SUSTN-103
Course

MILWAUKEE AREA TECHNICAL COLLEGE
TECHNICAL AND APPLIED SCIENCES (MATC/T&AS)

Sustainable Facilities Operations Program

SUSTN-103 Commissioning Process

National Science Foundation - National Center for Building Technician Education

Center for Energy Conservation & Advanced Manufacturing
ECAM
Milwaukee Area Technical College

BEST
Building Efficiency for a Sustainable Tomorrow

NSF

Course Documentation

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Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Technical and Applied Sciences Department
6665 South Howell Avenue
Oak Creek, WI 53154
Phone 414.571.4570

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Catalog description

This is an accelerated course that takes students through the commissioning process. This course explains the Commissioning (Cx) Process. Topics include the benefits of Cx and why it is important. Sample documents are developed by students. When complete, participants will have a thorough understanding of the Cx certifications. Course requires knowledge of building mechanical systems and good computer skills (word processing, Power Point, and spreadsheets).

Class hours

24 hours of lecture and 24 hours of self-directed research.

Self-directed research is part of each homework assignment, see sample in Appendix C.

Units

3 Credits

Entry skills needed

The following are required for admission to the course:

- A high school diploma or GED
- Demonstration of proficiency in basic skills through a course placement assessment
- Course requires computer skills in word processing, spreadsheets, and Power Point.

In addition, the potential for success in the program will be enhanced if students have:

- Work experience
- A strong interest in sustainability and facilities management
- Critical thinking and problem-solving skills
- And have organizational skills.

Syllabus

See Appendix A for sample syllabus with course schedule and policies.

Student learning outcomes

The exit skills listed in the next section support these three outcomes:

Commissioning Process

Student can discuss the commissioning process, list the four phases, list the four types, and list the benefits.

Commissioning Process Application

Student will be able to apply/perform the commissioning process on a building system including developing the OPR, BOD, functional performance testing, and developing the systems manual.

Commissioning For LEED

Student will be able to describe the portions of the LEED rating system which use commissioning and describe what parts of commissioning apply to LEED.

Exit skills

Course content to achieve student learning outcomes:

Student can list and describe each of the four phases of the Commissioning Process:

- Pre-design
- Design
- Construction
- Occupancy and Operations

Student can explain the owner project requirements (OPR):

- What it is meant to accomplish
- What type of language it is written in (lay-person)
- What is the process of developing the OPR
- Who should be involved with development
- When is it applied or used during the commissioning process

Student can explain the basis of design (BOD) including:

- Using the class project as an example.
- Describing what should be in a BOD.
- Stating the intended audience.

Student can explain the systems manual.

Student can design and perform a simple functional performance test including:

- Controls start up sequencing.
- Capacity check.

Student will be able to list and describe the four types of commissioning:

- New Construction, Cx
- Retro-Commissioning, RCx
- Re-commissioning, ReCx
- Continuous Commission, CCx

Student will be able to list the benefits of commissioning including:

- Systems performing as intended
- Lower energy use and cost
- Early detection of potential problems
- Better documented buildings
- Lower maintenance cost
- Improved maintainability of systems

Student can list at least five different building systems that can be part of a commissioning process.

Student can describe the prerequisites and credits of the LEED rating system that pertain to commissioning.

Student can list three of the various commissioning certifications and the associated certifying bodies.

Course materials

Principal text

None required

Lecture materials and handouts

Refer to Appendix B for an example

- Presentations (PowerPoint):
    - LP01a SUSTN103 Cx Introduction
    - LP01b BCA Introduction to LEED NC Building Commissioning
    - LP02a SUSTN103 Pre-Design Phase
    - LP02b SUSTN103 Cx OPR
    - LP02c SUSTN103 Cx OPR FA2013 Geothermal Heat Pump
    - LP03a SUSTN103 Design Phase
    - LP04 SUSTN103 Construction Phase
    - LP05 SUSTN103 Occupancy Phase
    - LP06a SUSTN103 Systems Manual
    - LP06b SUSTN103 Cx for LEED
    - LP07 SUSTN103 Project Functional Performance Testing Overview

Other reference materials

The Commissioning Process, ASHRAE Guideline 0-2005, ISSN 1049-894X

HVAC&R Technical Requirements for the Commissioning Process. ASHRAE Guideline 1.1-2007, ISSN1049-894X

