Introduction to HVAC Controls

Course Number: ME-02-105

PDH: 9

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Module 1: Introduction to HVAC Systems and Equipment

Learning Objectives

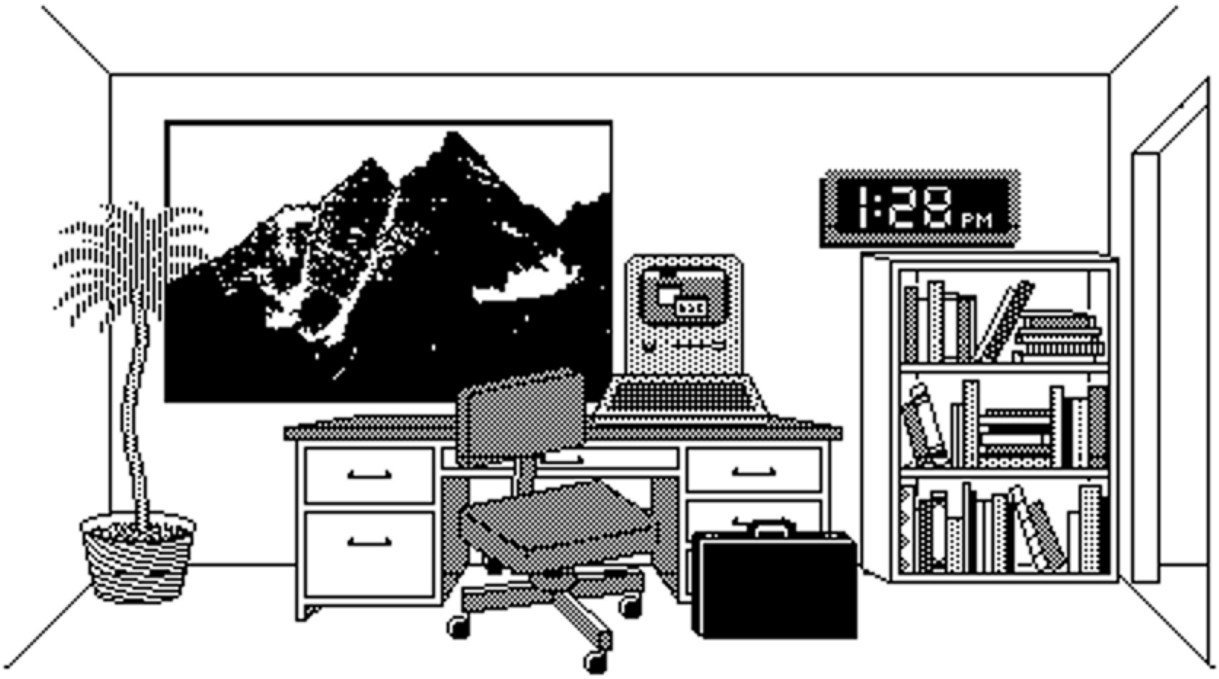
By the end of this section, you will be able to:

- **Identify** the four primary variables required to maintain a proper indoor environment.
- **Evaluate** the specific roles of the mechanical room, Air Handling Units (AHUs), and room controls within a building.
- **Select** appropriate heating and cooling equipment based on regional climate and specific load requirements.

Executive Summary: An HVAC control system integrates mechanical equipment to maintain a cost-effective, comfortable environment by precisely regulating temperature, humidity, pressure, and ventilation.

Function of HVAC Controls

The primary objective of an HVAC control system is to operate mechanical components—such as boilers, chillers, and fans—to sustain specific environmental parameters.



Environmental Variables

- **Temperature**: The standard comfort zone is defined as **68°F (20°C) to 75°F (25°C)**. Values below 68°F may cause occupants to feel cool, while temperatures exceeding 78°F (25°C) typically cause discomfort.

