THE CEM BODY OF KNOWLEDGE AND STUDY GUIDE

Preparation for the CEM Certification Exam

The CEM Certification Exam is a four-hour open book exam. The examination questions are based on the Body of Knowledge listed below. Because of the diversity of background and experience of Energy Managers, the examination has 17 different subject sections, all of which are included in the exam. You must bring a hand calculator to the exam as the CEM exam does not allow computers, tablets, or cell phones to be used during the test.

It is highly recommended that you review the complete Study Guide and answer the 36 Exam Review questions included in the Study Guide to determine your readiness for the exam.

The CEM Examination contains the following mandatory subjects:

Body of Knowledge	Percent of Exam
Codes and Standards	4 – 6 %
Energy Accounting and Economics	11 – 14 %
Energy Audits and Instrumentation	11 – 15 %
Electrical Systems	5 – 7 %
HVAC Systems	5 – 7 %
Motors and Drives	5 – 6 %
Industrial Systems	4 – 6 %
Building Envelope	4 – 5 %
CHP Systems and Renewable Energy	4 – 5 %
Fuel Supply and Pricing	4 – 5 %
Building Automation and Control Systems	4 – 6 %
High Performance Buildings	4 – 5 %
Thermal Energy Storage Systems	3 – 4 %
Lighting Systems	5 – 7 %
Boiler and Steam Systems	4 – 6 %
Maintenance and Commissioning	4 – 6 %
Energy Savings Performance Contracting and Measurement & Verification	4 – 5 %

Part C: STUDY GUIDE

CERTIFIED ENERGY MANAGERS (CEM® EXAM)

Online Self-Evaluation Exam Also Available

CEM Applicants have access to an online version self-evaluation CEM exam. The 65-question multiple choice self-evaluation exam simulates half the certification test, contains a two hour time limit, and covers seventeen sections. There is an **$80 fee** to take this online test and you may access the full details at:

Direct Link: www.aeecenter.org/cem/selfevaluation

Get a sense of how to time questions. The actual exam time allotted is 4 hours for 130 questions. You will need to complete the 65-question self-evaluation exam in 2 hours. At the end of the exam, you will receive a sections report that lets you know what sections you passed and failed. You will not be able to see the specific questions that you answered wrong/right or the answers.

The following is a list of the subjects for the CEM exam. Each subject covers a number of topics. Following the list of topics are suggested references with chapter numbers. The primary references are the Handbook of Energy Engineering, 7th by D. Paul Mehta and Albert Thumann, the Energy Management Handbook, 8th Edition by Steve Doty and Wayne C. Turner, and Guide to Energy Management, 8th Edition by Barney L. Capehart, Wayne C. Turner and William J. Kennedy. However, some other books are also referenced as appropriate.

The study guide will not lead you to answers to all of the questions, but it will certainly lead you to a very large number of correct answers. A person with the necessary experience who reviews the study guide should not have any problem passing the exam.

The exam will: be open book, last four hours, and have 130 questions to answer. Of the 130 questions, 120 are scored and 10 randomly located questions are trial questions being prepared for possible use on future exams. The 10 trial questions do not count toward the examinee's score. The trial questions are randomly located and are not identified. Therefore, all 130 questions should be answered. There are 17 sections listed below from which questions mainly are drawn.

BODY OF KNOWLEDGE: STUDY GUIDE TOPICS & REFERENCES

I. CODES AND STANDARDS

ISO 50001
ASHRAE/IESNA Standard 90.1-2012
IEC and IEEC Codes
ASHRAE Standard 90.2
ASHRAE Standard 62.1-2010
Model Energy Code
ASHRAE Standard 135-2008
ASHRAE Standard 189.1-2009

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 1.
REF: Turner, **Energy Management Handbook**, 8th, Chapter 20.
REF: **ASHRAE 62.1 2004 and 2007 Standard**

II. ENERGY ACCOUNTING AND ECONOMICS

Simple Payback Period
Time Value of Money
Present Worth
Net Present Value
Present Worth Method
After Tax Cash Flow Analysis
Internal Rate of Return
Energy Accounting
Point of Use Costs
Life Cycle Cost Method
Interest Formulas and Tables
Project Life
Annual Cost Method
Economic Performance Measures
Depreciation Methods
Impact of Fuel Escalation Rates
Btu Reporting
Efficiency Measures

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 2.
REF: Turner, **Energy Management Handbook**, Chapter 4.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 4.

