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DOE-STD-1176-2004
January 2004

DOE STANDARD

CHEMICAL PROCESSING FUNCTIONAL AREA QUALIFICATION STANDARD

DOE Nuclear Facilities Technical Personnel

U.S. Department of Energy
Washington, D.C. 20585

AREA TRNG

APPROVAL

The Federal Technical Capability Panel consists of senior U.S. Department of Energy managers responsible for overseeing the Federal Technical Capability Program. This Panel is responsible for reviewing and approving the Qualification Standard for Department-wide application. Approval of this Qualification Standard by the Federal Technical Capability Panel is indicated by signature below.

Roy J. Schepens
Chairman
Federal Technical Capability Panel

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ACKNOWLEDGMENT

The Savannah River Operations Office is the Sponsor for the Chemical Processing Qualification Standard. The Sponsor is responsible for coordinating the development and/or review of the Functional Area Qualification Standard by subject matter experts to ensure that the technical content of the standard is accurate and adequate for Department-wide application for those involved in chemical processing. The Sponsor, in coordination with the Federal Technical Capability Panel, is also responsible for ensuring that the Functional Area Qualification Standard is maintained current.

The following subject matter experts (SMEs) participated in the development and/or review of this qualification standard:

Pat Suggs	Savannah River Operations Office
Dave Faubert	Savannah River Operations Office
Bill Stubbs	Savannah River Operations Office
Rob Vrooman	DOE Headquarters
Joe Eizaquirre	Richland Operations Office
Joanne Shadel	Richland Operations Office
Jennifer Hamilton	Oak Ridge Operations Office

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U.S. DEPARTMENT OF ENERGY
FUNCTIONAL AREA QUALIFICATION STANDARD

Chemical Processing

PURPOSE

DOE Manual 426.1-1, Federal Technical Capability Manual, commits the Department to continuously strive for technical excellence. The Technical Qualification Program, along with the supporting technical Functional Area Qualification Standards, complements the personnel processes that support the Department's drive for technical excellence. In support of this goal, the competency requirements defined in the Technical Functional Area Qualification Standards should be aligned with and integrated into the recruitment and staffing processes for technical positions. The Technical Qualification Standards should form, the primary basis for developing vacancy announcements, qualification requirements, crediting plans, interviewing questions, and other criteria associated with the recruitment, selection, and internal placement of technical personnel. Office of Personnel Management minimum qualifications standards will be greatly enhanced by application of appropriate materials from the technical Functional Area Qualification Standards.

The Technical Qualification Standards are not intended to replace the U.S. Office of Personnel Management's (OPM) Qualifications Standards nor other Departmental personnel standards, rules, plans, or processes. The primary purpose of the Technical Qualification Program is to ensure that employees have the requisite technical competency to support the mission of the Department. The Technical Qualification Program forms the basis for the development and assignment of DOE personnel responsible for ensuring the safe operation of defense nuclear facilities.

APPLICABILITY

The Chemical Processing Functional Area Qualification Standard establishes common functional area competency requirements for Department of Energy chemical processing personnel who provide assistance, direction, guidance, oversight, or evaluation of contractor technical activities impacting the safe operation of defense nuclear facilities. The technical Functional Area Qualification Standard has been developed as a tool to assist DOE Program and Field offices in the development and implementation of the Technical Qualification Program in their organization. For ease of transportability of qualifications between DOE elements, Program and Field offices are expected to use this technical Functional Area Qualification Standard without modification or additions. Needed additional office/site/facility specific technical competencies should be handled separately. Satisfactory and documented attainment of the competency requirements contained in this technical Functional Area Qualification Standard, or similar Standards, ensures that chemical processing personnel possess the requisite competence to fulfill their functional area duties and responsibilities. Office/Facility-Specific Qualification Standards supplement this technical Functional Area Qualification Standard and establish unique operational competency requirements at the Headquarters or Field element, site, or facility level.

IMPLEMENTATION

This technical Functional Area Qualification Standard identifies the minimum technical competency requirements for Department of Energy chemical processing personnel. Although there are other competency requirements associated with the positions held by chemical processing personnel, this Functional Area Qualification Standard is limited to identifying the specific technical competencies. The competency statements define the expected knowledge and/or skill that an individual must meet. Each of the competency statements is further explained by a listing of supporting knowledge and/or skill statements.