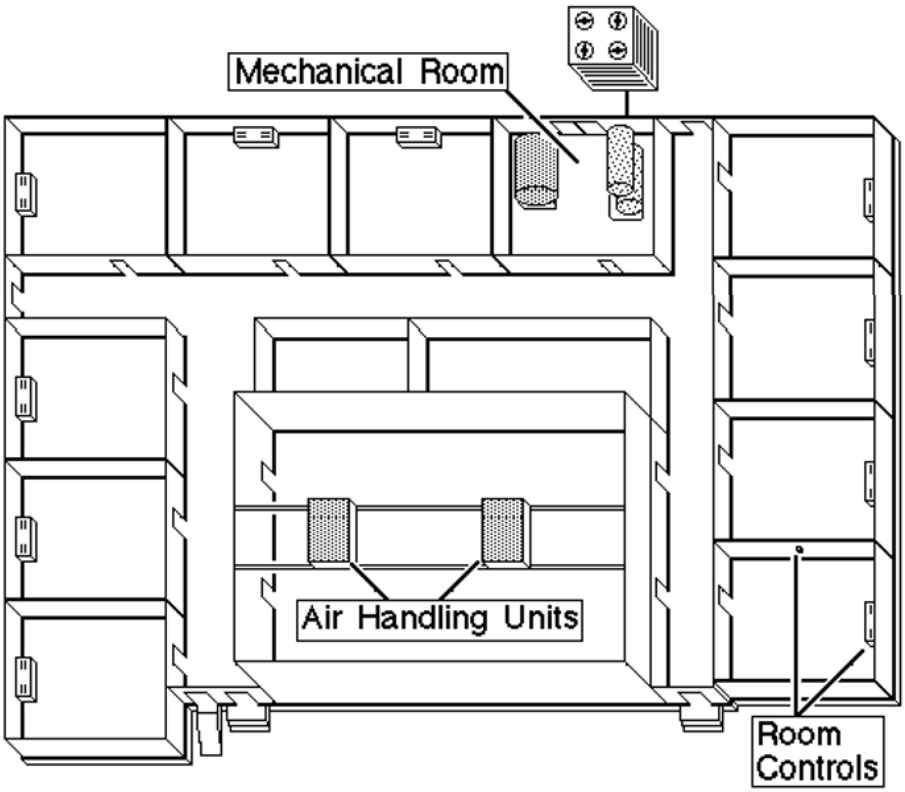
- **Humidity**: Optimal relative humidity (RH) is maintained between **20% and 60%**. Low humidity (<20%) causes excessive dryness affecting health and electronics, while high humidity (>60%) promotes mildew and "muggy" conditions.
- **Pressure**: Buildings are typically maintained at a **slightly positive pressure** to reduce untreated outside air infiltration and maintain cleanliness.
- **Ventilation**: Systems ensure multiple air changes per hour to maintain Indoor Air Quality (IAQ) and distribute air patterns that avoid uncomfortable drafts.

Location of Equipment

HVAC systems are distributed across three primary areas that work in tandem:

