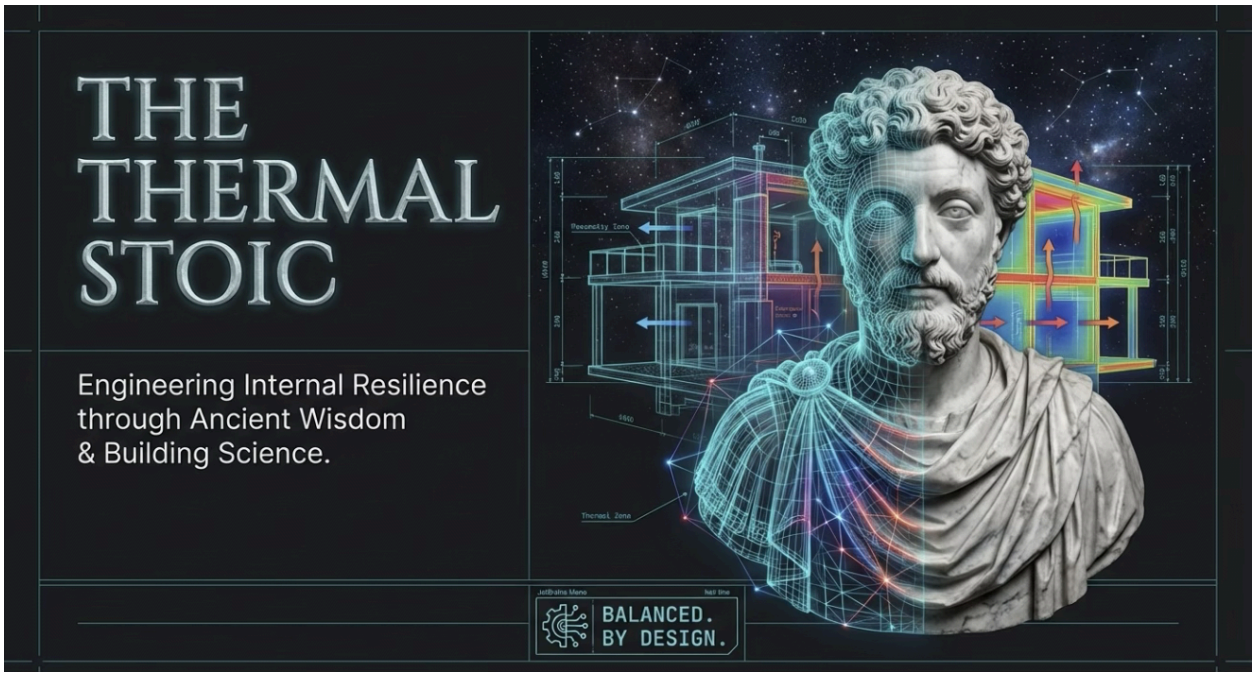
HVAC Design, Building Science & Thermodynamics Glossary

A Companion Reference for The Thermal Stoic Podcast Series

Balanced by Design Operating System

Listen on Spotify

Listen on Apple



This glossary contains every technical term used across The Thermal Stoic podcast series, organized by category for easy reference. Each entry includes the definition, relevant context, and practical application to HVAC design and building science.

How to Use This Glossary:

- Keep this document handy while listening to episodes
- Reference unfamiliar terms immediately for better retention
- Use the context field to understand how each concept applies to real design work
- Review full categories when preparing for specific project types

Thermodynamic Fundamentals

First Law of Thermodynamics

Definition: Energy cannot be created or destroyed, only transformed. In HVAC: the heat energy removed from your house doesn't disappear—it's moved outside.

Application: *Foundation for understanding why heat pumps work and why Manual J calculations must account for every energy pathway.*

Second Law of Thermodynamics

Definition: Heat naturally flows from hot to cold. Heat pumps use energy to reverse this natural flow.

Application: *Explains why heat pumps need electricity to move heat 'uphill' from cold outdoor air into your warm house.*

Enthalpy

Definition: The total heat content of air, including both sensible heat (temperature) and latent heat (moisture). Measured in BTU/lb.

