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 28

Class Announcements

Welcome to Class 28

Countdown to Complete:

2 Weeks

Class Announcements

Project 2C – Energy Improvement Project

Submission Next Week – Firm Date

Make sure that all of your Projects are complete because they are required for your BOC Certification.

Today's Objectives and Topics

- Energy Savings Calculations – Practice Problems
- Project Workshop – continuing with quantification
- Energy Audit
  - > Continue: how to read and utilize report
- Retro-Commissioning (RCx)
  - > how to recognize problems, what to do
- Project Workshop – final Peer Review
  - > projects can be readily understood
  - > projects are complete and properly presented

Quantification

Savings - where from?

- Reduction of operating hours
- Improve equipment efficiency
- Some measures - both types, both fuel & electricity

Let’s review an example of each type of calculation.
The exam will have questions with these calculations.

Quantification - Lighting

Example of Savings from reduction of operating hours

- Assume 170 days per year, 100 heating-days per year

Lighting: 100 fixtures, each with 2 F34 lamps,
Reduce on-hours by 3 hours per day

Energy Usage = Rate of Use x Hours of Use

= Watts x Hours of Use

Energy Saved = Rate of Use x Reduction of Hours of Use

= Watts x Reduction of Hours of Use

= Watt-hours

= kiloWatt-hours

Quantification - Lighting

Example of Savings from reduction of operating hours

> Assume 170 days per year, 100 heating-days per year

Lighting: 100 fixtures, each with 2 F34 lamps,
Reduce on-hours by 3 hours per day

Energy Saved = Rate of Use x Reduction of Hours of Use

Energy Saved = Watts x Reduction of Hours of Use

= $\frac{100 \times 2 \times 34 \times 1.1}{}$ x 3 x 170 days/yr

= 3,815,000 Watt-hours

= 3,815 KWH

> Do you know what each of the above #s represents?

Quantification - Motors

Example of Savings from reduction of operating hours

> Assume 170 days per year, 100 heating-days per year

Motors: 20 HP fan motor, 84% efficiency, 62% load factor
Shut-down for 2 hours per day (1 hp = 0.55 kW)

- *Herzog short-cut factor for HP-to-kW conversion*

Energy Usage = Rate of Use x Hours of Use

Energy Saved = kilo-Watts x Reduction of Hours of Use

Quantification - Motors

Example of Savings from reduction of operating hours

- Assume 170 days per year, 100 heating-days per year

Motors: 20 HP fan motor, 84% efficiency, 62% load factor
Shut-down for 2 hours per day (1 hp = 0.55 kW)

Energy Saved = Rate of Use x Reduction of Hours of Use

Energy Saved = kilo-Watts x Reduction of Hours of Use

= [20 HP x .55] x 2 x 170

= 3,740 KWH

Quantification – Boiler Run Time

Example of Savings from reduction of operating hours

- Assume 170 days per year, 100 heating-days per year

Boiler: Optimized start-up. Each of two boilers has a rated firing rate of 35 gph of oil. Save average 1.5 hours per day.

Energy Used = Rate of Use x Hours of Use

Energy Saved = Gallons/hour x Reduction of Hours of Use

Quantification – Boiler Run Time

Example of Savings from reduction of operating hours

- Assume 170 days per year, 100 heating-days per year

Boiler: Optimized start-up. Each of two boilers has a rated firing rate of 35 gph of oil. Save average 1.5 hours per day.

Assume that during heat-up the burner is at 100% firing rate.

Energy Saved = Gallons/hour x Reduction of Hours of Use

= 35 gph x 1.5 hr/day x 100 day/yr

= 5,250 gallons saved per year

Quantification – Boiler Run Time

Savings from reduction of operating hours

- Assume 170 days per year, 100 heating-days per year
- *What is Optimized shut-down time?*
- *Why is the energy savings from this harder to calculate?*

Quantification – Boiler Cycling Reduced

Example of Savings from improved equipment efficiency

Boiler Plant: Improve plant efficiency
Savings of 10% by reduction in cycling.
Plant uses 45,000 therms per year.

Energy Saved = % Saved x Original Energy Usage
= .10 x 45,000
= 4,500 therms saved / yr

This will also result in a 10% reduction in boiler run times (for electric motor savings).

Add motor savings per previous calculation.

Need to get motor HP and need to estimate run-hours per year.

Quantification – Heating Control Improved

Example of Savings from improved equipment efficiency

Heating Control: Improve heating control allows you to reduce temperature in **half of school** from average 80 dF to 74 dF. Use 1% savings per each 1 dF reduction in overheating. Plant uses 45,000 therms per year.

Energy Saved	= % Saved	x	Original Energy Usage
	= (80 - 74) x .01	x	45,000 x .5
	= 6 x .01	x	45,000 x .5
	= .06	x	22,500 therms

- *What impact on boiler run-times? Additional savings?*

Quantification – Multiple Measures

Be careful if you are doing multiple measures in the same system, say “heating” -- Measures can “interact” and lead to double-counting of savings.

