PF-501

COMFORT HEATING SIZING GUIDE

The facts and the recommendations made in this publication are based on our own research and the research of others and are believed to be accurate.

We cannot anticipate all conditions under which this information and our products or the products of other manufacturers in combination with our products may be used. We accept no responsibility for results obtained by the application of this information or the safety and suitability of our products either alone or in combination with other products. Users are advised to make their own tests to determine the safety and suitability of each such product or product combination for their own purposes.

Written By
Paul Rannick
Adam Heiligenstein

Chromalox® Industrial
Wiegand Industrial Division
Emerson Electric Company
701 Alpha Dr.
Pittsburgh, PA 15238
(412) 967-3800

Trademarks:
NFPA and NEC are registered trademarks of National Fire Protection Association
UL is a trademark of Underwriter Laboratories, Inc.
FM is a trademark of Factory Mutual Research Corporation
CSA is a registered trademark of Canadian Standards Association

Revised 8/98

Methods of Heat Transfer

To thoroughly understand which method of comfort heating best meets your application, it is important to understand the basic methods of heat transfer. Heat transfer is accomplished by CONDUCTION, CONVECTION, or RADIATION.

CONDUCTION is defined as transferring heat through a conducting medium by way of direct contact.

CONVECTION transfers heat via a medium such as liquid or air. In comfort heating a source of heat is used to warm the air and create a desired comfort level around people. Heated air can be circulated by fans or blowers to disperse the heat in a large enclosed area. Home heating with a forced-air furnace is an example of CONVECTION heat.

RADIANT, or INFRARED heat uses invisible, electromagnetic waves from an energy source. An example of electromagnetic infrared energy is heat from the sun. In an infrared system, these energy waves are created by a heat source - quartz lamp, quartz tube, or tubular. These waves are directed by optically designed reflectors toward or onto the object or person being heated. A fireplace is a familiar form of radiant heat.

Sizing Comfort Heating Applications

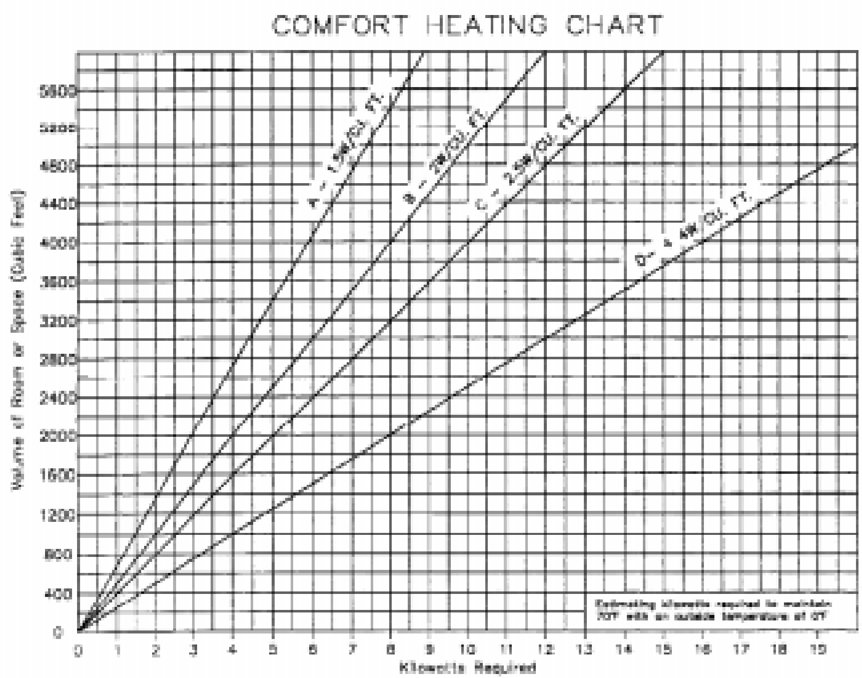
To get an approximate sizing of the heating requirements for a room, the following guide may be utilized. **For a more detailed analysis it is recommended that the ASHRAE guidelines be followed when performing an analysis for a complete building.** Also available is a computer-sizing tool that is designed to perform room-by-room heat loss estimates. When sizing the job, the first step is to determine the construction data and sizing requirements. You will need to collect the following information:

- Voltage and phase
- Length, width, and height of building
- R-factor for ceilings and walls
- Air changes or how much fresh air is brought in per hour
- Outside lowest temperature
- Desired inside temperature
- Size and number of windows and doors
- Floor Construction

Quick Estimations of Room Heat Loss

If a quick estimate is required, Graph 1 may be used to estimate heating requirements. This is an excellent chart when doing up front budgeting and sizing, or if there is simply a small room that needs some heat.

Graph 1: *Quick Estimation Chart for Various Room Heat Loss Conditions*



Curve A: Rooms with little or no outside exposure. No roof or floor with outside exposure; only one wall exposed with not over 15% door and window area.
Curve B: Rooms with average exposure. Roof and 2 or 3 exposed walls, up to 30% door and window area, but with roof, walls, and floor insulated if exposed to outside temperatures.
Curve C: Rooms with roof, walls, and floor uninsulated but with inside facing on walls and ceiling.
Curve D: Exposed guard houses, pump houses, cabins, and poorly constructed rooms with reasonably tight joints but no insulation. Typical construction of corrugated metal or plywood siding, single layer roofs.

General Industrial Sizing Guide

If more detail is required when doing the application sizing, a worksheet can be found at the back of this manual that may be used when gathering information and performing the calculations. A sample of the worksheet is shown below. The factors for the U-values may be found in Table 1 on the next page. **NOTE: U = 1 / R.** In addition, outside design temperatures may be found in Table 2 for various parts of the country.

CHROMALOX

General Industrial Sizing Guide

Heat Loss Calculation- Indoor

Job Name: ____________ **Date:** ____________
Location: ____________ **Room:** ____________
Bid Number: ____________ **Reference:** ____________

Voltage: ______ V **Phase:** ______

Room Size

Length: ______ ft. **Width:** ______ ft. **Ceiling Height:** ______ ft.
Total Square Footage: ______ square feet

Heater Mounting Height: ______ ft.

Design Information

Ceiling R-Factor: ______ **Outside Design Temperature:** ______ F
Wall R-Factor: ______ **Desired Inside Temperature:** ______ F
Temperature Rise: [ ] F
Air Changes Per Hour: ______ cubic foot per hour

Calculation

Item	Area	sq-ft	X	U-Factor	=	BTU/Hr/Degree F
Windows	______	sq-ft	X	______	=	______
Doors	______	sq-ft	X	______	=	______
Net Wall	______	sq-ft	X	______	=	______
Roof	______	sq-ft	X	______	=	______
Floor Perimeter *	______	ft	X	______	=	

Item A **TOTAL =** [ ] BTU/Hr/degree F

* For floor perimeter use U-factor of 1.2, 0.7, or 0.6 for exposed, 1" insulation, or 2" insulation respectively

Air Change Loss Cubic foot per hour X 0.019 BTU/cubic ft. = BTU/hr/degree F
Item B ______ cubic ft./hr X 0.019 BTU/cubic ft. = [ ]

TOTAL Item A + Item B = [ ] BTU/Hr/degree F

Item C Convert to Watts = Total / 3.412 = [ ] Watts/Hr/degree F

TOTAL HEATING REQUIREMENT

Item C x Temperature Rise = Watts/Hr
[ ] Watts/Hr/degree F **X** [ ] degree F **=** [ ]
Total Watts/Hr.

