



Fundamentals of HVAC

Space Loads



What you will Learn in this Lesson

- What is a load?
- Overview of contributing space loads
- How to calculate space loads
- How space loads fit into the “big picture”

What is a load?

- A load is “a heavy or bulky thing that is being carried or is about to be carried or moved”
- In our industry, the ‘thing’ that is being moved is heat
- Load varies throughout the day, and throughout the year
- When does this reach a maximum?

Load Overview

- Space loads are loads that occur because of the activities in that space
- Building loads are caused by the space loads, but also other loads that do not affect the space
- We will focus on space loads first, then build on those to form the building loads
- How do we calculate space loads?

Different types of Space Load Calculations

- Heat Balance Method (HB)
 - Most accurate, however, needs a computer to do iterations
- Cooling Load Temperature Differential Method with Solar Cooling Load Factor (CLTD/CLF)
 - Most straight forward and “easy” to do by hand
 - This is the way we will do it on paper
 - Values from table are assumed on July 21st for a building on 40° latitude, with a max outdoor temperature of 95°F, indoor design of 78°F and an outdoor range of 21°F
- Total Equivalent Temperature Differential Method with Time Averaging (TETD/TA)
- Radiant Time Series Method (RTS)
- Transfer Function Method (TFM)

Space Load Overview

- All spaces within a building are effected by internal and external gains
 - Lighting
 - Equipment (plug)
 - People
 - Solar
 - Infiltration
 - Ventilation
 - Heat Storage

Heat Transfer of a Space

- Some heat is absorbed and delayed before affecting room temperature

Lighting Loads

- Lights contribute a significant amount of heat to a space
- Not all of the heat from a light is added *directly* to a space
- Typically reported in W/ft^2
- The load ranges from 0.5 W/ft^2 for industrial lighting to 8 W/ft^2 for retail applications

Lighting Loads

$$q_{el} = 3.41 \cdot W \cdot F_{lu} \cdot F_{sa} \cdot CLF$$

Where:

q_{el} is instantaneous heat gain

W is the total wattage

F_{lu} is the lighting usage factor

F_{sa} is the lighting special allowance factor-how much light goes into the space instead of the plenum

CLF is the cooling load factor-based on a table

Lighting Loads-CLF Table

- The first step is to figure out the correct zone type for the lighting
- The first column is the number of hours/day the lights are on
- The rest of the columns are the number of hours after the lights have been turned on

Equipment Loads (Plug Loads)

- Depending on the application, plug loads also contribute a significant load to a space
- Given in W/ft^2 with the square footage of the room
- The range can vary between 0.5 W/ft^2 for hallways to 500 W/ft^2 for data centers

Equipment Loads (Plug Loads)

$$Q_{sensible} = Q_{input} \cdot F_U \cdot F_R \cdot CLF$$

Where:

Q_{input} is the rated energy input from the appliance

F_U is the usage factor (found in Appendix D of FAS)

F_R is the radiation factor (found in Appendix D of FAS)

CLF is the cooling load factor for appliances

*Latent load is 0 if the equipment is hooded

People Loads

- People impact building loads in two ways
 - People themselves are a heat source
 - For acceptable indoor air quality (IAQ) ventilation (outdoor) air is introduced into the building
 - Ventilation air is one of the largest loads in most buildings
- Population density ranges from 50 ft²/person for schools to 200 ft²/person for hotels
 - The heat load is given as both latent and sensible heat gains based on the description of activity
 - Sensible about 250 and latent about 200 Btu/hr for office work

People Loads

$$q_{sensible} = N \cdot SensibleHeatGain \cdot CLF$$

$$q_{latent} = N \cdot LatentHeatGain$$

Where:

N is the number of people in the space

Heat gains come from Appendix D in the FAS book

CLF comes from the same charts as unhooded equipment

Solar Loads

- Solar load can be avoided, or stored, or extracted
- Solar load appears as thermal energy through both glass and opaque wall and roof
- Depends on time of day, orientation of the building, percent glazing, R-Value of walls and roof

Solar Loads

$$q_{wall/roof} = U \cdot A \cdot CLTD$$

$$q_{window,cond} = U \cdot A \cdot CLTD$$

$$q_{window,rad} = SC \cdot A \cdot SCL$$

Where:

q is the cooling load

A is the area (ft²)

U is the coefficient of heat transfer (Btu/hr·ft²· F)

SC is the shading coefficient (from tables)

SCL is the solar cooling load (from tables) (Btu/hr·ft²)

$CLTD$ is the cooling load temperature difference (F)

Infiltration

- Very complex and difficult to calculate
- The science of infiltration is rich and broad
- More often than not – a rule of thumb is used
 - 0.30 CFM/ft² of exterior wall area
- Infiltration comes from pressure differences
 - Stack effect

Ventilation

- Based on Standard 62.1
- Bringing in fresh air creates a load on the system
- This will be talked about more in-depth later

Heat Storage-Thermal Mass

- Throughout the day, objects in the space can absorb heat and distribute that heat at a later point
 - The amount of heat that can be absorbed is dependent on the material and on the color
 - Dark absorbs, light reflects
- The CLTD method does not take this into account
- This will be covered more in-depth later

End of Lesson

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Questions?