Building Operator Certification Training Program
For Custodian Engineers

Practical Project 2

The Practical Projects are a requirement of the BOC – Level 1 Certification. They are also one of the most valuable aspects of the course, as they provide opportunity for each operator to gain a systematic perspective on their facility with particular focus on energy usage and conservation opportunities.

PROJECT 2 – PRINCIPLES OF ENERGY MANAGEMENT

The Practical Project for Principles Energy Management Is divided into three parts:

(A) Ventilation System & Outdoor Air Supply

(B) Whole-building and System-level Energy Consumption

(C) Energy Improvement Project

Each part is due at the end of its associated module, every 5th week of the course. Students may review progress with the instructor in advance of the final submission date. An in-class group review of projects will be conducted in 4th class of each module – students should have preliminary draft projects ready for this group review as it can be a very valuable aid in submitting a good project.

Work in this project emphasizes use of energy usage data (Part B &C)**.** Students will gain first-hand experience in working with data from Energy Star Portfolio Manager to understand the whole-building energy performance. Students will also gain experience at analyzing a system or major piece of equipment for its energy use and energy improvement opportunity, by using data from design documents, nameplates, rating sheets and direct measurement devices, generally following procedures described in the Herzog text and with calculation formulas provided in class. Students are encouraged to work in spreadsheets to calculate system-level energy use and reduction opportunities.

PRACTICAL PROJECT COMPONENTS AND SCHEDULE

Each Practical Project is arranged in three parts, the three parts of Practical Project 2 will be due on the schedule as shown:

Project Component	Course Module	Due Date	Due Date
Part 2A	4	Week 20	November 7th
Part 2B	5	Week 25	December 19th
Part 2C	6	Week 29	January 23rd

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PART A: VENTILATION SYSTEM & OUTDOOR AIR SUPPLY

Assigned: Week 16
Due: Week 20 (same day as Exam #4)

Describe the ventilation system(s) that supply the outdoor air to the main building of the school. Select one area of your school which has 3 or 4 types of rooms. See examples below:

Selected Area 1	Ventilation Type	Selected Area 2	Ventilation Type
Offices	Unit Ventilators	Gymnasium	Supply Fan
Cafeteria	Air Handler	Auditorium	Rooftop Unit
Classrooms	Unit Ventilators	Classrooms	Unit Ventilators
Bathroom	Exhaust Fans		

Sketch a **floor plan** of the one area and show the following for each room:

- Ventilation equipment location and type
- Location of outside air intakes
- Location of exhaust paths / exhaust points
- The flow path of supply air into each room, using arrows
- The flow path of exhaust air leaving each room, using arrows

Your floor plan drawing is expected to show 3 or 4 separate ventilation systems. Show the flow path of the ventilation air through each room. See the example drawing, which shows one area of a school. Your drawing is to be done on paper size 11 x 17. Or, you may use 2 pages of 8.5 x 11 and tape them together to create a 11 x 17.

Determine the ventilation air flow (CFM) at each intake and exhaust and note this on the sketch.
The air flow rate may be obtained from one of the following sources: plans, manuals, catalogs, equipment ratings, nameplate data, etc. You can also measure this with a velometer.

When you have completed the sketch, use the **Form** "Description of Ventilation Air Flow" to describe the ventilation air flow for each room by answering the following questions:

- 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?

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This table provides a summary of the common HVAC systems to deliver and control outside air. This table is for reference and you are not required to create a table like this.

Area	How Ventilation Air is Delivered	How is Outside Air intake Controlled?	How is Air Exhausted?	Operating Conditions
Class Rooms and Offices	Unit Ventilators ("uni-vents")	Fan switch, flow-actuated gravity dampers	to corridors to bathroom exhaust	Many Uni-vent motors failed, windows open
Cafeteria	Air Handler	Fixed outside air damper, thermostat fan control	Ducted return to air-handler	
Kitchen	Outside air intake fan	Fan switch inter-locked to hood fan	Range Exhaust Hood	Hood filters need cleaning
Gymnasium	Outside Air Intake fan		Separate exhaust fan	
Auditorium	Rooftop Air Handler	Motorized OA damper	Ceiling return to air-handler	Motor linkage disconnected
Bathrooms	Exhaust fans	Manual switch		

<u>Checklist:</u> Make sure you have completed these before you submit your project.

