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American National Standard

**Qualifications and
Certification of
Instrumentation and
Control Technicians
in Nuclear Facilities**



ANSI/ISA-S67.14 — Qualifications and Certification of Instrumentation and Control Technicians
in Nuclear Facilities

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Preface

This preface is included for informational purposes and is not part of ISA-S67.14.

This standard has been prepared as part of the service of ISA toward a goal of uniformity in the field of instrumentation. To be of real value, this document should not be static, but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms, and asks that they be addressed to the Secretary, Standards and Practices Board, ISA, 67 Alexander Drive, P. O. Box 12277, Research Triangle Park, NC 27709, Telephone (919) 990-9227, Fax (919) 549-8288, e-mail: standards@isa.org.

The ISA Standards and Practices Department is aware of the growing need for attention to the metric system of units in general, and the International System of Units (SI) in particular, in the preparation of instrumentation standards, recommended practices, and technical reports. The Department is further aware of the benefits to USA users of ISA standards of incorporating suitable references to the SI (and the metric system) in their business and professional dealings with other countries. Toward this end, this Department will endeavor to introduce SI-acceptable metric units in all new and revised standards to the greatest extent possible. *The Metric Practice Guide*, which has been published by the Institute of Electrical and Electronics Engineers as ANSI/IEEE Std. 268-1992, and future revisions, will be the reference guide for definitions, symbols, abbreviations, and conversion factors.

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The purpose of this standard is to provide the nuclear industry with bases for certifying the qualifications of instrumentation and control technicians who work on facility equipment that is important to safety, in order to help reduce the possibility that unqualified personnel could perform improper maintenance on such equipment. It is intended solely as a recommendation for functional organization, and offers a structured basis for certification of instrument and control technicians in each specific facility where they might be used.

It describes four (4) technician categories or levels, which are intended as functional descriptions of typical skill proficiency and competency levels identified at numerous facilities as well as empirically in job analysis. These are essentially points of reference for application of this standard to a specific facility situation. No specific number of categories, levels, or classifications are required by this standard since each facility has its own organizational structure and the information contained in this standard is not intended to change existing organizational arrangements.

This standard also recognizes that each plant or company needs a certification program, procedure, and/or plan to cross-reference the relationship between the facility job descriptions/categories and the four (4) functional levels. The key to this cross-reference is the existence of a good representative job description of each type of technician at a facility.

This standard can be used independently in circumstances where no equivalent, formally accredited program exists, and it may also be used to enhance formally accredited programs. It is not intended, however, to set forth qualifications, which differ according to the individual job

descriptions in each organization. For example, the "Typical knowledge and skills list" included as Appendix A is meant to be a guideline only.

The information contained in the preface, footnotes, and appendices is included for information only and is not a part of the standard.

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1 Scope

This standard identifies the criteria for certification of instrumentation and control technicians at nuclear facilities. These criteria address qualifications based on education, experience, training, and job performance. Many nuclear facilities maintain formally accredited training and qualification programs, as described in 10 CFR 50.120 (Training and Qualification of Nuclear Power Plant Personnel). Facilities maintaining such programs may be considered to fully meet the provisions of this standard.

2 Purpose

The purpose of this standard is to provide the nuclear industry with bases for certifying the qualifications of instrumentation and control technicians who work on equipment that is important to safety, where formally accredited programs, as described in 10 CFR 50.120, are not maintained.

3 Definitions

3.1 control loop: Two or more devices processing a single variable that may provide an input signal to a control system.

3.2 control system: A system in which deliberate guidance or manipulation is used to achieve a prescribed value of a variable (Reference: ANSI/ISA-S51.1-1979 (Reaffirmed 1993)).

3.3 device: An apparatus for performing a prescribed function (Reference: ANSI/ISA-S51.1-1979 (Reaffirmed 1993)).

3.4 direction: Having the person who is qualified to perform the task physically present when the task is performed or in continuous communication with the person performing the task.

3.5 experience: Applicable work in design, construction, pre-operational and start-up testing activities, operation, maintenance, on-site activities, or technical services. Observation of others performing work in the above areas is not experience. This experience can be obtained during start-up or operations in a nuclear facility, in fossil power plants, in other industries, or in the military.

3.6 group leader: The person in the highest level of functional supervision whose responsibilities are oriented solely toward instrumentation and control.

3.7 important to safety: Those structures, systems, and components that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public (Reference: 10 CFR Part 50, Appendix A).

3.8 instrumentation: A collection of instruments or their application for the purpose of observation, measurement, or control (Reference: ANSI/ISA-S51.1-1979 (Reaffirmed 1993)).

3.9 knowledge: Familiarity with theory and concepts, and detailed understanding of job-related topics.

3.10 may: An auxiliary term that is used to express permission but does not indicate a requirement or recommendation.

