

How Preservation Environments Use Energy

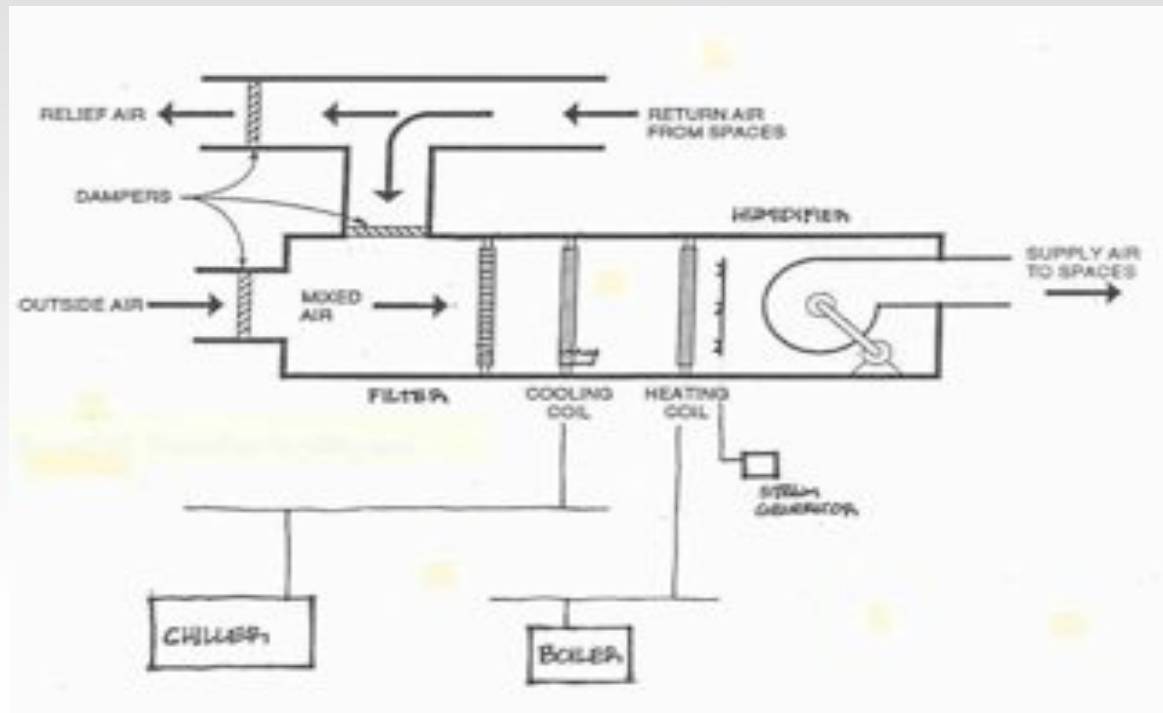
Sterling Memorial Library, Yale University, New Haven, CT
October 28-29, 2010



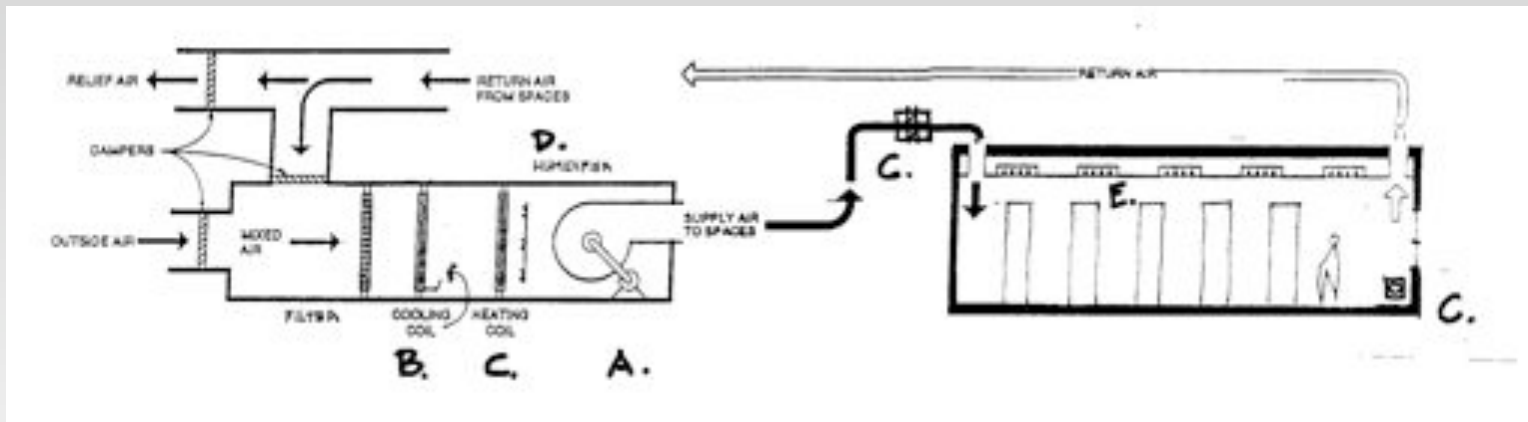
**NATIONAL
ENDOWMENT
FOR THE
HUMANITIES**

