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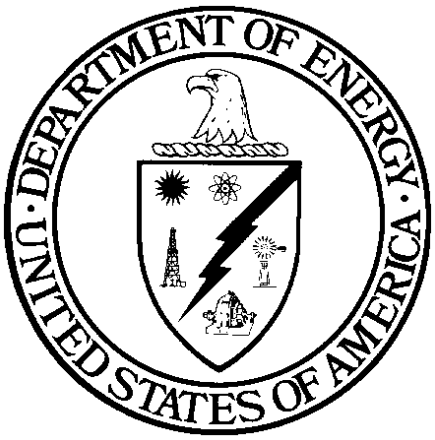
June 2008

DOE STANDARD

MECHANICAL SYSTEMS QUALIFICATION STANDARD

DOE Defense Nuclear Facilities Technical Personnel



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

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APPROVAL

The Federal Technical Capability Panel consists of senior U.S. Department of Energy (DOE) 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.

Karen L. Boardman, Chairperson
Federal Technical Capability Panel

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ACKNOWLEDGMENT

The Pantex Site Office is the sponsor for the Mechanical Systems Qualification Standard. The sponsor is responsible for coordinating the development and/or review of the Functional Area Qualification Standard (FAQS) 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 the mechanical systems program. The sponsor, in coordination with the Federal Technical Capability Panel, is also responsible for ensuring that the FAQS is maintained current.

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

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DOE-STD-1161-2008

U.S. DEPARTMENT OF ENERGY
FUNCTIONAL AREA QUALIFICATION STANDARD

Mechanical Systems

PURPOSE

DOE M 426.1-1A, *Federal Technical Capability Manual*, commits the Department to continuously strive for technical excellence. The Technical Qualification Program (TQP), along with the supporting technical 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 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. The U.S. Office of Personnel Management (OPM) minimum qualifications standards will be greatly enhanced by application of appropriate materials from the technical FAQSs.

The technical qualification standards are not intended to replace the OPM qualification standards or other Departmental personnel standards, rules, plans, or processes. The primary purpose of the TQP is to ensure that employees have the requisite technical competency to support the mission of the Department. The TQP forms the basis for the development and assignment of DOE personnel responsible for ensuring the safe operation of defense nuclear facilities.

APPLICABILITY

The Mechanical Systems FAQS establishes common functional area competency requirements for all DOE mechanical systems personnel who provide assistance in, direction or guidance to, or oversight or evaluation of contractor technical activities that could impact the safe operation of DOE's defense nuclear facilities. The technical FAQS has been developed as a tool to assist DOE program and field offices in the development and implementation of the TQP in their organization. For ease of transportability of qualifications between DOE elements, program and field offices are expected to use this technical FAQS without modification. Needed additional office/site/facility-specific technical competencies should be handled separately. Satisfactory and documented attainment of the competency requirements contained in this technical FAQS (see the Federal Technical Capability Program [FTCP] Directives and Standards page at http://www.hss.energy.gov/deprep/ftcp/directives/directives.asp for an example of the Mechanical Systems FAQS qualification card) ensures that personnel possess the minimum requisite competence to fulfill their functional area duties and responsibilities common to the DOE complex. Additionally, office-/site-/facility-specific qualification standards supplement this technical FAQS and establish unique operational competency requirements at the Headquarters or field element, site, or facility level.

It should be noted that the competency elements of management and leadership, general technical knowledge, regulations, administrative capability, and assessment and oversight are all embodied in the competencies listed in this standard. All of these factors have a bearing on safety. Although the focus of this standard is technical competence, elements such as good communication, recognized credibility, ability to listen and process information, and the ability to guide an effort to get it right the first time are recognized as important aspects of safety.

IMPLEMENTATION

This technical FAQS identifies the minimum technical competency requirements for DOE mechanical systems personnel. Although there are other competency requirements associated with the positions held by DOE mechanical systems personnel, this FAQS is limited to identifying the specific, common technical competencies required throughout all defense nuclear facilities. The competency requirements define the expected knowledge and/or skill that an individual must meet. Each of the competency requirements is further described by a listing of supporting knowledge and/or skill statements. The supporting knowledge and/or skill statements for each competency requirement are provided to challenge the employee in the breadth and depth of his/her understanding of the subject matter. In selected competencies, expected knowledge and/or skills have been designated as “mandatory performance activities.” In these competencies, the actions are not optional.

The terms “shall,” “must,” and “will” denote mandatory requirements in this standard. “Should” denotes a recommended practice that is not required. “May” denotes an option.

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 recognize the need to seek and obtain appropriate expert advice (e.g., technical, legal, safety) or consult appropriate reference materials required to ensure the safety of DOE 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 DOE practices.

Headquarters and field elements shall establish a program and process to ensure that DOE personnel possess the competencies required by their position, including the competencies identified in this technical FAQS. Documentation of the completion of the requirements of this standard shall be included in the employees’ training and qualification records. Satisfactory attainment of the competency requirements contained in this technical FAQS may be documented using the example Mechanical Systems FAQS qualification card that can be

obtained from the Federal Technical Capability Program Directives and Standards page at http://www.hss.energy.gov/deprep/ftcp/directives/directives.asp.

