BOC Exam Resource Guide

Section C - Perform Technical and Administrative Duties

Introduction

Section C of the exam covers the critical work functions for ***Perform Technical and Administrative Duties***. This resource guide is targeted to the content of the exam questions in this section of the exam. It is organized by topic area as noted in the Table of Contents. Each section provides the source of the citation, a link to where it can be found online, and a set of study questions about the content in the citation, followed by a paragraph or two of the material specific to the exam question. The study questions serve as guidance for independent study as candidates prepare for the exam. In addition to the study questions, the reading list provides practice questions and answers from the early versions of the certification exam. The study questions and practice questions are also covered in the BOC Exam Prep Webinar Series (http://www.theboc.info/certifications/exam/preparing-for-exam/). Additional resources are provided in the form of PDF documents which provide further discussion and useful illustrations, tables and figures. We recommend exam candidates familiarize themselves with the content and be prepared to answer the questions posed in each section.

Study Questions: These questions provide guidance for independent study of the topics in the Resource Guide. Study questions do not represent actual questions on the certification exam. Study questions appear under each citation in this document.

Practice Questions: These are questions that appeared on earlier versions of the certification exam and which have been retired from circulation. Practice questions are provided on the last page of this document.

Section C - Exam Blueprint Skill Areas and Number of Questions

- **Maintain records & reports and communicate with management, co-workers, & occupants (7 questions)**
  - Manage contracts with vendors and service providers.
  - Manage the work order process
  - Document work order results in a written or computer-based maintenance management system.
  - Manage building securities
- **Assist in occupant education and training (2 questions)**
  - Conduct tenant relations activities
  - Coordinate/conduct occupant training
- **Understand building codes (4 questions)**
  - Read as-built prints.
  - Update and revise as-built drawings.
  - Operate building systems to meet indoor environmental quality standards.

Table of Contents

Reading List

1. Recordkeeping, Data, Documents & Logs

HVAC Equipment

http://www.wbdg.org/om/om_manual.php; Hunt, Glen, post last updated 10/4/2013, System-Level O&M Manual Layout (HVAC), Comprehensive Facility Operation & Maintenance Manual, Whole Building Design Guide (WBDG) a program of the National Institute of Building Sciences

STUDY QUESTIONS: What documentation is important to include in the HVAC Heating, Ventilating & Air Conditioning (HVAC) section of an O&M Manual?

ANSWER: **Heating, Ventilating & Air Conditioning (HVAC)***:* O&M of the building's HVAC systems, including automated controls and exhaust, space heating, and central air systems. System level description, operating procedures, typical problems, PM procedures.

O&M Manual Layout and Contents

O&M Manuals provide procedures to operate and maintain a facility's various systems and equipment. It is important to analyze and evaluate a facility from the system level, then develop procedures to attain the most efficient systems integration, based on as-built information and the Maintenance Program philosophy. The following paragraphs provide an example of system-level O&M Manual layout and technical content/description that can be successfully applied to many facility types.

System-Level O&M Manual Layout

1. **Introduction**: Introduces the reader to the facility. Outlines the structure, content, how to use the manual, and includes a brief outline of the various systems covered. In addition, this chapter contains a list of emergency contacts and a list of supplementary material available on the facility such as:
    - Design/Construction Specifications
    - Submittals File
    - Completion Report
    - As-built Drawings
    - Materials List
    - Certified Tests and Reports
    - Civil/Sanitary
    - Mechanical/HVAC
    - Electrical
2. **Safety Data**: Safety hazards commonly associated with the operation of system/equipment applicable to the facility are identified and their prevention is discussed.
3. **Utility Systems**: Discusses the various site utility systems that interface with the facility. These include water supply systems, sanitary waste, electrical, natural gas, communications, security, and storm water, etc.
4. **Building Interior & Exterior**: Includes housekeeping and general maintenance of the facility. The importance of conducting an annual inspection is discussed together with record keeping forms for conducting the inspections.
5. **Plumbing**: O&M of the domestic water and sanitary waste systems.
6. **Fire Protection**: O&M of the fire protection wet/dry pipe sprinkler systems.
7. **Heating, Ventilating & Air Conditioning (HVAC)**: O&M of the building's HVAC systems, including automated controls and exhaust, space heating, and central air systems.

8. **Fire Detection & Intrusion Alarms**: O&M of fire detection, intrusion detection, and alarm systems (wet/dry pipe sprinkler).
9. **Electrical**: O&M of power distribution equipment and backup/emergency electrical systems (uninterruptible power supply, generator).
10. **Conveying Systems**: General information and preventive maintenance for elevators, escalators, wheel chair lifts, conveyors, etc.
11. **Other Systems Based on Facility Requirements**: General information and preventive maintenance requirements for other systems and equipment not already identified.
12. **Operating Logs**: General information and instructions for using maintenance log forms. A listing of maintenance tasks with their recommended frequencies of performance is included.
13. **Maintenance Charts**: Maintenance charts include maintenance frequency checklists, maintenance summary, lamp replacement data sheet, equipment data sheets, recommended maintenance and service contacts, and a recommended work order form.
14. **Manufacturers' Literature**: Identifies manuals, cut sheets, etc., from equipment manufacturers that amplify information provided within the system-level O&M manual. Manufacturers' literature generally provides procedures to operate, maintain, troubleshoot, and repair specific items at the equipment level. This information is contained in a separate volume of binders, identified by facility/system, for easy reference. Specific material or complete documents can also be electronically scanned for its 'on-line' use, such as linking from the system-level manual.

System-Level O&M Manual Technical Content/Description

1. **Description - System-Level**: Description of the system and its purpose, how it operates, and any interfaces it may have. A table can provide overall system design criteria, i.e. flow, pressure, temperature, capacity, power requirements, etc.
2. **Operating Procedures - Controls/Start-up/Shutdown/Emergency Over-Ride/Seasonal Changeover**: Operating instructions include equipment configurations for each mode of operation, e.g. valve positions, control settings, intended operating strategies, and break-in procedures.
3. **Problems and Solutions - Troubleshooting**: System-level troubleshooting tables guide maintenance personnel, via fault tree analysis, in a sequential, step-by-step isolation of a system problem to identify faulty equipment. Typical malfunctions, tests, or inspections, and corrective actions or recommendations to correct malfunctions are included.
4. **Preventive (Planned) Maintenance (PM) - Procedures/Intervals**: Maintenance tasks are developed for equipment that comprises the system. Preventive and corrective maintenance are discussed. Scheduled intervals (e.g., daily, weekly, monthly, etc.) are determined and assigned to PM tasks to maximize systems' run time, thereby reducing corrective maintenance tasks.

Refrigerant Leak Detection

https://www.rsdtotalcontrol.com/fx/pdf/Mechanical_Room_Guidelines.pdf

STUDY QUESTIONS: ASHRAE Standard 15-2004 provides guidance for refrigerant leak monitoring and detection.

Q1. What are the requirements under this standard?

Q2. Why is refrigerant leak detection important?

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http://www.epa.gov/ozone/science/myths/heavier.html

STUDY QUESTIONS:

Name two important areas that management of refrigeration emissions addresses.

What EPA regulation covers recordkeeping requirements for managing stationary refrigeration systems?