Energy-Consuming Components of HVAC Systems

- Air Handling Unit and Sources of: Cooling / Heating / Humidification



Energy-Consuming Components of HVAC Systems

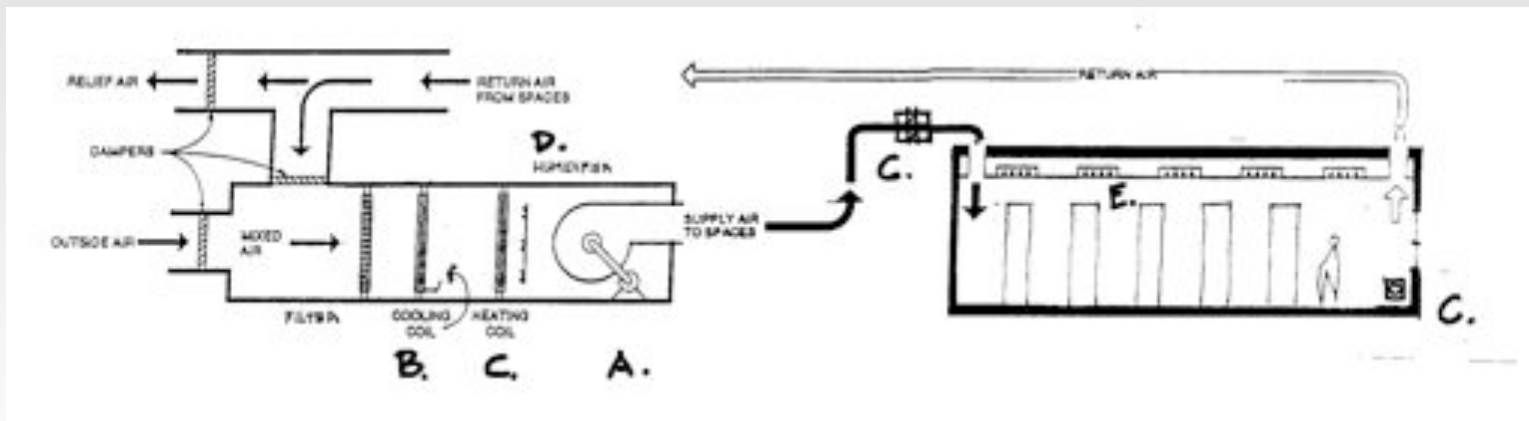


Components:

- A. Air Handling Fans
- B. Cooling/Dehumidification
- C. Heating/Reheating
- D. Humidification
- E. Lights

Energy-Consuming Components of HVAC Systems

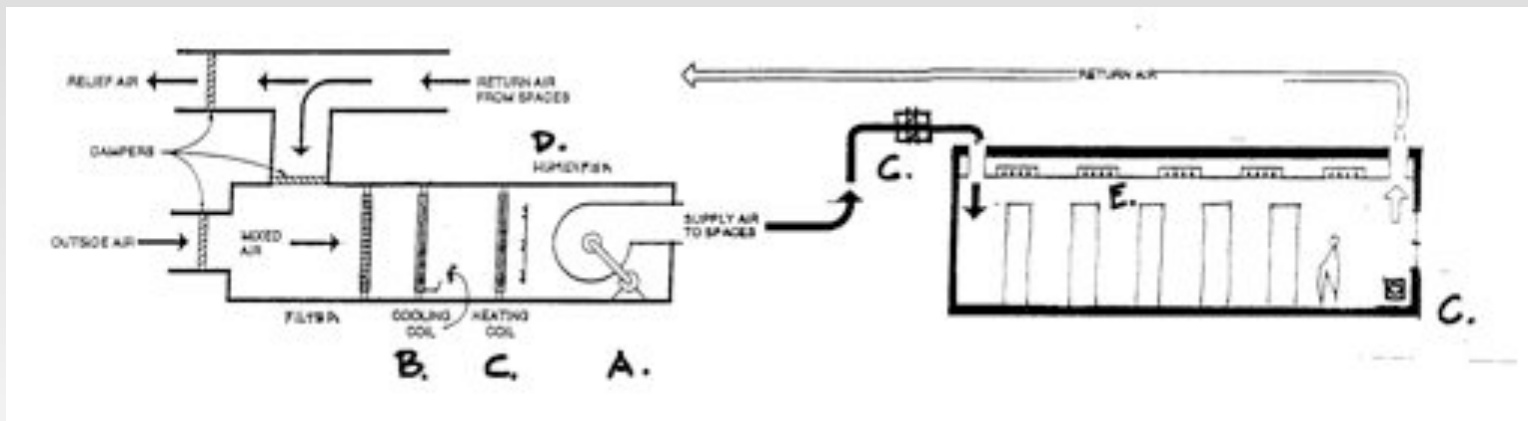
Operating Variables that Affect Energy Consumption



