

Electrical & Instrumentation Technologist Candidate Handbook

EIT CERTIFICATION



Electrical & Instrumentation Technologist Candidate Handbook

Version 10.12.2020

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 and at the bottom of each page.

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TABLE OF CONTENTS

INTRODUCTION	6
Executive Committee	6
Overview of the Certification Process	7
Certifications Offered by CWEA	7
APPLICATION PROCESS	8
Submitting an Application	8
Application Deadlines and Exam Windows	8
CWEA Application Fees	8
Minimum Qualifications: Qualifying Education and Experience	9
Application Approval	10
Rejected Application	10
Code of Ethics	10
Non-Discrimination Policy	11
Accommodations	12
Privacy	12
Out-of-State Programs	12
Reciprocity	12
SCHEDULING AN EXAM	13
Scheduling an Exam Appointment	13
Online Proctored Exams	13
Canceling an Existing Appointment	14
Rescheduling an Exam Appointment	14
Transferring Exam Windows	14
PREPARING FOR THE EXAM	15
Electrical & Instrumentation Technologist Certification Scope	15
Exam Content	16
EIT GRADE 1 EXAM CONTENT OUTLINE	17
Knowledge, Skills and Abilities (KSAs)	17
Study Materials	28
Practice Test	29

Answer Key35

EIT GRADE 2 EXAM CONTENT OUTLINE36

 Knowledge, Skills and Abilities (KSAs)36

 Study Materials49

 Practice Test.....51

 Answer Key63

EIT GRADE 3 EXAM CONTENT OUTLINE67

 Knowledge, Skills and Abilities (KSAs)67

 Study Materials81

 Practice Test.....82

 Answer Key91

EIT GRADE 4 EXAM CONTENT OUTLINE92

 Knowledge, Skills and Abilities (KSAs)92

 Study Materials106

 Practice Test.....107

 Answer Key118

EIT FORMULA SHEET119

CREATING A STUDY PLAN120

 Completing a Gap Analysis120

 CWEA Local Section Training120

TEST SITE INFORMATION121

 Test Site Admission.....121

 Calculators Allowed.....121

 Pearson VUE’s Candidate Rules Agreement121

AFTER THE EXAM122

 Exam Result Notification.....122

 Exam Appeal Policy122

 Exam Delivery Appeal.....122

 Exam Question Appeal.....122

 Retest Application.....123

 Receiving the Certificate and Blue Card.....123

MAINTAINING CERTIFICATION124

How to Renew.....124

Renewal Fees124

Continuing Education (CE) Requirement124

Earning Contact Hours.....125

Contact Hour Documentation126

Contact Hour Audit126

Temporary Deactivation.....126

Reinstating Certification.....127

Expired Certification.....127

Retiring Certification.....127

EXAM DESIGN AND FORMAT128

Exam Design.....128

Exam Delivery Mechanism.....128

Exam Format.....128

Weighting128

Pass Points129

How Pass Points are Set.....129

Why Use Modified Angoff?130

Exam Scoring130

Summary of Certification Activities.....131

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. 14).

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

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	
EDUCATION/CERTIFICATIONS	EXPERIENCE
None required to take test	None required to take test
GRADE 2	
EDUCATION/CERTIFICATIONS	EXPERIENCE
None	4 full-time years in vocation
Hold Grade 1 certificate in vocation for year	2 full-time years in vocation
Associate's, or higher degree in related field	2 full-time years in vocation
Bachelor's, or higher degree in related field	1 full-time years in vocation
GRADE 3	
EDUCATION/CERTIFICATIONS	EXPERIENCE
None	6 full-time years in vocation
Hold Grade 2 certificate in vocation for 2 years	4 full-time years in vocation
Associate's, or higher degree in related field	4 full-time years in vocation
Bachelor's, or higher degree in related field	3 full-time years in vocation

GRADE 4	
EDUCATION/CERTIFICATIONS	EXPERIENCE
None	8 full-time years in vocation with 1 year supervising others
Hold Grade 3 certificate in vocation for 2 years	6 full-time years in vocation with 1 year supervising others
Associate's, or higher degree in related field	6 full-time years in vocation with 1 year supervising others
Bachelor's, or higher degree in related field	5 full-time years in vocation with 1 year supervising others

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 \$40 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 \$80 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 \$80 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. 14).

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 \$40.

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.	Program manager level.
Level of knowledge, skill and ability within the job family, in relation to job tasks, including the taxonomic level of knowledge applied on the job.	Basic knowledge and ability, as needed to safely and effectively perform basic tasks. This includes: recall and recognition, comprehension, and application.	Knowledge and ability to safely and effectively accomplish most technical tasks in the job family. This includes: comprehension, application, and analysis.	Knowledge, skill and ability to safely and effectively accomplish and coordinate complex tasks. This includes: application, analysis and synthesis.	Knowledge, skill and ability to administer, coordinate and 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 over other staff.	Will 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.	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.

Specifications	Grade 1	Grade 2	Grade 3	Grade 4
Problem solving and troubleshooting responsibilities.	Follows directions.	Troubleshoots and solves common problems.	Troubleshoots and solves complex problems.	Evaluates program effectiveness and takes corrective actions as needed.
Actions in relation to safety problems.	Recognizes unsafe conditions.	Recognizes and corrects unsafe conditions.	Anticipates and prevents unsafe conditions.	Designs and administers safety programs.
Actions in relation to standard operating procedures (S.O.P.s), laws and regulations.	Has the ability to follow S.O.P.s.	Has the ability to understand and apply S.O.P.s, laws and regulations.	Formulates new S.O.P.s, in compliance with laws and regulations.	Assures program compliance with laws and regulations.
Actions in relation to documentation of work activities.	Completes minimal work process documentation.	Completes routine work process documentation.	Responsible for detailed technical report writing and review.	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 2013.

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 KSA in the column labeled % on the exam.

EIT GRADE 1 EXAM CONTENT OUTLINE

Knowledge, Skills and Abilities (KSAs)

Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual job description, they do reflect the core competencies and essential duties required of any Electrical & Instrumentation Technologist. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

Each KSA includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered.

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.

KSA 101**Weight: 8%**

Knowledge of electrical and instrumentation field as it relates to the water/wastewater industry.

KSA 101 General Competencies

Candidates will need to effectively understand and use technical documents. Ability to read, comprehend and synthesize the information provided by the documents is essential to apply to everyday job duties. Experience for this competency can be acquired, through the use of the following documents, but is not limited to:

- Standards of Operating Procedures
- Technical Manuals
- Codes
- Instructions
- Personal computers

KSA 101 Math Competencies

There are no specific math competencies for this KSA.

KSA 101 Suggested Reading

N/A

KSA 102**Weight: 9%**

Perform basic preventive maintenance and unplanned maintenance of E/I tools and equipment used in wastewater systems.

KSA 102 General Competencies

Candidates should be able to safely identify, repair and maintain equipment and tools in a safe and effective manner. They should be able to use basic test equipment properly and safely. Skills and knowledge of the test equipment should come from understanding the equipment manuals, field experience and proper training.

An E/I Technician will be responsible for the maintenance, preventative maintenance and calibration of equipment and must be familiar with the use of testing and calibration instruments. This may include, but is not limited to, the following measuring devices:

- volt meter
- amp meter
- ohm meter
- multi-meter
- multi-gas detector

KSA 102 Math Competencies

There are no specific math competencies for this KSA.

KSA 102 Suggested Reading

N/A

KSA 103**Weight: 11%**

Safe and effective operation of basic electrical hand tools and measuring instruments to perform maintenance and repair of E/I systems.

KSA 103 General Competencies

Candidate should be able to use basic test equipment properly and safely in order to maintain E/I systems. Skills and knowledge of the test equipment should come from understanding the equipment manuals, field experience and proper training.

An E/I Technician will be responsible for the safe use and operations of hand tools and measuring equipment used on a daily basis. This may include, but is not limited to, the following measuring devices:

- volt meter
- amp meter
- ohm meter
- multi-meter
- multi-gas detector

KSA 103 Math Competencies

There are no specific math competencies for this KSA.

KSA 103 Suggested Reading

N/A

KSA 104**Weight: 9%**

Interpret, record and communicate basic output data on electrical measuring tools and instruments.

KSA 104 General Competencies

Candidate should be able to safely install and accurately take instrument readings. They should be able to use basic test equipment properly and safely. Skills and knowledge of the test equipment should come from understanding the equipment manuals, field experience and proper training.

An E/I Technician will be using equipment used in testing, calibrating and verifying voltages, currents and resistance values. Technicians must have the ability to calibrate and verify safety equipment are properly working. Measuring devices such as, but not limited to:

- Daily Reports
- amp meter
- ohm meter
- multi-meter
- multi-gas detector

KSA 104 Math Competencies

There are no specific math competencies for this KSA.

KSA 104 Suggested Reading

N/A

KSA 105

Weight: 6%

Effectively communicate verbal and written technical information in the English Language.

KSA 105 General Competencies

Effective communication skills are imperative to a successful career in the industry. These skills can be learned and strengthened through formal schooling, completing training classes and reading books relating to this topic.

You will be required to document or verbally explain your daily tasks clearly and accurately. Some examples of these are:

- Daily Reports
- Calibration Sheets
- e-mail
- Work Request

KSA 105 Math Competencies

There are no specific math competencies for this KSA.

KSA 105 Suggested Reading

N/A

KSA 106

Weight: 10%

Maintain proper documentation and organized reports by using computerized record keeping systems such as computerized maintenance management systems (CMMS).

KSA 106 General Competencies

Candidates should be able to operate a computer effectively. Familiarity to various systems can be acquired through training, on the job experience, or through daily use of the following, but not limited to:

- Word processing (Word)
- Spreadsheets (Excel)
- Drawing / drafting (Auto Cad, Visio)
- Work Orders
- Calibration Sheets
- Daily Reports

KSA 106 Math Competencies

There are no specific math competencies for this KSA.

KSA 106 Suggested Reading

N/A

KSA 107**Weight: 14%**

Recognize unsafe work situations and take proper actions to prevent accidents.

KSA 107 General Competencies

In order for an E/I Technician to complete their duties, they will be required to work in many different environments and situations. The Technician will have to determine if these environments or situations pose any risks or hazards to themselves or others. Knowledge of effectively assessing unsafe work situations can be learned through formal training, understanding safety standards/regulations and through work experience. Must have understanding of the following procedures:

- Confined space entry procedures
- Proper lifting procedure
- Fall protection prevention

KSA 107 Math Competencies

There are no specific math competencies for this KSA.

KSA 107 Suggested Reading

- OSHA manual (online)
- NFPA 70E
- OSHA 3120
- W.A.T.C.H. Work Area Traffic Control Handbook, ISBN-13: 978-1557017550

KSA 108**Weight: 14%**

Perform proper work techniques and procedures to minimize accidents including maintaining a clean and safe work environment.

KSA 108 General Competencies

E/I Technician is required to maintain a clean and safe working environment for themselves and others. Being focused and not distracted is important to personal safety. Candidates must be able to identify risks or hazards through formal training, comprehending and following important safety regulations. Ability to analyze whether a situation is potentially hazardous and determine the proper procedure or technique to make it a safe operation. This can be learned through safety training, job experience, safety manuals and best practices.

Here are a few topics, but not limited to, what a E/I Tech would encounter:

- electrical safety
- lock out tag out (LOTO)
- electrical PPE (personal protective equipment)
- traffic safety
- hazardous materials (MSDS: material safety data sheets)
- bio- hazards
- disease pathogens awareness
- First Aid/CPR training

KSA108 Math Competencies

There are no specific math competencies for this KSA.