- Show the equipment which supplies outdoor air to each room
- Label each piece of ventilation equipment and each ventilation system
- Show the flow path of supply air into each room, using arrows
- Show the flow path of exhaust air leaving each room, using arrows
- Complete the **Form** "Description of Ventilation Air Flow" for each room
- Make a copy of your project for your records before you submit the project
- You name is placed on the top, right corner with you class (eg. Tuesday, PM)

Part B: WHOLE-BUILDING AND SYSTEM-LEVEL ENERGY CONSUMPTION

Assigned: Week 21
Due: Week 25 (same day as Exam #5)

Use the energy data for your school to provide an overview of the energy consumption at your school on two levels: Whole-Building and System-level.

Project 2-B involves the use of the actual energy usage data for your school. **Use data sources for your school including** your Energy Star Portfolio Manager account and the IBM Energy Dashboard.

Use the energy data for your school to complete two tables, shown below. These Tables are also available as an Excel spreadsheet, for those of you who wish to work in that format. The Excel spreadsheet is available on the BOC website, in the "Practical Projects."

Table 1 – Summary of Annual Energy Use by Energy Type
This table develops your whole-building annual energy use. You will enter the energy usage data for your school from you Energy Star Portfolio Manager account or the IBM Energy Dashboard **into the yellow-highlighted columns** and do calculations to complete the rest of the columns.

Table 2 – Annual Energy Use by End-Use Function
This table converts the whole-building energy use into the estimated usage by each building system (system level). For this table you will identify the energy types (electric or fuel) used for each building function. Using the data from Table 1, you will develop an estimate of the amount of energy (MMBTU) and the cost of energy your various building functions. In this Table you can use the default percentages provided for system-level energy use. However, you should also consider whether the percentages seem appropriate for your facility. There is a blank column to use if you are adjusting the percentage factors.

- For example, if your school kitchen has equipment for warming only, and uses no gas for cooking, you may adjust the default value of gas usage by the kitchen from 10% to 0%.
- If have a large summer electrical usage, suggesting that you should increase the percentage for AC, as shown by a load profile that you may prepare (your annual or monthly Load Profile). If you make increase the electric usage in one category, you should decrease other kinds of electrical use by an equal amount, so the total electric use is 100%. From the annual Load Profile, you could actually calculate the amount of electricity for AC. Or you could do the same for heating, using the winter months versus summer months.

- If you have significant amounts of electric space heating or water heating, adjustments will be necessary. See your instructor to make any large changes in the allocation.

<u>Checklist:</u> Make sure you have completed these before you submit your project.

- You have entered all of the numbers into the yellow columns, and the square footage
- You have the expected cost of electricity for a school of your size (square footage)
- You have the expected unit cost of electricity $0.18
- You have the expected unit cost natural gas $1.40/therm and fuel oil $1.90/gal
- Print out each table on one page each, and make a copy for your records
- You name is placed on the top, right corner with you class (eg. Tuesday, PM)

Part C: ENERGY & IEQ IMPROVEMENT PROJECT

Start: Week 26
Due: Week 29 (1 week before Exam #6)

Identify an energy improvement project or IEQ improvement project that could be made to your facility. Prefer and operational or maintenance change which can produce a large reduction in energy usage while not impacting occupant comfort. Characterize the project, describing the improvements which would be made to the operation or maintenance of the facility, systems or equipment.

We expect that you will select your project from the list provided. However, if you have another operating condition that you identify and want to address that is not on the list, you can do so, but you must consult with your instructor during a class workshop session. Remember that the project must be operational in nature which can be performed by you and your staff and funded by your budget. It should not require capital investment or extensive outside resources.

Estimate the energy savings of the project by using the methods given in the classroom and by using the “Calculation Guidance” worksheet.

