

## Calculating Heat Load

The amount of heat generated is known as the heat gain or heat load. Heat is measured in either British Thermal Units (BTU) or Kilowatts (KW). 1KW is equivalent to 3412BTUs.

The heat load depends on a number of factors, by taking into account those that apply in your circumstances and adding them together a reasonably accurate measure of the total heat can be calculated\*.

Factors include:

The floor area of the room

The size and position of windows, and whether they have blinds or shades

The number of room occupants (if any)

The heat generated by equipment

The heat generated by lighting

Floor Area of Room

The amount of cooling required depends on the area of the room. To calculate the area in square metres:

$$\text{Room Area BTU} = \text{Length (m)} \times \text{Width (m)} \times 337$$

### Window Size and Position

If, as is quite common, your Server Room has no windows, you can ignore this part of the calculation. If, however there are windows you need to take the size and orientation into account.

$$\text{South Window BTU} = \text{South Facing window Length (m)} \times \text{Width (m)} \times 870$$

$$\text{North Window BTU} = \text{North Facing windows Length (m)} \times \text{Width (m)} \times 165$$

If there are no blinds on the windows multiply the result(s) by 1.5.

Obviously if you are in the Southern Hemisphere you would swap the conversion factors as the heat on North facing windows is then greatest.

Add together all the BTUs for the windows.

$$\text{Windows BTU} = \text{South Window(s) BTU} + \text{North Window(s) BTU}$$

### Occupants

Purpose built Server Rooms don't normally have people working in them, but if people do regularly work in your Server Room you will have to take that into account. The heat output is around 400 BTU per person.

$$\text{Total Occupant BTU} = \text{Number of occupants} \times 400$$

## Equipment

Clearly most heat in a Server Room is generated by the equipment. This is trickier to calculate than you might think. The wattage on equipment is the maximum power consumption rating, the actual power consumed may be less. However it is probably safer to overestimate the wattage than underestimate it.

Add together all the wattages for Servers, Switches, Routers and multiply by 3.5.

Equipment BTU = Total wattage for all equipment x 3.5

## Lighting

Take the total wattage of the lighting and multiply by 4.25.

Lighting BTU = Total wattage for all lighting x 4.25

## Total Cooling Required

Add all the BTUs together.

Total Heat Load = Room Area BTU + Windows BTU + Total Occupant BTU + Equipment BTU + Lighting BTU

This is the amount of cooling required so you need one or more air conditioning units to handle that amount of heat.

So what size of unit do I need?

Small air conditioning units have a cooling capacity of between 5000 and 10000 BTUs. Small units may fit in windows, venting to the outside world.

Larger units may be rated in tons of cooling. 1 ton of cooling is equivalent to 12 thousand BTUs.

\* Disclaimer: This calculation is intended as a rough guide only. Complete accuracy cannot be guaranteed. Before you decide on an air conditioning unit you should commission an audit from a suitably qualified air conditioning equipment specialist or installer.

## Chiller Refrigeration Tons

A chiller refrigeration ton is defined as:

$$1 \text{ refrigeration ton} = 12,000 \text{ Btu/h} = 3,025.9 \text{ k Calories/h}$$

A ton is the amount of heat removed by an air conditioning system that would melt 1 ton of ice in 24 hours.

## Cooling Tower Tons

A cooling tower ton is defined as:

1 cooling tower ton = 15,000 Btu/h = 3,782 k Calories/h

#### Heat Load and Water Flow

A water systems heat load in Btu/h can be simplified to:

$$h = cp \rho q dt$$

$$= 1 \text{ (Btu/lbm oF)} 8.33 \text{ (lbm/gal)} q \text{ (gal/min)} 60 \text{ (min/h)} dt \text{ (oF)}$$

$$= 500 q dt \text{ (1)}$$

where

$h$  = heat load (Btu/h)

$cp$  = 1 (Btu/lbm oF) for water

$\rho$  = 8.33 (lbm/gal) for water

$q$  = water volume flow rate (gal/min)

$dt$  = temperature difference (oF)

#### Example - Water Chiller Cooling

Water flows with 1 gal/min and 10oF temperature difference. The ton of cooling load can be calculated as:

$$\text{Cooling load} = 500 (1 \text{ gal/min}) (10\text{oF}) / 12,000$$

$$= 0.42 \text{ ton}$$