Building Operator Certification – Level I

A Partnership of the NYC Department of Education Division of School Facilities, International Union of Operating Engineers, and the City University of New York

Department of Education
Dennis M. Walcott, Chancellor

The City University of New York

Class 16

Announcements: Important

These issues directly affect your course grade and can affect your pass / fail of the course.

These issues are:

- Attendance
- Make Up Project
- Project Completion
- IAQ Certification & IAQ Exam

See the BOC Course Website: “Week 16 Classroom Slides”

Announcements: Important

Class Attendance Policy

If you are not able to attend your regular class, you can attend another class during the week. You must contact the BOC Class Office and make a reservation, to make sure there is room in the class.

You must contact Deslyn George by phone or email.
If you just show up, and you have not arranged to attend a class, you will not be able to attend the class.

Phone: 718-610-0296
Email: DGeorge5@schools.nyc.gov

Announcements: Important

Make Up Project – for class absences

If you have missed 3 or more classes, or if you have a number of absences which is too high, you may reduce this by one absence by completing a “Make Up Project.”

Make Up Project – for exam missed

If you have missed an exam, you can make up the exam by completing a “Make Up Project.” If you are going to use this option, please make your request at the Administrative Office.

Announcements: Important

The Practical Projects are Important

If your Practical Projects are not complete you may not pass the course or get your certification. Ensure that each project is complete.

Project Status Sheet – This shows the status of your projects and any parts that are missing or still required to be submitted. Please review this very closely and follow the messages to you.

Project Folder – You should have only your completed projects in your Project Folder. There should be nothing else in your Project Folder. Remove your papers.

Announcements: Important

IAQ Certification & IAQ Exam

The IAQ Exam is required to be taken by all participants. This is part of the course.

This is the IUEO Union Exam which is normally given for the IAQ Certification. The IAQ Exam is based on the "IAQ Solutions Handbook"

We will review the "IAQ Solutions Handbook" during this section of the course and the "Test Review CD" These are valuable to prepare for this exam. It is extremely important that you use these resources to prepare for the exam.

Course Section 4 Overview

- Class 16: Air flow in Ducted Systems
  - Chapters 5, 7, 11
- Class 17: Contaminants, Testing and Prevention
  - Chapters 2, 3, 6, 9
- Class 18: Complaint Response & Protocols
  - Chapters 1, 4, 5, 15
- Class 19: Preventive Maintenance & other review
  - Chapter 10
- Class 20: Exam

Please adjust the reading assignments in your syllabus per the above

Today's Objectives

- Begin careful reading of IAQ text
- Know how air flow is tested and calculated in ducted systems
- Be familiar with ducted air system operation
  - Components
  - Economizer operation
  - Carbon-dioxide controlled ventilation
  - Filters and other air-cleaners
  - Common air-system types
- Begin use of CD for IAQ test prep

Today's Agenda

- Review ventilation basics
- Ducted Systems - Testing & Calculation of Air Flows
- Ducted Systems - Properties of Air, Components, Systems
  - Properties of Air
  - Components
  - System Types
- Review of sect. 3 exam and sect. 4 Practical Project
- Exercise Questions
  - use of textbook resources for self-study

How Air Moves Through Buildings (review)

Infiltration / Exfiltration

- the natural movement of air into, through, and out of a building
- Driven by pressure relationships
  - Wind
  - Stack effect

