

HVAC Hacks #1: HVAC Fundamentals - Essential Tips & Rules of Thumb

An Online Continuing Education Course for Engineers

Course Number: HV-6025

Credit: 6 Hours / 6 PDH / 6 CPD

HVAC Hacks #1: HVAC Fundamentals - Essential Tips & Rules of Thumb

A. Bhatia, Mechanical Engineer

Feeling lost in the world of HVAC? This course is your foundation.

This introductory course serves as your gateway to mastering the fundamentals of HVAC systems. In this comprehensive 6-hour course, you will gain a solid understanding of:

- a. Core Systems: Distinguish between various HVAC systems, gaining insight into their unique characteristics and their strengths and weaknesses.
- b. Application Expertise: Explore how different HVAC systems are best deployed across diverse settings, ranging from residential to commercial and beyond, optimizing comfort and efficiency in each environment.
- c. Foundational Knowledge: Grasp the fundamental principles of thermodynamics, heat transfer, and fluid dynamics that underpin the operation of HVAC systems.
- d. Heat Transfer Hacks: Explore core principles governing air and fluid behavior for efficient heat transfer and optimal comfort control without complex equations.
- e. Fluid Flow Fundamentals: Grasp fluid flow principles affecting airflow and pressure in HVAC systems.
- f. Energy Efficiency Essentials: Understand key factors impacting HVAC performance and cost savings.





Embedded within the course are essential metrics, practical tips, and handy rules of thumb to accelerate your learning journey and help you make well-informed decisions.

Let's get started with essential metrics and rules of thumb.


ACRONYM FOR HVAC

- a. H: Heating
- b. V: Ventilation
- c. AC: Air conditioning






FUNCTIONS OF HVAC

	Subjects	Rules of Thumb
	Air conditioning	<i>Comfort Standard: ASHRAE 55</i> <ul style="list-style-type: none">a. <i>Temperature: 75±2°F</i>b. <i>Relative humidity (RH): 50±5%</i>c. <i>Air quality: Adequate ventilation and filtration.</i>
	Ventilation	<i>Ventilation Standard: ASHRAE Standard 62.1.</i> <ul style="list-style-type: none">a. <i>Typical ventilation rates: 15 to 20 cubic feet per minute (CFM) of outdoor air per person.</i>b. <i>CO₂ levels between 600-1000 ppm. Above 1000 ppm is considered poor air.</i>
	Filtration	<i>Filtration Standard: ASHRAE 52.1.</i> <ul style="list-style-type: none">a. <i>MERV 8 for pre-filters</i>b. <i>MERV 13 for final filters</i>
	Heating system	<i>Comfort Standard: ASHRAE 55</i> <ul style="list-style-type: none">a. <i>Temperature: 68 to 70°F</i>b. <i>Relative humidity (RH): 30% and 50% to avoid condensation and mold.</i>c. <i>Freeze control: above 32°F.</i>




HVAC Capacity

	Description	Rules of Thumb
	Air-conditioning Capacity	<i>HVAC systems rated in tons of refrigeration (TR): 1 TR = 12,000 BTU/hr. or about 3.5 kW (Thermal).</i>



Relationship of Tons, BTU, and KW

	Main Unit (Ton)	Equivalent BTU	Equivalent kW
	1 Ton	12,000 BTU	3.51 kW
	1.5 Ton	18,000 BTU	5.27 kW
	2 Ton	24,000 BTU	7.03 kW
	2.5 Ton	30,000 BTU	8.79 kW
	3 Ton	36,000 BTU	10.55 kW

Classification of Refrigeration Systems






	Refrigeration Type	Rules of Thumb
	Low-temperature refrigeration	<i>Systems at 32°F or lower: Refrigerators, freezers, ice makers.</i>
	Medium temperature refrigeration	<i>Systems between 30°F and 45°F: Display cases, beverage coolers.</i>
	High-temperature refrigeration	<i>Systems between 45°F and 60°F: HVAC systems (air-based or hydronic).</i>

HVAC Systems

	System Type	Rules of Thumb
	Air-based HVAC systems	<i>Air circulation for heating and cooling: examples, Split and package units, furnaces.</i>
	Hydronic HVAC Systems	<i>Chilled or hot water for heat transfer: for example, Hydronic systems.</i>



HVAC Control

Higher heat in a room requires more sensible heat removal capacity, and higher moisture in a room requires more latent heat removal capacity.







	Parameters	Rules of Thumb
	Air conditioner capacity (Total load)	<i>AC capacity in tons (1 ton = 12,000 BTU/hr); 80% sensible, 20% latent load.</i>
	Sensible load	<i>Sensible heat (ΔT) alters temperature, not moisture; calculated using $Q = m * C_p * \Delta T$. <i>Where m is the mass of air, C_p is the specific heat of air, and ΔT is the temperature difference.</i></i>
	Latent load	<i>Latent heat handles moisture changes; standard ACs focus more on sensible cooling.</i>
	Temperature Control	<i>Adjust air quantity or supply air temperature for desired heating or cooling.</i>
	Humidity Control	<i>In hot, humid regions, customized HVAC with deep coils or dehumidifiers is effective for moisture control. Increasing AC capacity alone may not resolve high humidity.</i>

Type of HVAC systems

	HVAC Types	Rules of Thumb
	Window AC	<i>Capacity: 0.5 - 2 tons; Individual room cooling in residential and small offices.</i>
	Portable AC	<i>Capacity: 0.5 - 2 tons; Movable cooling solution for various spaces.</i>
	Single Split AC	<i>Capacity: 0.75 - 3 tons; Cooling for individual rooms or zones.</i>
	Multi-Split AC	<i>Capacity: 1.5 - 5 tons; Multiple indoor units connected to one outdoor unit.</i>
	VRF Systems	<i>Capacity: 5 - 30 tons; Precise control for large buildings with multiple zones.</i>
	Package System	<i>Capacity: 3 - 15 tons; Self-contained unit for rooftop or ground-level installation.</i>
	Package Through Wall	<i>Capacity: 1 - 5 tons; Through-wall installation for localized cooling.</i>
	Rooftop Units: Capacity	<i>5 - 25 tons; Commercial buildings with rooftop installation.</i>
	Air-Source Heat Pump	<i>Capacity: 1 - 5 tons; Heating and cooling for single spaces.</i>
	Ground-Source Heat Pump	<i>Capacity: 2 - 10 tons; High efficiency using ground temperature.</i>
	Water-Source Heat Pump	<i>Capacity: 1 - 10 tons; Efficient heating/cooling with water source/sink.</i>
	Air-Cooled Chiller	<i>Capacity: 10 - 300 tons; Commercial cooling using air for heat rejection.</i>
	Water-Cooled Chiller	<i>Capacity: 100 - 5000 tons; Commercial cooling using water for heat rejection.</i>
	District Cooling System	<i>Capacity: 10000 – 100000 tons; Centralized cooling for multiple buildings.</i>

	HVAC Types	Rules of Thumb
	Furnaces (Air-based): Capacity	20,000 - 150,000 BTU/h; Residential, commercial, and industrial space heating.
	Boiler (Hydronic): Capacity	Varies. Heats water for radiator, underfloor heating, or

Thermo

	F	reated nor
	Sec	to lower entropy,
	Boyl	nt temperature, ressure up,
	Charle	ands air, and
	Cooling	Heat quantity is determined by temperature difference (ΔT), mass (m), and specific heat (C_p) and is given by equation $m \cdot C_p \cdot \Delta T$.
	Water or Air	Water has much higher specific heat (about 4 times) than air, making it much more efficient in heating and cooling systems.

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

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