Barber, K. (2008, April 22). OPR, BOD, Systems Manual – Expensive, Useless Encumbrances or Valuable, Cost Effective Tools – It's Up to You . . Retrieved May 17, 2014, from http://www.bcxa.org/ncbc/2008/docs/Barber.pdf

Oberlander, G. (2007, May 2). The Nuts and Bolts of the Commissioning Process. . Retrieved May 17, 2014, from http://www.bcxa.org/ncbc/2007/proceedings/Oberlander_NCBC2007.pdf

Heinz, J. A., & Casault, R. B. (2004). The building commissioning handbook (2nd ed.). Alexandria, Va.: Association of Higher Education Facilities Officers.

Software required

Access to computer with:

- Microsoft Office Programs (Word, Excel, PowerPoint, etc.).
- Adobe Reader (for pdfs). Price: Free. Source: www.adobe.com.
- Access to computer with internet access. (i.e. Internet Explorer, Mozilla Firefox, Safari, etc.).

Lab setup and materials

To demonstrate various aspects of the commissioning process a select piece of equipment is used for developing the project. What is typically used at MATC is the 5 ton geothermal heat pump system or a 7.5 ton roof top unit.

Ability to test operational parameters of the unit is necessary.

Equipment & instruments required

Temperature probes, electrical monitoring (kW, amps volts), and data logging equipment are used.

Assessment

Methods

25.0% Quizzes: Taken online in BlackBoard weekly
25.0% Homework:
25.0% Project
17.0% Presentation
8.0% Class Participation

Sample test questions

There are six quizzes for this course:

1. NCBC Paper Barber Kent
2. LP01 BCA Intro to Cx
3. LP02 Pre-Design Phase
4. LP02 OPR
5. LP03a Design Phase
6. LP04 Construction Phase part 1: ASHRAE Guideline 0-2005

Refer to Appendix D for an example

Sample of weekly assignments

There are six weekly assignments for this course

1. HW: Intro Read reference pdfs, develop outline of OPR and Systems Manuals, Develop questions for OPR workshop, Locate PDFs of project equipment O&M manual and Engineering Specifications.

2. HW: OPR - Owners Project Requirements Develop OPR for project.

3. HW Construction Check List for Our Project Use provided Construction Checklist files to modify for class project.

4. HW O&M Manual specific to installed unit Use the O&M manual found online for the project equipment and cross our or eliminate any of it that does not pertain to the class project (eg – manual has all sizes, our class project is only one size)

5. HW: FPT Modify the generic functional performance tests files provided to match the class project as discussed in class.

6. HW CV Filled out from "Site Visit" Up load or hand in a hard copy of the construction check list for the heat pump. Don't over think this, just fill out what you were able to verify.

Refer to Appendix C for an example

Project

None required.

Adaptability to on-line format

This course should not be delivered on-line due to required project work.

Currently the entire course is in BlackBoard online but taught in lecture / discussion /lab format. Test is online. All homework is available online.

Appendix A – Sample syllabus

Syllabus
Commissioning Process: For Sustainability & Energy Efficiency
SUSTN-103
Room E114b in ECAM Building

Instructor: Ted Wilinski **Phone: (414) 571-4570**
Office: E108 (ECAM Building) **E-mail: wilinskt@matc.edu**
Office Hours: Before class, ~4:30 PM to 5:45 PM typically in room E114b
If not in designated room, try office rm E108. Available other times, email to arrange an appointment.
Class Meetings: Tuesdays 05:45PM - 08:40PM, 1/30-12/18

Text - None specified

References
1 – The Commissioning Process, ASHRAE Guideline 0-2005, ISSN 1049-894X
2 – HVAC&R Technical Requirements for the Commissioning Process. ASHRAE Guideline 1.1-2007, ISSN1049-894X
3 – See links to web sites in Blackboard

Course Schedule On the following pages the lecture schedule is given. Please note that these are approximate and tentative dates. Every effort will be made to keep as closely to the schedule as possible. However, ***regular attendance and referring to Blackboard regularly*** will ensure that you are aware of any adjustments that may become necessary.