Some examples -

- Combustion efficiency and cycling efficiency
- Boiler plant efficiency and steam traps
- Plant and trap efficiency and temperature reduction
- Plant efficiency and insulation

Discuss why this is so

Solution: “**Cascade**” the measures. Do calculation in sequence, reducing the calculation base each time.

Quantification - Cascading

Example of "**cascading**" of two energy saving measures

Building uses 74,000 therms of gas in its two boilers.
Improve average combustion efficiency to save **10%**
Improve fuel use 9% by replacing steam trap elements.

Burner adjustment: 10% x 74,000 =

.10 x 74,000 = 7400 therms / year

Steam Traps: .10 x (74,000 - 7400) =

.09 x 66,600 = 5,994 therms / year

Total Saving = 13,395 therms / year

Project - Workshop

Break into your groups-by-measure

Do we understand how to do the quantifications?

- > Pre (and post) measurements, KPI
- > Savings (energy reduction)
- > Costs

Everyone able to complete the project sheet?

Project - Workshop

RE-CONVENE FOR REPORT-BACK

Do we understand how to do the quantifications?

- > Savings (energy reduction)
- > Costs

Everyone able to complete the project sheet?

ANY LINGERING QUESTIONS, CONFUSION?

Announcement

If you came to class late, you are responsible for:

- Material from start of class, which will be on the exam
- Your name recorded in attendance

Break

Pop Quiz: Energy Audits

- What does ECM mean?
- In the case of burner replacement ECM discussed in class, what role must the operator play if the measure is going to save energy as projected?
- How are ECM's usually prioritized in the Summary of Recommendations?
- What is "Simple Payback"? How is it calculated?

More Practice with the Energy Audit Report

An audit provides a lighting schedule and a motor schedule that together add up to more than the actual electrical use reported by the audit.

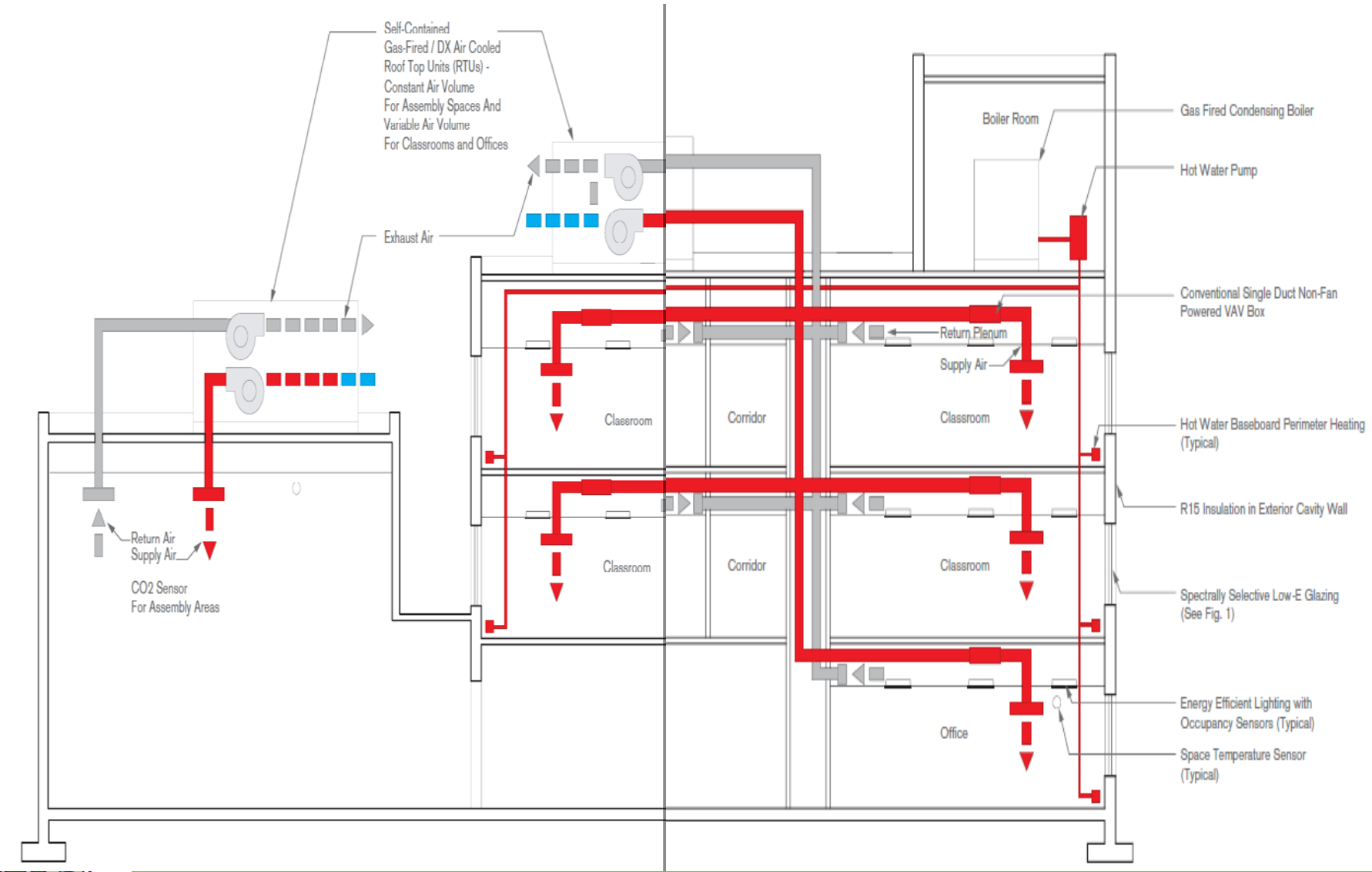
What do you make of this?

