to measured length (plus radiator allowance, if any).

Read horizontally to capacity equal to or greater than capacity needed.

Read up to top of column to determine pipe or tube size.

MAIN SIZES — IRON PIPE OR TYPE L COPPER TUBE

TABLE 5A
FOR PRESSURE HEADS BETWEEN
4.8 and 6.7 FT. OF WATER

Measured Length Ft.	CAPACITY IN Btu/Hr.					
	½" Tube	⅝" Tube	¾" Pipe or Tube	1" Pipe or Tube	1¼" Pipe or Tube	1½" Pipe or Tube
50	19,000	30,000	42,000	81,000	147,000	225,000
60	18,000	28,000	39,000	74,000	135,000	205,000
70	17,000	26,000	37,000	69,000	125,000	192,000
80	16,000	24,000	35,000	65,000	119,000	180,000
90	15,000	23,000	33,000	61,000	113,000	171,000
100	14,000	22,000	31,000	58,000	107,000	163,000
110	13,000	21,000	30,000	56,000	102,000	157,000
120	13,000	20,000	29,000	54,000	99,000	150,000
130	12,000	19,000	28,000	52,000	95,000	146,000
140	12,000	19,000	27,000	51,000	92,000	141,000
150	11,000	18,000	26,000	49,000	89,000	136,000
160	11,000	18,000	25,000	48,000	87,000	133,000
170	11,000	17,000	24,000	46,000	85,000	129,000
180	10,000	17,000	24,000	45,000	83,000	127,000
190	10,000	16,000	23,000	44,000	81,000	124,000
200	10,000	16,000	23,000	43,000	79,000	122,000
250	9,000	14,000	21,000	40,000	72,000	112,000
300	8,000	13,000	20,000	36,000	67,000	103,000
400	7,000	12,000	17,000	32,000	59,000	92,000
500	6,000	10,000	15,000	29,000	54,000	83,000

TABLE 5B
FOR PRESSURE HEADS BETWEEN
6.8 and 8.7 FT. OF WATER

Measured Length Ft.	CAPACITY IN Btu/Hr.					
	½" Tube	⅝" Tube	¾" Pipe or Tube	1" Pipe or Tube	1¼" Pipe or Tube	1½" Pipe or Tube
50	25,000	37,000	54,000	102,000		
60	23,000	34,000	49,000	93,000	171,000	
70	21,000	32,000	45,000	87,000	159,000	240,000
80	20,000	30,000	43,000	82,000	150,000	227,000
90	19,000	28,000	41,000	77,000	142,000	214,000
100	18,000	27,000	39,000	74,000	135,000	205,000
110	17,000	26,000	37,000	71,000	129,000	196,000
120	17,000	25,000	36,000	68,000	125,000	190,000
130	16,000	24,000	34,000	66,000	120,000	184,000
140	15,000	23,000	33,000	63,000	116,000	178,000
150	15,000	22,000	32,000	61,000	113,000	173,000
160	14,000	21,000	31,000	60,000	110,000	169,000
170	14,000	21,000	31,000	58,000	106,000	165,000
180	14,000	21,000	30,000	57,000	104,000	161,000
190	13,000	20,000	30,000	56,000	101,000	157,000
200	13,000	20,000	29,000	55,000	99,000	153,000
250	12,000	18,000	26,000	50,000	91,000	140,000
300	10,000	16,000	23,000	46,000	85,000	130,000
400	9,000	14,000	21,000	40,000	75,000	115,000
500	8,000	12,000	19,000	36,000	68,000	105,000

TO USE THESE TABLES

Enter left-hand column at figure nearest to measured length (plus radiator allowance, if any).

Read horizontally to capacity equal to or greater than capacity needed.

Read up to top of column to determine pipe or tube size.

