



**SOCIETY FOR MAINTENANCE & RELIABILITY  
PROFESSIONALS  
CERTIFYING ORGANIZATION**

**Certified Maintenance & Reliability Technician  
CMRT**

**Candidate Guide for Certification and Re-  
certification**

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**Society for Maintenance & Reliability Professionals Certifying Organization  
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Atlanta, GA 30339**

**SOCIETY FOR MAINTENANCE&RELIABILITY PROFESSIONALS  
CERTIFYING ORGANIZATION**

**CMRT Candidate Guide for Certification and Recertification**

**Table of Contents**

<b>I. Certification .....</b>	<b>4</b>
<b>A. Statement of Purpose .....</b>	<b>4</b>
<b>B. Rationale for Certification .....</b>	<b>4</b>
<b>C. Benefits of Certification.....</b>	<b>4</b>
<b>D. Exam Venues .....</b>	<b>5</b>
<b>E. Overview of the Certification Examination Process .....</b>	<b>5</b>
<b>F. Statement of Policy with Respect to Training Courses.....</b>	<b>5</b>
<b>II. Candidates and Certificants.....</b>	<b>6</b>
<b>A. Eligibility for Certification .....</b>	<b>6</b>
<b>B. Examination Process Security Requirements.....</b>	<b>6</b>
<b>C. Denial of Eligibility .....</b>	<b>6</b>
<b>D. Appeal of Denial of Eligibility.....</b>	<b>7</b>
<b>E. Testing in Languages Other than English .....</b>	<b>7</b>
<b>F. Policies for Applicants with English as a Second Language .....</b>	<b>7</b>
<b>G. Examination Accommodations for Candidates with Physical Disabilities .....</b>	<b>7</b>
<b>H. Examination Statistics .....</b>	<b>8</b>
<b>I. Candidate Confidentiality .....</b>	<b>8</b>
<b>J. Release of Certificant Information.....</b>	<b>9</b>
<b>K. Examination Score Reports.....</b>	<b>9</b>
<b>L. Length of time to Schedule and Take the Examination.....</b>	<b>9</b>
<b>M. Time Allowed to Sit for the Examination .....</b>	<b>9</b>
<b>N. Examination Security .....</b>	<b>9</b>
<b>O. Number of Times and Intervals Candidates May Take the Examination .....</b>	<b>10</b>
<b>P. Appeals Concerning Items on Exams and Scoring of Exams .....</b>	<b>10</b>
<b>Q. Mailing of Exam Results.....</b>	<b>10</b>
<b>III. Code of Ethics for Candidates and Certificants.....</b>	<b>10</b>
<b>IV. Subject Areas Addressed by the Certification Exam.....</b>	<b>12</b>

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**Domain I: Maintenance Practices ..... 12**

**Domain II: Preventive and Predictive Maintenance..... 14**

**Domain III: Troubleshooting and Analysis ..... 15**

**Domain IV: Corrective Maintenance..... 15**

**V. Re-certification..... 17**

**A. Re-certification Purpose, Philosophy and Requirements..... 17**

**Philosophy of the CMRT Recertification Program ..... 17**

**Notification and Certificant Responsibility ..... 17**

**Requirements for Recertification ..... 17**

**Certificant Preparation for Audit of Recertification Claims..... 18**

**Continuing Education (Option 1) ..... 19**

**Complete educational workshops, seminars, on-demand education, or other online courses classes relevant to subject areas in the BoK (Option 2)..... 19**

**Participate as an active member of a SMRP or SMRPCO Board or Committee or as a Proctor (Option 3)..... 19**

**Attend annual/executive/chapter meetings relevant to subject areas of the M&R BoK (Option 4) ..... 20**

**Attend conferences relevant to the subject areas of the BoK (Option 5)..... 20**

**Give presentation at a conference or seminar relevant to subject areas of the BoK (Option 6) 20**

**Publish articles or papers in publications relevant to the subject area of the BoK (Option 7).. 21**

**Author a book or significant chapter of a book relevant to the subject areas of the BoK (Option 8) ..... 21**

**Provide instruction for a course/workshop relevant to the subject areas of the BoK (Option 9) ..... 22**

**Participate in the development of questions for the CMRP exam (Option 10) ..... 22**

**Other activity or learning experience related to subject areas in the BoK (Option 11) ..... 22**

**Complete work hours relevant to the subject areas described in the BoK (Option 12) ..... 23**

**Application Process..... 23**

**Actions Taken Regarding Re-Certification Applications..... 23**

**Appeals Process..... 24**

**Extension Requests ..... 24**

**Waiver of Recertification Requirement..... 24**

**B. Inactive Status ..... 25**

**C. Lapsed Status ..... 25**

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**VI. Appendix A – Sample Exam Questions..... 26**  
**VII. Appendix B – Resources..... 28**

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## I. Certification

### A. Statement of Purpose

The Society for Maintenance and Reliability Professionals Certifying Organization (SMRPCO) is organized for the purpose of fostering high standards of ethical and professional practice in the delivery of services through a recognized, credible credentialing program that assures the competency of practitioners of Profession. The underlying ethic upon which the certification process rests is absolute fairness and equity in the administration of examinations and recertification for all applicants without discrimination (i.e. because of age, color, creed, gender, ethnic or religious background, lifestyle, marital status, national origin or political affiliation, race or sexual orientation).

### B. Rationale for Certification

Achieving the SMRP Mission. The key elements of SMRP's mission are the improvement of the maintenance and reliability profession and supporting the education of maintenance and reliability practitioners.

SMRP realizes that there are no consistent, well-defined standards for the body of knowledge and capabilities that maintenance technicians should have to be effective in their day to day activities. Further, there is no way to differentiate those who have mastered the various elements of excellence from those who simply hold the job. SMRP realizes that without a well-defined body of capabilities and a method of assessment it could not realistically fulfill all elements of our mission.

### C. Benefits of Certification

The benefits of certification are apparent for many fields and very attractive to maintenance technicians in many organizations. The following is a short summary of the benefits:

- Clearer direction for career development and education
- Improved visibility and recognition within your current organization
- Differentiated pay scales
- Portable job skills and knowledge between plants and companies
- Assists in job promotion
- Greater job effectiveness
- Improved ability to differentiate between candidates in the hiring and promotion process.

Many are aware of other organizations that offer similarly titled certifications in this or other related subjects. How does SMRPCO's process differ from these?

- SMRP is an independent, practitioner-based, non-profit organization without ties to any commercial venture.
- The SMRP body of knowledge used for the CMRT exam comprehensively addresses and examines skills in (a) maintenance practices, (b) preventive and predictive maintenance, (c) troubleshooting and analysis, and (d) reactive maintenance.
- SMRP uses broad representation in developing its Body of Knowledge and related certification program. Some of the leading organizations in manufacturing and service delivery, utilities, government activities and in the academic world participate on a regular basis to assure thorough validation of the work to develop the certification process.