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 on objective evidence of previous education, training, certification, or experience. Objective evidence includes a combination of transcripts, certifications, and in some cases, a knowledge sampling obtained through written and/or oral examinations. Equivalencies shall be granted in accordance with the TQP plan of the site/office/Headquarters organization qualifying the individual. The supporting knowledge and/or skill statements and mandatory performance activities should be considered before granting an equivalency for a competency.

Training shall be provided to employees in the TQP who do not meet the competencies contained in the technical FAQS. 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 on appropriate supporting knowledge and/or skill statements similar to the ones listed for each of the competency requirements. Headquarters and field elements should use the supporting knowledge and/or skill statements as a basis for evaluating the content of any training used to provide individuals with the requisite knowledge and/or skill required to meet the technical FAQS competency requirements.

EVALUATION REQUIREMENTS

Attainment of the competencies listed in this technical FAQS shall be documented in accordance with the TQP plan or policy of the site/office/Headquarters organization qualifying the individual and the requirements in DOE M 360.1-1B, *Federal Employee Training Manual*, and DOE M 426.1-1A.

The qualifying official or immediate supervisor should ensure that the candidate meets the background and experience requirements of this FAQS. Unless stated otherwise within the program or site TQP plan, attainment of the competencies listed in the Mechanical Systems FAQS should be evaluated and documented by either a qualifying official or immediate supervisor (note: if the immediate supervisor is not qualified in the Mechanical Systems FAQS, it is expected the supervisor will consult with an individual who is qualified in the Mechanical Systems FAQS), using a combination of the following methods:

- Satisfactory completion of a written examination
- Satisfactory completion of an oral examination
- Satisfactory accomplishment of an observed task or activity directly related to a competency
- Documented evaluation of equivalencies (such as applicable experience in the field) without a written examination

Field element managers/Headquarters program managers shall qualify candidates as possessing the basic technical knowledge, technical discipline competency, and position-specific knowledge, skills, and abilities required for their positions. Final qualification should be performed using one or a combination of the following methods:

- Satisfactory completion of a comprehensive written examination. The minimum passing grade should be 80 percent.
- Satisfactory completion of an oral examination by a qualified Senior Technical Safety Manager (STSM) or a qualification board of technically qualified personnel that includes at least one qualified STSM.
- Satisfactory completion of a walkthrough of a facility with a qualifying official for the purpose of verifying a candidate's knowledge and practical skills of selected key elements.

Guidance for oral interviews and written exams is contained in DOE-HDBK-1205-97, *Guide to Good Practices for the Design, Development, and Implementation of Examinations*, and DOE-HDBK-1080-97, *Guide to Good Practices for Oral Examinations*.

For oral examinations and walkthroughs, qualifying officials or board members should ask critical questions intended to integrate identified learning objectives during qualification. Field element managers/Headquarters program managers or designees should develop formal guidance for oral examinations and walkthroughs that includes:

- Standards for qualification
- Use of technical advisors by a board
- Questioning procedures or protocol
- Pass/fail criteria
- Board deliberation and voting authorization procedures
- Documentation process

INITIAL QUALIFICATION AND TRAINING

Qualification of mechanical systems personnel shall be conducted in accordance with the requirements of DOE M 426.1-1A.

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:

- DOE
- 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 activities and the requirements for the continuing education and training program for the Mechanical Systems FAQS 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 mechanical systems functional area:

A. Assess the management and technical oversight of design, construction, repair processes, modification processes, and decontamination/decommissioning associated with the mechanical systems functional area.

B. Assess the effectiveness of contracting mechanisms (cost-plus-award-fee, cost-plus-fixed-fee, etc.) and contractor performance evaluations.

C. Serve as a subject matter expert and technical resource for the training of mechanical systems personnel and for other technical matters.

D. Evaluate DOE facility and program-related mechanical systems for safe and efficient operation, maintenance, and testing, including emergency systems.

E. Participate in establishing and/or reviewing DOE Orders regarding the practices and requirements related to mechanical systems.

F. Evaluate contractor compliance with relevant DOE Orders, standards, codes, contractor operating procedures, etc.

G. Critically analyze system design-basis documentation and related safety documentation to ensure application of the principle of safety in design as described in DOE M 413.3-1, *Project Management for the Acquisition of Capital Assets*.

H. Verify the application of quality assurance, configuration management, and safety requirements to mechanical systems.

Position-specific duties and responsibilities for mechanical systems personnel are contained in their office-/site-/facility-specific qualification standard and/or position description.

BACKGROUND AND EXPERIENCE

The OPM *Qualification Standards Operating Manual* 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 mechanical systems personnel are:

1. Education:

   Bachelor of science degree in mechanical engineering from an accredited institution or meet the alternative requirements specified in the *Qualification Standards Operating Manual* for the GS-0800, Professional Engineering Series.

2. Experience:

   Industry, facility, operations, or other related experience that has provided a background in mechanical engineering and/or a Professional Engineer license. 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 (GTB) Qualification Standard. All mechanical systems personnel must satisfy the competency requirements of the GTB Qualification Standard prior to or in parallel with the competency requirements contained in this standard. Each of the competency requirements defines the level of expected knowledge and/or skill that an individual must possess to meet the intent of this standard. Each of the competency statements is further described by a listing of supporting knowledge and/or skill statements that describe the intent of the competency statements. In selected competencies, expected knowledge and/or skills have been designated as “mandatory performance activities.” In these competencies, the actions are not optional.

