PME 3502 - DESEMPENHO TERMO ENERGÉTICO DE EDIFICAÇÕES

Metodologias para avaliação de desempenho e indicadores (3/3)

Introduction to Building Measurements

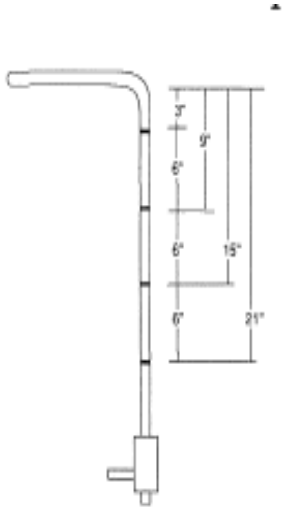
- Explain where the instruments come from that are used in the Building EQ submission
- Explain how to use the instruments
- Explain what FORM's that these measurements are called for in the Building EQ submission
- Discuss the basic measurements to be taken, and the optional measurements if desired.
- Explain the measurements involved in the IEQ ventilation sampling task; using a flow measurement algorithm that may involve a calculation using velocity and area measurements.

Temperature Probes and Instruments

Relative Humidity Probes and Instruments

Air flow instruments

Photo of Pitot tube traverse being taken



Return Grille Velocity testing (with a handheld velometer)

Measuring air flow on a ceiling grille with a Hood

Measuring Duct Pressures

Total Pressure =

Static Pressure (SP) +
Velocity Pressure (VP)

(TP= SP + VP)

- Instruments we use are:
  - Pitot tubes
  - Manometers (U-tube, micro-, or inclined manometers)
  - Magnehelic gauges

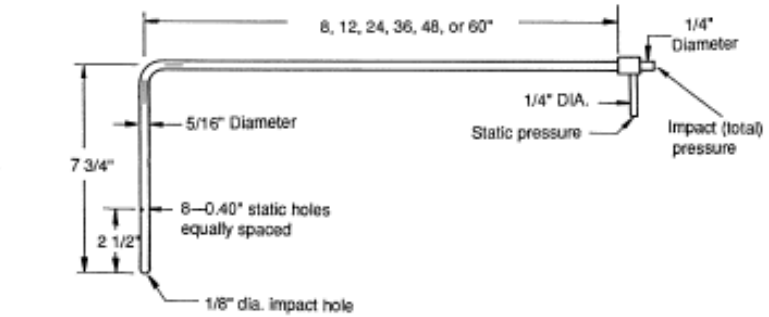


Fig. 1.6. Standard Pitot tube.

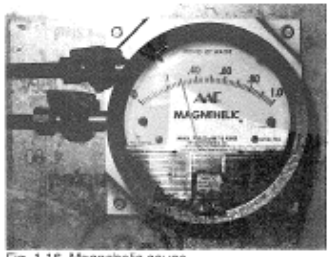


Fig. 1.16. Magnehelic gauge.

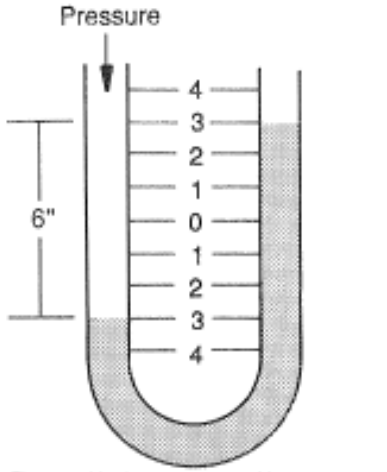


Fig. 1.15. U-tube manometer with pressure on one leg.

Air pressure instruments

Measuring Duct Air Flows (Step-1 Getting the Velocity measurements)

- Duct Traverses for Air flow measurements (velocity)
- There are standards and criteria for determining where to locate accurate traverse readings;
  - Traverses shall be made 8 diameters downstream and 2 diameters upstream from obstructions such as elbows, transitions, take-offs, etc.
- Use the formula for “Equivalent duct diameters” $d=\sqrt{4hw/\pi}$, where h=height, w=width, π=3.14
- For example using a duct that is 18” wide x 12” high, $d=\sqrt{4(12)(18)/\ 3.14} =16.6$”
  - 8 x 16.6”=132.8” downstream
  - 2x 16.6” = 33.2” upstream
- These are the points where the traverse points should be taken

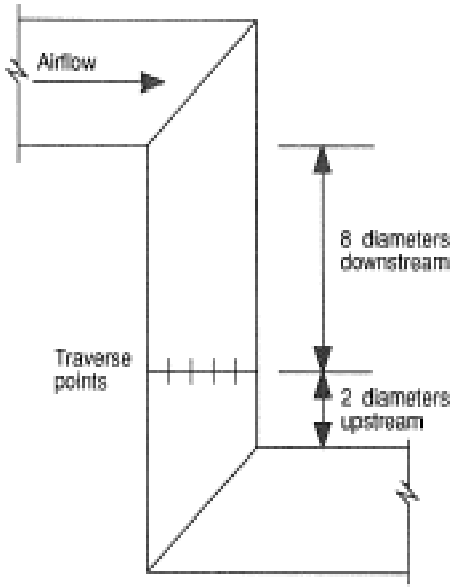
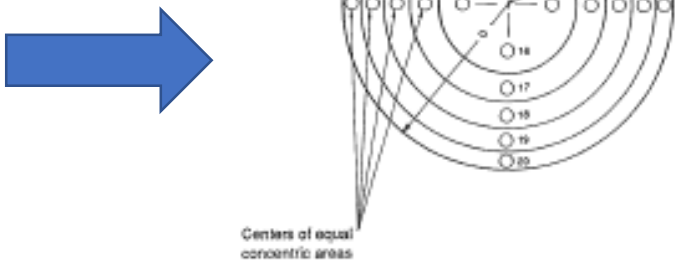


Fig. 1.17. Locations for Pitot tube in duct traverse.

Measuring Duct Air Flows (Step-1 Getting the Velocity measurements)

- Duct Traverses for Air flow measurements (velocity)
- There are standards and criteria for a minimum # of measurements based on size of the round ducts
  - If the round duct is LARGER than 10 “, it requires 20 velocity readings
    - If the round duct is 10” or SMALLER, it requires 12 velocity readings
  - A sample diagram is shown here for visualization



Measuring Duct Air Flows (Step-2 Calculating the Air flow measurements)

- Area calculations: cfm= area x velocity
- Rectangular ducts: area calculation: (Height x width)
- Round ducts: area calculation: ($\pi\, r^2$)
- Sample: Rectangular Duct = 18” x 12” ; Average velocity = 950 fpm.
- CFM= [18x12/144] ft^2 [950] ft/min
  - = 1.5 x 950
  - = 1,425 CFM