Energy = Rate of Consumption x Time of Operation

Energy-Consuming Components of HVAC Systems

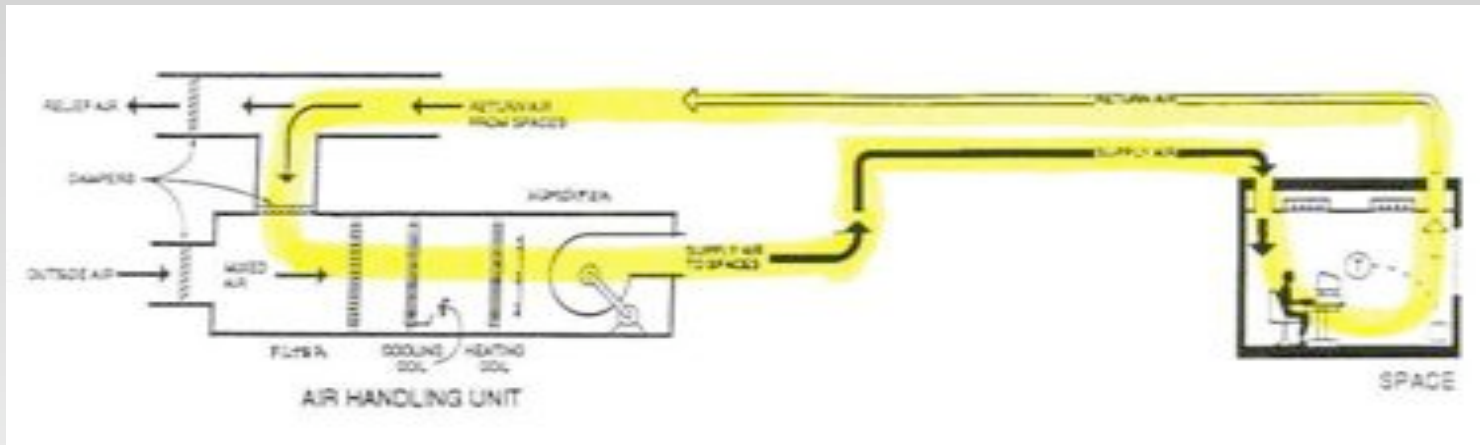
Operating Variables



A Air Handling Fans – Operating Drivers
Total Air Flow (VAV)
Schedule of Air Flow

Operating Variable – Total Air Flow

Example Air Change Calculation



Storage space area = 5,000 SF

Storage space ceiling height = 8 FT

Storage space volume = 5000 SF x 8 FT = 40,000 Cubic Feet (CF)