III. ENERGY AUDITS AND INSTRUMENTATION

Role of Audits
ASHRAE Type 1 Audit
Energy Management Measures
Combustion Analysis
Power Factor Correction
Very Basic Thermodynamics
Air Velocity Measurement
Light Level Measurement
Infrared Equipment
Fuel Choices
Energy Use Index
Audit Equipment
ASHRAE Type 2 Audit
Load Factors
Combustion Analyzers
Electric Metering Equipment
Temperature Measurement
Pressure Measurement
Humidity Measurement
Energy and Power Measurement
HHV and LHV
Energy Cost Index

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 3.
REF: Turner, **Energy Management Handbook**, Chapter 3.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 2.

IV. ELECTRICAL SYSTEMS

Demand and Energy
Real Power
Power Factor
Power Factor Correction
Rate Structure and Analysis
Variable Speed Drives
Power Quality
Grounding
Load Factors
Reactive Power
Three Phase Systems
Peak Demand Reduction
Motors and Motor Drives
Affinity Laws (Pump and Fan Laws)
Harmonics
IEEE PQ Standard 519

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 4.
REF: Turner, **Energy Management Handbook**, Chapter 11.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 3.

V. HVAC SYSTEMS

Heating, Ventilating, and Air Conditioning (HVAC)

Affinity Laws
Psychrometric Chart
HVAC Equipment Types
Degree Days
Heat Transfer
Vapor Compression Cycle
Cooling Towers
ASHRAE Ventilation Standard
Performance Rating (COP, EER, kW/ton)
HVAC Economizers
Air Distribution Systems (Reheat, Multizone, VAV)
Chillers
Energy Consumption Estimates
Absorption Cycle
Air and Water Based Heat Flow
Demand Control Ventilation

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 7, 8.
REF: Turner, **Energy Management Handbook**, Chapter 10.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 6.

VI. MOTORS AND DRIVES

AC Induction Motors
DC Motors
Load Factor and Slip
Motor Speed Control
Fan and Pump Laws
Motor Selection Criteria
Motor Management Software
AC Synchronous Motors
High Efficiency Motors
Power Factor and Efficiency
Variable Frequency Drives
Variable Flow Systems
New vs. Rewound Motors
Power Factor Correction

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 4.
REF: Turner, **Energy Management Handbook**, Chapter 11.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 12.

VII. INDUSTRIAL SYSTEMS

Waste Heat Recovery
Industrial Energy Management
Steam Systems
Heat Exchangers
Turbines
Compressed Air Systems
Air Compressor Controls
Boilers and Thermal Systems
Fuel Choices
Steam Tables
Compressors
Pumps and Pumping Systems
Air Compressors
Air Leaks

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 5, 6 & 12.
REF: Turner, **Energy Management Handbook**, Chapter 5, 6 & 8.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 7, 11.

VIII. BUILDING ENVELOPE

Thermal Resistance
Insulation
Solar Heat Gain
Thermally Light Facilities
Conduction Heat Loads
Air Heat Transfer
Heat Transfer Coefficients
Vapor Barriers
Solar Shading
Thermally Heavy Facilities
Psychrometric Chart
Water Heat Transfer

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 7.
REF: Turner, **Energy Management Handbook**, Chapter 9 & 15.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 6 & 11.

IX. CHP SYSTEMS and RENEWABLE ENERGY

Topping Cycles
Combined Cycles
Prime Movers
Regulations
Combined Heat and Power
HHV and LHV
Solar, Wind, Biomass, and Hydropower
Solar Thermal and Solar Photovoltaic Systems
Bottoming Cycles
Fuel Selection
Operating Strategies
Codes and Standards
Distributed Generation
Thermal Efficiencies
Wind Energy Systems

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 9.
REF: Turner, **Energy Management Handbook**, Chapter 7.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, 7th, Chapters 13 and 14

X. FUEL SUPPLY AND PRICING

Procurement of Natural Gas
Supply and Demand Impact on Pricing
Fuel Price Risks
Electricity as a Commodity
Procurement of Oil
Evaluating Supply Options
Trends in Deregulation around the World
Selection of Energy Supplier in a Deregulated Market

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 1.
REF: Turner, **Energy Management Handbook**, Chapter 21 & 24.