Application: *Critical for psychrometric calculations. Two air samples at the same temperature can have vastly different enthalpy if humidity differs.*

Entropy

Definition: A measure of energy that's no longer available to do useful work. Think of it as a thermal 'disorder.'

Application: *In HVAC design: explains why larger temperature differences are more efficient for heat transfer.*

Specific Heat

Definition: The amount of energy needed to raise the temperature of a material by one degree. Water has high specific heat; air has low specific heat.

Application: *Why hydronic systems can move more energy than air systems using smaller distribution components.*

Latent Heat

Definition: Energy absorbed or released during a phase change (solid↔liquid↔gas) without changing temperature.

Application: *Why dehumidification loads can exceed sensible cooling loads in humid climates. Moisture removal requires significant energy.*

Sensible Heat

Definition: Energy that changes temperature without changing phase. What a thermometer measures.

Application: *The 'easy' part of load calculation. Accounts for conduction through walls, windows, infiltration temperature difference.*

Thermal Mass

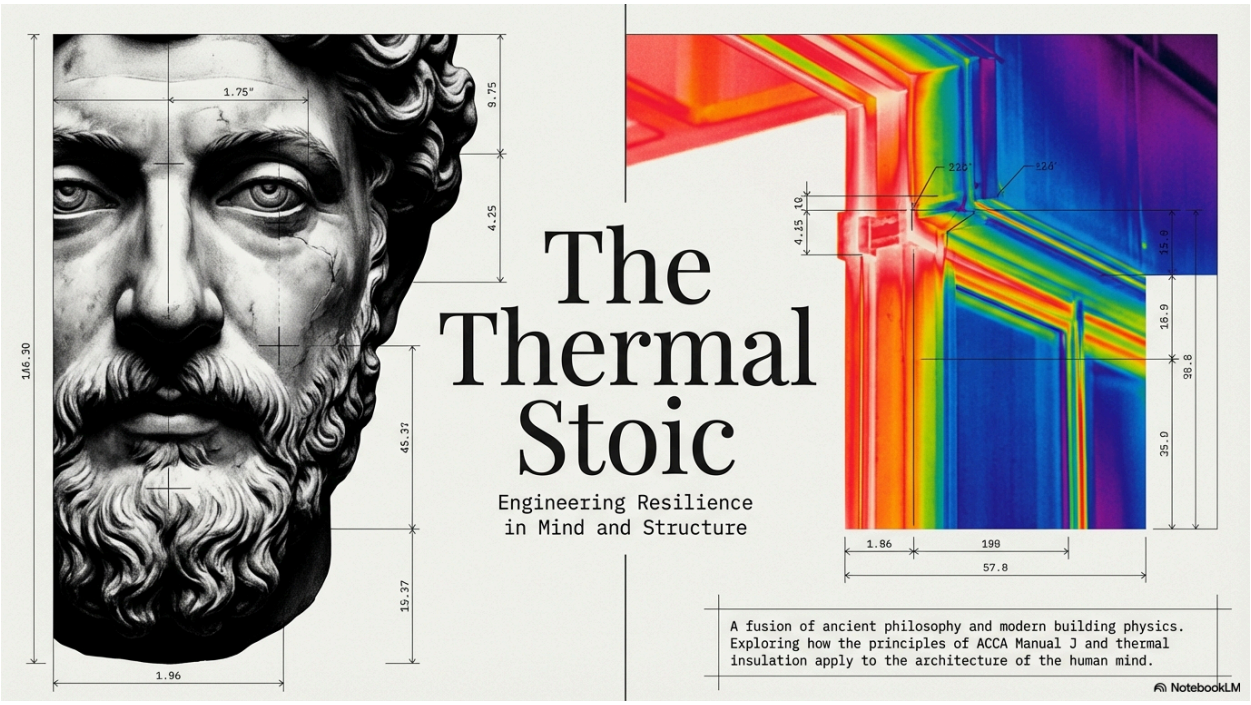
Definition: A material's ability to absorb and store heat energy. High mass = slow temperature change.

Application: *Why brick homes feel different than frame homes at the same thermostat setting. Affects recovery time and cycling patterns.*

Heat Capacity

Definition: The total amount of heat energy a material or system can store. Mass × specific heat.