Figure 1: *Heat Loss Calculation Form for General Industrial Applications*

Table 1: *U-Values for Common Building Materials*

MATERIAL	DESCRIPTION	THICKNESS	R- FACTOR
Glass	Single Pane	-	.88
	Double Pane	-	2.22
	Triple Pane	-	3.56
	Glass Block (avg.) 2"	-	2.50
	Glass Block (avg.) 4"	-	3.22
	Translucent Curtain Wall	-	2.50
Woods	Hardwoods (Maple, Oak)	1 "	0.91
	Softwoods (Fir, Pine)	1 "	1.25
Insulating Materials/			
Blanket and Batt:	Cotton Fiber	3" - 3 1/2"	11.00
	Mineral Wool	5 ¼"-6 1/2"	19.00
	Wood Fiber	8 1/2 "	30.00
Board and Slabs:	Cellular Glass	1 "	2.50
	Corkboard	1 "	3.70
	Glass Fiber (Avg.)	1 "	4.00
	Expanded Rubber (Rigid)	1 "	4.55
	Expanded Polystyrene (Styrofoam)	1 "	4.35
	Expanded Polyurethene	1 "	6.25
	Rapco Foam	1 "	5.00
	Mineral Wood with Resin Binder	1 "	3.70
	Mineral Fiberboard, wet felted (Acoustical tile)	1 "	2.86
	Mineral Fiberboard, molded (Acoustical tile)	1 "	2.38
	Homosote	1 "	2.38
	Roof Insulation (performed for above deck)	1 "	2.78
Loose Fill:	Cellulose	1 "	3.70
	Mineral Wool (glass, slag or rock)	1 "	3.70
	Sawdust or Shavings	1 "	2.22
	Silica Aerogel	1 "	6.25
	Vermiculite (Expanded)	1 "	2.13
	Wood Fiber (Avg.)	1 "	3.57
	Perlite (Expanded)	1 "	2.70
Masonry Materials:	Concretes:		
	Cement Mortar	1 "	0.20
	Gypsum-Fiber Concrete	1 "	0.60
	Stucco	1 "	0.20
	Dry Wall	1/2 "	0.50
Masonry Units:	Brick, Common (Avg.)	1 "	0.20
	Brick Face (Avg.)	1 "	0.11
	Concrete Blocks (three oval core)		
	Sand & Gravel Aggregate	8 "	1.11
	Cinder Aggregate	8 "	1.72
	Lightweight Aggregate	8 "	2.00
	Stucco	1 "	0.20

Table 1: U-Values for Common Building Materials (cont'd)

MATERIAL	DESCRIPTION	THICKNESS	R-FACTOR
Siding Materials:	Asbestos-Cement Shingles	-	0.21
	Wood (7 ½" Exposure)	16 "	0.87
	Wood (12" Exposure)	10 "	1.19
	Asbestos-Cement ¼ ", lapped	-	0.21
	Asphalt roll siding	-	0.15
	Asphalt insulating siding 112' bd.	-	1.46
	Wood, plywood, %' lapped	-	0.59
	Wood, bevel, ½' x 8" lapped	-	0.81
	Sheet Metal, single sheet (avg.)	-	0.83
	Architectural Glass	-	0.10
Roofing:	Asbestos-Cement Shingles	-	0.21
	Asphalt Shingles	-	0.44
	Slate	½ "	0.05
	Built-up Roofing	3/8 "	0.33
Air Spaces:	Horizontal: Ordinary materials-vertical flow	¾ " – 4 "	0.80
	Vertical: Ordinary matericals-horizontal flow	¾ " – 4 "	0.96
Exposed Doors:	Metal-Single Sheet	-	0.83
	Wood	1 "	1.56
	Wood	2 "	2.33

NOTE: R_{Factor} = L/k, where L is the thickness in inches and k is BTU*in / (ft^2*°F*hr)

Table 2: *Typical Outside Design Temperatures for the United States*

State	City	Mean Wind Speed: MPH[3]	Heating Degree Days[1]	Yearly Snow-fall Mean[4]	Outside Design Temp.[2]
Alabama	Birmingham	7.4	2844.0	1.2	17.0
	Huntsville	8.0	3302.0	2.5	11.0
	Mobile	9.2	1684.0	0.5	25.0
	Montgomery	6.8	2269.0	0.4	22.0
Alaska	Anchorage	6.7	10911.0	70.2	-23.0
	Fairbanks	5.3	14344.0	68.8	-51.0
	Juneau	8.5	9007.0	108.2	-4.0
	Nome	10.8	14325.0	54.5	-31.0
Arizona	Flagstaff	7.4	7322.0	88.6	-2.0
	Pheonix	6.2	1552.0	0.0	31.0
	Tucson	8.2	1752.0	1.4	28.0
	Winslow	8.8	4733.0	11.1	5.0

Table 2: Typical Outside Design Temperatures for the United States (cont'd)

State	City	Mean Wind Speed: MPH[3]	Heating Degree Days[1]	Yearly Snow-fall Mean[4]	Outside Design Temp.[2]
Arkansas	Ft. Smith	7.6	3336	5.7	12.0
	Little Rock	8.1	3354	5.1	15.0
California	Bakersfield	6.4	2185	0.0	30.0
	Bishop	N/A	4313	8.6	10.0
	Fresno	6.3	2650	0.1	28.0
	Los Angeles	7.4	1819	0.0	37.0
	Sacramento	8.3	2843	0.1	30.0
	San Diego	6.7	1507	0.0	42.0
	San Francisco/Oakland	8.2	3080	0.1	35.0
Colorado	Colorado Springs	10.4	6473	39.3	-3.0
	Denver	9.1	6016	59.0	-5.0
	Grand Junction	8.1	5605	26.3	2.0
	Pueblo	8.7	5394	30.9	-7.0
Connecticut	Hartford	8.9	6350	53.0	3.0
	New Haven	N/A	6026	N/A	3.0
	Bridgeport	12.0	5461	26.8	6.0
Delaware	Wilmington	9.1	4940	19.9	10.0
D.C.	Washington DC	9.3	4211	16.3	14.0
Florida	Daytona Beach	9.0	902	0.0	32.0
	Jacksonville	8.5	1327	0.0	29.0
	Miami	9.1	206	0.0	44.0
	Orlando	8.7	733	0.0	44.0
	Pensacola	8.3	1578	0.3	25.0
	Tallahassee	6.9	1563	0.0	27.0
	Tampa	8.8	718	0.0	36.0
Georgia	Atlanta	9.1	3095	1.5	17.0
	Augusta	6.6	2547	0.9	20.0
	Columbus/Lawson	6.9	2378	0.4	21.0
	Macon	7.8	2240	1.0	21.0
	Rome	N/A	3342	2.0	17.0
	Savannah/Travis Fld.	8.1	1952	0.4	24.0
Idaho	Boise	9.0	5833	21.5	3.0
	Lewiston	N/A	5464	17.9	-1.0
	Pocatello	10.3	7063	40.0	-8.0