Equation 1.9

$cfm = av$

where:

cfm = quantity of air in cubic feet per minute

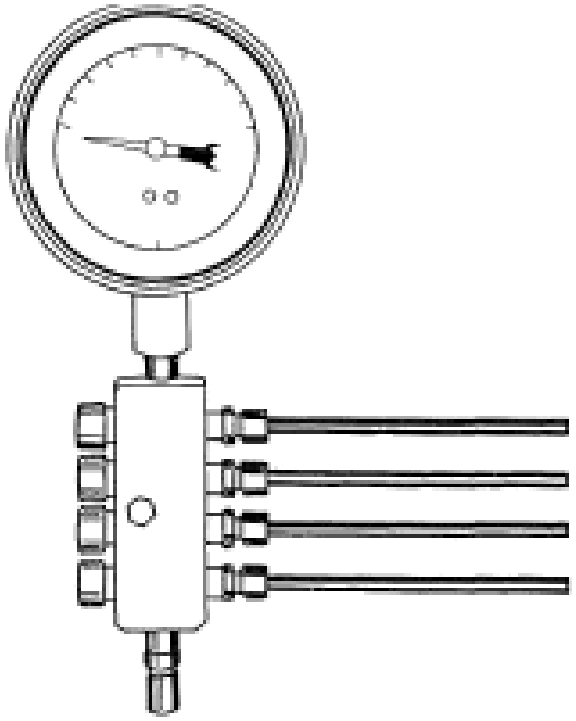
a = cross sectional area of the duct in square feet (sf)

v = velocity in feet per minute (fpm)

Water Pressure Meters

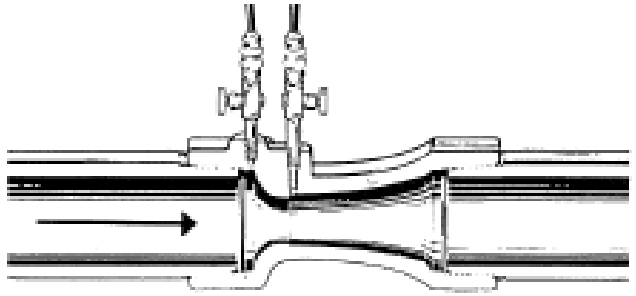
Water flow Instruments

Differential Pressure gauges

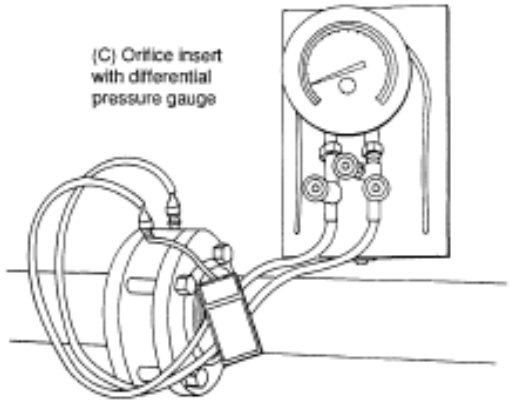


- Used on Pumps to measure suction and discharge pressures, strainer pressure drop, flow rates across flow meters, and pressure drop across discharge valves.
- Differential gauges eliminate the need for 2 separate gauges
- Can have manifolds that can be switched to have multiple functionality to read many different configurations

Flow Meters



Venturi Type



Orifice type with DP gauge

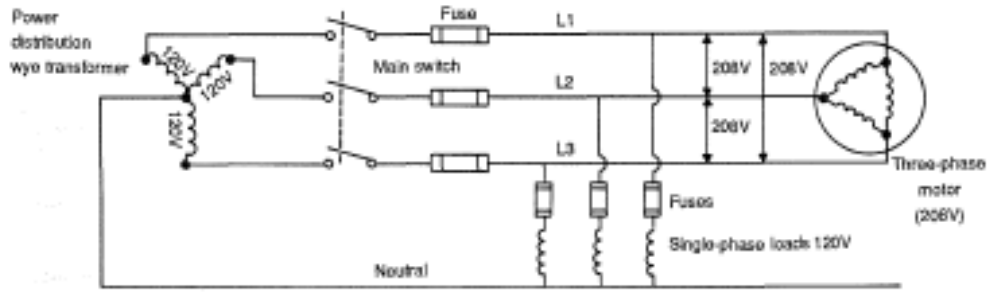
Paddle Wheel Type inserted into pipe

Basic Electrical Measurements

- Single Phase Alternating 110-120 volt
- Single Phase Alternating 220-240 volt
- Three-wire Delta 3-phase 220-240 volt
- 220-240 volt 3-wire Delta 3-phase circuit with 110-120 volt single phase supply
- Four-wire WYE circuit 120/208 volt 3-phase
- 480/277 volt 3-phase
- More…….

- Voltage (V)
- Amps (A)
- Watts = (W)
- Impedance (Z)
- Direct Current (DC)
- Alternating Current (AC)
- Frequency (Hz)
- Phase (ph)
- Kilowatt-hour (KwHr)
- Power factor (pf)

Fig. 3.2. Power-wheel or Ohm's-law chart.