Note: When regulations, DOE directives, or other industry standards are referenced in the FAQS, the most recent revision should be used. It is recognized that some mechanical systems personnel may oversee facilities that utilize predecessor documents to those identified. In those cases, such documents should be included in local qualification standards via the TQP.

General Technical

1. Mechanical systems personnel shall demonstrate a working level knowledge of steady-state heat transfer.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1012/2-92, *Thermodynamics, Heat Transfer, and Fluid Flow* (vol. 2 of 3)

a. Define the following terms:

- Conduction
- Convection
- Radiation
- Thermal conductivity
- Convectivity
- Emissivity

b. Discuss Fourier's law.

c. Describe the factors that contribute to the coefficient of thermal conductivity.

Mandatory Performance Activities:

a. Calculate the heat flux for one-dimensional, steady-state heat transfer through the following types of walls:

- Composite
- Series
- Parallel

b. Given data, calculate total heat transfer and local heat flux in a laminar flow system.

c. Given data, calculate the log mean temperature difference for heat exchangers.

2. Mechanical systems personnel shall demonstrate a working level knowledge of thermodynamics.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1012/1-92, *Thermodynamics, Heat Transfer, and Fluid Flow* (vol. 1 of 3)

a. Define the following terms:

- Compression
- Isothermic
- Isentropic
- Adiabatic

b. Discuss entropy and enthalpy as they relate to mechanical systems.

c. Given a Mollier diagram, read and interpret it.

d. Define and discuss the following cycles:

- Carnot
- Rankine
- Vapor-refrigeration
- Otto
- Gas standard

Mandatory Performance Activities:

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

- Entropy change
- Enthalpy change
- Pressure
- Temperature

3. Mechanical systems personnel shall demonstrate a working level knowledge of fluid mechanics.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1012/3-92, *Thermodynamics, Heat Transfer, and Fluid Flow* (vol. 3 of 3)

a. Define the following:

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

b. Describe the bulk modulus of elasticity and compressibility.

c. Describe the effects characterized by Pascal's law of fluid pressure.

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

e. Discuss the Reynold's number, including how it is used.

f. Discuss pressurized and non-pressurized flow.

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

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

i. Discuss the Darcy-Weisbach equation.

4. Mechanical systems personnel shall demonstrate a working level knowledge of the concepts, theories, and principles of basic material science.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1017/1-93, *Material Science* (vol. 1 of 2)

a. State the five types of bonding that occur in materials and the characteristics of those bonds.

b. Compare and contrast the properties, characteristics, and applications of stainless steel and those of carbon steel.

c. Discuss the process of general corrosion of iron and steel when they are exposed to water.

d. Discuss the conditions that can cause galvanic corrosion.

e. Discuss the following types of specialized corrosion:

- Pitting corrosion
- Stress corrosion cracking
- Crevice corrosion
- Fretting corrosion

f. Explain the ion exchange process.

g. Discuss the following terms:

- Compressibility
- Shear stress
- Tensile stress
- Compressive stress
- Strain
- Proportional limit
- Plastic deformation
- Permanent deformation

h. Given the stress-strain curves for ductile and brittle material, identify the following points on the curves:

- Proportional limit
- Ultimate strength
- Yield point
- Fracture point

i. Discuss the following terms:

- Strength
- Malleability
- Ductility
- Toughness
- Yield strength
- Hardness
- Ultimate tensile strength

j. Describe the adverse effects of welding on metal, including the types of stress.

k. Discuss the phenomenon of thermal shock.

l. Discuss the following terms, including their relationship to material failure:

- Ductile fracture
- Brittle fracture
- Nil-ductility transition (NDT) temperature

m. Explain fatigue failure and work hardening with respect to material failure.

n. Discuss the effects of radiation on the structural integrity of metals.

o. Discuss the need for fracture mechanics and the use of associated mathematical relations.

5. Mechanical systems personnel shall demonstrate a working level knowledge concerning the selection of appropriate components and materials in support of a mechanical system design or modification.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1017/1-93, *Material Science* (vol. 1 of 2)

a. Differentiate between nuclear-grade and non-nuclear-grade materials.

b. Discuss how the following material properties affect performance in different applications:

- Corrosion resistance
- Weight
- Erosion resistance
- Strength
- Cost
- Reactivity
- Composition/alloy
- Ductility
- Brittleness
- Weldability
- Machinability

c. Identify and discuss the various methods of verifying the properties of selected materials, including:

- Brinell hardness test
- Rockwell hardness test
- V-notch test
- Drop-weight test
- Tension test
- Fatigue test
- Creep test
- Corrosion test
- Crack propagation testing

d. Discuss the importance of traceability in nuclear system components.

6. Mechanical systems personnel shall demonstrate a working level knowledge of mechanical diagrams, including:

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

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1016/1-93, *Engineering Symbology, Prints, and Drawings* (vol. 1 of 2)

a. Identify the symbols used in P&IDs for the following types of items:

- Valves
- Valve operators
- Eductors and ejectors
- Basic instrumentation
- Signal controllers and modifiers
- System components (pumps, etc.)
- Lines

b. Identify the symbols used in P&IDs to denote the location of instruments, indicators, and controllers.

c. Identify how valve positions are depicted.