Week	Topic
Week 1 .....Tuesday, October 30	Course Overview BCA Introduction to LEED NC Building Commissioning Review Project Site
Week 2 .....Tuesday, November 6	Pre-Design Phase
Week 3 .....Tuesday, November 13	OPR Workshop
Week 4 .....Tuesday, November 20	Design Phase
Week 5 .....Tuesday, November 27	Construction Phase
Week 6 .....Tuesday, December 4	Functional Performance Testing
Week 7 .....Tuesday, December 11	Occupancy Phase
Week 8 .....Tuesday, December 18	Tying It All Together – Wrap Up / Presentations

*Schedule is only approximate and may vary somewhat depending on the progress of the class.
"ACCELERATED 24 PERIODS TO BE ASSIGNED" will be possibly Wednesday or Thursday evenings or Saturday mornings several weeks of the course. Students are strongly encouraged to attend the "To Be Assigned" sessions but it is also understood that not everyone will be able to so.

Credits
Three credits upon successful completion

Course Objectives "The Commissioning Process is a quality-oriented process for verifying and documenting that the performance of facilities, systems and assemblies meets defined objectives and criteria.." ASHRAE Guideline 1.1-2007. This course explains the Commissioning (Cx) Process. There will be discussions of what the benefits of Cx are and why it is important. The basics of the Cx Process will be discussed and sample documents developed by course participants. When complete, participants will have an understanding the Cx process.

Lectures Lectures will consist of the selected topics related to the course objectives. The lectures, resources, videos, students' presentations, and other reading material that may be recommended as the course progresses are complimentary to each other and will serve as guidelines for student's preparations.

Assignments Assignments are due the next class period unless otherwise specified. Late assignments will be given partial credit of 75% if handed in before the class period just after the due date, 50% thereafter, at Instructor's discretion.

Audit Report/Presentations Students are required to perform an energy audit, to write the report and to give a presentation on the audit. A sample audit report is provided on Blackboard as a reference. Specific sections of the sample report may be more or less detailed than the student will provide.

Testing The quizzes will be related to the material covered. Quizzes will include definitions, explanations, interpretations, translations, and problem-solving. Quizzes also include materials that have been discussed in the class including the contents of this syllabus. The students are expected to demonstrate their comprehension of the subject regardless of the number of questions and/or quiz formats.

Grading

Grading calculation

25.0% Quzzes
25.0% Homework
25.0% Projects
17.0% Presentation
8.0% Attendance
100.0% TOTAL

Note: sometimes during the course of a class portions of the course are adjusted. If for some reason this happens, the grading calculation could also be adjusted. For instance, if quizzes are dropped from the course, then the remaining categories will be adjusted to have the total equal 100%.

Grading scale

A for grades between 94% & 100%
A- for grades between 90% & less than 94%
B+ for grades between 87% & less than 90%
B for grades between 84% & less than 87%
B- for grades between 80% & less than 84%
C+ for grades between 77% & less than 80%
C for grades between 74% & less than 77%
C- for grades between 70% & less than 74%
D+ for grades between 67% & less than 70%
D for grades between 64% & less than 67%
D- for grades between 60% & less than 64%
U for grades less than 60%

Attendance

Attendance in the class as well as homework outside the class is vital to succeed in this course. You are responsible for attending all classes and completing all course requirements. Attendance will be taken on a daily basis. Students are expected to attend class regularly and to arrive on time. If you are absent, it is your responsibility to do the corresponding assignments. You may be dropped from the course for absenteeism. *Always email the instructor with reason for absence*. For drop procedures related to attendance, refer to the student hand book and student code of conduct – links in Blackboard, see "Syllabus"

General Policies

1. Attendance and Missing Work: Attendance is required. The student is responsible for obtaining missed material. Punctuality and class participation will reflect positively on your final grade. Conversely, truancy, tardiness and lethargy will reflect negatively on your final grade.
2. Instructor - Initiated Withdrawals (see also syllabus card): You may be dropped from the course for absenteeism:
    1. After two (2) consecutive absences from lecture.
    2. After a total of 7 hours of missed instruction from lecture.

You have the right to appeal a withdrawal by first discussing it with your instructor. If your instructor denies your appeal, a second appeal may be made with the Associate Dean. You have the right to remain in class during the appeal process unless your presence constitutes a safety hazard to yourself or anyone else.