Table 2: Typical Outside Design Temperatures for the United States (cont'd)

State	City	Mean Wind Speed: MPH[3]	Heating Degree Days[1]	Yearly Snow-fall Mean[4]	Outside Design Temp.[2]
Illinois	Rockford	9.9	6845	34.1	-9.0
	Moline	9.9	6395	30.3	-9.0
	Peoria	10.3	6098	24.3	-8.0
	Springfield	11.4	5558	23.1	-3.0
	Chicago	10.3	6497	37.4	-8.0
Indiana	Evansville	8.2	4629	13.4	4
	Fort Wayne	10.3	6209	31.5	-4
	Indianapolis	9.7	5577	21.6	-2
	South Bend	10.6	6462	68.5	-3
	Terre Haute	N/A	5366	N/A	-2
Iowa	Burlington	10.3	6149	25.7	-7
	Des Moines	11.1	6710	33.1	-10
	Dubuque	N/A	7277	42.6	-12
	Sioux City	10.9	6953	30.6	-11
	Waterloo	10.7	7415	31.2	-15
Kansas	Dodge City	14.1	5046	18.2	0
	Goodland	12.7	6119	33.6	-5
	Topeka	10.4	5243	20.8	0
	Wichita	12.5	4687	15.1	3
Kentucky	Lexington	9.7	4729	15.9	3
	Louisville	8.4	4645	17.6	5
Louisiana	Baton Rouge	7.9	1670	0.0	25
	Lake Charles	8.8	1498	0.0	27
	New Orleans	8.3	1465	0.0	29
	Shreveport	8.8	2167	0.0	20
Maine	Caribou	11.2	9632	112.9	-8
	Portland	8.8	7498	74.5	-6
Maryland	Baltimore	9.4	4729	21.2	10
Massachusetts	Boston	12.6	5621	42.1	6
	Worcester	10.4	6848	74.2	0

Table 2: Typical Outside Design Temperatures for the United States (cont'd)

State	City	Mean Wind Speed: MPH[3]	Heating Degree Days[1]	Yearly Snow-fall Mean[4]	Outside Design Temp.[2]
Michigan	Alpena	7.6	8518	84.9	-11
	Detroit/Metro.	10.4	6419	39.9	3
	Flint	10.4	7041	45.3	-4
	Grand Rapids	10.0	6801	76.6	1
	Lansing	10.3	6904	48.7	-3
	Marquette	8.3	8351	107.3	-12
	Muskegon	10.9	6890	95.9	2
	Sault Ste. Marie	9.6	9193	110.8	-12
Minnesota	Duluth	11.4	9756	77.8	-21
	International Falls	9.1	10547	60.1	-29
	Mpls./St. Paul	10.5	8159	46.1	-19
	Rochester	12.7	8227	44.4	-17
	St. Cloud	8	8868	43.1	-15
Mississippi	Jackson	7.6	2300	0.0	21
	Meridian	6	2388	0.0	19
Missouri	Columbia	9.9	5083	22.0	-1
	Kansas City	10.3	5357	20.0	2
	St. Joseph	10	5440	19.2	-3
	St. Louis	9.5	4750	18.5	2
	Springfield	11.1	4570	15.5	3
Nebraska	Grand Island	12.0	6425	29.0	-8
	Lincoln	10.6	6218	28.4	-5
	Norfolk	12.6	6981	28.8	-8
	North Platte	10.3	6747	29.9	-8
	Omaha	10.8	6049	32.0	-8
	Scottsbluff	10.7	6774	38.0	-8
Nevada	Elko	6.0	7483	38.9	-8
	Ely	10.5	7814	47.6	-10
	Las Vegas	9.0	2601	1.4	25
	Reno	6.4	6022	26.5	5
New Hampshire	Concord	6.7	7360	64.8	-8
New Jersey	Atlantic City	10.6	4940	15.8	10
	Newark	10.1	5034	27.3	10
	Trenton	9.0	4952	22.7	11

Table 2: Typical Outside Design Temperatures for the United States (cont'd)

State	City	Mean Wind Speed: MPH[3]	Heating Degree Days[1]	Yearly Snow-fall Mean[4]	Outside Design Temp.[2]
New Mexico	Albuquerque	9.0	4292	10.5	12
New York	Albany	8.9	6962	65.7	-6
	Binghamton	10.3	7285	86.9	-2
	Buffalo	12.3	6927	92.9	2
	New York/LaGuardia	12.2	4909	26.2	11
	Rochester	9.7	6719	86.9	1
	Syracuse	9.9	6678	110.7	-3
North Carolina	Asheville	7.8	4237	17.4	10
	Charlotte	7.6	3218	5.3	18
	Greensboro/Winston-Salem	7.7	3825	8.7	15
	Raleigh/Durham	7.9	3514	6.8	16
	Wilmington	9.0	2433	1.9	23
North Dakota	Bismarck	10.5	9044	38.7	-23
	Fargo	12.7	9271	35.5	-22
	Grand Forks	N/A	9871	N/A	-26
Ohio	Akron/Canton	9.9	6224	47.8	1
	Cincinnati	9.1	5070	23.9	1
	Cleveland	10.8	6154	52.2	1
	Columbus	8.7	5702	27.7	0
	Dayton	10.2	5641	27.8	-1
	Mansfield	11.1	5818	41.2	0
	Toledo	9.5	6381	38.9	-3
	Youngstown	10.1	6426	57.6	-1
Oklahoma	Oklahoma City	12.8	3695	8.8	9
	Tulsa	10.6	3680	9.1	8
Oregon	Baker	N/A	7087	N/A	-1
	Eugene	7.6	4739	7.6	17
	Medford	4.8	4930	8.7	19
	Pendleton	9.2	5240	17.7	-2
	Portland	7.8	4632	7.4	17
Pennsylvania	Allentown	9.4	5827	31.5	4
	Erie	11.4	6851	83.3	4
	Harrisburg	7.7	5224	34.5	7
	Philadelphia	9.6	4865	20.2	10
	Pittsburgh	9.4	5930	45.3	1
	Williamsport	7.9	5982	43.8	2
Rhode Island	Providence	10.7	5972	38.0	5

Table 2: Typical Outside Design Temperatures for the United States (cont'd)

