Basis of Working Rules for Pipes

(*Sections 1, 2, 3*)

a. These formulae are for 70 deg. temperature difference (outside temperature zero, inside temperature 70 deg. fahr.) When temperature difference is more than 70 deg., add 1½ per cent per deg. to final figures. When temperature difference is less than 70 deg., deduct 1½ per cent per deg. from final figures.

b. The values as given in Table A for use in the working rules, Article 3, Section 1, 2 and 3 are derived as follows:

Example: The unit of calculation adopted for this is the equivalent of 1,000 B.t.u. transmitted. Any other number than 1,000 might be selected if desired and the result would be the same. Calculations are based on the commonly accepted data for heat loss through different types of walls.[4] Thus, the factor 60, Item No. 1, Table A, is obtained in the following manner: The rate of heat transmission through a wall consisting of siding, paper, sheathing, studding, lath and plaster, is 0.238 B.t.u. per square foot, per hour, per degree difference between room and outside temperatures. At 70 deg. inside and zero outside, 1 sq. ft. of wall will transmit $0.238 \times 70 = 16.66$ B.t.u. per hour. 1,000 B.t.u. will then be lost through $1{,}000 \div 16.66 = 60$ sq. ft. of wall. Since it is found from experiment that 1 sq. in. of first-floor leader pipe delivers 111 B.t.u., it will require $1{,}000 \div 111 = 9$ sq. in. to compensate for the loss through 60 sq. ft. of wall. From this we derive the formula:

$$\frac{W \times 9}{60} = \text{area of first-floor leader.}$$

Substituting 167 for the second floor and 200 for the third floor in place of 111, gives the factors 6 and 5, respectively.

Other values in Table A for the different types of walls were obtained by substitution of proper coefficient of heat transmission for 0.238 in the above formula.

TABLE A[4]

(The factor 60 used in the foregoing example is for buildings constructed as in Item No. 1. When other types of walls are used substitute the appropriate factor as given below):

Exposed Walls	
No. 1.—Frame wall constructed of siding, paper, sheathing, studding, lath and plaster	60
No. 2.—Frame wall constructed of siding or stucco direct to sheathing (no paper), lath and plaster.	52
No. 3.— 9 in. Brick Wall, no plaster	40
No. 4.— 9 in. Brick Wall, plastered one side	48
No. 5.— 9 in. Brick Wall, air space, furred and plastered	65
No. 6.—13 in. Brick Wall, no plaster	53
No. 7.—13 in. Brick Wall, plastered one side	57
No. 8.—13 in. Brick Wall, air space, furred and plastered	75
No. 9.— 4 in. Brick, 4 in. hollow tile, plastered	55
No. 10.— 4 in. Brick, paper, sheathing, studding, lath and plaster (brick veneer)	68
No. 11.— 8 in. Hollow tile, stucco and plaster	52
No. 12.— 8 in. Hollow tile, stucco furred and plastered	75
Roofs	
No. 13.— 1 in. T & G Sheathing Tar and Gravel	48
No. 14.— 1 in. T & G Sheathing and Composition roof	40
No. 15.— 1 in. T & G Sheathing and Tin	24
No. 16.—Corrugated Iron on strips	9.3
Ceilings	
No. 17.—Lath and plaster without floor above	50
No. 18.—Lath and plaster with tight floor above	90
No. 19.—Metal without floor above	40
No. 20.—Metal with tight floor above	70

[4]The heat transmission factors upon which Table A is based do not in all cases agree with the factors given in Chapter 2 of THE GUIDE.

Explanatory Notes

Note 1.—In obtaining glass surface use full casement opening. An outside door is figured as glass.

Note 2.—To obtain net outside wall, multiply height by width and deduct the glass in all windows and outside doors as obtained in Note 1. For all rooms with attic spaces immediately above, full ceiling areas shall be taken into account, using Table A. Floors over unexcavated spaces shall be figured as 50 per cent exposed wall and fully exposed floors shall be figured as 100 per cent exposed wall.