3. Student - Initiated Withdrawal: Students may voluntarily withdraw from the course. The last day for doing this is two weeks before the end of the course. To withdraw from the course, a withdrawal form obtainable from the Liberal Arts and Sciences Office (M214) or the Registration and Records Office (S115) must be completed.

If according to current VTAE Board policy, the student is entitled to a refund, s/he is to be informed of this by Registration and Records personnel, who are available for help in preparation of the appropriate forms.

If withdrawal occurs after the mandated refund period, a final grade of "W" will appear on the student's official transcript and grade report. If the withdrawal occurs during the refund period, there is no official record of it.

Students who stop attending classes or do not turn up for the Final Exam without formally withdrawing or arranging for an incomplete grade will receive a "U" at the end of the semester.

ADA Statement : If you have a disability that impacts your classroom performance and wish to request accommodation, contact the Center for Special Needs at (414) 297-6838. They may require documentation regarding your disability to enable them to comply with your request. Admission of a disability is voluntary and will be handled in a confidential manner. MATC does not discriminate against individuals with disabilities and fully complies with the Americans with Disabilities Act. To ensure your academic success in this program, you are strongly encouraged to provide your instructor with a copy of the Instructor Notification Form from the Center. See link in Blackboard for Student Accommodation Services.

MATC Core Abilities: The Core Abilities are skills that allow students to continually adapt and learn. They have been called "employability skills," soft skills, and professional attributes. You may not be tested for all of the Core Abilities directly, but you will demonstrate or apply them to complete lessons or to improve skills. Those Core Abilities and indicators that you will be focusing on in this course are listed below.

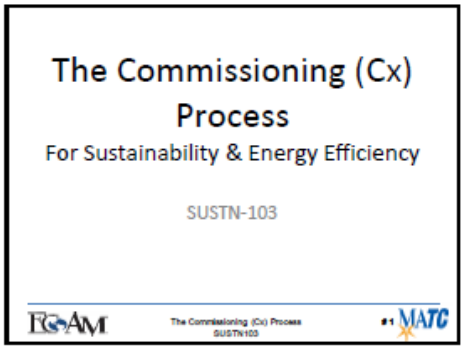
A. Communicate effectively.
B. Collaborate with others.
C. Respect diversity.
D. Demonstrate responsibility.
E. Think critically.
F. Utilize technology.
G. Apply math and science.

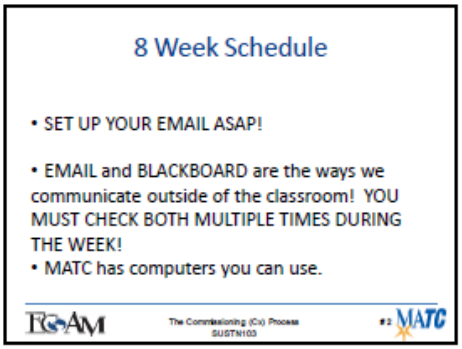
OTHER IMPORTANT INFORMATION:

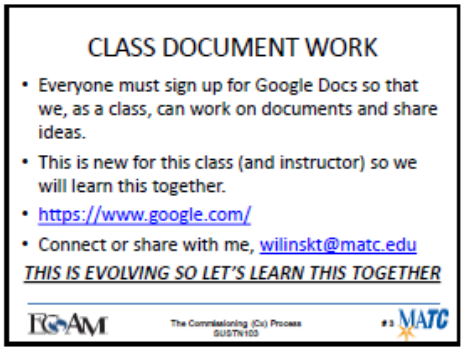
Please refer to the links in Blackboard under the "Syllabus" tab. Those links are:

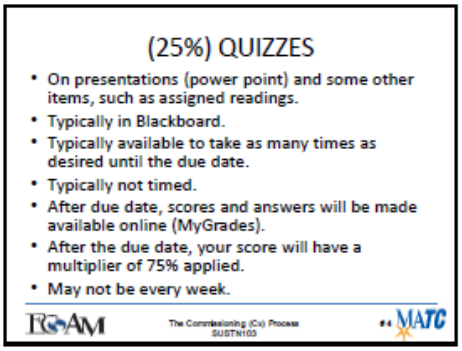
- Student Code of Conduct
- Student Accommodation Services
- Student Handbook