Heavier-Than-Air CFCs

CFCs and other ozone-depleting substances reach the stratosphere despite the fact that they are "heavier than air." For example, molecules of CFC-11 (CCl_3F) and CFC-12 (CCl_2F_2) are approximately 4–5 times heavier than the average molecule of air, since air is composed primarily of oxygen and nitrogen. The emissions of long-lived gases accumulate in the lower atmosphere (troposphere). The distribution of these gases in the troposphere and stratosphere is not controlled by the molecular weight of each gas because air is in continual motion in these regions as a result of winds and convection. Continual air motions ensure that new emissions of long-lived gases are horizontally and vertically well mixed throughout the troposphere within a few months. It is this well-mixed air that enters the lower stratosphere from upward air motions in tropical regions, bringing with it ozone-depleting substances emitted from any location on Earth's surface.

Atmospheric measurements confirm that ozone-depleting substances with long atmospheric lifetimes are well mixed in the troposphere and are present in the stratosphere (see Figure Q8-2). The amounts found in these regions are generally consistent with the emission estimates reported by industries and governments. Measurements also show that gases that are "lighter than air,"

such as hydrogen (H2) and methane (CH4), are also well mixed in the troposphere, as expected, and not found only in the upper atmosphere. Noble gases from very light helium to very heavy xenon, which all have very long atmospheric lifetimes, are also uniformly distributed throughout the troposphere and stratosphere. Only at altitudes well above the troposphere and stratosphere (above 85 kilometers (53 miles)), where much less air is present, does the influence of winds and convection diminish to the point where heavy gases begin to separate from lighter gases as a result of gravity.

Managing Refrigerant Emissions

Many refrigerants that are commonly used in refrigeration and air conditioning systems are ozone-depleting substances (ODS). Managing refrigerant emissions is an important strategy for addressing ozone layer depletion and protecting human health and the environment.

- Learn more about managing refrigerant emissions from stationary refrigeration and air conditioning systems here. Resources specific to managing refrigerant emissions from supermarket refrigeration systems are available through EPA's GreenChill Program.
- Learn more about managing refrigerant emissions from motor vehicle air-conditioning systems.
- Learn more about preventing ODS emissions by recovering refrigerant from old refrigerators, freezers, window air conditioners, and dehumidifiers through EPA's Responsible Appliance Disposal Program.
- EPA regulations (40 CFR Part 82, Subpart F) under Section 608 of the Clean Air Act include recordkeeping requirements that are specific to different persons or companies involved with stationary refrigeration and air-conditioning equipment. This page provides a brief overview of these requirements.

http://www.taylor-engineering.com/downloads/articles/HPAC%20Operable%20Windows%20-%20Daly.pdf; Allan Daly, P.E., 12/2002, Operable Windows and HVAC Systems

See PDF.

STUDY QUESTIONS:

What do you call an HVAC operation that integrates the building HVAC system with operable windows?

_____

Answer: Mixed mode operation.

Lighting Systems

http://www.gelighting.com/LightingWeb/na/images/GE2019-0852_LightSweep_Installation_Guide_tcm201-23272.pdf (page 8)

http://www.diffen.com/difference/Fluorescent_Bulbs_vs_Incandescent_Bulbs; Fluorescent (CFL) vs. Incandescent Bulbs, Diffen.

STUDY QUESTIONS:

What is the difference between a bulb and lamp?

_____

What four characteristics are commonly used to describe fluorescent bulbs?

_____

The letters A and R for incandescent lamps represent what?

_____

What document is referenced to figure out which relay controls specific areas in a centralized lighting control panel?

_____

Answer: Relay schedule.

There are different types of incandescent light bulbs that are available in the market and decorative lamps are perhaps the most commonly found lamps in use today. General Service lamps are either clear or frosted and high wattage general service lamps are of power 200 watts or greater. Reflector lamps help direct the light forward and are used in flood lights and spot type lamps. Examples of incandescent bulbs include PAR45 and A55. The letters (*A* and *R*) represent the shape, whereas the numbers represent the maximum diameter of the bulb. The diameter is measured in inches and is usually available in increments of 1/8th of the original size. 'A' is used to denote the standard pear shaped bulb while 'R' is used to define Reflectors.

A fluorescent light bulb is usually described by its power consumption, longevity, color of light they emit and other illuminating characteristics such as brightness. There are various types of fluorescent light bulbs like:

- the tanning bulbs that are used to induce artificial tanning.
- Grow lamps also incorporate fluorescent light and are used to encourage photosynthesis and growth in plants.

- The light has also found use in medical treatments with bilirubin lamps that aid in breaking up excess bilirubin in the body. In addition, germicidal lamps are used to kill germs present in the body.

The incandescent bulb is filled with argon to reduce evaporation and a filament of tungsten is wired inside the bulb. Electric current is made to pass through this filament which is connected to two contact wires and a conductor. The base of the bulb has a stem or glass mount anchored to it which allows for the smooth flow of the electrical current, that in turn generates visible light.

The fluorescent light bulb is filled with argon, krypton, neon or xenon and low pressure mercury vapor. The inside of the tube is then coated with various blends of metallic and rare earth phosphor salts. The cathode tube in the bulb is made of tungsten and is coated with barium, strontium and calcium oxides and evaporation of the organic solvents is allowed, after which the tube is heated in order to fuse the coating to the lamps.

Motor & VFD Management

http://www.copper.org/environment/sustainable-energy/electric-motors/case-studies/a6141.html
See PDF

STUDY QUESTIONS:

What is a motor management plan and who would benefit from having access to it?

_____

What data should be recorded in a motor inventory?

_____

What is a repair replace policy?

_____

http://www.ceati.com/freepublications/7025_guide_web.pdf; Scott Rouse and Dan Dederer, pages 7-9, Variable Frequency Drives Energy Efficiency Reference Guide, 2009 CEATI International

See PDF pages 7-9.

STUDY QUESTIONS:

Beyond energy savings, what additional benefits might a VFD provide?

_____

In a constant HP load condition, how might a VFD be applied to achieve energy savings?

_____

How much power is reduced in a motor when its speed is reduced?

_____

Answer: The cube of the speed according to the chart on page 8.

Roof Maintenance

http://www.certainteed.com/resources/Comm046RoofMaintenanceProgram.pdf

See PDF.

STUDY QUESTIONS:

What are the components of a roof system?

_____

How frequently should the roof system be inspected?

_____

What information should be recorded during an inspection?

_____

When might a roof inspection be necessary outside of the routine maintenance schedule?

_____

What is the minimum frequency that roofs should be inspected? Answer 2X a year.

_____

What should building owners maintain records and logs of as part of roof maintenance program?

_____

Answer: Maintenance procedures and roof access and activity.

Energy Consumption & Benchmarking

https://www.trendcontrols.com/en-GB/Documents/Trend_Energy_Manager_single%20_page_layout.pdf

Trend Energy Manager, Trend Control Systems Limited

STUDY QUESTIONS:

What reports are valuable for managing energy consumption and costs through an automated BMS?

A Building Energy Management System provides a highly efficient means of monitoring and controlling the environment and energy usage within a building.

REPORT AND MONITOR

Reports are generated for the purposes of monitoring energy usage and costs, and monitoring energy wastage based on forecasted usage against actual usage. Depending on your requirements, there is an option to drill down into the detail or display a summarized view, which can be printed or download as a CSV file.

ANALYSE AND IMPROVE

The analysis feature incorporates tools that take degree day and energy consumption data to form regression analysis and Cumulative Sum of the difference graphs (CUSUM); very useful for revealing trends in the performance, as well as showing the effect of changesto a building or its heating, ventilation and air conditioning (HVAC) plant, and the impact of energy saving measures. They also provide the information needed to set energy budgets. For example, you may choose to:

- Display energy performance against degree days from a previous period and compare with current performance *(fig. 5 & 6)* on a like for like basis, removing external variables such as
- outside temperature.
- Compare current energy consumption against a benchmark value to highlight areas of poor performance. *(fig. 7)*
- Plot heating and cooling consumption against outside air temperatures *(fig. 8)* to gain a better understanding of the relationship with external factors.