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

e. Discuss the origin and purpose of as-built drawings.

Mandatory Performance Activities:

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

7. Mechanical systems personnel shall demonstrate a working level knowledge of installed mechanical equipment.

Supporting Knowledge and/or Skills:

Suggested Reference Material: Applicable manufacturers' manuals and local safety basis documents

a. Discuss the function, required maintenance, and surveillance requirements (technical safety requirement [TSR] or good practice) for each type of component listed below.

Mandatory Performance Activities:

a. Given an as-built P&ID for a facility's fluid system, identify and physically locate in the facility the following components:

- Root valves
- Flow control valves
- Pumps
- Pump motors
- Speed increasers/decreasers
- Steam traps
- Filters
- Sumps
- Surge tanks
- Reservoirs
- Air compressors
- Air dryers
- Pneumatic valve operators
- Electric valve operators
- Hydraulic (if applicable) valve operators
- Basic types of instrumentation (pressure, differential pressure, temperature, flow)
- Supply lines
- Return lines
- Supply fans
- Exhaust fans
- Filter plenums
- Pressure differential gauges
- Dampers
- Air pre-heaters
- Air cooling coils

8. Mechanical systems personnel shall demonstrate a working level knowledge of a typical diesel generator, including support systems.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1018/1-93, *Mechanical Science* (vol. 1 of 2), applicable manufacturers' manuals, and local safety basis documents

a. Differentiate between two-stroke and four-stroke (two-cycle and four-cycle) engines.

b. Discuss the ignition principle of a diesel engine.

c. Discuss the purpose and principle of operation of a diesel engine injector.

d. Discuss the purpose of the following diesel engine support systems:

- Cooling water
- Lubrication
- Fuel oil
- Scavenging air
- Starting systems

e. Discuss the function, required maintenance, and surveillance requirements (TSR or good practice) for each of the following components:

- Diesel engine
- Electrical generator
- Fuel tank
- Day tank (if applicable)
- Starting system (air or battery)
- Fuel transfer pump(s)

Mandatory Performance Activities:

a. Given an as-built P&ID for a facility's diesel generator system, identify and physically locate in the facility the above components.

9. Mechanical systems personnel shall demonstrate a working level knowledge of the construction and operation of heat exchangers.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1012/2-92, *Thermodynamics, Heat Transfer, and Fluid Flow* (vol. 2 of 3); DOE-HDBK-1018/2-93, *Mechanical Science* (vol. 2 of 2).

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
- Telltale drain
- Parallel flow
- Counterflow
- Cross-flow

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

d. Explain the principle of operation of a natural convection` (parabolic) cooling tower.

Mandatory Performance Activities:

a. Given 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
- Counterflow
- Cross-flow

10. Mechanical systems personnel shall demonstrate a working level knowledge of the theory and operation of heating, ventilation, and air conditioning (HVAC) systems.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1018/2-93, *Mechanical Science* (vol. 2 of 2)

a. Define the following terms as they apply to HVAC systems:

- Latent heat of vaporization
- Latent heat of fusion
- Refrigerant
- Vaporization point
- Air and noncondensable gases

b. Discuss the function of the following components of a typical HVAC system:

- Blower
- Fan
- Damper
- Chiller
- Filter
- Heat exchanger
- Scrubber
- Hood
- Pressure sensor
- Differential pressure indicator
- Compressor
- Condenser
- Thermal expansion valve
- Evaporator coils
- Receiver

c. Discuss refrigerant leak detection.

d. Discuss the general hazards involved in handling refrigerants.

e. Compare and contrast the design, operation, and application of axial-flow and radial-flow fans.

f. Discuss the relationships among the following in ventilation systems:

- Supply ventilation
- Flow
- Exhaust ventilation

g. Describe the purpose of the ventilation system in the following applications:

- Hoods
- Gloveboxes
- Hot cells
- Confinement systems

h. Identify and discuss the circumstances under which maintaining a negative ventilation system pressure is desirable.

Mandatory Performance Activities:

a. Given a diagram of a basic HVAC system, discuss the theory of operation of HVAC systems and identify the system's components and their functions.

11. Mechanical systems personnel shall demonstrate working level knowledge of general piping systems.

Supporting Knowledge and/or Skills:

Suggested Reference Material: American Society of Mechanical Engineers, ASME B31.3, *Process Piping*; DOE-HDBK-1012/3-92, *Thermodynamics, Heat Transfer, and Fluid Flow* (vol. 3 of 3); John J. McKetta, Jr., *Piping Design Handbook*; Michael Frankel, *Facility Piping Systems Handbook*

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 associated with water hammer and how personnel and equipment may be affected.

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. Describe the principle of operation for the various methods of measuring piping system parameters (e.g., pressure, temperature, flow), including the following:

- Resistance temperature detector
- Differential pressure detector

- Pitot tube
- Thermocouple
- Bourdon tube pressure gauge
- Duplex pressure gauge
- Manometer
- Mechanical flowmeters
- Orifice flowmeters

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

g. Discuss the purpose and types of freeze protection measures used in piping systems.