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- SMRPCO was set up by SMRP and continues to be sponsored by SMRP, the leading organization for maintenance and reliability practitioners. SMRPCO has its own budget, Board of Directors and Staff and operates its program with minimal oversight from its sponsoring organization. No other organization in our field has that distinction.
- SMRPCO plans to enhance the value of certification to certified practitioners through other advanced certifications.

#### **D. Exam Venues**

The CMRT exam is administered exclusively at computer-based testing facilities. Visit [www.smrp.org](http://www.smrp.org) to locate a testing center near you.

#### **E. Overview of the Certification Examination Process**

The Examination for certification as a maintenance and reliability technician consists of 175 multiple-choice questions. Examinees are allowed three (3) hours to complete it. The examination is closed book with no reference materials allowed in the examination room (except strict translation dictionaries for candidates whose native language is not English, under conditions specified in Section II of this guide). A hand-held calculator with arithmetic functions is provided for use by those sitting for the exam. No other personal calculators, computers or electronic devices are permitted.

A set of sample exam questions is provided in Appendix A to this document. These are typical questions that will give the candidate exposure to the format of questions that are included on the exam. These sample questions will not appear on certification exams.

#### **F. Statement of Policy with Respect to Training Courses**

SMRPCO will not offer any training to assist persons in preparing for the certification examinations. A foundational belief in developing this examination is that maintenance and reliability technicians receive their experience and training from a variety of sources, both on the job and from outside training.

As such, SMRPCO will not develop any training courses to assist persons in successfully completing certification exams. SMRPCO's functions are:

- Development and administration of examinations that reflect, to the degree possible, the current CMRT Body of Knowledge
- Administration and conveyance of results and credentials associated with certification examinations and subsequent re-certification requirements

SMRPCO has developed and keeps current a list of publications on industrial maintenance subjects. The list is available for downloading from the SMRP web site. See the SMRP Certification Page of the web site for information. SMRPCO does not endorse any outside person, preparation course or product (such as a book, compact disc-based offering or other publication including those mentioned above on its web site) in connection with any certification program.

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## **II. Candidates and Certificants**

### **A. Eligibility for Certification**

There are no educational experiences or other requirements, other than completion of the application form, payment of applicable fees in advance and time since taking a previous certification exam for candidates who wish to take an examination for Certified Maintenance and Reliability Technician CMRT, and no conviction of a felony or other crime of moral turpitude under international, national, federal or state law in any matter related to the practice of or qualification for professional activity.

Candidates who are unable to comply with the eligibility requirements will not be allowed to sit for the exam at that time.

General criteria to qualify to take the CMRT examination includes a commitment to the SMRP Code of Ethics, (see Code of Ethics section), a completed application, and the application fee.

### **B. Examination Process Security Requirements**

SMRPCO includes a statement in the instructions preceding an exam which states that any violation of testing policies and procedures may result in dismissal from the exam venue, cancellation of exam scores and forfeiture of eligibility for exam fee refund.

SMRPCO requires that identification presented at the test site contain a valid photograph and signature. Appropriate forms of identification may include the following: a passport, driver's license, and other federal, national, provincial, territory or state government issued identification document or card.

Candidates testing outside their country of citizenship must present a valid passport.

Candidates who are unable to comply with the identification requirements will not be allowed to sit for the exam at that time.

### **C. Denial of Eligibility**

In the interest of serving the public trust, SMRPCO shall review all applicants' self-reported past and present criminal activities. SMRPCO reserves the right to perform a criminal history background check on applicants. Failure to provide accurate, true and correct information shall constitute grounds for denial of an application or removal of a credential. SMRPCO shall deny access to the certification examination from applicants who have pled guilty to, nolo contendere or have received deferred adjudication or are found guilty of charges of moral turpitude.

When any application for eligibility into a certification examination is denied, the applicant will be notified in writing (including e-mail), and the application fee, less a 10% processing fee, will be returned.

Denied applications may be appealed or resubmitted, with full fees, upon completion of all eligibility criteria.

Eligibility for entry into the certification examination for the maintenance and reliability technician may be denied when:

- Any part of the application is incomplete.
- Any part of the application is illegible.

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- The application is not accompanied with the correct fees (in acceptable currency with an acceptable payment vehicle)
- An application and its supporting documentation do not adequately substantiate or properly demonstrate that the applicant has met the minimum eligibility criteria. Application must be organized according to the specified format.

#### **D. Appeal of Denial of Eligibility**

The SMRPCO grants certification status to individuals in the maintenance and reliability profession who complete the application procedure, ascribe to and abide by the SMRPCO Code of Ethics for candidates and certificants that is included as part of the application, successfully pass the applicable certification exam and pay all registration fees within established deadlines.

Applicants who have been denied eligibility may appeal the decision in the following manner:

- The applicant submits a written (including e-mail) or faxed notice of appeal to the SMRPCO Staff who will forward it to the Certification Committee Chairman. The notice shall include the name, current address (including e-mail address), phone numbers and fax number (if applicable) of the applicant.
- The applicant submits additional written, (including by e-mail) factual documentation to support their appeal with an explanation of why he/she believes the decision is erroneous. The applicant shall bear the burden of proving the denial of eligibility was based on erroneous factual.

An initial review of an appeal is conducted by the Certification Committee Chair to ensure the applicant has met the above conditions. If the Certification Committee Chair determines that the appeal meets the above conditions and the denial of eligibility was due to prior criminal history or misconduct, the case will be referred to the Executive Committee of SMRPCO. If the denial of eligibility was due to other circumstances the case will be referred to the Certification Committee. If the Certification Committee Chair determines that the appeal has not met the above conditions, the applicant will be notified that the appeal is disallowed and forward the record to the Executive Committee of SMRPCO for final determination.

The decision of the Executive Committee of SMRPCO is final and will be communicated to the Certification Committee Chair in writing. The Certification Committee Chair will notify the applicant of the decision in writing.

There is no appeal allowed on the basis of incomplete applications.

This policy does not apply to certificants who have their certification or re-certification denied, suspended or revoked for fraud, misrepresentation, violation of testing procedures or other conduct in violation of the SMRPCO Code of Ethics, Standards of Conduct, Rules, Policies and Procedures.

#### **E. Testing in Languages Other than English**

Currently, SMRPCO offers the certification examination in English. Other languages may be added. The use of translators during the examination will not be permitted.

#### **F. Policies for Applicants with English as a Second Language**

Candidates, whose primary language is not English, may use a strict translation dictionary developed for common use during a certification examination. Candidates must bring their own

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dictionary to the testing center. Any dictionary that has definitions, any written notes, or additional text will not be allowed. Electronic dictionaries are not allowed. Dictionaries will be inspected by the exam proctor and those violating this policy will be seized. Candidates who refuse to allow the proctor to inspect the dictionary or brings a dictionary that does not meet the client guidelines will not be allowed to test with the dictionary. Candidates will have to test without the dictionary or re-register with SMRPCO in order to reschedule.