Energy Units of Measure

http://www.eia.gov/tools/faqs/faq.cfm?id=45&t=8; Frequently Asked Questions, U.S. Energy Information Administration – Independent Statistics & Analysis, Department of Energy, post last updated 3/30/2015

STUDY QUESTIONS:

What are Ccf, Mcf, Btu, and therms?

_____

How do I convert natural gas prices in dollars per Ccf or Mcf to dollars per Btu or therms?

_____

What are Ccf, Mcf, Btu, and therms? How do I convert natural gas prices in dollars per Ccf or Mcf to dollars per Btu or therm?

Btu—British thermal unit(s)
Ccf—the volume of 100 cubic feet (cf)
M—one thousand (1,000)
MM—one million (1,000,000)
Mcf—the volume of 1,000 cubic feet
MMBtu—1,000,000 British thermal units
Therm—One therm equals 100,000 Btu, or 0.10 MMBtu

- Natural gas may be priced in units of dollars per therm or dollars per cubic feet. The heat content of natural gas per physical unit (such as per cubic foot in the United States) is needed to convert these prices from one price basis to another. In 2016, the U.S. annual average heat content of natural gas for the residential, commercial, industrial, and transportation sectors was about 1,037 Btu per cubic foot. Therefore, 100 cubic feet (Ccf) of natural gas equals 103,700 Btu or 1.037 therms. One thousand cubic feet (Mcf) of natural gas equals 1.037 million Btu (MMBtu), 10.37 therms.
- You can convert natural gas prices from one price basis to another with these formulas (assuming a heat content of natural gas of 1,037 Btu per cubic foot):
  $ per Ccf divided by 1.037 equals $ per therm
  $ per therm multiplied by 1.037 equals $ per Ccf
  $ per Mcf divided by 1.037 equals $ per MMBtu
  $ per Mcf divided by 10.37 equals $ per therm
  $ per MMBtu multiplied by 1.037 equals $ per Mcf
  $ per therm multiplied by 10.37 equals $ per Mcf
- The heat content of natural gas may vary by location and by type of natural gas consumer, and it may vary over time. Consumers and analysts should contact natural gas

distribution companies or natural gas suppliers for information on the heat content of the natural gas that they supply to their customers. Some natural gas distribution companies or utilities may provide this information on customers' bills.

Understanding Demand & Consumption

http://www.think-energy.net/KWvsKWH.htm,

STUDY QUESTIONS:

What is the difference between electricity demand and electricity consumption?

_____

What are some ways a commercial building owner manage demand charges to minimize costs?

_____

How does this differ from managing consumption charges?

_____

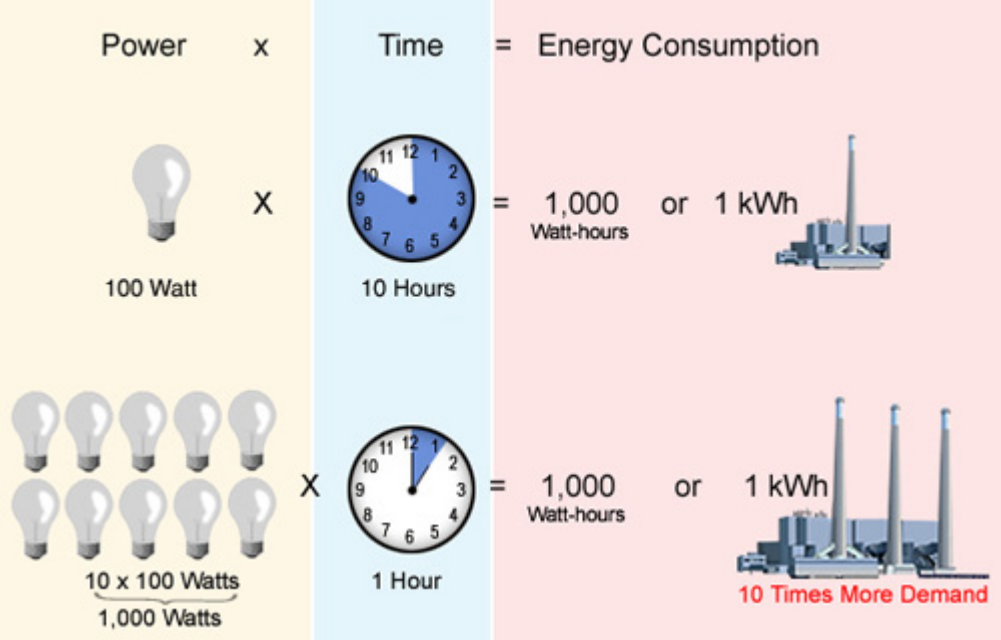
Understanding Demand and Consumption

Demand = KW

Consumption = KWH

The difference between demand (KW) and consumption (KWH) is vital to your choices in reducing your energy costs. A simple way to see the difference between demand and consumption is by considering two examples.

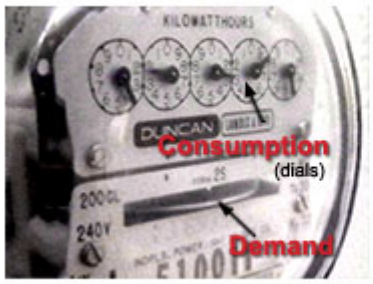
LIGHTING EXAMPLE: One 100-watt light bulb burning for 10 hours consumes 1,000 watt-hours or 1 kWh. The entire time it is on, it requires or "demands" 100 watts or 0.1 kW from the utility. That means the utility must have that 0.1 kW ready whenever the customer turns the lamp on.



Similarly, ten 100-watt light bulbs burning for 1 hour consume 1,000 watt-hours or 1 kWh. Note that in both examples, the **consumption is 1 kWh**, however, look how differently the second situation impacts the utility from a demand perspective. The serving utility must now be prepared to provide **ten times as much 'capacity'** in response to the "demand" of the 10 light bulbs operating all at once.

If both of these customers are billed for their consumption only, both will get the same bill for 1 kWh of energy. And that is the way most residential customers are billed. But the requirement for the utility to meet this energy requirement is very different. In the second case, the utility has to have **10 times** more generating 'capacity' to provide the second customer's brief high demand for power compared to the first case.

- Commercial and industrial customers are often billed for their hourly consumption patterns ***and*** their peak demand for energy. These customers often have special meters that measure both, unlike residential meters that just record total consumption in a time period, usually one month.



Residential Electric Meter

Commercial Electric Meter

So, you might ask, "why doesn't the utility bill all customers for demand and consumption?" Seems like that is only fair. And it would be, but the fact is that most homes have a pretty similar demand profile and the meters capable of measuring both demand and consumption are much more expensive. Far too expensive to justify having one on every home. So all most residential customers need to be concerned with now is consumption billing. As the cost of metering drops, and as automatic metering advances, we may see increased use of demand billing for homes.

ENERGY STAR and Energy Benchmarking (3 references)

http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager Energy Star Portfolio Manager website

http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/understand-metrics/what-energy Defining Energy Use Intensity (EUI)

STUDY QUESTIONS:

What is ENERGY STAR Portfolio Manager?

_____

Can it be used to manage energy and water for any type of commercial building?

_____

What is an energy use intensity (EUI)?

_____

What is the unit of measure for an EUI?

_____

What data inputs are needed for Portfolio Manager to generate an EUI?

What does a low EUI indicate?

What is the difference between an EUI and an ENERGY STAR energy benchmark score for a building?