KSA108 Suggested Reading

- OSHA Manual (online)
- Safety Guides and Manuals
- Case Studies
- NFPA 70E
- OSHA 3120
- W.A.T.C.H. Work Area Traffic Control Handbook, ISBN-13: 978-1557017550

KSA 109

Weight: 10%

Perform basic calculations using electrical formulas and equations.

KSA 109 General Competencies

Candidates will be required to be proficient in basic arithmetic calculations. Ability to use math equations can be learned through formal schooling, books, training and personal experience.

An E/I Technician will be calculating hours, material costs, footage, pressures, and much more, on a daily basis. Accuracy in calculations is critical. Here are some of the basic calculations that are required to know:

- Addition
- Subtraction
- Multiplication
- Division

KSA 109 Math Competencies

- Basic Math Textbooks
- Online Training
- Software

KSA 109 Suggested Reading

- Ugly's Electrical Reference
- Standard Textbook of Electricity, by Stephen Herman
- Electrical Controls for Motor Control Systems
- Basic Mathematics for Electricity and Electronics, Authors, Bertard Singer, Harry Forster, Mitchel E. Schultz

KSA 110

Weight: 9%

Read and interpret basic blueprints, schematics, single line drawings and equipment manuals to perform common electrical and instrumentation maintenance on wastewater facilities.

KSA 110 General Competencies

Candidates must be able to identify and interpret many forms of construction drawings/documents in various medias and digital formats. An E/I Technician will use different types of documents to perform their daily job requirements. Skill and knowledge of reading schematic plans should come from formal schooling, training classes, books and field experience.

The E/I Technician will have to look up and identify information needed on a variety of formats listed but not limited to:

- Blueprints
- Schematics
- Single Line Drawings
- Equipment Manuals
- Instruction Manuals
- CAD Drawings

KSA 110 Math Competencies

There are no specific math competencies for this KSA.

KSA 110 Suggested Reading

N/A

Study Materials

The following section includes the titles and information of primary and secondary references. These references contain the majority of the information needed for the CWEA certification test; it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

Study Materials Referenced in KSAs

- Ugly's Electrical Reference
- Audel Mechanical Trades Pocket Manual ISBN-10: 0764541706
- NFPA 70
- Standard Textbook of Electricity, by Stephen Herman.
- Electrical Motor Controls for Integrated Systems, by Rockis, Mazur.
- Basic Mathematics for Electricity and Electronics, Authors, Bertard Singer, Harry Forster, Mitchel E. Schultz
- Confined Space Entry (new edition)
- <https://www.osha.gov/Publications/osha3120.pdf>
- Handbook of water and wastewater treatment plant operations

Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter.

Select the best answer for each item below.

1. When conducting a confined space entry, you must test the atmosphere prior to opening, at entry, after opening, and every _____ minutes until the confined space entry is ended.
 - a. 30
 - b. 25
 - c. 20
 - d. 15
2. The best place to find out what personal protective gear is necessary when working with a chemical is:
 - a. MSDS.
 - b. container level.
 - c. EPA.
 - d. to consult other workers with previous experience.
3. When rigging a piece of equipment that requires a sling, what type of sling gives the highest safe load rating?
 - a. Choker
 - b. U-sling
 - c. 60-degree
 - d. 45-degree
4. When using a micrometer, the part of the micrometer that you grip and turn to adjust the micrometer is called the:
 - a. anvil.
 - b. spindle.
 - c. sleeve.
 - d. thimble.

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. What is the definition of plumb?
 - a. Vertical trueness
 - b. Horizontal trueness
 - c. Vertical paring
 - d. Horizontal paring
7. Which decimal prefix expresses 1/1000?
 - a. Micro
 - b. Milli
 - c. Kilo
 - d. Deka
8. 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.
9. The straight line distance from the center of a circle to the outer edge is called the:
 - a. diameter.
 - b. circumference.
 - c. chord.
 - d. radius.
10. 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.

11. When you need to seal the shaft of a pump so that practically no leakage occurs, you would use:
- angle cut packing.
 - butt cut packing.
 - angle cut packing and a lantern ring.
 - a mechanical seal.
12. Ohm's law is:
- $E = I \times R$
 - $I = E \times R$
 - $P = E \times I$
 - $E = P \times I$
13. A fence is to be installed on the perimeter of a sewer lift station. The sides of the pump station measure 235 feet, 366 feet, 266 feet and 298 feet. If a 20 foot gate is to be installed in the 266 foot section, how many linear feet of fence will be required?
- 1,140 ft
 - 1,145 ft
 - 1,165 ft
 - 1,265 ft
14. A circle has a circumference of 393 feet. What is its diameter?
- 63 ft
 - 98 ft
 - 125 ft
 - 197 ft
15. A circuit has 120 volts applied across a resistance of 6 ohms. What is the current?
- 20 amps
 - 50 watts
 - 75 watts
 - 720 amps

16. A trough is triangular in shape. The triangular cross section measures 3 feet across and 4 feet deep. What is the area of the cross section, in square feet?
- 3.5 ft²
 - 6 ft²
 - 12 ft²
 - 14 ft²
17. The training room at your plant needs new carpet. If the room is rectangular in shape and measures 30 feet by 54 feet, how much carpet is needed, in square yards.
- 84 yd²
 - 180 yd²
 - 540 yd²
 - 1,620 yd
18. A 480-volt system has a resistance of 20 ohms. What is the power consumed, in watts?
- 20 watts
 - 24 watts
 - 9,600 watts
 - 11,520 watts
19. A digester has a radius of 75 feet. What is the surface area of the sludge in the digester, in square feet?
- 29 ft²
 - 236 ft²
 - 17,673 ft²
 - 35,325 ft²
20. You are required to paint the walls of a room that is 20 feet wide, 30 feet long and 8 feet high. If the paint you are using covers 200 square feet per gallon, how many gallons of paint will you need?
- 2 gal
 - 4 gal
 - 10 gal
 - 20 gal

21. What is the volume of a digester that has a radius of 75 feet and a height of 50 feet, in million gallons (MG)?
- 6.61 MG
 - 28.05 MG
 - 33.03 MG
 - 118.13 MG
22. A wet well measures 30 feet deep, 25 feet wide and 35 feet long. What is its capacity, in gallons?
- 3,509,000 gal
 - 19,635,000 gal
 - 26,250,000 gal
 - 196,350 gal
23. If a digester is 75 feet tall and 150 feet in diameter, what is the volume, in million gallons (MG)?
- 0.26 MG
 - 6.61 MG
 - 9.91 MG
 - 13.25 MG
24. A trench is to be excavated. If the trench is 1,500 feet long and averages 6 feet deep and 3 feet wide, how many cubic yards of material will be removed?
- 270 yd³
 - 1,000 yd³
 - 7,000 yd³
 - 9,000 yd³
25. A steel bar is 6.5 inches long. It is heated from 75°F to 250°F. What is the new length of the steel bar? The coefficient of thermal expansion is 0.00000633/°F for steel.
- 6.4928 in
 - 6.5006 in
 - 6.5072 in
 - 6.5720 in

26. Which of the following is considered important when communicating with the public by telephone?
- a. Understanding
 - b. Rudeness
 - c. Courtesy
 - d. Decisiveness
27. 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
28. 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.

Answer Key

No.	Answer
1	C
2	A
3	B
4	D
5	A
6	A
7	B
8	C
9	D
10	D
11	D
12	A
13	B
14	C
15	A
16	B
17	B
18	D
19	C
20	B
21	A
22	D
23	C
24	B
25	C
26	C
27	A
28	D

EIT GRADE 2 EXAM CONTENT OUTLINE

Knowledge, Skills and Abilities (KSAs)

Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual job description, they do reflect the core competencies and essential duties required of any Electrical & Instrumentation Technologist. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

Each KSA includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered.

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.

KSA 201**Weight: 8%**

Working knowledge of preventive maintenance procedures in the electrical and instrumentation field and utilizing common tools, equipment and methods employed in wastewater maintenance.

KSA 201 General Competencies

Candidates shall be familiar with using electrical and instrumentation equipment, proper procedures and methods needed to perform a wide variety of tasks throughout the day. The candidate should become familiar with these methods through, but not limited to, training courses, online information, manufacturer seminars, manuals and on-the-job experience.

E/I technicians will be maintaining electrical and instrumentation equipment, as part of their daily duties. Grade II technicians should be familiar with, but not limited to the following equipment:

- vibration analysis
- calibration of analog loops
- thermography
- calibration of gas analyzers
- temperature measurements
- ultrasonic vibration detection
- ultrasonic leak detection
- HMI (Human Machine Interface)
- use of SCADA
- chart recorders
- power monitors
- read and interpret system maps
- transducers (pressure, ultrasonic, flow, vibration, and proximity)
- check pressure
- proper lubrication of equipment and instrumentation

KSA 201 Math Competencies

There are no math competencies for this KSA.

KSA 201 Suggested Reading

NFPA 820

Instrumentation and Controls: AWWA

<http://www.awwa.org/store/productdetail.aspx?productid=6696>

Electrical Controls for Motor Control Systems

Industrial Mechanics, by Albert Kemp

KSA 202

Weight: 8%

Accurately analyze test results of equipment and instruments used in wastewater facilities and recommend any changes required.

KSA 202 General Competencies

Candidates must be familiar with the use of and the safety requirements of electrical and instrumentation equipment. This experience should come from, formal schooling, training courses, online information, manufacturer seminars, books, manuals and any on-the-job experience.

E/I technicians, will replace and recommend replacement equipment to improve system operations and processes. Technicians will need to be familiar with the following, but not limited to:

- Megohmmeter
- phase rotation meter
- circuit tracers
- underground line locating equipment
- thermal imager
- harmonic analyzer
- oscilloscope
- hand bender
- electric pipe threader
- electric conduit bender

KSA 202 Math Competencies

There is no specific math competency required for this KSA.

KSA 202 Suggested Reading

Electrical Controls for Motor Control Systems

Industrial Mechanics, by Albert Kemp

Electrical Motor Controls for Integrated Systems, by Rockis, Mazur

KSA 203**Weight: 9%**

Read and interpret blueprints, schematics, construction drawings and installation manuals to perform electrical and instrumentation maintenance on wastewater facilities.

KSA 203 General Competencies

Candidate must be able to identify and interpret many forms of construction drawings/documents in different medias and digital formats. Skill and knowledge of reading construction plans can come from formal schooling, training classes, books and field experience.

E/I technicians must have the ability to reference various types of documents to perform their daily job requirements. They will have to look up and identify information needed on a variety of formats listed but not limited to:

- Blueprints
- Schematics
- Single Line Drawings
- Equipment Drawings
- Instruction Manuals

KSA 203 Math Competencies

There are no math competencies for this KSA.

KSA 203 Suggested Reading

NFPA 820

Handbook of Water and Wastewater Treatment Plant Operations, Third Edition; Spellman

Handbook of Electrical Design Details; Traister

KSA 204**Weight: 10%**

Properly use and interpret test instrumentation data to complete regular maintenance procedures and troubleshooting of wastewater equipment.

KSA 204 General Competencies

Candidate should be familiar with the proper and safe operation of various E/I tools. Proper use of the tools can be learned through training courses, formal schooling, manufacturers literature, online, manuals, and other resources along with on-the-job training.

Grade II technicians will work with many types of calibration and test equipment. Technicians are responsible for safely installing the equipment and accurately reading and documenting the output data. Familiarity with various equipment commonly used in the industry is listed below:

- pressure calibrator
 - process loop calibrator
 - Hart communication device
 - dead weight calibrator
 - emission analyzer
 - dry block calibrator
 - hand conduit bender
 - megohmmeter, oscilloscope
 - harmonic analyzer
 - phase rotation
 - pipe threader
 - circuit tracers
 - thermal imager
 - interlock circuits
 - alarm circuits
 - control loops
 - cameras
 - level control
 - flow control, pressure control
 - underground line locating equipment
- powered (electric or hydraulic) conduit bender

KSA 204 Math Competencies

There are no math competencies for this KSA.