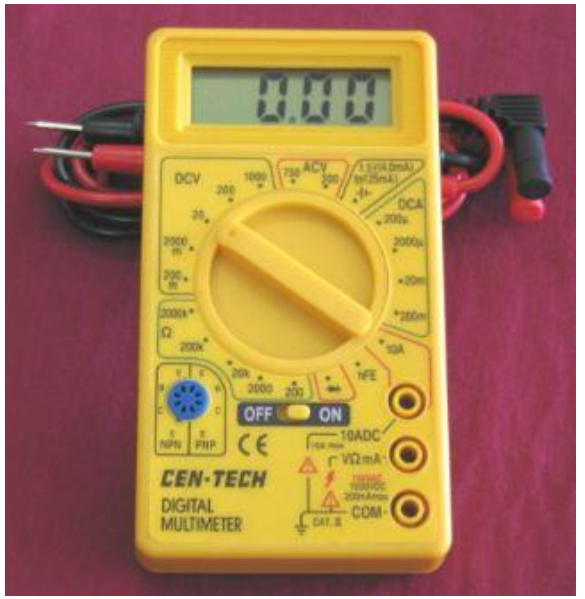
Illuminance and Light Level Meters

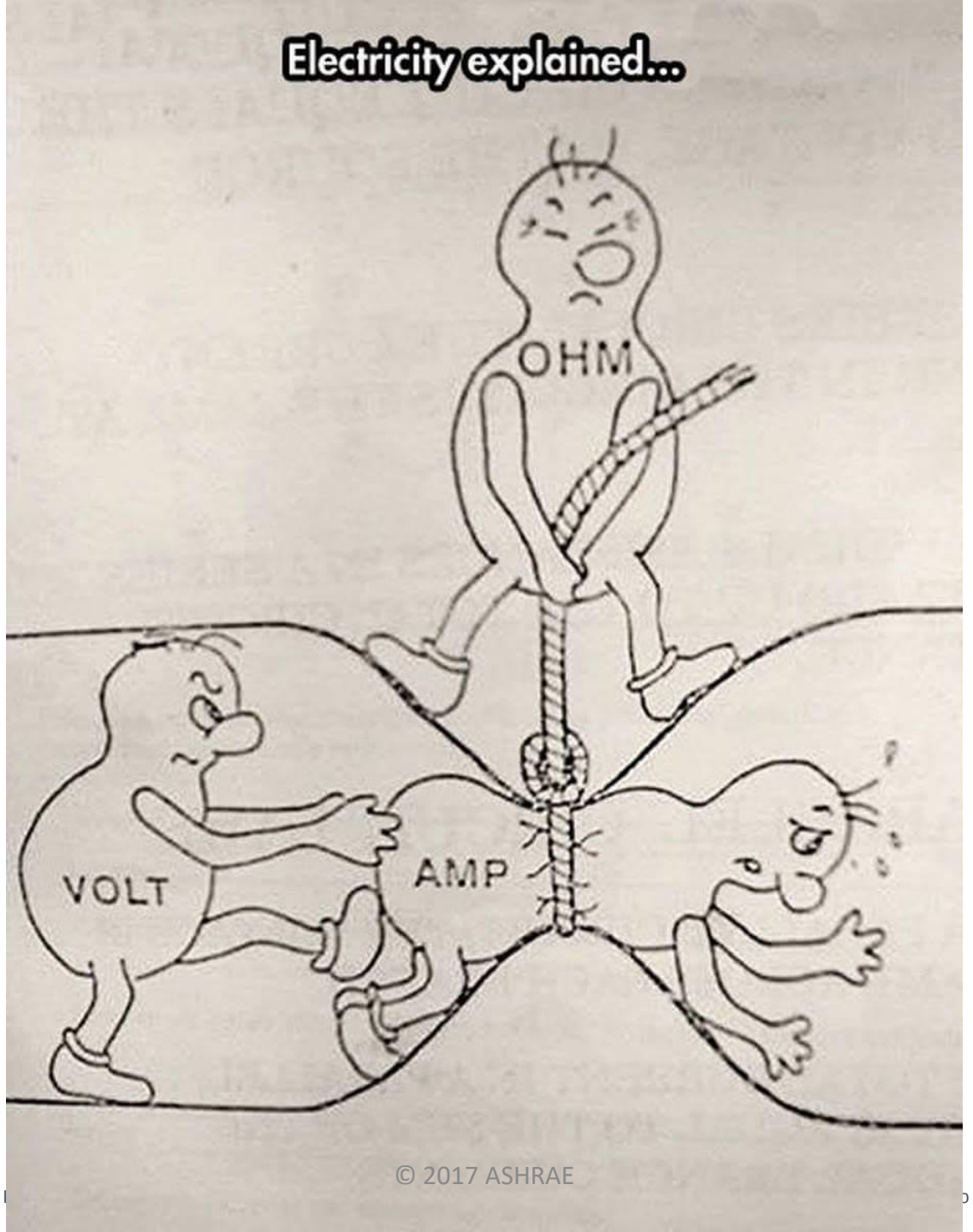
CO_2 measuring Instruments

AZ-0001
AZ-0018

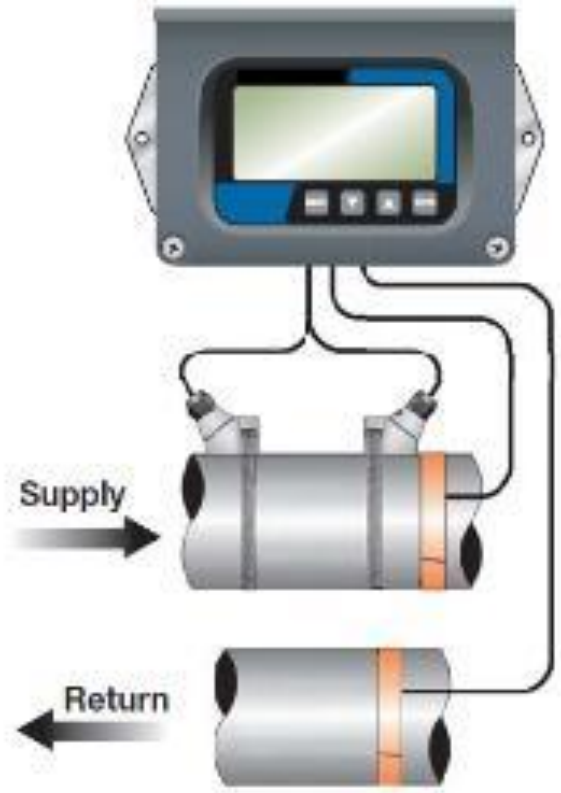
Sound Meters (dBA)