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http://aceee.org/files/proceedings/1996/data/papers/SS96_Panel4_Paper33.pdf; Terry Sharp (Oak Ridge National Lab), Energy Benchmarking in Commercial Office Buildings

STUDY QUESTIONS:

What is the Commercial Buildings Energy Consumption Survey (CBECS)?

What primary factors, in addition to square footage, influence the energy use intensity of a building?

What factors don't have impact on EUI?

Energy Benchmarking In Commercial Office Buildings

Office buildings must be improved to make major gains in reducing U.S. building energy use. Energy benchmarking offers initial building energy performance assessment without rigorous evaluation. ''Seeing'' that building energy use is excessive, is the first step to change. Energy benchmarks based on the Commercial Buildings Energy Consumption Survey (CBECS) are investigated in support of the U.S. Department of Energy's Energy Partnerships program.

The 1992 CBECS database is used to develop distributions of electric energy use intensities (EUIs) in office buildings for the nine U.S. census divisions. Individual building EUIs can be compared to these distributions as an indication of building energy performance. Median EUIs are less sensitive to individual building EUIs when groups of buildings are benchmarked to one another or to census division statistics. Excessive individual EUIs (exceeding 100 kWh/sqft) strongly influence averages in the CBECS database and in local sampling. Based on limited comparisons, however, both census division average and median EUIs are not reliable indicators for more localized EUIs.

Stepwise linear regression modeling was used to identify the strongest determinants of office building energy use intensities. Statistically significant relations were found between building EUIs and several CBECS variables. Beyond floor area, the most dominant variables were the number of workers, number of personal computers, owner-occupancy, operating hours, and the presence of an economizer or chiller. The resulting performance models can be used to predict EUIs that are much better benchmarks than simple census division statistics.

Preventive & Predictive Maintenance Programs

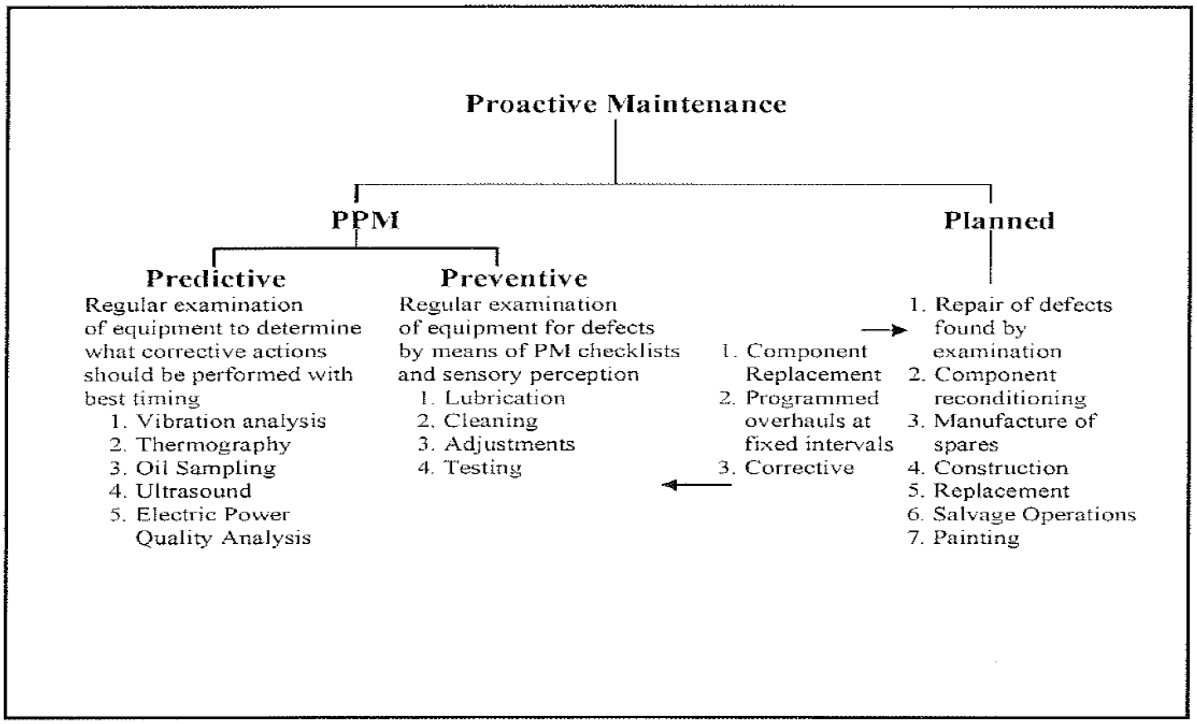
http://www.lce.com/pdfs/The-PMPdM-Program-124.pdf; page 4-6 (700ZB00102), Classification of Maintenance Work, Preventative and Predictive Maintenance

STUDY QUESTIONS:

Name three types of Proactive Maintenance.

What three phases are required for an effective PPM program?

Classification of Maintenance Work



1. A beginning—Start Preventive & Predictive Maintenance (PPM) practices immediately if you expect to establish an efficient operating system. One that delivers high quality output, on time, every time.
    A. Start small
    B. Sell expansion upon early successes
    C. Therefore select your early efforts wisely
    D. Applied A-B-C analysis to selection of equipment
2. Focus On the Correction as well as The Inspection
    A. Inspection Is The Investment
    B. Correction Is The Return On The Investment
3. Management Follow-upPPM Increases
    A. Maintenance staffing
    B. Repair parts costs
        - Preventive tends to increase parts cost
        - Predictive reduces parts cost
    C. Volume of work that can be planned and scheduled repetitively
    D. Work load leveling
    E. Equipment reliability and uptime

http://www.wwu.edu/fm/Metrics/index.shtml; Measuring FM Services, Facilities Management, Western Washington University, post updated 4/15/2015

EXAMPLE of PM Program Metrics:

Preventive Maintenance Program Metrics, Benchmarks and Reporting:

- Data analysis and reporting of all aspects of the preventive maintenance program and various maintenance issues
- Failure analysis and program improvement
- Benchmark program performance against unplanned outages and failures

Facilities Fast Facts

• Facilities Management has 180 Full-Time Employees.
• Western's Campus utilizes 125 Buildings encompassing 3,445,000 Gross Square Feet on 2,642 Total Acres across all of its campuses.
• Western's Infrastructure consists of 6.3 miles of Roads, 59.5 miles of Utilities, 3.1 miles of Tunnels, 24 acres of Sidewalks and Plazas.
• Western's annual energy consumption is 308,090 Million British Thermal Units (MMBTU) on Main Campus, 18,910 MMBTU for Off Campus sites, equaling 327,000 MMBTU total consumption.

Recordkeeping in CMMS

http://www.maintenanceassistant.com/cmms/

STUDY QUESTIONS:

What are six common task functions within a typical CMMS system?

CMMS stands for "computerized maintenance management system". A CMMS is software that helps maintenance teams keep a record of all assets they are responsible for, schedule and track maintenance tasks, and keep a historical record of work they perform.

2 - Communication with Management & Occupants

Building Data Dashboards

http://www.luciddesigngroup.com/; 2004-2015 Lucid

STUDY QUESTIONS:

What information about the building is important to share with occupants?

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http://www.workaci.com/sites/default/files/product_instruction/RSOseperateInput.pdf; page 1 of 2, version1.0 (10000122), Installation and Operation Instructions, Automation Components, Inc. (ACI)

STUDY QUESTIONS:

Which temperature sensors may be useful information for building occupants?

Answer – Room and Outside temperature sensors.