The competencies identify a familiarity level, a working level, or an expert level of knowledge; or they require the individual to demonstrate the ability to perform a task or activity. These levels are defined as follows:

> **Familiarity level** is defined as basic knowledge of or exposure to the subject or process adequate to discuss the subject or process with individuals of greater knowledge.
>
> **Working level** is defined as the knowledge required to monitor and assess operations/activities, to apply standards of acceptable performance, and to reference appropriate materials and/or expert advice as required to ensure the safety of Departmental activities.
>
> **Expert level** is defined as a comprehensive, intensive knowledge of the subject or process sufficient to provide advice in the absence of procedural guidance.
>
> **Demonstrate the ability** is defined as the actual performance of a task or activity in accordance with policy, procedures, guidelines, and/or accepted industry or Department practices.

Headquarters and Field elements shall establish a program and process to ensure that chemical processing personnel possess the competencies required of their position. That includes the competencies identified in this technical Functional Area Qualification Standard. Documentation of the completion of the requirements of the Standard shall be included in the employee's training and qualification record.

Equivalencies should be used sparingly and with the utmost rigor and scrutiny to maintain the spirit and intent of the TQP. Equivalencies may be granted for individual competencies based upon objective evidence of previous education, training, certification, or experience. Objective evidence includes a combination of transcripts, certifications, and, in some cases, a knowledge sampling through a written and/or oral examination. Equivalencies shall be granted in accordance with the Technical Qualification Program Plan of the office qualifying the individual. The supporting knowledge and/or skill statements, while not requirements, should be considered before granting equivalency for a competency.

Training shall be provided to employees in the Technical Qualification Program that do not meet the competencies contained in the technical Functional Area Qualification Standard. Training may include, but is not limited to, formal classroom and computer based courses, self-study, mentoring, on the job training, and special assignments. Departmental training will be based upon appropriate supporting knowledge and/or skill statements similar to the ones listed for each of the competency statements. Headquarters and Field elements should use the supporting knowledge and/or skill statements as a basis for evaluating the content of any training courses used to provide individuals with the requisite knowledge and/or skill required to meet the technical Functional Area Qualification Standard competency statements.

EVALUATION REQUIREMENTS

Attainment of the competencies listed in this technical Functional Area Qualification Standard should be documented by a qualifying official, immediate supervisor, or the team leader of personnel in accordance with the Technical Qualification Program Plan of the office qualifying the individual.

CONTINUING EDUCATION, TRAINING AND PROFICIENCY

DOE personnel shall participate in continuing education and training as necessary to improve their performance and proficiency and ensure that they stay up-to-date on changing technology and new requirements. This may include courses and/or training provided by:

- Department of Energy
- Other government agencies
- Outside vendors
- Educational institutions

Beyond formal classroom or computer based courses, continuing training may include:

- Self Study
- Attendance at symposia, seminars, exhibitions
- Special assignments
- On-the-job experience

A description of suggested learning proficiency activities, and the requirements for the continuing education and training program for Chemical Processing personnel are included in Appendix A of this document.

DUTIES AND RESPONSIBILITIES

The following are the typical duties and responsibilities expected of personnel assigned to the Chemical Processing Functional Area:

1. Evaluate the adequacy and responsibilities of chemical process safety programs and ensure compliance with the applicable codes, standards, guides, regulations, Department of Energy Orders, and accepted practices.

2. Monitor and assess contractor performance in the control of chemical processes, in accordance with programmatic goals, to include:

   - Operational performance and conditions
   - Training and qualification
   - Regulatory compliance
   - Workplace and process hazards
   - Technical support for process operations
   - Sampling data integrity
   - Drills

3. Participate in the preparation, review, and/or recommendation for approval of Authorization Basis documents.

4. Serve as Department of Energy technical point of contact for:

   - Chemical process operations
   - Chemical process safety issues
   - Training program development
   - Standards review and interpretation
   - Process testing and evaluation

5. Evaluate contractor emergency preparedness and emergency response activities related to chemical process incidents and provide support in conjunction with contractor, Federal, State, and local officials.

6. Maintain cognizance of current chemical facility conditions and communicate those conditions to management as appropriate.

7. Evaluate cost, scope, and schedule associated with chemical processing functions.

8. Participate in the investigation of incidents related to chemical processes.

9. Maintain cognizance of facility design basis, facility modifications, operating procedures, and process control.

Additional duties and responsibilities specific to the site, facility, operational activities, and/or other involved organizations shall be contained in the Facility-Specific Qualification Standard(s).