### **G. Examination Accommodations for Candidates with Physical Disabilities**

Special arrangements are made available to applicants with physical disabilities when requested in writing at the time the application is submitted or before, if the arrangements require longer time, subject to the following:

- If added expense is involved in accommodating the person with a physical disability, such expense (beyond requirements of law such as contained in the Americans with Disabilities Act) is borne by the candidate or the candidate's sponsor (e.g., employer or foundation providing support for persons with specific disabilities).
- If accommodation requires the presence of one or more persons to support the candidate because of the disability, they may not assist the candidate in any way in understanding exam content in such a way so as to give the candidate an unfair advantage over candidates without disabilities.
- Supporting personnel must sign a SMRPCO non-disclosure agreement and agree not to sit for the certification exam for that designation for a period of five (5) years.

### **H. Examination Statistics**

Official statistics regarding any certification examination for the maintenance profession, including all item performance data, individual and demographic group data will be considered confidential unless officially released by the Society for Maintenance and Reliability Professionals Certifying Organization. Candidates' scores will always remain confidential unless released with the express written permission of a candidate to the employer, or a representative of the sponsoring organization, or an authorized agency in response to legal requirements.

Statistics will be stored at the SMRPCO office headquarters by the SMRPCO Certification Administrative Manager or another authorized staff member. The Exam Director will be provided with copies of statistics for review purposes and for purposes of reporting to the Certification Committee or Board of Directors. Exam Team and Certification Committee members will have access to such statistics as required to fulfill their duties, but shall keep them under strict control to prevent release to unauthorized persons. Statistics may be maintained by any authorized testing company for the duration of any contract with SMRPCO. In the event that a contract is not renewed, any and all copies of statistical information shall be returned to the SMRPCO offices. Statistics remain property of SMRPCO.

Yearly, SMRPCO will release, at a minimum, statistics regarding the total number of candidates tested and the percent of candidates passing. The Board will release additional information at its own discretion.

### **I. Candidate Confidentiality**

A candidate's application and performance on any certification examination shall remain confidential unless otherwise stipulated by the examinee. Requests for score transfers to state licensing boards,

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regulatory commissions or government legal officials in pursuit of their duties and authority prescribed on law, must be made in writing (not by e-mail) by the candidate and submitted directly to SMRPCO. Scores will be sent directly to the state licensing/credentialing board or legal authority in the form of either a sealed transcript or a password protected electronic file.

## **J. Release of Certificant Information**

The Society for Maintenance and Reliability Professionals Certifying Organization maintains a registry of Certificants at its headquarters.

Unless specifically indicated that recognition is not desired by checking the appropriate block on the initial application for an examination or after becoming certified, notifying SMRPCO in writing (including e-mail) that recognition is desired, the Certificant's name, country and expiration date of certification will be listed on the SMRP/SMRPCO Website.

Upon written approval (including by e-mail) by a Certificant, the SMRPCO staff will release the name and country of certificants free of charge in response to a telephonic, faxed, or written (including e-mail) request from an officer, publicity chair, or media representative within the field of maintenance profession for purposes of acknowledgement and recognition.

Upon written approval (including by e-mail) by a Certificant, the SMRPCO staff will release the name, addresses, office telephone number, and the certification or recertification status of subject Certificant in good standing for the purpose of responding to referrals.

SMRPCO will never loan, rent or sell candidate or Certificant information.

The names of failed candidates are confidential and will not be released unless otherwise specified by the candidate in writing.

Except as provided above, no score reports of any candidate or Certificant will be released to anyone outside of SMRPCO Staff, Volunteer or Special Needs Members or SMRPCO consultants who need the information to perform their authorized duties.

## **K. Examination Score Reports**

The examination score reports will reflect only PASS or FAIL. Failing candidates and Certificants will be given diagnostic, non-numerical information indicating their overall performance for each domain of the exam.

## **L. Length of time to Schedule and Take the Examination**

Candidates must schedule and take an examination within six months of the date they make application and are made eligible to sit for it. Failure to do so within the time specified will result in forfeiture of all examination fees and the application will be considered void and returned to the candidate.

## **M. Time Allowed to Sit for the Examination**

Candidates will be allowed a period of up to three (3) hours to take the CMRT exam.

## **N. Examination Security**

The Society for Maintenance and Reliability Professionals Certifying Organization maintains strict policies to ensure the security of the examination.

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- Candidates or Certificants, who apply to take the test for reasons other than for initial certification or recertification, will be considered in violation of the SMRPCO Code of Ethics and will be subject to disciplinary procedures and/or legal action to mitigate the harm done to the certification process. Sanctions for Certificants could result in the termination of certification.
- Any individual who removes or attempts to remove exam materials from the testing site, including memorizing exam questions, will be prosecuted. Any Certificant who removes or attempts to remove examination materials, including memorizing exam questions, will be subject to disciplinary procedures in addition to legal action. Sanctions for Certificants could result in the removal of certification.
- Any unauthorized individual found in possession of exam materials will be prosecuted. Any unauthorized Certificant who is found in possession of exam materials will be subject to disciplinary procedures in addition to legal action. Sanctions for Certificants could result in the removal of certification.

Appropriate and specific test information will be provided to our stakeholders, if and when any are identified and verified to the satisfaction of the SMRPCO Board to have such an interest based on law of state, territory or country or Sustaining Sponsorship.

### **O. Number of Times and Intervals Candidates May Take the Examination**

Candidates who fail a certification examination will be permitted to retake the examination as many times as necessary to achieve a passing score. Candidates who do not achieve a passing score will be required to wait for a six (6) month period from the date of their last exam prior to retaking an exam. Application may be made in advance of the end of the time, up to 90 days as specified below.

### **P. Appeals Concerning Items on Exams and Scoring of Exams**

Following completion of the examination and prior to receipt of the examination (Pass/Fail) results, candidates may comment in writing on any question(s) they believe contain errors in content. Comments will be forwarded to the Exam Director of SMRPCO. If the Exam Director judges that an item(s) should not be scored, all exams score-sheets that reflect lower than the passing score by an amount equal to the sum of the values of the item(s) being challenged shall be re-scored by hand. Candidates, whose status changes from fail to pass as a result of the re-scoring, shall be issued a certificate.

Candidates who fail the examination and believe this was due to an error in scoring may have their examination results hand scored by submitting a request in writing (including e-mail) to SMRPCO. Candidates have seven (7) days to request a hand score from the time of receipt of notification that they failed. Candidates may not have access to the answer key. Candidates, whose status changes as a result of hand scoring from fail to pass, shall be issued a certificate. All similarly affected candidates shall have their exams rescored and acted upon accordingly.

### **Q. Mailing of Exam Results**

Examinees will receive an electronic copy of their exam results and may order a hard copy certificate. A hard copy certificate is provided at no cost upon passing the exam. Replacement certificates may be ordered for an additional fee.

