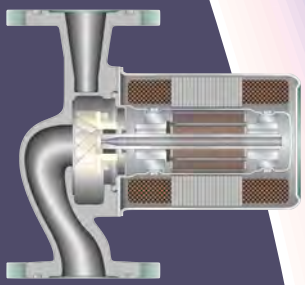
The Color of Water

Piping & Designing Hydronic Systems

Version 2.0



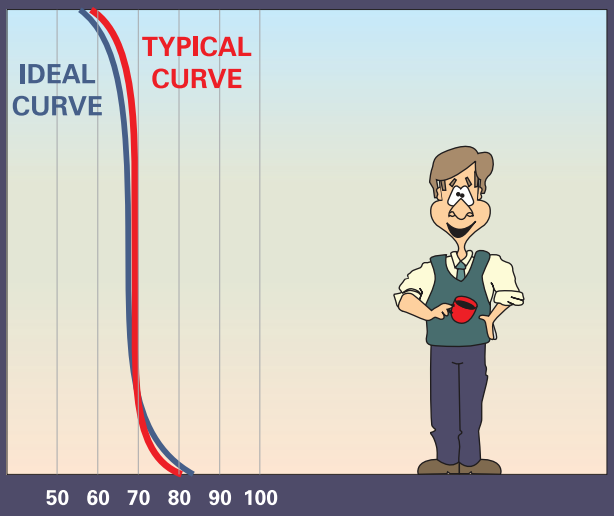
FULL COLOR TRAINING GUIDE SERIES

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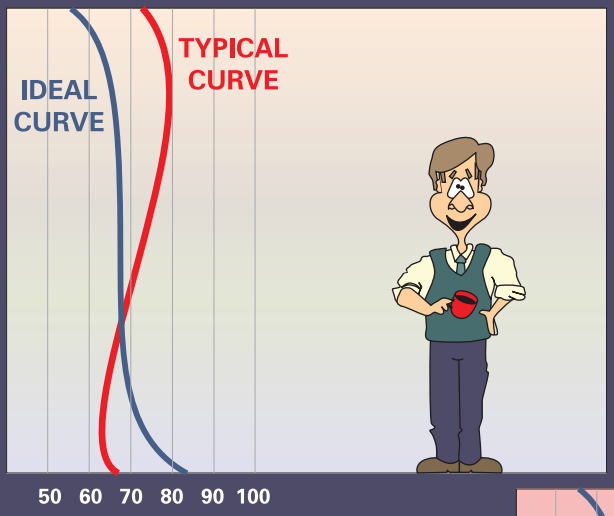
PeerlessBoilers.com

Installation and Training Information

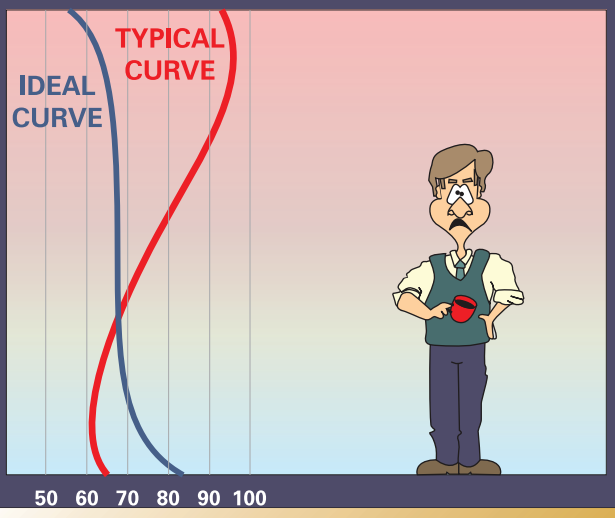
HYDRONIC COMFORT



RADIANT FLOOR SYSTEMS (Typical Temperature Map)