12. Mechanical systems personnel shall demonstrate a working level knowledge of the general construction, operation, and theory of valves.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1018/2-93, *Mechanical Science* (vol. 2 of 2)

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

- Disc
- Seat/backseat
- Throttle
- Actuator
- Bonnet
- Packing

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

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

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

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

- Manual
- Electric
- Solenoid
- Pneumatic
- Hydraulic

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

Mandatory Performance Activities:

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

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

b. Given a diagram of a globe valve, identify how the valve must be oriented related to flow.

13. Mechanical systems personnel shall demonstrate a working level knowledge of safety and relief devices.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1018/2-93, *Mechanical Science* (vol. 2 of 2)

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. Discuss the methods used to test relief valves.

e. Discuss the application of rupture discs.

Mandatory Performance Activities:

a. Given a cutaway drawing of a safety valve, identify the main components, including the following:

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

14. Mechanical systems personnel shall demonstrate a working level knowledge of pump theory and operation.

Supporting Knowledge and/or Skills:

Suggested Reference: DOE-HDBK-1018/1-93, *Mechanical Science* (vol. 1 of 2)

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. Discuss Bernoulli's law as it applies to the design and operation of centrifugal pumps.

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

- Reciprocating
- Rotary-screw
- Vane-axial

g. State the dangers to personnel and equipment associated with starting a positive displacement pump against a shut-off head.

h. Discuss the importance and methods of providing over-pressurization protection for positive displacement pumps.

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

Mandatory Performance Activities:

a. Given 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)

b. For each of the following system and/or pumped medium characteristics, identify the type of pump (e.g., centrifugal, reciprocating positive displacement, rotary-screw positive displacement) that is best suited for the application:

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

15. Mechanical systems personnel shall demonstrate a working level knowledge of strainers and filters.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1018/2-93, *Mechanical Science* (vol. 2 of 2); DOE-STD-3020-2005, *Specification for HEPA Filters Used by DOE Contractors*; DOE-HDBK-1169-2003, *Nuclear Air Cleaning Handbook*

a. Compare and contrast the design, operating characteristics, and applications of filters and strainers.

b. Describe the following types of strainers and filters, including an example of typical use for each:

- Electrostatic filters
- Cartridge filters
- Precoated filters
- Bucket strainers
- Deep-bed strainers
- High Efficiency Particulate Air (HEPA) filters
- Duplex strainers

c. Discuss the principal application of high efficiency particulate filters and the general content of DOE-STD-3020-2005 and DOE-HDBK-1169-2003.

d. Identify and describe the hazards associated with high efficiency particulate filters, including any fire safety concerns.

16. Mechanical systems personnel shall demonstrate a working level knowledge of the basic components, operations, and theory of hydraulic systems.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1018/2-93, *Mechanical Science* (vol. 2 of 2)

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.

17. Mechanical systems personnel shall demonstrate a working level knowledge of the components, operation, and theory of pneumatic systems.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1018/2-93, *Mechanical Science* (vol. 2 of 2)

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.

g. State the purpose of an air compressor unloader and discuss its basic operation.

h. Compare and contrast the principle of operation for centrifugal and reciprocating compressors.

18. Mechanical systems personnel shall demonstrate a working level knowledge of the basic design, construction, and operation of glovebox systems.

Supporting Knowledge and/or Skills:

Suggested Reference Material: American Glovebox Society, AGS-G001-1998, *Guideline for Gloveboxes,* second edition; AGS-G006-2005, *Standard of Practice for the Design and Fabrication of Nuclear Application Gloveboxes*

a. Explain the general functions of a glovebox and when glovebox use is appropriate.

b. Describe the design considerations of a glovebox, including shielding, criticality safety, seismic requirements, decontamination and decommissioning, materials, reinforcement, gloves and gloveports, filters, atmosphere, instrumentation, and testing.

c. Describe the operation of gloveboxes.

d. Describe the maintenance, including routine surveillances that may be applicable to gloveboxes.

19. Mechanical system personnel shall demonstrate a working level knowledge of the principles of lubrication.

Supporting Knowledge and/or Skills:

Suggested Reference Material: A. R. Lansdown, *Lubrication and Lubricant Selection*, third edition

a. Define the following terms as related to lubricants:

- Viscosity
- National Lubricating Grease Institute grease grades

b. Identify and discuss various types of lubricants and concerns regarding their potential corrosion of components and systems, including the following:

- Oil
- Water
- Solids/powders
- Gaseous
- Grease

c. Discuss the importance of viscosity.

d. Discuss the hazards to equipment associated with mixing different types of oils and greases.

e. Discuss the use and importance of filters and filtration in lubricating systems.

f. Discuss the principle of operation of moisture separators.

Mandatory Performance Activities:

a. Given vendor data about a component, determine the proper class of lubricant for the component.

20. Mechanical systems personnel shall demonstrate a familiarity level knowledge of reading and interpreting electrical diagrams and schematics.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1016/1-93, *Engineering Symbology, Prints, and Drawings* (vol. 1 of 2)

a. Identify the symbols and/or codes used on engineering electrical drawings.

b. Given a simple one-line diagram and initial conditions, identify the power sources and/or loads and their status.

c. Given an electronic block diagram, print, or schematic, identify the basic component symbols.

d. Given a relay ladder, explain the logic ties.

