# The Thermodynamics of Hydronic Snow & Ice Melting (SIM) Systems

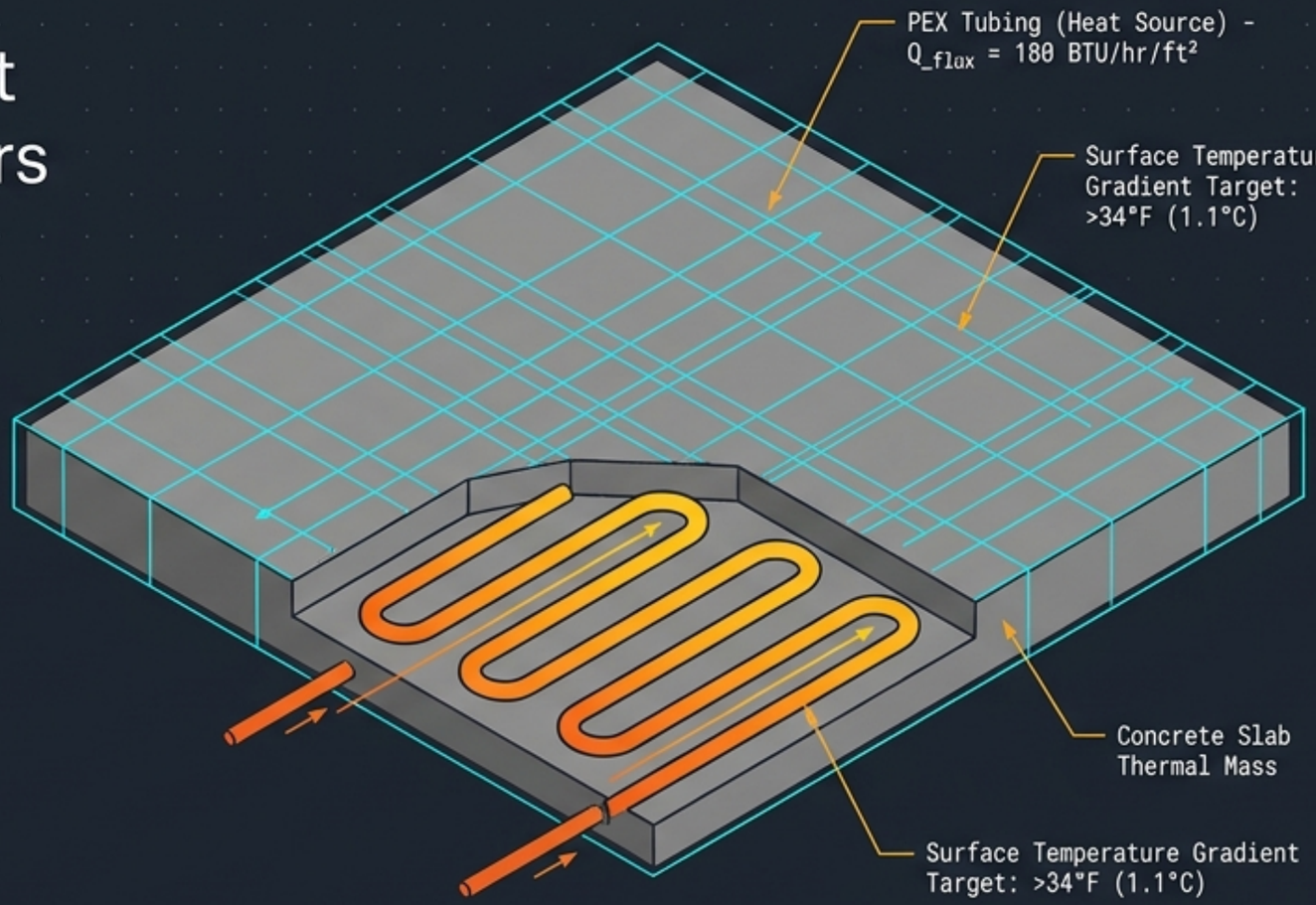
## A 5-Step Engineering Blueprint for HVAC Designers & Specifiers

### Target Applications

Commercial Class II & III (Critical Access)