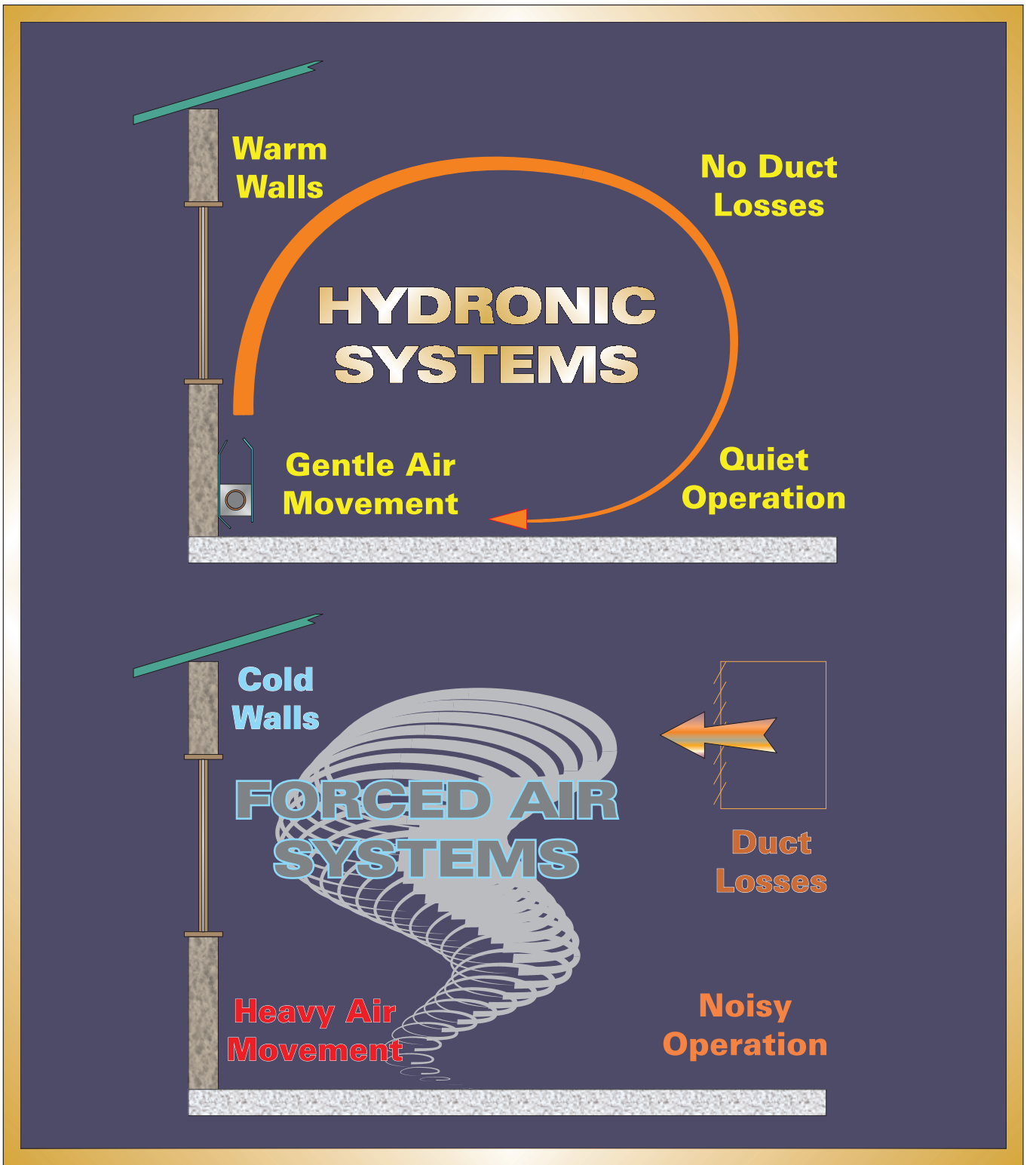
HYDRONIC BASEBOARD SYSTEMS (Typical Temperature Map)



FORCED AIR SYSTEMS (Typical Temperature Map)

Hydronic systems provide a better temperature distribution in the room. The Ideal is warm feet and cool head.