Green Leases

http://www.greenbiz.com/blog/2012/06/22/busting-landlord-tenant-barriers-greater-energy-efficiency; Roy Torbert, 6/22/2012, Busting Landlord-Tenant Barriers for Greater Energy Efficiency, posted to GreenBiz

STUDY QUESTIONS:

What is a green lease?

A split-incentive is one of the barriers to improving energy efficiency in tenant-occupied buildings – what is a split incentive?

What lease structure is likely to cause a split incentive?

List examples of how this barrier might be addressed between the tenant and landlord.

Busting Landlord-Tenant Barriers for Greater Energy Efficiency

To date, conversations around energy efficiency between landlords and tenants have largely revolved around the fact that landlords must pay for upgrades, but tenants receive the immediate benefits. Though some upgraded buildings perform well with both parties reaping the benefits of more efficient spaces, the availability of new technologies and processes doesn't always result in the implementation of energy efficient strategies -- even where there is a clear positive return on investment and a short payback period.

The conflict between landlords and tenants stemming from “split incentives” to install upgrades has been identified as one of the top barriers to capturing energy savings in buildings, according to an indicator survey published by the Institute for Building Efficiency in 2012. Consequently, leased space has historically lagged behind owner-occupied buildings in pursuing energy efficiency. “Energy efficiency retrofits will be most successfully implemented when the building owner, manager, and tenants work together as partners in the project, and have a shared sustainability goal for the building,” said Karen Penafiel, a vice president with Building Owners and Managers Association International (BOMA).

The most common split incentive issue results from the structure of commercial leases which make the building owner responsible for bearing the cost of all capital upgrades. Energy costs and routine operating expenses are paid by the tenants.

In other words, the owner makes the capital investment to improve the building and the tenant is the sole beneficiary of reduced operating expenses. And if a lease instead makes the owner responsible for all energy costs, tenants have no incentive to reduce their consumption.

But even leased buildings projects can reach major energy savings and increase building value. The Empire State Building, for example, recently completed a deep energy retrofit saving 38 percent of pre-retrofit energy with a three-year payback. Without tenant participation in the program such as saving lighting and plug load energy, the upgrade would not have succeeded. The energy components of the retrofit even attracted new tenants (such as LinkedIn) and supported retention.

Green leases and beyond

Codified by National Resource Defense Council's Energy Aligned Lease Language, green leases also help to overcome the split incentives barrier by sharing the costs of energy efficiency projects between the owner and the tenant. The document requires a more accurate matching of costs to financial benefits.

However, a green lease is not an entirely sufficient solution. A key principle in behavioral economics is that people are motivated not just by money. Other rewards spur them to act as well. When owners, tenants, and even occupants aim for collaborative participation in sustainability programs, the missing ingredient that can be the key to bring them together is something as simple as congregating over free donuts and coffee.

RMI and BOMA hypothesize that the human element of energy savings has been underemphasized, and increasing the collaboration between building owners and tenants can help accelerate adoption of efficiency improvements. In October 2011, the organizations convened a workshop to tackle this very issue. "Energy efficiency in an office environment must be a collaborative process," said Penafiel. "BOMA, RMI and the workshop participants were excited to explore the topic of collaboration, as often the barriers to energy efficiency are neither financial nor technological."

5 best practices for owner and tenant collaboration

The result: A five-step guide that reveals best practices for owner and tenant collaboration to promote sustainability in buildings.

1. Make energy use and costs more transparent

Although collecting data has a cost, that cost has steadily decreased as utilities governments, and technology solutions make a greater amount of data more accessible. Owners and tenants should access and share data, and then structure their relationship around the building's underlying energy performance.

2. Engage building occupants in saving energy

Occupants control a large (and growing) share of the energy consumption of a building, yet their schedules, equipment use, and attitudes are rarely considered in energy efficiency efforts. Some

studies have found 10 percent savings simply from informing tenants of their energy use. Holding competitions or organizing community–based programs can reap even larger savings. Councils such as Jones Lang LaSalle's use of Tenant Sustainability Boards of Directors allow tenant organizations and occupants to find new efficiency opportunities or multi-tenant programs.

3. Incorporate energy efficiency in tenant fit-outs

Owners and tenants can shape the process of finding and customizing a leased space by using green letters of intent and creating plans for efficient tenant fit-outs. Using a sustainability focused third party can also help improve negotiations between both parties early in the process.

4. Plan ahead for deep energy retrofits

Deep energy retrofits achieve bigger energy savings (sometimes over 50 percent reductions) at similar cost. They drive much larger savings than conventional retrofits, create value for both the owner and the tenant and are most cost-effective when implemented at the right time. Triggers such as a major tenant turnover or major equipment replacement allow deep retrofit practitioners to find cost-effective solutions for the entire building. This approach requires greater upfront investment in design, analysis, and communication between owner and tenants, but delivers much greater energy savings and other non-energy benefits.

5. Structure agreements to benefit both parties

The RMI/BOMA Guide provides guidance on working together to create an effective green lease. Owners and tenants can use basic principles for sustainability (provided by BOMA's Green Lease Guide) in a new green lease, an amendment to an existing lease, or a separate letter agreement.

Many of the mechanisms RMI and BOMA determined as key to creating a collaborative and effective environment involve a tactic Dan Ariely, a Duke professor of behavioral economics. Ariely calls this dynamic "reward substitution." Reward substitution involves using incentives -- even small or unrelated rewards -- to drive participation in efforts that don't always inspire action due to being more beneficial to society over the individual.

Sustainability competitions, building scorecards, benchmarking, and other mechanisms create additional and compelling reasons for owners and tenants to improve their building's energy performance. One example is of a tenant sustainability council that couldn't get any involvement from building occupants — until they started providing free coffee and donuts.

Getting people excited and on the same page helps get efficiency programs implemented correctly. With the proper approach, deep savings and untapped value are available for both owners and tenants.

Learn more about overcoming the split incentives barrier by downloading the RMI-BOMA Guide at the RetroFit Depot.

Occupant Education Program

http://www.theguardian.com/sustainable-business/blog/promoting-sustainable-behaviour-clever; 10/30/2012, Adam Corner, Promoting Sustainable Behavior Means More than Clever Slogans, The Guardian

Promoting sustainable behaviour means more than clever slogans

Even the best campaigns to promote sustainable behaviour will be limited in scope if they fail to link everyday actions to the bigger picture

STUDY QUESTIONS:

What is key to promoting meaningful changes in sustainable behavior?

Answer: To nurture and develop an identity and sense of environmental identity or citizenship.

Adam Corner

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If it were possible to solve climate change overnight through new technologies, the strict regulation of high-polluting industries or a binding political agreement that all the world's countries signed up to, wouldn't that make more sense than focusing on everyday attitudes and behavior? The problem, of course, is that there is no magic low-carbon wand, but if there was it would be waved by a person as susceptible to the quirks, biases, and pitfalls of human judgement as the rest of us. So although it is comforting to draw sharp distinctions between politics, technologies and individuals, the reality is that human behavior underpins it all. And this means that promoting sustainable behavior in the most effective way is an absolutely critical part of society's response to climate change.

At first, it was assumed that once people knew how environmentally damaging their actions were, they'd soon start making changes. Unfortunately, sustainable behavior campaigns require more than just a clever campaign slogan and clear facts to succeed. Many sustainability initiatives over the past 20 years have targeted low-hanging fruit – so-called "simple and painless" behavior changes like unplugging phone chargers, switching to energy-saving light-bulbs, or re-using plastic bags. But there is only limited evidence that starting with simple and painless changes is the best way of catalyzing further changes – and there is a risk that people will feel they have already done their bit.

