CIEP BODY OF KNOWLEDGE AND STUDY GUIDE
Preparation for the CIEP Certification Exam

The CIEP 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 Industrial Energy Auditors, the examination has 11 different subject sections, all of which are included in the exam. You must bring a hand-held calculator to the exam as the CIEP 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 21 Exam Review questions included in the Study Guide to determine your readiness for the exam.

The CIEP Examination contains the following subjects:

Body of Knowledge		Percent of Exam
1	Fundamentals to Industrial Energy Audits and Energy Management Systems	5 - 7%
2	Instrumentation and Controls	6 - 8%
3	Energy Investigation Support Tools	6 - 8%
4	Fuels, Furnaces, and Fired Equipment Basics	8% - 12%
5	Plant Water Systems	6% - 8%
6	Heat Exchange Systems	8% - 12%
7	Boiler and Steam Systems	10% - 14%
8	Electric Motors & Drives	8% - 12%
9	Pump Systems	8% - 12%
10	Fan Systems	7% - 11%
11	Compressed Air Systems	8% - 12%

CERTIFIED INDUSTRIAL ENERGY PROFESSIONAL (CIEP) EXAM

The following is a list of the subjects for the CIEP exam. Each subject covers several topics. Following the list of topics is a suggested reference with chapter numbers. The primary reference is the Industrial Energy Systems Handbook, 1st Edition, by Albert Williams. The reference book is available through the AEE eLibrary, which is a great resource for accessing searchable content as well as highlighting and taking notes. *Digital books cannot be accessed during the certification exam.*

The exam will: be open book, four hours, and have 100 multiple choice questions to answer. There are 11 sections listed below from which questions mainly are drawn.

BODY OF KNOWLEDGE: STUDY GUIDE TOPICS & REFERENCES

1	**Fundamentals to Industrial Energy Audits and Energy Management Systems**
101	Define the objectives of energy management
102	Awareness on climate change & clean energy
103	Conceptualize the need for industrial energy management
104	Understand energy basics
105	Understand energy systems efficiency
106	Understand energy balance
107	Overview of the energy audit types
108	Overview of the ISO50002 energy audit standard
109	Overview of the ISO50001 energy management systems standard
110	Develop an energy review, baseline, and energy performance indicators

REF: Williams, **Industrial Energy Systems Handbook**, Chapters 1, 2, 3, 4, 5 and 6

2	**Instrumentation and Controls**
201	Understand the basic process and concepts of control systems
202	Determine the types of control systems
203	Identify field input elements
204	Identify field output elements
205	Understand control valves, control algorithms, and control technologies
206	Define energy information systems
207	Identify Energy Efficiency Measures (EEMs) to enhance instrumentation and control system effectiveness

REF: Williams, **Industrial Energy Systems Handbook**, Chapter 7

3	Energy Investigation Support Tools
301	Consider industrial safety
302	Understand electrical metering equipment and data loggers
303	Understand combustion metering
304	Understand temperature metering
305	Understand leak detectors
306	Understand pressure metering
307	Understand flow metering (velocity, differential pressure, displacement, open flow)
308	Understand solar PV metering
309	Understand building metering (IAQ, humidity, building envelope)

REF: Williams, **Industrial Energy Systems Handbook**, Chapter 8

4	Fuels, Furnaces, and Fired Equipment Basics
401	Differentiate fuel types
402	Define heat transfer
403	Understand furnace types
404	Test furnace efficiency
405	Describe fired heater construction and components
406	Understand fuel train construction and components
407	Describe burner systems and combustion
408	Adjust fuel air ratio
409	Minimize flaring
410	Identify EEMs on furnaces and fired equipment

REF: Williams, **Industrial Energy Systems Handbook**, Chapter 9

5	Plant Water Systems
501	Establish water context and the need for water treatment
502	Understand basics and types of water treatment
503	Understand reverse osmosis system basics
504	Evaluate cooling towers and its water loss
505	Understand ion exchange in steam systems
506	Overview industrial water uses (Oil & gas, food & beverage, mining, construction, forestry, pulp & paper)
507	Compare water desalination methods and its energy consumption
508	Identify water efficiency measures on filtration, cooling towers, and operations

REF: Capehart, Turner, and Kennedy, **Guide to Energy Management**, Chapter 15

6	Heat Exchange Systems
601	Define heat exchanger basics and design
602	Identify main heat exchangers types and its applications
603	Understand heat recovery
604	Assess heat exchange fouling
605	Identify EEMs on heat exchangers and its components

