TECH TIP # 8

HEATING, AIRCONDITIONING & REFRIGERATION DISTRIBUTORS INTERNATIONAL

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USING TABLES DOESN'T HAVE TO BE A GUESSING GAME

Sooner or later most of us have to use tables. The trouble with a table is that, invariably, the person who prepared the table lists every value for every conceivable condition except the ones that you need. If the gas pressure at the job site is 3 ½ in. WG, your table probably lists spud sizes and gas flow rates for 3 and 4 in. WG pressures. Close, but not exactly what you wanted. Of course these situations reduce the convenience of a table but not its usefulness. The information that you need is there, between the lines and columns. You just have to work a little to get it out. Finding values between listed quantities is termed interpolation.

Strictly speaking, straight interpolation, which we are about to demonstrate, is valid only when the relationship between quantities is linear. That is: if we plot the values on a graph we can draw a straight line through them. However, little accuracy is lost even if the terms are not in a linear relationship -- especially when listed quantities are closely spaced. And in cases when you should not interpolate, the tables are usually so marked.

Consider this example. Table 1 lists outlet Btu/hr delivery for selected supply air temperatures and air flow rates. It is assumed that the room air is 75º F. Suppose we measure the flow and temperature of air discharging from a register and find them to be 67 cfm and 114º F respectively.

(continued)

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Table 1 --- REGISTER CAPACITY for selected supply air temperature and air flow rates.

Register heat delivery						
Air flow rate	Supply air temperature					
	90	100	110	120	130	140
40	648	1080	1512	1944	2376	2808
60	972	1622	2260	2922	3564	4221
80	1395	2163	3035	3886	4761	5609
100	1620	2700	3780	4860	5940	7020
125	2034	3112	4725	6085	7425	8765
150	2435	4050	6563	7295	8900	10055

The table lists delivered Btu/hr capacities on either side of our measured values 60 and 80 cfm at 110 and 120º F.

Here we have the worst situation which requires double interpolation. We must interpolate between 60 and 80 cfm and also between 110 and 120º F.

We can handle this problem “from either end” that is, either:

1) Find the Btu/hr delivery rate for 67 cfm at each of the two listed temperatures (110 and 120º F), or

2) Find the Btu/hr delivery rate at 114º F supply temperature at each of the two listed air flow rates (60 and 80 cfm) --- and after this, we take one additional step in either case.

We will use the first method. First we find the Btu/h delivery at 67 cfm and at 110º F -- and to do this we take a proportion: the difference between 67 and 60 cfm (7 cfm), divided by the difference between 80 and 60 cfm (20 cfm) will represent a fraction (7/20) that will be *proportional* to the fraction representing the difference in capacity (Btu/hr) at 67 and 60 cfm divided by the difference in the capacity at 80 and 60 cfm.

But in this second fraction we know only the denominator --- Btu/hr difference at 80 and 60 cfm. And so we use “x” --- the unknown, to represent the numerator, which is what we are looking for. We can picture…

```
[   [ 60        2260      ]     ]
    [              ?      ]  x  ]  775
    [ 67                  ]     ]
      80        3035            ]
```

and mathematically, we have:

$$\frac{7}{20} = \frac{X}{775}$$ (cross multiply the 7 and 775 and divide by 20)

or X = 7/20 x 775 = 271 Btu/hr.

Now, if we add 271 Btu/hr to the value found at the "intersection" of 60 cfm and 120º F (2260 Btu/hr), we have found the Btu/hr delivery for 67 cfm flow rate and temperature of 110º F which is 2531 Btu/hr.

Next we repeat the equation, except we move to the 20º F column -- taking 720 of the difference between Btu/hr's at 60 and 80 cfm: 7/20 x (3886 - 2992) = 337 Btu/hr.

Again, we add this answer to the capacity at 60 cfm - - 337 plus 2922 equals 3329 Btu/hr.

To repeat -- we have now established a new "line" in Table 1, at a flow rate of 67 cfm and on that line we have figured the Btu/hr's delivered at 110º F and 120º F air temperature -- 2531 and 3329 Btu/hr respectively. (See table below)

What we actually want is the Btu/hr's at 114º F, or four-tenths of the way "up" from 110 to 120º F. The difference between 3329 and 2531 is 798 Btu/hr. Four-tenths of 798 equal 319 Btu/hr.

Since we are going "up" we add the 319 to the value at 110º F (2531) and the result is 2850 Btu/hr. - - delivered Btu/hr. capacity of the register at 67 cfm and 114º F supply air temperature.

Table 2: Register Heat Delivery

Register Heat Delivery							
Air Flow Rate	Supply Air Temperature º F						
CFM	90	100	110	114 ←	120	130	140
40	648	1080	1512		1944	2376	2808
60	972	1622	2260		2922	3564	4221
→ 67			**2531**	2850	**3329**		
80	1395	2163	3035		3886	4761	5609
100	1620	2700	3780		4860	5940	7020
125	2034	3112	4725		6085	7425	8765
150	2435	4050	6563		7295	8900	10055

The critical part of the process is in remembering which “direction” we are going in this last step. We could have taken six-tenths of 798 and subtracted this from the 3329 Btu/hr value for 120º F - - this would have brought us “down” to 114º F from the higher value.

But to make sure we don’t multiply “up” and subtract “down” -- it is useful to use the figures of your new “line” in the table to draw another proportion, as follows:

```
          [        110        2531   ]      ]
          [   4 [                    ] x    ] 798
   10     [        114          ?    ]      ]
          [        120        3329          ]
```

From this, our equation is:

4/10 = X/798

$$X = \frac{4 \times 798}{10} = 319$$

And it is obvious that we must add to the lower figure to arrive at the proper answer (2531 + 319).

Interpolation is really easy. In fact, it’s a lot harder to explain it than to do it. It will become easier to keep track of “directions” with practice, and a good way to practice is to set up a few additional problems of your own using Table 1.

Try starting from the other direction -- establishing a new “line” at 114º F first, and then interpolating on that line over in the cfm column.

The whole process can soon be a matter of habit, and you will have fast, accurate answers to the “in between” problems of design.