SELECTING THE TYPE OF FIN-TUBE RADIATION

Factors to be considered when selecting the type of fin-tube radiation are:

- the type of building
- the relative length of windows and walls
- the ratio of glass to exposed wall area
- the location of supply and return piping
- the interior finish
- the cost in relation to desired appearance
- the construction of walls
- the heating medium and controlling it
- the occupancy.

Appearance is usually the controlling factor, as in schools and public buildings, where the units are mounted on light-colored walls. The front outlet is best, because it avoids the danger of smudging the walls. When a front outlet is blocked by furniture or equipment, use a sloping top or flat top covers.

A replaceable cover like a flat top or expanded metal is better in applications where covers can be damaged easily, as in factories. Certain acid fumes might determine the use of copper tubing and aluminum fins.

Wall construction and the extent of cold downdrafts may influence the kind of cover that you use. The absence of a nailing strip may make mounting of covers that fasten to the wall expensive on masonry walls. Backs may be required to prevent leakage of air into furred spaces. In some cases, insulating board must be placed behind the units. The matter of plastering behind or below units must be considered in selecting covers. The final selection is for size, and this depends on the heating medium.

STEAM SYSTEM APPLICATION OF FIN-TUBE RADIATION

To determine the design of a steam system for fin-tube radiation, apply the following six steps.
Step 1. Calculate the heat loss. A calculation method is outlined in Lesson 6.

Step 2. Convert the required ft\(^2\) EDR or Btu to standard conditions. Standard conditions on which the capacity of all fin-tube radiation is based on is 1 lb steam pressure and 65°F entering air. If job conditions differ from this standard, consult the proper conversion table for the factor to convert required EDR or Btu from step 1 to standard or catalog numbers.

Step 3. Determine EDR or Btu per foot of length. That is, divide the corrected value from step 2 by the space available in feet. This gives the rating shown in catalog tables. It should be noted that these tables are based on one foot of active or finned surface. There are 2\(\frac{1}{2}\) in. of bare pipe at each end of the element. Elements are furnished with tube elements overall from 2-ft to 10-ft long in 6-in. increments.

Step 4. Select the unit required from a capacity table from the manufacturer. This will determine the fin size and spacing, and the arrangement as to the number of tiers that will best suit requirements of the job and be most the economical. Consider in the selection that copper tube elements with aluminum fins cost more per unit of capacity than steel elements. They should be considered, however, if required capacity cannot be had in steel, or if they reduce the number of tiers. When jobs are installed with copper pipe throughout, it is better to use copper-tube elements to reduce the tendency toward electrolytic action at a junction of steel and copper pipe.

Also, a single-tier assembly is always less costly than multiple tiers. Two-tier assemblies, like that in Figure 8-18, double the cost of the element, but add only from 50% to 80% to the capacity. Three-tiers like that in Figure 8-19 triples the cost, but only doubles the capacity. This increase in the cost of the element is partially offset by covers and backs increasing in cost at a much lower rate. The most economical assembly is a one-tier steel element in a one-tier cover, even though the length may be greater than for a multiple-tier assembly. The only times two-tier and three-tier assemblies should be used are:

- when space limitations require the two-tier or three-tier assembly
- when a temperature control system is used, resulting in partial filling of elements in mild weather. Here, it would be advantageous to use more than one tier with a return bend at one end so that distribution of the heat will be more even.

It will often be found that the number of lineal feet required is less than the length of the space available. It must then be decided
whether to use a short unit or to select an element length of proper capacity, but run the cover from wall to wall. In the latter case, bare pipe enclosed within the cover should be figured as part of the heating surface and thus the finned surface shortened accordingly. The heating effect of bare steel pipe with 1 lb of steam and 65°F air is calculated as:

- 0.66 ft² EDR or 160 Btu per lineal ft of 1¼-in. pipe
- 0.93 ft² EDR or 223 Btu per lineal ft of 2-in. pipe.

**Step 5.** Standard ratings are also based on a certain height from the floor to the top of the cover or to the middle of the grille on a sloping top and front outlet cover. These heights are all based on the bottom of the cover being 4 in. above the floor. If job conditions require greater installation heights, a correction factor from Table 8-5 should be applied to capacities shown in the tables of a product catalog to obtain adjusted capacity.