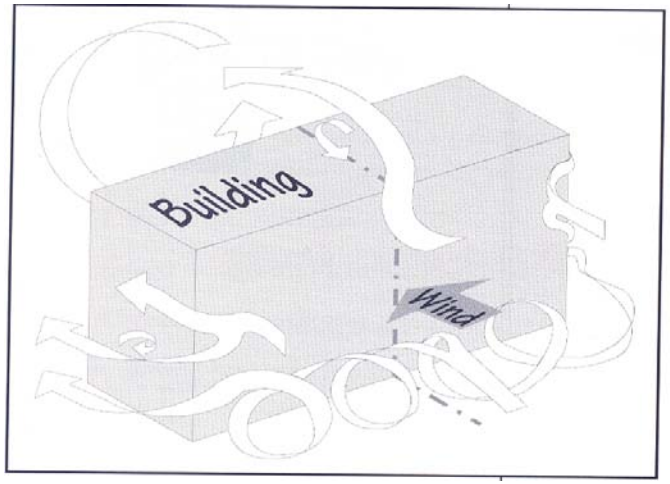
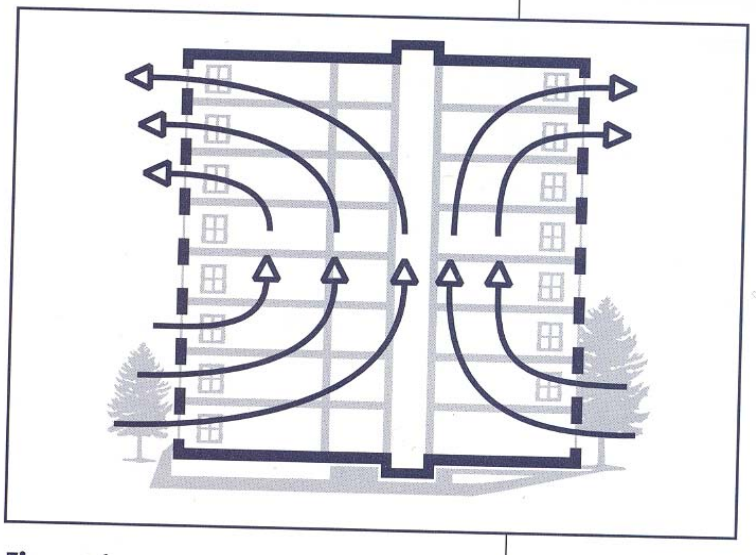


Figure 5: The "Stack Effect"



Mechanical Ventilation

- Fan Adjusment
- Distribution Balance
- Mixing within rooms

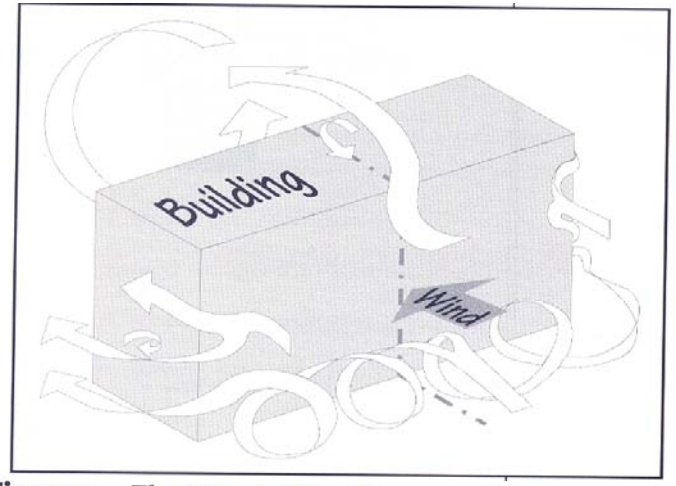
How Air Moves Through Buildings (review)

Ventilation equipment to identify

- Exhaust fans
- OA Iintake louvers, dampers
- Uni-vents
- Air-handling units

How much air?

