FINNED TUBE RADIATION

There are four common names for this product and even ASHRAE uses them interchangeably. They are **finned tube radiation**, **finned tube**, **finned-tube**, and **fin-tube**. I will use the term fin-tube because it is short. The term **baseboard radiation** refers to heating products which mount on the floor and take the place of a standard baseboard. Normally fin-tube is mounted above the floor and the term baseboard radiation is incorrect.

Fin-tube consists of a steel or copper pipe with fins bonded to it. This is called the **element**. Units usually include a sheetmetal cover or **enclosure**, but can be ordered with an expanded metal cover or as bare element.

The heat produced by fin-tube is primarily due to convection, although some is radiated. Units without covers, units with fewer fins, and steel units have a higher percentage of their heat produced as radiation and have higher surface temperatures. Surface temperature is not usually a concern with hydronic fin-tube, but can be for electric units or "Runtal" type heaters. Air flow is caused by the decreased density of heated air and there is no fan. Because of this the performance depends on the enclosure as well as the element. Enclosures which have a greater height difference between the element and the outlet will have greater draft and higher output.

Heat output is normally reported in Btuh/SF. Occasionally output is given in square feet, square feet EDR or EDR. One square foot EDR equals 240 Btuh which is the approximate output of one square foot of cast iron radiator surface when the radiator contains 1 psig steam. This is a method left over from the days when cast iron radiators were ordered by the square foot.

Copper elements are available between 1/2" and 1-1/4" size. Steel elements are available from 1" to 2" size. Both are available in a range of fin sizes, fins per foot and fin thicknesses. The resistance to water flow is similar to that for piping of the same nominal size (actually slightly less as the wall thickness of fin-tube is less than that of common piping materials). Copper elements are more common because they are more corrosion resistant, less expensive and have greater output in any given size. Steel elements are much stronger and are sometimes used without covers.

Fin-tube can be used with steam or hot water. Hot water is most commonly used for the following reasons:

1. There are no condensate pipes to corrode.
2. Water causes less noise than steam.
3. The temperature is easily varied according to outside temperature in order to keep valves in their throttling ranges.
4. Water piping can be raised and lowered easily, while steam and condensate piping must continue downward until a trap is

added.

5. There are no traps to repair.

RATINGS

Fin-tube is rated according to standards developed by the Institute of boiler and Radiator Manufacturers, which is now called the Hydronics Institute. The current standard is IBR Testing and Rating Code for Finned-Tube (Commercial) Radiation. Make sure that the fin-tube you specify bears the IBR symbol on the page which indicates its ratings. This standard requires testing of fin-tube units using 215 degree steam near the ceiling of a test chamber. All other ratings are calculated from the results of the steam test. The test results are multiplied by factors which compensate for water and room temperature, water velocity, and mounting height.

Water and room **temperature correction factors** are contained in a table. A factor of 1.00 is given to the standard condition which is 215 degree steam (or 215 degree **average** water temperature) and 65 degree entering air. The standard condition of 65 degree entering air is based on the assumptions that the room temperature will be 70 degrees in the center of the room five feet above the floor, that the fin-tube will be mounted near the floor along the outside wall and that the temperature of the air entering the fin-tube will be five degrees below that in the center of the room. The ratings you allow should be based on the conditions under which you will install the fin-tube. A common condition is 170 degree average water temperature (AWT) and 70 degree entering air temperature (75 degree room temperature) with a correction factor of 0.57.

All water ratings are based on the assumption that the **water velocity** is three feet per second or higher. Unfortunately fin-tube is rarely selected at velocities this high. The IBR recommends that fin-tube not be used at velocities below 0.25 fps, because flow may be laminar and heat transfer is not predictable. The only way to maintain the IBR certified ratings is to stay above 0.25 fps and fin-tube should not be selected below this velocity. At 0.25 fps a correction factor of 0.905 is applied to the ratings. Multiple rows of element may need to be piped in series in order to maintain this minimum velocity. The minimum flow rates for various size elements are given below.

ELEMENT SIZE	GPM AT 0.25 FPS	MINIMUM MBH WITH 20 DELTA-T	MINIMUM MBH WITH 30 DELTA-T	MAXIMUM SERIES FLOW GPM
1/2"	0.2	2	1.3	1.5
3/4"	0.4	4	2.7	4.0
1"	0.7	7	4.7	8.0
1-1/4"	1.2	12	8.0	15.0

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The Maximum Series Flow GPM column indicates the highest flow rate at which you may pipe the elements in series. Above that flow rate the elements should be piped in parallel to avoid noise or excessive pressure drop. I normally use parallel piping wherever possible as the balancing valve can obstruct the operator of the control valve in series piping systems.

In small rooms it is necessary to use small diameter elements or use more water than needed. Balancing valves are not very accurate at low flows and I have found that using 3/4" elements with a minimum flow rate of 0.4 gpm works well for all fin-tube on most jobs. Also, 1/2" elements require more frequent supports which add cost. I normally specify that all fin-tube ratings be corrected by a factor of 0.905 regardless of actual velocity because many will be at minimum velocity and the suppliers get confused if asked to calculate each element individually. A chart in ASHRAE indicates that this factor drops to around 0.60 if water flow becomes laminar. If you must have low flow in large tubes it is possible, but must be considered carefully and described in the schedule.

A **Heating Effect Factor** is added to the ratings of all fin-tube which is located near the floor, except for flat-top units. I do not know why flat top units are treated differently or why this factor is added, so I always specify that no credit may be taken for heating effect factor. Catalogs generally add 10 to 15% to the test results for this and indicate that you must deduct it if the fin-tube will not be mounted within the prescribed distance of the floor.

