# Right Sizing HVAC Equipment for Electronic Cooling Applications

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**Selecting the right HVAC equipment for critical facilities is extremely important. Unfortunately, there is confusion about how to do so, partially due to human comfort based cooling standards being utilized in electronic cooling applications.**

Insufficient HVAC capacity means that a single HVAC system failure could result in elevated temperatures and place the electronic equipment you are trying to maintain at risk.

Because this risk of under sizing is more or less "obvious", engineers will often oversize the HVAC capacity without necessarily understanding the negative impacts of doing so:

- Up front cost of purchasing "extra" HVAC capacity can be substantial.
- Oversized HVAC systems tend be less energy efficient and can suffer additional wear & tear due to excessive turn on-turn off cycles.
- In a 1+1 (aka Lead/Lag) configuration, oversizing can make it extremely difficult to "manage" indoor RH (Relative Humidity). This can be mitigated by "adding load" which is less than optimal from an efficiency standpoint.

In the World's largest electronic enclosures – data centers – cooling requirements are measured in sensible capacity. And yet, the human comfort method – measuring in "total capacity" -- is still generally used in electronic cooling applications. This paper examines how the "sensible" method can and should be used for electronic cooling applications.

Whether it is a small cabinet or a giant room housing electronic equipment the formula for "Right Sizing" HVAC capacity is essentially the same. There are two parts to this task:

I. **Determining Site Load**: Determining the total heat load the HVAC equipment is going to be asked to manage

II. **Determining HVAC Capacity**: Defining the HVAC equipment by its Sensible Capacity to handle that heat load

Before breaking down the parts, it is critical to understand that **Sensible Capacity** is what matters for electronic cooling applications.

HVAC equipment size is most commonly refenced by tonnage: "10 Ton" or "5 Ton" or "1 Ton", etc. This Tonnage Rating (TR) is a reference of the Total Cooling Capacity of the HVAC system and can be *very* misleading for electronics cooling applications.

**TOTAL** COOLING CAPACITY (tons) = **Sensible** Cooling (tons) + **Latent** Cooling (tons)

- Latent Capacity ≡ The amount of tonnage dedicated to the removal of moisture ($H_2O$) from the air
- **Sensible Capacity** ≡ The amount of tonnage dedicated to the removal of DRY BULB HEAT (no water)

KEY INFORMATION: **The heat load produced by powering electronics is 100% Sensible.** Unlike human comfort applications there is zero moisture in the heat load presented by electronics (Latent Load = 0). Therefore, Right Sizing for electronic equipment cooling is based *entirely* on **Sensible** capacity.

While having some latent capacity is useful, to manage moisture introduced from humans or from outside air being introduced, the sensible capacity of the HVAC being larger than the site load is the *most critical* parameter in Right Sizing HVAC equipment for electronic cooling applications.

## Determining Site Load

The heat load of any equipment enclosure/room has two basic components:

**Total Heat Load** = Heat Load from Electronics + Heat Load from Environment

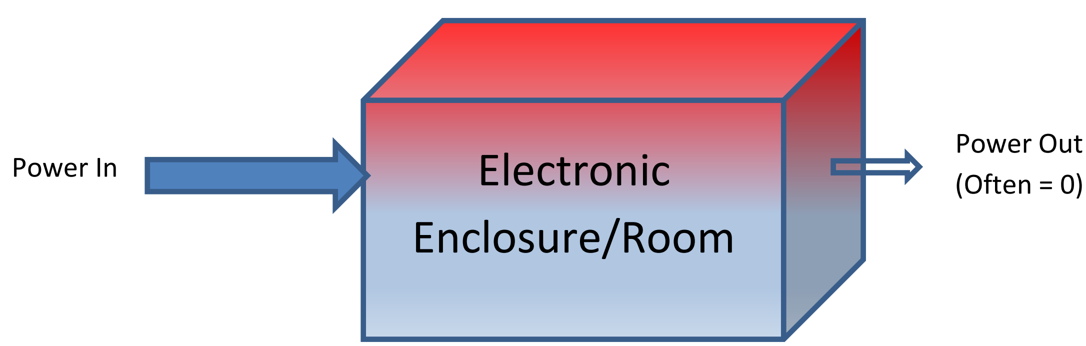
**Heat Load from Electronics**

In most applications the heat load presented via electronics equipment can be closely approximated by the total power consumed by the equipment:

**Electronics heat load** = Power into enclosure - Power out of enclosure

**Power**(Watts) = Voltage (Volts) * Current (Amps)

NOTE: If the HVAC system resides OUTSIDE, the enclosure (example: Wall Packaged Units) then the heat dissipated by the HVAC system operation DOES NOT add to the heat load of the enclosure/room.




