

THE CEA BODY OF KNOWLEDGE AND STUDY GUIDE Preparation for the CEA Certification Exam



The CEA 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 and background and experience of Energy Auditors, the examination has 10 different subject sections, all of which are included in the exam. You must bring a hand-held calculator to the exam as the CEA 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 10 Exam Review question included in the Study Guide to determine your readiness for the exam.

The CEA Examination contains the following mandatory subjects:

Body of Knowledge	Percent of Exam
Developing an Audit Strategy & Plan	12 - 18 %
Utility Analysis, Renewable Opportunities	11 - 17 %
Data Collection & Economic Analysis	11 - 17 %
Lighting Systems	7 - 10 %
HVAC & Heating Systems	16 - 24 %
Motors, Drives & Compressed Air	7 - 10 %
Ventilation Systems	4 - 6 %
Domestic Hot Water Systems	4 - 5 %
Building Envelope	3 - 5 %
Water Conservations	3 - 4 %

CERTIFIED ENERGY AUDITOR™ (CEA® EXAM)

The following is a list of the subjects for the CEA 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 Audits, 9th Edition, by Albert Thumann, Terry Niehus, and William J. Younger, the Commercial Energy Auditing Reference Handbook, 2nd Edition by Steve Doty, and the Energy Management Handbook, 8th Edition by Steve Doty and Wayne C. Turner. 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 140 multiple choice questions to answer. Each question is valued at 7.2 points for a total of 1,008 points available on the exam. There are 10 sections listed below from which questions mainly are drawn.

BODY OF KNOWLEDGE: STUDY GUIDE TOPICS & REFERENCES

Developing an Energy Audit Strategy and Plan

- Energy auditing fundamentals
- Energy and power units; Conversion factors
- Audit instrumentation
- Safety requirements and procedures
- Plan Energy Audit
- Define Required Audit procedures
- Select the Project team
- Analyze & Breakdown Energy end use
- Determine Appropriate Audit Level
- Define Pre- audit tasks
- Define Data required for energy analysis
- Estimate cooling and heating loads for the system or facility
- Plan a Pre-audit interview-
- Communicate procedures and data gathering
- Identify operations and maintenance team and create pre-audit O&M interview questions.
- Define audit report format and requirements
- Draft Audit report
- Select appropriate instrumentation

REF: Doty and Turner, **Energy Management Handbook**, Chapters 2 and 3

REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapter 1

Utility Analysis

- Demand and energy
- Power factor
- Define Required utility information
- Review Rate classifications

- Establish utility costs baseline
- Establish utility usage baseline
- Facility benchmarking
- Estimate savings potential
- Identify billing errors
- Verify Energy bill calculations
- Select optimal Rate options

REF: Doty and Turner, **Energy Management Handbook**, Chapter 4
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapters 2 and 3
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 1

Data Collection and Economic Analysis

- Energy accounting
- Define pre-site Data collection
- Collect pre-site Data
- Define on-site Data collection
- Collect on-site Data
- Calculate Energy savings and payback
- Evaluate Energy management opportunities
- Evaluate O&M characteristics and opportunities
- Detailed financial analysis
- Interactive effects of measures
- Computer simulations

REF: Doty and Turner, **Energy Management Handbook**, Chapter 4
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapter 4
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 6

Lighting Systems

- Measurement of light
- Determine Efficiency/efficacy of light source
- Determine Appropriate Light color-CCT/CRI
- Evaluate Lamp lumen depreciation
- Calculate replacement period given Lamp lumen depreciation
- Determine Lamp types and characteristics
- Evaluate Lamp types & characteristics for replacement
- Audit Lighting Control System
- Calculate replacement period given Lamp lumen depreciation
- Lighting power allowances

REF: Doty and Turner, **Energy Management Handbook**, Chapter 13
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapters 7
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 16

HVAC Systems

- HVAC basics
- Heat Pump classifications
- Heat Pump operations
- Audit & determine types of HVAC systems