Application: *Determines how quickly a building responds to temperature changes and how equipment should be sized for recovery.*



Heat Transfer Mechanisms

Conduction

Definition: Heat transfer through direct contact within a material. Molecules vibrating and passing energy to neighbors.

Application: *How heat moves through walls, windows, and building assemblies. R-value is resistance to conductive heat transfer.*

Convection

Definition: Heat transfer by fluid motion (air or water movement). Can be natural (buoyancy-driven) or forced (fan/pump).

Application: *How your distribution system actually delivers heating/cooling. Why airflow matters more than you think.*

Radiation

Definition: Heat transfer via electromagnetic waves. No physical contact or medium required.

Application: *Why south-facing windows create massive loads even with good insulation. Why radiant barriers work in attics.*

Thermal Conductivity (k-value)

Definition: How easily heat flows through a material. Higher k = better conductor = worse insulator.

Application: *Used to calculate R-values. Wood k≈0.08, concrete k≈1.0, steel k≈45 BTU·in/(hr·ft²·°F).*

Thermal Bridging

Definition: A path of higher conductivity through an assembly that bypasses insulation.

Application: *Why steel studs kill wall performance. Why continuous exterior insulation matters. Can reduce effective R-value by 50%.*

U-Factor

Definition: Overall heat transfer coefficient. Inverse of R-value (U = 1/R). Higher U = more heat loss.

Application: *Used for windows and overall assembly performance. Better for comparing assemblies with multiple components.*

R-Value

Definition: Thermal resistance. Higher R = better insulation. Measured in hr·ft²·°F/BTU.

Application: *Foundation of building envelope performance. Additive across layers (R5 + R13 = R18 total).*

Psychrometrics & Air Properties

Psychrometrics

Definition: The study of air-moisture mixtures and their properties. The foundation of HVAC load calculations.

Application: *Why we need psychrometric charts. Understanding this separates real designers from parts installers.*

Dry Bulb Temperature

Definition: Air temperature measured by a regular thermometer. What your thermostat reads.

Application: *Only tells half the story. Same dry bulb with different humidity = completely different comfort and load.*

Wet Bulb Temperature

Definition: Temperature air would reach if cooled by evaporating water into it until saturated. Always ≤ dry bulb.

Application: *Critical for cooling tower and evaporative cooler performance. Determines maximum achievable cooling.*

Dew Point Temperature

Definition: Temperature at which air becomes saturated and moisture begins to condense.

Application: *Why your ductwork sweats. Why evaporator coils form condensate. Key to understanding dehumidification.*

Relative Humidity (RH)

Definition: Ratio of actual moisture in air to maximum possible at that temperature. Expressed as percentage.

Application: *RH changes with temperature even if absolute moisture doesn't. Why basements feel damp in summer.*

Absolute Humidity

Definition: Actual mass of water vapor in air, independent of temperature. Grains/lb or lb water/lb dry air.

Application: *Better metric than RH for understanding actual moisture content. Used in latent load calculations.*

Specific Volume

Definition: Volume occupied by one pound of dry air. Changes with temperature and altitude.

Application: *Critical for CFM calculations. Same mass flow = different volume flow at different temperatures.*

Saturation

Definition: When air holds the maximum possible moisture at a given temperature. 100% relative humidity.

Application: *Air at saturation will form condensation if cooled further. Why cold surfaces sweat.*

Refrigeration Cycle

Refrigeration Cycle

Definition: The thermodynamic process that moves heat from cold to hot using phase change of refrigerant.

Application: *The heart of every heat pump and air conditioner. Four key components, four key processes.*

Compressor

Definition: Pumps refrigerant and increases its pressure and temperature. The only component that adds energy to the cycle.

Application: *Where electricity goes in. Performance directly affects system efficiency. Most expensive component to replace.*

Condenser

Definition: Heat exchanger where refrigerant rejects heat and condenses from gas to liquid.

Application: *The outdoor coil in cooling mode, indoor coil in heating mode. Where useful heat is delivered/rejected.*

Evaporator

Definition: Heat exchanger where refrigerant absorbs heat and evaporates from liquid to gas.

