CWEA TECHNICAL CERTIFICATION PROGRAM

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Electrical & Instrumentation Technologist **Candidate Handbook**

EIT CERTIFICATION

v04.25.22.01

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Version 04.25.22.01

Congratulations on pursuing certification. Certification is a great way to demonstrate competency, show commitment to the profession, and help with job advancement.

This handbook contains information about California Water Environment Association's Technical Certification Program for certification candidates. Please read this entire handbook to become familiar with CWEA's certification policies and procedures. Certification candidates are responsible for knowing the contents of this handbook. Please contact the CWEA office at (510) 382-7800 with any questions.

All policies are subject to change. The most recent edition of this handbook can be downloaded for free on Cert.CWEA.org. Candidates should ensure that they have the most current version as indicated by the date in the title above.

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INTRODUCTION TO THE TECHNICAL CERTIFICATION PROGRAM

CWEA's Technical Certification Program (TCP) develops and administers competency-based certification exams for wastewater professionals in a number of different vocations. The certification program was founded in 1937. The first certification offered was the Wastewater Treatment Plant Operator certification, which was later adopted by the State Water Board. The exams are developed and revised by CWEA Subject Matter Experts under the guidance of exam development professionals. The certifications continue to grow and be refined in accordance with water sector and certification professional practices. Exams are offered throughout the year and are experience based, ranging from entry level to upper management.

CWEA currently certifies over 7,000 individuals. Certification is a great way to demonstrate competency, show commitment to the water profession, and help with job advancement.

TECHNICAL CERTIFICATION PROGRAM

Executive Committee

The Technical Certification Program Executive Committee is the governing body of CWEA's certification program. It was created to develop and implement a multilevel technical certification program for individuals employed in the wastewater field. They are responsible for the development and administration of the Technical Certification Program, including the application, examination development, examination administration, and certification renewal process. They develop the guidelines, criteria, and testing procedures that are responsive to the needs of the water quality industry and allow participants to demonstrate technical competence. They are also responsible for maintaining the quality of the examinations through continuous upgrading and review.

For current Committee members, contact the CWEA office.

Overview of the Certification Process

To become certified all applicants must complete the following requirements:

1. Submit an application
2. Pay the application fee
3. Meet the minimum qualifications regarding professional experience
4. Pass the exam

Once an applicant successfully completes the requirements, they will be mailed their certificate. In order to maintain the certification once earned, certified individuals must continue to meet the following recertification requirements:

1. Submit 12 contact hours of continuing education every two years
2. Pay the annual renewal fee

Certifications Offered by CWEA

- Collection Systems Maintenance, Grades 1-4
- Mechanical Technologist, Grades 1-4
- Electrical & Instrumentation, Grades 1-4
- Laboratory Analyst, Grades 1-4
- Environmental Compliance Inspector, Grades 1-4
- Advanced Water Treatment Operator, Grades 3-5
    - Offered in partnership with California-Nevada Section of the American Water Works Association. For more information visit www.AWTOperator.org.

Please note that the **Wastewater Treatment Plant Operator Certification** and **Drinking Water Treatment Plant Operator Certification** are administered by the State of California. To work on a drinking water treatment system, distribution system or in a wastewater treatment plant, an individual must have a valid operator certificate or an operator-in-training certificate from the State Water Board. For information about these programs, please contact the State Water Board Office of Operator Certification.

APPLICATION PROCESS

Submitting an Application

Candidates must submit an application and be approved before they can schedule an exam. Applications can be faxed, emailed or mailed to the CWEA office at any time throughout the year. Applications are reviewed by CWEA TCP Staff and/or Subject Matter Experts. Once the application is processed, candidates are notified of their approval status via email. Please follow all instructions on the application carefully. Incomplete applications may delay approval. The application is available on the Cert.CWEA.org website.

Application Deadlines and Exam Windows

The year is divided into four exam windows, each with an application deadline. Applications are valid for one year from the first date of the applicant's original exam window. Applicants may transfer exam windows throughout the year, for details see *Transferring Exam Windows* (p. 17).

Exam Windows	Exam Dates	Application Deadlines
FALL	October 1st – December 31st	August 31st
WINTER	January 1st – March 31st	November 30th
SPRING	April 1st – June 30th	February 28th
SUMMER	July 1st – September 30th	May 31st

CWEA Application Fees

Current fees are listed on the application. Valid CWEA members qualify for a discounted member rate. The non-member rate includes a one-year CWEA membership. If an applicant does not wish to take advantage of the membership, they must note it on the application.

Minimum Qualifications: Qualifying Education and Experience

Applicants must meet the minimum qualifications for the exam at the time the application is submitted. The table below gives the combinations of education and/or experience that will satisfy the requirements. There is no education or experience requirement to take any Grade 1 exam, however, the Grade 1 exams test at the level of one year of experience in the field. Education and experience should be relevant to the vocation and reflect the job knowledge for that grade level. Relevancy is at the sole discretion of CWEA. Applicant's experience must be indicated on the application under "Job Duties". Applicants should provide sufficient detail to demonstrate they possess the relevant experience. The best way to provide this information is to include the official job description for the position. Applicants consent to a thorough investigation of employment records and other qualifications in related activities for the purpose of verification of qualifications. CWEA may verify job history by contacting employers.

EIT Certification Minimum Qualifications Chart

GRADE 1	▪ No experience required ▪ (1 year of experience in the vocation is recommended)
GRADE 2	▪ 2 years of experience in the vocation
GRADE 3	▪ EIT Grade 2 certification in good standing ▪ 4 years of experience in the vocation OR 3 years with any of the following: – bachelor's degree in a related field – associate degree in a related field – completion of an accredited apprenticeship program in a related field
GRADE 4	▪ EIT Grade 3 certification in good standing ▪ 6 years of experience in the vocation OR 5 years with any of the following: – bachelor's degree in a related field – associate degree in a related field – completion of an accredited apprenticeship program in a related field ▪ 1 year of experience supervising others in the vocation; crew lead experience qualifies OR proof of completion of a training course in management and supervision of at least 60 hours.

***Related experience from outside industries will be evaluated and may count for up to 50% of experience for Grades 2-4.**

***Electrical & Instrumentation experience in the wastewater or water treatment industry are both considered acceptable forms of experience.**

Acceptable Degrees for EIT Certification Application

Bachelor's Degrees

- Engineering (civil, mechanical, electrical, automation, controls)
- Computer Science
- Informatics
- Data Science
- Mechatronics
- Math
- Chemistry
- Physics
- Instrumentation Technology
- Information System Analysis

Associate Degrees

- Computer Science
- Electrical
- Mechanical
- Chemistry
- Math
- SCADA
- Automation Systems
- Instrumentation Technology
- Water/Wastewater

***Related degrees that are not listed may be submitted for consideration.**

Application Approval

Once an application has been approved, the applicant will receive a Certification Application Approval Notification via email. It is very important that applicants use a current email address when filling out the application. CWEA will only contact applicants in regard to their application status via email. The Certification Application Approval Notification will contain the certification exam the applicant has been approved for, the exam window and CWEA ID number. This ID number is needed when contacting Pearson VUE to schedule an exam appointment.

Rejected Application

Applications will be rejected if applicants do not meet all requirements at the time they apply. CWEA will refund the application fee minus a $50 admin fee. Refunds are automatically issued within two weeks of rejection to the original form of payment. Candidates may request that their rejected application be reviewed by the Technical Certification Program Executive Committee by submitting a request in writing to tcpcommittee@cwea.org.

Code of Ethics

All CWEA certification holders and applicants are expected to meet the following standards of professional conduct and ethics:

1. To protect public health, themselves, their co-workers, property, and the environment by performing the essential duties of the CWEA certified vocation safely and effectively, and complying with all applicable federal, state and local regulations.
2. To represent themselves truthfully and honestly throughout the entire certification process.
3. To adhere to all test site rules and make no attempt to complete the test dishonestly or to assist any other person in doing so.
4. To refrain from activities that may jeopardize the integrity of the Technical Certification Program.

The CWEA Code of Ethics establishes basic values and standards of conduct for certification applicants and certification holders. Any action of a certification holder or applicant that compromises the reliability of the certification process may be subject to the process described by the Ethics Procedures.

The Ethics Procedures provide a fair process for dealing with ethics complaints. The procedures define the participants in an ethics case and how each case will be handled. Individuals going through the process will be given opportunities to defend themselves and appeal any decisions made. The Ethics Officer handles all official ethics complaints and determines if there is enough merit in each case to follow through with the procedures. If appropriate, the Ethics Officer may suggest mediation to resolve ethics disputes without the formality of going through the entire procedural process. This information is paraphrased for clarity from the 05-01 CWEA Code of Ethics and Ethics Procedures.

A full copy of the policy can be requested by contacting the TCP department.

Some examples of violations would be:

- Providing false work history on an application
- Using prohibited reference materials during a test
- Taking test materials from a test site
- Falsifying documentation of continuing education contact hours

Any action that might undermine CWEA's process of certifying basic minimal competency will be investigated.

Non-Discrimination Policy

CWEA does not discriminate among applicants on the basis of age, gender, race, religion, national origin, disability, sexual orientation or marital status.

Accommodations

In compliance with the Americans with Disabilities Act, reasonable accommodations will be provided for those individuals who provide CWEA with a physician's certificate, or its equivalent, documenting a physical or psychological disability that may affect the individual's ability to successfully complete the certification examination. Written requests for reasonable accommodations must be submitted with the application.

Language barriers and lack of familiarity with computers are not covered under ADA laws.

Privacy

CWEA is committed to protecting privacy. Exam results and any other information regarding an application are confidential and will only be released to the applicant. Basic certification information is available on our Certification Registry. Employers can use the registry to verify an individual's certification status.

Out-of-State Programs

Anyone anywhere in the United States can apply for CWEA certification. Our certifications are specific to the state of California.

CWEA partners with the following water environment associations to administer certification exams for their members:

- Hawaii Water Environment Association
- Michigan Water Environment Association

Candidates wishing to earn certification through one of those associations should be sure to use the correct application that is specific to that association.

Reciprocity

CWEA does not grant certification by reciprocity. For other certification programs that do offer reciprocity, CWEA will provide any information necessary for verification upon request.

SCHEDULING AN EXAM

Scheduling an Exam Appointment

Once an applicant receives the approval notification email, they will be eligible to schedule an exam appointment. Applicants can schedule an exam appointment through Pearson VUE's website by creating an account or by logging into an existing account. The applicant's CWEA ID number is needed when creating an account. The CWEA ID number can be found in the approval notification email. To schedule an appointment over the phone, call Pearson VUE at

888-749-3881. Test centers are conveniently located throughout the U.S. Locations can be found on Pearson VUE's Test Center Search.

Online Proctored Exams

Online proctoring is available for CWEA exams. If available, candidates will be notified in their approval email of the option to schedule their exam online versus at an in-person test center. Candidates should examine both options before making the choice that is best for them. Candidates will make their selection at the time when they schedule their exam.

Online proctored exams are a convenient way to take an exam at home or at work. Candidates will complete a check in process and are monitored online by a live proctor. **An onscreen calculator and white board are provided, no physical calculators or scratch paper are allowed.**

For more information about the online proctored experience, please see: https://home.pearsonvue.com/cwea/onvue. Please review the system requirements and Pearson Vue policies and procedures for online proctored exams before you schedule your appointment. You will be required to accept and comply with these policies.