XI. BUILDING AUTOMATION AND CONTROL SYSTEMS

Energy Management Strategies
Basic Controls
BACnet & LON
Power Line Carriers
Distributed Control
Optimization Controls
Building Control Strategies
Expert Systems
Self-Tuning Control Loops
TCP/IP
BAS Systems
Terminology
PID Controls
Signal Carriers
Direct Digital Control
Central Control
Reset Controls
Communication Protocols
Artificial Intelligence
Energy Information Systems
Internet, Intranets and WWW
Web Based Systems

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 4 and 10.
REF: Turner, **Energy Management Handbook**, Chapter 12.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, 7th, Chapter 9 and 15.

XII. HIGH PERFORMANCE BUILDINGS

Green Buildings
Sustainable Design
ASHRAE 90.1 Energy Cost Budget Method
Certified, Silver, Gold, and Platinum
LEED CI
Water Efficiency
Materials and Resources
ENERGY STAR Rating
Energy Star Label
ASHRAE Standard 189
USGBC
LEED Certification
LEED O&M
LEED NC
LEED CS
Energy and Atmosphere
Indoor Environmental Quality
Portfolio Manager
Green Globes
ASHRAE Green Guide

REF: **United States Green Building Council, website with LEED v3 and LEED Rating Systems presentations, www.usgbc.org**
REF: **ENERGY STAR Building & Plants, ENERGY STAR website, www.energystar.gov**
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, 7th, Chapter 16

XIII. THERMAL ENERGY STORAGE SYSTEMS

Design Strategies
Storage Media
Chilled Water Storage
Sizing
Full Storage Systems
Operating Strategies
Advantages and Limitations
Ice Storage
Volume Requirements
Partial Storage Systems

REF: Turner, **Energy Management Handbook**, Chapter 19.

XIV. LIGHTING SYSTEMS

Light Sources
Lamp Life
Lumens
Zonal Cavity Design Method
Coefficient of Utilization
Lamp Lumen Depreciation
Dimming
Color Temperature
Visual Comfort Factor
Ballasts
Lighting Retrofits
LED Lighting
Efficiency and Efficacy
Strike and Restrike
Footcandles
Inverse Square Law
Room Cavity Ratios
Light Loss Factors
Lighting Controls
Color Rendering Index
Reflectors
Ballast Factor
IES Lighting Standards

REF: Mehta and Thumann**, Handbook of Energy Engineering**, Chapter 4.
REF: Turner, **Energy Management Handbook**, Chapter 13.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 5.

XV. BOILER AND STEAM SYSTEMS

Combustion Efficiency
Excess Air
Steam Traps
Air to Fuel Ratio
Boiler Economizers
Steam Leaks

Condensate Return
Waste Heat Recovery
Scaling and Fouling
HHV and LHV
Boiler Blowdown
Flash Steam
Turbulators
Condensing Boilers

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 6.
REF: Turner, **Energy Management Handbook**, Chapter 5 and 6.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 7 and 8.

XVI. MAINTENANCE AND COMMISSIONING

MAINTENANCE

Combustion Control
Steam Leaks
Insulation
Group Relamping
Preventive Maintenance
Boiler Scale
Compressed Air Leaks
Steam Traps
Outside Air Ventilation
Scheduled Maintenance
Proactive Maintenance
Water Treatment

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 11.
REF: Turner, **Energy Management Handbook**, Chapter 14.
REF: Capehart, Turner and Kennedy, **Guide to Energy Management**, Chapter 10 and 11.

COMMISSIONING

Purpose of Commissioning
Need for Commissioning
Retro-Commissioning
Measurement and Verification
Phases of Commissioning
Commissioning Documentation
Benefits of Commissioning
Commissioning New Buildings
Real Time and Continuous Commissioning
Commissioning Agent
Facility Design Intent
Re-commissioning

REF: Turner, **Energy Management Handbook**, 8th, Chapter 26

XVII. ENERGY SAVINGS PERFORMANCE CONTRACTING and MEASUREMENT AND VERIFICATION

Measurement and Verification Protocols
Energy Savings Performance Contracting
Shared Savings Contracts
Contracting and Leasing
Risk Assessment
Energy Service Companies
Utility Financing
Demand Side Management
Savings Determination
Loans, Stocks and Bonds

REF: Mehta and Thumann, **Handbook of Energy Engineering**, Chapter 13.
REF: Turner, **Energy Management Handbook**, Chapter 25.

EXAM REVIEW QUESTIONS (Sample Only)

Some of these review questions may be more complex or difficult than the exam but will be good practice problems.