- 15-20 cfm per person
- ASHRAE 62.1



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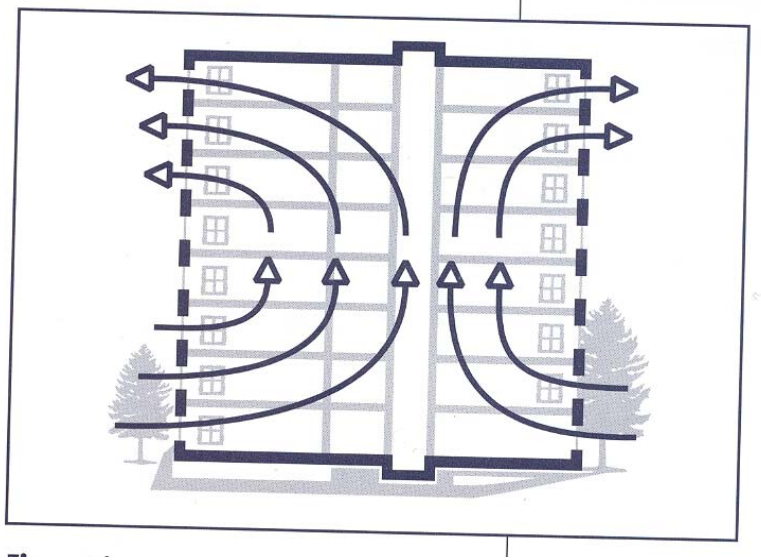


How much air is moving through a building?

- **Exhaust Fans Only – No ducted air system**
  - Total CFM of Outside Air
    = Total Flow of all exhaust fans
  - Air Changes per Hour – ACH
    - Volume of Space = Floor Area x Ceiling Height
    - Cu Ft / Hour = CFM x 60
    - ACH = Cu Ft / Hour / Volume of Space
- **Ducted Systems – Provides outdoor air**
  - Total CFM of Outside Air
    = % Outside Air x Total System Air Flow
- **Air Changes per Hour – ACH**

  ACH = 60 x Q / V

  = 60 x Flow Rate / Volume

Ducted Air-Handling System

- **Page 219**
- **Page 203 Single Zone ducted system**
  - 100% Outside Air (“once through”) – Top diagram
  - Mixed Air System (“re-circulation”) – Bottom diagram
    - Total Air vs Ventilation Air - air for heating/cooling

    - *See **Page 109** for a better labeled diagram*
      - *Labeling of dampers – OA, RA, MA, SA*
      - *Adds Return Fan – building pressurization*

- *What is the purpose of an HVAC system?*
- *What is the purpose of an HVAC control system?*

Ducted Air-Handling System

- What is Test Adjust and Balance (TAB)?
  - Chapter 7 - **Page 97 & 98**
- What is going on in the duct system?
  How much air flow?
  - Use of plans. **Page 101**
  - Instruments and measurements
    - What gets tested, p 98
- Tests at the Fan, **Page 102 - 103**
  - Tachometer (rotational speed)
  - amperage readings. **Page 128 - 129**
  - Pressure tests and use of Fan Curve (p 130)
  - Adjusting and Controlling Fan Speed (p 130 -132)

Measuring Air-flow in Ducts Pages 104 - 116

- Total, velocity and static Pressure with **Pitot Tube** or **Manometer**
  - Total Press = Velocity Press + Static Press
  - Velocity Press = Total Press - Static Press
  - Velocity Press >> Feet Per Minute (FPM)

- Direct air velocity measurement with **Anemometer**
  - Thermo-Anemometer (“hot wire”), Vane anemometers **P 110 - 116**
  - *Some digital anemometers will read out in cfm if the duct cross-sectional area is keyed in. Be careful.*

Measuring Air-flow inside Ducts

- **The Traverse - Page 106 - 107**
  - Air flow velocity varies across a duct
  - Especially between center and edges
  - **multiple test points** are required for accuracy
  - Use average from across traverse readings