To take an online proctored exam, candidates must meet the system requirements. If a candidate is testing at work, they should check with their Network Administrator or IT Professional that their system meets the requirements.

It is the candidate's responsibility to ensure they meet the system requirements prior to their appointment time. If a candidate does not meet the system requirements, they will not be able to complete their exam and will need to reschedule.

Canceling an Existing Appointment

To cancel an appointment, applicants must notify Pearson VUE 24 hours before their scheduled appointment time. Failure to notify Pearson VUE at least 24 hours before the existing appointment will result in an $85 No Show fee. Pearson VUE will send applicants a Cancellation Confirmation to the email on file in their Pearson VUE account.

The following are considered No Shows and will result in an $85 No Show fee:

- Failing to appear at a scheduled test appointment
- Failing to check-in for an online appointment
- Arriving at the test center without a current, government-issued photo ID
- Arriving at the test center 15 minutes or later to a scheduled test appointment

Applicants must pay the No Show fee to schedule a new test appointment. Applicants should contact the CWEA office to reschedule.

Rescheduling an Exam Appointment

To reschedule an existing appointment within the same exam window, applicants must call Pearson VUE directly at least 24 hours before their existing exam appointment, for details see *Canceling an Existing Appointment* (p. 16).

Applicants must contact the CWEA office to reschedule (transfer) an existing exam appointment to a different exam window. Before contacting CWEA, the applicant must cancel their existing appointment.

Transferring Exam Windows

Applications are valid for one year from the first date of the applicant's original test window. Applicants may transfer exam windows throughout the year. The first transfer is complimentary, subsequent transfers are $50.

Applicants can request a transfer at any time. If an applicant does not test by the last date of their original exam window, CWEA will automatically initiate a transfer and the applicant will be notified via email.

PREPARING FOR THE EXAM

Electrical & Instrumentation Technologist Certification Scope

Specifications	Grade 1	Grade 2	Grade 3	Grade 4
Brief description of the Grade Level in relation to the job family.	Entry and basic working level.	Skilled or journey level.	Lead/advanced technical level.	Division supervisor level.
Level of knowledge, skill and ability within the job family, in relation to job tasks, including the	Basic knowledge and ability, as needed to safely and effectively	Knowledge and ability to safely and effectively accomplish	Knowledge, skill and ability to safely and effectively	Knowledge, skill and ability to administer, coordinate and

taxonomic level of knowledge applied on the job.	perform basic tasks. This includes: recall and recognition, comprehension, and application.	most technical tasks in the job family. This includes: comprehension, application, and analysis.	accomplish and coordinate complex tasks. This includes: application, analysis and synthesis.	manage complex programs across vocations. This includes: analysis, synthesis, and evaluation.
Level of supervision received.	Receives direct supervision.	Receives limited supervision.	Receives general direction.	May receive broad direction.
Level of supervision exercised.	None.	May provide technical direction to other staff.	May oversee and direct complex tasks performed by others.	Will coordinate program activities within or across vocations.
Level of training provided to other personnel.	None.	May train lower level personnel.	Provides advanced technical training to lower-level personnel and may oversee a training program.	Designs and administers training programs within the job family.
Use of tools.	Will recognize the basic tools of the job family.	Will be able to apply most of the tools used by those in the job family.	Will select tools for individuals and teams in relation to specific problems.	Manages and evaluates systems and facilities.
Problem solving and troubleshooting responsibilities.	Follows directions.	Troubleshoots and solves common problems.	Analyzes, troubleshoots, and solves complex problems and recommends long-term solutions and system improvements.	Evaluates program effectiveness, takes corrective actions as needed, and oversees system improvements.
Actions in relation to safety problems.	Recognizes and reports unsafe conditions.	Recognizes, reports, and corrects unsafe conditions.	Anticipates and prevents unsafe conditions.	Participates in the design and administers safety programs.
Actions in relation to standard operating procedures (S.O.P.s),	Has the ability to follow S.O.P.s.	Has the ability to understand and apply	Formulates new S.O.P.s, in compliance with	Assures program compliance with

laws and regulations.		S.O.P.s, laws and regulations.	laws and regulations.	laws and regulations.
Actions in relation to documentation of work activities.	Completes own work process documentation.	Completes own and teamwork process documentation.	Completes complex work process documentation and updates CMMS and asset management.	Responsible for quality assurance of program documentation.

Exam Content

CWEA's Technical Certification Program Electrical & Instrumentation Technologist exams are based on exam blueprints that outline the exam content and are periodically reviewed by CWEA Subject Matter Experts. An exam blueprint is based on a job task analysis that includes research of the essential duties of an Electrical & Instrumentation Technologist worker at a representative cross-section of systems and facilities in California. The Electrical & Instrumentation Technologist Certifications were last reviewed by Subject Matter Experts in 2022.

The exam content outlines that follows presents content covered on the Electrical & Instrumentation Technologist exams and shows the amount of the exam devoted to each Domain in the column labeled weighting.

EIT GRADE 1 EXAM CONTENT OUTLINE

Content Domain	Weighting
Domain 1 – Installation and Configuration	19%
Domain 2 – Maintenance and Repair	24%
Domain 3 – Safety, Tools, and Equipment	28%
Domain 4 – Documentation and Foundational Principles	18%
Domain 5 – Math	11%
Total	100%

Domain 1: Installation and Configuration

Sub-Domain 1.1:

Installation

1. Assist in the installation and modification of water / wastewater communication systems
2. Assist in the installation of conduit, wire, relays, pull boxes, switchboards, and switches in making additions, extensions, or alterations in electrical systems in accordance with the National Electric Code
3. Understand basic cogeneration components and how cogeneration works
4. Assist in the installation of solar and wind generation systems as applicable, batteries, battery chargers, and uninterruptable power supplies (UPS)
5. Assist in the installation of pneumatic control valves and understand the configuration of the control scheme

Sub-Domain 1.2:

Configuration

1. Assist in the configuration of process and instrumentation diagrams (P&ID), control loop parameters and logic for programmable logic controllers (PLC) and control systems
2. Assist in the configuration of variable frequency drives (VFDs), electromechanical valves, instrumentation (level sensors), and pressure/temperature/flow transmitters, and similar analyzing instruments used in water / wastewater systems

3. Assist in the configuration of pneumatic and hydraulic control valves and sensors

Domain 2: Maintenance and Repair

Sub-Domain 2.1:

Systems

1. Assist in the maintenance, repair, and configuration of electronic systems, variable frequency drives (VFDs), and soft starters
2. Identify and assist in the troubleshooting, adjustment, and repair of low voltage electrical problems in water / wastewater facilities
3. Assist in the maintenance and repair of electrical and electronic operational control, recording, and alarm systems
4. Assist with the testing, location, and repair of damaged electrical circuitry and communication systems
5. Understand the basics of fiber optic systems
6. Read and interpret electrical schematics, including power distribution, motor control centers (MCCs), and programmable logic controller (PLC) control panels
7. Read and interpret process and instrumentation diagrams (P&ID), process flow diagrams (PFD), loop diagrams, functional diagrams, and networking diagrams including fiber optic, copper, and wireless installations
8. Identify equipment details from manuals and manufacturer documentation

Sub-Domain 2.2:

Equipment and Parts

1. Under direct supervision, maintain, repair, troubleshoot, and replace electrical and electronic equipment, including communication hubs, motors, pumps, generators, controllers, switchboards, switches and electronic boards, circuitry, components, and other equipment
2. Identify defects and assist in troubleshooting, testing, locating, calibrating, and repairing defects in instrumentation and electronic control equipment
3. Assist in solar, battery, and uninterruptable power supplies (UPS) maintenance
4. Demonstrate a basic understanding of conduit bending and installation

Domain 3: Safety, Tools, and Equipment

Sub-Domain 3.1:

Safety

1. Identify and understand occupational hazards and safety precautions necessary when working with Direct Current (DC) and Alternating Current (AC) power and voltages up to 480V maximum
2. Understand and perform confined space entries per CalOSHA regulations
3. Inspect electrical equipment and lighting to ensure safe and satisfactory functioning
4. Follow all OSHA guidelines, use safe work working practices, and report hazardous work conditions
5. Understand Arc Flash and boundaries, classified areas, and perform Lockout Tagout (LOTO)
6. Understand personal protective equipment (PPE) needs in electrical, mechanical, and chemical areas

Sub-Domain 3.2:

Codes

1. Basic understanding of applicable electrical codes (including the National Electrical Code pertaining to industrial and commercial, California Electrical Code, NFPA 820, 70, and 70E) for water professionals

Sub-Domain 3.3:

SCADA

1. Understand basic SCADA communications (radios, antennas, switches, routers), basic SCADA components (PLC, desktop, servers), and basic software used in SCADA systems (PLC programming, SCADA programming, communication and alarm servers, call out systems, etc.)
2. Understand the role of each device in the SCADA network professionals

Sub-Domain 3.4:

Tools and Equipment

1. Perform tool maintenance and general clean-up of tools, equipment, and work areas
2. Understand the difference between water and wastewater cleanliness for tools
3. Use a variety of diagnostic and test equipment including computers, process meters, and other equipment and devices to calibrate, repair, and maintain water / wastewater systems
4. Select and use appropriate hand tools and power tools for electrical tasks
5. Assist in the maintenance of electrical metering and telemetering equipment
6. Use appropriate measuring instrument to test voltage, amperage, resistance, electronic components, and 4-20 mA loops. Identify different categories of Digital Multimeter (DMM) and the appropriate application

7. Use cable and wire toners to locate circuits
8. Use CMMS to document maintenance, repairs, check spare part inventory, identify parts needed to complete a job, and order as needed
9. Identify and assess the health and functionality of different pumps and blowers

Domain 4: Documentation and Foundational Principles

Sub-Domain 4.1:

Documentation

1. At a basic level, read and interpret blueprints, wire and other diagrams, schematics, and electrical diagrams
2. Read basic PLC and other logic programs, including ladder logic, line, and function block programs
3. At a basic level, participate in the design of electrical systems as necessary
4. At a basic level, recommend development or changes to specifications
5. Maintain service records and daily logs
6. At a basic level, identify sources and participate in development of specification for requisitions for parts and electrical equipment

Sub-Domain 4.2:

Foundational Principles

1. Understand basic mechanical principles including length, width, levers, and pulleys
2. Understand basic electrical principles including Ohm's law, basic power, and energy consumption
3. Understand basic electronic principles including diodes, transistors, rectifiers, resistors, capacitors, coils, batteries, and inductors

Domain 5: Math

Sub-Domain 5.1:

Math

1. Measure dimensions accurately
2. Calculate area
3. Calculate volume
4. Calculate flow
5. Calculate velocity
6. Calculate pressure / head
7. Compute rate, ratio, and percent
8. Draw and interpret graphs
9. Compute ratings for motor overloads

10. Use basic geometry and trigonometry principles to determine component angles or configuration
11. Calculate the force of an electrical current (power, voltage, amperage, wattage)

Suggested References

CWEA's exam is based on a job task analysis that includes research of the essential duties of a Electrical & Instrumentation Technologist worker at a representative cross-section of systems and facilities in California. CWEA's exams do not correspond directly to any specific textbook, educational course, or program; instead, the exams are based on an analysis of the duties commonly performed in actual practice. In developing the exam, CWEA Subject Matter Experts used their years of experience in the field along with the key textbooks and reference materials listed below. Candidates should understand that the references listed do not necessarily cover all exam content. Candidates who meet the minimum qualifications for this exam may find these suggested references useful when preparing for this exam; however, these suggested references are not required reading and should not be interpreted as constituting the sole source of all exam questions.

