
Guidance for the Quality Assurance of Fire Protection Systems

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PURPOSE

This quality assurance document is intended to provide guidance for the DOE fire protection community in the continuing effort to ensure the reliability of fire protection systems. This guidance document applies the concepts of DOE Order 5700.6C, *Quality Assurance*, to the management of fire protection systems. The recommendations of this document are intended to supplement the management of a fire protection systems program, the requirements of incorporated standards, and manufacturers' recommendations.

SCOPE

This guidance recommends procedures and practices to implement while designing, maintaining, and ensuring the proper operability of fire protection systems at DOE sponsored facilities. The guidance can serve as a basis for a new quality assurance program or the improvement of an existing one. Fire protection systems under the purview of this document include automatic water extinguishing systems, manual water extinguishing systems, special extinguishing systems, water supply systems, and fire detection and alarm systems.

DOE Order 5700.6C, Quality Assurance

DOE Order 5700.6C, *Quality Assurance*, establishes quality assurance requirements for the DOE. The Order introduces DOE quality assurance policy, defines related terms, establishes DOE objectives, and outlines quality assurance criteria. The accompanying implementation guidance incorporates ten quality assurance criteria which are grouped into three functional categories:

Management

1. Program
2. Personnel Training and Qualification
3. Quality Improvement
4. Documents and Records

Performance

5. Work Processes
6. Design
7. Procurement
8. Inspection and Acceptance Testing

Assessment

9. Management Assessment
10. Independent Assessment

The guidance provided with DOE 5700.6C, *Quality Assurance*, states " that all work is a process that can be planned, performed, assessed, and improved" and "these quality assurance criteria reflect a comprehensive way of doing business throughout the life cycle of DOE programs and

projects." These criteria have been adapted for the management of fire protection systems programs in this document.

RISK ANALYSIS

DOE Order 5480.7A, **Fire Protection**, incorporates the National Fire Protection Association's (NFPA) **National Fire Codes** as the minimum requirements for ensuring the reliability of fire protection systems. A quality assurance program should ensure fire protection systems are designed, accepted, inspected, tested, and maintained in accordance with NFPA requirements.

Where fire protection systems protect high risk hazards requiring minimum requirements to be exceeded, a Quality Assurance Plan should be applied to the management of a fire protection systems commensurate with the consequences of systems failure and complexity of the fire protection systems.

QUALITY ASSURANCE OF FIRE PROTECTION SYSTEMS

I. Establishment of a Quality Assurance Plan

Management should develop and issue a written quality assurance policy to establish a quality assurance plan (QAP). Acting on the policy, the Fire Protection Manager¹ should develop a quality assurance plan specifically for fire protection systems or incorporate fire protection systems into a facility-wide quality assurance program.

- a. Responsibilities. The fire protection system QAP should assign responsibilities to the Fire Protection Manager, Fire Protection², and individuals such as engineers, specialists, and technicians.
 - 1) The Fire Protection Manager is responsible for implementing and maintaining the QAP, defining QAP responsibilities, and translating the responsibilities into daily activities.
 - 2) Fire Protection is responsible for achieving and maintaining the quality of fire protection systems.
 - 3) Individuals are responsible for achieving their assigned objectives.
- b. Definitions. The QAP should define:

¹Fire Protection Manager generically refers to the individual responsible for planning, directing, and leading a facility's fire protection systems program and the subordinate personnel assigned to it.

² Fire Protection generically refers to any individual or group which comprise an organizational unit responsible for developing, implementing, and maintaining a fire protection systems program at a facility.

- 1) Facility-specific QA and fire protection terminology.
- 2) Fire Protection organizational structure.
- 3) Functional responsibilities of Fire Protection related to fire protection systems.
- 4) How Fire Protection interfaces with other organizational units.

II. Qualifications and Training

All personnel involved in fire protection systems-related tasks should be qualified to perform assigned work.

a. Engineering Tasks

- 1) An individual performing engineering tasks should possess one of the credentials recommended by the DOE "Model" Fire Protection Program, Section 2.D.
- 2) Individuals possessing a Bachelor Degree or Associate Degree, within the discipline they are assigned; equivalent technical work experience; or, a combination of education and experience approved by management or the Fire Protection Manager are qualified to perform engineering tasks.

b. Inspection, Testing, and Maintenance Activities

Individuals performing tasks associated with the inspection, testing, and maintenance of fire protection systems should possess the minimum credentials:

- 1) Meet the Field Inspection qualifications of NFPA 1031, **Professional Qualifications for Fire Inspector**, 3-3.6, 4-3.5, and 5-3.4.
- 2) Possess a working knowledge of the tools, instruments, equipment, procedures, NFPA standards, and safe working practices associated with the task assigned to them.
- 3) Demonstrate a competency to perform associated tasks based on a combination of principles and education approved by management or the Fire Protection Manager.