KSA 204 Suggested Reading

Equipment Data Sheets

Equipment Manuals Online

KSA 205**Weight: 6%**

Effectively communicate verbal and written technical information in the English Language.

KSA 205 General Competencies

Effective communication skills are imperative to a successful career in the industry. These skills can be learned and strengthened through formal schooling, completing training classes and books relating to this topic. You will be required to document or verbally explain your daily tasks clearly and accurately. Some examples of this would be:

- Daily Reports
- Calibration Sheets
- e-mail
- Work Request

KSA 205 Math Competencies

There are no specific math competencies for this KSA

KSA 205 Suggested Reading

Supervision; Hilgert

OSHA standards

KSA 206

Weight: 7%

Perform calculations by applying basic geometry and algebra to electrical formulas and equations.

KSA 206 General Competencies

Candidates should be able to solve for common equations used in the industry. Ability to perform arithmetic

calculations can be acquired through formal schooling, training, on-the-job experience and through online resources.

An E/I Technician will use advanced math formulas to calculate pressures, surface areas, cylinder volumes, flows and other water related calculations. Grade II E/I technicians must have the ability to solve for the following calculations is required:

- surface area and volume of rectangular
- cylindrical and spherical shapes
- manipulate $V=IR$ to solve for I or R
- pressure of a given column of water
- solve equations with one unknown

KSA 206 Math Competencies

There are no specific math competencies for this KSA.

KSA 206 Suggested Reading

Ugly's (Electrical Reference)

Water/Wastewater Math textbooks Standard Textbook of Electricity, by Stephen Herman

Electrical Controls for Motor Control Systems

Basic Mathematics for Electricity and Electronics, Authors, Bertard Singer, Harry Forster, Mitchel E. Schultz

KSA 207**Weight: 13%**

Diagnose electrical and instrumentation equipment malfunctions.

KSA 207 General Competencies

Candidate must be familiar with the operation, maintenance and repair of various types of equipment. Skill needed to maintain common E/I equipment properly can be acquired from on-the-job experience, manufacturer trainings and online resources.

E/I technicians are responsible for troubleshooting, maintaining and repairing various types of monitoring, logging, recording and safety equipment. Grade II E/I technicians must have the ability to properly operate and maintain the following:

- pH meters
- DO meters and analyzers
- flow meters
- chlorine analyzers
- circuit breaker
- turbidity meter
- motor starter (VFD, FVNR, RVSS)
- relays and contactors
- air meters
- brushless excitation
- AC and DC motors
- level transmitters
- power supply
- PLC I/O
- UPS
- fuses
- process isolator

KSA 207 Math Competencies

There are no math competencies for this KSA.

KSA 207 Suggested Reading

Basic Mathematics for Electricity and Electronics, Authors, Bertard Singer, Harry Forster, Mitchel E. Schultz

KSA 208

Weight: 8%

Repair electrical and instrumentation equipment.

KSA 208 General Competencies

Candidates must be able to perform troubleshooting skills and techniques in a safe and efficient manner. Grade II candidates must be proficient in troubleshooting electrical and instrumentation equipment and also must be familiar with the operation of the system. Skills can be gained through on-the-job experience, formal schooling or technical seminars.

Grade II E/I technicians must have the ability to properly operate and maintain the following equipment:

- pH meters
- DO meters and analyzers
- flow meters
- chlorine analyzers
- circuit breaker
- turbidity meter
- motor starter (VFD, FVNR, RVSS) relays and contactors
- air meter
- brushless excitation
- AC and DC motors
- level transmitters
- power supply
- PLC I/O
- UPS
- Fuses
- process isolator

KSA 208 Math Competencies

There are no specific math competencies for this KSA.

KSA 208 Suggested Reading

Electrical Motor Maintenance and Troubleshooting

Basic Mathematics for Electricity and Electronics, Authors, Bertard Singer, Harry Forster, Mitchel E. Schultz

KSA 209**Weight: 8%**

Calibrate electrical and instrumentation equipment.

KSA 209 General Competencies

An E/I Technician will be responsible for maintaining and calibrating instrumentation and electrical equipment, as part of the job requirements. Because so much of the industry is being audited, for proper regulatory compliance, it is important that the equipment be installed, maintained and calibrated properly.

Candidates must be able to follow calibration schedules and have the ability to troubleshoot and repair Instrumentation and calibration equipment. Training in calibration can be acquired through on-the-job experience, technical seminars and online resources. Experience with the following equipment is required:

- pH meters
- DO meters and analyzers
- flow meters
- chlorine analyzers
- circuit breaker
- turbidity meter
- motor starter (VFD, FVNR, RVSS) relays and contactors
- air meters
- brushless excitation
- AC and, DC motors
- level transmitters
- power supply
- PLC I/O
- UPS
- fuses
- process isolator

KSA 209 Math Competencies

There are no specific math competencies for this KSA.

KSA 209 Suggested Reading

Instrumentation and Controls, AWWA

KSA 210

Weight: 12%

Follow safety regulations and SOPs to maintain a safe work environment and recognize and correct unsafe working conditions.

KSA 210 General Competencies

The candidate must be familiar with all safety standards and procedures in order to prevent accident to oneself or others. Candidate must be able to identify risks or hazards through training and understanding of safety regulations.

Knowledge in the following is essential, but not limited to:

- confined space entries
- proper lifting procedures
- fall protection
- noise levels
- electrical safety
- electrical PPE (personal protective equipment)
- lock out tag out (LOTO)
- traffic safety
- biohazards
- disease pathogens awareness
- first aid/CPR training
- arc flash
- material safety data sheets and communications

KSA 210 Math Competencies

There are no specific math competencies for this KSA.

KSA 210 Suggested Reading

OSHA manual (online)

First Aid/CPR Training

NFPA 70E

OSHA 3120

W.A.T.C.H. Work Area Traffic Control Handbook, ISBN-13: 978-1557017550

Standard Textbook of Electricity, by Stephen Herman

NEC

NFPA 820

CalOSHA

KSA 211

Weight: 6%

Accurately and concisely document information into logs, reports, and memos using manual or computerized maintenance management systems.

KSA 211 General Competencies

Candidate should be able to operate a computer effectively. On a daily basis a E/I Tech will need to enter information on a computer application for documentation and reporting.

- navigating trending software
- Standards of Operating Procedures
- Email
- word processing programs (Word)
- spreadsheet (Excel)
- drawing/drafting (Auto Cad, Visio)
- SCADA and trending software

KSA 211 Math Competencies

There are no specific math competencies for this KSA.

KSA 211 Suggested Reading

CalOSHA Confined Space Pocket Guide

Electrical Motor Controls for Integrated Systems

KSA 212

Weight: 5%

Maintain professional relationships with personnel and management, including those in associated departments, and also with vendors, consultants and other business partners.

KSA 212 General Competencies

An E/I Technician must be able to maintain a level of professionalism. On any given day an E/I Tech will have to work with other trades, vendors and outside contractors. A candidate must be able to follow directions and follow the chain of command. Minor confrontations and/or disagreements need to be resolved without escalating the situation. Many of these techniques can be learned through socialization, specialty trainings and on-the-job experience. They must be able to:

- Follow chain of command
- Resolve minor personnel issues in a diplomatic way
- Identify situations where a superior's input is required

KSA 212 Math Competencies

There are no specific math competencies for this KSA.

KSA 212 Suggested Reading

OSHA

Study Materials

The following section includes the titles and information of primary and secondary references. These references contain the majority of the information needed for the CWEA certification test; it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

Study Materials Referenced in KSAs

- Ugly's Electrical References George V. Hart, Sammie Hart and William C. Buchanan (Editor) ISBN: 0962322962 Pub Date: June 1999 Distributed by Burleson Distributing Corp., Houston, TX Available for purchase through online booksellers.
- Audel Mechanical Trades Pocket Manual: ISBN-10: 0764541706
- NFPA 70E: Standard for Electrical Safety Requirements for Employee Workplaces, 2000 Edition National Fire Protection Association 11 Tracy Drive Avon, MA 02322 800/344- 3555 www.nfpa.org
- NEC 2011: National Electrical Code, (NFPA 70) National Fire Protection Association 11 Tracy Drive Avon, MA 02322 800/344-3555 www.nfpa.org NFPA 70E & NFPA 820
- Standard Textbook of Electricity, by Stephen Herman. ISBN-13: 978-1-1115-3915-3 Copyright 2011, 2009 Delmar, Cengage Learning. 5 Maxwell Drive, Clifton Park, NY 12065-2919
- Electrical Motor Controls for Integrated Systems, by Gary Rockis and Glen A. Mazur. ISBN-13: 978- 0826912275 Amer Technical Pub; 5th edition (September 30, 2013) <http://www.amazon.com/Electrical-Controls-Integrated-Systems-Workbook/dp/0826912273>
- Basic Mathematics for Electricity and Electronics, Authors, Bertard Singer, Harry Forster, Mitchel E. Schultz. ISBN-10: 0028050223 Glencoe/McGraw-Hill; 8th edition (2000)
- ISA Standards www.isa.org ISA-2001 - Standards Library for Measurement and Control - CD ROM Product ID No: 1-55617-531-0 ISA-The Instrumentation Systems, and Automation Society 67 Alexander Drive Research Triangle Park, NC 27709 919/549-8411 Fax: 919/549-8288 www.isa.org
- Industrial Mechanics, by Albert Kemp. ISBN-10: 0826937055 Amer Technical Pub; 3rd Edition (January 10, 2012)

- OSHA Regulations (Standards-29 CFR) Available in print or on CD from: Government Institutes, Inc. 4 Research Place, Suite 200 Rockville, MD 20850 301/921-2300

Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter.

Select the best answer for each item below.

1. Receiving job instruction and planning equipment use are part of:
 - a. craft data.
 - b. job preparation.
 - c. work factors.
 - d. leveled time.
2. Anticipating other tasks or problems:
 - a. usually creates additional problems.
 - b. wastes time.
 - c. sharply reduces the number of emergencies.
 - e. often is not worth the effort.
3. Making job planning a group effort:
 - a. wastes time.
 - b. improves productivity.
 - c. causes confusion.
 - d. All the above
4. Rubber safety gloves should be tested how often?
 - a. Every 12 months
 - b. Every 9 months
 - c. Every 6 months
 - d. Every 4 months
5. Rubber safety blankets should be tested how often?
 - a. Every 6 months
 - b. Every 9 months
 - c. Every 12 months
 - d. Every 18 months

6. What is the interrupting current of a GFIC receptacle?
 - a. 20 VAL
 - b. 5 MA
 - c. 10 UDL
 - d. 20 MA
7. What type of stepladder is forbidden while working on electrical equipment?
 - a. Wood
 - b. Fiberglass
 - c. Aluminum
 - d. Ceramic
8. What is the killer of electrical shock?
 - a. Voltage
 - b. Current
 - c. Resistance
 - d. Ohms
9. The relationship between an electric current and a magnetic field is called:
 - a. matter.
 - b. atoms.
 - c. electromagnetism.
 - d. element.
10. Electrons flowing from one place to another make a:
 - a. current.
 - b. track.
 - c. circuit.
 - d. channel.
11. Between two objects, the development of static charges creates a:
 - a. potential difference.
 - b. battery.
 - c. thermocouple.
 - d. resistance.