Follow the outline of the form below. You can submit the project by hand written or word processor form. The form shown below is available as a Word document on the BOC website, in the “Practical Projects”

Project 2C Format

There are 2 tables to complete on your form, generally as per the following:

Table 1 **Project Description**	
Brief Description of Measure	*Instruction: Describe the energy improvement project or IEQ improvement project that could be made to your facility. Prefer and operational or maintenance change to produce a reduction in energy usage while not impacting occupant comfort, or to improve IEQ / IAQ. You must include the scope: eg: how many rooms are affected or number of lights.*
Problem Addressed:	*Instruction: Describe the conditions in your facility which could be improved, which are an opportunity for improvement in energy usage or improvement in IEQ / IAQ.*
Expected Impacts Energy:	*Instruction: Describe and Calculate the energy savings expected, the reduction of fuel usage or electricity usage. Before you can fill in the results here, first you must do the Quantification of the energy savings by using the "Calculation Guidance" worksheet.*
Expected Impacts IEQ	*Instruction: For an energy saving project, this should have no impact on the occupant comfort. For an IEQ / IAQ improvement project, describe the improvement in the IEQ / IAQ conditions.*
Pre-project Measurements	*Instruction: Describe the monitoring and/or measurement you would use to determine the current operating conditions, such as: the hours of operation of lighting or air handlers; the extent of boiler cycling. This pre-project measurement must be described, but it does not actually have to be implemented for this project.*
Project Steps	*Instruction: Provide an outline of the steps to implement this project. Describe the actions to be taken.*
Observable Outcomes:	*Instruction: Describe the improved conditions you would expect to see, including the monitoring and/or measurement you would use to confirm the improvement of the operations, as a result of the improvement.*
	Project Requirements
Materials	*Instruction: Describe the materials needed for the project.*
Manpower (internal)	*Instruction: Describe the extent of internal manpower (your staff) to implement this project.*
Manpower (external)	*Instruction: Describe the extent of external manpower to implement this project, which should be limited, as the focus of the projects is on O&M improvement and measures.*
Space access	
Timeframe	*Instruction: Describe the timeframe to implement this project.*

Table 2 **Cost Estimate**	
Internal manpower:	*Instruction: estimate the total # of hours of external manpower needed, calculate the projected cost:* *_____ man-hours @ $50 per hour = $_____*
External manpower:	*Instruction: estimate the total # of hours of external manpower needed, calculate the projected cost:* *_____ man-hours @ $75 per hour = $_____*
Materials (itemized)	
Supervision & Overhead (allow for 10% of total cost)	*Instruction: Calculate the projected cost of the project, then budget for "Supervision & Overhead." Estimate this cost as 10% of all other costs, and add it in to create a total project budget.*
Contingency (allow for 10%)	*Instruction: Calculate the total project budget then add an additional line item for Contingency. Estimate this cost as 10% of the total project budget.*
Total Estimated	*Instruction: Calculate the projected cost.*

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SAMPLE IMPROVEMENT PROJECTS LIST

These are example projects from which you may select your project.
You may want to combine several measures from within the same category.

BOILER PLANT
Test and improve combustion efficiency
Firing rate modulation – reduce cycling
Improve boiler sequencing – reduce cycling
Optimize start-up
Optimize shut-down

HEATING SYSTEM
Balance steam distribution, reduce overheating
Reduce pneumatic air leakage
Zone system for after-school programming
Maintain steam traps (replace disc elements)

LIGHTING
Use occupancy sensors in appropriate areas
Get better turn-off of unoccupied areas
Reduce lighting during cleaning hours
Introduce manual day-lighting in appropriate areas

VENTILATION
Test and adjust exhaust fans
Adjust kitchen hood
Use economizer cycle (rooftop or air-handler units)

MOTORS
Check loading, reduce speed with sheaves and pulleys
Adjust variable frequency drives (if present)

AIR-CONDITIONING & REFRIGERATION
Check and adjust refrigerant charge and clean coils
Better control of air-conditioners after hours (unoccupied)
Raise refrigerator and freezer temperatures
Increase air-conditioning set-points

IAQ/IEQ
Improve kitchen hood performance
Improve Uni-vent performance
Address odors – source/path analysis
Control dust sources