### Core Disciplines

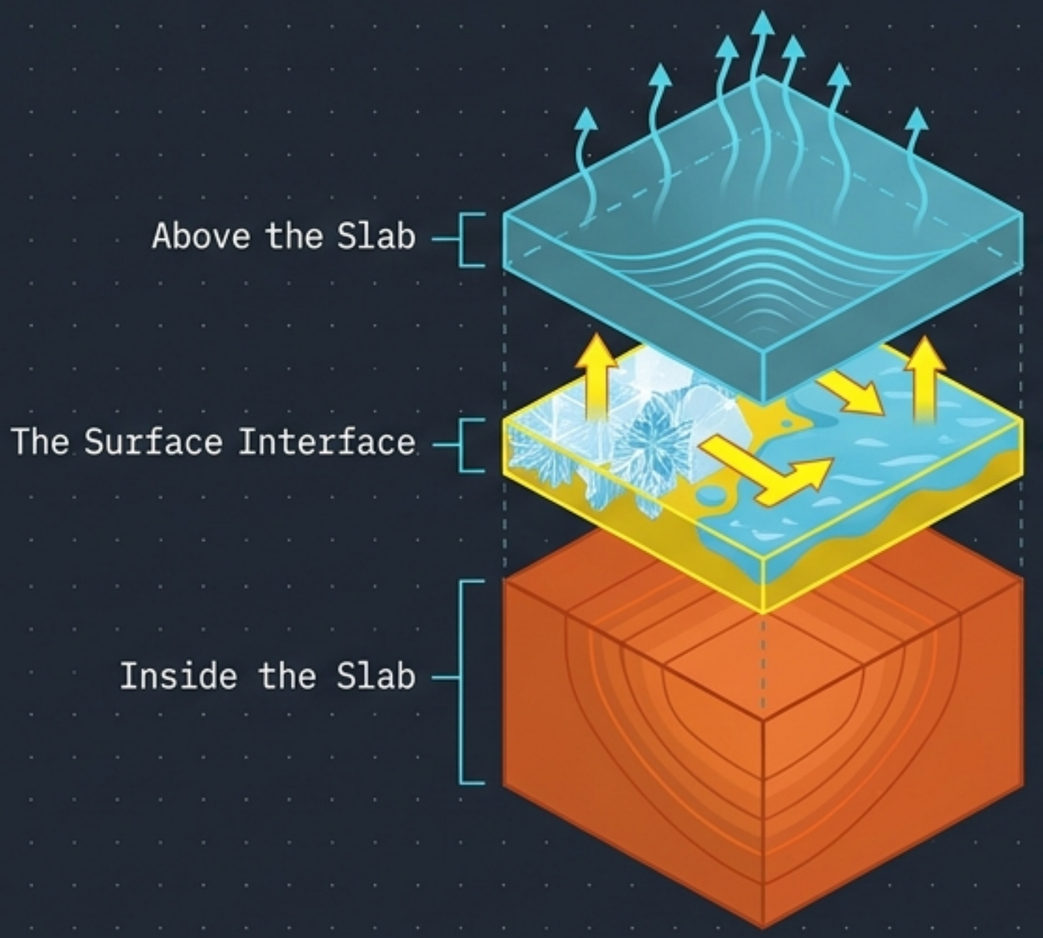
Thermodynamics | ASHRAE Environmental Sizing | Fluid Dynamics



# Step 1: Sizing the Physical Energy Phases of Snow Deicing

The core physics of melting frozen water dictate baseline thermal demand.

## Thermodynamic Energy Stack




### Tier 3: Evaporation

Energy required to evaporate left-over runoff water to completely prevent black ice pooling.

### Tier 2: Overcoming Latent Heat of Fusion

The massive energy spike required to force the phase change from solid ice to liquid water at 32°F.

Constant: 144 Btu/lb

### Tier 1: Warming the Mass

Energy required to raise frozen concrete to a 38°F melting temperature.