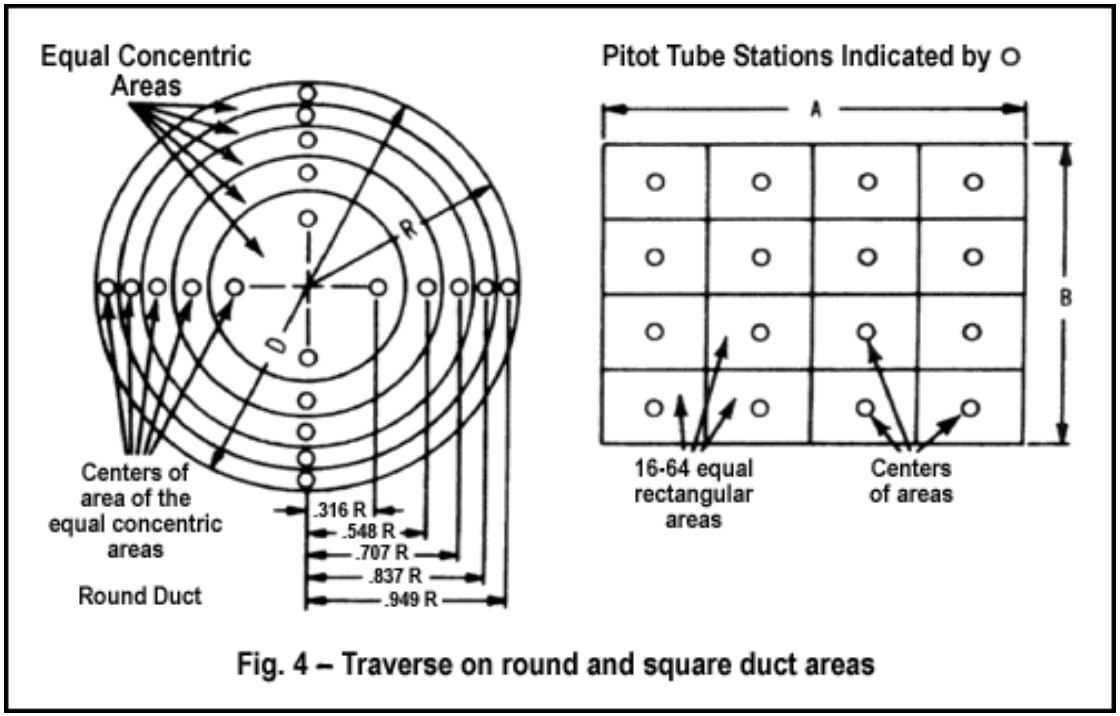


Fig. 4 – Traverse on round and square duct areas

Measuring Air-flow in Ducts

- Convert Velocity to air flow volume (CFM)

  - **Flow = Velocity x duct cross-sectional area**
  - **CFM = Velocity x Area**
  - **CFM = V X A**

  Example: see page 105
  Velocity = 2002.5 FPM
  Area = 2’ x 3’
  CFM = V X A

Capture Hood Page 117 - 120

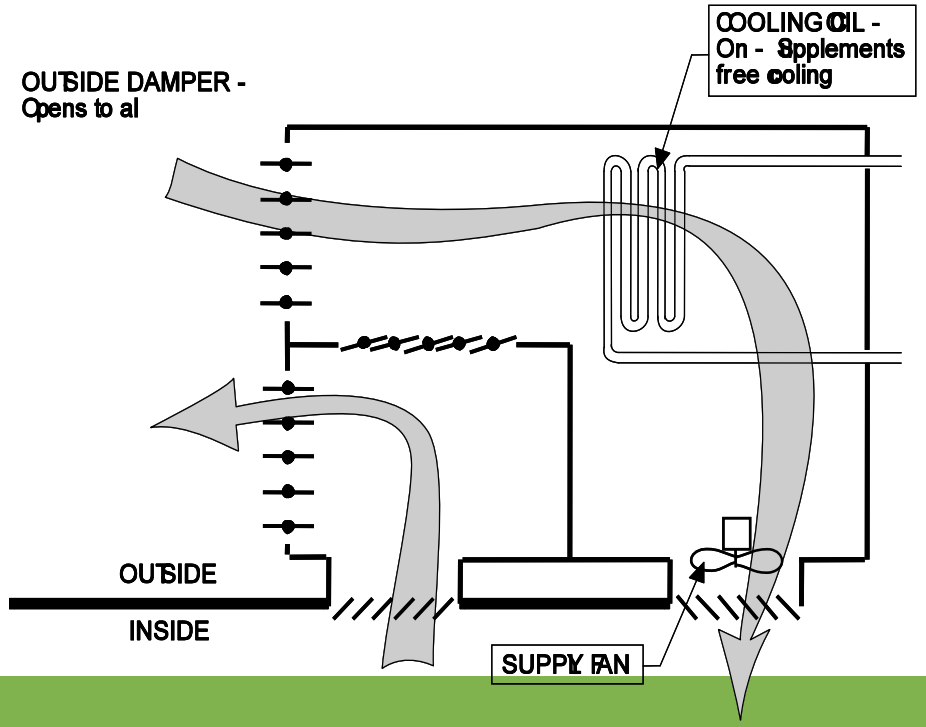
- Direct flow (cfm) measurement with **Capture Hood** (velometer, balometer)
- but only for use at outlet registers, not usable in ducts