This list does not include all the available textbooks and materials for studying for this exam. Candidates are strongly encouraged to seek additional material, training, and experience, especially in content areas for which the candidate is not adequately prepared. Candidates are encouraged to prepare for CWEA certification exams using as many different study materials as possible plus education events and on-the-job training. Candidates are encouraged to develop their own personal study plan based on individual needs and knowledge.

Domain 1 – Installation and Configuration	
Sub-Domain 1.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 450-459 Operation of Wastewater Treatment Plants Volume 1, 8th Edition. Pages 42-45, 56-60, 74, 89-100, 113-120 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 568-657, 706-709 Water Distribution System O & M, 7th Edition. Pages 173, 194, 197-201, 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 631-636 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 607-610, 633-675, 731
Sub-Domain 1.2	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 465-477 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 568-657, 706-709

	Water Distribution System O&M, 7th Edition. Pages 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 631-636, 647-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 633-675, 731
Domain 2 – Maintenance and Repair	
Sub-Domain 2.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 491-499 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-45, 56-60, 74, 89-100, 113-120 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 568-657, 706-709 Water Distribution System O & M, 7th Edition. Pages 264-265, 518-527 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 775-815 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 633-672, 731 Electrical Motor Controls for Integrated Systems, 5th Edition
Sub-Domain 2.2	Water Treatment Plant Operations, Volume 1, 7th Edition. Pages 36-51 Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 477-490 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 568-657, 706-709 Water Distribution System O&M, 7th Edition. Pages 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 631-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 607-610, 633-675, 731
Domain 3 – Safety, Tools, and Equipment	
Sub-Domain 3.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 85-97, 459-464, 690-716 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-45, 56-60, 74, 89-100, 113-120

	Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 596-616 Water Distribution System O&M, 7th Edition. Pages 392-399 Advanced Waste Treatment, 5th Edition. Pages 636-647 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 813-814 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 672 California Code of Regulations, Title 8, Section 5157 Confined Space Guide for General Industry, May 2019. State of California Department of Industrial Relations The Cal/OSHA Hazard Communication Regulation Control of Hazardous Energy, Lockout/Tagout, OSHA Title 29 CFR, 1910.147
Sub-Domain 3.2	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 85-97, 510-528 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 614-650 Water Distribution System O&M, 7th Edition. Pages 392-399 Advanced Waste Treatment, 5th Edition. Pages 631-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 788-801 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 646-660 NFPA 70, National Electrical Code (NEC) NFPA 70E, Standard for Electrical Safety in the Workplace NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities
Sub-Domain 3.3	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 491-495, 668-679 Water Distribution System O&M, 7th Edition. Pages 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 672-674 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 788-803 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 698, 725-731

Sub-Domain 3.4	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 450-459, 465-499 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 617-636 Water Distribution System O&M, 7th Edition. Pages 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 631-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 607-610, 633-675, 698, 731
Domain 4 – Documentation and Foundation Principles	
Sub-Domain 4.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 450-499, 668-679 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 617-636 Water Distribution System O&M, 7th Edition. Pages 568-572 Utility Management, 2nd Edition. Page 49 Manage for Success, 1st Edition. Pages 307-337 Advanced Waste Treatment, 5th Edition. Pages 631-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 607-610, 633-675, 731
Sub-Domain 4.2	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 510-528, 541-547, 573-579, 593-597 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 614-650 Advanced Waste Treatment, 5th Edition. Pages 636-640 Water Distribution System O&M, 7th Edition. Pages 173,194, 197-201, 392-399 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 788-803 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 633-672

Domain 5 – Math	
Sub-Domain 5.1	Water Treatment Plant Operations, Volume 1, 7th Edition. Pages 635-735 Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 734-820 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 944-1030 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 782-843 Water Distribution System O&M, 7th Edition. Pages 587-699

Suggested References List

- California Code of Regulations Title 8
  - Section 5157
- Advanced Waste Treatment, 5th Edition, Office of Water Programs
- Confined Space Guide for General Industry, May 2019. State of California Department of Industrial Relations
- Control of Hazardous Energy, Lockout/Tagout, OSHA, U.S. Department of Labor, 2002
- Electrical Motor Controls for Integrated Systems, 5th Edition, Gary J Rockis and Glen A Mazur
- Industrial Waste Treatment, Volume 1, 3rd Edition, Office of Water Programs
- Industrial Waste Treatment, Volume 2, 3rd Edition, Office of Water Programs
- Manage for Success, Effective Utility Leadership Practices, 1st Edition. Office of Water Programs
- NFPA 70, National Electrical Code (NEC)
- NFPA 70E, Standard for Electrical Safety in the Workplace
- NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- Operation of Wastewater Treatment Plants, Volume 1, 8th Edition, Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 2, 7th Edition, Office of Water Programs
- The Cal/OSHA Hazard Communication Regulation, Department of Industrial Relations, Division of Occupational Safety and Health, November 2020
- Title 29 CFR
  - 1910.147
- Utility Management, A Field Study Training Program, 2nd Edition. Office of Water Programs
- Water Distribution System O&M, 7th Edition, Office of Water Programs

- Water Treatment Plant Operations, Volume 1, 7th Edition, Office of Water Programs
- Water Treatment Plant Operations, Volume 2, 7th Edition, Office of Water Programs

Sample Questions

This section provides sample questions to help applicants become familiar with the exam format and subject matter.

1. What is the definition of plumb?
    a. Vertical trueness
    b. Horizontal trueness
    c. Vertical paring
    d. Horizontal paring
2. When you need to seal the shaft of a pump so that practically no leakage occurs, you would use:
    a. angle cut packing
    b. butt cut packing
    c. angle cut packing and a lantern ring
    d. a mechanical seal
3. The type of gear referred to as the basic gear, which has straight teeth that are parallel to the bore centerline, is called:
    a. a bevel gear
    b. a single helical gear
    c. a herringbone gear
    d. a spur gear
4. A pump needs to be repacked when:
    a. no more packing will fit into the stuffing box
    b. there is excessive leakage from the packing
    c. the packing is more than one year old
    d. the packing gland is pulled all the way down and there is excessive leakage
5. This type of screwdriver is very useful in starting screws in hard-to-reach areas.
    a. Split-tip
    b. Ratchet-handle
    c. Offset
    d. Electrician's
6. The best place to find out what personal protective gear is necessary when working with a chemical is:
    a. SDS
    b. container level
    c. EPA
    d. to consult other workers with previous experience
7. If you have been given written instructions that you do not understand:

a. do what you think is best
b. ask a co-worker
c. ask your supervisor
d. ask the author

8. Of the following, which would be most important when communicating with the public in person?
    a. Appearance and attitude
    b. Disheveled appearance
    c. Aggressiveness
    d. Answering the question even if you do not know the answer
9. A wet well measures 30 feet deep, 25 feet wide and 35 feet long. What is its capacity, in gallons?
    a. 3,509,000 gal
    b. 19,635,000 gal
    c. 26,250,000 gal
    d. 196,350 gal
10. A 480-volt system has a resistance of 20 ohms. What is the power consumed, in watts?
    a. 20 watts
    b. 24 watts
    c. 9,600 watts
    d. 11,520 watts

Answer Key and Solutions

1. A – Domain 1
2. D – Domain 1
3. D – Domain 2
4. C – Domain 2
5. A – Domain 3
6. A – Domain 3
7. D – Domain 4
8. A – Domain 4
9. D – Domain 5
   Solution:
   (30ftX25ftX35ft) X 7.48gal/cubic foot = 196,350 Gallons.
10. D – Domain 5
    Solution:
    Calculate current with ohms law which is E=IR, to solve for current it is I=E/R so 480v/20ohms = 24amps. Next solve for power which is current x voltage so 480Vx24amps= 11,520 watts

EIT GRADE 2 EXAM CONTENT OUTLINE

Content Domain	Weighting
Domain 1 – Installation and Configuration	18%
Domain 2 – Maintenance and Repair	23%
Domain 3 – Safety, Tools, and Equipment	25%
Domain 4 – Documentation and Foundational Principles	14%
Domain 5 – Administration and Training	11%
Domain 6 – Math	9%
Total	100%

Domain 1: Installation and Configuration

Sub-Domain 1.1:

Installation

1. Plan, install, modify and test water / wastewater site electrical equipment.
2. Research, design, replace, and install equipment and/or upgrade existing electrical/electronic systems
3. Understand basic cogeneration components and how cogeneration works
4. Install solar and wind generation systems as applicable, batteries, battery chargers, and uninterruptable power supplies (UPS)
5. Install pneumatic control valves and understand the configuration of the control scheme

Sub-Domain 1.2:

Configuration

1. Perform the configuration of process and instrumentation diagrams (P&ID), control loop parameters and logic for programmable logic controllers (PLC) and control systems
2. Configure variable frequency drives (VFDs), electromechanical valves, instrumentation (level sensors), pressure/temperature/flow transmitters, and similar analyzing instruments used in water / wastewater systems
3. Configure pneumatic and hydraulic control valves and sensors

4. Recommend adjustments, installation, and replacements for system improvements

Domain 2: Maintenance and Repair

Sub-Domain 2.1:

Systems

1. Maintain, repair, and configure electronic systems and Soft Starts
2. Identify, troubleshoot, adjust, and repair low voltage electrical problems in water / wastewater facilities
3. Maintain and repair electrical and electronic operational control, recording, and alarm systems
4. Test, locate, repair, and replace damaged electrical circuitry, communication systems
5. Understand basics of fiber optic systems
6. Read and interpret electrical schematics, including power distribution, motor control centers (MCCs), and programmable logic controller (PLC) control panels
7. Read and interpret process and instrumentation diagrams (P&ID), process flow diagrams (PFD), loop diagrams, functional diagrams, and networking diagrams including fiber optic, copper, and wireless installations
8. Identify equipment details from manuals and manufacturer documentation
9. Identify all components inside a PLC control panel, MCC bucket, Low Voltage (600V) and Medium Voltage (4160V) soft starters, and VFD control panels
10. Identify when system equipment is operating outside of specifications and the impact on system efficiency and maintenance

Sub-Domain 2.2:

Equipment and Parts

1. Maintain, repair, troubleshoot, and replace electrical and electronic equipment, including motors, pumps, generators, controllers, switchboards, switches and electronic boards, circuitry, and components
2. Repair or replace defective or inoperative electrical parts in communication hubs, motors, generators, pumps, controllers, switches, and other facilities and equipment
3. Troubleshoot, test, locate, correct, and repair defects in instrumentation and electronic control equipment
4. Maintain a variety of electronic control components used in operating electrical and mechanical equipment
5. Assist in solar, battery, and uninterruptable power supplies (UPS) maintenance

6. Demonstrate a basic understanding of conduit bending and installation

Sub-Domain 2.3:

Coordination of Repair and Maintenance

1. Coordinate repair and maintenance activities with operators and outside agency technical personnel to ensure water / wastewater processes are not impacted

Domain 3: Safety, Tools, and Equipment

Sub-Domain 3.1:

Safety

1. Identify and understand occupational hazards and safety precautions necessary when working with Direct Current (DC) and Alternating Current (AC) power and voltages up to 600V maximum
2. Understand the effects of hazardous chemical conditions encountered in water / wastewater treatment facilities and demonstrate knowledge of safety data sheets (SDS)
3. Perform confined space entries per CalOSHA regulations and safely use self-contained breathing apparatus (SCBA)
4. Inspect electrical equipment and lighting to ensure safe and satisfactory functioning
5. Follow all OSHA guidelines, use safe work working practices, and report hazardous work conditions
6. Understand Arc Flash and boundaries, classified areas, and perform Lockout Tagout (LOTO)
7. Understand personal protective equipment (PPE) needs in electrical, mechanical, and chemical areas

Sub-Domain 3.2:

Codes

1. Understand applicable electrical codes (including the National Electrical Code pertaining to industrial and commercial, the California Electrical Code, NFPA 820, 70, and 70E) for water professionals

Sub-Domain 3.3:

SCADA

1. Use a programming device to communicate with the SCADA system, PLCs, controllers, RTUs, radios, and smart instruments
2. Assist in the maintenance and general programming of SCADA system

3. Understand the methods, practices, and equipment used in the installation, construction, repair, maintenance, testing, and adjustment made to SCADA systems used in water / wastewater treatment operations
4. Understand SCADA hardware components (field instruments, PLCs, desktops, servers, graphical user interface), and software components (PLC/RTU programming, SCADA programming/configuration, communication protocols and configuration)
5. Understand networking protocols including VLAN partitions

Sub-Domain 3.4:

Tools and Equipment

1. Use a variety of diagnostic and test equipment including computers and other specialized equipment and devices to calibrate, repair, and maintain water / wastewater systems
2. Use and operate a variety of electrical, electronic, and mechanical tools, instruments, and equipment
3. Research equipment and parts information and order the necessary parts to maintain equipment and make effective repairs
4. Understand the programming of controllers used in water / wastewater treatment systems
5. Use appropriate measuring instrument to test voltage, amperage, resistance, electronic components, and 4-20 mA loops. Identify different categories of Digital Multimeter (DMM) and the appropriate application
6. Use cable and wire toners to locate circuits
7. Use CMMS to document maintenance, repairs, check spare part inventory, identify parts needed to complete a job, and order as needed
8. Identify and assess the health and functionality of process equipment in water / wastewater treatment facilities (e.g., pumps, blowers, etc.)
9. Maintain electrical metering and telemetering equipment
10. Perform tool maintenance and general clean-up of tools, equipment, and work areas
11. Understand the difference between water and wastewater cleanliness for tools

Domain 4: Documentation and Foundational Principles

Sub-Domain 4.1:

Documentation

1. Prepare, read, and/or interpret prints, P&IDs, wire diagrams, schematics, and other diagrams

2. Read basic PLC and other logic programs, including ladder logic, line, and function block programs
3. Participate in the design of electrical systems as necessary
4. Recommend development or changes to specifications
5. Maintain service records and daily logs
6. Identify sources and participate in development of specification for requisitions for parts and electrical equipment

Sub-Domain 4.2:

Foundational Principles

1. Understand basic mechanical principles including length, width, levers, and pulleys
2. Understand basic thermodynamics
3. Understand basic electrical principles including Ohm's law, basic power, and energy consumption
4. Understand basic electronic principles including diodes, transistors, rectifiers, resistors, capacitors, coils, batteries, and inductors

Domain 5: Administration and Training

Sub-Domain 5.1:

Administration

1. Estimate cost, time, and labor requirements
2. Requisition materials
3. Record and schedule maintenance work
4. Prepare bill of materials for all work and repair including parts, trade descriptions, and cost
5. Build and maintain positive working relationships with coworkers, other employees, and the public using principles of good customer service
6. Understand basic budgeting
7. Create equipment repair and operations instructions

Sub-Domain 5.2:

Training

1. Assist in the training of operations and maintenance personnel on the safe operation of new or modified electrical systems and equipment
2. Assist in the training of subordinate personnel

Domain 6: Math

Sub-Domain 6.1:

Math

1. Measure dimensions accurately
2. Calculate area
3. Calculate volume
4. Calculate flow
5. Calculate velocity
6. Calculate pressure / head
7. Compute rate, ratio, and percent
8. Draw and interpret graphs
9. Compute amperage rating for conductors
10. Compute ratings for motor overloads
11. Use basic geometry and trigonometry principles to determine component angles or configuration
12. Calculate the force of an electrical current (power, voltage, amperage, wattage)

Suggested References

CWEA's exam is based on a job task analysis that includes research of the essential duties of a Electrical & Instrumentation Technologist at a representative cross-section of systems and facilities in California. CWEA's exams do not correspond directly to any specific textbook, educational course, or program; instead, the exams are based on an analysis of the duties commonly performed in actual practice. In developing the exam, CWEA Subject Matter Experts used their years of experience in the field along with the key textbooks and reference materials listed below. Candidates should understand that the references listed do not necessarily cover all exam content. Candidates who meet the minimum qualifications for this exam may find these suggested references useful when preparing for this exam; however, these suggested references are not required reading and should not be interpreted as constituting the sole source of all exam questions.

This list does not include all the available textbooks and materials for studying for this exam. Candidates are strongly encouraged to seek additional material, training, and experience, especially in content areas for which the candidate is not adequately prepared. Candidates are encouraged to prepare for CWEA certification exams using as many different study materials as possible plus education events and on-the-job training. Recommended reading from the Office of Water Programs (which is a third-party) was provided by their team based on their expertise and review of CWEA's content outlines. Candidates are encouraged to develop their own personal study plan based on individual needs and knowledge.

Domain 1 – Installation and Configuration	
Sub-Domain 1.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 450-459 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-45, 56-60, 74, 89-100, 113-120 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 568-657, 706-709 Water Distribution System O&M, 7th Edition. Pages 173, 194, 197-201, 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 631-636 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 607-610, 633-675, 731

	Electrical Motor Controls for Integrated Systems, 5th Edition,
Sub-Domain 1.2	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 465-477 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 568-657, 706-709 Water Distribution System O&M, 7th Edition. Pages 173, 194, 197-201, 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 631-636, 647-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 633-675, 731 Instrumentation & Control, 3rd Edition
Domain 2 – Maintenance and Repair	
Sub-Domain 2.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 491-499 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-45, 56-60, 74, 89-100, 113-120 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 568-657, 706-709 Water Distribution System O&M, 7th Edition. Pages 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 631-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 775-815 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 633-672, 731 Instrumentation & Control, 3rd Edition Electric Motor Maintenance and Troubleshooting, 2nd Edition
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Sub-Domain 2.3	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 450-459, 668-679 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-45, 56-60, 74, 89-100, 113-120 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 568-657, 706-709 Water Distribution System O&M, 7th Edition. Pages 518-527, 568-572 Advanced Waste Treatment, 5th Edition. Pages 631-636 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 607-610, 633-675, 731
Domain 3 – Safety, Tools, and Equipment	
Sub-Domain 3.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 459-464, 690-716 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-45, 56-60, 74, 89-100, 113-120 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 596-616 Water Distribution System O&M, 7th Edition. Pages 392-399 Utility Management, 2nd Edition. Pages 39-47 Manage for Success, 1st Edition. Pages 337-385 Advanced Waste Treatment, 5th Edition. Pages 636-647 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 813-814 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Page 672 Control of Hazardous Energy, Lockout/Tagout, OSHA Title 29 CFR, 1926.32(f)
Sub-Domain 3.2	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 510-528

	Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 614-650 Water Distribution System O&M, 7th Edition. Pages 392-399 Advanced Waste Treatment, 5th Edition. Pages 631-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 788-801 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 646-660 NFPA 70, National Electrical Code (NEC) NFPA 70E, Standard for Electrical Safety in the Workplace NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities
Sub-Domain 3.3	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 491-495, 668-679 Water Distribution System O&M, 7th Edition. Pages 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 672-674 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 788-803 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 698, 725-731
Sub-Domain 3.4	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 450-459, 465-499 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 617-636 Water Distribution System O&M, 7th Edition. Pages 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 631-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 607-610, 633-675, 698, 731
Domain 4 – Documentation and Foundation Principles	
Sub-Domain 4.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 450-499, 668-679 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 617-636 Water Distribution System O&M, 7th Edition. Pages 568-572

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Sub-Domain 4.2	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 510-528, 541-547, 573-579, 593-597 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 614-650 Water Distribution System O&M, 7th Edition. Pages 173, 194, 197-201, 392-399 Advanced Waste Treatment, 5th Edition. Pages 636-640 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 788-803 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 633-672
Domain 5 – Administration and Training	
Sub-Domain 5.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 623-729 Water Distribution System O&M, 7th Edition. Pages 168-169, 474-580, 518-527 Utility Management, 2nd Edition. Page 28-49 Manage for Success, 1st Edition. Pages 279-385 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-43
Sub-Domain 5.2	Manage for Success, 1st Edition. Pages 169-199 Water Distribution System O&M, 7th Edition. Pages 168-169, 481-500, 539-567
Domain 6 – Math	
Sub-Domain 6.1	Water Treatment Plant Operations, Volume 1, 7th Edition. Pages 635-735 Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 734-820

	Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 944-1030 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 782-843 Water Distribution System O&M, 7th Edition. Pages 587-699 NFPA 70, National Electrical Code (NEC) Instrumentation & Control, 3rd Edition

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- Electric Motor Maintenance and Troubleshooting, 2nd Edition, Augie Hand
- Industrial Waste Treatment, Volume 1, 3rd Edition, Office of Water Programs
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- Instrumentation & Control, 3rd Edition, American Water Works Association
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- NFPA 70, National Electrical Code (NEC)
- NFPA 70E, Standard for Electrical Safety in the Workplace
- NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities
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- Water Distribution System O&M, 7th Edition, Office of Water Programs

- Water Treatment Plant Operations, Volume 1, 7th Edition, Office of Water Programs
- Water Treatment Plant Operations, Volume 2, 7th Edition, Office of Water Programs

Sample Questions

This section provides sample questions to help applicants become familiar with the exam format and subject matter.