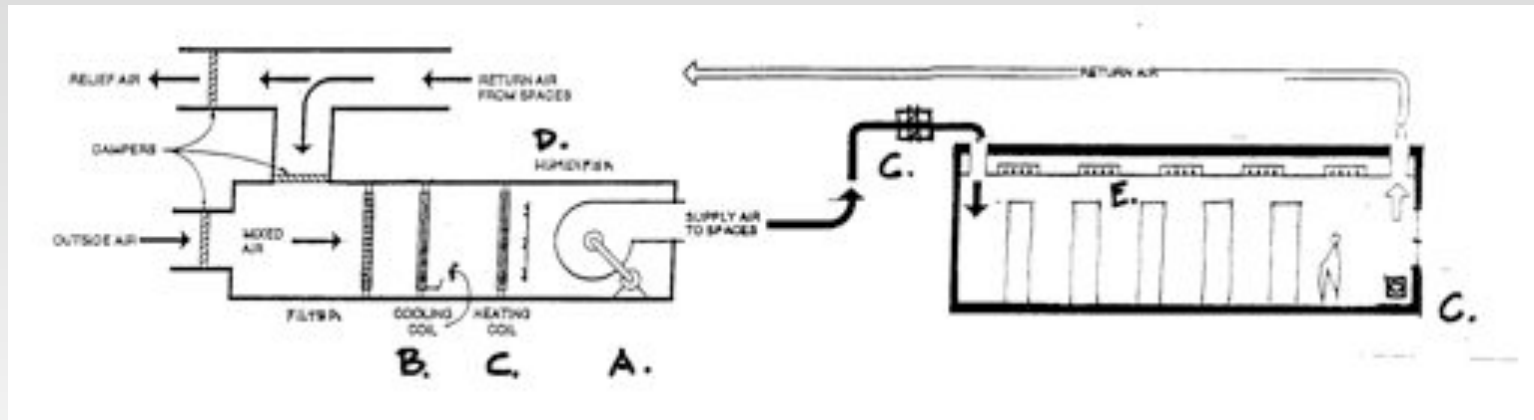
Supply air is 5,000 CFM x 60 minutes = 300,000 CF per Hour

300,000 CFH divided by 40,000 CF = **7.5 Air Changes per Hour**

At 10% OA = 0.75 Air Changes/Hour = **1 Outside Air change every 1.3 Hours**

Energy-Consuming Components of HVAC Systems

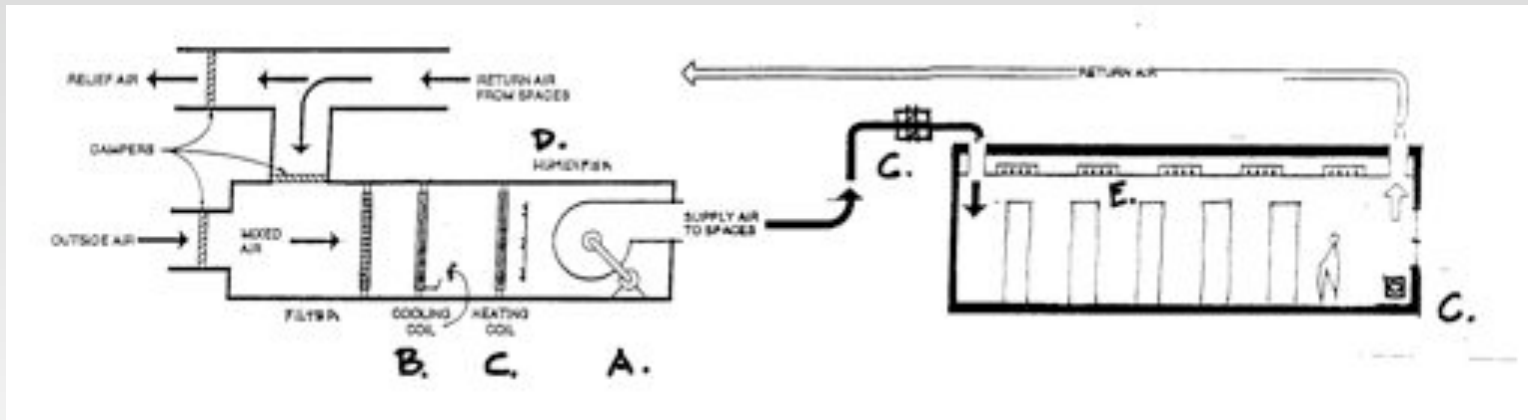
Operating Variables



B Cooling/Dehumidifying – Operating Drivers
Temp. and RH Setpoints & Schedule
Quantity of Outside Air & Schedule
Space Loads (Lighting)
Total Air Flow