Position-specific duties and responsibilities for chemical processing personnel are contained in their Office/Facility-Specific Qualification Standard or Position Description.

BACKGROUND AND EXPERIENCE

The U. S. Office of Personnel Management's Qualification Standards Handbook establishes minimum education, training, experience, or other relevant requirements applicable to a particular occupational series/grade level, as well as alternatives to meeting specified requirements.

The preferred education and experience for chemical processing personnel is:

1. Education:

   Bachelor of Science degree in Chemical Engineering from an accredited institution or meet the alternative requirements specified in the Qualification Standards Handbook for the GS-0800, Professional Engineering Series as a minimum to include thermodynamics, fluid mechanics, mass transfer, heat transfer, chemical process unit operation, reaction kinetics, mass balance, energy balance, and chemistries to include general, organic and physical chemistries.

2. Experience:

   Industry, facility, operations, or other related experience and/or a Professional Engineer license that has provided specialized experience in Chemical Processing. Specialized experience can be demonstrated through possession of the competencies outlined in this Standard.

REQUIRED TECHNICAL COMPETENCIES

The competencies contained in this Standard are distinct from those competencies contained in the General Technical Base Qualification Standard. All Chemical Processing personnel must satisfy the competency requirements of the General Technical Base Qualification Standard prior to or in parallel with the competency requirements contained in this Standard. Each of the competency statements defines the level of expected knowledge and/or skill that an individual must possess to meet the intent of this Technical Qualification Standard. The supporting knowledge and/or skill statements further describe the intent of the competency statements.

Note: When regulations or U.S. Department of Energy directives or other industry standards are referenced in the Qualification Standard, the most recent revision should be used.

GENERAL TECHNICAL

1. Chemical processing personnel shall have a working level knowledge of the operation of chemical processes.

Supporting Knowledge and/or Skills

a. Identify the light and heavy phases, and discuss the direction of mass transfer or separations aspects of the following unit operations:

- Solvent Extraction (Extractant, Raffinate, Emulsions, Coalescence, Counter-current multistage contactor, Extraction/Scrubbing/Stripping, Partition Coefficient, Efficiency)
- Gas Absorption/Stripping
- Ion Exchange
- Adsorption
- Filtration
- Evaporation
- Crystallization
- Sedimentation
- Leaching

2. Chemical processing personnel shall demonstrate an expert level knowledge of mass transfer and mass balances.

Supporting Knowledge and/or Skills

a. Discuss the ideal gas law as it applies to pressure, volume, and temperature relationships.

b. Discuss the application of mass balances and provide an example of an application in plant chemical flowsheets.

c. Define the following mass transfer terms and vapor-liquid equilibrium laws:

- Absorption
- Adsorption
- Partition Coefficient
- Raoult's Law
- Dalton's Law
- Henry's Law
- Azeotropes
- Phase Diagrams
- Vapor-liquid Equilibrium
- Binary Phase Equilibria
- Multi-component Vapor Equlibria
- Bubble-point, dew point, relative volatility

d. Discuss how the vapor-liquid equilibrium laws may be applied to determine a Composite Lower Flammability Limit in a vessel vapor space.

e. Perform an example calculation demonstrating the use of mass transfer coefficients to estimate a liquid to vapor mass transfer.

3. Chemical processing personnel shall demonstrate an expert level knowledge of stoichiometry and reaction kinetics.

Supporting Knowledge and/or Skills

a. Balance a chemical reaction equation, and discuss the concepts of limiting reactant and theoretical product yield.

b. Discuss how a rate constant for a first order reaction may be determined from experimental data.

c. Discuss the effects of temperature, catalysts, agitation and other conditions upon a reaction rate.

4. Chemical processing personnel shall demonstrate an expert level knowledge of process safety.

Supporting Knowledge and/or Skills

a. Discuss key requirements of the Process Safety Management (PSM) Rule (29 CFR 1910.119).

b. Discuss the role of Chemical Processing personnel in performing Process Hazard Analysis and other parts of PSM.

c. Discuss the following attributes of a Personnel Protection Program:

- Material Safety Data Sheets (MSDS) and 29 CFR 1910.1200
- Personal Protective Equipment

d. Discuss the startup/re-start requirements of DOE-O-425.1.

e. Discuss factors affecting integrity and performance of systems (age, pressure, service cycles, etc).

f. Discuss sources of information for chemical reactivity hazards, for lessons learned and for historical records of nuclear and chemical industry accidents.

g. Demonstrate a knowledge of basic chemical incompatibilities and reactive chemistry.

h. Discuss TBP properties and hazards including decomposition products and “red oil” safety issues.