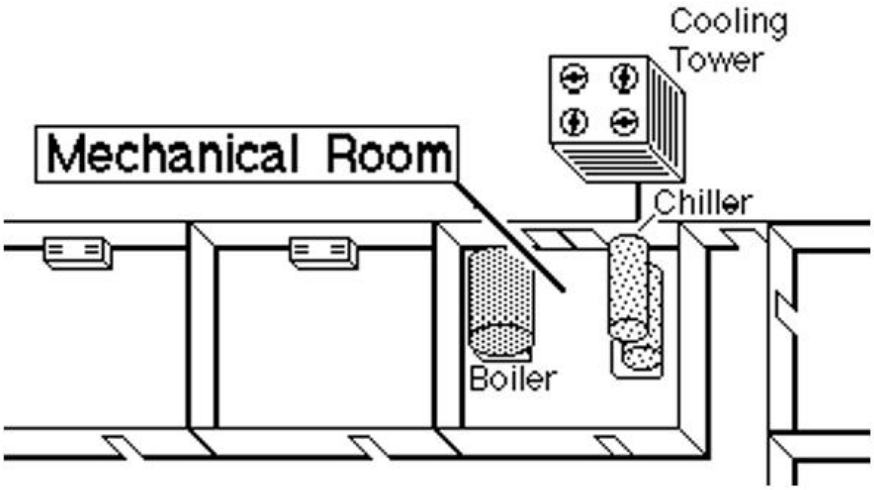
Equipment Distribution

- **Mechanical Room**: The "main equipment room" containing heavy machinery like boilers, chillers, and pumps.
- **Air Handling Units (AHUs)**: Located on roofs or in equipment rooms, these units condition air through heating, cooling, and filtration before distributing it.
- **Room Controls**: Regulate AHU-delivered air to specific rooms or **zones** using thermostats and **Variable Air Volume (VAV) boxes**.



Mechanical Room Fundamentals

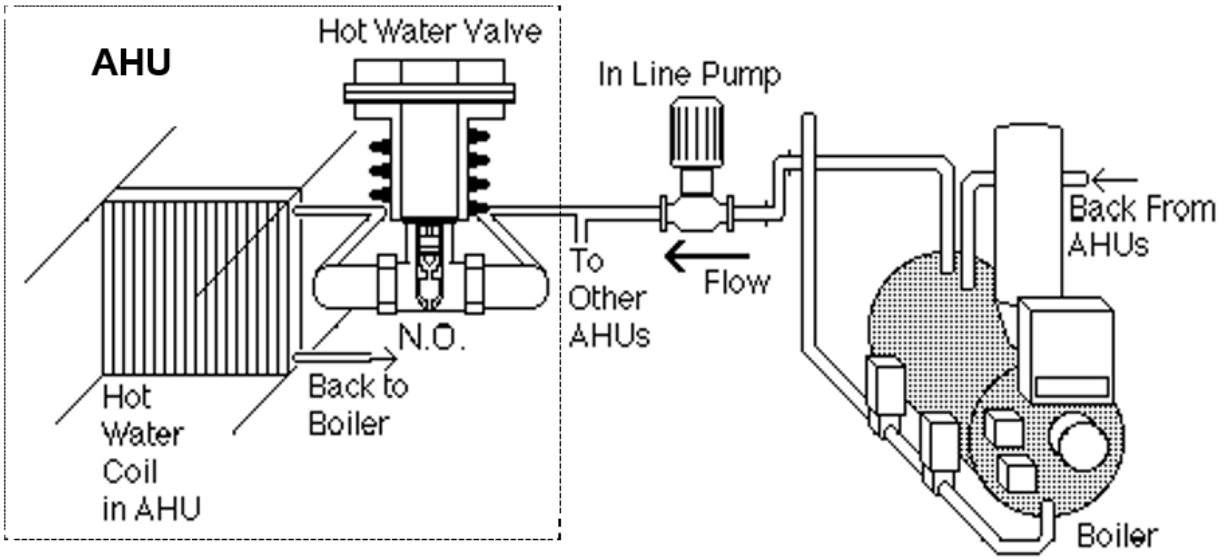
The mechanical room serves as the central plant for the building's thermal energy.