12. Metals are good conductors because they have many:
 - a. insulators.
 - b. free electrons.
 - c. resistors.
 - d. inductors.
13. The amount of potential difference a layer of insulation can withstand without breaking down is called:
 - a. resistance.
 - b. voltage drop.
 - c. dielectric strength.
 - d. ampacity
14. What is the name of the property of a coil of wire that opposes any change in the current in the coil?
 - a. Inductance
 - b. Resistance
 - c. Impedance
 - d. Watts
15. What is the correct name for “voltage” or electromotive force?
 - a. Element
 - b. Electron
 - c. Circuit
 - d. Potential difference
16. A rate of flow of one coulomb per second is called one:
 - a. ampere.
 - b. joule.
 - c. volt.
 - d. olhum.

17. Power companies use AC generators instead of DC generators because AC can be sent over long distances:
- at high cost.
 - at low cost.
 - slower.
 - faster.
18. What device changes alternating current to a different combination of potential difference and current?
- Generator
 - Capacitor
 - Alternator
 - Transformer
19. How does the power going into a transformer compare to the power coming out?
- Lower
 - Equal
 - Double
 - Higher
20. What changes continuously around the conductor when the current changes continuously, as in AC circuits?
- Voltage
 - Current
 - Magnetic field
 - Amps
21. Wires and cables can be classified according to their:
- color.
 - size.
 - type of insulation
 - shape.

22. What kind of starter provides full-voltage starting?
- Across-the-line
 - Synchronous start
 - Reactor starter
 - Reduced-voltage start
23. The choice between across-the-line starting and reduced-voltage starting depends in part on the size of the:
- starter.
 - wire size.
 - motor.
 - breaker.
24. The most important requirement for good maintenance of motor starters is:
- good record keeping.
 - safety of personnel.
 - proper lubrication.
 - clean, dry insulation.
25. A reversing starter reverses a three-phase motor by interchanging:
- main contacts.
 - two of the line leads.
 - all of the line leads.
 - control voltage.
26. What kind of protection is provided in a manual across-the-line three-phase motor control?
- Overload protection only
 - Ground-fault protection only
 - Short-circuit protection only
 - All of the above
27. Commonly used instead of fuses in industrial power distribution systems are:
- disconnects.
 - motor starters.
 - overcurrent relays.
 - circuit breakers.

28. Distribution protection usually consists of two elements, protection of both:
- equipment and circuit.
 - personnel and equipment.
 - wire and control relay.
 - ground fault and current.
29. What is the current in amperes of a 120-volt circuit with a resistance of 60 ohms, using Ohm's Law?
- 0.5 amperes
 - 2.0 amperes
 - 30 amperes
 - 10 amperes
30. What is the current for a 120-volt circuit with a 1440-watt load?
- 0.083 amperes
 - 10 amperes
 - 12 amperes
 - 15 amperes
31. What is the current of a circuit that consumes 625 watts through a 12.75-ohm resistor?
- 3.8 amperes
 - 7 amperes
 - 49 amperes
 - 175 amperes
32. What is the ampere load of a single-phase half-horsepower 115-volt motor, if the motor has an efficiency rating of 92% and a power factor of 80%?
- 9.5 amperes
 - 2.4 amperes
 - 4.4 amperes
 - 78.1 amperes
33. A 230-volt single-phase circuit has a 12-kilowatt power load and operates at 84% power factor. What is the current?
- 43 amperes
 - 52 amperes
 - 62 amperes

- d. 70 amperes
34. The difference between the measurement signal and the set point is called the:
- a. gap.
 - b. error.
 - c. feedback.
 - d. span.
35. The signal pressure is usually directly proportional to the process:
- a. span.
 - b. level.
 - c. variable.
 - d. loop.
36. Offset is the difference between the actual maintained value of the measured variable and:
- a. the set-point.
 - b. the span.
 - c. zero.
 - d. the level.
37. Another name for built-in error that usually occurs in a proportional control system is:
- a. deadband.
 - b. offset.
 - c. set point.
 - d. span.
38. An automatic controller always compares a measured variable to:
- a. zero.
 - b. span.
 - c. reset.
 - d. set point.
39. The specific value at which an automatic control holds a process variable is called the:
- a. span.
 - b. variable.
 - c. control point.
 - d. set point.

40. The drawing that provides a view of the entire system in process control is the:
- P&ID drawing.
 - I/P drawing.
 - element drawing.
 - primary drawing.
41. A tag number with a code reading FRC identifies a:
- field recording controller.
 - flow recorder controller.
 - temperature controller.
 - pressure recorder.
42. The most commonly used type of diagram in process control is:
- a loop diagram.
 - an installation drawing.
 - a piping and instrument drawing.
 - a location drawing.
43. A signal from a measuring device to the controller is called:
- zero.
 - correcting.
 - span.
 - feedback.
44. In a closed loop control system, the control process of measuring, comparing, computing and connecting goes on:
- continually.
 - intermittently.
 - never.
 - whenever the operator takes some action.
45. A control system in which the output is regulated only by changes from outside the process is called:
- open loop.
 - closed loop.
 - set point.
 - measuring.

46. A common converter used in process control is the I/P converter, which converts signals to signals.
- zero, span
 - analog, digital
 - current, pneumatic
 - linear, nonlinear
47. Time lag can be defined as the time between:
- turning an instrument on and off.
 - a high reading and a low reading.
 - a proportional reading, and an inverse reading.
 - input to an instrument and output from an instrument.
48. Name the three most common mediums of data transmission.
- Twisted pair, radio, fiber optics
 - Phone, telemetry, radio
 - Cable, phone, radio
 - Coax, phone, fiber optics
49. The small region of an instrument range where input changes cause no corresponding output change is called:
- range.
 - deadband.
 - span.
 - linear.
50. Instrument error is usually expressed as:
- percent.
 - span.
 - zero.
 - linear.
51. A pressure-transmitting system is one in which the signal tubes are filled with:
- air.
 - liquid.
 - mercury.
 - acid.

52. In supervisory control, the computer plays a(n):
- analog role.
 - inactive role.
 - active role.
 - plotter role.
53. The abbreviation SCADA stands for:
- Safety Control and Data Answering.
 - Supervisory Control and Data Acquisition.
 - System Computer and Digital Analog.
 - Self Contained and Data Acquisition.
54. A computer program operates under the control of a(n):
- operating system.
 - controller system.
 - interface system.
 - process system.
55. The configuration in which individual computers are connected for the purpose of communication is a:
- CPU.
 - BIU.
 - network.
 - loop.
56. The abbreviation LAN stands for:
- Level Alarm Network.
 - Loop Alarm Neutral.
 - Local Alarm Network.
 - Local Area Network.
57. Whole circuits manufactured with all components in place and ready to work are called:
- semiconductor circuits.
 - microprocessor circuits.
 - rectifier circuits.
 - integrated circuits.

58. What is the pressure in units (psi) if the height of a column of water is 55.4 inches?
- 2 psi
 - 4.1 psi
 - 27 psi
 - 55.4 psi
59. How many inches of mercury are required to obtain a pressure of 4 psi?
- 4 inches
 - 8.144 inches
 - 54.4 inches
 - 110.8 inches
60. 77°F is equal to how many degrees Celsius?
- 81°C
 - 60°C
 - 43°C
 - 25°C
61. The supply of spare parts, tools, and test instruments should be monitored by the:
- supervisory control operation.
 - limited control operation.
 - computer control operation.
 - inventory control operation
62. Which of the following is the best choice of work clothing fabric when working with electricity?
- Cotton
 - FR Rated Fabric
 - Nylon
 - Polyester
63. The best combination of gloves to wear when performing electrical work is:
- leather over rubber.
 - leather over cotton.
 - synthetic over rubber.
 - synthetic over cotton.
64. When working with electricity, it is especially important to inspect tools for:

- a. bent shafts.
 - b. cracked handles.
 - c. damaged insulation.
 - d. work tips.
65. 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.

Answer Key

No.	Answer	No.	Answer
1	B	34	B
2	C	35	C
3	B	36	A
4	C	37	B
5	C	38	D
6	B	39	D
7	C	40	A
8	B	41	B
9	C	42	C
10	A	43	D
11	A	44	A
12	B	45	A
13	C	46	C
14	A	47	D
15	D	48	A
16	A	49	B
17	B	50	A
18	D	51	B
19	A	52	C
20	C	53	B
21	C	54	A
22	A	55	C
23	C	56	D
24	C	57	D
25	B	58	A
26	A	59	B
27	D	60	D
28	A	61	D
29	B	62	C
30	C	63	A
31	B	64	C
32	C	65	C
33	C		

Selected Problem Solutions

29. What is the current in amperes of a 120-volt circuit with a resistance of 60 ohms, using Ohm's Law?
- 0.5 amperes
 - 2.0 amperes
 - 30 amperes
 - 10 amperes

Solution:

$$P = VI \quad I = V/R$$
$$= 120V/60R = 2.0A$$

30. What is the current for a 120-volt circuit with a 1440-watt load?
- 0.083 amperes
 - 10 amperes
 - 12 amperes
 - 15 amperes

Solution:

$$P = VI \quad I = P/V$$
$$I = 1440/120 = 12A$$

31. What is the current of a circuit that consumes 625 watts through a 12.75-ohm resistor?
- 3.8 amperes
 - 7 amperes
 - 49 amperes
 - 175 amperes

Solution:

$$P = I^2R \quad I^2 = P/R$$
$$I = \sqrt{PR} = \sqrt{625/12.75} = 7 A$$

32. What is the ampere load of a single-phase half-horsepower 115-volt motor, if the motor has an efficiency rating of 92% and a power factor of 80%?
- 9.5 amperes
 - 2.4 amperes
 - amperes
 - 78.1 amperes

Solution:

$$(.5\text{HP})(746\text{W/HP}) = 373\text{W}$$

$$P = VI \therefore I = \frac{P}{V} = \frac{373}{120} = 3.10\text{A} = \text{THEOR. POW.}$$

$$\text{ACTUAL POWER} = \frac{3.10}{(.92)(.8)} = 4.22\text{A}$$

33. A 230-volt single-phase circuit has a 12-kilowatt power load and operates at 84% power factor. What is the current?
- 43 amperes
 - 52 amperes
 - 62 amperes
 - 70 amperes

Solution:

$$P = 12,000\text{W} \quad \text{PF} = .84$$

$$P = VI \therefore I = \frac{P}{V} = \frac{12,000}{230} = 52.17 = \text{THEOR. POW.}$$

$$\text{ACTUAL POWER} = \frac{52.17}{.84} = 62\text{A}$$

58. 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

Solution:

$$(55.4 \text{ inches}) \left(\frac{1 \text{ foot}}{12 \text{ inches}} \right) = 4.61'$$
$$4.61' / 2.31' / \text{psi} = 2 \text{ psi}$$

59. How many inches of mercury are required to obtain a pressure of 4 psi?
- a. 4 inches
 - b. 8.144 inches
 - c. 54.4 inches
 - d. 110.8 inches

Solution:

$$4 \text{ psi} / .491 \text{ psi/ft.}$$

60. 77°F is equal to how many degrees Celsius?
- a. 81°C
 - b. 60°C
 - c. 43°C
 - d. 25°C

Solution:

$$77^{\circ}\text{F} - 32^{\circ}\text{F} = 45^{\circ}\text{F}$$
$$\frac{5}{9}(45^{\circ}) = 25^{\circ}\text{C}$$

EIT GRADE 3 EXAM CONTENT OUTLINE

Knowledge, Skills and Abilities (KSAs)

Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual job description, they do reflect the core competencies and essential duties required of any Electrical & Instrumentation Technologist. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

Each KSA includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered.