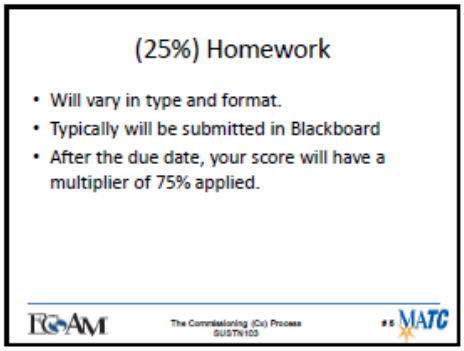
Appendix B – Sample Power Point

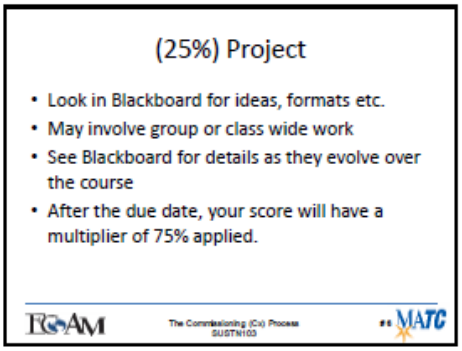












(25%) Project (continued)

- The project will be as a class. It will depend on what is selected for that semester.
- Since a new construction project is difficult to find and complete in such a short time frame, an installed piece of equipment will typically be used to demonstrate the various steps of the process.
- The first two, maybe three classes will involve establishing the scope of this project

(25%) Project (continued)

Potential goals of class projects:

- Establish the owners project requirements
- Write BODs
- Establish necessary training for operating personnel
- Drawings – Hard copy and electronic -
- Develop construction verification checklists (CVs)
- Fill out CVs
- PDFs -O&M, Installation, marketing, & other equipment literature
- Develop FPT(s)
- Conduct FPT(s)
- Develop systems manual(s) which include all of the above.

(17%) Presentation

- Keep checking on Blackboard and listening for updates in class because this will shape up as the course progresses.
- Everyone must listen to all presentations.
- Anyone who leaves early will be counted as absent that day, no excuses.
- After the presentation date, your score will have a multiplier of 75% applied.

(8%) Attendance

A big part of life is just showing up!

- Attendance will be taken every class period.
- If not present when taken, you will receive a zero for attendance that day.
- If you do come in late, instructor may note it and give half of the points for that day.

The Terms

- Cx – Commissioning, typically new construction
- RCx – Retro-Commissioning – the commissioning of existing buildings that have never been commissioned before
- CxA – Commissioning Authority
- EB-Cx – Same as RCx
- ReCx – The re-commissioning of buildings that have been commissioned in the past.
- OPR – Owner Project Requirements
- BOD – Basis Of Design

The Commissioning Process

- Quality assurance process
- Starts before design to insert owners needs for the facility
- Guides basis of design from architects and engineers
- Guides construction process so systems are installed and perform to owners needs

What it is not!

- Construction Administration!
- Not Construction Management!
- Not quality control for the contractors!
- Not system start up!

ASHRAE Definition:

"The Commissioning Process is a quality-oriented process for verifying and documenting that the performance of facilities, systems and assemblies meets defined objectives and criteria.."

ASHRAE Guideline 1.1-2007
American Society Of Heating, Refrigeration, and Air Conditioning Engineers

Building Commissioning Association (BCA)

"Building commissioning provides documented confirmation that building systems function according to criteria set forth in the project documents to satisfy the owner's operational needs. Commissioning existing systems may require developing new functional criteria to address the owner's current requirements for system performance."

- www.bca.org

BCA – Existing Buildings

"Commissioning for Existing Buildings (sometimes referred to as retro-commissioning) is a systematic process for investigating, analyzing, and optimizing the performance of building systems by improving their operation and maintenance to ensure their continued performance over time. This process helps make the building systems perform interactively to meet the owner's current facility requirements."