1. What is the basis for Commercial Building Codes by most states?
    A. ASHRAE 90.2
    B. ASHRAE 90.1
    C. ASHRAE 62.2
    D. ASHRAE 60.1

2. ASHRAE Standard 55 has rules for:
    A. Ventilation for acceptable indoor air quality
    B. Energy standard for buildings except low rise residential buildings
    C. Thermal environmental conditions for human occupancy
    D. All the above

3. If electricity is selling for $0.06 per kilowatt-hour and is used for electric heating with an efficiency of 90%, what is the equivalent price of natural gas per therm if it can be burned with an efficiency of 80%?
    A. $1.33/therm
    B. $1.47/therm
    C. $1.56/therm
    D. $1.65/therm
    E. $1.780/therm

4. An energy saving device will save $25,000 per year for 8 years. How much can a company pay for this device if the interest rate (discount rate) is 15%?
    A. $10,000
    B. $77,000
    C. $112,000
    D. $173,000

5. What would be used to find hot spots or phase imbalances in an AC circuit?
    A. Ohmmeter
    B. Infrared Camera
    C. Wattmeter
    D. All of the above

6. An audit for one firm showed that the power factor is almost always 70% and that the demand is 1000kW. What capacitor size is needed to correct power factor to 90%?
    A. 266 kVAR
    B. 536 kVAR
    C. 618 kVAR
    D. 1000 kVAR

7. The amount of reactive power that must be supplied by capacitors to correct a power factor of 84% to 95% in a 400 HP motor at 75% load and 98% efficiency is
    A. 72.4 kVAR
    B. 82.5 kVAR
    C. 90.04 kVAR
    D. 92.4 kVAR
    E. 123.5 kVAR

8. Power factor correcting capacitors may be located
    A. At the inductive load
    B. At load control centers
    C. At the customer side of the service transformer
    D. All of the above

9. You find that you can replace a 50 HP motor with a 5 HP motor by cutting the total air flow requirements. Both motors operate at full load. Calculate the total dollar savings, given the information below: {Hint: savings of 45 HP}

Runtime:	8,760 hours/year
Motor Efficiency:	90% (both motors)
Electrical Rate:	$9.00/kW/mo
	$0.05/kWh
Fuel Cost Adjustment:	$0.005/kWh

    A. $22,000
    B. $18,798
    C. $15,650
    D. $12,710
    E. $9,874

10. An absorption system with a COP of 0.8 is powered by hot water that enters at 200 F and exits at 180 F at a rate of 25 gpm. The chilled water operates on a 10 F temperature difference. Calculate the Chilled water flow. You do not need to know how an absorption chiller works to solve this problem.
    Use COP = qout/qin.
    A. 10 gpm
    B. 20 gpm
    C. 40 gpm
    D. 45 gpm
    E. 50 gpm

11. 10,000 cfm of air leaves an air handler at 50 F; it is delivered to a room at 65 F. No air was lost in the duct. No water was added or taken away from the air in the duct. How many BTU/hr was lost in the ductwork due to conduction?
    A. 162,000 BTU/hr
    B. 126,550 BTU/hr
    C. 75,000 BTU/hr
    D. 42,550 BTU/hr
    E. 10,000 BTU/hr

12. An investment tax credit of 10% for a **single project** (Not the company) at a large company:
    A. Reduces the company's overall taxes by 10%
    B. Increases depreciation rate by 10%
    C. Effectively reduces first cost of the project by 10%
    D. A and C

13. Air at 69 F dry bulb and 50% relative humidity flows at 6750 cubic feet per minute and is heated to 90 F dry bulb. How many BTU/hr is required in this process?
    A. 50,000 BTU/hr
    B. 75,000 BTU/hr
    C. 152,000 BTU/hr
    D. 310,000 BTU/hr

14. Estimate the seasonal energy consumption for a building if its design-heating load has been determined to be 350,000 BTU/hr for a design temperature difference of 70 F. This means that the Building Load Coefficient, U x A, equals 5000. The heating season has 3,500-degree days. The heating unit efficiency is 80%. Assume 1 MCF = 10^6 BTU.
    A. 625 MCF/year
    B. 525 MCF/year
    C. 420 MCF/year
    D. 356 MCF/year
    E. 225 MCF/year

15. A wall has a total R-value of 15. Determine the annual cost of the heat loss per square foot in a climate having 5,000 heating degree-days. The heating unit efficiency is 70% and the fuel cost is $5.00/million BTUs.
    A. $0.057/yr/ft^2
    B. $0.040/yr/ft^2
    C. $0.0312/yr/ft^2
    D. $0.0201/yr/ft^2