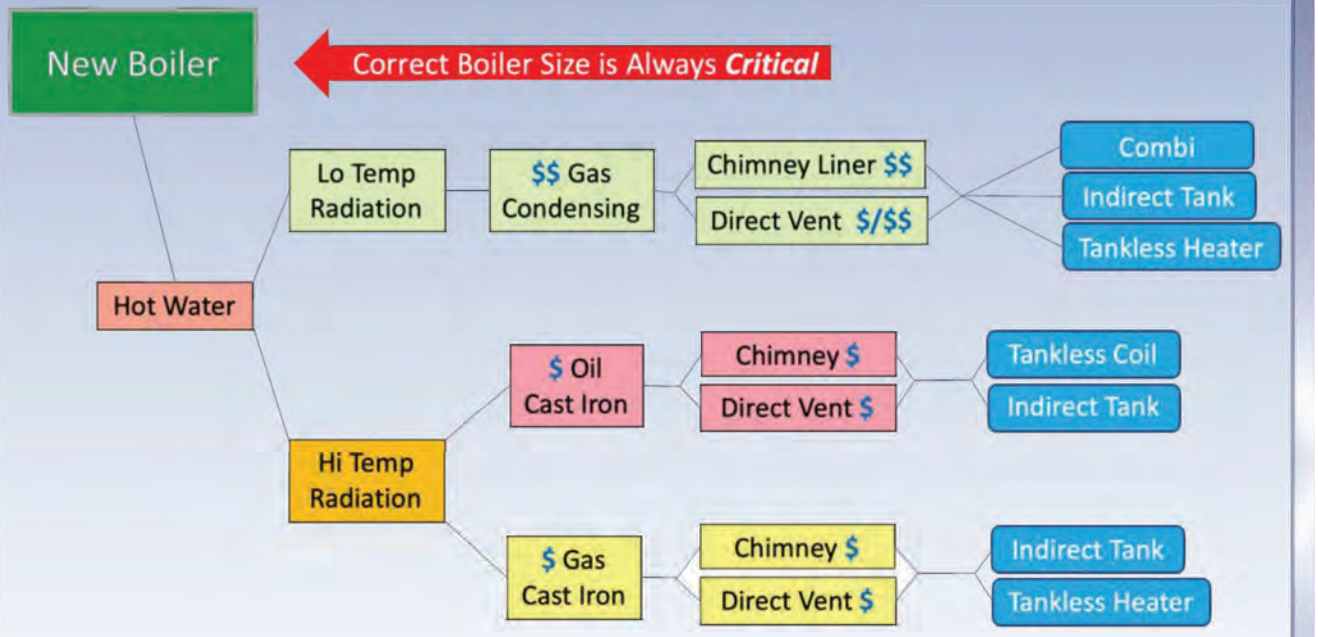
Radiant floor systems provide the best results. The temperature map almost exactly matches the Ideal heating curve.



Hydronic heating is comfortable, quiet and efficient.

Warm air heating cannot equal the performance of a hydronic system.

CHOOSING THE RIGHT BOILER



QUESTIONS WHEN CHOOSING THE BOILER

Heat load of the building?

Capacity of the heat radiation?

Type of heat distribution?

High or low system water temperature?

Flue gas venting options?

Domestic Hot Water from boiler? How much?

Is the radiator capacity way more than the heat load of the building?

Examples of heat radiation are copper baseboard, cast iron radiators or baseboard, air handlers, in-floor radiant, panel radiators and towel warmers.

IMPORTANCE OF CORRECT BOILER SIZING

It's natural to worry about undersizing. What about oversizing? Is bigger always better?