5. Chemical processing personnel shall demonstrate a working level knowledge of DOE Safety Basis requirements.

Supporting Knowledge and/or Skills

a. Discuss the following aspects of 10 CFR 830 subpart B:

- Documented Safety Analyses
- Technical Safety Requirements
- Unreviewed Safety Question
- Safe Harbor Methodology
- DOE-STD 1027, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports
- DOE-STD 3009, Preparation Guide for US Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses

b. Discuss the function of the following documents which may be in a Safety Basis Program:

- Justification for Continued Operation
- Basis for Interim Operations (DOE-STD 3011)
- Potential Inadequacy in the Safety Analysis
- New Information
- Health and Safety Plan
- Authorization Agreements
- Criticality Safety Evaluation and the Double Contingency Principle (DOE Order 420.1)

6. Chemical Processing Personnel shall demonstrate a working level knowledge of safety and relief devices.

Supporting Knowledge and/or Skills

a. Define the following terms as they pertain to safety and relief valves:

- Set point
- Accumulation
- Blowdown
- Weep
- Pilot-actuated
- Gagging device

b. Compare and contrast the purpose and operation of safety and relief valves.

c. Discuss how blowdown and accumulation are controlled in safety and relief valves.

d. Using a cutaway drawing of a safety valve, identify the main components to include:

- Seat
- Disc
- Blowdown ring
- Main spring
- Set-point adjustment mechanism

e. Discuss the methods used to test relief valves.

f. Discuss the application of Rupture Discs.

7. Chemical Processing Personnel shall demonstrate working level knowledge of general piping systems.

Supporting Knowledge and/or Skills

a. Define the following terms as they relate to piping systems:

- Pipe schedule
- Water hammer
- Hydrostatic test pressure
- Laminar flow
- Turbulent flow

b. Discuss the potential hazards to personnel and equipment associated with water hammer.

c. Identify and discuss the typical causes of water hammer in piping systems.

d. Discuss the purpose of seismic restraints (whip restraints or snubbers) in piping systems.

e. Identify and discuss different methods of pipe joining (threaded, butt weld, socket weld, seal weld, etc.)

8. Chemical Processing Personnel shall demonstrate a working level knowledge of mechanical diagrams, including:

- **As-built drawings**
- **Piping and Instrumentation Diagrams (P&ID)**

Supporting Knowledge and/or Skills

a. Using an engineering print, read and interpret the information contained in the title block, the notes and legend, the revision block, and the drawing grid.

b. Identify the symbols used in piping and instrumentation diagrams for:

- Types of valves
- Types of valve operators
- Types of educators and ejectors
- Basic types of instrumentation
- Types of instrument signal controllers and modifiers
- Types of system components (pumps, etc.)
- Types of lines

c. Identify the symbols used in piping and instrumentation diagrams to denote the location of instruments, indicators, and controllers.

d. Identify how valve conditions are depicted.

e. Determine system flowpath(s) for a given valve lineup.

f. Discuss the origin and purpose of "as-built drawings."

9. Chemical Processing Personnel shall demonstrate a working level knowledge of the general construction, operation, and theory of valves.

Supporting Knowledge and/or Skills

a. Define the following terms as they relate to valves:

- Disc
- Seat
- Throttle
- Actuator
- Bridgewall mark
- Packing

b. Using a drawing of a valve, identify which of the following general types of valve it is and, describe its normal design application in a piping system:

- Gate
- Globe
- Ball
- Check
- Butterfly
- Regulating/reducing

c. Discuss why the design of a globe valve enables it to throttle fluids efficiently.

d. Using a diagram of a globe valve body showing the bridgewall mark, identify how the valve must be oriented in the system related to flow.

e. Discuss why gate valves, ball valves, and butterfly valves should never be used to throttle flow.

f. Discuss how cavitation occurs in valves and state any harmful effects that can result from cavitation.

g. Describe the construction and principle of operation for the following types of valve actuators:

- Manual
- Electric
- Solenoid
- Pneumatic
- Hydraulic

h. Describe the principles of operation and applications for modulating and pressure reducing valves.