c. Training Plans. A training plan should be established to develop, maintain, and improve the proficiency of personnel who perform fire protection systems activities. An effective training plan includes the following concepts:

- 1) Training plans are designed to accommodate individuals assigned to every shift. Organized, on-the-job training is acceptable for inclusion in the training plan.
- 2) Training accommodates the personnel's work schedules.
- 3) Training is provided to individuals where new systems,

- procedures, or processes are introduced to the facility.
- 4) Training is provided to individuals who need to maintain certifications associated with fire protection systems activities.
 - 5) Fire Protection is given the opportunity to recommend relevant training curricula.
- d. Job-Instruction-Training. Job-Instruction Training (JIT) is used for training new employees, introducing new skills to existing employees, and providing refresher training utilizing a mentor-type relationship.

This type of training allows the trainer to provide instruction about fire protection systems and related activities under realistic conditions while at the same time accomplishing an assigned task. Most fire protection systems are not identical when the hazards protected, design, and configuration are considered. JIT allows a trainer who is already familiar with the different fire protection systems to teach a trainee what is unique about particular systems at a facility. Effective JIT includes:

- 1) Training Schedule. A training schedule for the trainee is established with expected milestones. Detailed records of progress on specific skills or tasks are kept.
- 2) Selection of Trainer. Trainers are chosen based on experience and interpersonal dynamics. An individual assigned as a mentor is able to demonstrate a thorough knowledge of the task and possess the necessary skills to serve as a trainer. The trainer is capable of fostering a one-on-one relationship with the trainee.
- 3) Preparation. The trainer makes the trainee feel comfortable and assesses the trainee's current level of knowledge and skills. The trainer also provides proper safety equipment and explain the hazards related to the task.
- 4) Presentation. The trainer demonstrates the task step by step allowing the trainee to observe them. The trainer stresses principles, key points, and emphasizes safety precautions.
- 5) Performance. The trainee performs the task under the close supervision of the trainer. The trainee explains each step of the task to demonstrate his/her understanding. The trainer observes weaknesses and reinforces proper practice by coaching the trainee. The trainer constantly evaluates the trainee. When the trainee is able to safely and proficiently perform the task, the trainer will authorize the trainee to perform that task.
- 6) Follow-up. The trainer follows-up on the trainee at a later date to ensure continued proficiency and improvement in

completing the task.³

- e. Review. The qualifications and training system should be reviewed at least annually by the Fire Protection Manager to evaluate the effectiveness of training. The review should consider:
 - 1) The progress of individuals, as well as Fire Protection, to ensure training schedules and objectives are being satisfied.
 - 2) The effectiveness of the training plan and JIT program.
 - 3) Future training needs.
- f. The results of the review can be communicated to upper management in the annual Fire Protection Summary Report.

III. Quality Improvement

While implementing a QAP, management should delegate the responsibility of performing tasks, providing services, and developing products that meet or exceed quality requirements to individual employees. This assumes that management and the individual understand the concept that the individual performing the task is an expert at that task. Quality improvement efforts should concentrate on the individual-task interface. Management should, therefore, delegate authority to the individual to allow him/her to ensure service and product requirements are being met.

- a. Quality Improvement Principles
 - 1) Management portrays a "no fault" attitude. This attitude emphasizes the importance of correcting problems and deficiencies at their respective sources instead of assessing blame.
 - 2) Personnel have the authority to suggest improvements, identify problems, and recommend corrective actions.
 - 3) The root cause of quality problems are analyzed, documented, and later trended among a large population of root causes. Studying the root causes over time is essential for determining the reliability of fire protection systems. Eliminating problems at their source also increases the likelihood of reducing the variance of quality.
- b. Personnel Performance Reviews. Performance reviews of Fire Protection personnel should include an evaluation of the individual's contribution to the quality assurance program. This is the medium for holding individuals accountable for the quality of their own work.

³*Accident Prevention Manual for Business and Industry*, 10th ed., National Safety Council, Itasca, Illinois, 1992.

- c. Fire Protection Meetings. The Fire Protection staff should meet regularly to identify, evaluate, and monitor the status of the quality and performance of fire protection systems. This function can be accomplished as part of a larger problem-solving group. Recommended quality improvement activities are listed below:
- 1) Evaluate methods and procedures.
 - 2) Conduct self-assessments.
 - 3) Review risk analyses and other related documents.
 - 4) Review training and work activity systems.
 - 5) Analyze performance data.
 - 6) Review the status of corrective actions.
 - 7) Design reviews.
 - 8) Procurement analyses/needs assessment.