So what should we be doing instead? First and foremost, individuals – and individual behaviors – cannot be separated from their social context. We act according to our personal values and priorities and in line with the social norms of our peer group. The key to promoting meaningful changes in sustainable behavior – that do more than just pay lip service to tackling climate change – is to nurture and develop a sense of environmental identity or citizenship.

When a person acts for self-interested reasons, that person will perceive themselves as someone who does things for their own benefit. They will only engage in further sustainable behaviors if there is something in it for them – so as soon as the 'sweeteners' dry up, so will their interest in sustainability. But if people begin to think of themselves as someone who does things for the environment, the chance that they will engage in other sustainable behaviors is much higher.

It may not always be the quickest way of promoting a specific sustainable behavior, but ultimately people can figure out for themselves whether something is in their own interest or not. The job of a sustainable behavior practitioner is to help them see the bigger picture, and make the arguments about sustainability that an appeal to their wallet cannot do.

A huge amount of everyday energy use is embedded in habitual behaviors. The problem is that something seemingly straightforward like getting the bus to work is actually made up of lots of smaller (habitual) decisions, for example leaving home earlier or showering the night before to save time, all of which can derail even the best intentions. Research on how habits form (and how they change), shows that breaking habitual behaviors down into detailed "if/then" style plans is one way to break bad habits and create more sustainable ones.

But even the best-designed campaign to promote sustainable behavior is limited in its scope if it fails to link everyday behaviors to the wider challenges of sustainability. Most people do not have a social network with sustainability at its core, but working to develop a group – rather than individual – sense of environmental responsibility and identity should be at the heart of any sustainability campaign.

Similarly, for those who are trying to promote sustainable behavior in the workplace, then there is an obvious place that most employees would look to for leadership: their employer. Changes in personal behaviors among workers can catalyze further changes from an employer because the argument that "we've done our bit – now you do yours" is a powerful one.

Cultivating reciprocal links like these – between staff and employer, or between members of a social network – is one of the ways to ensure that promoting sustainable behavior isn't detached from the politics of sustainability. How people act says something about their underlying values, the priorities they hold, and the type of world they want to live in.

It may have become a tired old cliché, but being the change you want to see still sends out an important message. If done right, promoting sustainable behavior can mean so much more than a clever slogan or an appeal for people to do their bit – it can be a political act in itself.

3 - Understanding Building Codes

OSHA Standards & Guidelines

https://www.osha.gov/OshDoc/data_General_Facts/factsheet-lockout-tagout.pdf, page 1 of 2, OSHA Fact Sheet, Lockout/Tagout), 2002

STUDY QUESTIONS:

What is the OSHA standard for control of hazardous energy sources?

The OSHA standard for The Control of Hazardous Energy (Lockout/Tagout), Title 29 Code of Federal Regulations (CFR) Part 1910.147, addresses the practices and procedures necessary to disable machinery or equipment, thereby preventing the release of hazardous energy while employees perform servicing and maintenance activities. The standard outlines measures for controlling hazardous energies—electrical, mechanical, hydraulic, pneumatic, chemical, thermal, and other energy sources. In addition, 29 CFR 1910.333 sets forth requirements to protect employees working on electric circuits and equipment. This section requires workers to use safe work practices, including lockout and tagging procedures. These provisions apply when employees are exposed to electrical hazards while working on, near, or with conductors or systems that use electric energy.

Why is controlling hazardous energy sources important?

Employees servicing or maintaining machines or equipment may be exposed to serious physical harm or death if hazardous energy is not properly controlled. Craft workers, machine operators, and laborers are among the 3 million workers who service equipment and face the greatest risk. Compliance with the lockout/tagout standard prevents an estimated 120 fatalities and 50,000 injuries each year. Workers injured on the job from exposure to hazardous energy lose an average of 24 workdays for recuperation.

How can you protect workers?

The lockout/tagout standard establishes the employer's responsibility to protect employees from hazardous energy sources on machines and equipment during service and maintenance. The standard gives each employer the flexibility to develop an energy control program suited to the needs of the particular workplace and the types of machines and equipment being maintained or serviced. This is generally done by affixing the appropriate lockout or tagout devices to energy-isolating devices and by deenergizing machines and equipment. The standard outlines the steps required to do this.

What do employees need to know?

Employees need to be trained to ensure that they know, understand, and follow the applicable provisions of the hazardous energy control procedures. The training must cover at least three areas: aspects of the employer's energy control program; elements of the energy control procedure relevant to the employee's duties or assignment; and the various requirements of the OSHA standards related to lockout/tagout.

What must employers do to protect employees?

The standards establish requirements that employers must follow when employees are exposed to hazardous energy while servicing and maintaining equipment and machinery. Some of the most critical requirements from these standards are outlined below:

- Develop, implement, and enforce an energy control program.
- Use lockout devices for equipment that can be locked out. Tagout devices may be used in lieu of lockout devices only if the tagout program provides employee protection equivalent to that provided through a lockout program.
- Ensure that new or overhauled equipment is capable of being locked out.
- Develop, implement, and enforce an effective tagout program if machines or equipment are not capable of being locked out.

https://www.osha.gov/OshDoc/data_General_Facts/FireSafetyN.pdf

STUDY QUESTIONS:

What should employers do to protect workers from fire hazards?

Employers should train workers about fire hazards in the workplace and about what to do in a fire emergency. If you want your workers to evacuate, you should train them on how to escape. If you expect your workers to use firefighting equipment, you should give them appropriate equipment and train them to use the equipment safely. (See Title 29 of the Code of Federal Regulations Part 1910 Subparts E and L; and Part 1926 Subparts C and F.)

What does OSHA require for emergency fire exits?

Every workplace must have enough exits suitably located to enable everyone to get out of the facility quickly. Considerations include the type of structure, the number of persons exposed, the fire protection available, the type of industry involved, and the height and type of construction of the building or structure. In addition, fire doors must not be blocked or locked when employees are inside. Delayed opening of fire doors, however, is permitted when an approved alarm system is integrated into the fire door design. Exit routes from buildings must be free of obstructions and properly marked with exit signs. See 29 CFR

Part 1910.36 for details about all requirements.

Do employers have to provide portable fire extinguishers?

No. But if you do, you must establish an educational program to familiarize your workers with the general principles of fire extinguisher use. If you expect your workers to use portable fire extinguishers, you must provide hands-on training in using this equipment. For details, see 29 CFR Part 1910 Subpart L.

Must employers develop emergency action plans?

Not every employer is required to have an emergency action plan. OSHA standards that require such plans include the following:

- Process Safety Management of Highly Hazardous Chemicals, 1910.119
- Fixed Extinguishing Systems, General, 1910.160
- Fire Detection Systems, 1910.164
- Grain Handling, 1910.272
- Ethylene Oxide, 1910.1047
- Methylenedianiline, 1910.1050
- 1,3 Butadiene, 1910.1051

When required, employers must develop emergency action plans that:

- Describe the routes for workers to use and procedures to follow.
- Account for all evacuated employees.
- Remain available for employee review.
- Include procedures for evacuating disabled employees.
- Address evacuation of employees who stay behind to shut down critical plant equipment.
- Include preferred means of alerting employees to a fire emergency.
- Provide for an employee alarm system throughout the workplace.
- Require an alarm system that includes voice communication or sound signals such as bells, whistles, or horns.
- Make the evacuation signal known to employees.
- Ensure emergency training.
- Require employer review of the plan with new employees and with all employees whenever the plan is changed.

Must employers have a fire prevention plan?