The Mixing Plenum and Dampers (Page 208)

- Coordination of OA, RA, Exhaust ("Spill") dampers
- Damper maintenance list
- Good mixing in the mixing plenum

Economizer sequence of operations (P 204-205)

- When outdoor condition is favorable, use outside air instead of return air
- Coordinate damper sequence to
  - Open OA damper
  - Close RA damper
  - Open Exhaust damper
- Very important energy efficiency control strategy



So now we know (how to measure) the total air flow in a duct….How do we know how much Ventilation is being provided? Pages 209 – 211

- **Using temperatures or CO2 to calculate percentage OA**
  pp 209-212, same calcs also in chapter 7, pp 121-124

  - **OA % = (MAT - RAT) / (OAT - RAT) x 100**
  - Work the examples in the text (p 210, illustrations on p 211, 212)

- Apply OA % to Total Air flow

  OA CFM = OA % x Total (supply) air flow, CFM

  where Total (supply) air flow is established from duct measurement

OA Air Calculation Summary -

- Derive % of OA as part of total air flow
  - % OA = (MAT - RAT) / (OAT - RAT) X 100
- Measure total air flow in supply duct
  - Pitot tube to derive velocity pressure and then calculate velocity
  - Direct velocity measurement with anemometer
  - Remember Traverse requirements
- Calculate duct air flow from velocity
  - FPM x duct cross-sectional area (sf) = CFM, total air flow
- Total Air Flow, cfm x % OA = OA,cfm

Section 2

- Sample OA Quantity Problem & Solution

- Air Properties
- CO2 Ventilation Control
- Air Handling Components
- Air Cleaning and Air Filters

Air Properties in a Facility, Pages 62 - 66

What are the desired properties of air that the air-handling system must produce?

- Temperature and Relative Humidity (RH)
- Volume (specified delivery quantities - TAB)
- Air circulation within zones and rooms
  - Short-circuit by-passes
  - Velocity of air from diffusers
    - Too high = noise problems
    - Too low = poor mixing in rooms

What is conditioned air?

Carbon Dioxide and Dynamic Ventilation Control

CO2 limits

- 1,000 ppm (per text**, pp 70 - 71**)
  - (also note Carbon Monoxide testing, **pp 68 - 69**)
- Other references: 800 ppm > ambient, where ambient is typically 380 ppm but can be much higher in NYC, up to 600 ppm

Using CO2 for Ventilation System Control

- **Page 286**: adjust ventilation (dampers, fan speeds) based on permanent CO2 sensors.
- Especially useful for spaces that have large, varying occupancy, such as ….?

Air-Handling Components

- Ductwork
- Dampers
- Fans
- Filters and other air-cleaners
- Coils, Heating and Cooling

Air-handlers - integrated, packaged assemblies of the above elements

Air-handling Components

- Ductwork (pp 218-220)
  - Leakage and balance
  - Velocity
  - Accumulated dust
- Fans and air-handling units (pp 206 - 207)
  - Positive and negative pressurization of building areas. See also pp 229-230
  - Fan component wear as air-stream contaminants
  - No exhaust fans in boiler rooms**!**
- Coils and coil issues (p 220 - 223)
  - Cooling coil moisture issues - pans, carry-over, corrosion
  - Heating coils
    - » Humidification requirements to avoid too-dry air
    - » Warm-water pans - Legionella