REF: Williams, **Industrial Energy Systems Handbook**, Chapter 10

7	Boiler and Steam Systems
701	Comprehend fundamentals to steam systems and boiler types
702	Understand steam properties and use saturated and superheated steam tables
703	Compare fuel heating values
704	Determine boiler losses (shell, blowdown, stack)
705	Calculate and improve combustion efficiency
706	Assess boiler blowdown
707	Evaluate deaerators
708	Audit the distribution system, steam traps, flash steam, and steam leaks
709	Understand the basics and the types of cogeneration
710	Compare CHP technologies
711	Understand conventional power generation cycles
712	Understand steam turbines and its components
713	Understand distributed generation and smart grids
714	Identify EEMs on boilers, steam systems, and turbines

REF: Williams, **Industrial Energy Systems Handbook**, Chapter 11

8	Electric Motors and Drives
801	Understand electrical fundamentals (induction, electromagnets, powerfactor)
802	Understand electric motor basics, types, and construction
803	Comprehend electric motor nameplate data (Frame size, kW, class, SF, Volt, etc.)
804	Evaluate motor efficiency and efficiency classes
805	Evaluate losses in motors
806	Understand motor drives and speed control
807	Identify EEMs in motors

REF: Williams, **Industrial Energy Systems Handbook**, Chapter 12

9	Pump Systems
901	Establish pump system fundamentals
902	Differentiate pump classifications and pump types
903	Understand pump system components (impellers, casings, bearings, seals, piping, controls)
904	Calculate delivered power, total head and efficiency of a pump
905	Calculate total head, friction head, static head, velocity head
906	Determine distribution losses
907	Analyze pump and system performance curves
908	Analyze pump in series and in parallel
909	Identify pump cavitation, its causes, and remedies
910	Calculate Net Positive Suction Head available
911	Establish pump maintenance and reliability aspects
912	Identify EEMs on pump operation, maintenance, and control

REF: Williams, **Industrial Energy Systems Handbook**, Chapter 14

10	Fan Systems
1001	Establish fan system fundamentals and components
1002	Differentiate fan types and their pros and cons
1003	Apply fan types to its optimal application regarding impellar efficiency and dust loading
1004	Analyze fan and system performance curves
1005	Understand damper types and its impact on fan system performance
1006	Compare fan controls methods
1007	Calculate the effect of variable flow by using the fan/affinity laws
1008	Establish fan maintenance practices
1009	Identify low cost, retrofit, and maintenance EEMs on fan systems

REF: Williams, **Industrial Energy Systems Handbook**, Chapter 13

11	Compressed Air Systems
1101	Establish compressed air system fundamentals
1102	Understand compressed air
1103	Understand compressor types and their applications
1104	Analyze flow capacity control
1105	Apply multiple compressors and correct sizing
1106	Understand air treatment, distribution, and storage
1107	Measure leaks and perform leakage tests
1108	Identify and reduce artificial demand
1109	Identify and reduce inappropriate use
1110	Identify EEMs on compressed air supply, treatment, and demand

REF: Williams, **Industrial Energy Systems Handbook**, Chapter 15

EXAM REVIEW QUESTIONS (Sample Only)

1. A system fed by a pump has a static head of 3m and a friction head of 10m at a flow of 100 m^3/h. What is the electrical power consumption of the pump system at a flow of 60m^3/h? The pump is driven directly and at 60 % flow the motor efficiency is 91% and the pump efficiency is 78%.
    A. 1.1 kW
    B. 1.5 kW
    C. 2.7 kW
    D. 5.2 kW

2. Modulating (throttling) inlet control allows the output of a compressor to be varied to meet flow requirements. Throttling is usually accomplished by closing the inlet valve, thereby restricting inlet air to the compressor. This control method:
    A. Can be used on all kind of compressors.
    B. Cannot be used on reciprocating or lubricant-free rotary screw compressor.
    C. Can be used on centrifugal compressors.
    D. B and C.
    E. Can only be used on lubricant-injected rotary screw compressors

3. A natural-gas fired boiler produces 1.4 kg / s of steam at 1 bar, 250°C. Calculate the power savings from returning the condensate to the boiler (a study shows that 70 % can be recovered) as feed water. Incoming makeup water temperature is 15°C and boiler efficiency is 80 %. Assume condensate is saturated water at 1.0 bar.
    A. 434 kW
    B. 996.3 kW
    C. 1 417.5 kW
    D. 1 996.3 kW

4. Calculate the percentage of blow-down for a boiler that has an allowable limit of 500 ppm of impurities and uses feed water with 10 ppm of impurities.
    A. 0.6%
    B. 1.2%
    C. 2.0%
    D. 3.8%
    E. 4.0%

5. If electricity is selling for $0.08 per kilowatt-hour and is used for electric heating with an efficiency of 100%, what is the equivalent price of natural gas per GJ if it can be burned with an efficiency of 80%?
    A. $8.00 /GJ
    B. $15.10 /GJ
    C. $17.77 /GJ
    D. $21.20 /GJ
    E. $24.30 /GJ