State	City	Mean Wind Speed: MPH[3]	Heating Degree Days[1]	Yearly Snow-fall Mean[4]	Outside Design Temp.[2]
South Carolina	Charleston	8.8	2146	0.0	24
	Columbia	6.9	2598	1.7	20
	Greenville	6.8	3163	5.7	18
South Dakota	Aberdeen	11.2	8616	36.4	-19
	Huron	11.9	8054	39.5	-18
	Pierre	N/A	7283	N/A	-15
	Rapid City	11.3	7324	39.3	-11
	Sioux Falls	11.2	7838	39.1	-15
Tennessee	Bristol	5.6	4306	15.6	9
	Chattanooga	6.3	3505	4.0	13
	Knoxville	7.3	3478	12.2	13
	Memphis	9.1	3227	5.5	13
	Nashville	8.0	3696	10.9	9
Texas	Abilene	12.2	2610	4.5	15
	Amarillo	13.7	4183	14.3	6
	Austin	9.3	1737	1.0	24
	Brownsville	11.8	650	0.0	35
	Dallas/Ft. Worth	10.9	2382	2.9	17
	El Paso	9.5	2678	4.7	20
	Galveston	11.0	1224	0.3	31
	Houston	7.6	1434	0.4	27
	San Antonio	9.4	1570	0.5	18
Utah	Milford	N/A	6412	43.8	5
	Salt Lake City	8.7	5983	58.3	3
Vermont	Burlington	8.8	7876	79.3	-12
Virginia	Lynchburg	7.9	4233	18.1	12
	Norfolk	10.6	3488	7.0	20
	Richmond	7.5	3939	13.9	14
	Roanoke	8.4	4307	24.1	12

Table 2: Typical Outside Design Temperatures for the United States (cont'd)

State	City	Mean Wind Speed: MPH[3]	Heating Degree Days[1]	Yearly Snow-fall Mean[4]	Outside Design Temp.[2]
Washington	Olympia	6.7	5530	19.2	16
	Seattle	9.2	5185	14.6	21
	Spokane	8.7	6835	53.3	-6
	Walla Walla	5.3	4835	20.0	0
	Yakima	7.2	6009	24.5	-2
West Virginia	Beckley	9.5	5613	55.8	-2
	Charleston	6.5	4590	29.6	7
	Huntingdon	6.4	4624	24.1	5
Wisconsin	Green Bay	10.2	8098	44.6	-13
	LaCrosse	8.8	7417	42.9	-13
	Madison	9.9	7730	40.2	-11
	Milwaukee	11.8	7444	45.9	-8
Wyoming	Casper	13.1	7555	73.9	-11
	Cheyenne	13.3	7255	51.2	-9

[1]**Heating Degree Days** – A unit based upon temperature difference and time, used in estimating fuel consumption and specifying nominal heating load of a building in winter. For any one-day, when the mean temperature is less than 65^o F, there exist as many degree-days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65^o F. These heating degree-days (as listed in above chart) were compiled during the 1941-1970 period as published by the *National Climate Center.*

[2]**Outside Design Temperature** – This figure represents the temperature which will include 99% of all the winter-hour Fahrenheit temperatures. A base of 2160 hours (total hours in Dec., Jan., and Feb.) was used. Therefore, using this figure, as a design temperature will, on an average, cover all but 22 hours of expected winter temperatures. **ASRAE 1976 SYSTEMS HANDBOOK.**

[3]**Mean Wind Speed: MPH** – This figure was arrived at through existing and comparable exposures. This information was obtained from the *Local Climatological Data, 1977.* (This figure is for reference only – not required in computation)

[4]**Yearly Snowfall: Mean –** This mean value is for the period beginning 1944 through 1977. This information was obtained from the *Local Climatological Data, 1977.*

Electric Infrared Comfort Heating

HEATS PEOPLE WITHOUT HEATING AIR
Infrared travels through space and is absorbed by people and objects in its path. The air does not absorb infrared energy. With convection heating the air itself is warmed and circulated, however, warm air always rises to the highest point of a building. With Infrared heating, the warmth is directed and concentrated at the floor and people level where it is really needed.

ZONE CONTROL FLEXIBILITY
Infrared heating is not dependent upon air movement like convection heat. Infrared energy is absorbed solely at the area it is directed. Therefore, it is possible to divide any area into separate smaller zones while maintaining a different comfort level in each zone. For example, Zone A, with a high concentration of people, could be maintained at a 70 degree comfort level while at the same time Zone B, a storage area, could be kept at 55 degrees or even turned off completely.

REDUCED OPERATING COSTS
The previous statements are advantages in themselves; but combined, they account for an energy/fuel savings of up to 50 percent. Actual savings will vary from building to building depending on factors such as insulation, ceiling height and type of construction.

INSTANT HEAT
Electric infrared produces virtually instant heat There is no need to wait for heat buildup. Turn the heaters on just prior to heating requirements.

STAGING
Another unique control feature of electric infrared that increases comfort conditions and saves energy consumption is staging. Where most systems are either "fully ON" or "fully OFF" the staging feature allows only a portion of the equipment's total capacity to be used. For example, a two-stage control would work as follows: During the first stage, one heat source in every fixture would be energized. During the second stage, two heat sources in every fixture would be energized. For further control sophistication, a large area can be both zoned and staged. These systems, then, allow a more consistent and uniform means of maintaining a specific comfort level and avoid the "peak & valley" syndrome.

LOW MAINTENANCE
Electric infrared is strictly a resistance type heat. There are no moving parts or motors to wear out; no air filters or lubrication required. Periodic cleaning of the reflectors and heat source replacement is all that will be required.

CLEAN
Electric infrared, like other forms of electric heating, is the cleanest method of heating. There are no by-products of combustion as with fossil fuel burning units. Electric infrared adds nothing to the air nor takes anything from it.

SAFE
· No open flame
· No moving parts to malfunction
· No fuel lines to leak
· No toxic by-products of combustion
· UL available on some models

EFFICIENT
Electric Heaters convert energy to heat at 100% efficiency.

Indoor Spot Heating

An indoor spot heating design will maintain an isolated comfort level within a larger and cooler area. The ambient temperature of the surrounding areas must be considered to help determine proper input to the work area. The ambient temperature in the area will not increase by the spot heating approach. Many times a series of spot heat areas can be incorporated within the total area to avoid maintaining a higher ambient temperature throughout the building.

Comfort levels will depend on the intensity of the wattage delivered. Wattage should be sufficient to balance normal body heat losses, and will depend on ambient conditions, dress, and activity of the individual in the work area.