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.

KSA 301**Weight: 8%**

Apply advanced knowledge of electrical and instrumentation principles to perform complex corrective and preventive maintenance tasks using equipment such as precision measuring devices, special and general electrical and instrumentation test meters.

KSA 301 General Competencies

Candidates should be able to perform test, adjusts, modifies, and maintains analog, digital, and logic circuitry, microprocessor controlled devices, and elements and components such as programmable logic controllers, process control equipment, telemetering devices, recorders, sensors, and controllers on water and or waste- water treatment process instrument and devices.

The candidate should have a journey level or advanced understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; a vocational training center, an industrial apprenticeship, college level course work, manufacturer training seminars, professional trade organization training such as ISA, or a combination of these. Must have experience with the following/but not limited to:

- predictive/preventive maintenance
- power quality analysis
- electromagnetic interference/noise
- ground loops
- thermography
- calibration of gas analyzers
- HART programming
- radio telemetry
- networking fundamentals
- PLC modifications
- SCADA/HMI modifications
- circuit breaker trip curves and fault settings

KSA 301 Math Competencies

Algebra, Geometry, Trigonometry, Binary Functions, Boolean logic, Wastewater math

KSA 301 Suggested Reading

Measurement and Control Basics 978-1-55617-916-7

CompTIA Network+ Study Guide

KSA 302**Weight: 12%**

Safely and properly use all electrical test equipment, PPE, power and hand tools.

KSA 302 General Competencies

Candidates must be able to follow safe and proper procedures for use of various hand tools, power tools, and test instruments.

The candidate should have a journey level or advanced understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; a vocational training center, an industrial apprenticeship, college level course work, manufacturer training seminars, professional trade organization training such as ISA, or a combination of these. Must have experience with the following/but not limited to:

- pH meter
- DO meter and analyzer
- turbidity meter
- air meter
- pressure calibrator
- hand conduit bender
- multimeter
- amp meter
- megohmmeter
- process loop calibrator
- oscilloscope
- powered (Chicago style, electric or hydraulic) conduit bender
- harmonic analyzer
- phase rotation
- dead weight calibrator
- Hart communication device
- emission analyzer
- pipe threader
- underground line locating equipment
- circuit tracers
- thermal imager
- dry block calibrator
- network cable tester (Fiber and UTP)

KSA 302 Math Competencies

Algebra, Geometry, Trigonometry, Binary Functions, Boolean logic, Wastewater math

KSA 302 Suggested Reading

Measurement and Control Basics ISBN 978-1-55617-916-7

Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-2

UGLYS Electrical Reference

KSA 303**Weight: 8%**

In an employee training setting, teach staff electrical and instrumentation principles and applications.

KSA 303 General Competencies

Candidates should be able to perform common preventive and corrective maintenance by isolating power, grounding wires, troubleshooting problems, making repairs, restoring power, and checking for proper operation.

The candidate should have a journey level or advanced understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through college level course work, correspondence or online courses, professional trade organization training such as ISA, or a combination of these. Must have experience with the following/but not limited to:

- test instruments
- Ohm's law
- Kirchhoff's law
- field instruments
- AC and DC circuit principles
- motors and transformers

KSA 303 Math Competencies

Algebra, Geometry, Trigonometry, Binary Functions, Boolean logic, Wastewater math

KSA 303 Suggested Reading

Measurement and Control Basics 978-1-55617-916-7

CompTIA Network+ Study Guide ISBN-10: 1118137558

Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-2

UGLYS Electrical Reference

KSA 304**Weight: 8%**

Interpret and apply federal, state and local environment and safety orders and National Fire Protection Association (NFPA) 70E & 820 regulations, and National Electric Code (NEC).

KSA 304 General Competencies

Candidates should be able to follow proper safety practices, precautions, and procedures, such as confined space entry; storing, handling, and transporting gases; using correct lockout and tagout procedures; and assisting in the rigging, as required, for the movement or placement of heavy machinery or equipment.

The candidate should have a journey level or advanced understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; college level course work such as wastewater treatment courses, CWEA training seminars, on the job training etc. Must have experience with the following/but not limited to:

- Regional Board
- EPA
- California Code of Regulations (archeological)
- State Workers Insurance Fund (environmental)
- Endangered Species Act
- OSHA
- DOT

KSA 304 Math Competencies

Addition, subtraction, multiplication, division

KSA 304 Suggested Reading

NFPA 70

NFPA 70E

NFPA 820

http://www.dir.ca.gov/dosh/dosh_publications/Electrical_Safety.pdf#zoom=100 (CalOSHA Electrical safety pocket guide)

Standard Textbook of Electricity, by Stephen Herman.

KSA 305**Weight: 7%**

Coordinate predictive/preventive maintenance and repair of electrical and instrumentation equipment related to power production systems including co-generation generators, standby generators, pumps, centrifugal blowers and compressors.

KSA 305 General Competencies

Candidates should be able to maintain and repair electrical and instrumentation equipment and facilities such as motors, generators, switch-gears, substations, and control equipment.

The candidate should have a journey level or advanced understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; a vocational training center, an industrial apprenticeship, manufacturer training seminars, professional trade organization training such as EGSA, diesel maintenance programs, etc. Must have experience with the following/but not limited to:

- vibration analysis
- oil analysis
- breaker testing
- cathodic protection
- thermography
- life cycle analysis (equipment)

KSA 305 Math Competencies

Addition, subtraction, multiplication, division, algebra

KSA 305 Suggested Reading

Audel Mechanical Trades Pocket Manual ISBN-10: 0764541706

Maintenance Manager's Standard Manual ISBN: 1557017069

KSA 306**Weight: 10%**

Maintain electrical and instrumentation, power, control and communication systems of water quality treatment plants, pump stations and recycled water facilities.

KSA 306 General Competencies

Candidates should be able to perform basic maintenance, inspection, and repair task on mechanical and electrical process control equipment.

The candidate should have a journey level or advanced understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; a vocational training center, an industrial apprenticeship, on the job training, manufacturer training seminars, etc. Must have experience with the following/but not limited to:

- precision metering (oscilloscope, harmonic analyzer)
- coordinate resources to solve complex problems
- failure analysis
- recommend PMs

KSA 306 Math Competencies

Algebra, Geometry, Trigonometry, Binary Functions, Boolean logic, Wastewater math

KSA 306 Suggested Reading

Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-

Operation Of Wastewater Treatment Plants, Volume II ISBN: 978-1-59371-038-5

KSA 307

Weight: 9%

Using appropriate communications technology, effectively communicate verbal and written reports and technical information to maintenance, operations and management staff.

KSA 307 General Competencies

Candidates should be able to communicate effectively and concisely with language that is exact; has unity and coherence. It must follow a logical order and guidance from point to point. Establishes and maintains effective working relationships.

The following workplace skills could be learned through online courses, on the job training, technical writing courses at 2 and 4 year colleges, etc. Must have experience with the following/but not limited to:

- Effective communication (Verbal, written and electronic)
- Competency in Business software application (Word processing, spreadsheet, email, presentation)
- Complete logs and maintenance reports
- Competency in computerized maintenance management systems

KSA 307 Math Competencies

Addition, subtraction, multiplication, division

KSA 307 Suggested Reading

Maintenance Manager's Standard Manual ISBN: 1557017069

KSA 308

Weight: 9%

Establish and maintain cooperative working relationships with agency staff, engineering and management outside vendors, and consultants.

KSA 308 General Competencies

Candidates should be able to develop, understand and maintain interpersonal relationships with their co-workers, agency staff, and outside vendors and consultants that result to an effective working relationship with others in the daily work environment.

The following workplace skills can be best learned by mentoring, on the job training, employee development seminars, or some combination of all of these. Must have experience with the following/but not limited to:

- Effective communication (Verbal, written and electronic)
- Presentation skills
- Competency in Business software application (Word processing, spreadsheet, email, presentation)

KSA 308 Math Competencies

Addition, subtraction, multiplication, division

KSA 308 Suggested Reading

Water Utility Management ISBN : 0-89867-063-2

Utility Management ISBN: 978-1-884701-49-8

KSA 309**Weight: 6%**

Evaluate, modify and design advanced electrical and instrumentation circuits and control loops.

KSA 309 General Competencies

Candidates should be able to perform basic and advanced electrical and instrumentation circuit installation for additions or modifications by bending and installing conduit, pulling wire, wiring in circuits as shown on blue- prints, and testing systems for proper installation.

The candidate should have a journey level or advanced understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; a vocational training center, an industrial apprenticeship, manufacturer training seminars, professional trade organization training such as ISA, etc. Must have experience with the following/but not limited to:

- interlock circuits
- alarm circuits
- control loops
- cameras
- level control
- flow control
- pressure control

KSA 309 Math Competencies

Algebra, Geometry, Trigonometry, Binary Functions, Boolean logic, Wastewater math

KSA 309 Suggested Reading

Measurement and Control Basics 978-1-55617-916-7

CompTIA Network+ Study Guide ISBN-10: 1118137558

Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-

NFPA 70

NFPA 820

UGLY'S Electrical Reference

KSA 310**Weight: 11%**

Accurately recognize, diagnose, and repair electrical and instrumentation equipment problems and recommend upgrades and improvements.

KSA 310 General Competencies

Candidates should be able to understand the operational process of a water and or wastewater plant, in order to become fully educated as to the equipment that is in use, and understands all of the microprocessor-controlled devices, elements, controllers, sensors, and process control equipment that are part of the treatment process.

The candidate should have a journey level or advanced understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; a vocational training center, an industrial apprenticeship, manufacturer training seminars, professional trade organization training such as EASA, industrial electrical maintenance programs, etc. Must have experience with the following/but not limited to:

- Flowmeters
- PLC's, analyzers
- HMI's, motors
- Conductors
- Lights
- Conduit

KSA 310 Math Competencies

Algebra, Geometry, Trigonometry, Binary Functions, Boolean logic, Wastewater math

KSA 310 Suggested Reading

Measurement and Control Basics 978-1-55617-916-7

CompTIA Network+ Study Guide ISBN-10: 1118137558

Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-

NFPA 70

NFPA 820

UGLY'S Electrical Reference

KSA 311

Weight: 6%

Interpret, implement and document complex maintenance requirements, electrical and instrumentation testing and calibration routines and remote process control systems.

KSA 311 General Competencies

Candidates should be able to interpret and works from basic drawings, designs, schematics, sketches, and written and verbal instructions; performs basic maintenance, repairs, fabrication, and rebuilding of shop, field, and plant equipment used in water and or wastewater treatment facilities, pump stations, and collection systems.

The candidate should have a practical understanding of the following computer/IT skills listed below as used a municipal or industrial wastewater treatment facility. These skills could be acquired through; a vocational training center, a 2 or 4 year college, correspondence or online courses, on the job training or a combination of these. Must have experience with the following/but not limited to:

- Navigating trending software
- Following SOP's, SCADA
- Email
- Word processing programs

KSA 311 Math Competencies

Algebra, Geometry, Trigonometry, Binary Functions, Boolean logic, Wastewater math

KSA 311 Suggested Reading

Measurement and Control Basics 978-1-55617-916-7

Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-

Maintenance Manager's Standard Manual ISBN: 1557017069

KSA 312**Weight: 6%**

Perform advanced wastewater and electrical mathematical calculations.