3.11 shall: An auxiliary term that is used to express a requirement.

3.12 should: An auxiliary term that is used to express a recommendation.

3.13 skill: The ability to demonstrate the practical application of knowledge.

3.14 technical supervision: Providing guidance as needed to a subordinate in the performance of an assigned task.

4 Technician categories

4.1 Introduction

This section describes four (4) technician categories or levels that are meant to be functional descriptions. No specific number of categories, levels, or classifications are required.

4.2 Technician I

4.2.1 Shall be a person who performs single tasks without direction on devices that perform basic functions such as temperature, pressure, flow, or level measurement.

4.2.2 Shall be a person who can perform Technician II level tasks under the direction of a Technician II.

4.2.3 Shall be a person who can provide technical assistance or instruction or both during on-the-job training to a Technician I.

4.3 Technician II

4.3.1 Shall be a person who can perform the tasks of a Technician I and tasks such as troubleshooting, calibration, and repair without direction on instrumentation and control loops.

4.3.2 Shall be a person who can perform Technician III level tasks under the direction of a Technician III.

4.3.3 Shall be a person who can provide technical assistance or instruction or both during on-the-job training to a Technician I or Technician II.

4.4 Technician III

4.4.1 Shall be a person who can perform the tasks of a Technician II and can perform complex troubleshooting, calibration, and repair without direction on instrumentation, control systems, or equipment.

4.4.2 Shall be a person who can perform Technician IV level tasks under the direction of a Technician IV.

4.4.3 Shall be a person who can provide technical assistance or instruction or both during on-the-job training to a Technician I, Technician II, or Technician III.

4.5 Technician IV

4.5.1 Shall be a person who can perform the tasks of a Technician III and can provide technical supervision to other technicians.

4.5.2 Shall be a person who can provide technical assistance or instruction or both during on-the-job training to a Technician I, Technician II, Technician III, or Technician IV.

4.6 The terms "Technician I," "Technician II," "Technician III," "Technician IV," and "Group Leader" need not be used as job titles. However, the job titles and job descriptions shall be correlated with the above terms in the facility certification program.

5 General criteria

5.1 The Instrumentation and Control (I&C) Group in a nuclear facility shall consist of a Group Leader and one or more persons who are certified in the categories of Technician I, Technician II, Technician III, and/or Technician IV. The I&C Group Leader's qualifications are defined in ANSI/ANS-3.1-1981, "Selection and Training of Personnel for Nuclear Power Plants." The Group Leader may also be a Technician IV. Personnel who are not qualified in one of the above categories may be a part of the I&C Group, provided they do not work on equipment important to safety without direction.

5.2 A program to certify the knowledge and skills qualifications that are not facility-specific shall be instituted by the employer of personnel in the technician categories. A program to certify the knowledge and skills qualifications that are facility-specific shall be instituted by the facility operator in which personnel in the technician categories work. The facility operator has ultimate responsibility for assuring that every technician performing work on facility equipment is properly certified at the appropriate level. The program requirements are specified in [Section 6](#). For example, a contractor providing the technician would certify the technician in nonfacility-specific items, while the facility operator who is operating the facility would certify the contractor's technician in facility-specific items only. The facility operator would certify its own technician in both nonfacility-specific and facility-specific items. The qualifications for each technician category shall be based upon the job description of each category in a specific facility. The job description shall be a list that may not be complete but shall clearly identify the types of tasks that each level of technician can perform without direction.

5.3 In addition to the knowledge and skills items, there shall be minimum education and experience requirements for each technician category. These requirements are specified in [Section 7](#).

6 Certification of qualifications

6.1 Each technician shall be tested on at least a representative sample of the knowledge and skills items from the job description of the category for which the technician is to be certified.

6.2 Knowledge proficiency shall be demonstrated and documented by written and/or oral examination.

6.3 Skill proficiency shall be demonstrated and documented by direct observation of the technician's performance of actual or simulated tasks by a technician possessing at least the next higher certification or by an individual designated by management.

6.4 A technician may be certified to individually perform tasks of the next higher technician category by successful completion of the knowledge and/or skills proficiency examination(s) directly related to those tasks.

6.5 The facility operator shall maintain documentation, in accordance with existing facility and personnel procedures, on each technician to show the following items:

- 1) name of employer and certifying agency;
- 2) name of certified individual;
- 3) level of technician certification;
- 4) dates of effective period of certification;
- 5) signature of employer's or certifying agency's designated representative;
- 6) training records to support certification;
- 7) education and experience from outside sources; and
- 8) evaluation by the immediate supervisor.

6.6 The facility operator shall maintain documentation, in accordance with existing facility and personnel procedures, on skill proficiency and written and oral examinations to show the following:

- 1) name of technician;
- 2) name of evaluator;
- 3) date of examination;
- 4) pass/fail criteria;
- 5) pass/fail status of the technician;
- 6) question and answer keys for written examinations;
- 7) evaluation criteria and results for skill proficiency examinations; and
- 8) questions and pass/fail criteria for each question on oral examinations.