MAIN SIZES — IRON PIPE OR TYPE L COPPER TUBE

TABLE 5C
FOR PRESSURE HEADS BETWEEN
8.8 and 10.7 FT. OF WATER

Measured Length Ft.	CAPACITY IN Btu/Hr.					
	½" Tube	⅝" Tube	¾" Pipe or Tube	1" Pipe or Tube	1¼" Pipe or Tube	1½" Pipe or Tube
50	29,000	44,000				
60	27,000	41,000	58,000			
70	25,000	38,000	54,000			
80	23,000	36,000	51,000	96,000	176,000	
90	22,000	34,000	49,000	91,000	167,000	
100	21,000	32,000	47,000	86,000	159,000	243,000
110	20,000	31,000	45,000	83,000	152,000	233,000
120	19,000	30,000	43,000	80,000	147,000	224,000
130	18,000	29,000	42,000	77,000	141,000	216,000
140	18,000	28,000	40,000	75,000	137,000	209,000
150	17,000	27,000	39,000	73,000	133,000	203,000
160	17,000	26,000	38,000	71,000	129,000	197,000
170	16,000	25,000	37,000	69,000	126,000	193,000
180	16,000	24,000	36,000	67,000	124,000	188,000
190	15,000	24,000	36,000	66,000	120,000	184,000
200	15,000	23,000	35,000	65,000	118,000	181,000
250	13,000	21,000	31,000	59,000	108,000	166,000
300	12,000	19,000	28,000	55,000	100,000	154,000
400	10,000	17,000	25,000	47,000	88,000	136,000
500	9,000	15,000	22,000	43,000	80,000	123,000

TABLE 5D
FOR PRESSURE HEADS BETWEEN
10.8 to 12.7 FT. OF WATER

Measured Length Ft.	CAPACITY IN Btu/Hr.					
	½" Tube	⅝" Tube	¾" Pipe or Tube	1" Pipe or Tube	1¼" Pipe or Tube	1½" Pipe or Tube
50	33,000	50,000				
60	30,000	46,000				
70	28,000	43,000	61,000			
80	26,000	40,000	57,000			
90	24,000	38,000	54,000			
100	23,000	36,000	52,000	98,000		
110	22,000	35,000	50,000	94,000	172,000	
120	21,000	33,000	48,000	91,000	166,000	
130	20,000	32,000	47,000	88,000	160,000	245,000
140	20,000	31,000	45,000	85,000	156,000	237,000
150	19,000	30,000	43,000	83,000	151,000	231,000
160	19,000	29,000	42,000	81,000	147,000	225,000
170	18,000	28,000	41,000	79,000	144,000	220,000
180	18,000	27,000	40,000	78,000	140,000	215,000
190	17,000	27,000	40,000	76,000	137,000	210,000
200	17,000	26,000	39,000	74,000	135,000	206,000
250	15,000	24,000	36,000	67,000	121,000	188,000
300	14,000	22,000	33,000	62,000	113,000	175,000
400	12,000	18,000	28,000	54,000	100,000	154,000
500	11,000	16,000	25,000	49,000	91,000	141,000

TO USE THESE TABLES

Enter left-hand column at figure nearest to measured length (plus radiator allowance, if any).

Read horizontally to capacity equal to or greater than capacity needed.

Read up to top of column to determine pipe or tube size.

I=B=R FORM 6001-31

I=B=R CALCULATION SHEET 6001

ESTIMATED BY

OWNER _____ ADDRESS _____ DATE _____

DEALER _____ KIND OF BUILDING Residence CHIMNEY SIZE _____

CONSTRUCTION: WALL 4" brick-paper-sheathing-studs-lath-plaster ROOF OR CEILING lath & plaster-no floor above-3-5/8" rock-wool