Since actual ambient temperatures are not maintained, several factors involved with indoor spot heating must be considered:

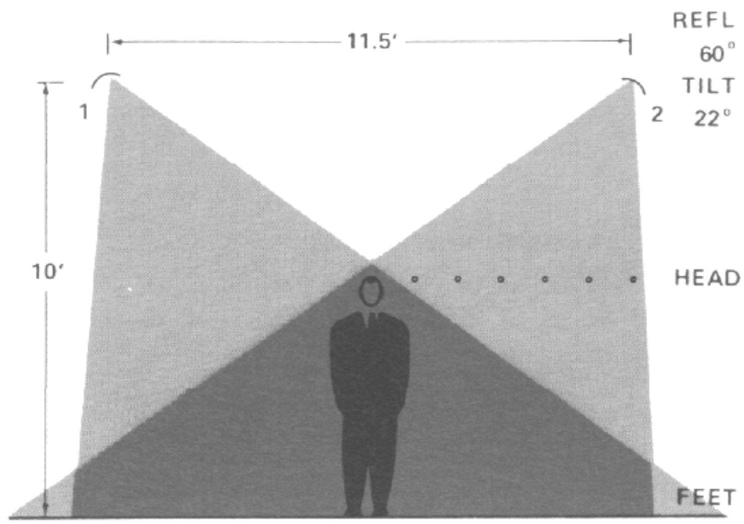


Figure 2: Typical Infrared Heating Pattern

1. Beam patterns should always cross approximately 5' above floor level to provide even heat at the work area.

2. Avoid installing only one fixture directly over a person's head at a workstation.

3. All spot heat applications, regardless of area size, should heat the person or object from two sides.

4. Fixtures should be mounted so that the long dimension of the heat pattern is parallel to the long dimensions of the area to be heated.

5. Spot heating systems can be controlled manually, or preferably, with a thermostat located away from the direct pattern of the heaters. Percentage timers may be used, but are not as effective.

6. Avoid mounting fixtures at heights less than 8'.

The estimator must also have the following specific information available before calculating the heating load and fixture layout:

1. Design voltage and phase to be employed.
2. Minimum practical mounting height for the heating equipment.
3. Specific dimensions of the area to be heated.
4. Specific statement of the heating task including the design temperature required.

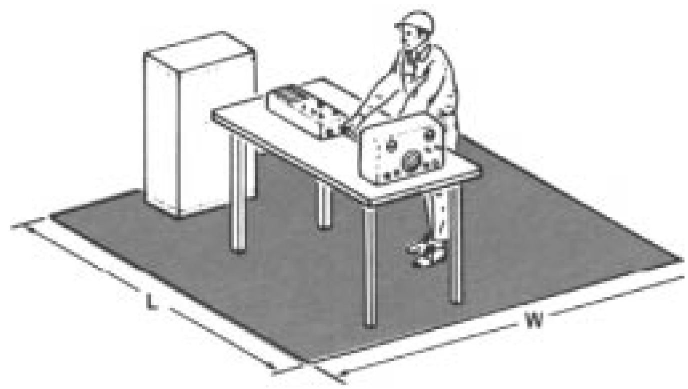


Figure 3: *Typical Spot Heating Work Space*

The following procedures facilitate the calculation of the required infrared capacity and system layout of infrared heater fixtures.

Supplemental Spot Heating - Indoor

Consider these guidelines for spot heating (areas with length or width less than 50 feet).

1. Determine the coldest inside temperature the system must overcome. If freeze protection is provided by another heating system, this temperature will be around 40° Fahrenheit.
2. Determine the operational temperature desired. (That temperature which the customer would want if convection heating were installed. 70° Fahrenheit is a nominal average.)
3. Subtract 1 from 2 to determine the increase in operational temperature (Δt_0) expected from the infrared system. If drafts are present in the occupied area (air movement over 44 feet per minute velocity), wind shielding for the area occupants should be provided.

4. Determine the area to be heated. This is termed the “design area” (A_d). (See Figure 4.)

5. Multiply 4 above by the watt density found in Table 3 for total KW required.

Table 3: *Required Watt Density By Application and Temperature Rise Requirement*

WATT DENSITY FOR TYPICAL APPLICATIONS Vs. TEMPERATURE RISE

APPLICATION	CONDITION	DENSITY WATTS / SQUARE FOOT DESIRED COMFORT TEMPERATURE RISE °F				
		5°F	10°F	15°F	20°F	25°F
Indoor Supplementry Heat		15 TO 30 WATTS / SQUARE FOOT				
Indoor Personnel Comfort	No Drafts No Cold Walls	5 to 6	11 to 13	17 to 20	22 to 26	28 to 33
Indoor Personnel Comfort	Average Conditions	7 to 9	15 to 18	23 to 28	30 to 36	39 to 47
Indoor Personnel Comfort	Drafty Area Cold Walls	10 to 12	20 to 24	30 to 36	40 to 48	50 to 60
Indoor Personnel Comfort	Large Mall Type Buildings	40 TO 60 WATTS / SQUARE FOOT				
Indoor Moisture	Removal and Control	15 TO 30 WATTS / SQUARE FOOT				
Outdoor Loading Dock	Protected Area With Wind Shield	80 TO 120 WATTS / SQUARE FOOT				
Outdoor Marquee Heating	Snow & Ice Melting 20 ft. Mounting Hgt.	Check Factory				
Outdoor Personnel Comfort	Not Open To Sky Protected Area No Wind	10 to 12	20 to 24	30 to 36	40 to 48	50 to 60

Radiant Fixtures for spot heating of individuals should be mounted 10 to 12 feet from the floor with coverage from at least two (2) sides and directed at the individuals waist and never directly overhead.
If fixture must be mounted over 12' from the floor, add 25% to the indicated watt density up to a maximum of 15'.

6. Determine fixture mounting locations:

   a.) In areas where the width dimension is 25' or less, warm personnel from at least 2 directions, tilting in the heaters so more area of the person is covered. Tilt should be such that the upper limit of the beam is about six feet above the center of the work station. Refer to Figure 5.

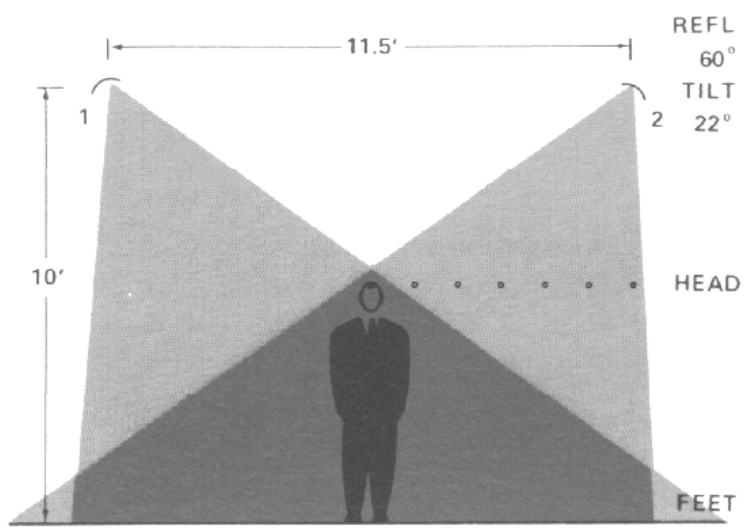


Figure 4: Typical Infrared Heating Pattern

   b.) When locating fixtures, be sure to allow adequate clearances for large moving equipment such as cranes and lift trucks.

   c.) Don't direct infrared onto outside walls. This practice usually results in waste of energy.