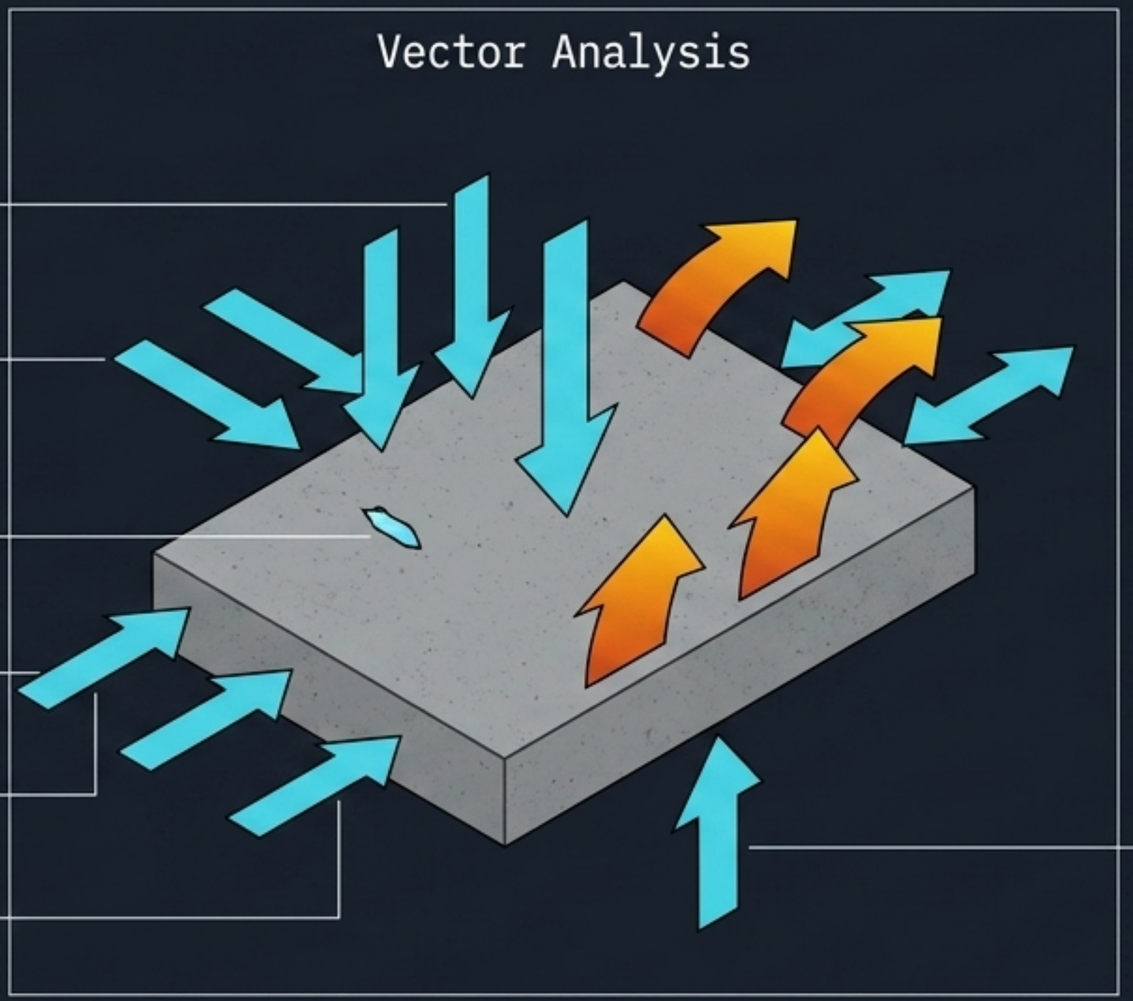
Constant: 0.51 Btu/lb

# Step 2: Sizing Environmental Boundary Conditions

Quantifying the atmospheric variables that disrupt thermal equilibrium.

## Incoming Vectors
(Top-Down Forces)

- Air Temperature (°F)
- Wind Velocity (mph)
  - Accelerates surface heat stripping
- Rate of Snowfall (liquid equivalent)
- Snow Density
- Humidity
- Apparent Sky Temperature




## Internal/Bottom Vectors
(Upward/Downward Forces)

- Slab Startup Temperature

The initial cold state of the concrete mass.

# Step 3: Selecting the Snow-Free Area Ratio (Ar)

Balancing client expectations against physical heat flux reality using ASHRAE frequency tables.

Ar = 1.0 (100% Snow-Free, zero accumulation) vs.
Ar = 0.5 (50% Snow-Free, temporary accumulation during storms).