Oversizing Causes Boiler Short-Cycling - with

Higher fuel usage

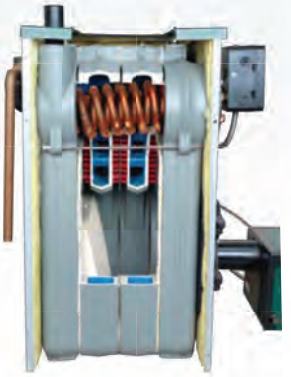
Reduced lifetime - Premature boiler failure

Boiler needs new parts all the time



All oversized boilers can suffer from short-cycling

High-efficiency modcon boilers are most affected



COMMON CONCERN: If the boiler's too small, it will show up at the worst possible time. The boiler will keep running and just won't keep up.

If the boiler's too big, what's the worst that can happen? Nobody ever complains they are too warm, right? (Actually, it could be even *worse* than being too small.)

BOILER SHORT CYCLING

HIGHWAY DRIVING VS CITY DRIVING





SHORT-CYCLING : TELLTALE SIGNS

FREQUENT SERVICE CALLS



HIGH FUEL BILLS



HIGH IGNITION CYCLE COUNTS



Long burner cycles are more fuel-efficient, like highway driving.
Frequent starts and stops waste fuel and wear out parts faster.
What harm does city driving or heavy traffic do to the engine and to miles-per-gallon?
That's what happens to a boiler that short cycles.

SIZING REPLACEMENT BOILERS

COPPER BASEBOARD SYSTEM

Rule of Thumb

Calculate the building heat loss - or -

Measure the installed length of baseboard element and multiply the number times: 600 Btus for standard baseboard with 180° system water.



Select a boiler with Net Output rating at least equal to the load.

RADIANT FLOOR SYSTEM

Rule of Thumb

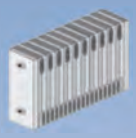
Calculate the building heat loss.

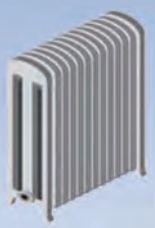
Increase the calculated heat loss by 10% to 15% for extra piping and pick-up losses.

Add for domestic water load if necessary

Select a boiler with a Net Rating at least equal to the load, but not much more.

Apply these guidelines for baseboard systems and radiant floor systems.



SIZING REPLACEMENT BOILERS

Rule of Thumb

CONVERTED GRAVITY SYSTEM - or - LARGE WATER CONTENT SYSTEM

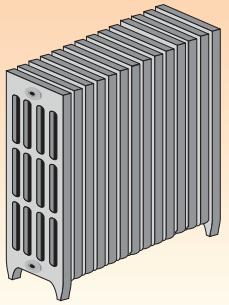
- *Calculate the installed square feet of radiation. You can use the cast iron radiation table in this book, or other references for radiation types not shown.*
- *Increase the load by 15% to 25% for additional piping and pick-up losses.*
- *Change the calculated load in square feet of radiation to Btuh by multiplying by 150 for average water temperature of 180°F.*
- *Add for domestic water load if necessary*
- *Select a boiler with a Net I=B=R rating at least equal to the load, but not much more.*

Use these rules of thumb for high volume systems and gravity return systems.

CAST IRON RADIATORS

Rule of Thumb

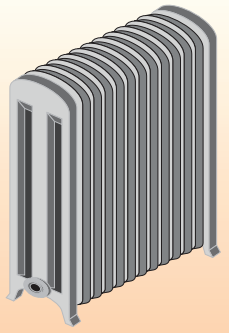
One square foot of radiation will put out 150 Btuh when the system water temperature is 180° F.