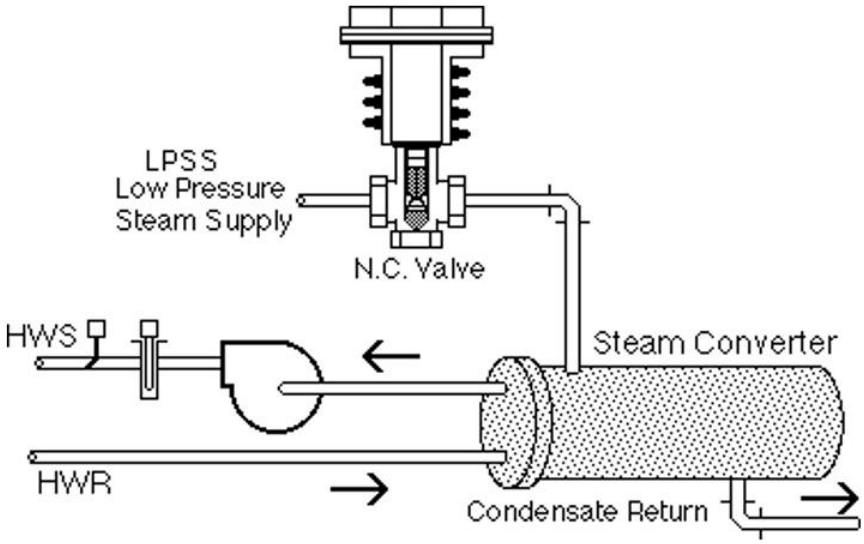


Heating Systems

Boilers generate heat using gas, coal, oil, or electricity. In cooler climates, systems may utilize large or modular boiler arrays, whereas warmer climates require minimal heating infrastructure.

- **Hot Water Supply (HWS)**: Boilers produce hot water circulated through coils within AHUs or perimeter fin-tubes.
- **Steam Converters**: In steam-based systems, a heat exchanger (converter) uses steam to heat water for distribution.

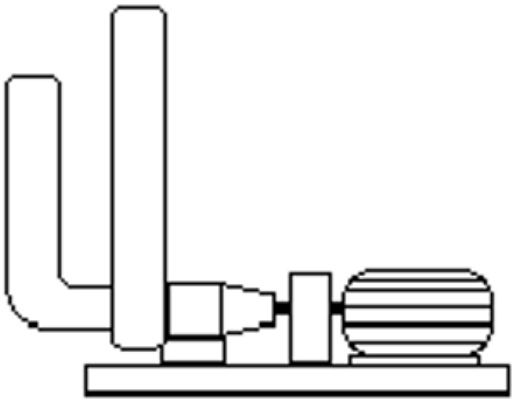




💡 **Design Tip**: In cold climates, utilize a **normally open (N.O.)** valve for heating coils; this ensures that if control power is lost, the valve fails to 100% open, providing maximum heat to prevent coil freezing.

Water Pumps

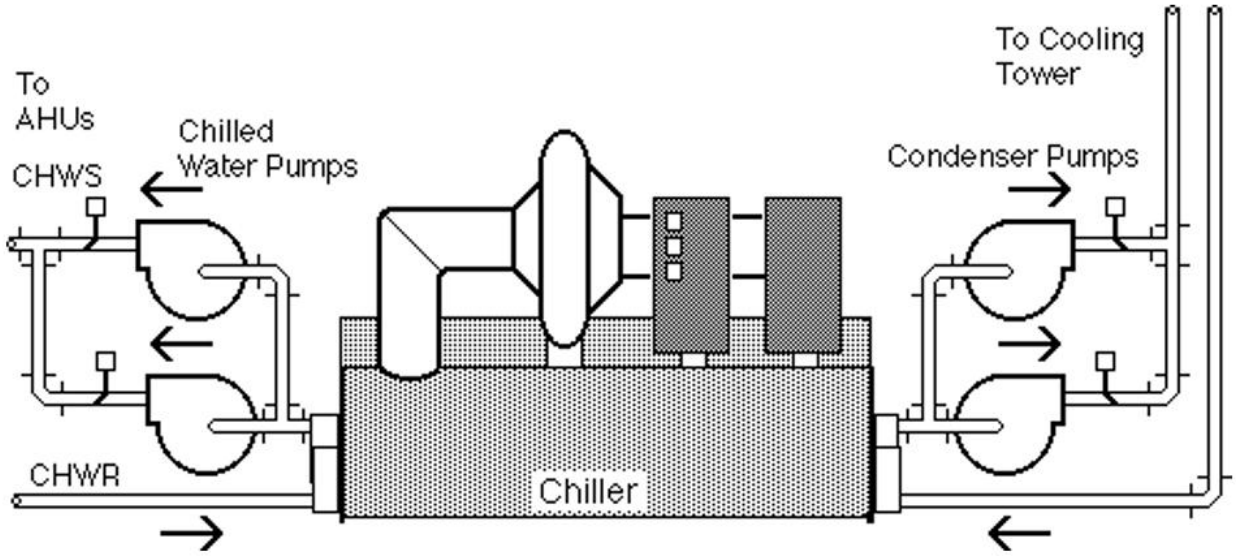
Pumps move water from central equipment to terminal units. Critical applications utilize a **lead/lag** configuration (primary and secondary pumps) to ensure system redundancy in case of an operating pump failure.