The following is a summary of the calculation of the actual output from the two tier radiation in the detail from Grain Processing (#91048 on CAD):

	Steam Rating at 1 psig and 65 degree EAT	2690 Btuh/ft
x	Temperature Correction Factor	0.53
x	Velocity Correction Factor	0.905
/	Heating Effect Factor Included in Ratings	1.00
=	Corrected Capacity	1290 Btuh/ft

The sample schedule included includes notes regarding ratings. Trane fin-tube has thinner fins than Vulcan or Sterling (____" vs. 0.020") and, therefor, has lower ratings for the same cabinet, fin size and number of fins per foot. Also the fins are more easily damaged.

CABINETS

Cabinets are generally made of 14, 16 or 18 gauge galvanized steel. For units mounted low enough to stand on and in areas where abuse is likely, 14 gauge should be used. For units mounted into credenzas and other less demanding areas 16 gauge is often adequate.

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Tall cabinets produce more heat that short cabinets from the same element (provided that the element is located at the bottom of the cabinet) due to greater stack effect. Also taller cabinets can accommodate more than one row of element. Often a 24" cabinet is used and the supply and return mains and two rows of element are located inside the cabinet. This eliminates much piping up and down in walls between the fin-tube and the mains.

It is important that access to the valves is maintained, particularly the control valve. Each section of cabinet has one section which must be removed first. This section should always be located near the control valve. Often that section is at the opposite end of the room and the entire length of cabinet must be removed to get to the control valve. Access doors are so small that they are of little use. I have never seen a control valve located so that it could be maintained through its access door.

Many styles of cabinet are available. The most common is stamped slope-top such as Vulcan model DS. Slope-top is popular because it is inexpensive and durable. It is difficult to stand on or set things on and is, therefore, naturally resistant to damage. Its major drawback is that it is not attractive.

Stamped flat-top units are also common. They have slightly greater capacity than slope-top units (if no heating effect factor is added to the slope-top ratings), are slightly more attractive, and offer a shelf which some users like. It is not as resistant to damage as slope-top, but is still very durable when constructed in 14 gauge steel.

Flat-top units are available with extruded aluminum grilles. The grilles restrict air motion and the output is somewhat lower than for units with stamped grilles. They are less durable than stamped units. Their main advantage is that they are much more attractive.

Many custom radiation cabinets are available and for a large job Vulcan and Sterling will make almost any cabinet which you can dream up. Modern versions of cast iron radiators are also available. One example is Runtal which is popular with some architects. With care these products can make very attractive and effective heating systems, but at increased cost.

Often floor space is an issue. Commercial cabinets are generally available in 4-1/4" and 5-5/16" depths with 3-1/4" and 4-1/4" wide fins respectively. In many buildings the fin-tube can be built into a perimeter credenza with little or no lost floor space. If well detailed this type of unit can be inexpensive, provide easy access and have high capacity.

Cabinets are available with and without full backs. Normally a full back is not required, but in some circumstances the back may be visible.

FINISH

Most manufacturers treat the surface of the galvanized cabinet so that it can be painted without special cleaning or priming. Factory painted finishes are available, but the color selection is limited and the finish is usually damaged during installation. The preferred method is to specify the field-paintable galvanized finish and have the architect paint the cabinets in the field.

EXPANSION COMPENSATION

Copper expands at the rate of 1.134" per 100 feet per 100 degrees. Fin-tube cabinets can generally accommodate 1" of movement at each end of a straight run, so the total expansion must be kept below 2". This is a particular problem for systems which house all of the pipes inside the cabinet with few offsets. The temperature of the piping can vary from 40 degrees (on the day it was installed) to 200 degrees. The total expansion is, therefore, 1.8" per 100 feet. Sections over 111 feet long should contain either expansion loops or expansion joints. I normally include one EJ-1 in each straight section over 100 feet long plus one EJ-1 for each additional 100 feet. Each EJ-1 can accommodate 2" of expansion and must include guides and anchors per specification section 15121.

PIPING DETAILS

Each section should include two shutoff valves and one control valve. A balancing valve may be substituted for one of the shutoff valves. TWO unions are required at the control valve to remove it without also removing the element. One union is required at the opposite end of the element to allow removing it without soldering. If the fin-tube is above the main pipes an air vent will also be required.

Schedule the cabinet at least 18" longer than the element plus 6" for each 8 feet of element to allow length for the valves, unions and element ends. Allow an additional 9" for tees and elbows if more than one row of element will be used. The element normally has 2-3" of non-finned tubing on each end and is available only in 6" increments with a maximum length of 8 feet per section. If your calculations indicate that you need 17.1 feet of element, you will need to schedule 17.5 feet and the actual length will be around 17'-6" + 6" +6" = 18'-6". If the unit has two rows of element you will need at least 20'-9" of cabinet. Additional space will be required if 3-way valves are used.

The supply pipe should enter the bottom of the cabinet with all water flow proceeding upward in order to prevent air binding. Do not insulate supply or return pipes directly above or below the finned element as this will obstruct the air flow and reduce capacity. You may choose to insulate other pipes inside of the cabinets or not depending on your budget and whether or not you want the "free" but uncontrolled extra heat. Pipes dropping in walls to fin-tube are allowed to be insulated with 1/2" Armaflex instead of the fiberglass specified in other areas.

CORROSION

Corrosion is not normally a major problem in closed systems, however, it can be if a small amount of steel is used in an all copper system. Dielectric fittings should be used where piping changes from steel to copper. Brass valves in steel piping do not require isolation in closed systems.