KSA 312 General Competencies

The candidate should have a practical understanding of the mathematics listed below - as applied to Electrical and Instrumentation work in a municipal or industrial wastewater treatment facility. These skills could be acquired through; a 2 or 4 year college, online mathematics courses, on the job training, or a combination of these. Must have experience with the following/but not limited to:

- elemental trig
- Boolean and Cartesian algebra
- algebra
- geometry
- trigonometry
- binary functions
- Boolean logic
- wastewater math

KSA 312 Math Competencies

- Addition, subtraction, multiplication, and division with and without a calculator
- Concept of percentages
- Applied basic geometry: Example: Ability to calculate surface area and volume of rectangular, cylindrical, and spherical shapes
- Algebra: Ability to manipulate $V=IR$ to solve for I , or R .
- Applied algebra and geometry: Example: Given $Q=VA$ for flow through a pipeline - be able to determine A and then manipulate as required to solve for V .
- Application example: Given a known volumetric flow, be able to
- calculate linear velocity for purpose of sourcing a new flow meter Ability to determine pressure of a given column of liquid of any density relative to water (specific gravity)
- Applied trigonometry
- Example 1: Ability to use right triangle trigonometry to calculate conduit offsets and kicks.
- Example 2: Ability to use basic trigonometric functions such as “cosine” to calculate power factor for an AC electrical system.
- Ability to analyze and interpret graphical data with respect to time or another variable.

- Ability to create new and modify existing electronic spreadsheets.
- Understanding of basic logarithmic relationships such as pH, and log/log plots of circuit breaker trip curves.
- Understanding of other nonlinear relationships such as “affinity relationships” for centrifugal pumps - http://www.engineeringtoolbox.com/affinity-laws-d_408.html
- Application example: Be able to select the appropriate variable frequency drive configuration for a centrifugal pump application (most likely variable torque)
- Understanding of vacuum, gauge pressure, and absolute pressure
- Understanding of absolute temperature scales
- Understanding of basic chemistry as related to analytical instruments (and safety for that matter)
- Ability to understand and analyze technical reports such as an exhaust emissions analysis or harmonic analysis?

KSA 312 Suggested Reading

N/A

Study Materials

The following section includes the titles and information of primary and secondary references. These references contain the majority of the information needed for the CWEA certification test; it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

Study Materials Referenced in KSAs

- UGLYS Electrical Reference
- Audel Mechanical Trades Pocket Manual ISBN-10: 0764541706
- NFPA 70, 70E, 820
- Maintenance Manager's Standard Manual ISBN: 1557017069
- Utility Management ISBN: 978-1-884701-49-8
- Water Utility Management ISBN : 0-89867-063-2
- Standard Textbook of Electricity, by Stephen Herman
- Measurement and Control Basics 978-1-55617-916-7
- Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-2
- ISA Standards
- Operation Of Wastewater Treatment Plants, Volume II ISBN: 978-1-59371-038-5
- CalOSHA Electrical safety pocket guide

Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter.

Select the best answer for each item below.

1. If the potential difference across the coil is low, the coil will:
 - a. draw too much current.
 - b. become too hot.
 - c. produce too much magnetic force.
 - d. not heat up.
2. 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
3. Which of the following reduces high voltages and currents to safe values for measurements?
 - a. Auto transformer
 - b. Megohmmeter
 - c. Instrument transformer
 - d. Variable transformer
4. In a three-wire control circuit, when a power failure occurs:
 - a. the interlock contact will close the circuit.
 - b. the operator can restart the meter automatically.
 - c. the motor can restart unexpectedly.
 - d. the operator must restart the meter manually.

5. Pushbuttons are classified as standard-duty or heavy-duty according to the:
 - a. kind of enclosure.
 - b. service conditions.
 - c. frequency operation.
 - d. current carrying ability.
6. A push-to-test pilot light is used in applications where the pilot light is:
 - a. rarely needed.
 - b. a neon bulb.
 - c. used only in DC applications.
 - d. in constant use.
7. The advantage of LCDs over LEDs is:
 - a. accuracy.
 - b. better visibility.
 - c. lower power consumption.
 - d. sensitivity.
8. Shielding protects an analog meter from:
 - a. damage due to careless handling.
 - b. harmful UV rays.
 - c. over-current and surges.
 - d. stray magnetic fields.
9. 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
10. Bar graphs and wave forms can be displayed on a LCD screen when the multimeter has:
 - a. analog/digital circuits.
 - b. microprocessor circuitry.
 - c. opposing coils and a commutator.
 - d. parallel ports.

11. The difference between the squirrel-cage rotor and the wound rotor is in:
 - a. their pole-phase groups.
 - b. how the conductors are connected.
 - c. how the current is induced in the conductors.
 - d. all of the above.
12. The frame, the core, the winding, and the end plates are all parts of the:
 - a. rotor.
 - b. stator.
 - c. alternator.
 - d. induction motor.
13. Which of the following is a sign of overheating rotor bars?
 - a. Reduced starting torque.
 - b. Noise.
 - c. Discoloration.
 - d. All of the above.
14. Two sources of power, one AC and one DC, are required for running a(n):
 - a. induction motor.
 - b. squirrel-cage motor.
 - c. synchronous motor.
 - d. wound-rotor motor.
15. Modern synchronous motors have:
 - a. both brushes and slip rings.
 - b. brushes, but no slip rings.
 - c. slip rings, but no brushes.
 - d. neither brushes nor slip rings.
16. All the following are true of 240-volt systems compared to 480-volt systems, except:
 - a. they cost more to operate.
 - b. they require more current per unit of power.
 - c. they require smaller circuit breakers.
 - d. they are safer.

17. If a charged capacitor is removed from a circuit, the capacitor:
- retains its charge.
 - loses some of its charge.
 - loses most of its charge.
 - loses all of its charge.
18. Control systems are usually designed so that each individual circuit controls:
- all functions of the machine.
 - at least two functions.
 - only one function.
 - only one device.
19. A 115-volt, 2-KVA, single-phase generator operating at full load will deliver how many amperes?
- 0.23
 - 17.4
 - 57.5
 - 230
20. What is the current when a circuit has a 1,500- watt load and a power factor of 86%, and operates from a three-phase 230-volt source?
- 9.7 amps
 - 6.5 amps
 - 4.4 amps
 - 3.8 amps
21. What is the amp-load of a three-phase, 0.5-hp, 230-volt motor with an efficiency rating of 92% and a power factor of 80%?
- 1.27 amps
 - 1.19 amps
 - 2.55 amps
 - 4.41 amps
22. A three-phase, 460-volt motor draws a current of 52 amperes. The motor has an efficiency rating of 94% and a power factor of 80%. What is the horsepower?
- 24.1 hp
 - 41.7 hp

- c. 50.0 hp
 - d. 73.8 hp
23. A 120-volt AC circuit draws a current of 5 amperes. Determine the power consumption.
- a. 60 watts
 - b. 120 watts
 - c. 4.8 watts
 - d. 600 watts
24. In a simple ratio system, the independent variable is:
- a. both measured and controlled.
 - b. controlled but not measured.
 - c. measured but not controlled.
 - d. neither measured nor controlled.
25. The root-mean-square method is used to calculate:
- a. integral and derivative action.
 - b. proportional band or gain.
 - c. system accuracy.
 - d. transducer bias.
26. To simulate an RTD input, you use a:
- a. digital VOM.
 - b. potentiometer.
 - c. resistance decade box.
 - d. wally box.
27. SCADA systems typically span:
- a. an entire plant.
 - b. many miles.
 - c. part of the plant.
 - d. up to 5,000 feet.
28. In the ISA tag PIC-21, the P stands for:
- a. Positive.
 - b. Pressure.
 - c. Process.
 - d. Proportional.

29. The outputs of a digital transducer are in the form of:
- 1 to 5 mv.
 - 4 to 20 ma.
 - digital computer words.
 - on or off signals
30. A shield around the signal lead is the most effective protection against:
- impedance.
 - unwanted conductance.
 - noise.
 - inverted sources.
31. The most important consideration in loop control is:
- accessibility.
 - accuracy.
 - cost.
 - response.
32. Which element makes a programmable logic controller system flexible?
- Memory.
 - I/O.
 - Program.
 - Power supply.
33. Local I/O expansion involves the addition of:
- a second processor.
 - a shift register.
 - data-handling capabilities.
 - I/O points within the rack.
34. A major cause of problems in multi-layer printed circuit boards is:
- age.
 - corrosion.
 - interlayer separation.
 - overheating.

35. A software problem that causes incorrect results is called a:
- a. bug.
 - b. crash.
 - c. glitch.
 - d. spike.
36. The CPU of a microcomputer is a(n):
- a. ALU.
 - b. microcontroller.
 - c. microprocessor.
 - d. printed circuit assembly.
37. Where is a computer's start-up program usually stored?
- a. In RAM
 - b. In ROM
 - c. On disk
 - d. On magnetic tape
38. How many signal conditions can digital I/O devices have?
- a. One
 - b. Two
 - c. Eight
 - d. An infinite number
39. A CDU (Command and Display Unit) computer screen that senses finger pressure is:
- a. a digitizer.
 - b. an intelligent terminal.
 - c. a scanner.
 - d. a touch screen.
40. Which of the following is not a goal of a microprocessor-based engine control system?
- a. Better engine performance
 - b. Better fuel economy
 - c. Lower exhaust emissions.
 - d. Lower noise emissions

41. The RS232C standard applies to what type of digital data transmission?
- Balanced
 - Fiber optic
 - Parallel
 - Serial
42. 10°C is equal to how many degrees Fahrenheit?
- 23.3°F
 - 50°F
 - 75.6°F
 - 47.6°F
43. What is the volume of a cylinder with a 40-foot diameter and height of 23 feet?
- 1,444 cu ft
 - 7,222 cu ft
 - 28,888 cu ft
 - 33,221 cu ft
44. 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?
- 64.4 lbs
 - 74.8 lbs
 - 83.4 lbs
 - 624 lbs
45. To select the proper protection for a motor, you need to know all the following except the:
- ambient temperature.
 - full-load current rating.
 - service factor.
 - time rating.
46. An on-off switch with overload relays is called a:
- magnetic control.
 - manual starter.
 - reversing starter.

- d. combination starter.
47. Hydraulic actuators:
- a. can produce very large thrust.
 - b. offer an indirect response to input.
 - c. require almost no maintenance.
 - d. usually use water as the fluid.
48. Scheduling should precede:
- a. planning.
 - b. material procurement.
 - c. workload balancing.
 - d. job execution.
49. Which of the following should you NOT do after giving your crew instructions?
- a. Repeat key points
 - b. Justify your instructions
 - c. Refuse to change assignments
 - d. Seek further information on a job
50. The surest way to get feedback is through:
- a. a suggestion box.
 - b. the company newsletter.
 - c. asking questions.
 - d. All of the above
51. The best way to motivate a crew is though:
- a. force.
 - b. playing favorites.
 - c. recognition.
 - d. threats.

Answer Key

No.	Answer	No.	Answer
1	D	27	B
2	A	28	B
3	C	29	C
4	D	30	C
5	D	31	D
6	A	32	C
7	C	33	D
8	D	34	C
9	D	35	A
10	B	36	C
11	B	37	B
12	B	38	B
13	C	39	D
14	C	40	D
15	D	41	D
16	C	42	B
17	A	43	C
18	C	44	D
19	B	45	A
20	C	46	B
21	A	47	A
22	B	48	D
23	D	49	C
24	C	50	C
25	C	51	C
26	C		

EIT GRADE 4 EXAM CONTENT OUTLINE

Knowledge, Skills and Abilities (KSAs)

Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual job description, they do reflect the core competencies and essential duties required of any Electrical & Instrumentation Technologist. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

Each KSA includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered.

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.

KSA 401**Weight: 7%**

Implement management directives utilizing comprehensive knowledge of methods, materials and equipment used in the corrective maintenance, preventive maintenance and construction of various types of electrical/instrumentation systems and components in water quality treatment plants, pumping stations and recycled water facilities.