Where would you have had to look to notice this?

What are the most likely sources of error that could be causing this?

What implications for projected savings?

Commissioning - Cx



Retro-Commissioning (RCx)

You are operating a school that has a circulating hot water system for perimeter heating. The main header has 5 valves, each to a zone. What do you think/do in each of the following cases:

1. You notice that the balancing valves on all the loops are throttled down, varying from 50% to 70% closed.

2. The circulating hot water temperature is at 175 dF throughout the heating season. The setpoint is set from a computerized (digital) controller.

Retro-Commissioning (RCx)

Pump fixes

- right-size, replace
- trim impeller
- speed control
  - > Two-speed or three-speed motors
  - > Variable frequency drives

Same for fans, except replace “trim impeller” with “**pulley & sheave** speed reduction”

Retro-Commissioning (RCx)

You are operating a schools that has (rooftop) AHU with motorized dampers and belt-drive fan for heating and cooling. What do you think/do in each of the following cases:

1. One AHU's outlet (supply air) damper is manually set at 50%.
2. Outdoor air damper stays at minimum position when air-conditioning is required on a mild (65dF), dry day.
3. Outdoor air damper is 40% open (at more than minimum position) when heating is required.
4. During the building warm-up in the early morning (during pre-occupancy) what position should the OA dampers be in?

Retro-Commissioning (RCx)

- What kinds of investigation?
  - Data-loggers, for
    - Lighting hours
    - Other electric load hours - AC, computers
    - Motor loads. Motor hours. (Burner cycling, compressor)
    - Temperatures (room, refrigerators & freezers, hot water)
  - Tests
    - Combustion efficiency
    - Steam traps (radiator thermostatic, F&T)
- What kinds of measures?
  - Adjustments - especially of controls

Break

Quantification - Calc Methods Quiz

For a building with the following characteristics:

Boiler plant uses 68,000 therms per year. Two boilers, each rated 28 therms/hour, with15 HP motor on the burner fan. Average of their tested combustion efficiencies at 78%. Plant has poor cycling pattern - firing rate modulation not in use, poor lead-lag control.

How would you calculate…..

1. Combustion efficiency improvement
2. Reduction of cycling
3. Reduced operating hours (optimized start-up)

Quantification - Calc Methods Quiz

For previous building characteristics, plus

An after-school program in the gym for which boilers are left operating, heating the whole school. Entire school is open during regular school hours (8am - 4pm) (8 hours)

Only the Gym is open after hours (4pm - 8pm) M-F.
The Gym heating zone is 20% of the total school floor area.

How would you calculate…..

Manual zoning with the steam header valves

The improvement in your fireman's skill level and conscientiousness

PRICELESS. You are training the next generation of Facility leadership!!

Quantification - Calc Methods Quiz

For previous building characteristics plus

System imbalance and overheating.

You estimate that half of the building is at an average of 80 dF with observable window-opening.

How would you calculate…..

- Combination of system balancing and reduction of overheating

Quantification - KPI, Monitoring, M&V

What do these mean?

Why should we care?

How would we implement?

How will you know if your project is working?

- Energy savings - but "a lot of noise" in the data

Quantification - KPI, Monitoring, M&V

You want to address and reduce air leakage in your pneumatic control system.

How could you do this?

What would you measure before and after to check on your progress?

List some useful KPI for various other kinds of projects.

Project Workshop

Break into your original Peer Groups

Exchange project write-ups
Read each other's work and comment critically

- Is the project comprehensible – goal, conditions addressed?
- Are project impacts considered?
- Are steps and requirements impacts spelled out?
- Are quantifications well developed?

Project Workshop

Report back

- Discussion
- Questions?

Close

- **Complete your project and submit next week.**
  No reading assignment – Get your project done!

- **Bring calculator for the review session, Week 29**

- **Bring calculator for the exam, Week 30.**
  No cell phones or smart phones allowed.