Air Cleaning, Pages 210 - 217

- Methods to reduce pollutant concentrations in indoor air
  - Source Control
  - Ventilation (Dilution)
  - Air Cleaning
- Types of Air-cleaners
  - Electronic
  - Ultraviolet
  - Mechanical Filters
  - Chemical Filters (activated carbon)
- Air-cleaner applications
  - Electronic and mechanical filters for Particulates
  - Ultraviolet for biologicals, especially in spot use
  - Carbon filters for chemical contaminants such as VOC

Air Filters, Pages 215 - 217

- MERV Filter Rating System, p 217

  (Minimum Efficiency Reporting Value)

  - ASHRAE Std 52 (52.1, 52.2)
  - MERV rating provides a short-hand for other filter characteristics
  - Trade-offs in higher filter efficiency --
    - Higher pressure drop, more fan energy for more filtering
    - More frequent changing of high MERV filters
  - Filter Maintenance
    - Watch out for by-pass from poorly fitted filter section
    - When to change filters

  - http://www.theonion.com/articles/department-of-interior-to-clean-nations-filter,18031/

Air-handling system types, Pages 224 - 229

- Single zone
  - **Constant volume** with fan on-off or air temperature reset
- Multizone
  - Constant volume to independently controlled zones, that may be air-handlers with coils or dual duct mixing boxes
- Dual duct
  - Heated and cooled air in separate ducts, mixed to zone needs
  - Simultaneous heating & cooling, very expensive to operate
- Reheat
  - Constant volume, single duct with terminal heating unit to adjust final temperature.
- Variable volume
  - Constant temperature air with **volume varied** by zone control VAV box, often with variable speed central fan
  - Common current system - SCA design

Section 3

- Practical Project 2A – Discussion of requirements
- Exam Review
- Review CD - Practice Questions on IAQ

Practical Project 2 Part A
Ventilation System & Outdoor Air Supply

Describe the ventilation system(s) that supply the outdoor air

- Review of Project Instructions – Yellow Sheets
- Review of Example Sketch – **Course Book – see next slide**
- Sketch of **one area** of your building.
- Identify your building's air intake and exhaust points.
- Describe how the air flows through your facility.
- Answer the questions on the **Form** cover the main points of the ventilation systems.
- Start to make a rough sketch of boiler room

Practical Project 2 Part A

Practical Project 2A – Description of Ventilation Air Flow – For Each Room

Offices

How is outside air supplied to this room?

Unit Ventilators OA Intake

How is outside air / mixed air distributed in this room?

By the UniVentilators

How is the mixed air exhausted from this room?

Out the door to exhaust fans

How is outside air controlled to this room?

Controls on Unit Verts

Cafeteria

How is outside air supplied to this room?

Air Handler AHU-2 OA Intake

How is outside air / mixed air distributed in this room?

Ductwork to diffusers on ceiling

How is the mixed air exhausted from this room?

Cafe has 2 exhaust Fans + Air Handler return

How is outside air controlled to this room?