WINDOWS single, with storm sash SILL HEIGHT: 1ST FLOOR _____ 2ND FLOOR _____

BASEMENT HEIGHT: ABOVE GRADE _____ BELOW GRADE _____ AVERAGE WATER TEMPERATURE _____ TEMP. DIFF. 75 F

COLUMN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ROOM	ROOM SIZE			WINDOWS AND DOORS			AREA - SQ. FT.			(SEE NOTE)	VOLUME CU. FT.	TOTAL AT 70 F TEMP. DIFF.	TOTAL CORRECTED TO 75 F.	PANEL AREA AVAILABLE	PANEL AREA REQUIRED		RADIATION (OTHER THAN PANEL)	
	L	W	H	NUMBER OR SIZE	AREA	GROSS WALL	GLASS (FACTOR .45)	NET WALL (.27)	CEILING (.08)	FLOOR (.69)	.011 .017 .027				FLOOR	CEILING	SIZE	SQ. FT.
Kitchen	13	10	8	4 A	11	120	44	76	130	15	1040	5000	5360	130	107	89		
							1400	1400	700	700	800							
Dining Rm	8	8	8	2 B	9	64	18	46	64	8	512	2700	2890	64	58	48		
							600	900	400	400	400							
Entrance	7	8	8	1 F 1 C	19 14	56	33	23	56	7	448	2800	3000	56	60	50		
							1000	400	300	300	800							
Bath	7	12	8	2 E	4	72	8	64	84	9	672	2900	3730*	84	75	62		
							300	1200	500	400	500							
Bedroom 1	15	14	8	4 A	11	232	44	188	210	29	1680	9600	10290	210	206	172		
							1400	3600	1200	1400	2000							
Bedroom 2	11	10	8	4 A	11	168	44	124	110	21	880	6300	6750	110	105	113		
							1400	2300	600	1000	1600							
" (Recalculated with insulated walls-factor .08 from Table 1)						168	44	124	110	21	880	4700	5040	110	101	84		
							1400	700	600	1000	1000							
Study	13	12	8	3 A	11	168	33	135	156	21	1248	7000	7500	156	150	125		
							1000	2600	900	1000	1500							
Living Rm	26	14	8	1 F 6 D	19 14	296	103	193	364	37	2912	14300	15320	364	306	255		
							3300	3700	2000	1800	3500							
Hall	10	4	8						40			200	210	36				
									200									
Utility	10	14	8	1 F 5 E	19 4	272	39	233	140	34	1120	10100	5410**	140	108	90		
							1200	4400	800	1600	2100							
TOTALS													58,750					

NOTE: FOR CONCRETE FLOOR ON GROUND OR FILL AT GRADE LEVEL, USE LINEAR FEET OF EXPOSED EDGE. FOR ALL OTHER FLOORS, USE SQUARE FEET OF AREA.