Application: *The indoor coil in cooling mode, outdoor coil in heating mode. Where useful cooling/heat absorption happens.*

Expansion Valve/Metering Device

Definition: Creates a pressure drop that allows refrigerant to expand and cool before entering the evaporator.

Application: *Controls refrigerant flow rate. Can be fixed orifice (TXV/piston) or variable (electronic expansion valve).*

Superheat

Definition: Temperature of refrigerant vapor above its saturation temperature at a given pressure.

Application: *Measured at compressor suction. Ensures no liquid refrigerant enters compressor. Typical target: 10-15°F.*

Subcooling

Definition: Temperature of refrigerant liquid below its saturation temperature at a given pressure.

Application: *Measured at condenser outlet. Ensures vapor-free liquid to expansion device. Typical target: 8-12°F.*

Coefficient of Performance (COP)

Definition: Ratio of useful heating/cooling delivered to energy consumed. COP = Output/Input.

Application: *Heat pumps can have COP > 3 (300% efficient by conventional thinking). Why heat pumps beat resistance heat.*

Energy Efficiency Ratio (EER)

Definition: Cooling capacity (BTU/hr) divided by power input (watts) at specific test conditions.

Application: *Snapshot efficiency at one operating point. Used for comparing equipment, but doesn't tell seasonal story.*

Seasonal Energy Efficiency Ratio (SEER)

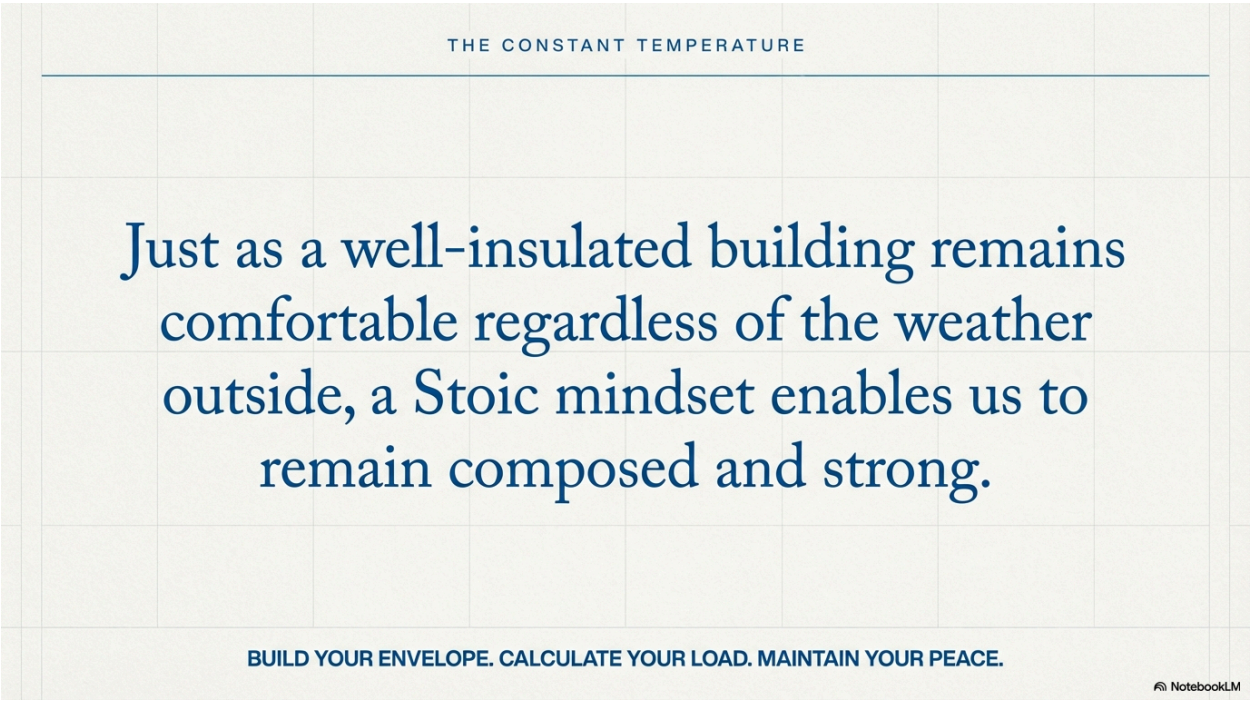
Definition: Total cooling output over typical season divided by total energy consumed. Weighted average efficiency.