KSA 401 General Competencies

Candidates must be able to explain, use, and understand the differences between strategic planning and tactical planning within each organizational structure. The candidate should have an advanced or supervisory level understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; college level course work, management training seminars, mentoring, or on the job training.

- Scheduling
- Planning
- project management
- understanding of energy usage and efficiency
- failure analysis
- wrench time analysis
- work estimates
-

KSA 401 Math Competencies

- Averages
- Statistical Analysis

KSA 401 Suggested Reading

Maintenance Manager's Standard Manual ISBN: 1557017069

KSA 402**Weight: 11%**

Apply comprehensive knowledge of confined space work entries and safety principles established by OSHA, NFPA (National Fire Protection Association) 70E and state safety orders to all aspects of electrical and instrumentation work, equipment and training of personnel.

KSA 402 General Competencies

Candidates must understand what the Occupational Safety and Health Act covers, and how they affect the manager's role within the working environment. The candidate should have an advanced or supervisory level understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; safety training institutes, college level course work, management training seminars, or on the job training.

- Confined space procedures
- arc flash
- LOTO
- fall protection prevention
- electrical safety
- traffic safety
- hazardous materials
- communications

KSA 402 Math Competencies

Addition, subtraction, multiplication, division

KSA 402 Suggested Reading

NFPA 70E

http://www.dir.ca.gov/dosh/dosh_publications/ConfSpa.pdf#zoom=100 (CalOSHA Confined space pocket guide)

http://www.dir.ca.gov/dosh/dosh_publications/Electrical_Safety.pdf#zoom=100 (CalOSHA Electrical safety pocket guide)

Utility Management ISBN: 978-1-884701-49-8

KSA 403

Weight: 8%

Professionally and effectively lead staff by managing employee schedules, assignment of tasks and responsibilities, training requirements, motivation, and performance evaluations, and other staffing functions.

KSA 403 General Competencies

Candidates must understand what it means to be an operative leader through managing a department and must have effective interpersonal skills.

The candidate should have an advanced or supervisory level understanding of the following as applied to a E/I department management of a municipal or industrial waste water treatment facility. These skills could be acquired through; college level course work, management training seminars, mentoring, or on the job training.

- run staff meetings
- delegate staff trainings
- oversee recurring training for staff
- goal setting
- understanding motivational factors (Herzberg's hygiene and motivators)
- timely employee recognition
- total quality management principles
- performance monitoring
- understanding of individual differences

KSA 403 Math Competencies

There are no specific math competencies for this KSA.

KSA 403 Suggested Reading

PMBOK (Project Management Body of Knowledge)

KSA 404

Weight: 9%

Manage a maintenance program through planning, budgeting and scheduling effective use of personnel, equipment and materials.

KSA 404 General Competencies

Candidates should understand and describe the control process: a process that consists of measuring actual performance, comparing results with standards, and taking corrective action.

The candidate should have an advanced or supervisory level understanding of the following as applied to an E/I department management of a municipal or industrial wastewater treatment facility. These skills could be acquired through; college level course work, management training seminars, mentoring, or on the job training

- capital and maintenance budgeting
- prepare presentations

KSA 404 Math Competencies

Wastewater math.

KSA 404 Suggested Reading

Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-2

Operation Of Wastewater Treatment Plants, Volume II ISBN: 978-1-59371-038-5

KSA 405

Weight: 7%

Plan, organize, direct and control maintenance tasks associated with water treatment facilities, electrical and instrumentation systems and equipment.

KSA 405 General Competencies

Candidates should have an understanding of what Key Planning Guides are and how to apply them (i.e. standing plan, policies, or procedures).

The candidate should have an advanced or supervisory level understanding of the following as applied to a E/I department management of a municipal or industrial waste water treatment facility. These skills could be acquired through; college level course work, technical training institutes, IT training seminars, vendor training seminars, or on the job training.

- SCADA
- LIMS
- CMMS
- WIMS
- Productivity training applications

KSA 405 Math Competencies

Wastewater math.

KSA 405 Suggested Reading

Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-2

Operation Of Wastewater Treatment Plants, Volume II ISBN: 978-1-59371-038-5

KSA 406**Weight: 10%**

Using appropriate communications technology, effectively communicate verbal and written reports and technical information to maintenance, operations and management staff.

KSA 406 General Competencies

Candidates should know the communication process, methods of communication, and the differences of formal and informal communication

- Effective communication (Verbal, written and electronic)
- Presentation skills
- Competency in Business software application (Word processing, spreadsheet, email, presentation)

KSA 406 Math Competencies

Addition, subtraction, multiplication, division

KSA 406 Suggested Reading

NFPA 70

NFPA 70E

NFPA 820

Utility Management ISBN: 978-1-884701-49-8

KSA 407**Weight: 8%**

Interpret and apply pertinent internal policies, federal, state, and local laws, codes and regulations such as safety and environmental protection to tasks associated with water treatment plant, pumping stations and recycled water facilities.

KSA 407 General Competencies

Candidates should be familiar with the supervisory effects of the Occupational Safety and Health Act, as well as explain how a supervisor can create a healthy work environment.

The candidate should have an advanced or supervisory level understanding of the following as applied to a E/I department management of a municipal or industrial waste water treatment facility. These skills could be acquired through; college level course work, management training seminars, or on the job training.

- Regional board
- EPA
- California Code of Regulations (archeological)
- State Workers Insurance Fund (environmental)
- Principles of regulatory law
- Endangered Species Act

KSA 407 Math Competencies

Addition, subtraction, multiplication, division

KSA 407 Suggested Reading

NFPA 70

NFPA 70E

NFPA 820

KSA 408**Weight: 8%**

Establish and maintain effective working relationships including relationships with staff from other agencies, a variety of government officials and the general public.

KSA 408 General Competencies

Candidates must understand the communication process; methods of communication and the barriers to effective communications. As well as develop a special communication skill in active listening.

The candidate should have an advanced or supervisory level understanding of the following as applied to a E/I department management of a municipal or industrial waste water treatment facility. These skills could be acquired through; college level course work, management training seminars, or on the job training.

- Effective communication (Verbal, written and electronic)
- Presentation skills
- Competency in Business software application (Word processing, spreadsheet, email, presentation)

KSA 408 Math Competencies

There are no specific math competencies for this KSA.

KSA 408 Suggested Reading

Water Utility Management ISBN: 0-89867-063-2

Utility Management ISBN: 978-1-884701-49-8

KSA 409**Weight: 7%**

Ability to oversee all processes associated with electrical and instrumentation circuits and control loops including planning, coordinating and implementing evaluations, modifications and designing.

KSA 409 General Competencies

Candidates should be able to understand the differences between a Gantt chart and a Pert chart, and understand the scheduling, events, activities, and critical paths within each chart.

The candidate should have an advanced or supervisory level understanding of the following as applied to a E/I department management of a municipal or industrial waste water treatment facility. These skills could be acquired through; college level course work, technical training institutes, IT training seminars, vendor training seminars, or on the job training.

- CAD
- Initiating
- Planning
- Executing
- monitoring and controlling and closing a project
- risk analysis
- project tracking management
- Gantt charts

KSA 409 Math Competencies

Statistics, Algebra

KSA 409 Suggested Reading

NFPA 70

NFPA 820

Measurement and Control Basics 978-1-55617-916-7

PMBOK Project Management Body of Knowledge

UGLYS electrical reference

KSA 410**Weight: 6%**

Manage all aspects of a project to completion including initiation, planning, executing, monitoring, and controlling.

KSA 410 General Competencies

Candidates should be able to understand the differences between a Gantt chart and a Pert chart, and understand the scheduling, events, activities, and critical paths within each chart.

The candidate should have an advanced or supervisory level understanding of the following as applied to a E/I department management of a municipal or industrial waste water treatment facility. These skills could be acquired through; college level course work, management training seminars, or on the job training.

- Gantt charts
- critical path
- deliverables
- project management

KSA 410 Math Competencies

There are no specific math competencies for this KSA.

KSA410 Suggested Reading

N/A

KSA 411**Weight: 6%**

Direct all electrical and instrumentation resources used in water quality treatment plant, pump station and recycled water facilities.

KSA 411 General Competencies

Candidates should be able to focus on the customer, and seek continuous improvement in the quality of everything the organization does.

The candidate should have an advanced or supervisory level understanding of the following as applied to a E/I department management of a municipal or industrial waste water treatment facility. These skills could be acquired through; college level course work, technical training institutes, IT training seminars, vendor training seminars, or on the job training.

- Alarms
- control circuits
- communication networks

KSA 411 Math Competencies

Algebra, Geometry, Trigonometry, Binary Functions, Boolean logic, Wastewater math

KSA 411 Suggested Reading

Measurement and Control Basics 978-1-55617-916-7

CompTIA Network+ Study Guide ISBN-10: 1118137558

Operation Of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-2

KSA 412

Weight: 7%

Prepare clear and concise reports of budgets, maintenance activities and operation of equipment.

KSA 412 General Competencies

Candidates must understand that effective communication has many barriers in the language used, the listening habits, lack of feedback, the perception of how the message is presented, and the emotions involved with the communication.

The candidate should have an advanced or supervisory level understanding of the following as applied to a E/I department management of a municipal or industrial waste water treatment facility. These skills could be acquired through; college level course work, technical training institutes, IT training seminars, vendor training seminars, or on the job training.

- Power Point presentations
- Spreadsheets
- failure analysis
- accounting principles

KSA 412 Math Competencies

Statistics, Algebra

KSA 412 Suggested Reading

Managerial Accounting ISBN: 0078111005

Maintenance Manager's Standard Manual ISBN: 1557017069

KSA 413**Weight: 6%**

Mastery of wastewater math and electrical and instrumentation principles.

KSA 413 General Competencies

Candidates should have attended college level classes within the intermediate algebra range at the very minimum. Grade 3 requirements plus understanding of basic accounting principles. Advanced electronic spreadsheet development, modification, interpretation, and analysis.

The candidate should have an advanced or supervisory level understanding of the following as applied to a municipal or industrial wastewater treatment facility. These skills could be acquired through; college level course work, online training.

- Algebra
- Geometry
- Trigonometry
- binary functions
- Boolean logic
- wastewater math
- statistics
- accounting principles

KSA 413 Math Competencies

There are no specific math competencies for this KSA.

KSA 413 Suggested Reading

N/A

Study Materials

The following section includes the titles and information of primary and secondary references. These references contain the majority of the information needed for the CWEA certification test; it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

Study Materials Referenced in KSAs

- UGLYS Electrical Reference
- Audel Mechanical Trades Pocket Manual ISBN-10: 0764541706
- NFPA 70, 70E, 82
- Maintenance Manager's Standard Manual ISBN: 1557017069
- Utility Management ISBN: 978-1-884701-49-8
- Water Utility Management ISBN: 0-89867-063-2
- Maintenance Engineering Handbook, 5th Edition
- Operation of Wastewater Treatment Plants, Volume I ISBN: 978-1-59371-039-2
- Supervision Today
- Managerial Accounting ISBN: 0078111005
- Operation of Wastewater Treatment Plants, Volume II ISBN: 978-1-59371-038-5
- CalOSHA Electrical safety pocket guide

Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter.

Select the best answer for each item below.