## Madison, WI (ASHRAE 90% Frequency)

Target Ar = 1.0 -> Requires 138 Btu/h·ft²

Target Ar = 0.5 -> Requires 82 Btu/h·ft²

## Albany, NY (ASHRAE 90% Frequency)

Target Ar = 1.0 -> Requires 125 Btu/h·ft²

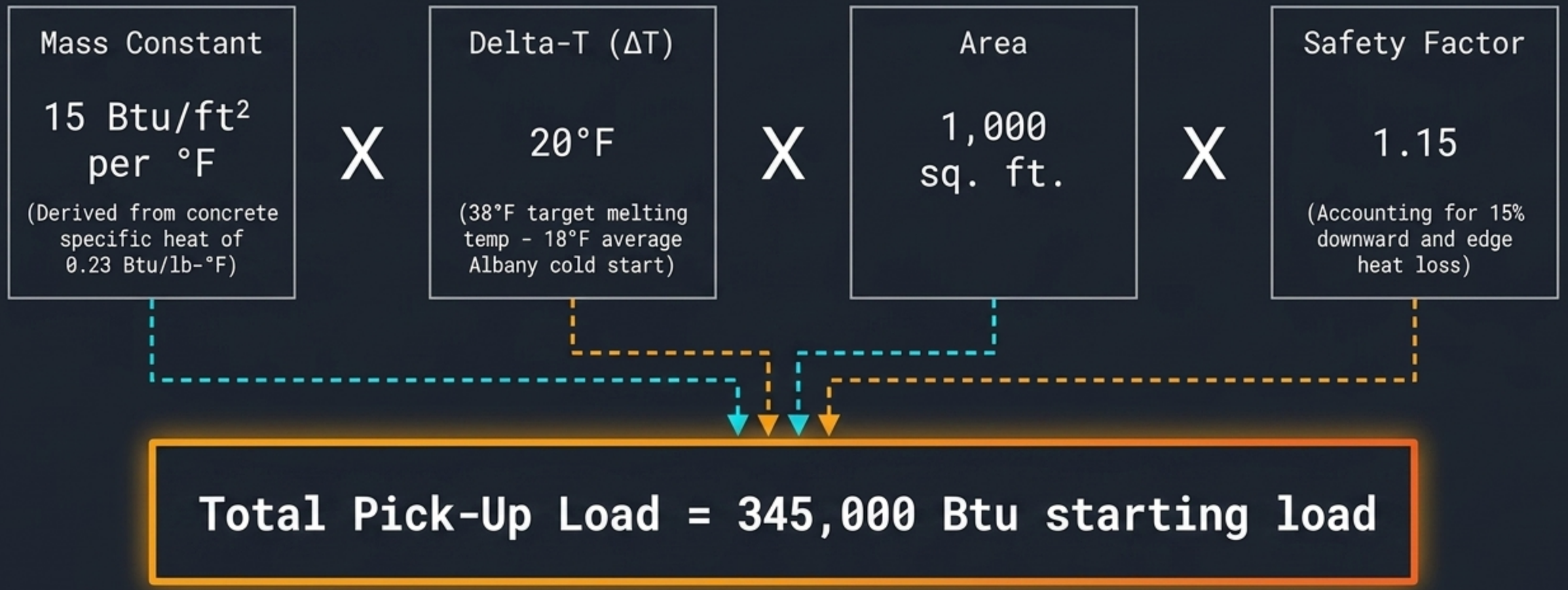
Target Ar = 0.5 -> Requires 86 Btu/h·ft²

**Insight Callout:** Guaranteeing a 100% clear slab (Ar = 1.0) frequently requires >45% more raw energy output than an Ar = 0.5 system.