21. Mechanical systems personnel shall demonstrate a familiarity level knowledge of reading and interpreting electrical logic diagrams.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-HDBK-1016/2-93, *Engineering Symbology, Prints, and Drawings* (vol. 2 of 2)

a. Identify the symbols used on logic diagrams to represent the components.

b. Identify the symbols used to denote a logical “1” (or high) and a logical “0” (or low) as used in logic diagrams.

c. Given a basic logic diagram and appropriate information, determine the output of each component and the logic circuit.

Regulatory

22. Mechanical systems personnel shall demonstrate a working level knowledge of the requirements of DOE O 420.1B, *Facility Safety*, and the associated guidance of DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety;* and DOE G 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Nonnuclear Facilities*.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE O 420.1B, *Facility Safety*; DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety;* DOE G 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Nonnuclear Facilities*

a. Discuss the general requirements of chapter I, “Nuclear and Explosives Safety Design Criteria,” of DOE O 420.1B.

b. Discuss the general requirements of chapter II, “Fire Protection,” of DOE O 420.1B.

c. Discuss the general requirements of chapter IV, “Natural Phenomena Hazards Mitigation,” of DOE O 420.1B.

d. Discuss the scope and general content of DOE G 420.1-1 and DOE G 420.1-2.

23. Mechanical systems personnel shall demonstrate a working level knowledge of safety in design as described and required in DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets,* DOE M 413.3-1, *Project Management for the Acquisition of Capital Assets* and DOE-STD-1189-2008, *Integration of Safety into the Design Process.*

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets;* DOE M 413.3-1, *Project Management for the Acquisition of Capital Assets*; DOE-STD-1189-2008, *Integration of Safety into the Design Process.*

a. Discuss the mechanical system reviewer’s responsibilities at each critical decision point as described in DOE O 413.3A.

b. Discuss the mechanical systems reviewer’s responsibilities as stated in DOE M 413.3-1.

c. Discuss the mechanical systems reviewer’s responsibilities as a member of the Integrated Project Team as stated in DOE-STD-1189-2008.

24. Mechanical systems personnel shall demonstrate a working level knowledge of the following standards related to natural phenomena hazards:

- **ASCE/SEI 43-05, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities***
- **DOE-STD-1020-2002, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities***
- **DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components***
- **DOE-STD-1022-94, Natural *Phenomena Hazards Site Characterization Criteria***

Supporting Knowledge and/or Skills:

Suggested Reference Material: ASCE/SEI 43-05, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities;* DOE-STD-1020-2002, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities;* DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components;* DOE-STD-1022-94, *Natural Phenomena Hazards Site Characterization Criteria*

a. Discuss the purpose and scope and the application of the provisions detailed in the listed standards.

b. Briefly describe the levels of function required for mechanical systems following a natural phenomena hazard and the safety measures and design features commonly used as

safeguards against natural hazards. Include HVAC systems, fluid systems, and diesel generator systems in the discussion.

c. Identify which systems require emergency power to remain functional following loss of normal power.

25. Mechanical systems personnel shall demonstrate a working level knowledge of DOE maintenance management requirements as defined in DOE O 433.1A, *Maintenance Management Program for DOE Nuclear Facilities*.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE O 433.1A, *Maintenance Management Program for DOE Nuclear Facilities*

a. Explain DOE's role in the oversight of contractor maintenance operations.

b. Identify the key elements of a contractor maintenance plan required by DOE O 433.1A.

c. Describe configuration control and its relationship to the maintenance work control process and the maintenance history file.

d. Describe the mechanisms for feedback of relevant information, such as trend analysis and instrumentation performance/reliability data, to identify necessary program modifications.

e. Discuss the importance of post-maintenance testing and the elements of an effective post-maintenance testing program.

26. Mechanical systems personnel shall demonstrate a working level knowledge of DOE standard DOE-STD-1073-2003, *Configuration Management*.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE-STD-1073-2003, *Configuration Management*

a. Describe the purpose and objectives of configuration management, emphasizing the following elements:

- Design control
- Work control
- Change control
- Document control
- Assessment

b. Discuss the site-specific process for dispositioning work and change packages.

Mandatory Performance Activities:

Given a randomly selected mechanical system, perform the following:

a. Verify adequate and comprehensive documentation exists for the system design and safety bases (e.g., technical specifications, documented safety analysis, safety evaluation report, TSRs, etc.).

b. Perform a walkdown of the system to confirm the accuracy of system drawings (P&ID/flow diagrams).

c. Review the system maintenance history.

d. Confirm that configuration management was maintained and documentation reflects any modifications.

e. Verify the adequacy of the system to perform through the full spectrum of operations, including initial system testing, required surveillance testing, and post-maintenance testing.

f. Confirm knowledgeable and qualified technical personnel (system engineers, operators, and maintenance personnel) are monitoring, operating, and maintaining the system properly.

27. Mechanical systems personnel shall demonstrate a familiarity level knowledge of the codes and standards of the American Society of Testing and Materials (ASTM).

Supporting Knowledge and/or Skills:

a. Discuss the general scope and subject matter range of the various ASTM codes and standards, noting those that provide relevant guidance to activities conducted at DOE defense nuclear facilities.

b. Describe the hierarchy of the mechanical system rules, codes, Orders, and standards at defense nuclear facilities and explain where ASTM standards fall within that hierarchy.

c. Discuss the difference(s) between ASME material specifications and ASTM material specifications.

d. Discuss the responsibilities of DOE as owner of facilities as defined by the standards.