Energy-Consuming Components of HVAC Systems

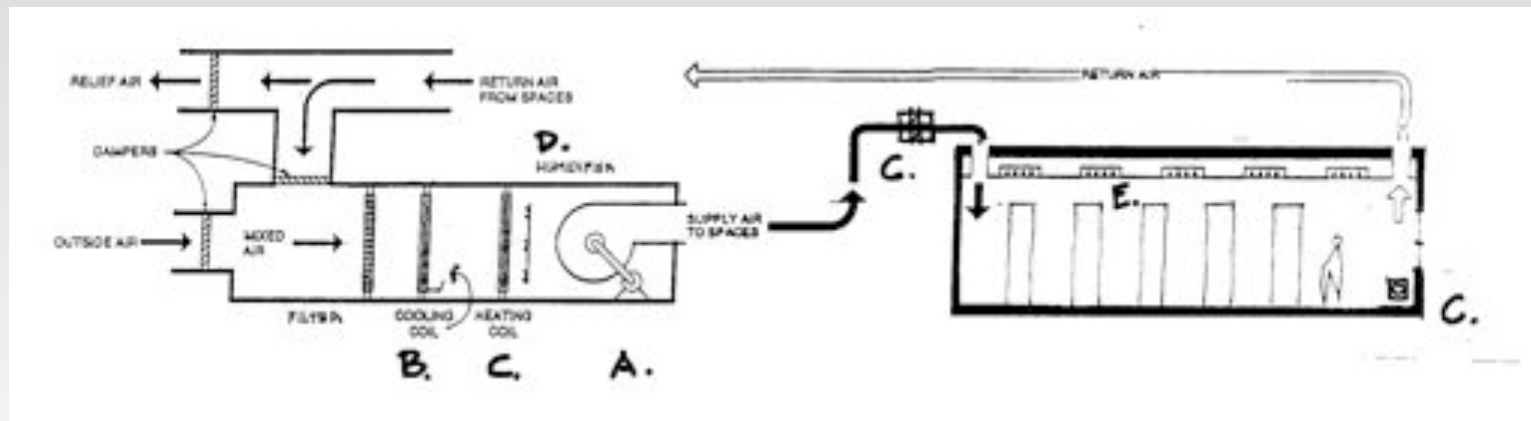
Operating Variables



- C Heating/Reheating – Operating Drivers
 - Temp. Setpoint & Schedule
 - Quantity of Outside Air & Schedule
 - Seasonal Control
 - Total Air Flow & Schedule

Energy-Consuming Components of HVAC Systems

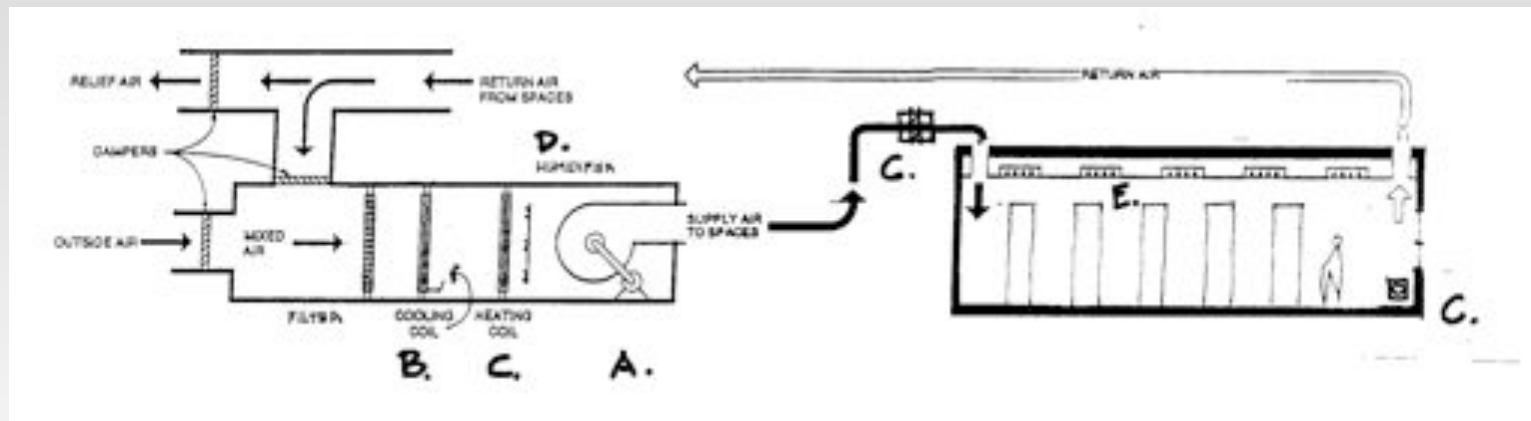
Operating Variables



D Humidifying – Operating Drivers
RH Setpoint
Quantity of Outside Air & Schedule

Energy-Consuming Components of HVAC Systems

Operating Variables



E Lights – Operating Drivers
Schedule (hours of operation)

Example Allocation of Storage Area Annual Energy Cost

Component	% of Annual Energy Cost
A. Air Handling Fans	19%
B. Cooling Coil	30%
C. Heating Coil	40%
D. Humidifier	5%
E. Lighting	6%

Energy-Consuming Components of HVAC Systems Operating Variables

Summary of Operating Variables:

Total air flow and schedule

Temperature and RH setpoints and schedule

Quantity of outside air and schedule

Space Loads (Lighting)