OSHA standards that require fire prevention plans include the following:

- Ethylene Oxide, 1910.1047
- Methylenedianiline, 1910.1050
- 1,3 Butadiene, 1910.1051

- Employers covered by these standards must implement plans to minimize the frequency of evacuations. All fire prevention plans must:
- Be available for employee review
- Include housekeeping procedures for storage and cleanup of flammable materials and
- flammable waste.
- Address handling and packaging of flammable waste. (Recycling of flammable waste such as paper is encouraged.)
- Cover procedures for controlling workplace ignition sources such as smoking, welding,
- and burning.
- Provide for proper cleaning and maintenance of heat producing equipment such as burners, heat exchangers, boilers, ovens, stoves, and fryers and require storage of flammables away from this equipment.
- Inform workers of the potential fire hazards of their jobs and plan procedures.
- Require plan review with all new employees and with all employees whenever the plan is changed.

https://www.osha.gov/shpmguidelines/SHPM_guidelines.pdf 1989, OSHA® Fact Sheet, Voluntary Safety & Health Program Management Guidelines, Occupational Safety & Health Administration (OSHA), U.S. Department of Labor

See PDF.

STUDY QUESTIONS:

What's the primary vehicle for management to communicate its commitment to safety and health program?

Answer: A clear and well written safety and health policy.

What core element of a safety and health program ensure all employees understand the program and are clear what their roles are within the program.

Answer: Education and Training.

https://nonprofitrisk.org/tools/workplace-safety/nonprofit/c3/elements-prg.htm; Fact Sheet Four Elements of a Workplace-Safety Program, U.S. Depart of Labor/ Occupational Safety & Health Administration, 2008 Nonprofit Risk Management Center

STUDY QUESTIONS:

What element of a safety program identify existing potential safety hazards in the workplace?

_____

Answer: Workplace Analysis

Four Elements of Workplace Safety Program

Element #1 Management Leadership and Employee Involvement

- Employer and employee involvement and communication on workplace-safety and health issues are essential
- Post the company's written safety and health policy for all to see.
- Involve employees in policy making on safety and health issues.
- Take an active part in safety activities.

Element #2 Workplace Analysis

- Analyze all workplace conditions to identify and eliminate existing or potential hazards.
- Perform analysis on a regular and timely basis.
- Make certain all employees know and understand current hazard analysis for all jobs and processes.
- Focus workplace design on all physical aspects of the work environment, including the following:
- Size and arrangement of work space
- Physical demands of the tasks to be performed
- Design of tools and other devises people use
- The fundamental goal of workplace design is to improve people's ability to be productive, without error or accident, for extended time periods.
- Proper workplace design improves both safety and productivity.

Element #3 Hazard Prevention and Control

- Regularly and thoroughly maintain equipment and vehicles.
- Ensure that employees know how to use and maintain personal protective equipment.
- Train employees in proper procedures for handling specific situations.

Element #4 Safety and Health Training and Education

- It is important that everyone in the workplace be properly trained
    - Managers and supervisors
    - Outside contractors
    - Part-time and temporary employees and volunteers
- Allow only properly authorized and instructed employees to do any job.
- Make sure no employees do any job that appears unsafe.
- Hold emergency-preparedness drills for employees.
- Pay particular attention to employees learning new operations to make sure they have the proper job skills and awareness of hazards.
- Train supervisors and managers to recognize hazards and understand their responsibilities.

https://www.osha.gov/Publications/OSHA3696.pdf, OSHA's Hazard Communication Standard (HCS), 29 CFR 1910.1200, OSHA Fact Sheet, Steps to an Effective Hazard Communication Program for Employers that Use Hazardous Chemicals, Occupational Safety & Health Administration (OSHA), 3-2014

STUDY QUESTIONS:

When does OSHA require a workplace employer to have a hazard communication program?

What are the three primary elements of a hazard communication program?

What are the requirements for labeling containers? For the inventory records for safety data sheets (SDS)?

Employers that have hazardous chemicals in their workplaces are required by OSHA's Hazard Communication Standard (HCS), 29 CFR 1910.1200, to implement a hazard communication program. The program must include labels on containers of hazardous chemicals, safety data sheets (SDSs) for hazardous chemicals, and training for workers. Each employer must also

describe in a written program how it will meet the requirements of the HCS in each of these areas.

Employers can implement an effective hazard communication program by following these six steps.

See PDF.

Building Envelope

http://portal.hud.gov/hudportal/HUD?src=/program_offices/public_indian_housing/programs/ph/phecc/strat_b7; ECM: Building Envelope, HUD.Gov website 2015

STUDY QUESTIONS:

What is R-value?

_____

A high R-value indicates what?

_____

What materials are used in wall insulation?

_____

What considerations should be given to the proper installation of wall insulation?

_____

ECM: Building Envelope – Wall Insulation

Description

The purpose of wall insulation is to reduce the amount of heat that flows from a dwelling unit through the walls to the cold outside air. By reducing this heat loss, wall insulation reduces the amount of energy needed to heat the dwelling unit. Wall insulation also can save on cooling costs and reduce overheating in the summer.

A material's resistance to heat flow is measured in units of "R-value." The higher the R-value, the better the insulating properties. The R-value of insulation depends on the type of insulation and its thickness.

Applicability

- Single-family and multifamily buildings with uninsulated walls
- Buildings located in heating degree day zones 1.5 and above

Types

- Sprayed or blown insulation
  - cellulose
  - foams
  - blown fibers
- Rigid board
  - foam
  - fiberglass

Considerations

- A professional insulation contractor must implement this Energy Conservation Measure (ECM).
- Cavity fill insulation must be compatible with building materials.
- Cavity fill insulation should be blown in under pressure or expanded within the wall to insure even distribution.
- All materials must meet local codes.
- Exterior and interior insulating panels should be protected from impacts, vandalism, and abrasions.
- Exterior insulation panels should be protected from weather and ultraviolet radiation.
- Finish and detailing around doors, windows, and other openings should be considered so as not to detract from building appearance and operation of equipment.

Performance/Economics

- Increasing wall insulation can reduce energy costs approximately 15 to 25 percent.

As Built Drawings

http://qseng.com/publications/rte/01/esmag01jun.htm; As Built Drawings, Questions & Solutions Engineering, 2015

STUDY QUESTIONS:

What are As-Built Drawings?

_____

Why are they important?

What are some ways owners can ensure the accuracy and timeliness of As-Built Drawings?

As Built Drawings

Some of the most important Operations and Maintenance (O&M) documentation products of a construction project are the AS BUILT drawings. As built drawings are usually the original design drawings revised to reflect any changes made in the field, i.e., design changes issued by change order, component relocations required for coordination, rerouting of distribution systems, etc.

As built drawings are important for at least two primary purposes. First, they are a record from which future system changes and/or additions can be designed. Future renovation projects will be more efficient and less disruptive if the as built documents can be depended upon for critical information such as pipe and duct routing and sizing, terminal unit locations, control system sensor locations, etc. Second, the as built drawings can be a valuable tool for the O&M staff. For example, we know that the accurate depiction of shut off valve locations is considered critical for emergency preparedness.

A standard, though by no means only, approach to as built drawing preparation is for the installation contractors to maintain a master set of manually marked-up “red line” RECORD DRAWINGS in the construction trailer. As changes are made in the field and as all components of the installation are completed, the contractors are required to confirm that they are installed per the original drawings or record the changes directly on the hard copy drawings.

At the completion of construction all red-lined changes are transferred to electronic CAD drawings, typically using the designers’ original design drawing files as the starting point. These CAD drawings are then considered the final as builts and submitted to the owner as part of the project close out process.