IV. Documents and Records

- a. Records should document the life cycle of the fire protection systems at an appropriate level of detail. Documentation related to the life cycle includes but is not limited to system justification, code compliance, policies, procedures, safety analyses, drawings, calculations, computer files, vendor receipts and proposals, and inspection, testing, and maintenance results.
- b. Review Process. All documents related to fire protection systems which will become part of the permanent record or will be distributed to sources beyond Fire Protection should be reviewed. An effective review process incorporates the following concepts:
- 1) Documents are reviewed by someone other than the originator who is technically competent in the subject area being reviewed.
 - 2) The review is documented.
 - 3) The document is approved by the Fire Protection Manager prior to use.
- c. Document Control. Documents should be controlled when they are determined to be technically complex or organizationally sensitive.
- 1) Management or the Fire Protection Manager determines the complexity or sensitivity of a document.
 - 2) Procedures outlining the preparation, review, approval, issuance, and revision of controlled documents are developed.

- 3) Controlled documents are distributed to only those individuals who would be affected by the scope of the document.
 - 4) Individuals initial a document control form to verify their receipt and review of controlled documents. The document control form is stored for the life cycle of that document.
 - 5) Approved revisions to controlled documents are distributed to all personnel listed on the document control form.
- d. Records Management. The Fire Protection Manager should document the life cycle of fire protection systems. Effective documentation includes the following concepts:
- 1) A records management system is established to store fire protection system documentation in a central location.
 - 2) Drawings and specifications are stored in a controlled and central location.

V. Fire Protection Systems-Related Activities

Fire protection systems-related activities include but are not limited to work processes such as inspection, testing, maintenance, acceptance testing, calibration, and self-assessment.

- a. Individuals should be qualified and trained to successfully complete the work activities they are assigned.
- b. Written Procedures. Written procedures for fire protection systems-related activities should be developed and implemented for every activity and work process. Nationally accepted good practices can be recognized. Effective procedures include the following concepts:
 - 1) Procedures are prepared by individuals who possess a thorough knowledge of the specific fire protection systems, the hazard(s) the systems protect, and the associated risks.
 - 2) Procedures incorporate the requirements and/or guidance of NFPA standards or recommended practices, the DOE "Model" Fire Protection Program, insurers, and manufacturers.
 - 3) Organizations affected by the procedure have the opportunity to review the procedures, changes to procedures, or revisions and provide structured feedback.
 - 4) Written procedures are verified for accuracy, usability, and safety by a qualified individual other than the individual who wrote the procedure.
 - 5) Fire Protection approves the draft procedure after structured

- feedback has been incorporated.
- 6) The Fire Protection Manager implements the procedure into practice with an effective date after the affected personnel have been trained in the use of the new procedure.
 - 7) Written procedures are distributed to each individual of Fire Protection who has a responsibility in the procedure. In addition, a manual of all written procedures are centrally located and maintained for reference.
 - 8) Management clearly communicates the responsibility of each individual for ensuring the quality of their work while following established procedures.
- c. Identification and Control of Tangible Items. A method to account for tangible items related to work activities should be developed and implemented. Tangible items can include but are not limited to consumables, tools, measuring equipment, and other materials needed to complete a procedure. An effective method includes the following concepts:
- 1) The marking or labeling items to identify that they belong to Fire Protection. Items that cannot be physically scarred are tagged.
 - 2) The identification of a tangible item is maintained from the time of initial receipt, or fabrication, up to and including installation or end use.
 - 3) Records documenting the service life of the item.
 - 4) Hazardous items are controlled in accordance with organizational and regulatory requirements including provisions for the decontamination of items.
- d. The Fire Protection Manager should identify applicable procedures when he/she assign activities.
- e. The Fire Protection Manager should develop and implement a work activity planning system. An effective work activity planning system incorporates the following concepts:
- 1) Prioritizes activities such that those involving fire protection systems which protect the greatest risks are given the highest priority for completion. (See Section 8.5 for impairments).
 - 2) Re-evaluates the prioritization of work activities as each new request for a work activity is introduced into the system.
- f. A work activity completion report should be prepared upon the accomplishment of an activity. Multiple activities of the same

nature should be compiled in one report. An effective report documents:

- 1) Date the activity was assigned.
 - 2) Date the activity was completed.
 - 3) Basis for activity.
 - 4) Task performed/corrective action applied.
 - f) Degree of success.
- g. Completion reports should be maintained in a central location.