6.7 Evaluation by the immediate supervisor shall include, but not be limited to, comment on the technician's technical competence and quality of work.

7 Education and experience requirements

7.1 The minimum education and experience requirements are specified below.

7.2 Technician I

- 1) high school diploma or equivalent, as specified in 4.1 of ANSI/ANS3.1-1981;
- 2) six (6) months of experience in instrumentation; and
- 3) certification of Technician I knowledge and skills qualifications.

7.3 Technician II

- 1) high school diploma or equivalent, as specified in 4.1 of ANSI/ANS3.1-1981;
- 2) three (3) years of working experience in his/her specialty; and
- 3) certification of Technician II knowledge and skills qualifications.

or

- 1) associate degree or higher in electronics, instrumentation, or a related field;
- 2) one (1) year of working experience in his/her specialty; and
- 3) certification of the Technician II knowledge and skills qualifications.

7.4 Technician III

- 1) education and experience requirements of Technician II; and
- 2) certification of the Technician III knowledge and skills qualifications.

7.5 Technician IV

- 1) education and experience requirements of Technician II; and
- 2) certification of the Technician IV knowledge and skills qualifications.

8 Training

8.1 In order for each person to meet the qualifications in the technician categories, a training program shall be an integral part of the certification program. An example of the skills and knowledge subjects for a training program is provided in [Appendix A](#).

8.2 Maintenance of certification shall be accomplished by enrollment and participation in an ongoing continuing training program.

9 Recertification

9.1 A technician must be recertified under the following conditions:

- 1) when the Technician transfers to another plant or unit in which the Technician is not certified; or
- 2) if the Technician does not work in his/her certification level for a period of time exceeding the facility operator's requirements ([see 8.2](#)).

10 References

AMERICAN NUCLEAR SOCIETY (ANS)

ANSI/ANS-3.1-1981 Selection, Qualifications and Training of Personnel for Nuclear Power Plants

Available from: **American Nuclear Society**
555 North Kensington Avenue,
LaGrange Park, IL 60525 Tel: (708) 352-6611

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ANSI/ASME N45.2.6-1978 Qualifications of Inspection, Examination and Testing Personnel for Nuclear Power Plants

Available from: **American Society of Mechanical Engineers**
345 East 47th Street
New York, NY 10017 Tel: (212) 705-7722

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ANSI/ISA-S51.1-1979 Process Instrumentation Terminology
(Reaffirmed 1993)

Available from: **ISA**
PO Box 12277
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UNITED STATES CODE OF FEDERAL REGULATIONS

Title 10, Part 50,
Appendix A Training and Qualification of Nuclear Power Plant Personnel

Available from: **Superintendent of Documents**
U.S. Government Printing Office
Washington, DC 20402

Appendix A Typical knowledge and skills list

This appendix is not part of the standard but is attached to provide information to facilitate determination of the knowledge and skills an Instrumentation and Control Technician should have to work safely and effectively in a nuclear facility. The knowledge and skills listed here are typically found in I&C training programs. Each facility should tailor its training program content and technician skill requirements to the specific needs of the nuclear facility. It is expected that this may be accomplished by adding to or subtracting from these lists.

A.1 Knowledge

- 1) Mathematics
 - Arithmetic operations
 - Ratio and proportions
 - Algebra
 - Geometry
 - Trigonometry
 - Fundamental calculus
- 2) Physical sciences
 - Physics
 - Mechanics
 - Heat transfer fundamentals
 - Nuclear physics
 - Health physics
 - Chemistry fundamentals
 - Pneumatics/hydraulics
 - Basic water chemistry

The following topics will include theory of operation and failure mechanisms and modes:

- 3) Electricity and electronics
 - Basic electricity
 - Basic electronics
 - Analog electronics
 - Digital electronics

- Fundamental computer theory
- Electrical/electronic measurement and test equipment theory of operation
- Electrical/electronic maintenance and repair techniques
- 4) Process measurements and instrumentation
 - Basic concepts and terminology
 - Temperature measurement fundamentals and applications
 - Fluid thermometry
 - Thermocouples
 - Bimetallic devices
 - Resistance temperature detectors
 - Thermistors
 - Pressure measurement fundamentals and applications
 - Bourdon tube devices
 - Diaphragms
 - Bellows
 - Capsules
 - Strain gauges
 - Level measurement fundamentals and applications
 - Float systems
 - Displacer systems
 - Differential pressure devices
 - Radiation level systems
 - Sonic level systems
 - Flow measurement fundamentals and applications
 - Primary elements
 - Differential pressure devices
 - Magnetic flow measurement
 - Turbine flowmeters
 - Rotometers
 - Miscellaneous transducers
 - Fire detection transducers
 - Security system transducers