28. Mechanical systems personnel shall demonstrate a working level knowledge of the codes and standards of the American Society of Mechanical Engineers.

Supporting Knowledge and/or Skills:

Suggested Reference Material: ASME Boiler and Pressure Vessel Code

a. Discuss the scope and subject matter of the 12 sections of the ASME Boiler and Pressure Vessel (B&PV) Code, noting relevance of the various sections to activities conducted at DOE defense nuclear facilities.

b. Discuss the ASME power piping and valve construction codes, noting the relevance of using these piping codes rather than parallel portions of the B&PV code.

c. Discuss the applicability of other ASME codes to defense nuclear facilities, including codes for cranes and hoists, fasteners, storage tanks, and compressors.

d. Discuss the responsibilities of DOE as owner of facilities as defined by the standards.

29. Mechanical systems personnel shall demonstrate a familiarity level knowledge of the following organizations' non-mechanical systems-specific codes and standards:

- **American Petroleum Institute**
- **American National Standards Institute (ANSI)**
- **American Nuclear Society**
- **American Institute of Steel Construction**
- **National Fire Protection Agency (NFPA)**

Supporting Knowledge and/or Skills:

a. Discuss the scope and subject matter of the listed organizations' various codes, noting relevance to activities conducted at DOE defense nuclear facilities.

b. Discuss the responsibilities of DOE as the owner of facilities as defined in the standards.

30. Mechanical systems personnel shall demonstrate a familiarity level knowledge of the codes and standards of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

Supporting Knowledge and/or Skills:

a. Discuss the general scope and subject matter range of the various ASHRAE codes and standards, noting those that provide relevant guidance to activities conducted at DOE defense nuclear facilities.

b. Discuss the responsibilities of DOE as owner of facilities as defined by the standards.

31. Mechanical system personnel shall demonstrate a working level knowledge of the quality control inspection techniques described in sections V and XI of the ASME Boiler and Pressure Vessel Code and the verification of mechanical system integrity, including:

- **Ultrasonic test (UT)**
- **Visual inspection (VI)**
- **Magnetic particle test (MT)**
- **Dye-penetrant test (PT)**
- **Radiographic test (RT)**
- **Hydrostatic test (HT)**
- **Load test (LT)**

Supporting Knowledge and/or Skills:

Suggested Reference Material: ASME Boiler and Pressure Vessel Code

a. Describe the test methodology for each of the listed test and inspection techniques, including the expected degree of accuracy.

b. Discuss the advantages and disadvantages of each of the listed test and inspection techniques.

c. Identify and describe the usual application for each of the listed test and inspection techniques.

d. For each of the listed test and inspection techniques, identify and discuss the safety considerations and precautions that must be observed.

e. Identify the special hazards that are associated with radiographic testing and discuss how they are mitigated.

f. Identify the special qualifications needed by technicians performing each of the listed test and inspection techniques and discuss how those qualifications are achieved.

Mandatory Performance Activities:

a. Given system specifications, including a system diagram, determine the key information for a hydrostatic test on that system.

b. Given a work package, determine the appropriate tests needed to ensure proper installation of the mechanical system.

c. Given component information, describe the load tests required prior to lifting that component.

Management, Assessment, and Oversight

32. Mechanical systems personnel shall demonstrate a working level knowledge of problem analysis principles and the ability to apply techniques necessary to identify problems, determine potential causes of problems, and identify corrective actions.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE G 231.1-2, *Occurrence Reporting Causal Analysis Guide*

a. Describe and explain the application of problem analysis techniques, including the following:

- Root cause analysis
- Causal factor analysis
- Change analysis
- Barrier analysis
- Management oversight risk tree (MORT) analysis

b. Describe and explain the application of the following root cause analysis processes in the performance of occurrence investigations:

- Event and causal factors charting

- Root cause coding
- Recommendation generation

Mandatory Performance Activities:

a. Given event and/or occurrence data, apply problem analysis techniques and identify the problems and how they could have been avoided.

b. Participate in at least one contractor or DOE problem analysis and critique the results.

c. Given data, interpret a fault tree analysis.

33. Mechanical systems personnel shall demonstrate a working level knowledge of assessment techniques (such as the planning and use of observations, interviews, and document reviews) to assess facility performance and contractor design and construction activities, report results, and follow up on actions taken as the result of assessments.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE G 414.1-1B, *Management and Independent Assessments Guide*

a. Describe the role of mechanical system personnel in the oversight of government-owned, contractor-operated facilities.

b. Describe the assessment requirements and limitations associated with mechanical system personnel's interface with contractor employees.

c. Explain the essential elements of a performance-based assessment, including the areas of investigation, fact-finding, and reporting.

d. Explain the essential elements of a performance-based assessment, including investigation, fact-finding, and reporting. Include a discussion of the essential elements and processes of the following assessment activities:

- Exit interviews
- Closure process
- Tracking to closure
- Follow-up
- Contractor corrective action implementation

e. Describe the actions to be taken if a contractor challenges assessment findings and explain how such challenges can be avoided.

f. Discuss the graded approach process that DOE line management uses to determine an appropriate level of coverage by mechanical system personnel. Include in this discussion the factors that may influence the level of coverage.

Mandatory Performance Activities:

a. Participate in at least two performance-based assessments as a team member.

b. Participate in at least one performance-based assessment as a team leader.