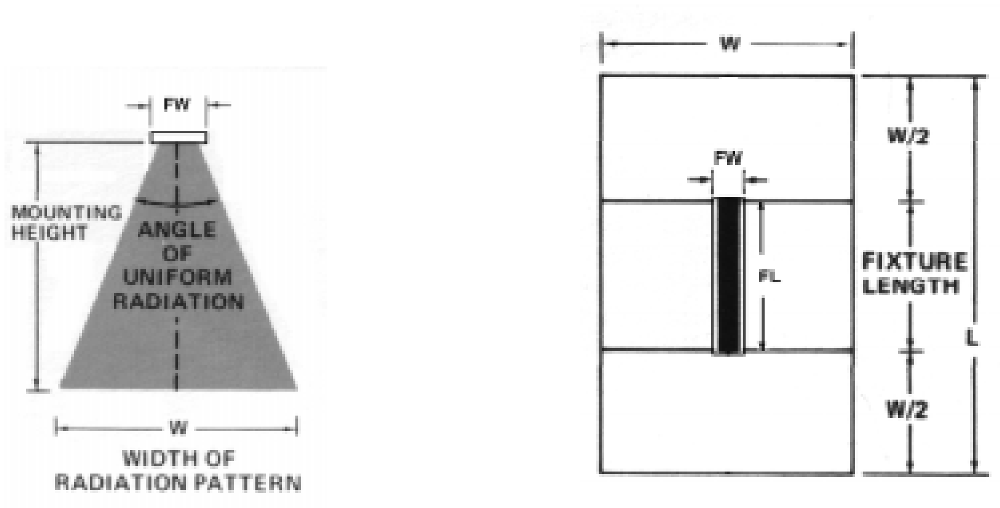


Figure 5: *Radiated Pattern Area*

7. Tentatively estimate the radiated pattern area. Add length of fixture to the fixture pattern width (W) to establish pattern length (L). Pattern area = L x W. See Figure 6. The formulas for the width and the length of the pattern area are shown in Figure 8.

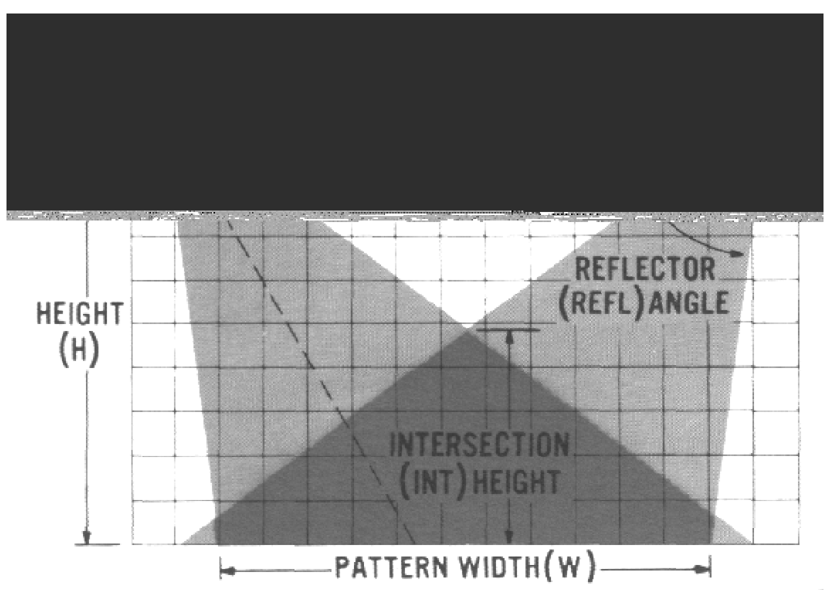
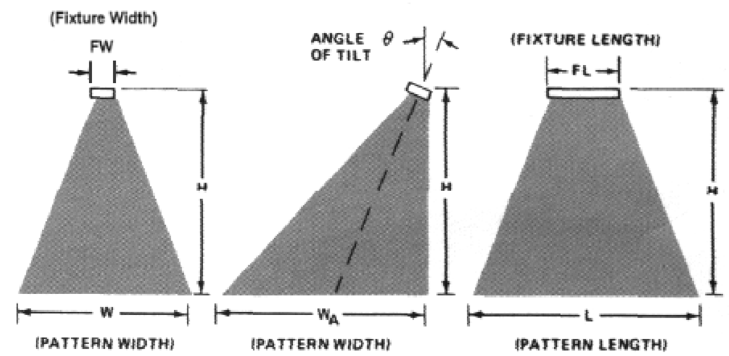


Figure 6: *Cross Coverage of the Radiation Pattern by Angling the Heater in a Supplemental Heat Application*

Radiation Pattern Areas
(pattern area = W x L)

Type of Reflector	Width of Pattern on Floor (W)		Length of Pattern on Floor (L)
	Vertical Mounting	Angle Mounting	



	Pattern Width-Vertical	Pattern Width- Angle	Pattern Length
60° Sym-metrical	W=1.15H+FW	15° W_A=1.25*H + FW 22° W_A=1.4*H + FW 30° W_A=1.7*H + FW	L = W + FL

Figure 7: *Radiation Pattern Areas for Vertical and Tilt Mount.* ***NOTE:*** *For vertical mounting of RBC type fixtures, refer to Graphs 2-6.*

Heater Type	KR, SKR, RBCC	RBC-3, RBC-6	RBC-14
Fixture Width (FW)	0 feet	1.0 feet	2.0 feet

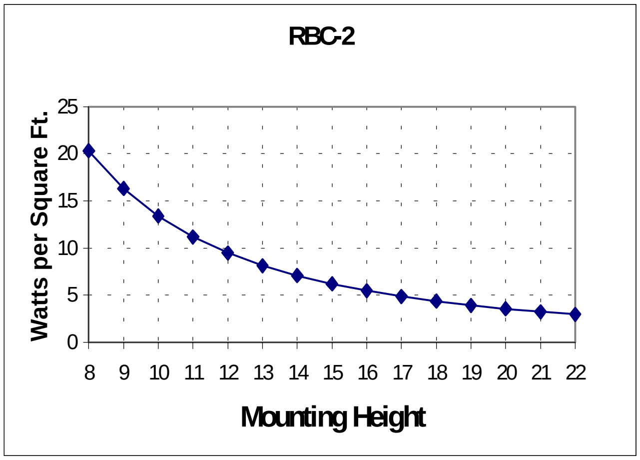
Table 4: *Suggested Fixture Widths (FW) for Various Chromalox Heaters*