Voltage and Amperage ++ Meters





BTU-Energy Meters

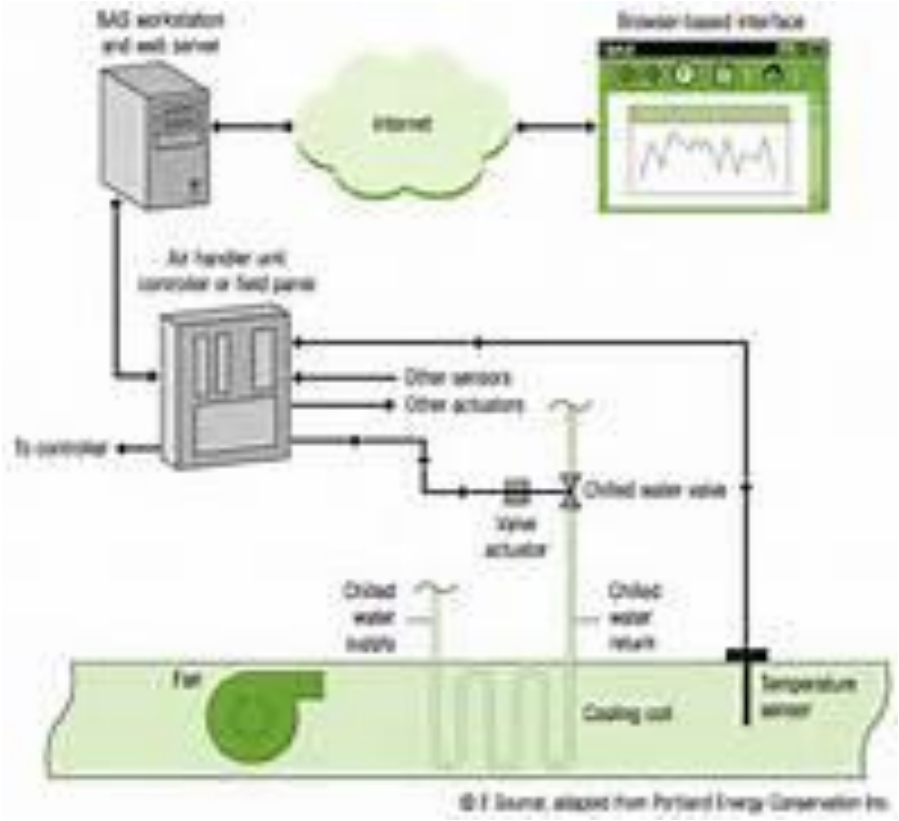


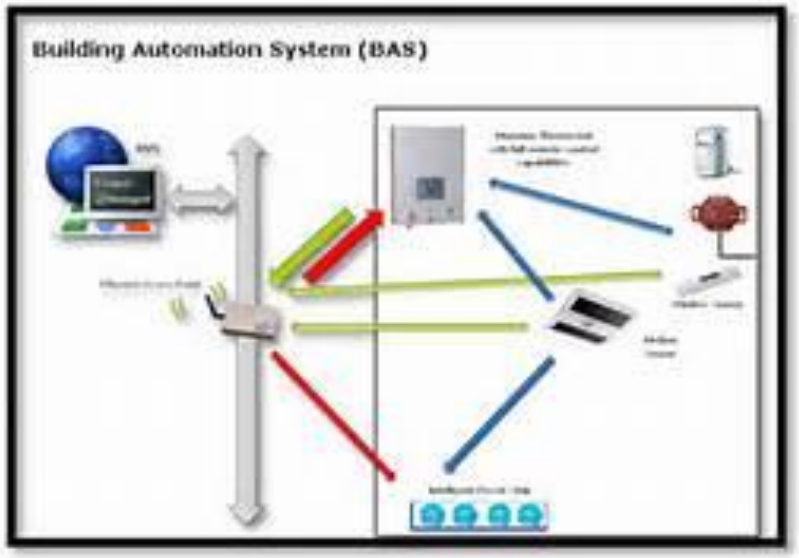
Kilowatt-hour (Energy) meters

Introduction to building energy and monitor control systems

- What does the typical BAS system architecture look like?
- How does the Building EQ assessor interface with the BAS to “access” or acquire data to use in the submission?
  - Temperature's
  - Humidities
  - CO2
  - OA air flows
  - Light levels
- What is the role of the BAS in saving energy and assisting in “energy conservation measures”
- What are the typical BAS and control points used to support Building EQ?
- What do Lighting control systems look like ?
- What does a daylighting system look like?
- How do lighting control systems work to save energy?

Building Automation System (BAS) Architecture





Building Automation System (BAS) Architecture

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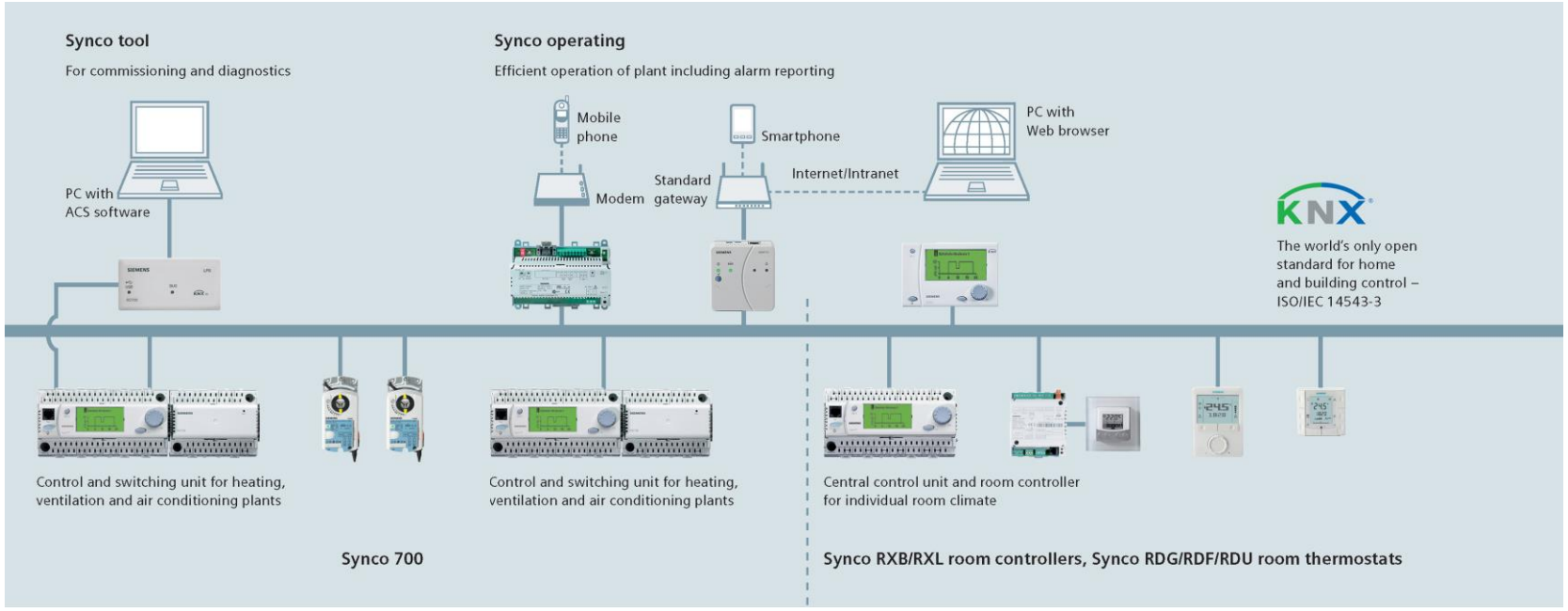
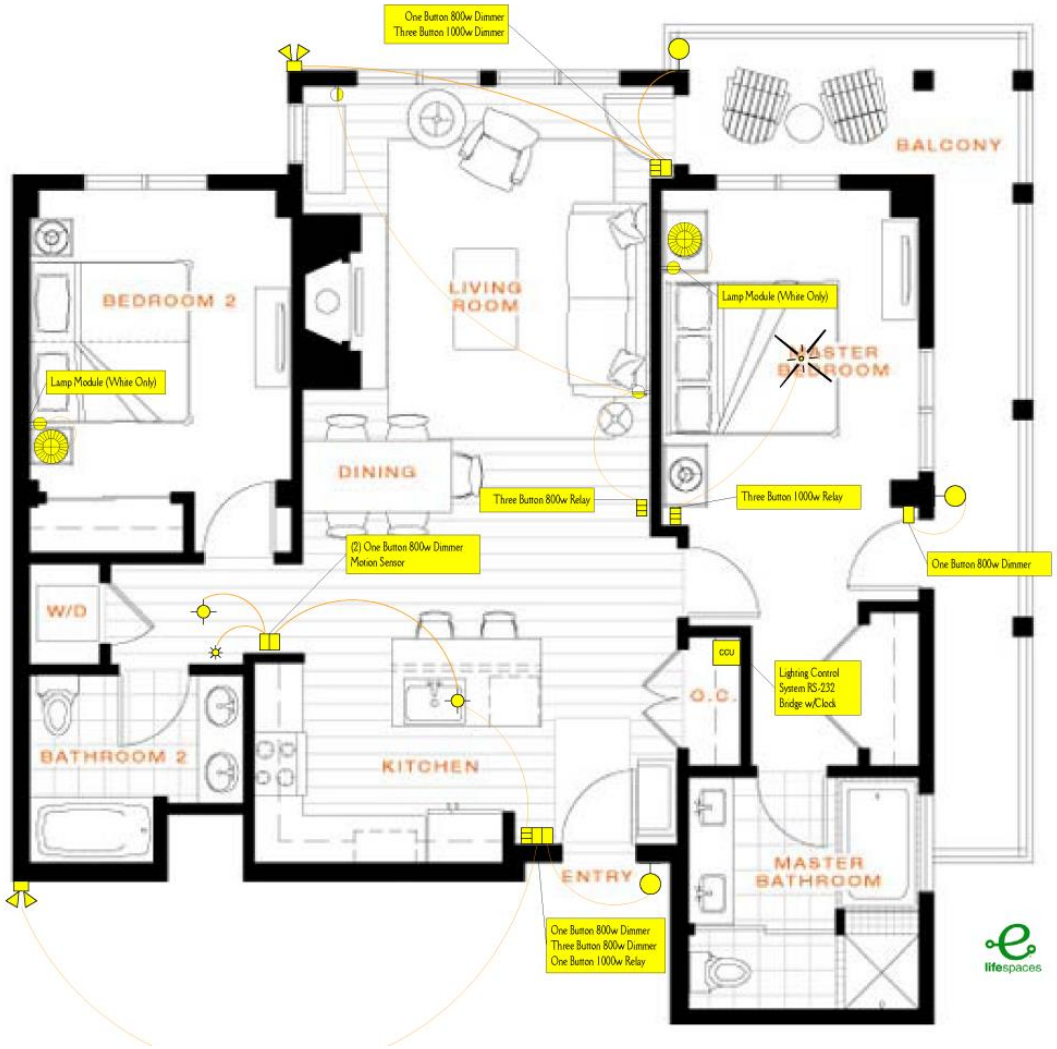