- Environmental transducers
 - Seismic transducers
 - Meteorologic transducers
- Analytical transducers
 - In-line and laboratory pH
 - Meters
 - O₂ analyzers
 - H₂ analyzers
 - Conductivity/salinity cells
- 5) Signal processing/conditioning equipment
 - Transducers
 - Pneumatic/electronic
 - Force balance
 - Motion balance
 - Moment balance
 - Signal conditioners
 - Integrators/rate meters, function generators, and square rooters
 - Signal converters
 - Such as: P/I, I/P, E/P, P/E, E/I, and A-D/D-A
 - Summers
 - Amplifiers
 - Bistables
 - Control relays/solenoids
 - Indicators
 - Visual
 - Audible, etc.
 - Annunciators
 - Recorders

- 6) Process control instrumentation
 - Automatic control theory
 - Controllers
 - Pneumatic
 - Electronic
 - Analog control systems
 - Digital control systems
 - Final control elements
 - Positioners
 - Actuators
- 7) Radiation detection instrumentation
 - Portable radiac
 - Area radiation monitors
 - Portal radiation monitors
 - Process radiation monitors
 - Reactor/nuclear monitoring systems
- 8) Plant systems
 - Theory/construction
 - Nuclear systems and flow paths
 - Auxiliary systems
 - Emergency/safeguard systems
 - Control and protection systems
 - Major electrical distribution
- 9) Basic plant operation
 - Plant layout
 - Plant procedures
 - Company policies
- 10) Advanced plant instrumentation
 - Computer systems
 - Multivariable control systems
 - Multiplexed control and information systems
 - Microprocessor/minicomputer-based systems

A.2 Skills

- 1) Proper use of the following technical information:
 - Maintenance/instrumentation/administrative procedures
 - Technical manuals
 - Wiring and termination drawings
 - Design specification sheets
 - Solid-state schematics
 - Power distribution drawings
 - Assembly drawings
 - Unit conversion tables
 - Functional control drawings
 - Integrated circuit schematics
 - Electro-mechanical drawings
 - P & IDs
 - Electronic control drawings
 - Piping and elementary drawings
 - Relay logic drawings
 - Complex logic diagrams
 - Computer flow charts
- 2) Proper use of the following measurement and test equipment:
 - Miscellaneous hand tools
 - Digital VOM
 - VOM
 - Electrometers
 - Function generators
 - Differential (null) VM
 - Power supplies
 - Calibrators—pneumatic/electronic
 - Calibrated resistance/decade boxes
 - Oscilloscopes/oscillographs
 - Calibration standards
 - Various gauges
 - XY plotters/recorders
 - Wheatstone bridge

- N₂ pressure regulator calibration units
 - Strip chart recorder/visicorders
 - Millivolt potentiometers
 - Kelvin bridges
 - Vacuum testers
 - Deadweight testers/comparators
 - Capacitance bridges
 - Transistor testers
 - Noise/vibration analyzers
 - Megohm bridges
 - Oscilloscope photography/cameras
 - Tubing benders
 - Frequency spectrum analyzers
 - Pulse counters
 - Frequency counters
 - Pico amp sources
 - Pico ammeters
 - High speed event recorders
 - Meter shunts
 - Inductance bridges
 - Stroboscopes
- 3) Align, calibrate, test, troubleshoot, adjust, and repair the following:
- Typical analog and digital circuitry
 - Process measurement sensing elements and transducers
 - Signal processing/conditioning equipment
 - Process control loops
 - Complex measurement and control systems
 - Nuclear radiation instrumentation systems
 - Plant control/instrumentation systems
 - Advanced plant instrumentation
 - Proper valving techniques

- 4) Proper use of the following plant administrative documents or systems:
- I&C shop practices/procedures/forms
 - Information/library/records management systems
 - Equipment utilization forms
 - Maintenance orders/work orders
 - Bypass control/jumper/wire removal forms
 - Plant tagging systems
 - FSAR and technical specifications
 - Radiation work permits/forms
 - Channel check procedures/forms
 - Functional test procedures/forms
 - Calibration procedures/forms
 - Alignment procedures/forms
 - Receipt/inspection procedures/forms
 - Document control systems/forms
 - Surveillance test procedures/forms
 - Confined space entry techniques/forms
 - Nonconformance items
 - Review, approval, and control of procedures/changes
 - Training and certification procedures/forms
 - Temporary procedure changes/forms
 - Facility/equipment change or modification procedures/forms
- 5) Proper facility safety practices
- First aid/CPR
 - Electrical safety techniques
 - Handling of toxic materials
 - Handling of radioactive sources/contaminated materials
 - Use of safety equipment
 - Use of high pressure/temperature/pneumatic/hydraulic, and fluid systems

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