Water Pumps

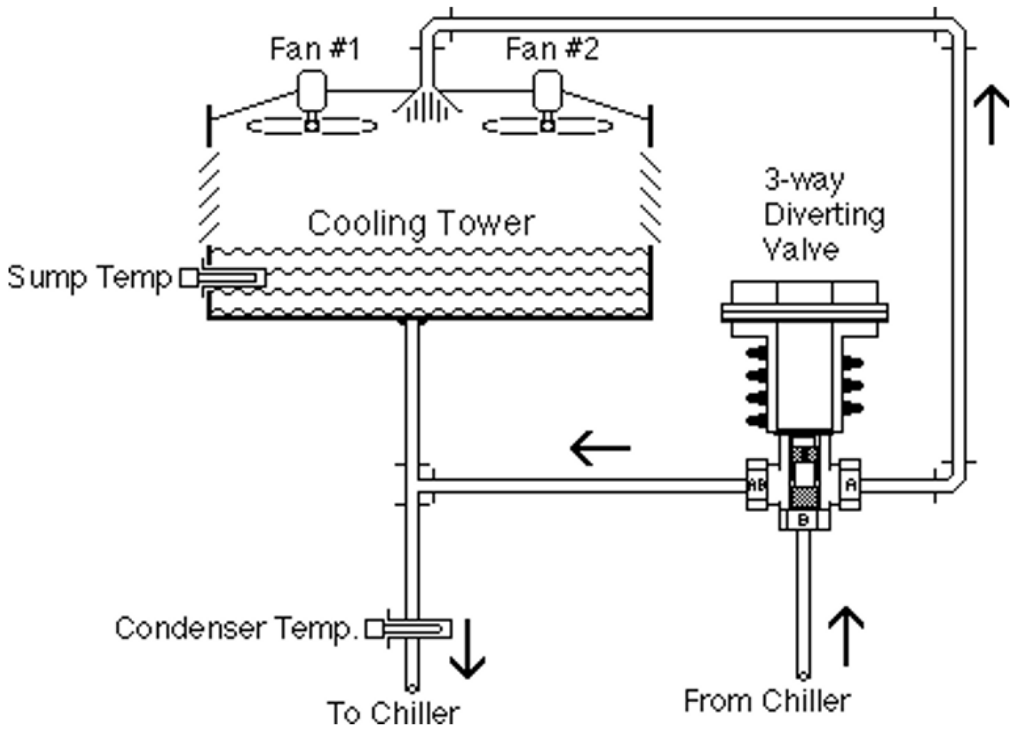
Cooling Systems

The **Chiller** is the primary cooling source, typically producing water at approximately **42°F (5°C)**.



The Heat Transfer Process

1. **Chilled Water Supply (CHWS)** is pumped to AHU cooling coils; heat is absorbed and returned as Chilled Water Return (CHWR).



2. The chiller transfers this heat to a **refrigerant**, then to the cooling tower loop.

3. The **Cooling Tower** rejects the heat to the atmosphere via evaporation, often aided by fans.

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