16. A 10,000 square foot building consumed the following amounts of energy last year. What is the Energy Use Index of the building in BTU per square foot per year?
    - Natural Gas 5,000 therms/year
    - Electricity 60,000 kWh/year

    A. 7,500 BTU/square foot/yr
    B. 18,000 BTU/square foot/yr
    C. 31,500 BTU/square foot/yr
    D. 70,500 BTU/square foot/yr
    E. 700,000 BTU/square foot/yr

17. Assuming that adding 2 inches of fiberglass insulation drops the U-value of a building from 0.24 to 0.098, calculate the annual cooling savings per square foot from the data given below:
    - 2,000 cooling degree days; Cooling COP = 2.5; Electrical cost $0.05/kWh

    A. $0.010/ft^2-yr
    B. $0.025/ft^2-yr
    C. $0.040/ft^2-yr
    D. $0.195/ft^2-yr
    E. $0.202/ft^2-yr

18. How much fuel is wasted if 100 pounds per hour of condensate at 30 psia saturated liquid is drained to the sewer and is made up with water at 60 F. Assume the boiler is 80% efficient and ignore blowdown effects.
    A. 12,090 BTU/hr
    B. 15,200 BTU/hr
    C. 18,000 BTU/hr
    D. 23,850 BTU/hr
    E. 29,800 BTU/hr

19. Select the equipment best suited to efficient **air-to-air heat exchange and humidity** control in the HVAC system of a large office building:
    A. Heat pipe
    B. Radiation recuperator
    C. Rotary sensible heat wheel
    D. Shell and tube heat exchanger
    E. Run around heat exchanger loop

20. Chilled water reset increases chiller efficiency and succeeds because it ________ .
    A. Restarts the system.
    B. Raises the water temperature leaving the chiller.
    C. Lowers the water flowrate through the chiller.
    D. Stops water flow to zones with no occupancy.

21. The difference between the setting at which the controller operates to one position and the setting at which it changes to the other is known as the:
    A. Throttling range
    B. Offset
    C. Differential
    D. Control Point

22. An all-electric facility pays $100,000 annually for energy. The compressed air system has energy costs of $20,000 per year. The system air pressure can be lowered by 10 psi. Approximately how much will be saved annually?
    A. $20,000
    B. $10,000
    C. $5,000
    D. $2,000
    E. $1,000

23. With a load leveling TES strategy, a building manager will
    A. Not operate the chiller during peak hours
    B. Essentially base load the chiller (i.e., operate at high load most of the time)
    C. Operate only during the peaking times
    D. Operate in the "off" season

24. In retrofitting a large commercial building with a TES, which of these considerations would be least important?
    A. System efficiency
    B. Space issues
    C. Demand cost
    D. Equipment cost

25. A building presently has the following lighting system:

    Present System
    Type: 196 mercury vapor light fixtures
    Size: 250 watt/lamp (285 watt/fixture, including ballast)

    You have chosen to replace the existing system with the following:

    Proposed System
    Type: 140 high pressure sodium fixtures
    Size: 150 watt/lamp (185 watt/fixture)

    The facility operates 24 hours/day. Approximate the **heating effect** if the heating system efficiency is 80%, fuel costs $5.00 per million BTUs and there are 200 heating days (not heating degree days) per year. That is, find the increased heating cost for the heating system when the lights are more efficient, and produce less heat.
    A. $6,986/year
    B. $5,289/year
    C. $4,485/year
    D. $3,070/year
    E. $2,548/year

26. A program available at no-cost from a US Department of Energy website that displays cost and efficiency data on electric motors is:
    A. Freeware
    B. Building Life Cycle Cost
    C. MotorMaster
    D. 3EPlus
    E. QuickPEP

27. Given the same amount of excess air and the same flue gas stack temperature rise (look at 50% excess air and 500 degrees F stack temperature rise, for example), which fuel provides the highest boiler combustion efficiency?
    A. Natural Gas
    B. No. 2 Fuel Oil
    C. No. 6 Fuel Oil

28. A boiler is rated at 30 boiler horsepower and 80% efficient. What is the input rating?
    A. 1,255,000 BTU/hr
    B. 1,005,000 BTU/hr
    C. 2,502, 500 BTU/hr
    D. 3,628,750 BTU/hr
    E. 13,400,000 BTU/hr

29. In a steam system, several things can happen to the condensate. Which of these is the best from the standpoint of energy expense?
    A. Drain condensate to sewer
    B. Recover condensate in an insulated system at atmospheric pressure
    C. Recover condensate in an un-insulated system at boiler pressure
    D. Recover condensate in an insulated system at or near boiler pressure