1. The choice between across-the-line starting and reduced-voltage starting depends in part on the size of the:
    a. starter
    b. wire size
    c. motor
    d. breaker
2. Commonly used instead of fuses in industrial power distribution systems are:
    a. disconnects
    b. motor starters
    c. current relays
    d. circuit breakers
3. The configuration in which individual computers are connected for the purpose of communication is a:
    a. CPU
    b. BIU
    c. network
    d. loop
4. The small region of an instrument range where input changes cause no corresponding output change is called:
    a. range
    b. deadband
    c. span
    d. linear
5. Voltage testers are typically used to:
    a. cut off power to a circuit
    b. distinguish between AC and DC circuits.
    c. measure potential differences.
    d. verify that the circuit is de-energized.
6. Rubber safety gloves should be tested how often?
    a. Every 12 months
    b. Every 9 months
    c. Every 6 months
    d. Every 4 months

7. The drawing that provides a view of the entire system in process control is the:

a. P&ID drawing
b. I/P drawing
c. element drawing
d. primary drawing

8. A tag number with a code reading FRC identifies a:
    a. field recording controller
    b. flow recorder controller
    c. temperature controller
    d. pressure recorder
9. Making job planning a group effort:
    a. wastes time
    b. improves productivity
    c. causes confusion
    d. All the above
10. Anticipating other tasks or problems:
    a. usually creates additional problems
    b. wastes time
    c. sharply reduces the number of emergencies
    d. often is not worth the effort
11. What is the pressure in units (psi) if the height of a column of water is 55.4 inches?
    a. 2 psi
    b. 4.1 psi
    c. 27 psi
    d. 55.4 psi
12. What is the current for a 120-volt circuit with a 1440-watt load?
    a. 0.083 amperes
    b. 10 amperes
    c. 12 amperes
    d. 15 amperes

Answer Key and Solutions

1. C – Domain 1
2. D – Domain 1
3. C – Domain 2
4. B – Domain 2
5. C – Domain 3
6. C – Domain 3
7. A – Domain 4
8. B – Domain 4
9. B – Domain 5
10. C – Domain 5
11. A – Domain 6
    Solution:
    55.4/27.7 =
    1 psi is 27.7 in/wc, would need formula tables/conversion tables
12. C – Domain 6
    Solution:
    1440/120 = 12
    Power(watts) = Voltage x Current, so Current = Power/Voltage

EIT GRADE 3 EXAM CONTENT OUTLINE

Content Domain	Weighting
Domain 1 – Installation, Inspection, and Design	21%
Domain 2 – Maintenance and Repair	21%
Domain 3 – Safety, Tools, and Equipment	16%
Domain 4 – Documentation and Foundational Principles	18%
Domain 5 – Administration and Training	16%
Domain 6 – Math	8%
Total	100%

Domain 1: Installation, Inspection, and Design

Sub-Domain 1.1:

Installation

1. Participate directly in site upgrades and the planning of new construction
2. Participate directly in the installation and testing of system-wide electrical infrastructure and control strategies in accordance manufacturer procedures and standard industry practice
3. Understand basic installation and operational principles of medium voltage (above 4160V) power generation equipment, switchgear, and protective devices
4. Understand basic installation practices for fiber optic cabling and interface devices
5. Interface with vendors, computer software and hardware specialists, engineers, and plant operating personnel in order to obtain information to meet water / wastewater system electrical and instrumentation objectives
6. Serve as the project point of contact in the installation of electrical, instrumentation, and control equipment, circuits, and components

7. Recommend solar and wind generation systems as applicable, batteries, battery chargers, uninterruptable power supplies (UPS), cogeneration systems, and other new electrical equipment
8. Evaluate and recommend instrumentation, electrical distribution, control systems, and network protocols
9. Understand proper grounding of medium voltage (MV) equipment
10. Review and comment on construction plans and specifications prior to the public bid process

Sub-Domain 1.2:

Inspection

1. Perform testing on electrical equipment, circuits, and components to identify abnormalities such as shorts, ground faults, open circuit conditions, and insulation/dielectric strength breakdown
2. Perform ultrasonic testing on electrical equipment to identify possible fault conditions
3. Understand and interpret thermography testing results of electrical equipment to identify possible fault conditions
4. Understand and interpret vibration analysis results of electrical equipment to identify possible fault conditions
5. Assist with capital improvement project quality control inspections

Sub-Domain 1.3:

Design

1. Participate in the design of logic instructions and programs using one of the International Electrotechnical Commission (IEC 61131-3) programming languages
2. Participate in the design of various control, data, power, and process system
3. Participate in the review and design of process analyzer installations
4. Participate in the review and design of motor control circuits

Domain 2: Maintenance and Repair

Sub-Domain 2.1:

Systems

1. Supervise and perform maintenance, repair, configuration, and troubleshooting of complex electrical instrumentation, and control system equipment
2. Recommend equipment modifications or upgrades to improve safety and process efficiency
3. Understand proper bus transfer procedures
4. Oversee staff and electrical contractors hired to ensure the completion of safe and compliant projects

5. Perform calibration of instruments, maintain records, and document results

Sub-Domain 2.2:

Equipment and Parts

1. Maintain, repair, troubleshoot, and replace electrical and electronic equipment, including motors, pumps, generators, controllers, switchboards, switches and electronic boards, circuitry, and components
2. Repair or replace defective or inoperative electrical parts in communication hubs, motors, generators, pumps, controllers, switches, and other facilities and equipment
3. Troubleshoot, test, locate, correct, and repair defects in instrumentation and electronic control equipment
4. Maintain a variety of electronic control components used in operating electrical and mechanical equipment

Sub-Domain 2.3:

Coordination of Repair and Maintenance

1. Coordinate repair and maintenance activities with operators and outside agency technical personnel to ensure optimal efficiency of procedures and process
2. Provide technical supervision, inspection, and coordination over control system modifications by contractors
3. Schedule, assign, and follow up on preventative and corrective maintenance of equipment using computer maintenance management systems (CMMS)
4. Communicate alternate steps with staff and contractors in the event that failures occur

Domain 3: Safety, Tools, and Equipment

Sub-Domain 3.1:

Safety

1. Evaluate working conditions to recognize hazardous chemical conditions in water / wastewater settings
2. Consult Safety Data Sheets (SDS) to establish proper handling procedures, protective equipment, first aid, firefighting, and accidental release measures
3. Perform confined space entries per Cal-OSHA regulations
4. Use personal protective equipment (PPE) in alignment with regulatory authority and manufacturer instructions
5. Identify potential occupational hazards and employ appropriate hazard control methods (elimination, substitution, engineering controls, administrative controls, PPE, etc.)

6. Monitor subordinate personnel to ensure regulatory and agency precautions and procedures are understood and followed
7. Employ regulatory and agency compliant energy control plan
8. Execute agency standard operating procedures (SOPs) to negate hazardous energy under energy control plan
9. Assist in the development and implementation of agency safety and training programs
10. Identify and understand occupational hazards and safety precautions necessary when working with Direct Current (DC) and alternating current (AC) power at low and medium voltages

Sub-Domain 3.2:

Codes

1. Understand and apply National Fire Protection Association (NFPA) 70E Standards for Electrical Safety in the Workplace
2. Understand and apply National Fire Protection Association (NFPA) 70 National Electrical Code (NEC)
3. Understand and apply National Fire Protection Association (NFPA) 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities
4. Understand and apply California Occupational Safety and Health Administration (Cal-OSHA) Title 8 D1C4.5 Electrical Safety Orders
5. Understand and apply the California Electrical Code (CEC)

Sub-Domain 3.3:

SCADA

1. Participate in the development and implementation of functional requirements, specifications, purchase, and commissioning of highly complex computer-based systems for monitoring and control of water / wastewater facilities
2. Operate and manage the SCADA system to reflect the current condition of the utility system
3. Perform preventative and corrective maintenance on process instruments and controllers in accordance with manufacturer instructions
4. Perform verifications and calibrations on process instruments and controllers in accordance with manufacturer instructions or industry practice
5. Install and perform initial configuration on controllers and instruments in accordance with manufacturer instructions or industry practice
6. Direct and participate in the development and implementation of all database modifications in computer-directed control systems for equipment additions, modifications, and deletions for current system operation

7. Assist in checking control loops, validating telemetry inputs and outputs, and assuring proper PLC and SCADA system functionality

Sub-Domain 3.4:

Tools and Equipment

1. Operate computer terminals, portable programming units, and complex electrical test equipment
2. Clean and replace control apparatus and associated equipment on all types of electrical devices, motors, controls, panels, and switchboards
3. Use a variety of diagnostic and test equipment including meggers, volt meters, ohm meters, scope meters, phase rotation meters
4. Understand the uses of oscilloscopes and optical time-domain reflectometers (OTDR), frequency generators, hi-pot, thermal and ultrasonic measuring devices, and vibration analysis
5. Arrange for and participate in rigging and hoisting heavy electrical equipment in electrical installations
6. Inspect, clean, lubricate, and replace bearing, brushes, and auxiliary equipment on large high voltage motors and generators
7. Identify tools and equipment used in the installation, testing, maintenance, and repair of electronic systems, meters, telemetering and instrumentation equipment, microprocessors, and related items

Domain 4: Documentation and Foundational Principles

Sub-Domain 4.1:

Documentation

1. Create preliminary and post-construction drawings of equipment modifications and new installations
2. Prepare, read, and interpret technical illustrations, prints, maps, plans, specifications, schematics, and other diagrams
3. Prepare wiring diagrams, material lists, and cost estimates
4. Manage data files, develop record keeping procedures, and draft forms and reports
5. Review and comment on construction plans and specifications prior to the public bid process
6. Document as-built changes made to electrical or control systems (e.g., autocad, visio, red lines, etc.)
7. Read advanced PLC and other logic programs, including ladder logic, line, function block and structured text programs
8. Lead the design of electrical systems as necessary

9. Lead development or changes to specifications

Sub-Domain 4.2:

Foundational Principles

1. Understand general principles and practices of electrical engineering and data processing, including electrical circuits, AC/DC electrical power supplies, and supervisory controls
2. Understand modern methods and techniques used in maintaining and operating a wide variety of substation and central control systems, and communication equipment
3. Understand functional, operational, and testing principles of solid-state electronics, solid-state and electro-mechanical controls, and real-time computer control systems.
4. Understand principles and practices of PLC programming, theory and operation of digital computers, PLCs, and water / wastewater instrumentation.
5. Understand electrical principles including Ohm's law, Kirchoff's law, power, and energy consumption
6. Understand thermodynamics related to electrical and instrumentation in water / wastewater settings

Domain 5: Administration and Training

Sub-Domain 5.1:

Administration

1. Estimate cost, time, and labor requirements
2. Requisition materials
3. Record and schedule maintenance work
4. Prepare bill of materials for all work and repair including parts, trade descriptions, and cost
5. Interface with engineering and operations divisions of the electric and water systems to assist in the development and implementation of goals, objectives, policies, and priorities
6. Prepare required plans and secure permits
7. Assist in budget preparation and administration
8. Perform, check, and supervise implementation of station and central control projects in close communication with utility personnel
9. Coordinate and prepare request for bid documents
10. Generate reports based on CMMS data, service records and daily logs

Sub-Domain 5.2:

Training

1. Supervise, train, and evaluate subordinate personnel
2. Provide technical advice and support to all staff
3. Assist in the development and implementation of training programs
4. Assist in providing network security training

Domain 6: Math

Sub-Domain 6.1:

Math

1. Calculate values common to electrical circuits and instrumentation devices
2. Draw and interpret complex graphs
3. Perform basic algebra and trigonometry in determining values for more complex calculations
4. Understand decimal, binary, octal, and hexadecimal number systems
5. Calculate complex equations for volume and flow

Suggested References

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Domain 6 – Math	
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Sample Questions

This section provides sample questions to help applicants become familiar with the exam format and subject matter.