8. Divide the design area (Step 4) into the pattern area (Step 7).

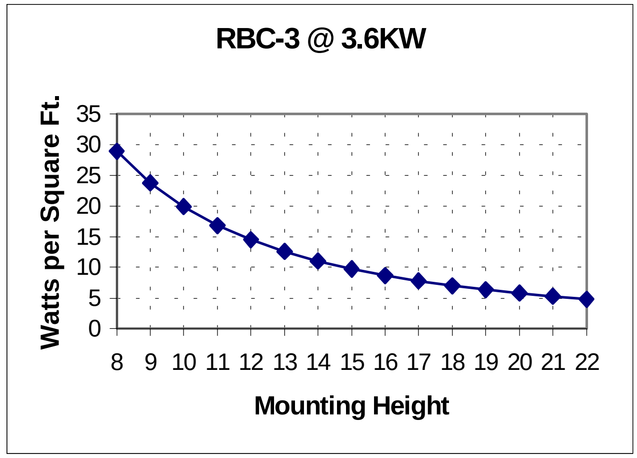
$$Q = \frac{\text{Pattern Area}}{\text{Design Area}}$$

If the Pattern Area exactly equals the Design Area, the above quotient will be “1”, and the radiation per square foot per degree operational temperature difference will be equal to requirements in Step 5. (For maximum efficiency, try to maintain a “Q” equal to 1).

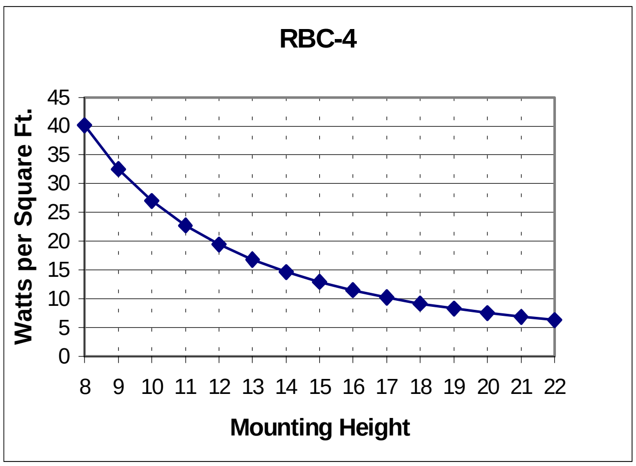
VERTICAL PATTERN AREAS FOR RBC HEATERS



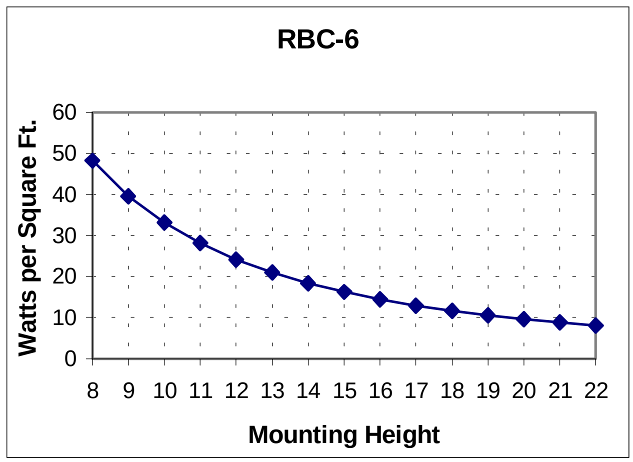
Graph 2



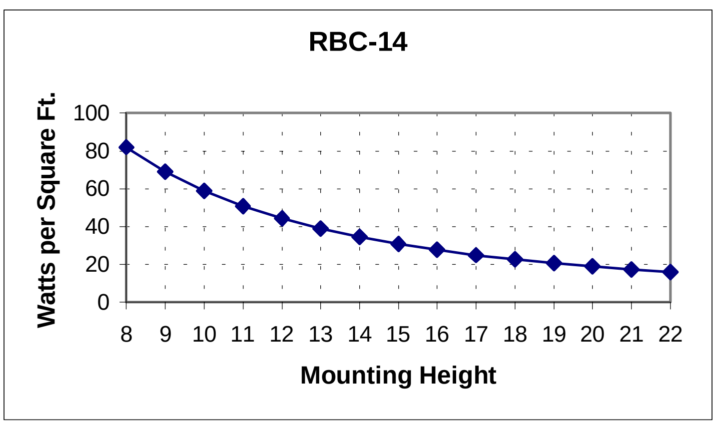
Graph 3



Graph 4



Graph 5



Graph 6

9. If the design area exceeds the pattern area of individual fixtures, locate multiple fixtures with patterns overlapping as necessary. Select fixtures based on ¼ of the watts per square foot requirement (see Figure 9) at a given mounting height and element. For example, if 25 watts per square foot are required, choose a fixture with an input watt density of 6.3 at the required mounting height. For primary area heating do not install less than 12 watts per square foot. Double the watt density along areas adjacent to the outside walls of the building. Do not radiate outside walls.