**Step 6.** Consider expansion, heat control, pitch, and pressure drop.

- **Expansion:** If the steel pipe cools down, for example, to 50°F, when it is heated to 220°F (about 3 lb pressure), then it will expand about ¼ in. for every 10 ft of length. A 40-ft length will, therefore, expand ½ in. It then would be necessary to use adjustable wall hangers or ball-bearing brackets, like those in Figure 8-17. For short lengths, ordinary wall brackets will do. In any event, allow for expansion in the end connections to avoid damage to valves and fittings.

- **Heat control:** When fin-tube radiation is run in series through several rooms, precluding the use of valves to turn off individual room units, dampers must be used for each unit. The steam should also be properly controlled. Without control, heat from covers coupled with unavoidable

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**TABLE 8-5. Installed-height correction factors for thermo-vector radiation**

<table>
<thead>
<tr>
<th>Installed height, in.*</th>
<th>36 or more</th>
<th>34</th>
<th>32</th>
<th>30</th>
<th>29</th>
<th>28</th>
<th>27</th>
<th>26</th>
<th>25</th>
<th>24 ¼</th>
<th>24</th>
<th>23</th>
<th>22</th>
<th>21</th>
<th>20</th>
<th>19</th>
<th>18 or less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
<td>1,000</td>
<td>1,009</td>
<td>1,018</td>
<td>1,027</td>
<td>1,036</td>
<td>1,044</td>
<td>1,053</td>
<td>1,062</td>
<td>1,071</td>
<td>1,078</td>
<td>1,080</td>
<td>1,089</td>
<td>1,098</td>
<td>1,107</td>
<td>1,116</td>
<td>1,124</td>
<td>1,133</td>
</tr>
</tbody>
</table>

*If the unit is to be installed at a different height than that recommended, then the capacity must be adjusted as follows: Adjusted capacity = capacity × (factor above for the actual installed height ÷ factor above for minimum installed height). Example: Thermo-vector 1¼ OTS 52 steel fins (4¼) 1 tier 24 in actual installed height. Adjusted capacity = 6.2 EDR × (1.080 ÷ 1.133) = 5.90 EDR. Per linear ft of active finned length.
air leakage around dampers may cause overheating. A control that operates on the basis of partial filling of radiation with steam will leave end units cold in mild weather. A typical control is the Vari-Vac® system where steam piping is kept full of steam at a temperature adjusted to the need for heat.

- **Pitch:** With the large free internal area of 1 1/4-in. and 2-in. pipes, and with steam and condensate flowing in the same direction, it is not necessary that there be any pitch in the piping. However, make some allowance for pitch in runs over 20-ft long to prevent backgrading and trapping of water.

- **Pressure drop:** With steam, pressure drop is so small that it ordinarily need not be considered. However, to keep within the limits of a total system pressure drop of 1/2 lb in areas where surrounding air temperature is about 70°F, limit runs to 75 ft for a 1 1/4-in. pipe, and 100 ft for a 2-in. pipe. With such long runs, it is essential that you use expansion loops or joints.

**Example.** Apply the above steam heating application of fin-tube radiation to a building that has rooms in bays. They measure 20 ft from column to column, which are furred out for pipe spaces so that the available distance from face-to-face is 18 ft. The window sash extends the full length of this space and sills are 30-in. high. It is desired to spread the heat along the whole wall, using front outlet covers mounted with the top of the cover at the sill line. You need as thin of a convector as possible. Steam is controlled by a modulating valve on each unit operated by a room thermostat.

Some space, at least 1 ft, has to be allowed at each end for connections, so actual length available for finned pipe is not more than 16 ft. The heating medium is steam at a 10-lb pressure and room air is held at 70°F.

- **Step 1:** Heat loss has been calculated at 24,000 Btu or 100 ft² EDR.

- **Step 2:** Conversion tables show the correction factor to be 1.17. Dividing 100 EDR by 1.17 gives 86.3, which is the EDR capacity required at standard conditions.

- **Step 3:** The EDR per foot of length of 86.3 divided by 16 or 5.4.