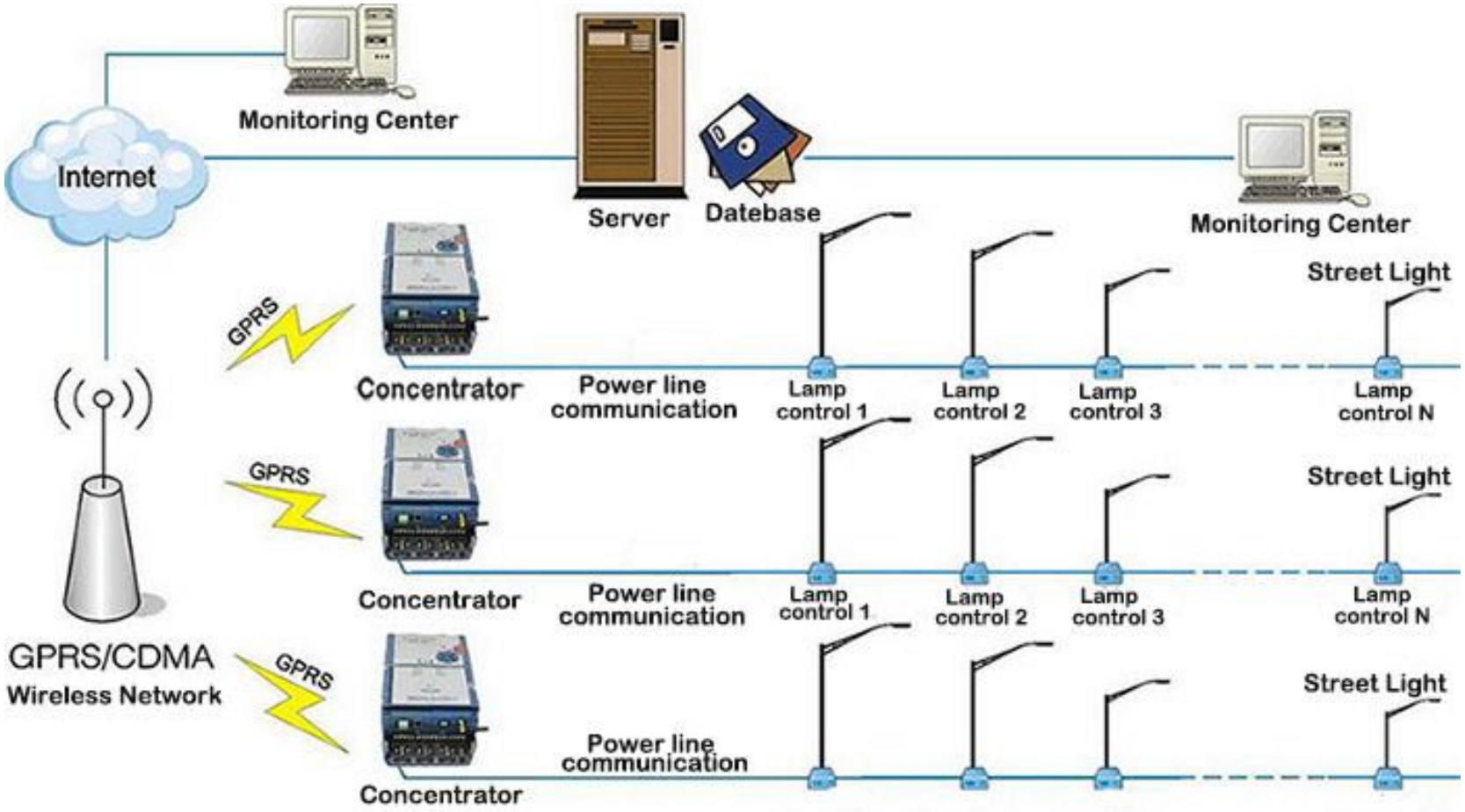
Typical Measurement “BAS” Points for HVAC systems that support Building EQ

- Space temperature
- Space humidity
- Building pressure
- Carbon Dioxide (CO2)
- Light levels
- Sound levels (dBA)
- Air flows and velocities (Ventilation and exhaust)