# Step 4: Sizing the Pick-Up Energy Load

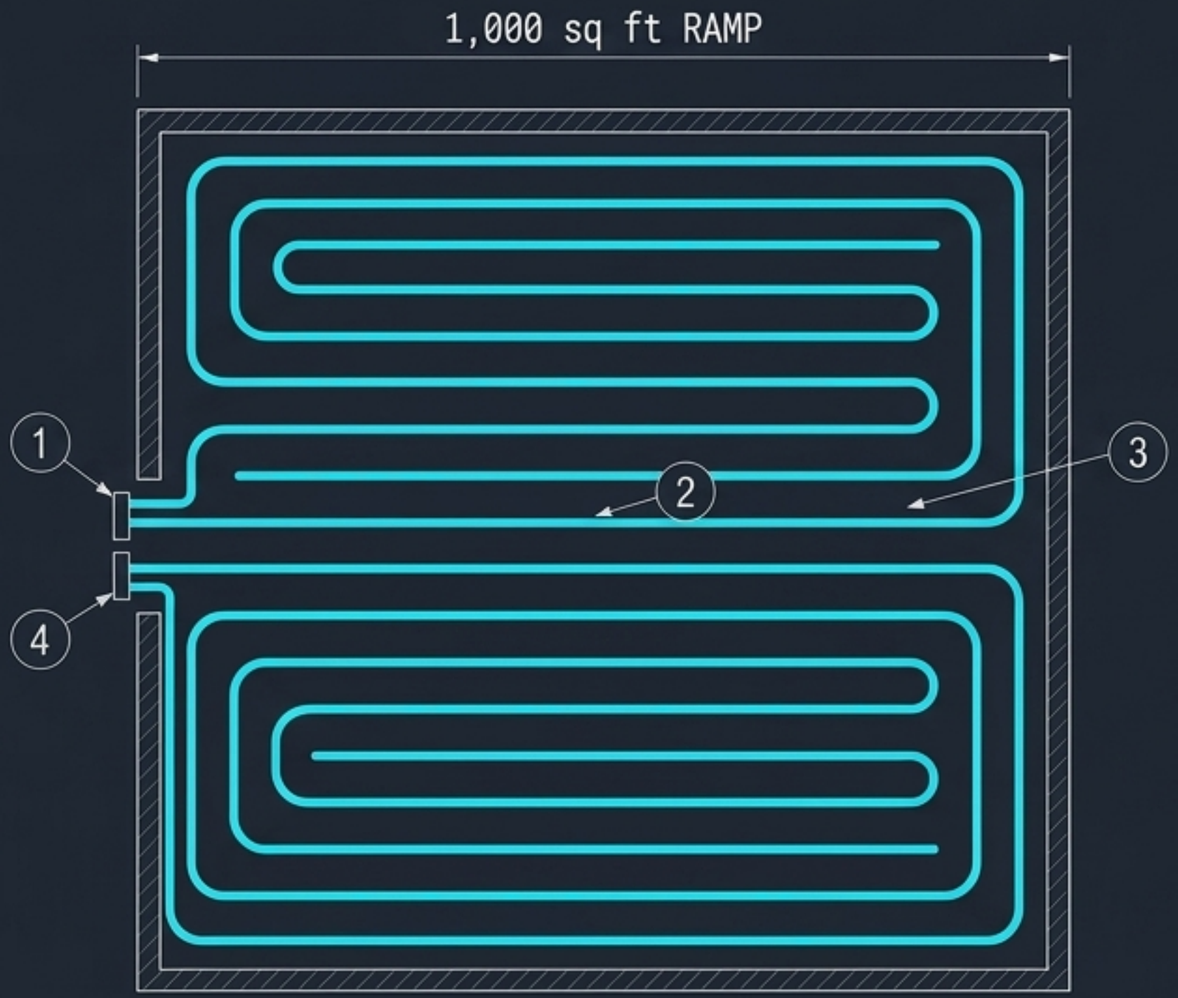
**Project Parameters:**
Albany, NY | 1,000 sq. ft. commercial ramp | 6-inch poured concrete

The largest system burden is often the cold-start: waking up the thermal mass of the slab.



# Step 5a: Sizing the Piping Network & Circuit Distribution

Geometric loop layouts to achieve target Btu/h delivery without exceeding pressure drop limits.