*Corrected heat loss plus 20%

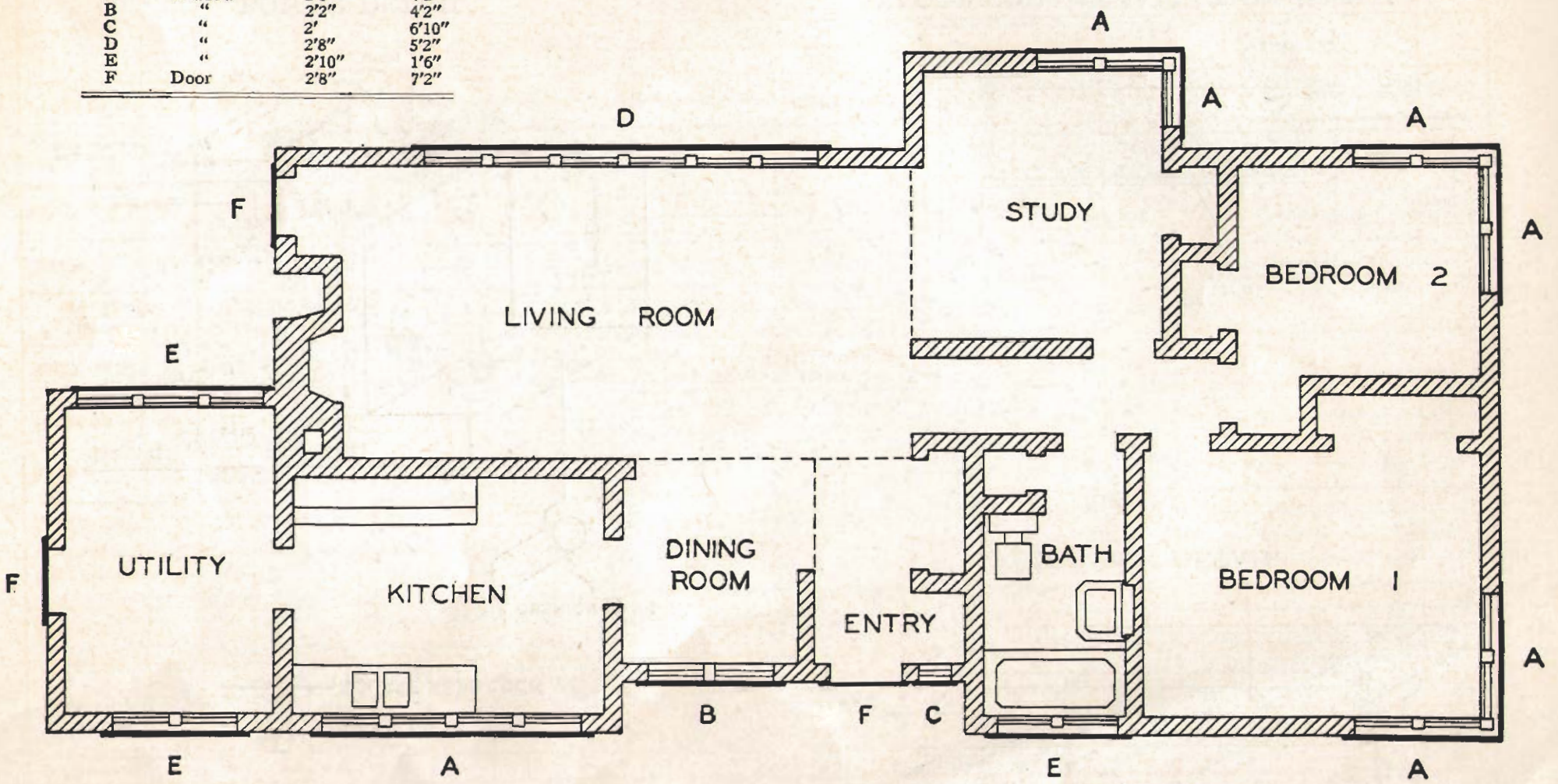
**Assume boiler will supply 50% of loss

FOR USE WITH I=B=R INSTALLATION GUIDE NO. 6

FORM 6001

WINDOW AND DOOR SCHEDULE

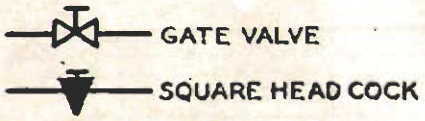
Symbol	Item	Window Opening or Door Size	
		Width	Height
A	Window	2'8"	4'2"
B	"	2'2"	4'2"
C	"	2'	6'10"
D	"	2'8"	5'2"
E	"	2'10"	1'6"
F	Door	2'8"	7'2"