Application: *Better predictor of operating costs than EER. SEER2 is newer, more realistic test standard.*

Heating Seasonal Performance Factor (HSPF)

Definition: Total heating output over typical season divided by total energy consumed. Heat pump heating efficiency metric.

Application: *Like SEER for heating mode. HSPF2 is newer standard. Higher HSPF = lower heating costs.*



Building Science

Building Envelope

Definition: The physical separator between conditioned interior and exterior environment. Includes walls, roof, windows, doors, foundation.

Application: *First priority in any retrofit. Control the envelope before you size equipment.*

Air Barrier

Definition: Continuous layer that prevents uncontrolled air movement through the envelope.

Application: *More important than insulation. 1 sq in hole can negate 100 sq ft of insulation. Must be continuous.*

Thermal Boundary

Definition: The insulated plane that separates conditioned from unconditioned space.

Application: *Should align with air barrier. Misalignment creates moisture and performance problems.*

Pressure Boundary

Definition: The plane that separates different pressure zones.

Application: *Should align with air and thermal boundaries. Critical for controlling infiltration and moisture movement.*

Infiltration

Definition: Uncontrolled air leakage into building through envelope defects. Measured in ACH50 or CFM50.

Application: *Can be 30-40% of heating/cooling load in leaky homes. Why blower door testing matters.*

Ventilation

Definition: Controlled introduction of outdoor air for indoor air quality. Required by building codes.

Application: *Must be designed and measured. Not the same as infiltration. ASHRAE 62.2 provides calculation methods.*

Air Changes per Hour (ACH)

Definition: Number of times the entire building volume is replaced with outdoor air per hour.

Application: *Natural ACH varies with weather. ACH50 is at 50 Pa test pressure. Typical tight house: <3 ACH50.*

Blower Door Test

Definition: Diagnostic tool that measures building air tightness by pressurizing/depressurizing with a calibrated fan.

Application: *Provides CFM50 and ACH50 metrics. Essential for understanding infiltration loads and ventilation needs.*

Stack Effect

Definition: Buoyancy-driven air movement in buildings. Warm air rises, creating positive pressure at top, negative at bottom.

Application: *Why two-story homes are harder to balance. Why basement doors slam shut in winter. Drives infiltration patterns.*

Vapor Barrier

Definition: Layer that restricts moisture movement by diffusion. Typically defined as <1 perm.

Application: *Location matters based on climate. Wrong placement can trap moisture. Often confused with air barrier.*

Vapor Retarder

Definition: Layer that slows moisture movement by diffusion. Less restrictive than barrier (1-10 perms).

Application: *Often more appropriate than vapor barriers. Allows some drying capacity.*



Load Calculation

Manual J

Definition: ACCA standard for residential load calculation. Room-by-room analysis accounting for all heat gain/loss pathways.

Application: *Non-negotiable foundation for proper system sizing. Equipment selection without Manual J is guessing.*

Design Temperature

Definition: Outdoor temperature used for heating/cooling calculations. Typically 99%/1% conditions (exceeded 1% of hours).

Application: *Not the coldest/hottest day ever. Represents realistic extreme for equipment sizing.*

Internal Gains

Definition: Heat generated inside building from occupants, lights, appliances, equipment.

Application: *Can significantly offset heating loads. Major contributor to cooling loads. Varies by occupancy pattern.*

Solar Gain

Definition: Heat entering building through windows from direct and diffuse solar radiation.

Application: *Dominant cooling load in many homes. Varies by window orientation, shading, and glazing type.*

Infiltration Load

Definition: Energy required to condition outdoor air entering through envelope leaks.

Application: *Both sensible (temperature difference) and latent (moisture difference). Why air sealing pays off.*

Ventilation Load

Definition: Energy required to condition intentional outdoor air brought in for air quality.