- **Step 4:** Remembering the requirement for a front outlet, and the desire to use as thin a convector as possible, requires inspection of capacities with the 3 1/4 by 3 1/4 fins. It is seen that with steel tube and fins, it is...
necessary to use two tiers with 42 fins per foot, which has a capacity of 6.75 EDR per foot. Two tiers with a return bend would be good for the modulating control and 1½-in. pipe would be easier to connect. This is the best selection.

- **Step 5:** Capacity tables show the installed height for two tier to be 17½ in. Correction factors shown in Table 8-5 for height show the factor for 27 in., which in this case is the closest tabular value for installed height (the sill height less 2½ in. to the middle of the outlet grille), is 1.053. The factor for any height below 18 in. is 1.133. Multiplying 6.75 by the ratio of 1.053:1.133 is 6.4 as the corrected value. Therefore, less than 16 ft of finned surface will do. The actual selection may be two 7-ft, 6-in. elements, which is 87.3 ft² EDR for an actual fin length of 14 ft 2 in.

The above capacities include the factor shown in Table 8-5 for the indicated minimum installed height.

**HEAT-DISTRIBUTING UNITS: UNIT HEATERS**

Where applicable, *unit heaters* permit warming of relatively large spaces with minimum piping. They occupy a comparatively small amount of space, keep floor areas free from obstruction, and because of their light weight, they can be hung from almost any convenient portion of the building structure.

**Types of propeller fans**

**Horizontal discharge units.** The *horizontal discharge* unit heater has outlet velocities from about 400 to 1,000 ft/min and is best suited for commercial and industrial buildings. It is used most effectively in rooms or spaces under 16 ft in height, with no major obstructions to the horizontal flow of air, where it can be installed to blow air along the outside wall or toward an exposure, creating a gentle, circular motion of the air.

Horizontal discharge heaters are assembled with louvers, which permit individual adjustment for directing the flow of warm air. Heaters should be located to offset downdrafts from roofs of large areas. Low outlet temperature and relatively high outlet velocities promote better heat distribution.

**Vertical discharge units.** The *vertical discharge* unit heater is used primarily in spaces with large roof areas. This is especially true where there are obstructions to horizontal distribution of heat and to installation of piping. They have outlet velocities from about 1,000 to 2,200 ft/min.
Heated air has a tendency to rise. Since heated air is projected downward by the vertical discharge heater, relatively high outlet velocities and low outlet temperatures are necessary for maximum efficiency.

*Caution:* Objectionable drafts may be caused by too low of a mounting height, or too great of a velocity at an occupied level.

Various types of diffusing outlets assist distribution. The louver or cone-type adjustable diffusers are most commonly used. The anemostat is used mainly where mounting height is unusually low. It protects occupants against drafts.

**Cabinet units: types of centrifugal fans**

*Cabinet* unit heaters are generally used where appearance, moderate outlet velocities, and quiet operation are essential and space is at a premium. Equipped with centrifugal fans, the high-capacity unit at top speed makes it possible to supply a large quantity of warm air in a short time. With multispeed motors, operating speed can be varied to maintain an even room temperature and, if desired, to heat outside air for ventilation. Manual mixing dampers are on units for heating and ventilating to permit mixing of inside and outside air. Rechargeable or throw-away type filters are normally used with these units. You can install the cabinet unit heater in positions to discharge air upward, which would be mounted on the floor or wall and to discharge air downward, mounted in an inverted position or on the wall.

**STEAM SYSTEM APPLICATION FOR UNIT HEATERS**

Unit-heater capacity is based on the difference in temperature between the heating medium in the radiator and the temperature of air entering the radiator. Standard capacities are in EDR and are based on 2 lb of steam pressure and 60°F entering air. Table 8-6 on the next page is a capacity table for horizontal discharge unit heaters, which is based on 2 lb of steam and 60°F entering air.

Raising steam pressure or lowering entering air temperature increases the temperature difference, thereby increasing capacity. Conversely, lowering steam pressure or raising entering air temperature, decreases capacity. You should keep steam pressure as low as possible to maintain a low outlet temperature. Low pressure boilers ordinarily operate at pressures not in excess of 5 lb. A good average operating pressure is 3 lb.

All heating elements are tested to withstand a water pressure of 400 psi and to operate at working pressures of up to 150 psi. However, it is not good to exceed 125 lb of steam pressure.