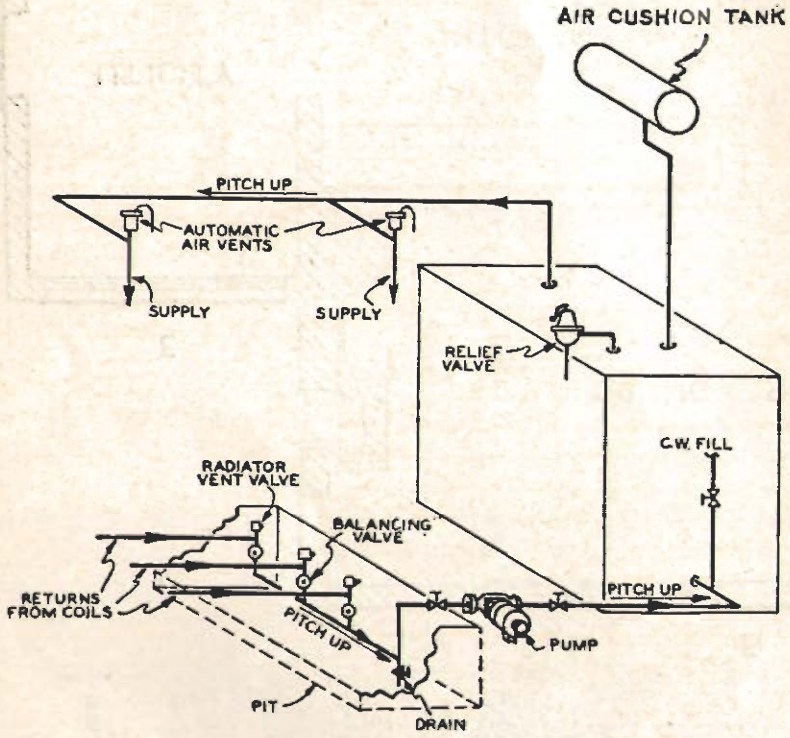


FLOOR PLAN

Figure A

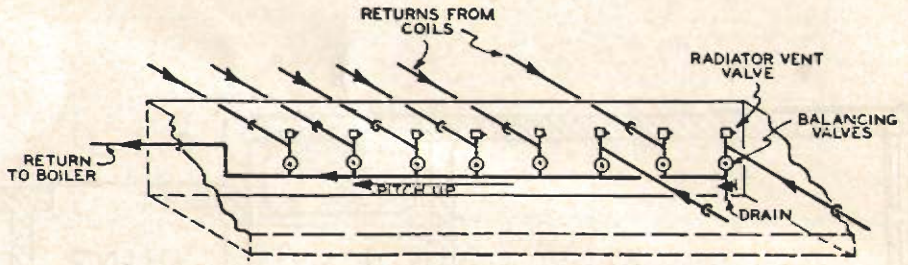
FLOOR PANEL SYSTEM





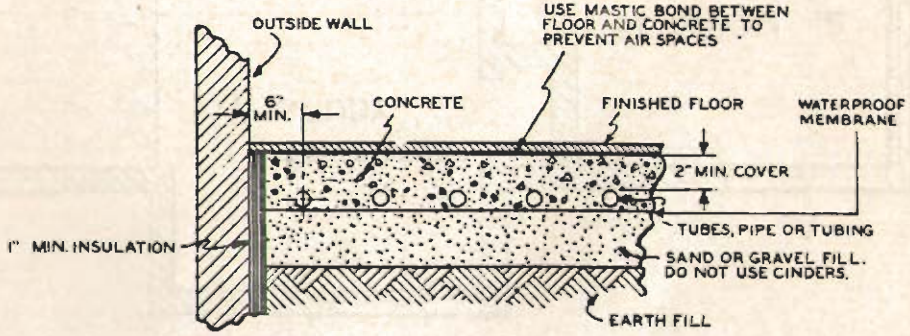
BOILER DETAIL

Figure B



FLOOR BOX DETAIL