TUBULAR RADIATION

RATING - Square Feet per Section

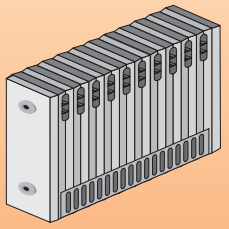
Height	3 Tube	4 Tube	5 Tube	6 Tube	7 Tube
14"					2.67
17"					3.25
20"	1.75	2.25	2.67	3.00	3.67
23"	2.00	2.50	3.00	3.50	
26"	2.33	2.75	3.50	4.00	4.75
32"	3.00	3.50	4.33	5.00	5.50
38"	3.50	4.25	5.00	6.00	6.75



COLUMN RADIATION

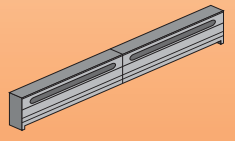
RATING - Square Feet per Section

Height	1 Column	2 Column	3 Column	4 Column	5 Column
14"					4.00
17"					4.00
18"			2.25	3.00	5.00
20"	1.50	2.00			5.00
22"			3.00	4.00	6.00
23"	1.67	2.33			
26"	2.00	2.67	3.75	5.00	
32"	2.50	3.33	4.50	6.50	
38"	3.00	4.00	5.00	8.00	
44"				10.00	
45"		5.00	6.00		



RADIANT CONVECTOR

Width	Height	Square Feet Per Section
5"	20"	2.25
7 1/2"	20"	3.40



CAST IRON BASEBOARD

Width	Height	Square Feet Per Linear Foot
2 1/2"	10"	3.40

Use these charts to figure the total heating surface of all cast iron radiation in the home.

The output from the radiation will be 150 Btuh per square foot when the system water temperature in the radiation is 180° F.

CAST IRON RADIATOR RECORDING SHEET

Radiation Measuring Sheet

(Enter #T for Tubes or #C for Columns)

*EDR = Square feet of Equivalent Direct Radiation

	Room Name	§ Feet of Copper Baseboard Element	Number of CI Radiators	# of Tubes or Columns	Number of Sections	Cast Iron Height	Cast Iron Width	Feet of CI Baseboard	EDR*/Section or /Foot from Chart	Total
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										

= Total Feet of Copper BB Element	TOTAL EDR =
= Element x 600 BTUH§ (@180˚)	EDR x 170 BTUH† (@180˚) =
§Water temperature other than 180˚ see capacity chart	† For water temperature other than 180˚, see EDR Output Chart

SAMPLE LISTING

	Room Name	§ Feet of Copper Baseboard Element	Number of CI Radiators	# of Tubes or Columns	Number of Sections	Cast Iron Height	Cast Iron Width	Feet of CI Baseboard	EDR*/Section or /Foot from Chart	Total
1	Den		2	5T	7	26			3.5	24.5
2	1/2 Bath		1	3C	3	22			3	9
3	Dining Room		3	5T	5	26			3.5	17.5

= Total Feet of Copper BB Element	TOTAL EDR =	370.71
= Element x 600 BTUH§ (@180˚)	EDR x 170 BTUH† (@180˚) =	55606.5
§Water temperature other than 180˚ see capacity chart	† For water temperature other than 180˚, see EDR Output Chart	