The Commissioning Process (cont)

- Minimizes post-occupancy problems
- Establishes testing protocols
- Assist with training of operators and facility staff

BCA Presentation

- Link to BCA Presentation

Appendix C – Sample Homework

HW: 01

Read the articles at the links below and complete the associated quiz in the (25%) Quizzes tab.
http://www.bcxa.org/ncbc/2008/docs/Barber.pdf

- Alternate link to a power point - http://www.bcxa.org/ncbc/2008/docs/Proceedings08/Barber_ppt.pdf
- http://www.bcxa.org/ncbc/2007/proceedings/Oberlander_NCBC2007.pdf

Project Owners Project Requirements (OPR) - Based on the readings, write a quick outline of what you think should be in the OPR for our class project. This is not to be lengthy, it is to be quick and bring to next week's class for discussion, as well as upload MSWord file here in Blackboard.

Project Systems Manual (SM) - Based on the readings, write a quick outline of what you think should be in the SM for our class project. This is not to be lengthy, it is to be quick and bring to next week's class for discussion, as well as upload MSWord file here in Blackboard. It can be as simple as listing items.

Write up questions that you would pose to the owner and others as part of the OPR Workshop for our class project.

Locate on the internet the PDFs of items listed below for the <project equipment> heat pump in E113 and in the submission area state what the model number means for this unit.

Installation, Operation and Maintenance manual
Engineering Specifications
Climate Master Tranquility 20, Earth Pure Single Stage,
Model #TSV060AGC30CLTS
Refrigerant - HFC410A

HW: OPR - Owners Project Requirements

Using the format as provided, develop an OPR for our limited project. Keep in mind that a new construction project normally would involve an entire building. However, we have limited time so we are focused on one system in room E113 - the geothermal heat pump which is a pre-designed, pre-installed system.

HW05 Construction Check List for Our Project

Attached Files:

- File Ground Source Heat Pump CV.pdf (57.427 KB)

- File CV-23 73 13 - Modular AHU Water to Air HP ECAM FA2013 Starting Point.doc (156.5 KB)
- File CV-23 21 13 - Ground Loop Pumps ECAM FA2013 Starting Point.doc (117.5 KB)

Everyone must make use a construction checklist for the project heat pump. The starting point is attached (Ground Source Heat Pump CV.pdf) but is a pdf and not able to be edited. To get a similar file in word, go to the state of WI web site in the WEB Links Tab at the left (under functional tests). You will have to download the zip file and look in the div 23 (mechanical systems) to find a similar format to cut and paste into from the pdf file.

This is due the night before next class.

This is due as part of the O&M Systems Manual.

NOTE: Fall 2012 files from class have been located. You can view the files under the Project tab, "GEOTHERMAL HEAT PUMP Fall 2012 files"

HW05b O&M Manual specific to installed unit

Attached Files:

- File Manual Front Pages.docx (108.136 KB)

Everyone must go through the O&M manuals found for HW01 and cross out all the data that is not applicable to our unit so it is easy to see what is specific to our unit.

You may want to download some PDF software to modify the documents. AutoDesk has a free software package for doing this. You can find it at: http://usa.autodesk.com/design-review/

You only need to do this to one of the manuals (see attached file):
INSTALLATION, OPERATION & MAINTENANCE
SUBMITTAL DATA manual

HW06: FPT

Attached Files:
File 2011 FPT-23 89 41 GSHP Heating Mode.docx (23.496 KB)
File 2011 FPT-23 89 41 GSHP Cooling Mode.docx (23.479 KB)
For our functional performance test you must get a FPT test form ready.

Some items to consider:
Think about the two sets of test we discussed, Heating Mode and Cooling Mode.
The performance parameters of the unit in heating and cooling mode are needed from the O&M manual

- COP (heating)
- EER (cooling)
- Air side test parameters:

- Temperature of the room (Tr),
- Temperature of discharge air (Td),
- Air Flow rate (cfm)

Testing for capacity so the rated capacity and conditions that is based on need to be found in the O&M manual.

BTH (btus per hour) = cfm x 1.1 x (Td - Tr) - Be prepared to calculate this during the testing on the last day.