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### **III. Code of Ethics for Candidates and Certificants**

The Code of Ethics of the Society for Maintenance and Reliability Professionals Certifying Organization (SMRPCO) requires those who sit for the certification examination (Candidates), Certificants, Special Members, Staff, and Consultants to uphold professional standards that allow for the proper discharge of their responsibilities to those served, protect the integrity of the profession, and safeguard the interest of individual clients.

#### **All persons who sit for any SMRPCO examination shall:**

- Agree to maintain the confidentiality of the examination content and to never disclose examination content to others. Prohibited conduct includes disclosure of exam content, removal of exam materials from the examination room, copying by photography, use of audio recording equipment, or any other means that could be used to transfer the content to others.
- Attest to their identity as the registered examinee, and not represent anyone other than themselves in the taking of the exam.
- Attest that the work and selections made on the subject examination are theirs and theirs alone.

#### **Those examinees that pass a SMRPCO examination (hereafter known as Certificants):**

- Pledge to represent their profession ethically and honorably. Conduct by a Certificant that is detrimental to the SMRPCO Certification program may result in revocation of said Certification. Examples of detrimental conduct include but are not limited to dishonesty, misrepresentation of professional qualifications, and certain illegal acts leading to felony conviction. Certificants have the right to appeal revocations of Certification through due process that as is described in the SMRPCO Policies and Procedures Document.
- Represent their qualifications honestly, including their educational achievements and professional affiliations, and provide only those services which they are qualified to perform.
- Consistently maintain and improve professional knowledge and competence, striving for professional excellence through regular assessment of personal and professional strengths and weaknesses and through continued education training.
- Conduct their business and professional activities with honesty and integrity, and respect the inherent worth of all persons.
- Refuse to unjustly discriminate against clients.
- Safeguard the confidentiality of all client information, unless disclosure is required by law, court order, or is absolutely necessary for the protection of the public.
- Refrain, under all circumstances, from initiating or engaging in any act of moral turpitude
- Avoid any interest, activity or influence which might be in conflict with the Certificant's obligation to act in the best interests of the client or the profession.
- Follow all policies, procedures, guidelines and requirements promulgated by the Society for Maintenance and Reliability Professionals Certifying Organization

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## IV. Subject Areas Addressed by the Certification Exam

Four major performance domains account for the examination's content. These four domains, as well as the task statements for each domain, are listed below.

### Domain I: Maintenance Practices

Task 1: Adhere to safety, health, and environmental standards and policies by taking personal responsibility in order to prevent injury or illness from exposure to hazards. The candidate must demonstrate knowledge in the following:

1. Blood borne pathogens
2. Confined space entry
3. Electrical safety
4. Emergency response (ER) and evacuation
5. Environmental compliance
6. Ergonomics
7. Eye protection
8. Fall protection
9. Fire safety
10. HAZCOM/MSDS
11. Hearing conservation
12. Ladder safety
13. Lockout/tagout procedures
14. Personal protective equipment (PPE)
15. Process safety management (PSM)
16. Respiratory protection
17. Rigging
18. Safety system and devices
19. Scaffolding

Task 2: Inform production control personnel about the maintenance activity required in accordance with company protocol in order to adjust the operations schedules. The candidate must demonstrate knowledge in the following:

1. Lockout/tagout procedures
2. Process overview
3. Work permits

Task 3: Perform the proper lockout/tagout procedures on equipment in accordance with applicable standards in order to ensure zero energy state prior to commencing maintenance work and minimize health, safety, and environmental hazards to employees and the community. The candidate must demonstrate knowledge in the following:

1. Lockout/tagout procedures
2. Multiple energy sources
3. Zero energy states

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Task 4: Perform a pre-use inspection on maintenance tools and equipment using established standards and guidelines in order to ensure safe operation and to extend the life of the tools and equipment. The candidate must demonstrate knowledge in the following:

1. Cranes and hoists
2. Field machinery and tools
3. Ladder safety
4. Rolling stock/mobile equipment (e.g., mobile cranes, man-lift/scissor lift, fork lift)
5. Shop machinery and tools
6. Rigging equipment (e.g., slings, shackles, eyebolts, chains, hooks)

Task 5: Use maintenance tools and equipment in accordance with manufacturers' specifications and established safety policies in order to ensure safety and efficiency. The candidate must demonstrate knowledge in the following:

1. Equipment and tool specifications
2. Established equipment and tool-safety policies and procedures

Task 6: Use measuring tools and equipment in a manner that will ensure accurate measurements in order to perform maintenance tasks properly. The candidate must demonstrate knowledge in the following:

1. Application of specific tools
2. Basic math (e.g., fractions, addition, subtraction, multiplication, division)
3. Calibration requirements for measurement tools (e.g., torque wrench, calipers, alignment tools)
4. Conversion of appropriate measurement and engineering units
5. Measurement principles (e.g., mass, force, motion, distance, acceleration, power, fluid, bulk)
6. Measurement tools (e.g., rulers, gauges, tapes, micrometer, calipers, lasers)

Task 7: Handle all maintenance materials and parts in accordance with established standards and procedures in order to prevent damage to the parts and equipment. The candidate must demonstrate knowledge in the following:

1. Company safety policies
2. Material handling techniques and procedures
3. Material storage procedures
4. Original equipment manufacturers' (OEM) instructions

Task 8: Maintain housekeeping by adhering to established site standards and by removing all maintenance-related parts and waste in order to ensure a safe and orderly job site. The candidate must demonstrate knowledge in the following:

1. Facility and regulatory policies on housekeeping
2. Hazards of improper housekeeping
3. Proper organization and cleaning of job site

Task 9: Document maintenance activities using the facility's maintenance management system in order to record history, assist with planning and scheduling, and support root-cause failure analysis. The candidate must demonstrate knowledge in the following:

1. Documentation systems (e.g., paper filing systems, computer filing systems, email)

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2. Maintenance planning and scheduling

**Domain II: Preventive and Predictive Maintenance**

Task 1: Perform preventive and/or predictive maintenance according to the work plan in order to maximize mean time between failures. The candidate must demonstrate knowledge in the following:

1. Company safety, health, and environmental policies
2. Equipment function and use
3. Predictive maintenance procedures
4. Preventive maintenance procedures
5. Work plan requirements

Task 2: Apply predictive maintenance techniques by observing equipment performance and collecting ongoing performance data in order to maximize mean time between failures. The candidate must demonstrate knowledge in the following:

1. Company safety, health, and environmental policies
2. Function of equipment
3. Operation parameters for equipment, including baseline conditions
4. Predictive maintenance techniques and technologies (e.g., oil samples, vibration readings, thermographic equipment, ultrasonic testing)

Task 3: Lubricate equipment in accordance with the lubrication schedule and equipment specifications in order to ensure reliable performance and prevent damage. The candidate must demonstrate knowledge in the following:

1. Company safety, health, and environmental policies
2. Equipment specifications
3. Filtering systems
4. Lubricant specifications
5. Lubricating systems
6. Lubrication principles
7. Lubrication route