**Tubing Spec:** 3/4 inch PEX-A or PE-RT tubing.
(Note: PEX-A preferred for freeze-thaw resilience).

**Density Math:** 8-inch on-center spacing = 1.5 ft of pipe per sq. ft.

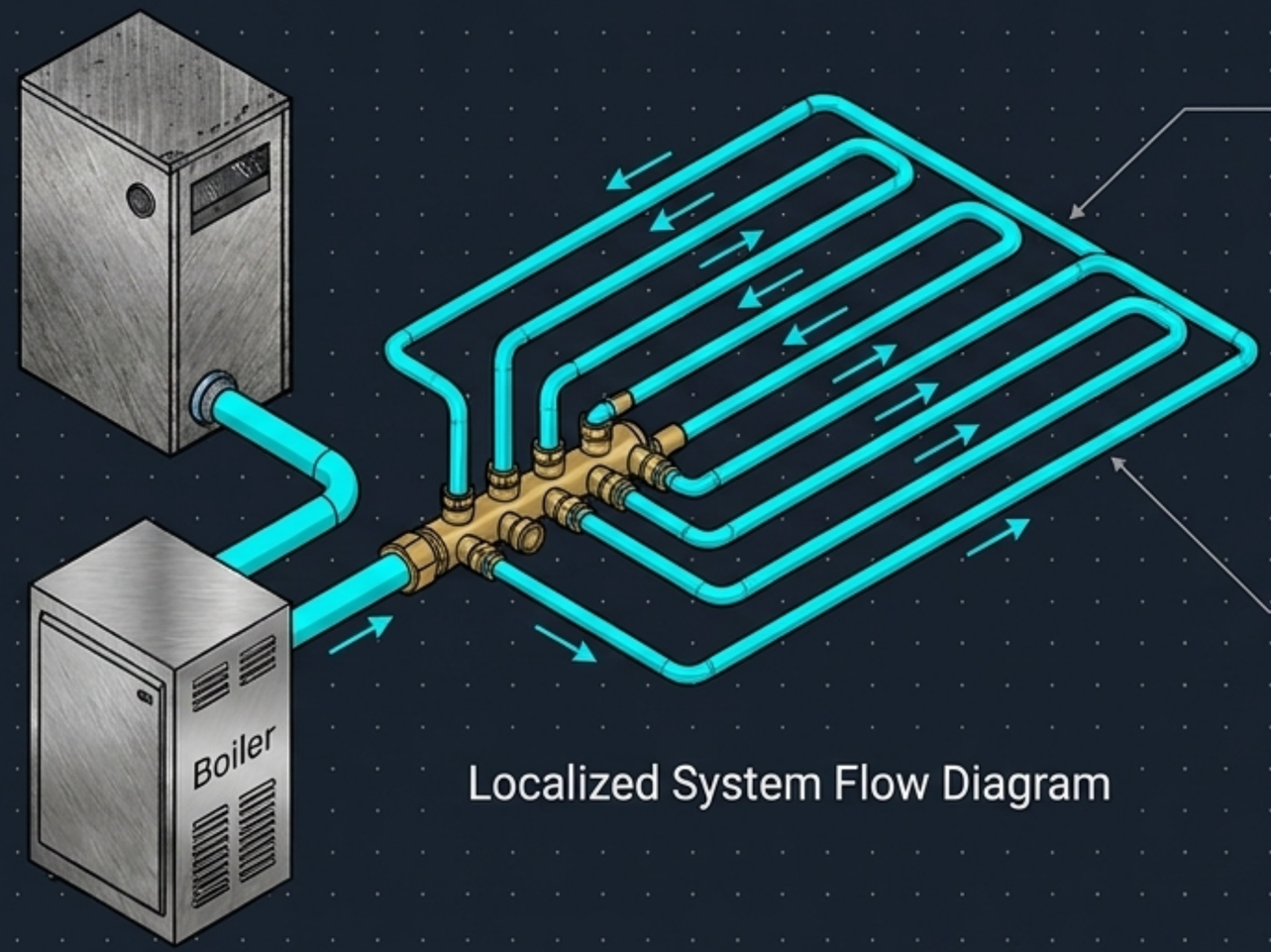
**Total Pipe Length:** 1,000 sq. ft. x 1.5 = 1,500 ft of total tubing.

**Circuit Division:** 1,500 ft divided into 6 equal circuits of 250 ft.

**Delivery:** Each 250 ft loop is engineered to deliver exactly 25,000 Btu/h at peak load.

# Step 5b: Hydraulic Fluid Calculations & Pump Sizing

Calculating flow rates and head loss for highly viscous glycol mixtures.




Localized System Flow Diagram

Fluid Medium: 50% Propylene Glycol Mix (Requires viscosity correction vs. pure water).

- Operating Temp: 25°F ΔT across the circuit.
- Manifold Sizing: 1 1/4 inch trunk lines.
- Flow Rate Math: Total flow requirement of 13.6 GPM (Divided evenly: 2.2 GPM per loop).

| Results | | |
|---|---|---|
| Flow Regime: | Laminar | |
| Pressure Drop: | 6.0 Psi | 41.4 kPa |
| Head Loss: | 13.9 ft water | |
| Velocity*: | 2.0 ft/s | 0.6 m/s |

Calculation Details | Print | Email

System Resistance: At 60°F average fluid temperature, the 2.2 GPM flow through a 250 ft 3/4 inch PEX circuit results in 13.9 ft of head loss. This metric dictates circulator pump selection.