30. Which of the following projects, or ECOs, would likely reduce boiler and steam system costs?
    A. Adding boiler endplate insulation
    B. Installing condensate return system
    C. Repairing steam leaks
    D. Installing combustion air preheater
    E. All the above

31. Estimate the waste heat available in Btu/minute from a refinery flare gas leaving a process unit at 800 deg F if it is flowing at 1,000 cfm and weighs 0.08 lb/cubic foot. Its specific heat or heat content over the temperature range is 0.3 Btu/lb·°F and you should assume the waste gas could be reduced in temperature to 250 deg F.
    A. 178,000 Btu/min
    B. 165,000 Btu/min
    C. 44,000 Btu/min
    D. 19,200 Btu/min
    E. 13,200 Btu/min

32. Water at 70 deg F is supplied to a 100 psia boiler. 1000 lb/hr of steam from the boiler is supplied to a process. How much heat was required to be added in the boiler to create the 1000 lb/hr of steam?
    A. 1000 Btu/hr
    B. 234,500 Btu/hr
    C. 729,250 Btu/hr
    D. 1,150,000 Btu/hr
    E. 3,759,000 Btu/hr

33. A 100 HP rotary screw air-compressor generates heat equivalent to about:
    A. 1000 Btu/hr
    B. 12,000 Btu/hr
    C. 100,000 Btu/hr
    D. 250,000 Btu/hr

34. An optimum start is a control function that**:**
    A. shuts off the outside ventilation air during start up of the building
    B. shuts off equipment for duty cycling purpose
    C. senses outdoor and indoor temperatures to determine the start time needed to heat or cool down a building to desired temperatures
    D. starts randomly

35. Which of the following could be used to detect failed steam traps?
    A. Ultrasonic equipment to listen to the steam trap operation
    B. Infrared camera to detect the change in temperature
    C. Real time MMS using conductance probes
    D. All of the above

36. Calculate the group re-lamping interval for T8 lamp fixtures with instant start ballasts that annually operate for 4,160 hrs with rated life of 15,000 hrs (assuming replacements at 70% of rated life)
    A. 1.0 year
    B. 2.5 years
    C. 3.5 years
    D. 4.5 years

CEM Exam questions Key

Questions	Answers
1	(B)
2	(C)
3	(C)
4	(C)
5	(B)
6	(B)
7	(A)
8	(D)
9	(A)
10	(C)
11	(A)
12	(C)
13	(C)
14	(B)
15	(A)
16	(D)
17	(C)
18	(D)

Questions	Answers
19	(A)
20	(B)
21	(C)
22	(E)
23	(B)
24	(A)
25	(D)
26	(C)
27	(C)
28	(A)
29	(D)
30	(E)
31	(E)
32	(D)
33	(D)
34	(C)
35	(D)
36	(B)

For a listing of AEE Certification Programs: Visit www.aeecenter.org/certification

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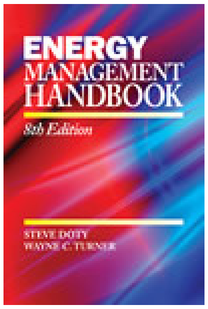
RECOMMENDED TEXTS FOR CEM EXAM PREPARATION

Order Form provided on next page, or order online at www.aeecenter.org/books



ENERGY MANAGEMENT HANDBOOK, 8TH Edition

By Steve Doty and Wayne C. Turner

Newly revised and edited, this eighth edition includes significant updates to energy management controls systems, commissioning, measurement and verification, and high performance green buildings. Also updated are chapters on motors and drives, HVAC systems, lighting, alternative energy systems, building envelope, performance contracting and natural gas purchasing.

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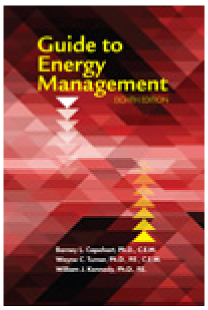

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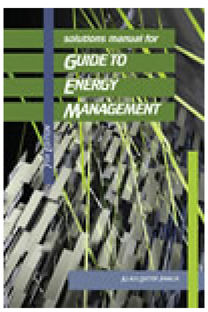

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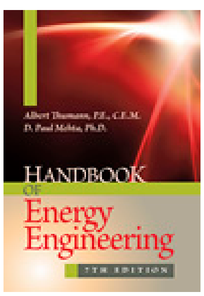

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