Application: *Cannot be eliminated, only managed. Why energy recovery ventilators make sense in extreme climates.*

Block Load

Definition: Total heating/cooling needed for entire building at design conditions.

Application: *Used for equipment selection. Sum of all room loads, but not necessarily at same time.*

Room Load

Definition: Heating/cooling needed for individual room at design conditions.

Application: *Used for airflow distribution. Critical for comfort. Cannot be ignored even if block load is correct.*

Peak Load

Definition: Maximum heating/cooling demand expected. Occurs at design temperature conditions.

Application: *Equipment must meet peak load, but runs at peak <1% of time. Why modulation and staging matter.*

Part Load

Definition: Operating conditions when demand is less than equipment capacity. 95%+ of operating hours.

Application: *Where real efficiency and comfort are determined. Why SEER matters more than EER.*



Distribution Systems

Total External Static Pressure (TESP)

Definition: Total resistance to airflow in duct system. Sum of supply and return static pressure.

Application: *Critical for equipment selection and performance. High TESP reduces capacity and efficiency.*

Available Static Pressure (ASP)

Definition: Pressure the equipment can provide for ductwork at rated airflow. Read from equipment specs.

Application: *Must exceed TESP for proper performance. Running over ASP destroys efficiency and capacity.*

Duct Design

Definition: Sizing and layout process to deliver required airflow to each room within pressure constraints.

Application: *Manual D is the standard. Proper design ensures balanced system and efficient operation.*

Manual D

Definition: ACCA standard for residential duct design. Accounts for fitting losses, duct sizing, register selection.

Application: *Ensures each room gets design airflow. Cannot be skipped for proper comfort.*

Equivalent Length

Definition: Straight duct length that would create the same pressure loss as a fitting.

Application: *Used to account for elbows, transitions, takeoffs. Critical for accurate static pressure calculation.*

Velocity Pressure

Definition: Pressure component related to air velocity. Increases with square of velocity.

Application: *Why overspeeding air through small ducts is inefficient. Why larger ducts reduce operating costs.*

Static Pressure

Definition: Pressure component perpendicular to flow direction. What manometer measures in duct.

Application: *What fan must overcome to move air. Sum of friction losses and fitting losses.*

Friction Rate

Definition: Pressure loss per 100 feet of straight duct. Function of duct size, airflow, and roughness.

Application: *Typical target: 0.06-0.08 in wc/100 ft for residential. Lower = quieter, more efficient.*

Aspect Ratio

Definition: Ratio of long to short dimension in rectangular duct. AR = length/width.

Application: *High aspect ratio (flat ducts) increase pressure loss and noise. Keep AR < 4:1 when possible.*

Throw

Definition: Distance air travels from register before velocity drops to certain level (typically 50 fpm).

Application: *Must reach occupied zone for comfort. Affected by register type, airflow, and mounting location.*



Balanced System Philosophy

Balanced System

Definition: Cameron's methodology for HVAC design that optimizes the relationship between envelope, equipment, and distribution.

Application: *Design-first approach that considers all variables simultaneously rather than treating equipment selection as isolated decision.*

Design-First Thinking

Definition: Starting with load calculation and distribution design before equipment selection.

Application: *Opposite of sales-first approach. Ensures right equipment for actual building conditions.*

Dual-Fuel Pathway

Definition: System design that enables both air-source heat pump and backup heating to operate optimally.

Application: *Not just 'heat pump + furnace.' Requires thoughtful integration for efficiency and reliability.*

LiDAR Scanning

Definition: Laser-based technology for creating precise 3D models of existing buildings.

Application: *Cameron's differentiator for retrofit design. Eliminates guesswork on existing duct layouts and dimensions.*

Thermal Stoicism

Definition: Cameron's philosophy connecting thermodynamic principles with Stoic mental frameworks.

Application: *Using physics of heat transfer and entropy as metaphors for emotional regulation and resilience.*

Inner Citadel

Definition: Marcus Aurelius's concept of an impenetrable mental fortress. Thermal equivalent: proper building insulation.

Application: *Just as insulation resists heat flow, mental discipline resists external chaos.*