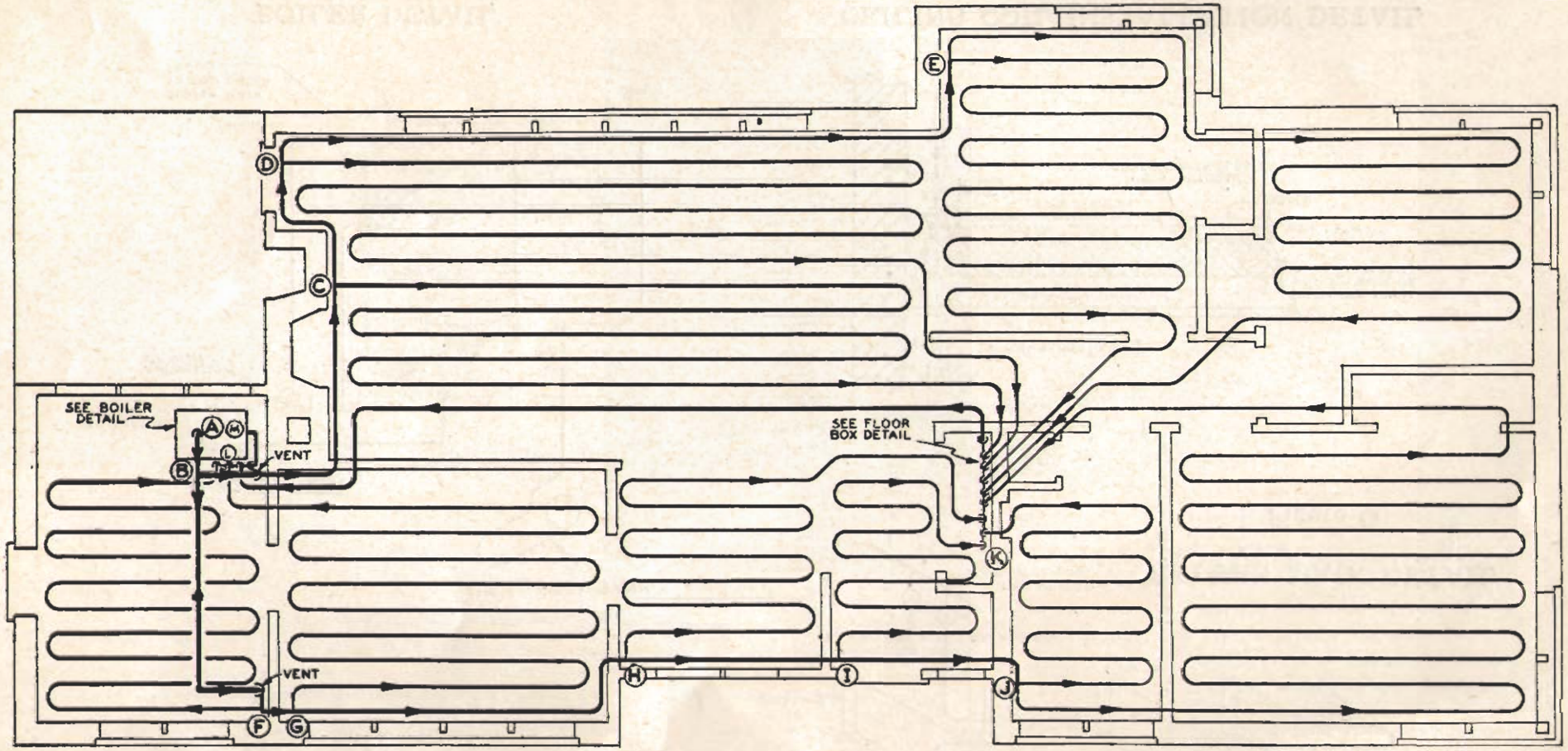
Figure C



FLOOR COIL INSTALLATION DETAIL

Figure D

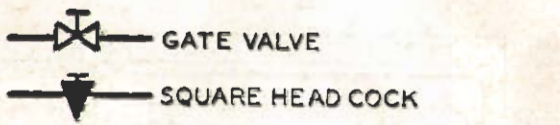
FLOOR PANEL SYSTEM

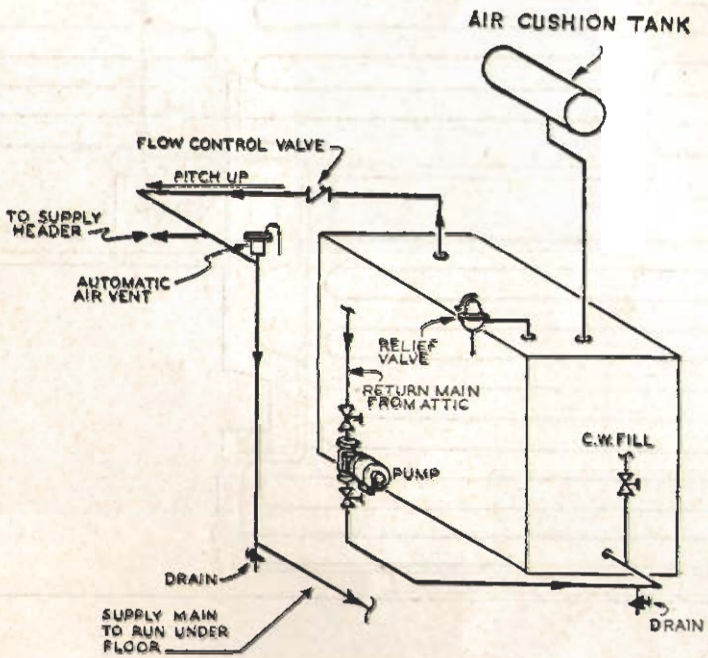