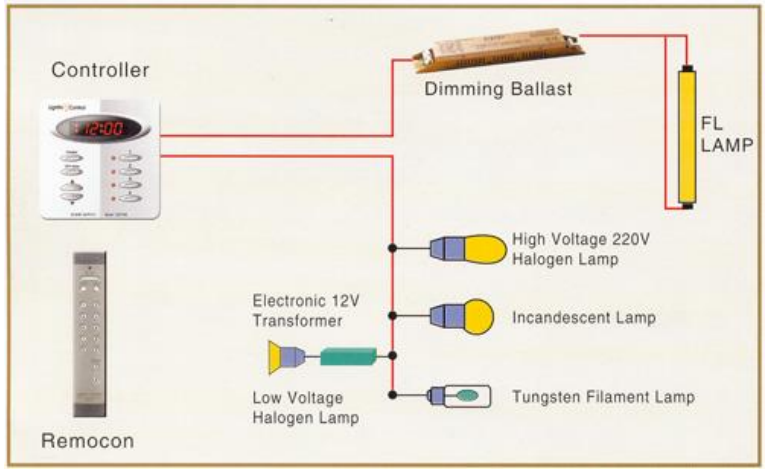
Lighting control systems

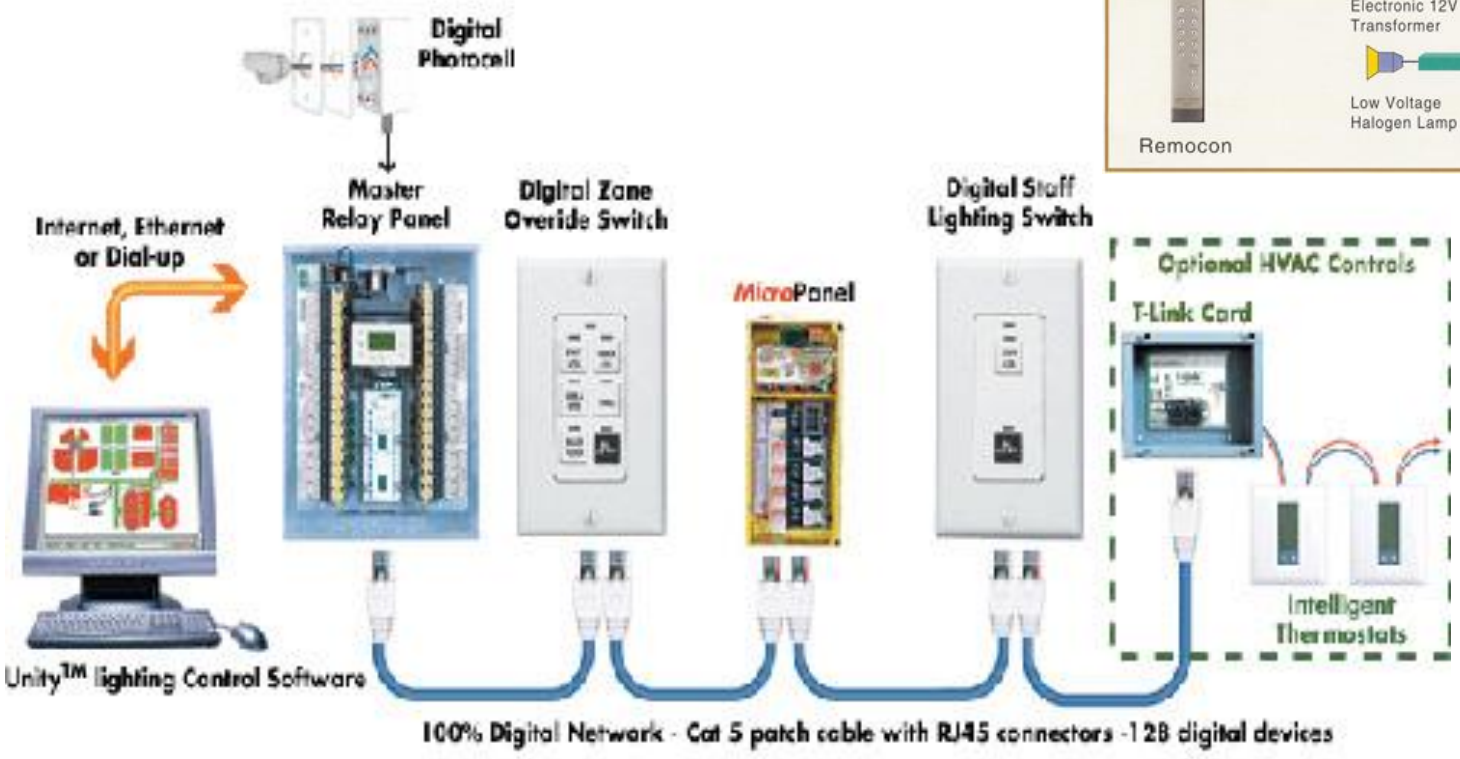


Lighting control systems

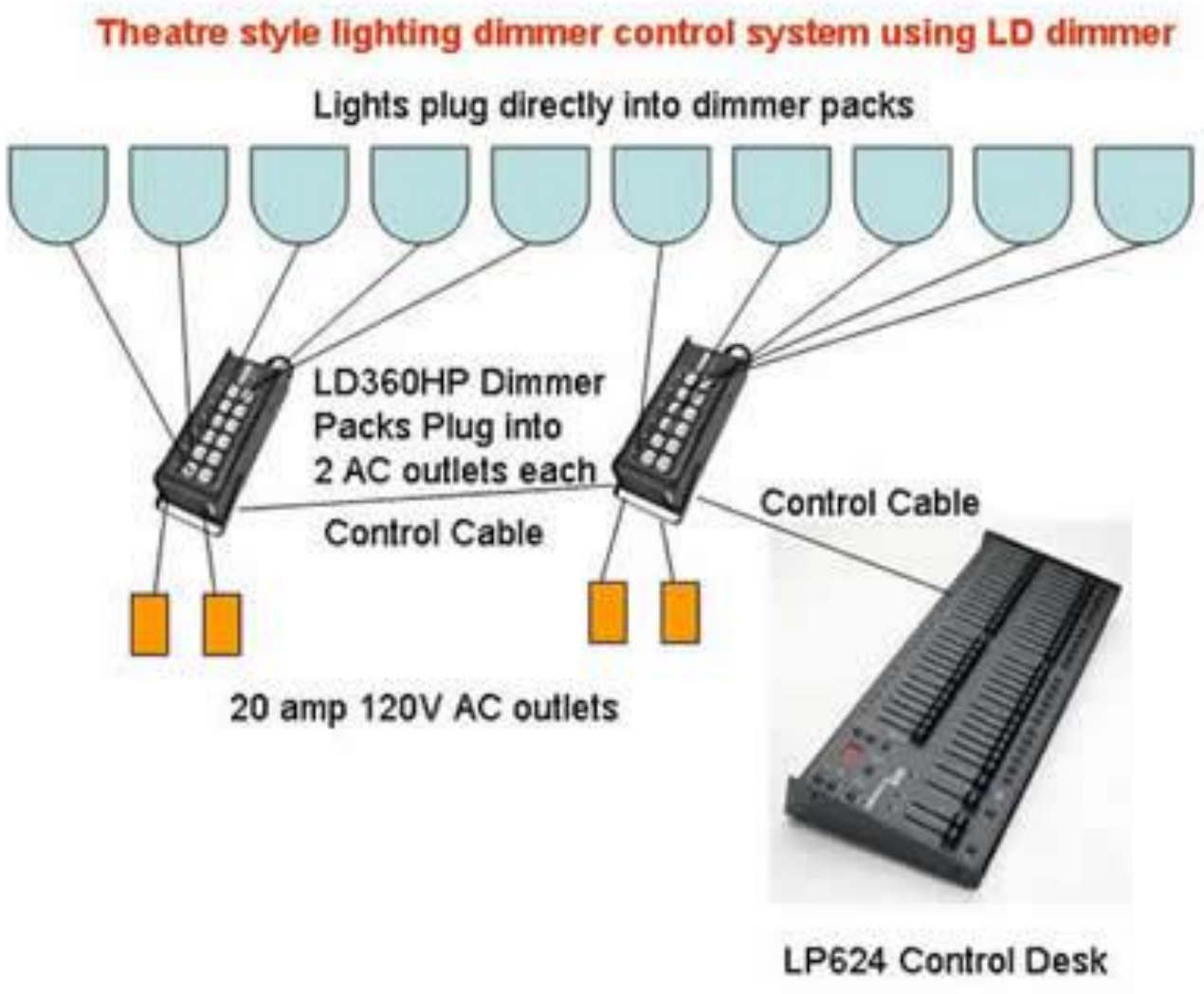


Lighting control systems

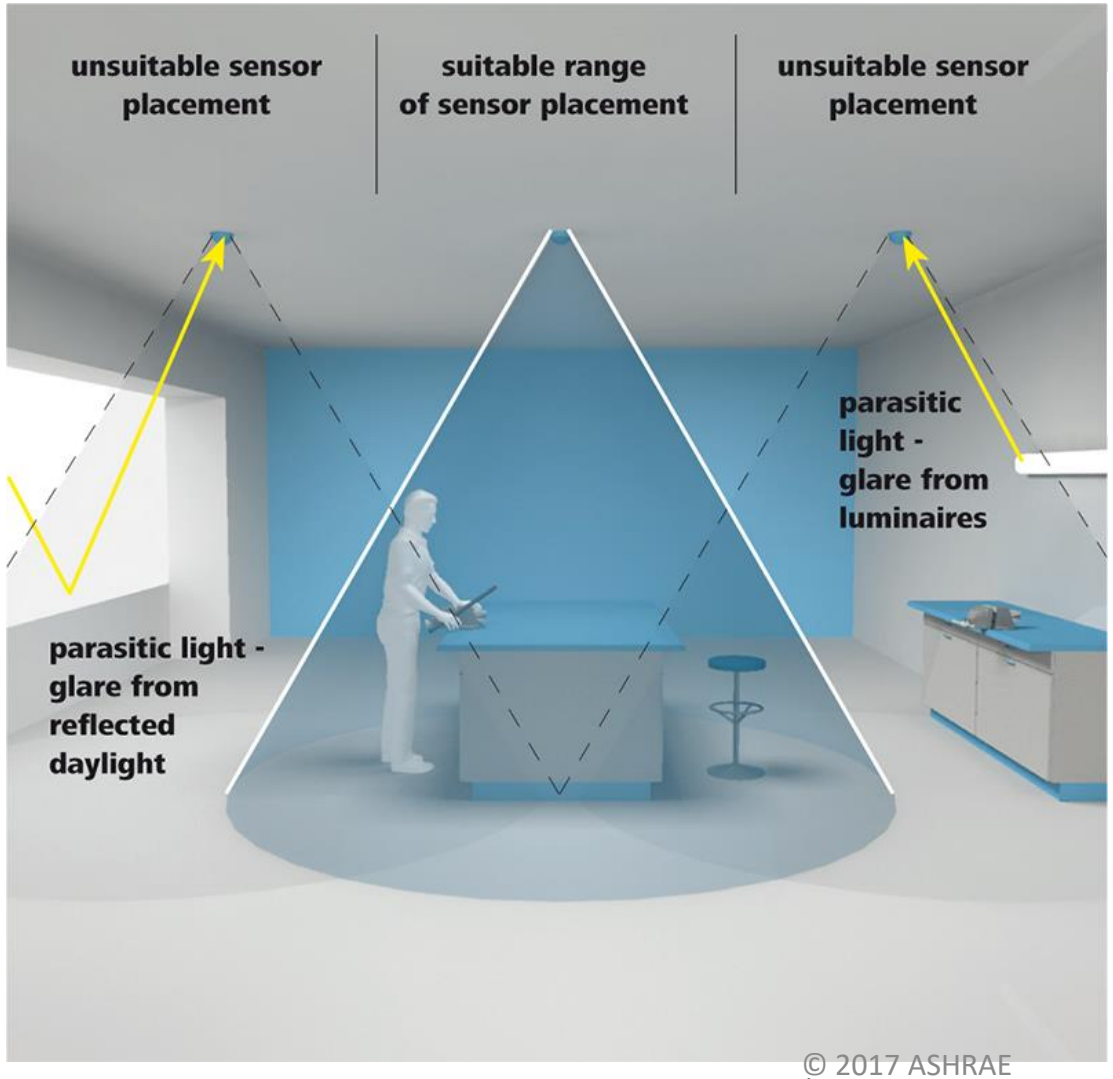




Lighting control systems

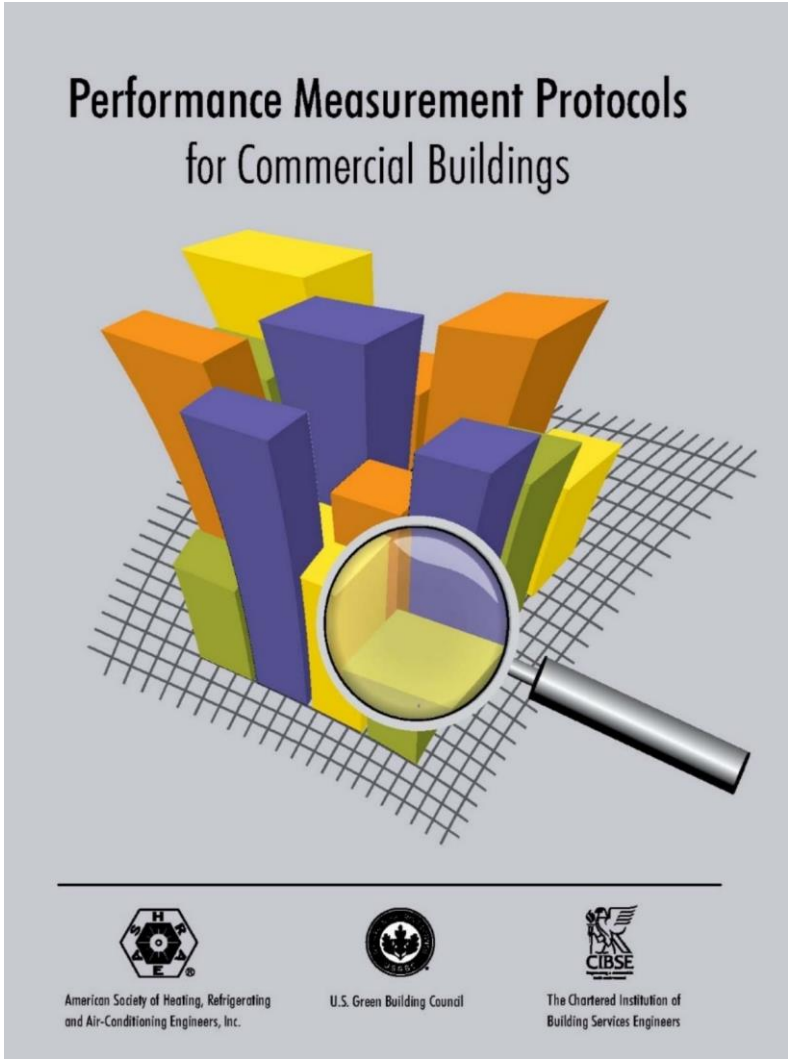


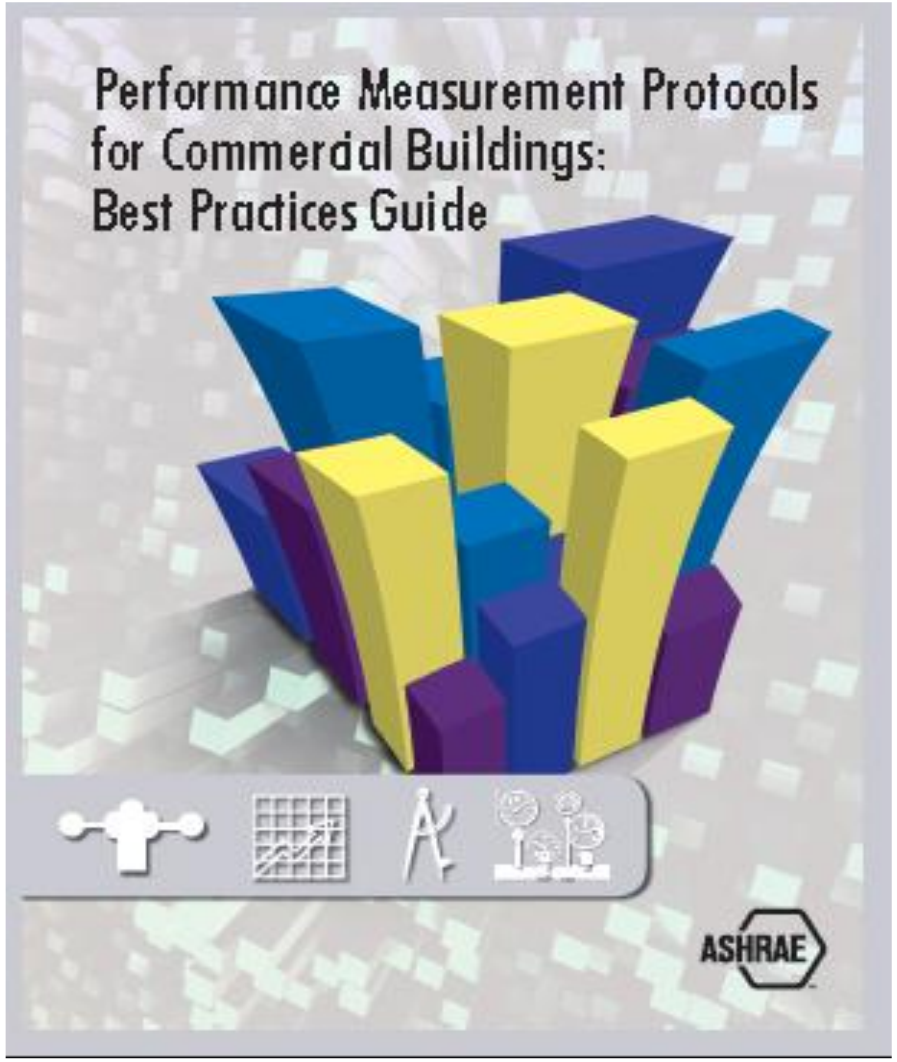
Daylighting systems and sensors



4. Suggested resources for review and study

- Performance Measurement Protocols.
- Fundamentals of HVAC Control systems
- AABC National Standards for Total System Balance
- ASHRAE Standard Testing Adjusting and Balancing





Performance Measurement Protocols for Commercial Buildings