1. What is the main electrical danger when using power tools?
 - a. Excessive heat
 - b. Low-resistance grounding
 - c. Over-current
 - e. Short circuit
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. The first requirement on a work site is:
 - a. preventive maintenance.
 - b. work quality.
 - c. meeting deadlines.
 - d. safety
5. What is the purpose of the cage in an anti-friction bearing?
 - a. Keep the grease next to the rolling elements
 - b. Hold the rolling elements in the races during assembly
 - c. Hold the rolling elements in the races during operation
 - d. Properly space the rolling elements and guide them through the load zone

6. What does the term “braided” refer to when applied to a pressure hose and/or fuel line?
 - a. Type of inner hose reinforcement
 - b. Type of material used for fluid contact
 - c. Method of connecting hose sections
 - d. Hose covering material
7. The pitch of a screw thread is:
 - a. the angle included between the sides of the thread measured in the axial plane.
 - b. the distance from a point on the screw thread to a corresponding point on the next thread.
 - c. the angle included between the side of a thread and the centerline, measured in the axial plane.
 - d. the distance a screw advances axially in one turn.
8. Which welding process produces the highest quality weld on stainless steel?
 - a. Oxyacetylene
 - b. Shielded metal-arc
 - c. Gas metal-arc
 - d. Gas tungsten-arc
9. Which of the following “trouble causes” would be associated with a pump that fails to discharge on start- up?
 - a. Leaks in the stuffing box
 - b. Excessive pump clearances
 - c. Lift too high
 - d. Air or vapor in the liquid
10. The two main classifications of air compressors are:
 - a. positive-displacement and dynamic.
 - b. air-cooled and water-cooled.
 - c. reciprocating and rotary.
 - d. vane and piston.

11. The three major functions of a flexible coupling are:
 - a. transfer rotary motion, compensate for slight misalignment, and damping vibration.
 - b. transfer rotary motion, compensate for slight misalignment, and minimize or eliminate the conduction of electricity.
 - c. transfer rotary motion, compensate for slight misalignment, and allow for axial movement of the shafts.
 - d. transfer rotary motion, damping vibration, and allow for axial movement of the shafts.
12. A pump operating at 1,770 RPM supplies 6,500 gpm. The suction pressure is 10 psi and the discharge pressure is 75 psi. If the pump is 78% efficient and the motor is 86% efficient, what is the brake horse- power? The specific gravity of the pumped liquid is 1.12.
 - a. 276 hp
 - b. 354 hp
 - c. 408 hp
 - d. 463 hp
13. A parking lot has a bank of ten 400- watt lights that operate for 10 hours a day. It also has a 150-watt sign that is always on. If power cost \$0.095 per kilowatt-hour (kwh) what is the cost to operate this lot for 30 days?
 - a. \$21.66
 - b. \$114.00
 - c. \$124.26
 - d. \$216.60
14. A pump station has six 500 hp pumps that run an average of 5 hours a day each, a 5 hp sump pump that operates for 1.5 hrs/day, twenty 100-watt lights that are always on, and six 300-watt night lights that are on 10 hours a day. What is the monthly operating cost if power cost 8.75 cents per kwh? (A month is 30 days)
 - a. \$29,373.75
 - b. \$29,388.44
 - c. \$29,514.44
 - d. \$29,561.69

15. A holding tank requires chlorination to 2.5 ppm. The tank holds 3.5 million gallons. How many pounds of chlorine will be needed?
- a. 8.75 lbs
 - b. 50 lbs
 - c. 73 lbs
 - d. 182 lbs
16. Which kinds of bearings are used when a motor is to be mounted horizontally?
- a. Radial
 - b. Thrust
 - c. Angular
 - d. Antifrictio
17. With which kind of equipment is PM effective?
- a. Equipment in any condition
 - b. Equipment in need of an overhaul
 - c. Equipment that is up to standard
 - d. Equipment that is not up to standard
18. The simplest kind of electrical meter to read is the:
- a. D'Arsonval meter.
 - b. digital meter.
 - c. pointer meter.
 - d. dial meter.
19. The insulation in a capacitor is called:
- a. condenser.
 - b. farad.
 - c. dielectric.
 - d. electrolyte.
20. 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.

21. Dual-element cartridge fuses are designed mainly for:
 - a. high-voltage installations.
 - b. home-lighting circuits.
 - c. motor-circuit protection.
 - d. supplementary protection.
22. Which kind of drawings use both normal and actual dimensions?
 - a. Architectural
 - b. Electrical
 - c. Installation
 - d. Riser
23. A Power-Installation drawing shows:
 - a. power outlets.
 - b. lighting receptacles.
 - c. plug receptacles.
 - d. computer terminal location
24. 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.
25. Which of the following is not needed in your motor-location file?
 - a. Graph and log
 - b. Lubrication schedule
 - c. List of repairs performed
 - d. Name of the manufacturer
26. How many cams are located on the shaft of a percentage timer?
 - a. 0
 - b. 1
 - c. 2
 - d. 3

27. All special single-wire terminals:
- must have matching receptacles.
 - are non-insulated.
 - require butt connectors.
 - are pre-marked for identification.
28. You should never connect an electrolytic capacitor:
- across a DC line.
 - across an AC line.
 - with the common terminal negative.
 - with the common terminal positive.
29. To provide a long service life, capacitors require:
- frequent maintenance.
 - proper installation.
 - ambient temperatures lower than 60°F.
 - regular lubrication.
30. Dual-voltage motors are:
- always Delta-connected.
 - always Y-connected.
 - either Y- or Delta-connected.
 - neither Y- nor Delta-connected.
31. A signal of 4 to 20 MA is an example of a(n):
- analog electrical signal.
 - ASCII.
 - binary signal.
 - digital pneumatic signal.
32. Which of the following is optional in a single-variable control loop?
- Controller
 - Final control element
 - Recorder
 - Transducer

33. The ability of an instrumentation system to cancel common mode noise is expressed in:
- decibels.
 - hertz.
 - ohms.
 - volts.
34. A disturbance inside a control loop:
- does not affect output.
 - is a manipulated variable.
 - is corrected for by feedback.
 - results in a process error.
35. The first step in troubleshooting a programmable logic controller system is:
- gathering information.
 - understanding how the system works.
 - developing a test strategy.
 - replacing any suspicious components.
36. Each device connected to a network works through a:
- controller.
 - data packet.
 - node.
 - token.
37. A DCS workstation performs:
- back-up control in case of failure.
 - control algorithms only.
 - high-level process control.
 - no process control.
38. Maintenance cost reports should show:
- the cost of labor and materials.
 - major jobs such as lubrication.
 - particular standing work orders.
 - replacement of capital items.

39. The real objective of measuring performance is to:
- a. identify areas that need improvement.
 - b. determine maintenance cost.
 - c. determine work distribution.
 - d. update historical data.
40. Which of the following do maintenance reports typically exclude?
- a. Manpower use
 - b. Maintenance cost
 - c. The status of specific jobs
 - d. Information on crew performance
41. Quality supervision:
- a. reduces pressures.
 - b. increases the workload.
 - c. shifts all responsibility to the crew.
 - d. is a result of crew productivity.
42. Making job planning a group effort:
- a. wastes time.
 - b. improves productivity.
 - c. causes confusion.
 - d. all of the above.
43. When interviewing a potential employee, do NOT ask him or her about:
- a. age.
 - b. religion.
 - c. family status.
 - d. any of the above.
44. Unscheduled repairs require:
- a. consulting a planner.
 - b. use of unskilled labor.
 - c. a relatively short period of time.
 - d. immediate attention.

45. If you are angry or impatient with one worker:
- make an example of him or her.
 - put him or her on a job in another part of the plant.
 - make sure that other workers know what he or she did wrong.
 - avoid transferring that feeling to others.
46. A crew responds positively when:
- kept informed.
 - work quality improves.
 - group effort is absent.
 - discipline is needed.
47. The most important consideration in training is:
- communication.
 - testing.
 - practice.
 - trainee orientation.
48. The best way to motivate trainees to learn is to:
- offer them raises.
 - let them learn what they like.
 - relate the training to their jobs.
 - ask lots of questions to everyone in the group.
49. Your objective, during an employee's probationary period, is to:
- evaluate the employee's workmanship.
 - convince the employee not to join the union.
 - punish the employee.
 - look for the employee's replacement.
50. Normally, your first corrective action move in response to a minor violation should be a(n):
- written warning.
 - oral warning.
 - casual talk.
 - suspension.

51. When should you obtain statements from witnesses of an incident?
- At the hearing
 - After the offender has been suspended
 - Immediately after the violation
 - After physical evidence is recovered
52. Many organizations have personal computers using a LAN to allow information to be shared. LAN stands for:
- location and network.
 - logically allowed networking.
 - local area network.
 - logically allocated network.
53. Managers have many roles in an organization. The majority of the roles fall under the four major functions of a manager. These four major functions are:
- planning, organizing, directing, and controlling.
 - planning, organizing, staffing, and directing.
 - organizing, directing, optimizing resources and controlling.
 - planning, organizing, directing, and coaching.
54. Many maintenance organizations are implementing predictive maintenance programs. Predictive maintenance may be best described as:
- predicting equipment failures using high tech equipment such as vibration analysis and infrared thermography.
 - using observed information to predict the life expectancy of a particular type of equipment and replace or rebuild the equipment just prior to expected failure.
 - taking measurements on equipment under operating conditions in order to detect symptoms that are not in line with predetermined parameters and classify the causes.
 - using machinery history to predict the maintenance required in the future to set up a proper program to handle the maintenance in an effective and efficient manner.

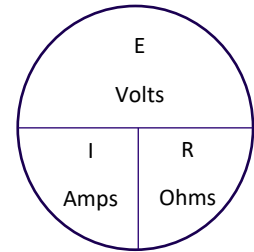
55. You have decided that it has become necessary for all plant personnel to participate in housekeeping. There are many who have raised the objection that higher-paid workers should not waste time with housekeeping. Who is the first person/group that you need to convince in order for your plan to work?
- a. The people required to do the work.
 - b. The first line supervisors.
 - c. Management.
 - d. Your peers.

Answer Key

No.	Answer	No.	Answer
1	D	29	B
2	C	30	C
3	A	31	A
4	D	32	C
5	B	33	A
6	A	34	C
7	B	35	B
8	C	36	A
9	D	37	D
10	A	38	D
11	C	39	A
12	B	40	D
13	C	41	A
14	D	42	B
15	C	43	D
16	A	44	C
17	C	45	D
18	B	46	B
19	C	47	A
20	D	48	C
21	C	49	A
22	A	50	B
23	A	51	C
24	B	52	C
25	A	53	A
26	C	54	C
27	A	55	C
28	B		

EIT FORMULA SHEET

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 VA = V × A × 1.732
$Area_{circle} = \pi \times radius^2$	Flowing quantity = Area × Velocity
$A = \pi r^2$	Efficiency = $\frac{work\ output}{work\ input}$
$Perimeter_{rectangle} = 2 \times (length + width)$	Energy = power × time
<i>Thermal expansion = coeff. of thermal expansion × length × ΔT</i>	
<i>Hydrostatic force = column area × column height × fluid density</i>	
$Motor\ horsepower = \frac{flow \times head \times specific\ gravity}{3960 \times efficiency\ pump \times efficiency\ motor}$	
$Brake\ horsepower = \frac{flow \times head \times specific\ gravity}{3960 \times efficiency}$	
$3\ phase\ A = \frac{746 \times horsepower}{1.732 \times V \times efficiency \times power\ factor}$	
$Brake\ horsepower = \frac{water\ horsepower}{efficiency}$	
$Water\ horsepower = \frac{flow \times total\ head \times specific\ gravity}{3960}$	
$V = d / t$	

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](#).

TEST SITE INFORMATION

Test Site Admission

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.

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 <i>except</i> 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 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.

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. 125).

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 \$25 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. 126).

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 \$25 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. 129).

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

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 – 100 points

Summary of Certification Activities

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