Task 4: Perform alignment checks on rotating equipment (e.g., pumps, fans, blowers, turbines, gear boxes, compressors) in accordance with equipment specifications in order to ensure reliable performance and prevent damage. The candidate must demonstrate knowledge in the following:

1. Company safety, health, and environmental policies
2. Equipment alignment techniques (e.g., laser, reverse, straight edge, rim and face)
3. Equipment functions
4. Thermal growth
5. Operation principles for rotating equipment

Task 5: Perform checks on safety systems and devices in accordance with equipment design specifications in order to ensure reliable operation and protect employees. The candidate must demonstrate knowledge in the following:

1. Company safety, health, and environmental policies

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2. Consequences of bypassing safety systems
3. Equipment design specifications
4. Equipment functions (e.g., limit switches, photoelectric eyes)
5. Operation of safety systems

### **Domain III: Troubleshooting and Analysis**

Task 1: Gather information relating to a maintenance request by reviewing the work order and/or interviewing operations personnel in order to determine the general nature of the problem. The candidate must demonstrate knowledge in the following:

1. Effective interpersonal relations
2. Equipment and/or processes
3. Maintenance work order systems

Task 2: Verify that the problem is valid by systematically testing and/or observing the equipment's performance, as conditions permit, in order to determine if a problem actually exists. The candidate must demonstrate knowledge in the following:

1. Function and use of the equipment
2. Process indicators (e.g., gauges, annunciators, Human Machine Interface [HMI] displays)

Task 3: Obtain appropriate technical documentation using facility resources in order to gain full understanding of designed operating parameters and/or sequences. The candidate must demonstrate knowledge in the following:

1. Facility resources (e.g., CMMS, technical library, engineering files)
2. Operating parameters and sequences
3. Technical documentation (e.g., schematics, P&ID, blueprints, O&M manuals, SOP, MSDS)

Task 4: Investigate previous maintenance activities, as conditions require, by reviewing equipment history in order to identify information that will facilitate troubleshooting. The candidate must demonstrate knowledge in the following:

1. Facility maintenance record systems
2. Facility preventative maintenance scheduling programs or systems
3. Preventative maintenance techniques and theories (e.g., lubrication, seals and bearings, alignments)

Task 5: Identify the cause of the problem using a systematic process of elimination in order to determine what is causing the malfunction. The candidate must demonstrate knowledge in the following:

1. Equipment and/or process design parameters
2. Hazards involved with operating and/or maintaining specific process equipment
3. Systematic troubleshooting and analysis

### **Domain IV: Corrective Maintenance**

Task 1: Verify troubleshooting analysis by disassembling and inspecting components using established procedures in accordance with applicable standards and guidelines in order to confirm that the identified corrective action is appropriate. The candidate must demonstrate knowledge in the following:

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1. Common mechanical systems (e.g., lubrication, seals and bearings, alignment, power transmission, cams, cranks, pneumatics, hydraulics, thermodynamics, heat transfer, piping systems, steam systems)
2. Correct use of tools and equipment, including measuring devices
3. Equipment specifications
4. Equipment and component functions
5. Operation of equipment and components
6. Results of troubleshooting analysis
7. Specific equipment repair procedures, applicable standards, and guidelines

Task 2: Repair the malfunction by performing required corrective maintenance tasks in accordance with best maintenance practices in order to return the equipment to the desired operating condition. The candidate must demonstrate knowledge in the following:

1. Common mechanical systems (e.g., lubrication, seals and bearings, alignment, power transmission, cams, cranks, pneumatics, hydraulics, thermodynamics, heat transfer, piping systems, fabrication, steam systems)
2. Correct use of tools and equipment, including measuring devices
3. Equipment specifications
4. Equipment and component functions (e.g., pumps, fans, blowers, turbines, gear boxes, compressors, fasteners, motors, piping systems, gaskets/packing, drive systems, conveying systems)
5. Equipment and component operation
6. Specific equipment repair procedures, applicable standards, and guidelines

Task 3: Monitor the equipment after it has been repaired while operating it under normal conditions in order to determine whether or not the repair was successful. The candidate must demonstrate knowledge in the following:

1. Equipment and component functions (e.g., pumps, fans, blowers, turbines, gear boxes, compressors, fasteners, motors, piping systems, gaskets/packing, drive systems, conveying systems)
2. Equipment and component operation

Task 4: Release repaired equipment for return to service using standard operating procedures in order to resume normal operations. The candidate must demonstrate knowledge in the following:

1. Procedures for releasing equipment for return to service

## V. Re-certification

### A. Re-certification Purpose, Philosophy and Requirements

Re-certification assures the public that the Certificant is adhering to the SMRPCO Code of Ethics, and Policies and Procedures concerning re-certification.

#### Philosophy of the CMRT Recertification Program

- Re-certification is defined as a process designed to facilitate continued competence including ethics and practice in the maintenance profession through participation in a learning process that enhances the Certificant's knowledge, skills and abilities.
- Upholding high standards of ethical and generally accepted maintenance and reliability practices is the foundation of certification.
- Certificants need to continue to learn throughout their professional lives to remain up-to-date in their areas of work.
- Maintaining "hands-on" experience in the maintenance profession is essential to maintaining skills.
- Learning occurs in multiple ways beyond the formal educational setting and includes learning through professional and life experiences.
- Self-assessment can be a valuable strategy for identifying some of the Certificant's needs, but is not mandatory.

#### Notification and Certificant Responsibility

Each Certificant will be notified at 12 months, 9, 6, 3, 2 and 1 month in advance of the renewal date, with a final email sent approximately 1 month following expiration with notification of grace period and final lapsed date. It is the responsibility of each Certificant to notify the SMRPCO office of address and name changes in writing to be aware of the expiration date of their certification, and to know when to apply for recertification. A copy of the current verification form may be downloaded from the SMRP/SMRPCO website, [www.SMRP.org](http://www.SMRP.org) at any time following initial certification.

#### Requirements for Recertification

Certificants must meet recertification requirements during the current three (3) year certification cycle to retain certified status for each subsequent three (3) year cycle. This requires ongoing personal and professional development in the area of maintenance profession. The process is also designed to facilitate and recognize contributions to the profession. Recertification candidates must strictly comply with all requirements contained in the recertification.

Individuals can recertify under the recertification program which requires 50 recertification credits (e.g., 1 hour = 1 credit) from a combination 2 or more activities (Options) described below.

- Option 1 – Continuing professional education in areas relevant to the four (4) domains of the exam – Actual hours spent in the classroom are counted.
- Option 2 - Complete educational workshops or seminars relevant to subject areas in the body of knowledge used to develop this exam – Actual hours spent in the workshop or seminar.
- Option 3 – Participate as an active member of an SMRP or SMRPCO Board or Committee – Actual hours spent in such meeting activity.