Fixed Damper on AHU OA Intake

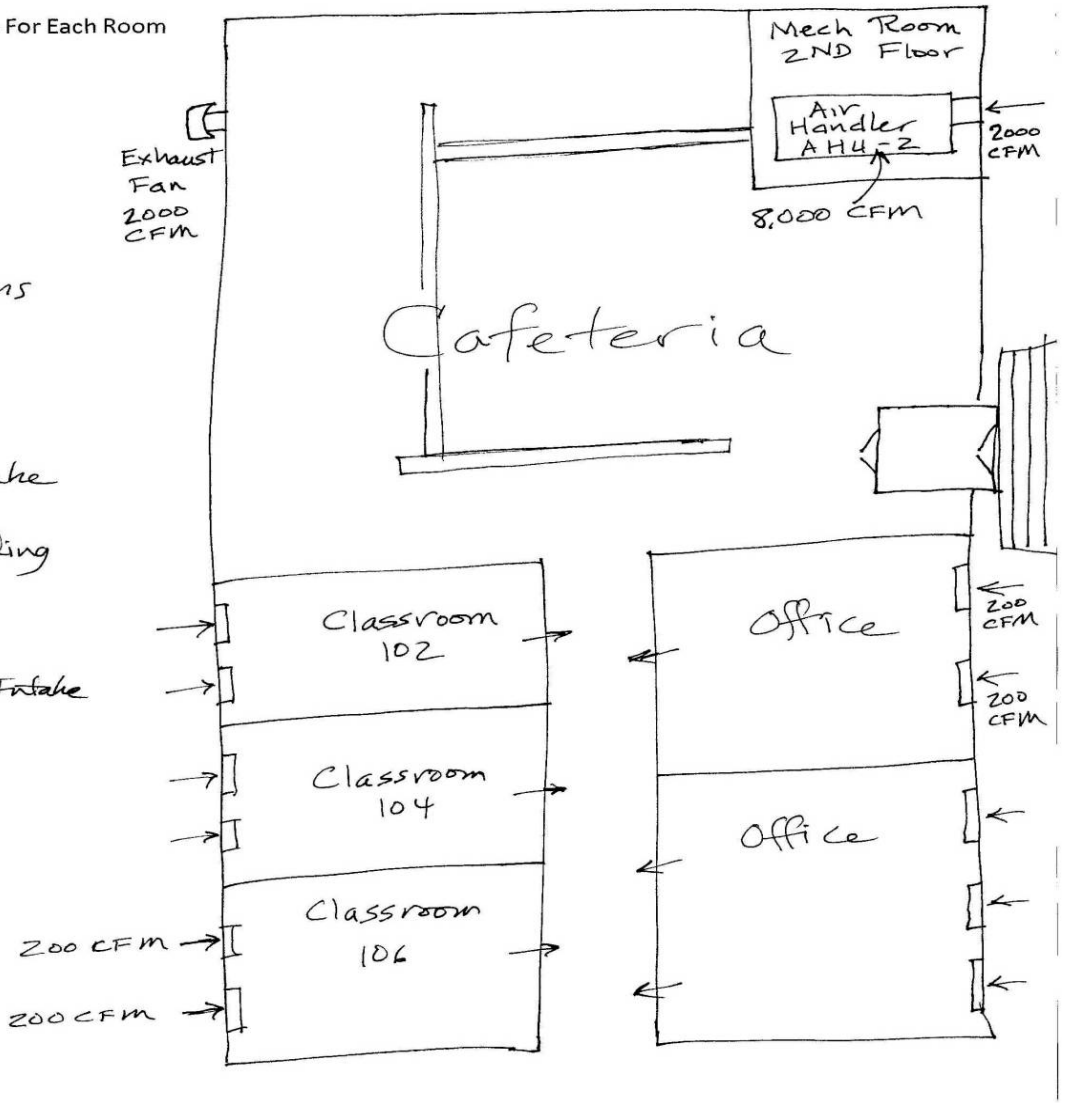
Classrooms

How is outside air supplied to this room?

How is outside air / mixed air distributed in this room?

How is the mixed air exhausted from this room?

How is outside air controlled to this room?



Module 3 Exam Review

- 15 minute review of the exam last week

Review of Practice Questions

Demonstration of Test Review CD - IUOE Text Book

Review these parts of the CD:

- Quick Quiz – Chapters 7 and 11
- Resources within the Quick Quiz
  - Text Book – Quick Topic Excerpts
  - Illustrated Glossary
- Flash Cards – Chapter 7 and 11

Using these resources will prepare you for the IOUE Union IAQ Certification Exam, and help to raise your score on the Exam.

These are not the exact questions that will be on the test.

Review and Class Reading Assignments

- IUOE Chapter 2, 3, 6, 9

  - READINGS IN IUOE INDOOR AIR QUALITY SOLUTIONS ARE EXTREMELY IMPORTANT FOR TAKING THE UNION CERTIFICATION EXAM

  - USE THE "TEST REVIEW CD" THAT IS AT THE BACK OF THE BOOK FOR STUDY AND PRACTICE PURPOSES