10. Chemical processing personnel shall demonstrate a working level knowledge of measurement, data collection, and analysis.

Supporting Knowledge and/or Skills

a. Discuss the types of instrumentation and the principles of operation for measuring chemical process parameters (e.g., pressure, temperature, flow) to include:

- Resistance Temperature Detector (RTD)
- Thermocouple
- Differential pressure detector
- Pitot tube
- Thermocouple
- Bourdon tube pressure gauge
- Duplex pressure gauge
- Manometer
- Mechanical flow meters

b. Discuss the following with respect to probability and statistics:

- Standard Deviation
- Mean/median/mode
- Variance
- Sample size/frequency
- Error analysis

11. Chemical Processing Personnel shall demonstrate a working level knowledge of pump theory and operation.

Supporting Knowledge and/or Skills

a. Define the following terms as they relate to pumps:

- Head
- Net positive suction head
- Cavitation
- Shut-off head
- Run-out
- Centrifugal pump
- Positive displacement pump

b. Describe the general principle of operation for centrifugal pumps.

c. Describe the general principle of operation for positive displacement pumps.

d. Using a cutaway drawing of a centrifugal pump, identify the following components and discuss their purpose:

- Impeller
- Packing or mechanical seal
- Volute
- Lantern ring
- Wearing rings (impeller and/or casing)

e. Discuss why centrifugal pumps should normally be started against a shut-off head and the hazards associated with continuously running against a shut-off head.

f. State the dangers to personnel and equipment associated with starting a positive displacement pump against a shut-off head. Discuss the importance and methods of providing over pressurization protection for positive displacement pumps.

g. Compare and contrast the principle of operation and typical pumped medium of the following types of positive displacement pumps:

- Reciprocating
- Rotary-screw
- Vane-axial

h. Using the following list of system and/or pumped medium characteristics, identify which type of pump (e.g., centrifugal, reciprocating positive displacement, rotary-screw positive displacement) is best suited for the application.

- Slurries
- Fluids with high viscosities
- Low volume, high head
- Low head, high volume
- Water
- Oil

i. Discuss the concept of pump cavitation and describe its harmful effects.

12. Chemical Processing Personnel shall demonstrate a working level knowledge of fluid mechanics and properties.

Supporting Knowledge and/or Skills

a. Define the following:

- Temperature
- Pressure
- Viscosity
- Specific volume
- Specific gravity
- Capillarity
- Laminar flow
- Turbulent flow
- Uniform flow
- Surface tension

b. Explain the equation of continuity as it applies to fluid flow.

c. Discuss the Reynold's number and how it is used.

d. Discuss Bernoulli's equation as it applies to steady-state flow rate calculations.

13. Chemical Processing Personnel shall demonstrate the ability to calculate flow rates in fluid systems.

Supporting Knowledge and/or Skills

a. For non-compressible fluids, calculate flow rates using the following methods:

- Volume flow rate
- Mass flow rate
- Steady-State continuity equation
- Bernoulli's equation
- Darcy's formula

b. Discuss the limitations of the above methods.

14. Chemical Processing Personnel shall demonstrate a working level knowledge of thermodynamics.

Supporting Knowledge and/or Skills

a. Define the following:

- Compression
- Isothermic
- Isentropic
- Adiabatic
- Heat of Dilution
- Specific Heat

b. Discuss entropy and enthalpy as they relate to chemical processes and performing energy balances.

c. Define and discuss the following:

- Carnot cycle
- Rankine cycle

d. Read and interpret a Mollier diagram.

e. Using data from a steady-state system, calculate the following:

- Entropy change
- Enthalpy change
- Pressure
- Temperature

15. Chemical Processing Personnel shall demonstrate a working level knowledge of steady-state heat transfer.

Supporting Knowledge and/or Skills

a. Define:

- Conduction
- Convection
- Radiation
- Thermal conductivity

b. Discuss Fourier's law.

c. Describe the factors that contribute to the co-efficient of thermal conductivity.

d. Calculate the heat flux for one-dimensional, steady-state heat transfer through the following:

- Composite wall
- Series wall
- Parallel wall

e. Using data, calculate total heat transfer and local heat flux in a laminar flow system.