**NOTE: If the equipment is powered from a DC plant**, the heat generated from rectifier loss should be added to the electronics heat load.

EXAMPLE: 48 Volt plant (54 VDC float voltage) with 200 Amps of current & 100% of equipment is run from a DC plant with 96% efficiency rectifier.

$$Power\ In\ = \frac{54V * 200A}{0.96} = 11.25\ kW\ (38{,}400\ BTUH)$$

## Heat Load from Environment

The environment surrounding the room or enclosure can either add to the internal heat load or it can subtract from the internal load. For sizing the HVAC system our main concern is to ensure we have capacity for the worst case/highest total heat load condition. This would be on the warmest day in the summer time where the environmental load will be the highest.

Additional heat enters the space through the floor, the walls, and the ceiling. The amount of heat that enters the room is based on the outdoor temperature and the insulation value of each of the surfaces in question. A high level of insulation (example R30) minimizes the heat gain/loss from the environment, a low level (< R10) will increase the gain/loss from the environment.

$$Load\ From\ Environment\ (BTUH) = k * \left(\frac{A_{ceiling}}{R_{ceiling}} + \frac{A_{floor}}{R_{floor}} + \frac{A_{floor}}{R_{floor}}\right) * \Delta T$$

Where
$\Delta T$ = Difference between indoor and outdoor temperatures (°F)
k = constant, ≈ 1 BTU/ft$^2$/°F/h or 0.293 W/ft$^2$/°F
A = Surface Area (ft$^2$)
R = Insulation R-Value

EXAMPLE: 12x20x9ft building with indoor temperature setpoint of 80°F and maximum summer temperature of 105F. The building has insulation values of R12, R9, and R5 on wall, ceiling, and floor respectively.

$$Environment\ Load = \left(\frac{12 * 20}{9} + \frac{12 * 20}{5} + \frac{9 * 2 * (20 + 12)}{12}\right) * (105 - 80)\ BTUH$$
$$= 3{,}100\ BTUH\ (or\ 0.9kW)$$

Important Notes:

- For sites with higher equipment heat loads (>20 kW or > 70,000 BTUs) and basic isolation between indoor and outdoor then the environmental load is typically negligible.
- The smaller the equipment load, the more likely the environmental load becomes a significant % of the overall load, especially in warmer climates.

## Determining HVAC Capacity

When determining the needed HVAC capacity, it is important to ensure that redundancy is included. Having one more unit than is needed to maintain site temperature is recommended as it allows for sufficient capacity if one of the units is not available.

**IMPORTANT NOTE**: Outdoor packaged HVAC systems like a WPU (Wall Packaged Unit) are rated for capacity and EER (Energy Efficiency Ratio) at AHRI 390 Test conditions → 95°F Outdoor Temperature, 80°F Dry Bulb/67°F Wet Bulb Indoor Temp. If the site location experiences outdoor temperatures >95°F, capacity derating of 4% per 5°F above 95°F should be considered when determining the HVAC capacity.

In addition, a safety margin of 5-10% should be implemented to account for performance degradation due to the following factors:

- Dirt, grime and other debris reducing condenser heat exchange
- Air filter collecting particulates, reducing supply airflow
- Compressor wear

To summarize:

$$Min.\,HVAC\ Sensible\ Capacity = \frac{Total\ Heat\ Load}{1 - Safety\ Margin} * (1 + Temperature\ Derating)$$

Example: using the scenario outlined in the previous sections and a 10% safety margin:

$$Min.\,HVAC\ Sensible\ Capacity \ = \frac{11.25kW + 0.9kW}{1 - 0.1} * (1 + 0.08)$$
$$= 14.6kW(49{,}700\ BTUH)$$

## Conclusion

When selecting HVAC products for electronics cooling in critical facilities, make sure to examine the *sensible* capacity of the machine and ensure that it is greater than the site load. Be aware that manufacturers whose products are designed for electronics cooling tend to have a higher ratio of sensible to total cooling than others. This often allows the use of a unit with a smaller “total” capacity, saving money and delivering a higher quality cooling experience.

For more information on how to find these products, visit https://airsysnorthamerica.com.