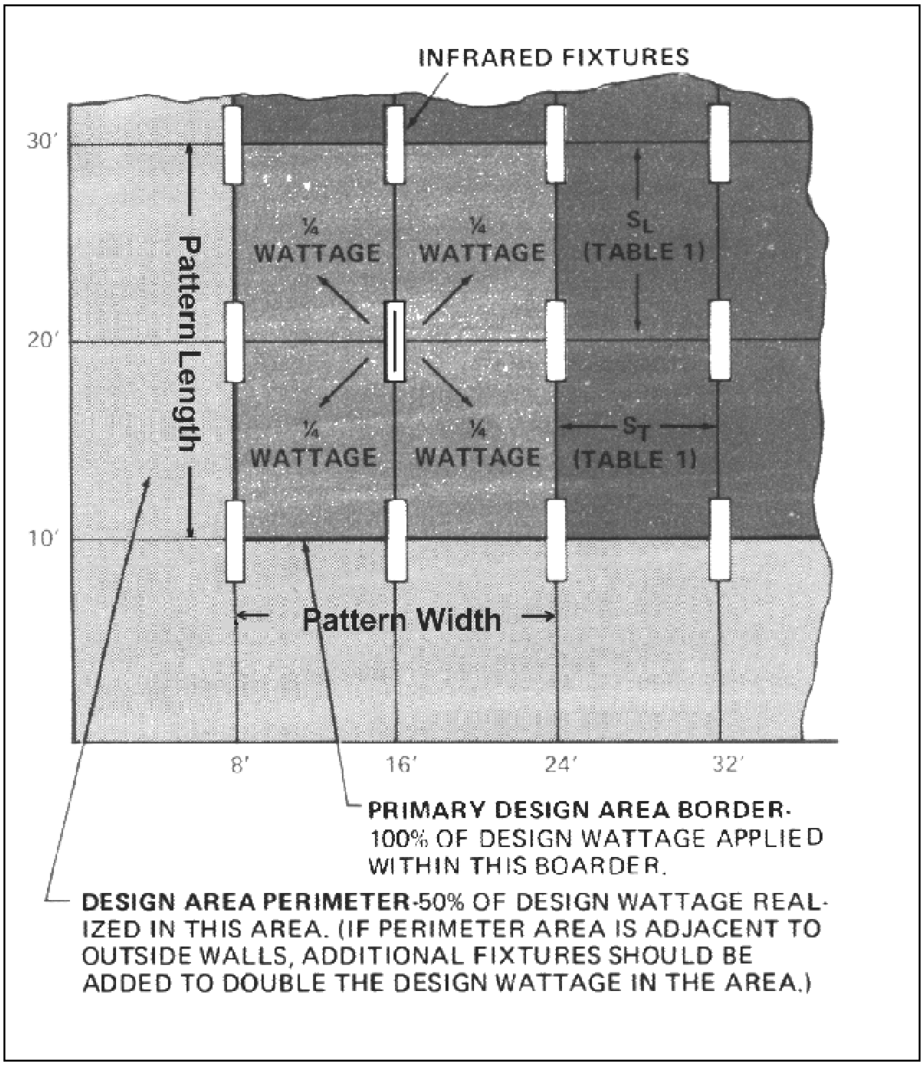


Figure 8: Typical Area Heating Layout

10. Choose specific fixtures that meet the heating requirements noting that half the wattage should be on each side of the workstation in the design area. Space the heaters to provide a 50% overlap using the formula provided in Figure 8. See Figure 7 for typical layout.

11. To provide better control of comfort it is usually desirable to divide the total heat required into two or three circuits so that each fixture or heating element circuit can be switched on in sequence, as the ambient conditions require. It may, therefore, require three fixtures on each side to provide maximum comfort in a spot heating application.

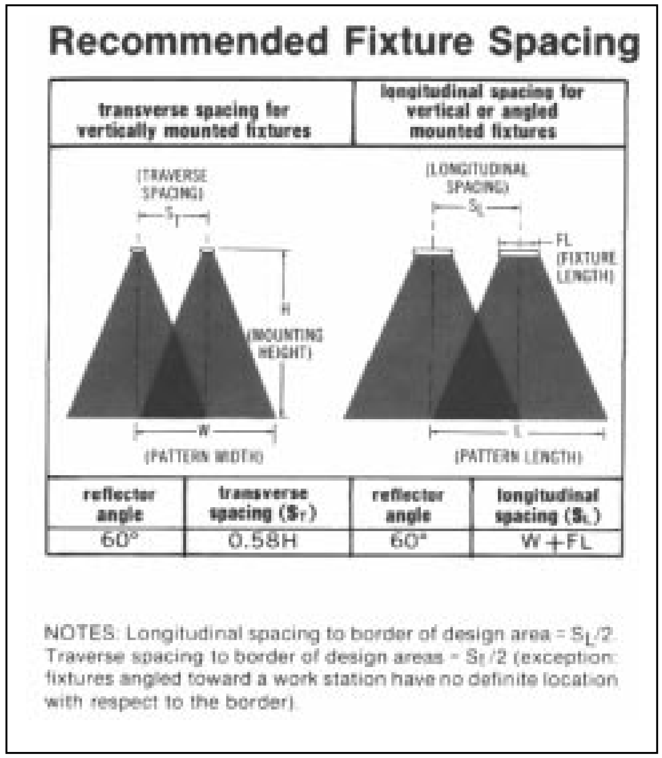


Figure 9: Recommended spacing for 50% overlap

Primary Area Heating with Radiant

Primary area heating refers to all heating being done using radiant heat. Room temperature is not maintained by convection. Radiant is the sole source of warmth. These guidelines apply to any enclosed space of any size or design area with length and width each having a dimension greater than 50 feet.

1. **Calculate Heat Loss.** Calculate the room heat loss as if the room air would be heated by a conventional heating system using the General Industrial Sizing Guide.
2. **Determine Watts per Square Foot.** Divide the heat loss in watts by the design area to be heated to arrive at watt density per square foot.
3. **Adjust Wattage for Radiant Application.** Multiply the watts per square foot in Step 2 by 0.85 to obtain the amount of actual watt density radiation required. This multiplier compensates for the lower air temperature possible in comfort infrared applications. This is due to the fact that the ambient air does not get heated up in infrared heating.

CHROMALOX
General Industrial Sizing Guide
Heat Loss Calculation- Indoor

Job Name: ____________ **Date:** ________
Location: ____________ **Room:** ________
Bid Number: ____________ **Reference:** ________

Voltage: ______V **Phase:** ______

Room Size
Length: ______ft. **Width:** ______ft. **Ceiling Height:** ______ft.
Total Square Footage: ________ square feet

Heater Mounting Height: ______ ft.

Design Information
Ceiling R-Factor: ______ **Outside Design Temperature:** ______F
Wall R-Factor: ______ **Desired Inside Temperature:** ______F
Temperature Rise: [ ] F
Air Changes Per Hour: ______ cubic foot per hour

Calculation

Item	Area	sq-ft	X	U-Factor	=	BTU/Hr/Degree F
Windows	______	sq-ft	X	______	=	______
Doors	______	sq-ft	X	______	=	______
Net Wall	______	sq-ft	X	______	=	______
Roof	______	sq-ft	X	______	=	______
Floor Perimeter *	______	ft	X	______	=	

Item A **TOTAL =** [ ] BTU/Hr/degree F

* For floor perimeter use U-factor of 1.2, 0.7, or 0.6 for exposed, 1" insulation, or 2" insulation respectively

Air Change Loss Cubic foot per hour X 0.019 BTU/cubic ft. = BTU/hr/degree F
Item B ________ cubic ft./hr X 0.019 BTU/cubic ft. = [ ]

TOTAL Item A + Item B = [ ] BTU/Hr/degree F

Item C Convert to Watts = Total / 3.412 = [ ] Watts/Hr/degree F

TOTAL HEATING REQUIREMENT
Item C x Temperature Rise = Watts/Hr
[ ] Watts/Hr/degree F **X** [ ] degree F **=** [ ]
Total Watts/Hr.

Figure 10: *The General Industrial Sizing Guide may be used for sizing radiant applications in an enclosed space where radiant is the primary heat source.*

Portable Radiant Spot Heating

When performing radiant spot heating using portable heaters, the sizing is somewhat different. In Table 5, the amount of square footage that can be heated to a specified comfort level is shown.

Table 5: *Portable Spot Heating Coverage Areas*

PORTABLE RADIANT SPOT HEATING	**Non-Protected Areas** Heated Area Size in Square Feet		**Semi-Protected Areas** Heated Area Size in Square Feet	
Fixture Size	Below 35°F	Above 35°F	Below 35°F	Above 35°F
2.0kW	25	36	40	50
4.5kW	64	75	90	125
6.0kW	85	100	120	150
13.5kW	192	225	270	375