PIPING PLAN

Figure E

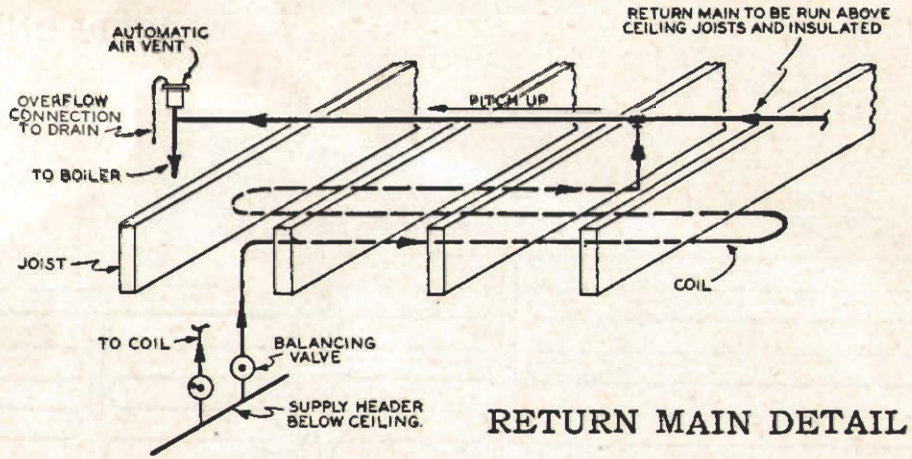
CEILING PANEL SYSTEM





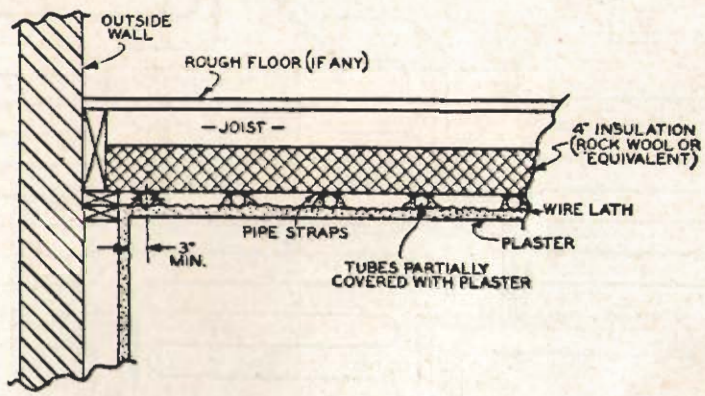
BOILER DETAIL

Figure F



RETURN MAIN DETAIL

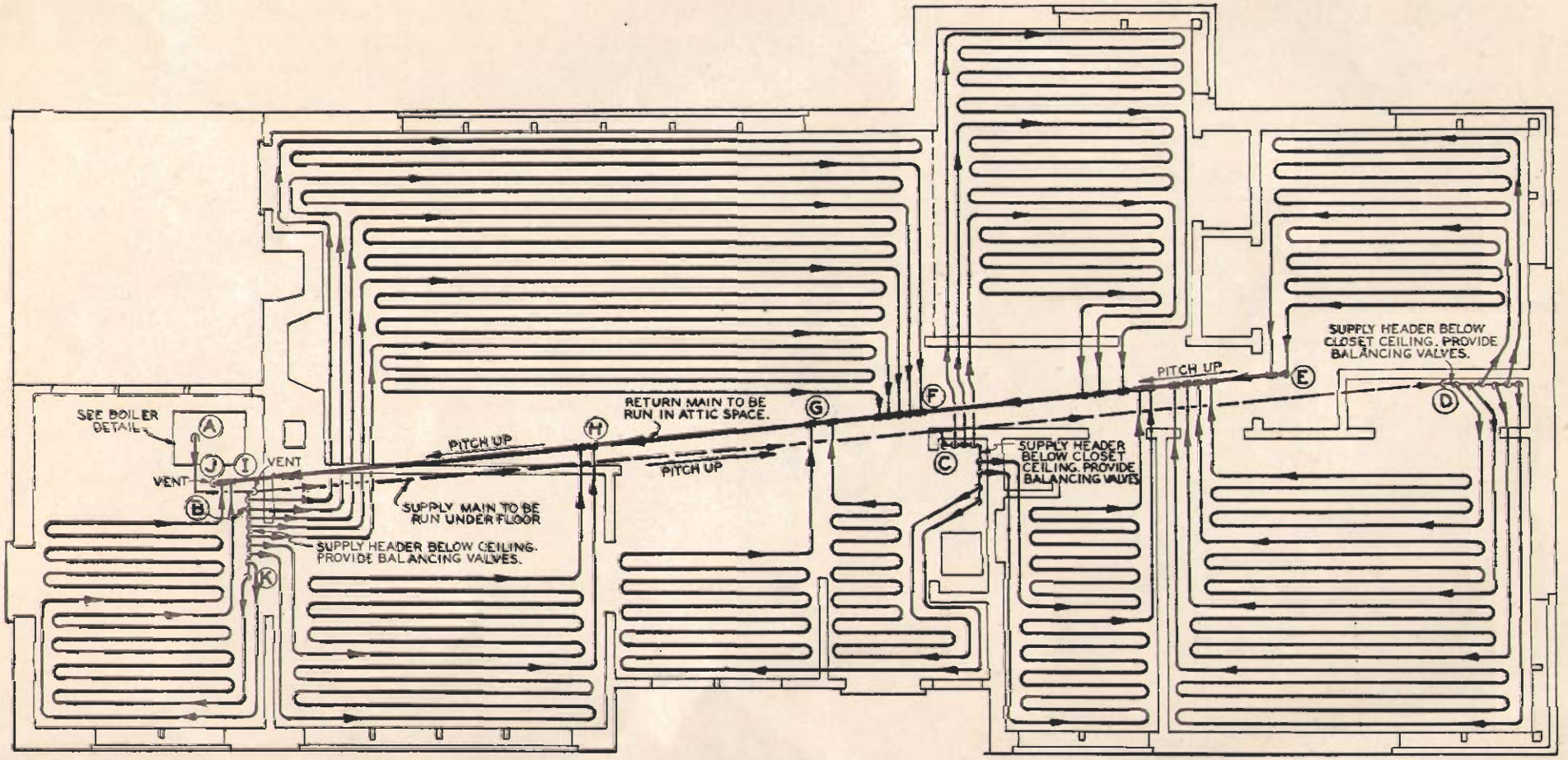