BASEBOARD - HOT WATER RATINGS

BTU/hr per linear foot with 65º entering air

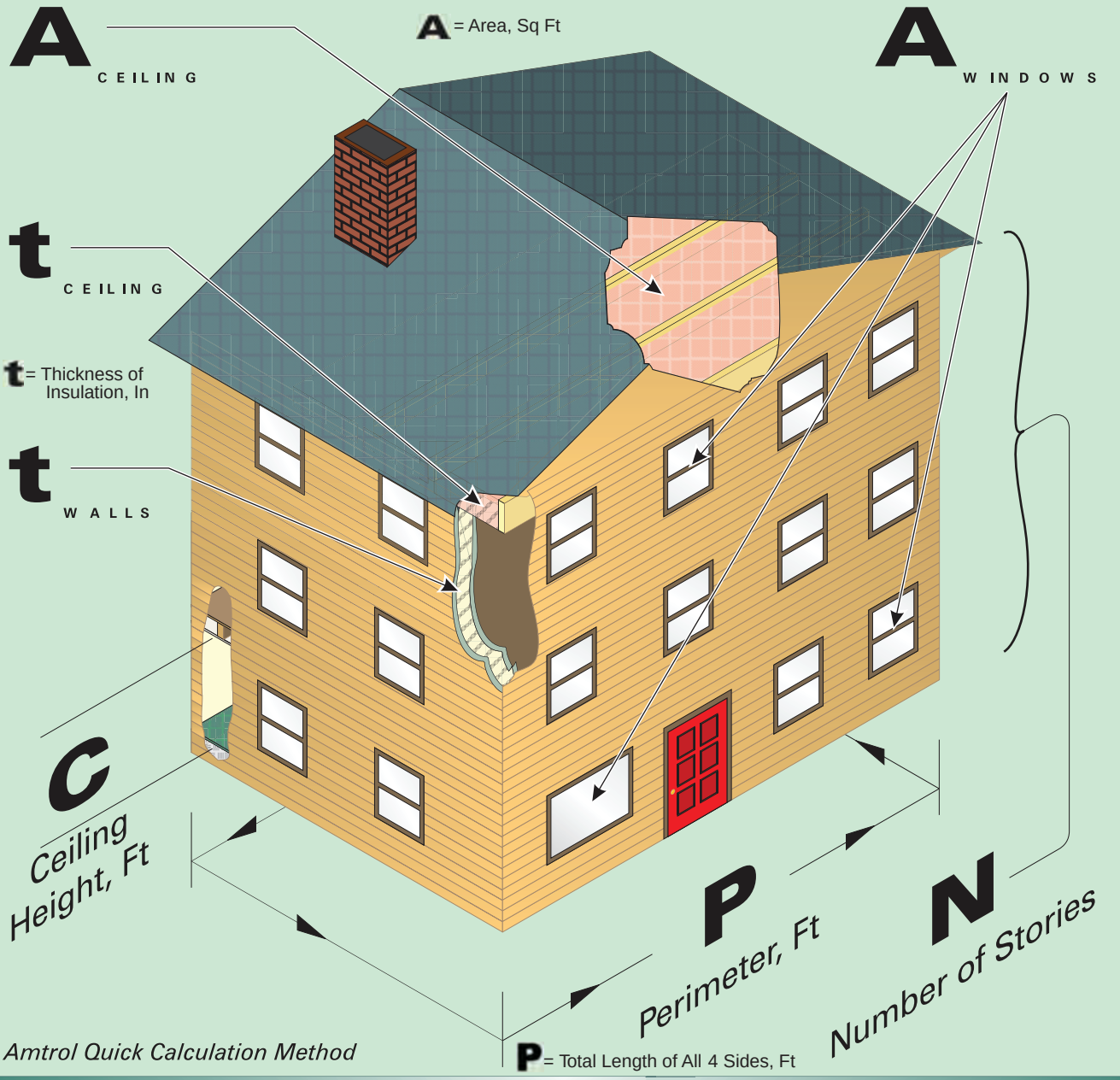
	Water Flow	110˚F	120˚F	130˚F	140˚F	150˚F	160˚F	170˚F	180˚F	190˚F	200˚F	210˚F	215˚F	220˚F
3/4" Element	1 GPM	160	210	260	320	380	450	510	580	640	710	770	810	840
	4 GPM	160	220	270	340	400	480	540	610	680	750	810	860	890

Use the blue column to record the length of copper fin-tube element (not the baseboard casing.)

Use the remaining columns to record the dimensions and shapes of cast iron radiators or convector blocks. Use the third from last column to record length of cast iron baseboard.

Use the hot water ratings chart to convert feet of copper fin-tube baseboard to BTUs.

HEAT LOAD CALCULATIONS



Amtrol Quick Calculation Method

This manual heat load calculation is courtesy of Amtrol, developed by their training group.