Water side test parameters (well, actually a glycol mix, so properties will have to be determined - http://fluidh.com/documents/CIH-Taco3-CalcFlow---WEB-BILL.pdf):

Temperature of supply water (Tsw),
Temperature of return water (Trw),
Water Flow rate (gpm)
Testing for capacity so the rated capacity and conditions that is based on need to be found in the O&M manual
S.G. = specific gravity (this is a glycol solution so you need to track down the ratio and then determine S.G.)
S.H. = specific heat of the solution
BTH = gpm x 500 X S.G. X S.H. X (Tsw - Trw) - Be prepared to calculate this during the testing on the last day.
SH and SG => see if you can determine SH and SG needed based on what information is on the drawings and in the document url listed for this item, #4.
Electrical measurements - we need watts for COP and EER
COP = BTH / watts / 3.412
EER = BTH / watts
EER = COP x 3.412

Other items to consider:
How often and how many measurements should be taken?
Start test for heating or cooling mode first?
How will we determine when system is putting out maximum load? Start up? When stabilized?
Set up a spreadsheet for logging this data and doing the calculations

HW07 CV Filled out from "Site Visit"

Up load or hand in a hard copy of the construction check list for the heat pump. Don't over think this, just fill out what you were able to verify.

Homework #1

Commissioning Process: For Sustainability & Energy Efficiency

SUSTN-103-500A

1) Read the articles in the content area of Blackboard - Web Links that start with Wk#1 Reading

2) Find 5 separate OPR items online. Past links into word document.

Find and paste the link into Blackboard for 5 separate OPR items you found online. Ideally these are either sample OPRs or guidelines for writing. I will consolidate and post in Week two these sites for all to see - YOU MUST DO THIS ASSIGNMENT BY CLASS OF WEEK 2 to get credit!

3) Find 5 separate Systems Manual items you found online. Past links into word document

Find and paste the link into Blackboard for 5 separate Systems Manual items you found online. Ideally these are either sample System Manuals (or portions of) or guidelines for writing. YOU MUST DO THIS ASSIGNMENT BY CLASS OF WEEK 2 to get credit.

4) List at least 5 items for ECAM Geothermal System that should be included in the systems manual.

List out your items:

1.

2.

3.

4.

5.

5) PDF of Submittal Set for the heat pump in E113 and in the submission area state what the model number means for this unit. (note - this last item is not listing in the word doc below but is still required!)

Appendix D – Sample Quiz

SUSTN103 Cx OPR

True/False
Indicate whether the statement is true or false.

____ 1. ASHRAE Guideline 0-2005 "The Commissioning Process" defines the OPR as: "A written document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information."

____ 2. The OPR once defined and documented in the Pre-Design Phase cannot be changed.

____ 3. Information for the OPR can be gathered by interviewing building staff, conducting an OPR workshop, and surveying users.

____ 4. Does the OPR end up in the Systems Manual?

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 5. OPR is the acronym for:
a. Outside Priority Requirements
b. Owner Project Requirements
c. Owner Priority Requirements
d. Owner Priority Requests
e. Outside Project Requirements
f. Outside Project Requests

____ 6. The OPR should attempt to engage all stakeholders. Which of the following is not a stakeholder:
a. Owners
b. Operators
c. Occupants
d. People who have nothing to do with the building or process.

____ 7. Which statement about OPRs is false:
a. Can take on many different forms or formats
b. Generally goes from general information to specific
c. Listing of information is ok
d. Narratives are helpful to relay concepts
e. None of the these

____ 8. Who creates the OPR?
a. Users / Occupants
b. O&M Staff
c. CxA
d. Owner
e. Designers such as Architect, Engineer
f. All of these people

____ 9. Who typically would not be involved with the OPR workshop?
a. family members of occupants
b. owner
c. maintenance staff
d. none of these

Multiple Response
Identify one or more choices that best complete the statement or answer the question.

____ 10. The OPR:
a. Forms the basis from which all acceptance decisions should be made
b. Forms the basis from which all construction decisions should be made
c. Forms the basis from which all operational decisions should be made
d. Forms the basis from which all design decisions should be made

BEST Center Curricula, Resources & Recordings

Academic Programs
Georgia Piedmont Technical College - Building Automation Systems
Milwaukee Area Technical College - Sustainable Facilities Operations
Laney College - Commercial HVAC Systems
City College San Francisco - Commercial Building Energy Analysis & Audits

Professional Development Materials, Presentations & Videos
National Institutes
Building Automation Systems Instructor Workshops
Webinars (e.g., BEST Talks)

Faculty Profile Videos
Reports & Case Studies
Marketing Resources

BEST
Building Efficiency for a Sustainable Tomorrow

NSF National Science Foundation