6. An industrial plant uses 500 kilolitres of no. 6 oil in the month of June (calorific value 41.72MJ per litre). The electrical equipment in the plant reaches a maximum demand of 15 MW. The monthly load factor is 0.78. The plant produces 30500 tons in that month. Calculate the overall energy intensity.
    A. 0.68 GJ/ton
    B. 0.99 GJ/ton
    C. 1.68 GJ/ton
    D. 1.96 GJ/ton

7. The energy audit identifies in quantitative terms:
    A. How and where energy enters the facility, department, system or piece of equipment
    B. Where it goes and how it is used
    C. Any variances between inputs and uses
    D. How it can be used more effectively or efficiently
    E. All of the above

8. In a DDC control system distributed processing means
    A. the algorithms for central control are located with the host computer
    B. the network carries the central station commands to the individual control panels for execution
    C. the decision-making and control process is largely handled by the local control panel
    D. All of the above

9. What is the flow rate of 16 °C water through a control valve with a flow coefficient of 0.01 and a pressure difference of 100 kPa?
    A. 0.1 LPS
    B. 0.2 LPS
    C. 0.4 LPS
    D. 0.6 LPS

10. In selecting a control valve for a chilled water coil which of the following will generally be true?
    A. The valve will be slightly smaller than the coil connection size
    B. The pressure drop for CV calculation will be about 27-35 kPa
    C. The valve will be either a ball or globe type
    D. All are true
    E. None are true

11. Which of the following equipment can be used to conduct a steam trap operation audit?
    A. Infrared pyrometer
    B. Stethoscope
    C. Ultrasonic leak detector
    D. Thermocouple
    E. All the above

12. In operating a boiler with dual fuel capability, which is the lowest cost of fuel given the following: Natural gas $4.00/GJ; efficiency = 92%. Fuel oil $123/ton; efficiency = 88% (42,000 kJ/kg)
    A. Natural gas
    B. Fuel oil

13. Which factor(s) is considered an essential parameter in selecting a waste heat device?
    A. Amount and type of contaminant in discharge fluid
    B. Chemical composition
    C. Flow Rate
    D. All of the above

14. Determine the water saved per annum if you replace 50 standard shower head with 50 flow rate of 20 liters per minutes, with a water-efficient shower head with a flow rate of 10 liters per minute in a hotel. Assume that the average person showers for 7 minutes and that the hotel is at full capacity for 200 days of the year.
    A. 285.71 litres
    B. 2 000 litres
    C. 14 000 litres
    D. 25 550 litres
    E. None of the above

15. Cleaning the heat exchange surfaces on boiler tubes will result in
    A. Reduced stack temperature
    B. Increased O_2
    C. A reduction in the steam to coal ratio
    D. None of the above

16. Which of the following heat exchanger types is most likely to allow cross contamination between heat exchange fluids?
    A. Shell & tube
    B. Heat pipe
    C. Heat wheel
    D. Recuperator

17. What is the overall efficiency of the co-generation plant described below:
    Heat in = 1000 kW
    Electricity generated = 200 kW
    Thermal energy = 600 kW
    A. 20%
    B. 40%
    C. 60%
    D. 80%
    E. 100%

18. How does steam injection into a gas turbine affect the operation?
    A. Increases thermal efficiency
    B. Reduces NO_x
    C. Increases NO_x
    D. A and B
    E. A and C

19. An automotive shock manufacturer has been approached by a cogeneration developer who claims that they can reduce the plants' energy costs. They plan to install a 150 kW packaged cogeneration system with the following specifications listed below:
    - Output: 150 kW_e
    - Electrical Efficiency: 30 %
    - Total Efficiency: 75 %
    - Fuel Cost: $ 5 / GJ
    - Current electric Cost: $ 0.20 / kWh
    - Existing boiler efficiency: 85 %
    - Hot Water Usage of centre: 100 000 litres / day (19 °C)

    What is the hourly fuel consumption in GJ / hr?
    A. 1.8 GJ/h
    B. 2.3 GJ/h
    C. 4.3 GJ/h
    D. 12.3 GJ/h
    E. 23 GJ/h

20. Five bucket steam traps are stuck open in your facility. They all exhaust to the drain. If LPG gas for the boiler costs $ 2 / kg and your steam system is 78 % efficient, what is the cost of these malfunctioning steam traps per year? Each trap has a 2.5 mm orifice. The steam line pressure is 690 kPa.
    A. $22 489 / yr
    B. $56 500 / yr
    C. $110 000 / yr
    D. $220 489 / yr
    E. $224 890 / yr

21. Cosine ϕ correcting capacitors may be located:
    A. At the inductive load
    B. At load control centres
    C. At the primary transformer (customer side)
    D. All of the above
    E. A & B only

Answer Key:

1- A
2- D
3- A
4- C
5- C
6- C
7- E
8- C
9- A
10- D
11- E
12- B
13- D
14- E
15- A
16- C
17- D
18- D
19- A
20- C
21- D