The advantage of this calculation is that you don't need a software program to run it. Running a manual calculation gives a better understanding of where a building loses heat.

WHAT YOU NEED TO KNOW

$A_{WINDOWS}$, Ft^2	_ _ _ _ _ _ _ _ _ _ _ _ _	
$A_{CEILING}$, Ft^2	_ _ _ _ _ _ _ _ _ _ _ _ _	
$t_{CEILING}$, Inches	_ _ _ _ _ _ _ _ _ _ _ _ _	
t_{WALLS}, Inches	_ _ _ _ _ _ _ _ _ _ _ _ _	
N Number of Stories	_ _ _ _ _ _ _ _ _ _ _ _ _	
C Ceiling Height, Ft	_ _ _ _ _ _ _ _ _ _ _ _ _	
P Perimeter, Ft	_ _ _ _ _ _ _ _ _ _ _ _ _	
U Window Heat Loss Factor	_ _ _ _ _ _ _	

Single Pane U = 1.15
Single Pane w/ Storms U = 0.65
Double Pane U = 0.53

F Infiltration Factor	_ _ _ _ _ _ _ _ _ _ _ _ _	

Loose Construction (1 1/2 air changes per hour) F = 0.027
Average Construction (1 air change per hour) F = 0.018
Tight Construction (2/3 air change per hour) F = 0.012

Take measurements on the house and fill in the blanks.

The thicknesses, tCEILING and tWALLS, above are thickness of the insulation only.

AREAS AND VOLUMES

A_{WALL}, Ft^2 = Total Wall Area, Ft^2

	x		x		=	
P		C		N		A_{WALL}, Ft^2

$A_{NETWALL}$, Ft^2 = Net Wall Area, Ft^2

	–		=	
A_{WALL}		$A_{WINDOWS}$*		$A_{NETWALL}$, Ft^2

V_{HOUSE}, Ft^3 = Volume of House, Ft^3

	x		x		=	
$A_{CEILING}$		C		N		V_{HOUSE}, Ft^3

R FACTORS

R_{WALL}

4	+ (	3	x		) =	
				t_{WALL}		R_{WALL}

$R_{CEILING}$

4	+ (	3	x		) =	
				$t_{CEILING}$		$R_{CEILING}$

Calculate the Areas, Volume and R Factors and write in the numbers above.

* A quick rule of thumb to calculate the area of windows is to multiply the AWALL by .25.

HEAT LOSSES

T_{DIFF} = Design Temperature Difference

H_{WALLS}, Btuh = Heat Loss Through Walls

[ ] x [ ] ÷ [ ] = [ ]

A_{WALLS} T_{DIFF} R_{WALLS} H_{WALL}, Btuh

$H_{CEILING}$, Btuh = Heat Loss Through Ceiling

[ ] x [ ] ÷ [ ] = [ ]

$A_{CEILING}$ T_{DIFF} $R_{CEILING}$ $H_{CEILING}$, Btuh

$H_{WINDOWS}$, Btuh = Heat Loss Through Windows

[ ] x [ ] x [ ] = [ ]

$A_{WINDOWS}$ U T_{DIFF} $H_{WINDOWS}$, Btuh

H_{INFILT}, Btuh = Heat Loss Through Infiltration

[ ] x [ ] x [ ] = [ ]

V_{HOUSE} F T_{DIFF} H_{INFILT}, Btuh

H_{TOTAL}, Btuh = TOTAL HEAT LOSS FOR HOUSE

[ ] + [ ] + [ ] + [ ] = [ ]

H_{WALLS} $H_{CEILING}$ $H_{WINDOWS}$ H_{INFILT} H_{TOTAL}, Btuh

Calculate the heat losses and write in the numbers above.

TDIFF is the temperature difference between indoors and outdoors on the coldest normal day.

Example: Indoor Temp 70º - 0º Outdoor = 70º TDIFF