1. A shield around the signal lead is the most effective protection against:
    a. impedance
    b. unwanted conductance
    c. noise
    d. inverted sources
2. How many signal conditions can digital I/O devices have?
    a. one
    b. two
    c. eight
    d. an infinite number
3. Which of the following is a sign of overheating rotor bars?
    a. reduced starting torque
    b. noise
    c. discoloration
    d. all of the above
4. The RS232C standard applies to what type of digital data transmission?
    a. balanced
    b. fiber optic
    c. parallel
    d. serial
5. The NEC identifies environments that contain flammable vapors and gases as which class of hazardous locations?
    a. Class I
    b. Class II
    c. Class III
    d. Class IV
6. An ammeter should be connected:
    a. across the line.
    b. around an inductor.
    c. in parallel with the load.
    d. in series with the load

7. In the ISA tag PIC-21, the P stands for
    a. positive
    b. pressure
    c. process
    d. proportional
8. Control systems are usually designed so that each individual circuit controls:
    a. all functions of the machine
    b. at least two functions
    c. only one function
    d. only one device
9. Scheduling should precede:
    a. planning
    b. material procurement
    c. workload balancing
    d. job execution
10. The best way to motivate a crew is though:
    a. force
    b. playing favorites
    c. recognition
    d. threats
11. What is the volume of a cylinder with a 40-foot diameter and height of 23 feet?:
    a. 1,444 cu ft
    b. 7,222 cu ft
    c. 28,888 cu ft
    d. 33,221 cu ft
12. One gallon of water weighs 8.34 pounds and one cubic foot contains 7.48 gallons of water. A fish tank measures 36 inches long, 24 inches wide and 20 inches high. How many pounds of water will be in the fish tank?
    a. 64.4 lbs
    b. 74.8 lbs
    c. 83.4 lbs
    d. 624 lbs

Answer Key and Solutions

1. C – Domain 1
2. B – Domain 1
3. C – Domain 2
4. D – Domain 2
5. A – Domain 3
6. D – Domain 3
7. B – Domain 4
8. C – Domain 4
9. D – Domain 5
10. C – Domain 5
11. C – Domain 6

    Solution:

    Area = 3.14(40/2) sq = 1256 sq ft

    Volume = area x height = 1256 sq ft x 23 ft = 28,888 cu ft
12. D – Domain 6

    Solution:

    36 in x 24 in x 20 in= 17280 cu in

    1728 cu in per cu ft

    17280/1728= 10 cu ft

    10 cu ft x 7.48 gallons = 74.8 gallons

    *8.34 lb*74.8 gallons = 624 lb*

EIT GRADE 4 EXAM CONTENT OUTLINE

Content Domain	Weighting
Domain 1 – Installation, Inspection, and Design	26%
Domain 2 – Maintenance and Repair	20%
Domain 3 – Safety, Tools, and Equipment	19%
Domain 4 – Documentation	12%
Domain 5 – Administration	23%
Total	100%

Domain 1: Installation, Inspection, and Design

Sub-Domain 1.1:

Installation

1. Schedule, assign, oversee, and participate in the installation of electrical equipment including switchgear, controllers, electric motors, motor control centers, etc.
2. Supervise and participate in the installation and testing of system-wide electrical infrastructure and control strategies, including conduit, wiring, relays, control and timing devices, electronic metering, and telemetering equipment
3. Supervise and participate in site upgrades and the planning of new construction
4. Supervise and participate in the installation and testing of system-wide electrical infrastructure and control strategies in accordance manufacturer procedures and standard industry practice
5. Understand the requirements for electric vehicle charging station installation.
6. Understand the components, benefits, and challenges of various renewable energy sources (solar, wind, biogas, etc.) in order to participate in the design and oversee implementation, construction, and acceptance testing of renewable energy supply projects

Sub-Domain 1.2:

Inspection

1. Inspect existing electrical equipment, circuits, and control systems to ensure compliance with all applicable regulatory requirements
2. Inspect new construction and upgrades to electrical equipment, circuits, and control system to ensure compliance with all applicable regulatory requirements
3. Review plans and specifications for new construction and retrofit work for compliance with all regulatory and agency requirements
4. Perform capital improvement project quality control inspections

Sub-Domain 1.3:

Design

1. Design of logic instructions and programs using one of the International Electrotechnical Commission (IEC 61131-3) programming languages
2. Design various control, data, power, and process systems
3. Review and design process analyzer installations
4. Review and design motor control circuits

Domain 2: Maintenance and Repair

Sub-Domain 2.1:

Systems

1. Understand the principles and practices of maintenance and repair to electrical systems, industrial electrical control systems, radio and fiber optic communication networks, and electronic services
2. Plan, prioritize, assign, supervise, and review the work of staff involved in the maintenance and repair of utility-related industrial electrical controls and systems, and electronic communication systems
3. Understand the principles, practices, and uses of computers, programmable logic controllers (PLC), smart relays, transducers, and other SCADA and telemetry equipment in the electrical maintenance field
4. Understand the principles, practices, and uses of electrical and instrumentation systems

Sub-Domain 2.2:

Equipment and Parts

1. Oversee the maintenance, repair, troubleshooting, and replacement of all electrical equipment, controls, and instrumentation
2. Oversee maintenance and repair to cogeneration equipment, electrical distribution equipment (wiring, switchgear, breakers, etc.), motor control centers, motors, and all other electrical equipment

3. Supervise and participate in troubleshooting and repair defects in complex electrical and electronic circuits and instrumentation equipment
4. Identify and correct SCADA and PLC programming issues
5. Schedule, assign, supervise, and participate in the maintenance and repair of all electrical and electronic equipment
6. Understand, in depth, maintenance and repair principles and practices related to solid state devices, circuits, wiring, and equipment
7. Understand rigging and hoisting requirements for heavy equipment
8. Understand, in depth, requirements of solar, wind, battery, battery back-up, and uninterruptable power supplies (UPS) maintenance
9. Understand internal functioning and connections motors, generators, and other rotating electrical equipment

Domain 3: Safety, Tools, and Equipment

Sub-Domain 3.1:

Safety

1. Ensure all work is performed in compliance with all applicable safety regulations, laws, and requirements
2. Oversight of all NFPA 70E Arc-Flash safety regulatory compliance
3. Understand Hazardous Energy Control Program requirements, including LOTO procedures and safe working practices on or in proximity to energized low and high voltage conductors and equipment
4. Evaluate working conditions to recognize hazardous chemical conditions in water / wastewater settings
5. Identify potential occupational hazards in water / wastewater settings and employ appropriate hazard control methods (elimination, substitution, engineering controls, administrative controls, PPE, etc.)
6. Ensure equipment manuals and documentation are up to date
7. Oversee the development and implementation of agency safety programs
8. Oversee confined space entries per Cal-OSHA regulations
9. Monitor the use personal protective equipment (PPE) in alignment with regulatory authority and manufacturer instructions
10. Monitor subordinate personnel to ensure regulatory and agency precautions and procedures are understood and followed
11. Develop and oversee regulatory and agency compliant energy control plan
12. Develop agency standard operating procedures (SOPs) to negate hazardous energy under energy control plan

13. Identify and understand occupational hazards and safety precautions necessary when working with Direct Current (DC) and alternating current (AC) power at low and medium voltages

Sub-Domain 3.2:

Codes

1. Understand and ensure compliance with all applicable regulatory requirements with regard to safety and industry best practice
2. Ensure compliance with the California Electrical Code (CEC),
3. Ensure compliance with the National Fire Protection Association (NFPA) 70 National Electrical Code (NEC)
4. Ensure compliance with the National Electrical Safety Code
5. Ensure compliance with the National Fire Protection Association (NFPA) 70B, Recommended Practice for Electrical Equipment Maintenance (NFPA 70B)
6. Ensure compliance with the National Fire Protection Association (NFPA) 70E Standards for Electrical Safety in the Workplace
7. Ensure compliance with the National Fire Protection Association (NFPA) 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities
8. Ensure compliance with the California Occupational Safety and Health Administration (Cal-OSHA) Title 8 D1C4.5 Electrical Safety Orders

Sub-Domain 3.3:

Tools and Equipment

1. Operate a variety of electrical and electronic programming, diagnostic, and test equipment
2. Understand, in depth, the tools and equipment used in the construction, installation, maintenance, and repair of electrical systems
3. Develop calibration and maintenance program for electrical and electronic programming, diagnostic, and test equipment

Domain 4: Documentation

Sub-Domain 4.1:

Documentation

1. Prepare field drawings and estimates for electrical maintenance purposes
2. Prepare, read, and interpret technical illustrations, prints, maps, plans, specifications, schematics, manuals, wiring diagrams, pneumatic diagrams, P&ID diagrams, electrical diagrams, and loop diagrams
3. Generate sketches and layouts for electrical construction, alterations, replacement, or extension

4. Supervise and assist in documenting updates and changes made to electrical or control systems (e.g., field changes, autocad, visio, red lines, etc.)
5. Ensure compliance with regulatory documentation requirements

Domain 5: Administration

Sub-Domain 5.1:

Staffing

1. Participate in the selection and recommendation of the appointment of personnel
2. Supervise, plan, lay out, assign, coordinate, schedule, review, and inspect the work of subordinates
3. Establish performance standards for personnel, implement discipline procedures, and work with staff to correct deficiencies
4. Oversee, coordinate, and document staff training
5. Oversee, coordinate, and document safety training for subordinates
6. Participate in employee development and advancement initiatives and succession planning

Sub-Domain 5.2:

Policies and Procedures

1. Participate in the development and implementation of policies and procedures and monitor work activities to ensure compliance
2. Evaluate operations and activities of assigned responsibilities and recommend improvements and modifications
3. Develop and recommend policies and procedures related to assigned operations
4. Recommend and assist in the implementation of goals and objectives

Sub-Domain 5.3:

Budgeting

1. Participate in budget preparation, development, and administration
2. Prepare cost estimates for budget recommendations
3. Develop and submit justifications for equipment, materials, and supplies
4. Monitor and control expenditures

Sub-Domain 5.4:

Reports and Records

1. Prepare material lists and estimates for costs, time, and labor requirements
2. Oversee and maintain inventory or electrical and electronic parts, materials, equipment, and supplies

3. Prepare various reports on operations and activities, including time, work, and material reports
4. Keep maintenance logs and other records
5. Use CMMS to document maintenance, repairs, and inventory
6. Maintain and evaluate records of electrical maintenance, repair, and inspection activities
7. Prepare required plans and secure electrical permits
8. Understand and comply with all document and record retention policies

Sub-Domain 5.5:

Coordination and Review

1. Assist in coordinating electrical services activities with other departments, divisions, and outside agencies
2. Review plans and specifications for contract work and inspect work performed by contractors to ensure compliance with standards
3. Respond to inquiries and provide information to the public
4. Investigate complaints and recommend corrective action
5. Establish and maintain effective working relationships with those contacted in the course of work, including peers, operators, direct reports, superiors, vendors, contractors, customers, and the public
6. Respond to and maintain order in emergency situations

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	Industrial Wastewater Treatment, Volume 2, 3rd Edition. Page 672 Title 29 CFR, 1910.147
Sub-Domain 3.2	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 510-528 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 614-650 Water Distribution System O&M, 7th Edition. Pages 392-399 Advanced Waste Treatment, 5th Edition. Pages 631-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 788-801 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 646-660 NFPA 70, National Electrical Code (NEC) NFPA 70B, Recommended Practice for Electrical Equipment Maintenance California Code of Regulations Title 8, Section 5157
Sub-Domain 3.3	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 450-459, 465-499 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 617-636 Water Distribution System O&M, 7th Edition. Pages 264-265, 518-527 Advanced Waste Treatment, 5th Edition. Pages 631-678 Industrial Wastewater Treatment, Volume 1, 3rd Edition. Pages 749-752, 775-817 Industrial Wastewater Treatment, Volume 2, 3rd Edition. Pages 607-610, 633-675, 698, 731 NFPA 70B, Recommended Practice for Electrical Equipment Maintenance California Code of Regulations Title 8, Section 3314
Domain 4 – Documentation	
Sub-Domain 4.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 450-499, 668-679 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 617-636 Water Distribution System O&M, 7th Edition. Pages 568-572