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- Option 4 – Attend annual/executive/chapter meetings at organizations relevant to subject areas of the body of knowledge used to develop this exam – (e.g., SMRP, ASQC, ASNT, CSNDT, NGLI, CMVA, STLE, IIE, IMC, etc.) - Actual hours spent in such activities
- Option 5 – Attend Conferences relevant to the subject areas in the body of knowledge used to develop this exam – (e.g., SMRP, ASQC, ASNT, CSNDT, NGLI, CMVA, STLE, IIE, IMC, RCM, PdM Vendor Sponsored Conferences etc.,) - Actual hours spent in conference sessions up to six hours for each day of attendance.
- Option 6 – Give presentations at conference or seminar relevant to subject areas in the body of knowledge used to develop this exam. Up to 40 hours to develop and deliver a paper.
- Option 7 – Publish articles or papers in publications to subject areas of the body of knowledge used to develop this exam – 40 hours for writing an article
- Option 8 - Author a book or a significant chapter of a book relevant to subject areas in the body of knowledge used to develop this exam – Actual hours spent writing the book
- Option 9 - Provide instruction for a course or workshop relevant to subject areas in the body of knowledge used to develop this exam – 3 hours for development and delivery for each classroom hour (i.e., 6-hour course = 18 hours)
- Option 10 – Participate in development of questions for the CMRT Exam - 8 hours per question submitted or worked on.
- Option 11 – Other activity or learning experience in subject areas of the body of knowledge used to develop this exam - Submit hours for approval (by SMRPCO Certification Committee).
- Option 12- Complete work hours relevant to the subject areas described in the Body of Knowledge (BOK). – Up to 8 hours (CMRTs) and 5 hours (CMRPs) for each year of full-time work experience within the three-year renewal period.

#### **Certificant Preparation for Audit of Recertification Claims**

Although the SMRPCO's recertification program is conducted on an honor system of reporting, measures need to be in place to verify the accuracy of reporting. The audit process requires five (5) percent of applicants to furnish additional documentation that supports compliance with recertification requirements. Examples are given in paragraphs **IV.A.e)** through **o)** below of the type of documentation that is acceptable. It behooves candidates to collect and retain such documentation as the requirements for recertification are met so as to enable prompt response when requested. Failure to respond in timely fashion (to be specified in the request for verification) may be grounds for denying recertification. This obligation rests with the certifiants who seek recertification.

A computerized log, a logbook, or an appointment book can provide documentation by certifiants who are self-employed. Certifiants who are contracted by an employer may submit a letter from an employer, conference, chapter, committee or board chairman, workshop or course sponsor on official letterhead verifying the number of hours engaged. The documentation must include the date and length of participation. Conference brochures listing papers given or copies of actual pages containing articles from publications will be accepted. Pay stubs or tax forms are **not** acceptable documentation for work experience hours for recertification.

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The SMRPCO recognizes that many certificants are involved in the teaching aspect of the profession. Therefore, Certificants may claim hours for hands-on teaching. Hands-on teaching is defined as imparting of knowledge from teacher of a formal course or workshop facilitator to students or workshop participants of some aspect related to the M & R BoK.

The SMRPCO recognizes that many certificants also provide hands-on work as volunteers of one or more professional societies. Therefore, certificants may claim hours for hands-on volunteer service in support of the M & R Profession.

**Continuing Education (Option 1)**

Continuing professional education hours must meet the following definition:

Learning experiences in a formal school setting that are designed to facilitate continued or improved competency, including ethical and legal practice in the M & R Profession through participation in a learning process that enhances the Certificant's knowledge, skills and abilities in the profession. Audited courses are not awarded recertification credit hours. A certificate of completion or other document attesting to the Certificant's presence at such school should be held for verification in the event of audit. The courses must be completed by dates that are within the current certification cycle and prior to submission of the application for recertification to SMRPCO

**Complete educational workshops, seminars, on-demand education, or other online courses classes relevant to subject areas in the BoK (Option 2)**

In order to meet the requirements for attaining re-certification credit hours through this option, the following criteria and conditions must be met:

- Workshops and seminars must have been formally organized and scheduled in advance by a competent provider of such services and completed within the current three (3) year cycle of the certificants and prior to submission of the application for re-certification to SMRPCO.
- Re-certification credits hours may be claimed based on hours actually spent in the seminar or workshop viewing the online presentation.
- A certificate of completion or other documentation attesting to the Certificant's presence at such event should be held for verification in the event of audit.

**Participate as an active member of a SMRP or SMRPCO Board or Committee or as a Proctor (Option 3)**

In order to meet the requirements for attaining re-certification credit hours through this option, the following criteria and conditions must be met:

- Must be satisfactorily completed within the current three (3) year certification cycle and prior to submission of the re-certification application to the SMRPCO.
- Name must appear in the minutes of any activity of SMRP or SMRPCO in which the Certificant participates.

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- Name must appear on the exam sign-in sheet.
- Copies of such minutes should be retained by the certificants for presentation in the event of audit.
- Must have served at least one year in the position
- Actual hours spent working on activities or proctoring an exam may be claimed for re-certification credit

**Attend annual/executive/chapter meetings relevant to subject areas of the M&R BoK (Option 4)**

In order to meet the requirements for attaining recertification credits through this option, the following criteria and conditions must be met:

- Must be satisfactorily completed within the current three (3) year certification cycle and prior to submission of the recertification application to SMRPCO.
- Name must appear in the minutes or attendance list of any activity in which the Certificant participates.
- Copies of such minutes or attendance list should be retained by the certificants for presentation in the event of audit.

**Attend conferences relevant to the subject areas of the BoK (Option 5)**

D. In order to meet the requirements for attaining recertification credits through this option, the following criteria and conditions must be met:

- Attendance must be completed within the current three (3) year recertification cycle and prior to submission of the recertification application to SMRPCO.
- Name must appear in the attendance list of any activity in which the Certificant participates.
- Copies of receipt for fees paid for conference and/or attendance list marked to show the Certificant's name should be retained by the certificants for presentation in the event of audit
- Six (6) hours credit may be claimed for each day of attendance.

**Give presentation at a conference or seminar relevant to subject areas of the BoK (Option 6)**

In order to meet the requirements for attaining recertification credits through this option, the following criteria and conditions must be met:

- Presentations may be at a conference, workshop or seminar of any organization that supports the M & R Profession.
- Must be pertinent, current and applicable to the scope of practice of the M & R Profession.
- The presentation must be at least 40 minutes in length.
- Presentation cannot be part of a panel.
- Copy of event program, workshop or seminar marked to show the Certificant's contribution to it should be retained by the Certificant for presentation in the event of audit. It must also show that the presentation was made during the current three

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(3) year certification cycle and before submission of the application for re-verification.

**Publish articles or papers in publications relevant to the subject area of the BoK (Option 7)**

In order to meet the requirements for attaining recertification credit hours through this option, the following criteria and conditions must be met.