Note 3.—For rooms having unusual exposure, ordinarily north, northeast and northwest, add 15 per cent to pipe area. For east and west exposure, add 10 per cent.

Note 4.—Use no basement warm-air duct less than 8 in. in diameter. If a basement warm-air duct figures greater area than any standard commercial size then the nearest commercial size shall be used, provided however, that the total duct area shall in no case be less than the total requirements according to Sections 1, 2 and 3.

Note 5.—It is understood in using the above values for determining basement warm-air duct areas, that these ducts should be run comparatively straight and that they should not be over 12 ft. in length. Sharp turns and long ducts should have extra capacity. When warm-air ducts exceed 12 ft. in length or have more than two 90 deg. turns the next larger commercial size must be used.

Note 6.—The value of 800 (used in cubic contents) is for an estimated air change of one room volume per hour. If it is desired to provide for one and one-half room volume use the figure 600. If for two-room volumes use the figure 400.

Method for Determining Size of Wall Stacks

Section 4. First Floor Rooms.

Same as Section 1.

Section 5. Second Floor Rooms.

Not less than 70 per cent of basement pipe area as determined in Section 2.

Section 6. Third Floor Rooms.

Not less than 70 per cent of basement pipe area as determined in Section 3.

Where two or more rooms are heated from the same basement pipe and stack, the area of such basement pipe and stack shall equal the combined areas as determined in Article 3, Sections 1, 2 and 3.

Transition Fittings to Stacks

Section 7. (*a*) Transition from warm-air pipes to stacks or register heads shall be made with a well-designed elbow or boot and no stack shall be less than 70 per cent of the area of the warm-air pipe leading to it.

b. All first-floor fittings and connections shall maintain a free area equal to the round basement pipes leading to them.

Method for Determining Size of Registers

Section 8. All registers shall have a free area at least equal to the area of the basement pipes leading to them.

Method for Determining Size of Furnace

Section 9. (*a*) Add together the areas (expressed in square inches) necessary for heating the building, as determined by the foregoing calculated requirements, Art. 3, Secs. 1, 2 and 3, and install a furnace, rated by the following formula:

Furnace Rating Formula

$$L = 1.75\,G\,[\,1 + 0.02\,(R - 20)\,]$$

L = square inches of warm-air pipe connected to the furnace as calculated.

G = grate area in square inches; the area of the firepot at the grate level; its most restricted area.

R = ratio of heating surface area to grate area;

1.75 = a constant based upon the results obtained in the Association Research on a furnace having 20 sq. ft. of heating surface for each square foot of grate, and including factors for:

E = efficiency of heater;
C = combustion rate;
F = calorific value of fuel;
0.75 = percentage of heat available at registers;
136 = B.t.u. delivering value of 1 sq. in. of pipe, assuming half of the heat is sent to each floor. This value is based on an operating temperature of 175 deg. fahr. at the register.

The formula allows 1.75 sq. in. of warm-air pipe area for each square inch of grate area, for the furnace having a ratio of heating surface to grate surface of 20 to 1. For furnaces having other ratios of heating surfaces to grate surface, it adds 2 per cent or deducts 2 per cent for each unit above or below a ratio of 20.

Application:

		No. 1 Positive Correction	No. 2 No Correction	No. 3 Negative Correction
Grate area, square inch.	=	346	346	346
Heating surface area, square inch.	=	7540	6920	5665
Ratio heating surface area to grate area	=	21.8 to 1	20.0 to 1	16.4 to 1
$R - 20$	=	1.8	0.0	−3.6
Correction per cent	=	3.6	0.0	−7.2
$1.75\,G$	=	606	606	606
$L = 1.75\,G$ + correction	=	628	606	562

a. In second-floor duplex, flats or apartments where separate heating plants are used, add 50 per cent to the total net *calculated* areas as determined in Art. 3, Sec. 2. This