	Utility Management, 2nd Edition. Pages 6-49 Manage for Success, 1st Edition. Pages 307-337
Domain 5 – Administration	
Sub-Domain 5.1	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 623-729 Water Distribution System O&M, 7th Edition. Pages 168-169, 474-580, 518-527 Utility Management, 2nd Edition. Page 28-49 Manage for Success, 1st Edition. Pages 101-385 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-43
Sub-Domain 5.2	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 624-729 Water Distribution System O&M, 7th Edition. Pages 473-580 Utility Management, 2nd Edition. Pages 1-49 Manage for Success, 1st Edition. Pages 131-405 NFPA 70B, Recommended Practice for Electrical Equipment Maintenance
Sub-Domain 5.3	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 624-729 Water Distribution System O&M, 7th Edition. Pages 511-518 Utility Management, 2nd Edition. Pages 28-30 Manage for Success, 1st Edition. Pages 279-307
Sub-Domain 5.4	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 652-653, 656-660, 668-679, 716-721 Water Distribution System O&M, 7th Edition. Pages 501-503, 506-510, 568-572 Utility Management, 2nd Edition. Pages 47-49 Manage for Success, 1st Edition. Pages 71-101, 307-337, 385-405
Sub-Domain 5.5	Water Treatment Plant Operations, Volume 2, 7th Edition. Pages 624-729 Water Distribution System O&M, 7th Edition. Pages 473-580 Utility Management, 2nd Edition. Pages 1-49 Manage for Success, 1st Edition. Pages 7-405

Suggested References List

- California Code of Regulations Title 8
  - Section 2320.2
  - Section 2700
  - Section 3314
  - Section 5157
- Advanced Waste Treatment, 5th Edition, Office of Water Programs
- Electric Motor Maintenance and Troubleshooting, 2nd Edition, Augie Hand
- Industrial Waste Treatment, Volume 1, 3rd Edition, Office of Water Programs
- Industrial Waste Treatment, Volume 2, 3rd Edition, Office of Water Programs
- Manage for Success, Effective Utility Leadership Practices, 1st Edition, Office of Water Programs
- NFPA 70, National Electrical Code (NEC)
- NFPA 70B, Recommended Practice for Electrical Equipment Maintenance
- NFPA 70E, Standard for Electrical Safety in the Workplace
- Operation of Wastewater Treatment Plants, Volume 1, 8th Edition, Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 2, 7th Edition, Office of Water Programs
- Title 29 CFR
  - 1910.120
  - 1910.147
  - 1910.184
- Utility Management, A Field Study Training Program, 2nd Edition, Office of Water Programs
- Water Distribution System O&M, 7th Edition, Office of Water Programs
- Water Treatment Plant Operations, Volume 1, 7th Edition, Office of Water Programs
- Water Treatment Plant Operations, Volume 2, 7th Edition, Office of Water Programs

Sample Questions

This section provides sample questions to help applicants become familiar with the exam format and subject matter.

1. Before releasing new equipment for operation, you should:
    a. never operate the equipment
    b. check the fuse and overload relays
    c. make and record capacitance measurements
    d. only test it under no-load conditions
2. What is the most important feature for adequate equipment grounding?
    a. insulation
    b. low current
    c. low-impedance path
    d. over-current devices
3. An explosion-proof enclosure:
    a. can withstand and contain an internal explosion
    b. can withstand an external explosion
    c. is identical to a purged enclosure
    d. prevents internal explosions
4. Which of the following is optional in a single-variable control loop?
    a. controller
    b. final control element
    c. recorder
    d. transducer
5. The National Electrical Code defines a qualified person as someone who:
    a. has been on the job a minimum of one year
    b. is a supervisor or manager
    c. is certified by a testing laboratory
    d. is familiar with equipment operation and hazards
6. The simplest kind of electrical meter to read is the:
    a. D'Arsonval meter
    b. digital meter
    c. pointer meter
    d. dial meter
7. Which kind of drawings use both normal and actual dimensions?
    a. architectural
    b. electrical
    c. installation
    d. riser

8. A Power-Installation drawing shows:
    a. power outlets
    b. lighting receptacles
    c. plug receptacles
    d. computer terminal location
9. The first requirement on a work site is:
    a. preventive maintenance
    b. work quality
    c. meeting deadlines
    d. safety
10. When interviewing a potential employee, do NOT ask him or her about:
    a. age
    b. religion
    c. family status
    d. any of the above

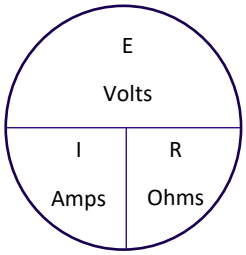
Answer Key and Solutions

1. B – Domain 1
2. C – Domain 1
3. A – Domain 2
4. C – Domain 2
5. D – Domain 3
6. B – Domain 3
7. A – Domain 4
8. A – Domain 4
9. D – Domain 5
10. D – Domain 5

EIT FORMULA SHEET

This formula sheet is available onscreen during the exam.

1 cubic foot	1,728 cubic inches
1 cubic foot	7.48 gallons
1 cubic foot of water	62.43 pounds
1 gallon of water	8.34 pounds
1 cubic foot/second	448.8 gallons/minute
1 MGD	694 gallons/minute
1 horsepower	33,000 foot-pounds/minute
1 psi	2.31 feet of water
1 kilowatt	1000 watts
1 horsepower	746 watts
1 horsepower	42.45 Btu/minute
1 MGD	1.55 cubic feet/second
1 Btu	778 foot-pounds
1 watt	3.412 Btu/hour
1 thermal unit	100,000 Btu
π	3.14
Coefficients of thermal expansion	Steel: 0.00000633/°F
	Brass: 0.00001/°F



$Circumference_{circle} = \pi \times diameter$	$Volume_{rectangular\ solid} = length \times width \times height$
$Area_{triangle} = \frac{base \times height}{2}$	$Volume_{triangular\ solid} = \frac{base \times height \times length}{2}$
$Area_{circle} = \frac{\pi}{4} \times diameter^2$	$Volume_{cylinder} = \frac{\pi}{4} \times diameter^2 \times height$
$Area_{circle} = 0.785 \times diameter^2$	$Volume_{cylinder} = \pi \times radius^2 \times height$
$Area_{rectangle} = base \times height$	$3\ phase\ V\ A = V \times A \times 1732$
$Area_{circle} = \pi \times radius^2$	$Flowing\ quantity = Area \times Velocity$
$A = \pi r^2$	$Efficiency = \frac{work\ output}{work\ input}$
$Primeter_{rectangle} = 2 \times (length + width)$	$Energy = power \times time$
$Thermal\ expansion = coeff.of\ thermal\ expansion \times length \times \Delta T$	
$Hydrostatic\ force = column\ area \times column\ height \times fluid\ density$	
$Motor\ horsepower = \frac{flow \times head \times specific\ gravity}{3960 \times efficiency\ pump \times efficiency\ motor}$	
$Brake\ horsepower = \frac{flow \times head \times specific\ gravity}{3960 \times efficiency}$	
$3\ phase\ A = \frac{746 \times horsepower}{1.732 \times V \times efficiency \times power\ factor}$	
$Brake\ horsepower = \frac{water\ horsepower}{efficiency}$	
$Water\ horsepower = \frac{flow \times total\ head \times specific\ gravity}{3960}$	
$V = d/t$	

CREATING A STUDY PLAN

Completing a Gap Analysis

CWEA certification exams are experience based. The Gap Analysis Tool is designed to help candidates identify which grade level is best suited to their current level of experience, and where they may be lacking sufficient experience.

This free self-evaluation is available on the CWEA website for all vocations.

Candidates are encouraged to develop their own personal study plan based on individual needs, experience and knowledge. Candidates should seek as many different study materials as possible as well as attend educational events and on-the-job training. This is especially important for areas in which the candidate is not adequately prepared.

CWEA's exams do not correspond directly to any specific textbook, educational course, or program. Instead, the exams are based on an analysis of the duties commonly performed in actual practice.

CWEA Local Section Training

It is the goal of CWEA's Technical Certification Program to operate in line with established best practices for certification programs. As such, CWEA is careful to separate its education and training activities from its certification program to ensure that no conflict of interest exists. Any educational materials or trainings that are designed to prepare candidates for an exam are developed and conducted by individuals that do not have access to the exams.

CWEA Local Sections host education and training events throughout the year that focus on the job duties tested by our certifications. These trainings are limited based on demand and volunteer availability.

Local Section trainings can be found on the CWEA Events Website. For questions about a Local Section training, please contact the Local Section directly. Contact information for individual Local Sections can be found in our Directory.

EXAM DAY INFORMATION

Test Site Admission and Exam Information

Applicants are required to show at least one current, valid, government-issued photo identification, such as a state driver's license or ID, or passport. A temporary license is acceptable if there is an expiration date, or if it is accompanied by paperwork explaining an expiration date.

Candidates have three (3) hours to complete the exam.

The formula sheet from this Handbook will be available on the exam screen.

For more information about the number of questions on each exam, see *Exam Scoring* (p. 95).

Calculators Allowed

An onscreen calculator with basic and scientific capability is available on all CWEA exams. Applicants may bring a handheld calculator to a test center as long as it is from the CWEA approved calculator list:

Casio	All FX-115 models (any Casio calculator with FX-115 in its name)
Texas Instruments	All TI-30x and TI-36x models
Sharp	EL models *except* EL-W516B and EL-W535B

Pearson VUE's Candidate Rules Agreement

Pearson VUE maintains its own rules regarding professional examinations. All applicants are required to sign the Candidate Rules Agreement at the test center prior to sitting the exam. Applicants are responsible for knowing and complying with these rules. CWEA recommends all applicants familiarize themselves with this agreement prior to testing.

AFTER THE EXAM

Exam Result Notification

Applicants will see their result on the screen immediately after the exam is submitted. An Official Score Report will be printed out and given to the applicant before they leave the test center. Additional copies can be obtained by logging into the Pearson VUE user account. All results are confidential and will only be released to the applicant. No results will be given over the phone, by fax or email.

Exam Appeal Policy

All appeals must be submitted within two weeks of the exam date. Appeals will be reviewed by CWEA staff and/or Subject Matter Experts. Candidates' personal information will remain confidential and will not be accessible to Subject Matter Experts. Candidates will be updated on the status of their appeal within 4-6 weeks, and they will be notified in writing when a decision has been made. Once an appeal has been processed, candidates cannot submit a new appeal for the same exam.

Candidates cannot submit an appeal simply because they did not pass the exam.

Candidates can appeal under the following justifications:

Exam Delivery Appeal

Candidates may appeal testing conditions severe enough to have caused a major disruption of the examination process. CWEA staff will review the appeal and consult our exam administrator, Pearson VUE, to investigate the appeal if necessary. Please note, under Pearson VUE's candidate agreement, candidates must notify the proctor immediately during the exam of any issues to open a claim documenting the incident. If candidates did not notify the proctor during the exam, an appeal may still be submitted but may be dismissed if CWEA cannot verify the validity of the complaint.

Exam Question Appeal

If the candidate wishes to comment on specific exam questions, they may flag the question during the exam using the Flag to Enter a Comment function. Candidates are allowed to add comments about any question as long as there is time remaining. All comments will be

reviewed and considered by the Technical Certification Program as part of the ongoing exam review and development process. Candidates that wish to submit an appeal of their exam results, must complete the form below within two weeks of their exam date. Candidates that wish to have specific comments considered in support of their appeal should indicate so on the appeal form.