Calculate estimated heating & cooling loads
Identify any special ventilation code requirements that may or may not be met at this time.
Determine existing HVAC efficiencies
Identify existing control strategies including locations of thermostats, scheduling of loads and occupants.
Evaluate ductwork and fan systems for leaks, insulation and or pressure drop
Identify HVAC system components
Audit & determine types of chillers: electric, gas driven, absorbers
Identify piping arrangements for chilled water and or refrigerant systems
Audit & determine types of heat pump, chillers, or split system units
Analyze heat pump or split system efficiencies

REF: Doty and Turner, **Energy Management Handbook**, Chapter 10
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapter 9
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 11

Heating Systems

Audit & determine types of boilers: fire tube, water tube, cast iron
Audit & determine types of furnaces: electric, gas, pulse, condensing
Evaluate distribution systems, (ductwork and or piping), for insulation, pressure drop, leaks.
Compare terminal units

REF: Doty and Turner, **Energy Management Handbook**, Chapter 10
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapters 8
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 1

Motors and Drives

Audit & determine types and sizes of motors
Evaluate appropriate types of motors
Determine operating characteristics of motors and drives
Calculate efficiencies of motors and drives
Review potential energy savings of variable frequency drives

REF: Doty and Turner, **Energy Management Handbook**, Chapter 11
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapters 7
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 12

Compressed Air Systems

Analyze existing conditions for improvement opportunities
Evaluate for upgrade to DDC
Perform savings calculations

REF: Doty and Turner, **Energy Management Handbook**, Chapter 3
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapter 10
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 14

Cogen Opportunities

Evaluate option for Cogen opportunity
Perform savings calculations

REF: Doty and Turner, **Energy Management Handbook**, Chapter 7
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapter 2

Renewable Energy

Evaluate opportunities for use of renewable energy source

REF: Doty and Turner, **Energy Management Handbook**, Chapter 16
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapter 16

Ventilation Systems

Audit & determine types of ventilation systems
Define characteristics
Ventilation requirements, (code related).
Ventilation control options
Determine heat recovery options

REF: Doty and Turner, **Energy Management Handbook**, Chapter 3
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapters 10
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 14

Domestic Hot Water Systems

Audit & determine types of hot water systems
Calculate efficiencies
Identify temperature set points
Evaluate circulating pumps
Evaluate energy savings opportunity for heat pump water heaters

REF: Doty and Turner, **Energy Management Handbook**, Chapter 5
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapter 13
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 18

Building Envelope

Heat flow concept
Determine R and U values
Evaluate efficiency of walls, roofs, windows
Evaluate replacement with Low E glass
Audit building envelope infiltration
Balance point temperature
Thermal weight

REF: Doty and Turner, **Energy Management Handbook**, Chapter 9
REF: Thumann, Niehus, and Younger, **Handbook of Energy Auditing**, Chapter 6
REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 17

Water Conservation

Water conservation methods
Determine Rate structures
Apply Water conservation methods
Evaluate Irrigation and landscaping installation and efficiency

Survey Leak detection system
Audit water use

REF: Doty, **Commercial Energy Auditing Reference Handbook**, Chapter 18

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.

- Which of the following is not always correct?
 - 10 kWh = 34,120 Btus
 - 5 therms = 500,000 Btus
 - 3 tons = 36,000 Btu/hr
 - 1 MCF = 1 MMbtu
- Determine the solar heat gain through a 1' x 3' window at 1:00 pm in August located at latitude 28° N. The window has an east orientation. The SHGF for the specified conditions is 160 BTU/Hr- ft². The SC is 0.70.
 - 1,120 Btu/hr
 - 228.6 Btu/hr
 - 336 Btu/hr
 - None of the above
- The lighting efficacy term is lumens per watt.
 - True
 - False
- A chiller has a full load rating of 0.7 kW/ton. What is the full load kW if this unit has a 200 ton rating?
 - 286
 - 140
 - 900
 - 75
- What is the \$/MMBtu delivered to the space for an 80% efficient gas furnace if gas costs \$12.00/MCF?
 - \$8.89
 - \$11.23
 - \$22.46
 - \$15.00
- Ground source heat pumps may not meet efficiency projections due to:
 - Improperly installed ground loop
 - Poor water treatment
 - Soil contamination
 - Oversizing
- ASHRAE standard 62-2010 defines the minimum standards for:

- (A) HVAC equipment sizing
 - (B) Acceptable indoor air quality levels
 - (C) Chiller efficiencies
 - (D) Motor efficiencies
8. An office building has 50 employees and is occupied for 250 work days a year. It is estimated that each employee uses, on the average, 1 gallon of hot water per day for hand washing. The hot water temperature required is 120°F and the city water is 60°F. Calculate the amount of annual energy required to heat this water.
- (A) 12.50 MMBtus
 - (B) 6.25 MMBtus
 - (C) 25 Mbtus
 - (D) 15.4 MMBtus
9. A three phase induction motor draws 13 amps at 240 volts. The power factor is 0.9. Determine the kW.
- (A) 5.54
 - (B) 5.16
 - (C) 4.86
 - (D) 6.32
10. A hospital uses 400,000 gallons of water per year just for showers. The showers have the old style showerheads that use 4.5 gpm. What is the annual amount of water saved if they replace the showerheads with new ones that comply with the maximum flow rates allowed per the Energy Policy Act of 1992?
- (A) 200,000 gallons per year
 - (B) 285,765 gallons per year
 - (C) 222,222 gallons per year
 - (D) 177,778 gallons per year

Answer Key:

- 1- D
- 2- C
- 3- A
- 4- B
- 5- D
- 6- A
- 7- B
- 8- B
- 9- C
- 10- D

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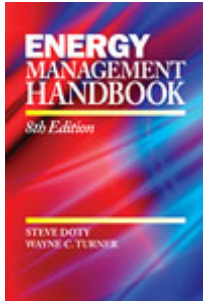
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CEA application, procedures, requirements, and eligibility are subject to change.

RECOMMENDED TEXTS FOR CEA EXAM PREPARATION

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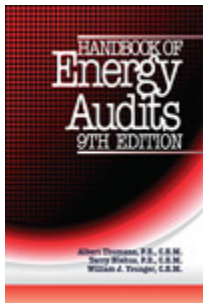


ENERGY MANAGEMENT HANDBOOK, 8th Edition

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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HANDBOOK OF ENERGY AUDITS, 9th Edition

By Albert Thumann, Terry Niehus, and William Younger

This best-selling handbook is the most comprehensive and practical reference available on energy auditing in buildings and industry. Completely edited throughout, this latest edition includes new chapters on investment grade energy audits and retro-commissioning audits, as well as new information on ISO 50001 and the Superior Energy Performance program. Topics include energy assessment, utility bill analysis, and the latest computer software available to guide you in planning and carrying out a thorough, accurate audit of any type of facility.

6 x 9, 495 pp., Illus., Hardcover / ORDER CODE: 0675



COMMERCIAL ENERGY AUDITING REFERENCE HANDBOOK, 2nd Edition

By Steve Doty

This practical desk reference for energy engineers, now fully updated and expanded with new material throughout, is designed to serve as a comprehensive resource for performing energy audits in commercial facilities. The second edition provides new material on such topics as early replacement decision making, impact of lease arrangements on energy project interest, coordination of upstream/downstream set points, semiconductor fab multi-stage HVAC air tempering, commissioning, overlapping heating and cooling and much more.

6 x 9, 689 pp., Illus., Hardcover / ORDER CODE: 0644

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***CEA candidates who are taking the Fundamentals of Energy Auditing preparatory seminar will automatically receive a copy of the Handbook of Energy Audits, and therefore do not need to purchase it.**

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