16. Chemical Processing Personnel shall demonstrate a working level knowledge of the construction and operation of heat exchangers.

Supporting Knowledge and/or Skills

a. Describe the principle of operation for the following types of heat exchangers:

- Shell and tube
- Fin and tube
- Cooling tower

b. Define the following terms as they apply to heat exchangers:

- Tube sheet
- Tell-tale drain
- Parallel flow
- Counter flow
- Cross flow

c. Using a cutaway drawing of the following types of heat exchangers, show the flow paths of the cooling medium and the medium to be cooled:

- Parallel flow
- Counter flow
- Cross flow

d. Using data, calculate the log mean temperature difference for heat exchangers.

e. Explain the principle of operation of a forced-draft cooling tower.

f. Explain the principle of operation of a natural-draft (parabolic) cooling tower.

17. Chemical Processing Personnel shall demonstrate a working level knowledge of the components, operation, and theory of pneumatic systems.

Supporting Knowledge and/or Skills

a. Define the following terms and discuss their relationship:

- Dew point
- Dehydrator
- Dew point indicator
- Actuator

b. Describe the basic operation of a pneumatic system.

c. Discuss how energy in a pneumatic system is converted to work.

d. Discuss the hazardous relationship between high pressure air and oil.

e. Identify and discuss the general hazards associated with pneumatic systems and their components and the over-pressurization of these systems.

f. Discuss the hazards associated with portable gases such as cylinders of oxygen, nitrogen, etc.

18. Chemical Processing Personnel shall demonstrate a working level knowledge of the basic components, operations, and theory of hydraulic systems.

Supporting Knowledge and/or Skills

a. Define the following terms and discuss their relationship in hydraulic systems:

- Force
- Work
- Pressure
- Reservoir
- Accumulator
- Actuator

b. Describe the basic operation of a hydraulic system.

c. Discuss how energy in a hydraulic system is converted to work.

d. Discuss the purpose and basic construction of a hydraulic reservoir.

e. Discuss the purpose and basic construction of a hydraulic accumulator.

f. Identify and discuss the hazards associated with hydraulic systems and their components.

19. Chemical processing personnel shall demonstrate a working level knowledge of Project and Contract Management.

Supporting Knowledge and/or Skills

c. Discuss the phases of a project lifecycle as described in DOE O 413.3. Briefly describe each of the critical decision points.

b. Using the guidance in DOE-STD-1073-93, Guide for Operational Configuration Management Program, discuss the System Engineer concept as it applies to oversight of safety systems. Specifically address the following areas of configuration management:

- Assessment of system status and performance
- Technical support for operation and maintenance activities
- Technical support for Documented Safety Analysis reviews.
- Document Control
- Change Control
- Design Requirements
- Assessments

c. Describe the quality assurance criteria of 10 CFR 830.120 which addresses the following:

- Management
- Performance
- Assessment

d. Briefly discuss the maintenance management requirements as described in Life Cycle Assessment Management (DOE-O-430.1).

e. Discuss the basic performance measurement tools used to monitor contractor performance.

20. Chemical Processing Personnel shall demonstrate a familiarity level of knowledge of Software Quality Assurance relationships between the problems being addressed by safety analysis and design codes, the design requirements for the codes, and the components of the codes.

Supporting Knowledge and/or Skills

a. Identify how functional requirements and applicability of safety analysis and design computer codes are defined, documented, and controlled relative to modeling and data assumptions, design constraints, sizing and timing conditions and input/output parameters.

b. Review a development project for safety analysis or design software. Explain how the problem being addressed by the software was translated into functional requirements, how the requirements were established and controlled, and how the code was reconciled with the original problem.

21. Chemical Processing Personnel shall demonstrate a familiarity level of knowledge of Software Quality Assurance functional interfaces between safety system software components and the system-level design.

Supporting Knowledge and/or Skills

a. Identify how system-level requirements are established and then assigned to hardware, software, and human components of a digital instrumentation and control system.

b. Identify the typical requirements that define functional interfaces between safety system software components and the system-level design, as described in standards such as ANSI/IEEE 830, *IEEE Guide to Software Requirements Specifications* and IEEE 7-4.3.2, *Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations.*

c. Identify the specific records that must be maintained and the requirements for maintaining these records to document the development of safety system software.