Non-substantive appeals or appeals without just cause will be automatically rejected. If candidates are not satisfied with the outcome of their appeal, they may submit a request for review by the Technical Certification Program Executive Committee at tcpcommittee@cwea.org. The committee's decision will be final.

All communication related to certification decisions and appeal results with the Technical Certification Program Executive Committee must be sent in writing to tcpcommittee@cwea.org. We ask that candidates do not contact committee members directly.

The appeal form can be accessed here: CWEA Exam Appeal Form.

Retest Application

If the candidate does not pass the exam the first time, they can submit a retest application along with the appropriate fees. The candidate will be required to skip at least one exam window before they are eligible to retest. If the candidate tested within the first 15 days of a window, they are not required to skip an exam window. Under no circumstances are candidates allowed to sit for the same exam twice in the same window. There are no exceptions to this policy.

To be eligible to use the retest application form, candidates must submit the application within one year of their original exam date. Candidates must meet the minimum qualifications of the exam for which they are applying. CWEA may require candidates to fill out a full application with job history to verify candidates meet the minimum requirements. Use of a retest application does not guarantee approval for any exam.

Receiving the Certificate and Blue Card

Certificates and Blue Cards will be issued to all candidates who pass their exam. The certificate contains the certification number and expiration date. The Blue Card contains the expiration date, contact hour due date and contact hour period. These documents are mailed along with

the Score Report within 4 weeks to the address on file with CWEA. Candidates are responsible for making sure this address is current.

MAINTAINING CERTIFICATION

How to Renew

All certifications must be renewed annually. Certifications expire one year from the last day of the month in which the certification was earned. Renewal notices are mailed to certification holders three months before the expiration date. Certification holders can pay their renewal online by logging into their mycwea.org account or by mailing their renewal notice with a check or credit card information to the CWEA office. Renewal certificates and blue cards will be mailed within 4 weeks to the address on file with CWEA.

Certification holders are required to meet Continuing Education (CE) requirements. This requirement is met by completing 12 contact hours (1.2 CEUs) of vocation-related education or training every two years. For more information about earning contact hours, for details see *Earning Contact Hours* (p. 90).

Not meeting these requirements by the expiration date will cause the certification to expire. Certifications that have been expired for more than three months are subject to a $35 late fee. If a certification holder does not meet the renewal requirements within two years of their expiration date their certification will permanently expire. To become certified once again, the individual must re-apply for certification and pass the exam. It is the certification holder's responsibility to ensure that his or her certification remains valid. There are no exceptions to these policies.

Renewal Fees

Current fees are listed on the CWEA website. Valid CWEA members qualify for a discounted member rate. The non-member rate includes a one-year CWEA membership. If an applicant does not wish to take advantage of the membership, please inform CWEA.

Continuing Education (CE) Requirement

Certification holders are required to meet Continuing Education (CE) requirements. This requirement is met by completing 12 contact hours (1.2 CEUs) of vocation-related education or training every two years. Certification holders may submit up to 50% (6 contact hours) of the required contact hours in safety related training. One contact hour is defined as 50 minutes of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction.

Contact hours must be earned within the contact hour period. Hours are earned on the date of completion of the educational or training program. The program may begin before, but must be completed during the contact hour period. If a certification holder will not earn the required hours within their contact hour period, they must notify CWEA before the period ends if they wish to remain certified, for details see *Temporary Deactivation* (p. 92).

Individuals holding more than one CWEA certification can apply the same contact hours to each certification as long as the training is relevant to each vocation. Training is acceptable as long as it is related to the vocations in which certification is held. CWEA may send contact hour certificates to Subject Matter Experts to determine relevancy.

In-house training can be used to meet this requirement as long as standard Safety Tailgate meetings do not exceed 50% (6 contact hours). In-house training includes any training that is conducted by an employer, or a trainer contracted by an employer.

Earning Contact Hours

Contact hours may be earned by any of the following activities:

- Attendance at educational/training programs, including in-house training
- Teaching, instructing or presenting educational/training material (1 hour per 25 min)
- Developing and reviewing CWEA certification exam content as a Subject Matter Expert (1 hour per 25 minutes)
- Authorship of published books or articles (2 hours per book or article)
- Retesting and passing the relevant CWEA certification exam (12 hours)
- Membership in professional membership organizations (.5 hours per year, per membership, with a maximum of 6 hours per contact hour period)

CWEA may require and request additional documentation to assess the authenticity and/or relevance of these activities.

This information is paraphrased for clarity from the 02-03 TCP Re-Certification Policy; a full copy of the policy can be requested by contacting the TCP department.

Contact Hour Documentation

Proof of contact hour completion for an educational/training program must meet these following guidelines:

- The name of the training organization
- The training title
- The name of the attendee who completed the program
- The number of contact hours earned
- The date of completion
- An official signature or stamp from the training organization, instructor's signature is acceptable

For other continuing education activities, CWEA may request additional information. Any documentation that does not meet these guidelines will not be accepted. It is the certification holder's responsibility to retain verification of records documenting earned contact hours and submit proof to CWEA.

Contact Hour Audit

Audits are conducted on a regular basis by CWEA to ensure that certification holders are complying with the continuing education requirement and that the documentation meets the guidelines. Certification holders are randomly selected for an audit of contact hours. The audit reviews the relevancy of the trainings to the vocation, and the dates in which the contact hours were earned to ensure that they fall within the appropriate contact hour period.

Selected participants will be notified via email that they have either successfully passed the audit, or that CWEA requires further information.

Temporary Deactivation

The Temporary Deactivation program is for certification holders that will not meet the continuing education requirement for recertification by their expiration date. Under this program, certification holders can request that CWEA temporarily deactivate their certification for up to two years from their expiration date. This grants the individual extra time to earn the required contact hours. During the time of temporary deactivation, the CWEA certification is invalid and may not be used. Certification holders can apply for reactivation once they fulfill all requirements. Certification must be in good standing to qualify for this program. For more information including current fees, or to request an application for temporary deactivation, contact the CWEA office.

The application must be submitted before the certification expiration date. There is no exception to this policy.

Reinstating Certification

If a certification expires, it is invalid until all recertification requirements are met. There is a three-month grace period before a certification is considered lapsed. Once a certification becomes lapsed, the certification holder will need to pay a $35 late fee in addition to meeting the renewal requirements. Certification will remain lapsed for up to two years from the expiration date. If a lapsed certification is not renewed within the two-year period, the certification becomes permanently expired.

Expired Certification

Certificates expired for two years, or longer, cannot be reinstated under any circumstances. To become certified once again, the individual must re-apply for certification and pass the exam. It is the certification holder's responsibility to ensure that his or her certification remains valid. There are no exceptions to these policies.

Retiring Certification

Certification holders can request that CWEA retire their certification at the time it expires if they no longer wish to hold it. Once a certification has been retired, the certification will no longer be valid and CWEA will cease all communications regarding the certification. A retired

certification can be reactivated only if the certification holder has met all renewal requirements within the appropriate timeframe and the certification has not permanently expired.

EXAM DESIGN AND FORMAT

Exam Design

All certification exams are designed to test knowledge required to perform the essential duties of a job at a given grade level with minimum acceptable competence. Exams are created by Subject Matter Experts under the guidance of exam development professionals.

Exam content is developed from a job task analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California. All exam items are written by subject matter experts based on the content outline established by the job task analysis. These items are used to create the exam forms. The pass point for each exam is based on difficulty, using the Modified Angoff Method, for details see *Pass Point* and *How Pass Points are Set* (p. 94).

Exam Delivery Mechanism

All exams are computer-based format and are available in the English language only. Exams are delivered at Pearson VUE testing centers or via Pearson VUE's online testing platform On Vue.

Exam Format

Candidates are given 3 hours (180 minutes) to complete the exam. All certification exams are in multiple-choice format. Multiple-choice is considered the most effective format for use in standardized tests as it allows for greater content coverage for a given amount of testing time and improves competency measurement reliability. Multiple choice questions range in complexity from simple recall of knowledge to the synthesis and evaluation of the subject matter.

Weighting

The percentage of the exam that covers a particular content area is referred to as its weighting. Weightings are established through a Job Task Analysis and are based on the frequency and criticality of the task. A weighting is approximate and shows the relative importance of a particular area compared to the other portions of the exam. Weightings are indicated on the content outline for each exam and can be found in the preparation materials. Each weighting on the actual certification exam may vary slightly.

Pass Points

An exam pass point is the minimum score required to pass a certification exam. The pass point is also known as a cut score or passing score. Candidates should try to score as high as possible on their exam. Pass points for CWEA certification exam vary with each exam form. The pass point for each vocation, grade level and exam form is set independently.

How Pass Points are Set

A modified Angoff Method is used to determine the pass point for each version of each exam. The modified Angoff Method uses expert judgments to determine the difficulty level of the exam. The easier the exam, the higher the pass point. Likewise, the more difficult the exam, the lower the pass point.

The following is a basic outline of the modified Angoff Method (some details have been omitted):

1. A group of Subject Matter Experts (SMEs) independently rate each exam question within a given exam. The ratings are defined as the probability, or likelihood, that a minimally competent person with the requisite education and experience will answer the question correctly. A minimally competent person is defined as someone who adequately performs all job functions safely and requires no further training to do so.
2. The SMEs review each exam question as group. A consensus is reached for the rating of each exam question. During this time the SMEs review comments submitted in writing by exam-takers. Any exam question that is judged to be ambiguous, has more than one correct answer, or has no correct answers is eliminated from the scoring process for that exam. These exam questions are then revised for future use, re-classified, or deleted from the exam item bank.

3. After the data are refined, the final step is to calculate the mean, or average, of all the exam question ratings. This becomes the overall pass point estimation.

Why Use Modified Angoff?

Each version of a given certification exam pulls questions from an exam item bank. Each of these questions varies in difficulty. Because a different mix of questions is used in each exam form, the overall difficulty level is not fixed. Thus, it is important to make sure that the varying difficulty level is reflected in the pass point of each exam to ensure that results are reliable. Exam reliability is concerned with the reproducibility of results for each version of a given exam. In other words, for an exam to be reliable it must yield the same result (pass or fail) for the same individual under very similar circumstances. For example, imagine a candidate takes an exam at a certain grade level and passes it. Immediately after completing the exam, the candidate takes the same grade level exam, but a different version. If the exam is reliable they will achieve the same result: pass. If they do not, it is likely that the exam is not a reliable measure of minimal competency.

By taking into consideration the difficulty level of an exam, the modified Angoff Method significantly increases the reliability of the exams. Also, since each exam is adjusted for difficulty level, each exam version has the same standard for passing. Thus, exam-takers are treated equitably and fairly, even if they take different versions of the exam.

There are other methods for setting pass points. However, for the type of exams administered by CWEA, the modified Angoff Method is the best.

Exam Scoring

All exams are electronically scored by Pearson VUE. Most exam items are valued at one point unless otherwise stated on the exam. After exams are scored, total points are compiled, and an overall score is calculated as the sum of all points earned on the exam. If the overall score is equal to, or greater than the established pass point, the candidate has passed the exam. Each question is worth 1 point. Total points possible for each exam are as follows:

- Grade 1 – 100 points
- Grade 2 – 100 points
- Grade 3 – 100 points
- Grade 4 – 85 points

Summary of Certification Activities

A summary of certification activities for each vocation is available upon request. The summary includes pass/fail statistics, and the number of individuals currently certified. To request this information, please visit the CWEA website.