- The article or paper must appear in a recognized periodical publication aimed at members of the M & R Profession
- The article or paper must have been published or accepted for publication within the current three (3) year certification cycle and prior to submission of the application for recertification to SMRPCO.
- A copy of the article or paper with the title page or table of contents should be retained by the certificants for presentation in the event of audit. In the event publication has not yet occurred, a letter of acceptance from the publication may be submitted that indicates the date the article will be published.
- Not to exceed forty (40) hours for writing the article.

**Author a book or significant chapter of a book relevant to the subject areas of the BoK (Option 8)**

In order to meet the requirements for attaining recertification credits through this option, the following criteria and conditions must be met:

- A. The book or significant chapter must relate directly to the practice of the M & R Profession
- B. Must meet one or more of the following criteria:
  - i. Contributes to the understanding of the value of use of some M & R technique, methodology or skill.
  - ii. Relates to the practice in the M & R Profession:
    - a) Contributes to understanding of the profession and practice of Maintenance and Reliability
    - b) Research or case studies on M & R practices
    - c) Statistical research – such as trends and growth of the M & R Profession.
- C. The Certificant must be a principal author or contributor of a chapter of a book.
- D. The book must have been published or accepted for publication during the certificants current three (3) year certification period and prior to the submission of the application for recertification.
- E. Actual hours spent writing may be claimed, in conjunction with hours in any other option for re-certification.
- F. A copy of the book cover, title page and/or page upon which the ISBN data book title and author and contributors' names appear may be submitted to SMRPCO for verification in the event of audit. For a book accepted for publication but not yet in print, copy of a letter of acceptance from the publisher may be submitted that includes the date the book was/will be published.

**Provide instruction for a course/workshop relevant to the subject areas of the BoK (Option 9)**

In order to meet the requirements for attaining re-certification credit hours through this option, the following criteria and conditions must be met:

- A course or workshop that qualifies for recertification credit must relate to the practice of M & R Profession and have been conducted within the re-certification cycle of the Certificant.
- The Certificant must be the primary instructor, co-instructor, workshop facilitator or co-facilitator.
- Course or workshop must have been formally scheduled, conducted and documented on behalf of participants within the current three (3) year certification cycle and before submission of the application for recertification.
- Certificants may claim 3 hours for development and delivery of each classroom or workshop hour (e.g., 6 hours in class or workshop = 18 hours).
- Certificants should retain and may submit any formal documentation concerning having scheduled, conducted or completed the course or workshop, in the event of audit.

**Participate in the development of questions for the CMRP exam (Option 10)**

The following requirements must be met in order for the Certificant to be awarded recertification credit hours under this option:

- The CMRP Question Data bank must contain the name of the Certificant as an originator and date entered into the bank of any questions submitted that have been accepted as candidate questions and claimed for recertification credit. The dates must fall within the Certificant's current three (3) year certification cycle and prior to submission of the application for recertification.
- The Exam Director, who maintains the Exam Data bank, must verify that the Certificant has been given credit for questions accepted as candidate questions.
- Certificants will be given eight (8) hours credit for each candidate question in the bank accepted within the Certificant's re-certification cycle.

**Other activity or learning experience related to subject areas in the BoK (Option 11)**

The following requirements must be met in order for the Certificant to be awarded recertification credit hours under this option:

- The activity or learning experience that qualifies for recertification credit hours must relate to the practice of M & R Profession and have been conducted within the current certification cycle of the Certificant and prior to the submission of the application for recertification.
- The certificants **must** submit supporting documentation with the completed for Application for Recertification Form consideration of the hours claimed.
- The SMRPCO Staff must gain the approval of the Certification Committee Chairperson to give credit for the hours claimed in each case under this option.

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### **Complete work hours relevant to the subject areas described in the BoK (Option 12)**

The following requirements must be met in order for the Certificant to be awarded re-certification credit hours under this option:

- Practice of the M & R Profession that qualifies for re-certification credit hours must relate to the subject areas described in the BOK and have been conducted within the current certification cycle of the Certificant and prior to the submission of the application for re-certification.
- A letter from the Certificant's supervisor or other documentation attesting to the Certificant's work hours should be held for verification in the event of an audit.

### **Application Process**

Applicants may submit a completed re-certification application and a non-refundable fee before the end of their current certification cycle. The SMRPCO staff will review each application for re-certification to determine whether the applicant has met the re-certification requirements. SMRPCO staff will contact the applicant if further information is needed and a deadline will be given for submitting the additional materials. If the application is incomplete, the applicant will receive a letter specifically detailing the items that are missing. He/she will have up to 90 days from the date of the expiration of their certification to submit the missing items. If the applicant does not submit the missing items within this period, the SMRPCO will send a second letter informing the applicant that the applicant's certification status has expired. The applicant's certification status will also be terminated. If the Certificant requests to cancel the application within the period after submittal up to 90 days of certification expiration, the application and documentation will be returned and the Certificant will forfeit all fees.

### **Actions Taken Regarding Re-Certification Applications**

Once an application has been reviewed, the following actions can be taken:

- **Approved** - When the application has been reviewed and it is determined that all requirements for recertification have been met, the application will be approved. Upon approval, a certificate for another three (3) year period will be issued to the applicant within 30 days.
- **Deferred** - If a recertification application is deferred (e.g., because it was chosen for audit), the specific reason(s) for that action will be made available to the Certificant in writing. Certificants who have their recertification deferred will be given the opportunity to submit additional requested materials.
- **Denied** - If a Certificant has not met the requirements for recertification, the application will be denied. In addition, should it be determined that the applicant has provided false or misleading information when applying for recertification, the Chairperson of the Certification Committee may deny recertification and begin disciplinary proceedings in accordance with the SMRPCO's established Rules and Procedures Regarding Ethical and Professional Complaints.

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## **Appeals Process**

A Certificant who disagrees with a ruling regarding their specific re-certification status may ask for review by the Certification Committee members who did not review the initial application. This must be accomplished within 30 days of the initial ruling and the request must be made in writing (including e-mail) to the Certification Committee Chair along with reasons for requesting the appeal stating the reasons for the disagreement.

If the Certificant does not agree with the subsequent ruling, the applicant may appeal that decision in writing to the Executive Committee of SMRPCO within 30 days. The Executive Committee of SMRPCO has the final authority in ruling on all appeals.

Communications sent to the applicants during the appeals process will include instructions for or have attached a means to substantiate proof of response to an appeal request.

## **Extension Requests**

An extension of the recertification deadline, for extenuating circumstances, may be granted for up to six (6) months beyond the expiration date. The Certificant must submit the following information in writing before the expiration date: a statement of the extenuating circumstances, the number of completed recertification credits, the number of work hours completed and a detailed plan stating how all requirements will be fulfilled by the requested extended deadline. The Certification Committee Chair reserves the right to modify the extension. If an extension is granted, the original expiration date will remain constant. During this extension period, the individual is not certified, cannot claim to be, nor use the CMRT or another credential issued by SMRPCO. Should re-certification ultimately be granted, the original expiration date shall be the date of the beginning of the new certification cycle.