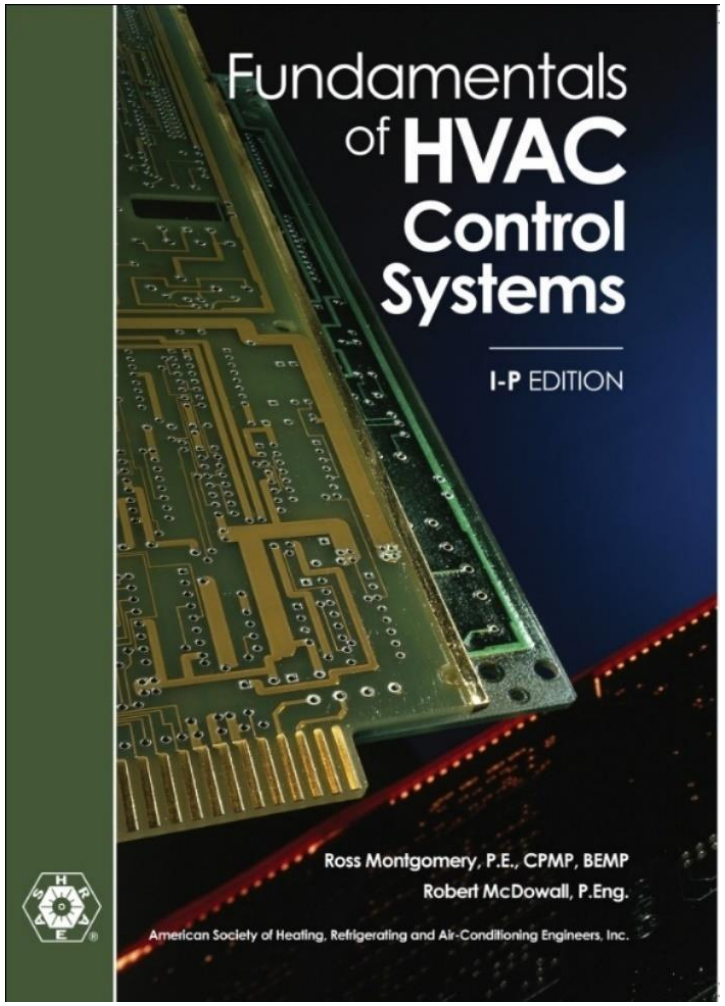
The protocols identify what to measure, how to measure it, and how often it is to be measured for inclusion in the building's operation and maintenance plan. Protocols are developed at three levels for each of six performance categories: energy, water, thermal comfort, indoor air quality(IAQ), lighting, and acoustics.

Fundamentals of HVAC Control Systems, I-P & SI (2nd edition)

This book provides a thorough introduction and a practical guide to the principles and characteristics of HVAC controls. It describes how to use, select, specify and design control systems.

This book will help you understand:

- Control theory, the basics of electricity, input and output devices, and the influence of input and output characteristics on control possibilities and performance
- How to use written specifications, schedules, and control diagrams to identify what is to be installed, how it is to be installed, and how it is expected to operate
- DDC (direct digital controls) system components, interoperability of controllers, network and data protocols
- Replacement, modification and maintenance of pneumatic and electric controls



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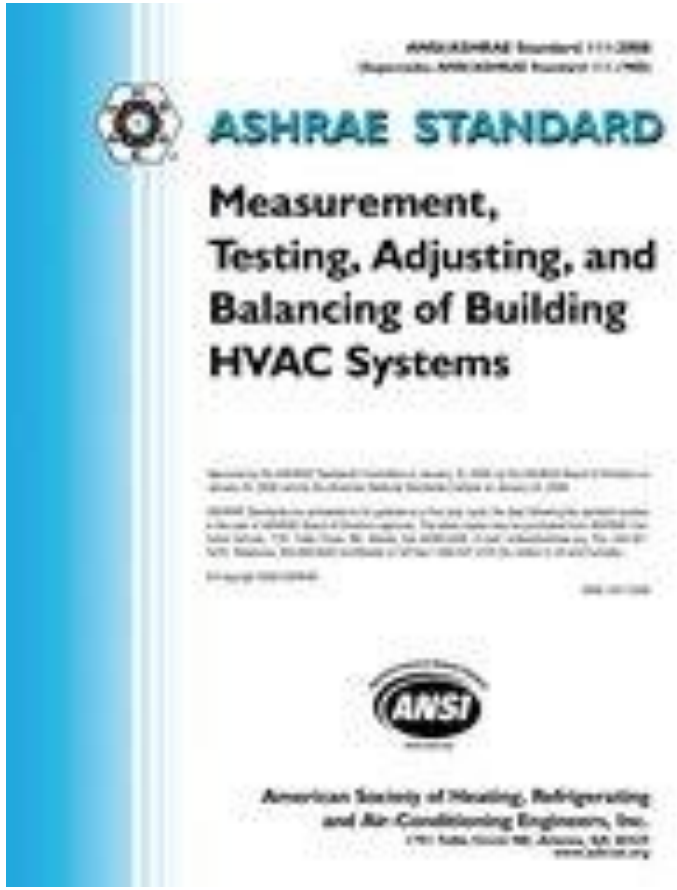
ANSI Standards for Testing Adjusting and Balancing



Standards and procedures onhow to take measurements, such as AABC, NEBB, TABB, etc.