Other

34. Mechanical systems personnel shall demonstrate a working level knowledge of the safety and health fundamentals of mechanical systems and/or components.

Supporting Knowledge and/or Skills:

Suggested Reference Material: 29 CFR 1910, "Occupational Safety and Health Standards"

a. Discuss the hazards associated with the use of corrosives (acids and alkalies).

b. Describe the general safety precautions required for the handling, storage, and disposal of corrosives.

c. Discuss the general safety precautions regarding toxic compounds.

d. Describe the criteria used to determine if a compound is a health hazard and discuss the ways toxic compounds may enter the body.

e. Discuss the general safety precautions regarding the use, handling, and storage of compressed gases, including hydrogen, oxygen, and nitrogen.

f. Explain the difference between a flammable material and a combustible material.

g. Describe the general safety precautions regarding the use, handling, and storage of flammable and combustible materials.

h. Identify and discuss the elements of a mechanical system-related safety program, including the following:

- Protective equipment
- Lockout and tagout
- Stored energy
- Component labeling

35. Mechanical systems personnel shall demonstrate a working level knowledge of the following engineering design principles:

- **Value engineering**
- **Systems engineering**
- **Life-cycle cost**
- **Reliability**
- **Availability**
- **Maintainability**
- **Human factors**

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE P 413.2, *Value Engineering*; DOE O 420.1B, *Facility Safety*; DOE G 430.1-1, *Chapter 23: Life-Cycle Cost Estimate*; DOE G 433.1-1, *Nuclear*

Facility Maintenance Management Program Guide for Use with DOE O 433.1; and DOE-HDBK-1140-2001, *Human Factors/Ergonomics Handbook for the Design for Ease of Maintenance*.

a. Define the following terms:

- Value engineering
- Systems engineering
- Life-cycle cost
- Reliability
- Availability
- Maintainability
- Human factors

b. Describe how the principles of value engineering can be applied to mechanical system projects.

c. Explain how life-cycle costs are determined for a mechanical system and how those costs can be used.

d. Explain systems engineering principles and benefits.

e. Describe why reliability, availability, and maintainability must be considered in mechanical system design.

f. Discuss, in general terms, DOE-HDBK-1140-2001, *Human Factors/Ergonomics Handbook for the Design for Ease of Maintenance*.

36. Mechanical systems personnel shall demonstrate a working level knowledge of maintenance management practices related to mechanical systems.

Supporting Knowledge and/or Skills:

Suggested Reference Material: DOE O 433.1A, *Maintenance Management Program for DOE Nuclear Facilities;* DOE G 433.1-1, *Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1*

a. Define each of the following maintenance-related terms and explain its relationship to the others:

- Corrective
- Planned
- Preventive
- Reliability centered
- Predictive

b. Describe the elements of an effective work control program and the documentation used to control maintenance.

c. Discuss the importance of maintaining a proper balance of preventive and corrective maintenance.

d. Define the term “life-limiting component” and discuss its impact on facility operation.

e. Identify typical maintenance performance indicators and discuss their importance.

f. Discuss how maintenance is related to conduct of operations, quality assurance, and configuration management.

g. Discuss the purpose of reliability, availability, maintainability, and inspectability (RAMI) analyses in the establishment of maintenance requirements.

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APPENDIX A
CONTINUING EDUCATION, TRAINING, AND PROFICIENCY PROGRAM

The following list represents suggested continuing education, training, and other opportunities that are available for DOE personnel after completion of the competency requirements in this technical FAQS. It is extremely important that personnel involved with this program maintain their proficiency primarily by regularly demonstrating their competency through on-the-job performance, supplemented with continuing education, training, reading, or other activities, such as workshops, seminars, and conferences. The list of suggested activities was developed by the subject matter experts involved in the development of the FAQS and is not all-inclusive.

Based on the knowledge and experience of the subject matter experts, it is suggested that the following activities support the maintenance of proficiency in the Mechanical Systems Functional Area after completion of the competencies in the standard and other requirements of the TQP.

LIST OF CONTINUING EDUCATION, TRAINING, AND OTHER ACTIVITIES

1. Complete continuing technical education and/or training covering topics directly related to the mechanical systems area as determined appropriate by management. This may include courses/training provided by DOE, other government agencies, outside vendors, or local educational institutions, as well as courses leading to Master's or PhD degrees. Continuing training topics should also address identified weaknesses in the knowledge or skills of the individual personnel.

2. Actively perform the duties of mechanical systems specialist at a DOE facility a minimum of 800 hours per year.

3. Attend seminars, symposia, or technical meetings related to mechanical systems.

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

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

6. Document specific continuing training requirements in an individual development plan (IDP).

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CONCLUDING MATERIAL

Review Activity:
EM
NNSA
NE
SC

Preparing Activity:
DOE-NNSA-PXSO

Project Number:
TRNG-0059

Field and Operations Offices:
CBFO
CH
ID
OH
ORP
RFFO
RL
SR

Site Offices:
Argonne Site Office
Brookhaven Site Office
Fermi Site Office
Kansas City Site Office
Livermore Site Office
Los Alamos Site Office
Nevada Site Office
Pantex Site Office
Savannah River Site Office
Sandia Site Office
Y-12 Site Office