## **Waiver of Recertification Requirement**

The Recertification requirement may be temporarily waived by the Certification Committee under either of the following circumstances:

- The individual has experienced catastrophic health or medical problems or has been caring for someone with catastrophic health or medical problems
- The individual has been called to active military duty.

The Certification Committee will review all requests to waive the recertification requirements meeting the criteria above, but all requests must be in writing.

If the Certification Committee approves the Recertification Waiver request, the individual must meet requirements for recertification when either of the following occurs:

- When the catastrophic health or medical issue has been resolved
- The individual has returned from active military duty

Once the conditions upon which the recertification waiver was approved no longer exist, the individual must complete the recertification process in the time that the recertification was required prior to the request for the waiver.

- As an example, if an individual's recertification is due within three months and the individual's request for a recertification waiver is approved, the requirement to recertify is temporarily

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suspended. When the relevant conditions no longer exist, the individual must notify SMRPCO and the individual will have three months to complete the recertification process.

## **B. Inactive Status**

Inactive status can be granted to candidates on a case-by-case basis for special circumstances. A Certificant's request for inactive status will be reviewed and granted at the discretion of the Certification Committee. Examples of conditions that might necessitate inactive status include: pregnancy, illness, injury, military duties or personal hardship. An inactive status may be granted to a Certificant for up to a maximum of three years. During this time, the individual is not certified, cannot claim to be, nor use the CMRT or another credential issued by SMRPCO. However, any recertification credit hours taken during this period will count toward recertification. Once an applicant applies to reactivate their status, the Certification Committee will determine the length of time that the applicant has to meet the recertification requirements. If the inactive status goes beyond three years after the expiration date of the original certification or subsequent recertification, the individual's record will be annotated as certification having expired. If within this three-year time frame, the individual desires to recertify, pay current recertification fee, and meet all current recertification requirements with appropriate documentation. Furthermore, the original expiration date will remain valid. If nothing has occurred within those three years, the individual's record will be identified in the SMRPCO's files as not certified.

## **C. Lapsed Status**

Certification will enter "lapsed" status for up to three months (90 days) after the expiration date of the original certification or subsequent recertification period. If within this time frame the lapsed Certificant wishes to recertify, he/she must pay the current recertification fee and meet all current recertification requirements with appropriate documentation. The Certificant's original date of expiration will remain valid as the starting point for the new certification period when the new certificate is issued. If the individual whose certification has lapsed takes no action within the 90-day time frame, that person's record will be annotated in the SMRPCO's files as not being certified and, if recognition is authorized, the listing will be removed from the SMRP website. If at a future time the formerly certified applicant wishes to become certified, they must register as a candidate, meet all eligibility requirements, and successfully complete a current form of the certification examination.

## VI. Appendix A – Sample Exam Questions

1. The Best way to assure that a full-face respirator has a positive seal is to place the palms of your hands:
  - A. Over the discharge and inhale
  - B. Over the inlet and inhale
  - C. On the front and press toward your face
  - D. On the bottom and push up
  
2. According to industry standards, at which minimum working height would an individual be required to wear a safety harness?
  - A. 3 feet
  - B. 4 feet
  - C. 5 feet
  - D. 6 feet
  
3. In OSHA regulations, the term point-of-operation protection device refers to what feature in maintenance?
  - A. Lockout-tagout
  - B. Machine guarding
  - C. Personal protective equipment
  - D. Pre-operational inspection
  
4. Which of the following is an example of predictive maintenance task?
  - A. Changing oil on an hour meter set point
  - B. Changing V belts once a year on a fan drive
  - C. Lubricating equipment on a set schedule
  - D. Monitoring with a vibration equipment
  
5. The opening of a relief valve is caused due to an increase in:
  - A. Pressure
  - B. Temperature
  - C. Valve
  - D. Flow
  
6. There are often multiple reasons when equipment fails. What is the appropriate tool use to determine the reason?
  - A. Cause and effect analysis
  - B. Equipment failure analysis
  - C. Process failure analysis
  - D. Root cause analysis
  
7. What instrument is used to check the quality of an electric motor's insulation resistance?
  - A. A megohmmeter
  - B. A multimeter

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- C. A volt-ohmmeter
  - D. A light meter
8. What is the main advantage of a flexible coupling over a rigid one?
- A. They are able to accept shock loads
  - B. They are easier to install
  - C. They are less expensive
  - D. They compensate for some misalignment
9. What type of mechanical damage to a centrifugal pump can be caused by cavitation?
- A. Pitting and erosion
  - B. Motor current under load
  - C. Premature gasket failure
  - D. Scaling and clogging
10. When performing an alignment on a new idler pulley on a belt conveyor, you must start with the belt in what load condition?
- A. ½ full
  - B. ¾ full
  - C. Empty
  - D. Under-full

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

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## VII. Appendix B – Resources

### **OSHA Standards for General Industry as of January 2010**

CCH Incorporated

Paperback: 940 pages, Publisher: CCH Inc.; 1 edition February 1, 2010,  
ISBN-10: 0808022733

### **Accident Prevention Manual for Industrial Operations**

National Safety Council

Hardcover: 1523 pages, Publisher: National Safety Council; 7th edition 1974,  
ISBN-10: 087912024X

### **Fundamentals of Industrial Hygiene, Fifth Edition**

Barbara A. Plog

Hardcover: 1100 pages, Publisher: National Safety Council; 5th edition December 27, 2001,  
ISBN-10: 0879122161

### **An Introduction to Predictive Maintenance, Second Edition**

R. Keith Mobley

Hardcover: 437 pages, Publisher: Butterworth-Heinemann; 2nd edition October 10, 2002,  
ISBN-10: 0750675314

### **Practical Troubleshooting of Electrical Equipment and Control Circuits (Practical Professional Books from Elsevier)**

Mark Brown, Jawahar Rawtani M.Sc(Tech) MBA , Dinesh Patil B.E (I&C) DipEE Paperback: 248 pages,  
Publisher: December 27, 2004,  
ISBN-10: 0750662786

### **Machinery's Handbook 28th Larger Print Edition**

Oberg, Jones, Horton, and Ryffel

Hardcover: 2704 pages, Publisher: Industrial Press; 28th edition February 15, 2008,  
ISBN-10: 0831128011

### **Machinery's Handbook Pocket Companion**

Richard Pohanish and Christopher McCauley

Paperback: 318 pages, Publisher: Industrial Press; Updated edition March 1, 2008,  
ISBN-10: 083112802X

### **Lockout/Tagout: The Process of Controlling Hazardous Energy (Occupational Safety and Health Series)**

Edward V. Grund

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Hardcover: 435 pages, Publisher: National Safety Council January 2, 1995,  
ISBN-10: 0879121890

**Hydraulics and Pneumatics, Second Edition**

Andrew Parr

Paperback: 244 pages, Publisher: Butterworth-Heinemann; 2 edition March 22, 1999,  
ISBN-10: 0750644192

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