APPENDIX A
CONTINUING EDUCATION, TRAINING AND PROFICIENCY PROGRAM

The following list represents suggested continuing education, training and other opportunities that are available for chemical processing personnel after completion of the competency requirements in this technical Functional Area Qualification Standard. It is extremely important that personnel involved with chemical processing maintain their proficiency through continuing education, training, reading, or other activities such as workshops, seminars, and conferences. Subject publications and training include those offered by the American Institute of Chemical Engineers (AIChE) and by the Center for Chemical Process Safety (CCPS), a directorate of the AIChE. These may be found on their Internet home pages: <http://www.aiche.org> and <http://www.aiche.org/ccps>. Information presented by AIChE and CCPS include detailed course descriptions and summaries of their publications. Additional safety information may be found at the DOE website http://tis.eh.doe.gov/web/chem_safety/. The list of suggested activities was developed by the Subject Matter Experts involved in the development of the Functional Area Qualification Standard and is not all-inclusive.

LIST OF CONTINUING EDUCATION, TRAINING AND OTHER ACTIVITIES

Chemical Processing Personnel shall participate in an Office/Facility-specific continuing training and qualification program that includes the following elements:

1. Continuing technical education and/or training covering topics directly related to the Chemical Processing area as determined appropriate by management. This may include courses/training provided by Department of Energy, other government agencies, outside vendors, or local educational institutions. Continuing training topics should also address identified weaknesses in the knowledge or skills of the individual personnel.

2. Actively perform the duties of a Chemical Processing specialist at a Department of Energy facility a minimum of 6 months per year.

3. Attend seminars, symposia, or technical meetings related to Chemical Processing.

4. Engage in self-study of new regulations, requirements, or advances related to Chemical Processing.

5. Participation in practical exercises such as emergency or operational drills, simulations, or laboratory-type exercises.

6. Specific continuing training requirements shall be documented in Individual Development Plans.

7. Suggested training courses and resources include the following:

    - *Bulk Pharmaceutical and Chemical Process Development*, American Institute of Chemical Engineers (AIChE), Course #279
    - *Distillation in Practice*, AIChE Course # 004

- *Heat Exchanger Design and Operation*, AIChE Course # 294
- *Industrial Fluid Mixing*, AIChE Course # 090
- *Ion Exchange: Theory and Practice*, AIChE Course # 103
- *Separation Processes: Performance, Selection and Scale-Up*, AIChE Course # 246
- *Solid/Liquid Separation: Fundamentals and Practice*, AIChE Course # 289
- *Spreadsheet Power!* , AIChE Course # 201
- *Using Mathcad to Solve Chemical Engineering Problems*, AIChE Course # 092
- *Chemical Modeling of Aqueous Systems*, AIChE Course # 523
- *Practical Project Evaluation: Capital and Operating Cost Estimation*, AIChE Course #140
- *Project Management*, AIChE Course # 050
- *Automatic Control of Processes*, AIChE Course # 058
- *Distillation Control*, AIChE Course # 117
- *Advanced Wastewater Treatment*, AIChE Course # 035
- Air Pollution and Regulatory Compliance: Models, Measurement and PSD Analysis *Designing Air Pollution Control Equipment*, AIChE Course # 056
- *Designing Air Pollution Control Equipment*, AIChE Course # 061
- *Industrial Applications of Absorption, Stripping and Distillation for Environmental Control*, AIChE Course # 283
- Reports from the U.S. Chemical Safety and Hazard Investigation Board (website is http://www.chemsafety.gov)
- A nuclear criticality safety course
- *Consequence Assessment and Mitigation*, AIChE Course #303
- *Engineering Design for Process Safety*, AIChE Course #508
- *Evaluating Characteristics of Vapor Cloud Explosions, Flash Fires and BLEVES*, AIChE Course #503
- *Fundamentals of Process Safety*, AIChE Course #500
- *Hazard Evaluation: Qualitative Methods for Hazard*, AIChE Course #301
- *How to Comply With the EPA RMP and the OSHA PSM Regulations*, AIChE Course #518
- *Investigating Process Safety Incidents*, AIChE Course #504
- *Understanding and Preventing Explosions*, AIChE Course #536

CONCLUDING MATERIAL

Review Activity:

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Field and Operations Offices

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Preparing Activity:

DOE-EH-22

Project Number:

TRNG-0031