Many owners have been disappointed with the accuracy, completeness, and timeliness of as built drawings they have received following a construction project. Therefore, they have elected to include quality assurance of the as built documents as a part of their commissioning process. So, what is “commissioning of as built drawings”? As with many things, it can be whatever the facility owner wants it to be and/or can afford it to be.

There are a series of questions owners must ask of themselves in order to define the level of effort desired in the commissioning of as built drawings. The first set of questions has to do with the desired results of the commissioning process. Does the owner want one or more of the following results?

1. Timely delivery of the as built drawings (i.e., within a prescribed period of time after substantial completion)?
2. Confidence that the as built drawings are accurate with respect to elements most important for O&M purposes (i.e., location of all system components requiring O&M attention)?
3. Confidence that the as built drawings are completely accurate with respect to the location and sizes of all components (i.e., equipment and distribution systems)?

If accuracy of the as built documents is one of the priorities, the owner must then determine when and by whom that accuracy will be verified. The following are options for "when" the manual record drawings could be reviewed against actual installation, listed in order of increasing effectiveness:

1. After construction is complete. This would be a one time walkthrough of the building which could be disruptive if the reviewers need to see above ceilings and/or work around occupants. The ability to verify installation of concealed, non-accessible elements would be minimal.
2. Before system elements are concealed. This would require close coordination between the installers and the reviewers to make sure that the installers provide adequate scheduling information to make sure the reviewers have an opportunity to observe all completed installations prior to concealment without delaying the construction process. This would typically be done in multiple review sessions, because systems are concealed at various points in the project.
3. On a regular basis (perhaps monthly) as construction proceeds. This can be very time intensive (and costly) but is probably the most effective way of ensuring that all system components are documented without jeopardizing the construction schedule.

The reviewers should be, in order of decreasing preference, the owner's O&M staff, the commissioning consultant, or the designers. If accuracy is the concern, the real "check" on accuracy needs to be at the manual record drawing stage to make sure that the contractors are keeping up with their documentation requirements. If the red-lined record drawings are deemed accurate, then the only check on the electronic as built documents will be to review and confirm that all red-lines have been picked up and represented in the CAD drawings.

As-built drawings and record drawings

http://www.designingbuildings.co.uk/wiki/As-built_drawings_and_record_drawings

STUDY QUESTIONS:

What circumstance might necessitate revisions and updates to As-Built Drawings?

On building projects it is common for changes to be made during construction because of circumstances that emerge on site. These changes can be relatively minor or can be very significant. As a result, it is common for the client to require that as-built drawings are prepared, either during the construction process or when construction is complete, to reflect what has actually been built. The contractor will generally mark up changes to the 'final construction issue' drawings on-site using red ink, and these can then be used by the consultant team to create record drawings showing the completed project. This information may be supplemented by as-built surveys. These record drawings (sometimes referred to as 'as constructed' drawings) may be required for the Health and Safety File or the operation and maintenance manual issued to the client on completion of construction.

Apart from registering on site changes to the engineers' and architect's drawings it is essential that specialist trade contractors record what has been installed on site. Records of installations such as under-floor cabling in city offices is a particular problem because successive tenants cut off, but leave in, their predecessors cables then instal their own systems. Without cabling records this can prove very problematic for subsequent companies that occupy the premises.

The client's facilities management team must keep record drawings up to date, incorporating details of future modification to the building. If they do not do this, ultimately, surveys may become necessary to re-create accurate measured drawings.

The requirement to produce **as-built drawings and record drawings** must be set out in tender documentation, and should not be assumed to be part of 'standard' services. It can be a time-consuming exercise, and as the project team will be keen to move on to other jobs, it is important that adequate retention remains to ensure completion of as-built and record drawings.

If a building information model has been produced, this must be updated to reflect any changes to the design, and then issued to the client in a form that the facilities management team can continue to develop.

National Electrical Code

http://en.wikipedia.org/wiki/National_Electrical_Code; Background, National Electrical Code, Wikipedia, page last modified 5/12/2015

STUDY QUESTIONS:

How often is the National Electric Code updated and published?

Answer: 3 Years

What American standard development agency approved the NEC as the national standard?

ANSWER: ANSI American National Standards Institute

The NEC is developed by NFPA's Committee on the National Electrical Code, which consists of 19 (20 in 2008) code-making panels and a technical correlating committee. Work on the NEC is sponsored by the National Fire Protection Association. The NEC is approved as an American national standard by the American National Standards Institute (ANSI). It is formally identified as ANSI/NFPA 70.

First published in 1897, the NEC is updated and published every three years with the 2017 edition being the most current. Most states adopt the most recent edition within a couple of years of its publication. As with any "uniform" code, a few jurisdictions regularly omit or modify some sections, or add their own requirements (sometimes based upon earlier versions of the NEC, or locally accepted practices). However, the NEC is the least amended model code, even with it setting minimum standards. No court has faulted anyone for using the latest version of the NEC, even when the local code was not updated.[5]

In the U.S., anyone, including the city issuing building permits, may face a civil liability lawsuit for negligently creating a situation that results in loss of life or property. Those who fail to adhere to well known best practices for safety have been held negligent. This liability and the desire to protect residents has motivated cities to adopt and enforce building codes that specify standards and practices for electrical systems (as well as other departments such as water and fuel-gas systems). This creates a system whereby a city can best avoid lawsuits by adopting a single, standard set of building code laws. This has led to the NEC becoming the de facto standard set of electrical requirements.[6] A licensed electrician will have spent years of apprenticeship studying and practicing the NEC requirements prior to obtaining his or her license.

The Deactivation and Decommissioning (D&D) customized extension of the electrical code standard defined by National Electrical Code was developed since current engineering standards and code requirements do not adequately address the unique situations arising during D&D activities at U.S. Department of Energy (DOE) facilities. The additional guidance is needed to clarify the current electrical code for these situations. The guidance document provides guidance on how to interpret selected articles of NFPA 70, “National Electrical Code” (NEC), in particular certain articles within Article 590, “Temporary Power,” for D&D electrical activities at DOE sites.[7]

The NEC also contains information about the official definition of HAZLOC and the related standards given by the Occupational Safety and Health Administration and dealing with hazardous locations such as explosive atmospheres.

4. Practice Questions and Answers

The practice questions below are retired exam questions from early versions of the certification exam. Candidates should review the questions and answers, and be prepared to answer questions of similar content.

1. Electric utility rates for large commercial buildings will typically have several different $/kWh costs. Which of the following variables does NOT impact the cost of electrical energy for large commercial facilities?

a. Time of day
b. Time of year
c. Service voltage provided by utility
d. Number of occupants in facility

2. Which of the following is NOT a good reason to develop a motor management plan? A motor management plan…

a. identifies the application for each motor in a facility and helps the staff understand which motors are critical to daily operation.
b. provides a running tally of motor run-time and can be used to calculate the duty cycle of motors.
c. can reduce downtime after a motor failure since it includes all the information required to specify replacement motors.
d. provides a record of the physical location of all motors within a facility.

3. Potential savings through energy conservation is possible by adding this to equipment:

a. digital sensors
b. variable-frequency drives
c. power data loggers
d. energy consumption meters

4. Which are not effective methods for promoting sustainability at your institution?

a. publicizing failed energy conservation measures
b. discouraging the use of personal items; i.e. fans, lamps, & heaters
c. building a team and appointing an energy manager
d. holding informational sessions on recycling; i.e. reduce waste, going paperless, etc.

5. A Hazard Communication Program should not include:

a. Proper Labeling of chemicals
b. Employee Training on the use of chemicals
c. SDS access to chemical information
d. Financial Appropriation of chemicals

Practice Question Answers:

1. D 2. B 3. B 4. A 5. D