Figure G



CEILING COIL INSTALLATION DETAIL

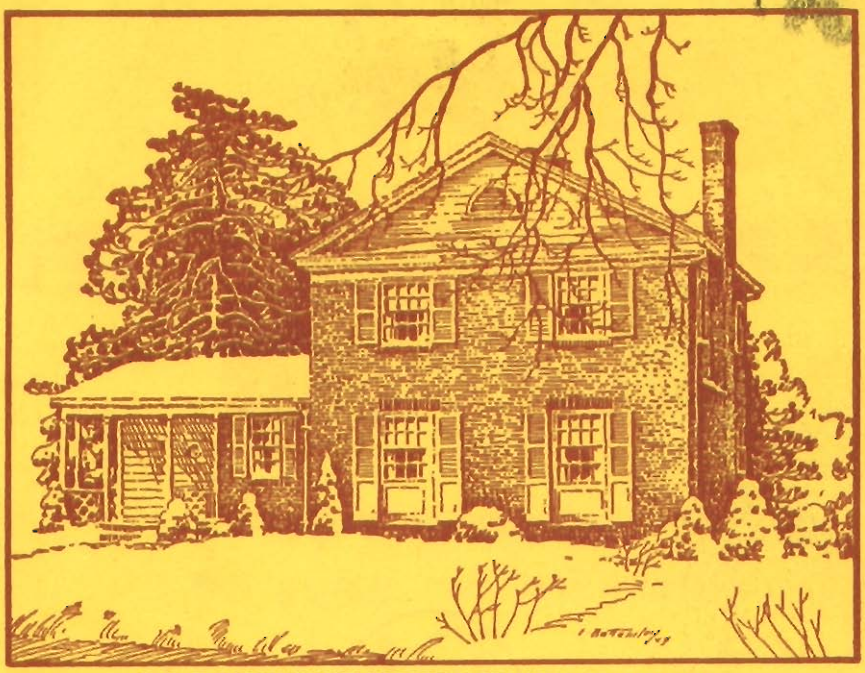
Figure H

CEILING PANEL SYSTEM



PIPING PLAN

Figure I



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