VI. Design

A written design process should be developed and implemented for the design of fire protection systems. An effective design process includes:

- a. Documentation. Each step of the design process is documented.
- b. Design Input. During the planning phase of a fire protection system design project, all input necessary for the design is identified. Design input includes but is not limited to design basis, reliability requirements, performance objectives, permits, codes, and standards.
- c. Fire protection system designers employ state-of-the-art equipment that has been tested by a nationally recognized testing laboratory for its intended use.
- d. Conceptual Designs. Conceptual designs for new fire protection systems and modifications to existing fire protection systems are reviewed by qualified personnel familiar with the facility where the system will be installed to ensure proposed designs will sufficiently protect hazards.
- e. Design input is correctly translated into the design output. The individual or group ensuring that the design basis and technical requirements are correctly represented in the design output (such as specifications, drawings, procedures, and instructions) are different from the individual or group responsible for the input, where possible.
- f. Design Transfer. The transfer of designs between Fire Protection and groups within the organization, as well as other organizations is controlled. Effective transfer procedures include:
 - 1) A method of feedback to ensure designs were received.
 - 2) Opening a channel of communication for further design input.

- 3) Documenting the transfer of designs between parties.
 - 4) Responsibilities for the individual providing the interface is defined.
- g. Design Verification. Design inputs, processes, calculations, changes, and design outputs should be verified.
- 1) The verification process ensures the design is reliable, able to be constructed, operable, and able to be maintained.
 - 2) Qualified individuals or groups conduct the design verification.
 - 3) The individual or group verifying the design are different than the individual or group that prepared the design.
 - 4) The rigor of verification can be based on risk, complexity, and uniqueness of design.
 - 5) A tracking system for comments related to the design are developed and implemented to ensure all comments are recorded and reviewed.
 - 6) Computer programs such as models and calculating tools are validated.
- h. Design Modifications. Changes or modifications to design outputs should be justified, reviewed, and approved by the Fire Protection Manager. Modifications should also be documented.
- i. Configuration Management. A process for managing the configuration of fire protection systems should be developed and implemented to ensure the systems and their components conform to documented design. An effective process includes the following:
- 1) Evaluation. An evaluation process identifies and examines fire protection systems, components, and documents through periodic assessments. The evaluation process measures the effectiveness of modification and document control.
 - 2) Design Basis. The design basis is updated when approved modifications are made.
 - 3) Modification Control. Modifications to fire protection systems are correctly identified, evaluated, designed, verified, and implemented. Fire protection system modifications are documented throughout the life cycle of the system.
 - 4) Document Control. All documents that record the life cycle of the fire protection systems are maintained and stored in a central location. Individuals or groups outside of Fire Protection are prohibited from removing documents from the central location.

VII. Procurement

Procurement Control. A procurement control system should be developed and implemented to ensure purchased items such as system components and service meet established requirements and perform as expected.

- a. Identify Needs. The reason for procurement of a new fire protection system or the replacement, modification, or repair of an existing system is documented. An evaluation of safety factors such as hazards and associated risks are discussed to justify the procurement.
- b. Acceptance Criteria. Applicable technical and administrative requirements are documented. These include but are not limited to codes, standards, regulations, tests, inspections, insurers' recommendations, and other quality requirements.
- c. Suitability. The procurement is reviewed by an individual other than the individual who developed the documentation. The justification and suitability of the item are examined.
- d. Evaluate Suppliers. Potential suppliers are evaluated for the reliability of their product or service and ensure they are qualified to provide the item. An evaluation of reliability includes analyzing a suppliers past performance, receipt inspection process, frequency of use, established product trends, complexity of procurement, and justification of quality through documentation.
- e. Method of Acceptance. Procurement documentation defines the method of verification that will be used to ensure the delivered product or service complies to the acceptance criteria. The documentation will also identify who will perform the verification and what method will be used to document the acceptance of the product or service.
- f. Inspection. Fire protection systems should be inspected and tested after they are installed, replaced, or repaired. Operability is verified before the fire protection system is placed into service.
- g. Performance Evaluation. Fire protection systems performance is evaluated regularly after being placed in service. Routine inspection and testing at frequencies defined by the NFPA standard related to the type of system is required.
- h. Information regarding the delivery of intentionally substandard quality products or services must be forwarded to the DOE Office of the Inspector General.

VIII. Inspection, Testing, and Maintenance

Fire protection systems should be maintained in an operable condition as outlined in respective NFPA standards and the DOE "Model" Fire Protection Program.

- a. Written procedures for inspection, testing, maintenance and operations, should be developed and utilized.
- b. The frequency of activities will be determined by the NFPA standard, the NFPA recommended practice, manufacturer's recommendation, or insurer's requirement related to the type of fire protection system.
- c. Inspection, testing, and maintenance activities should be planned under the work activity system.
- d. Where possible, equipment used during inspections, tests, and maintenance activities should be properly calibrated.
 - 1) Equipment is calibrated at regular intervals and before and after use utilizing nationally recognized calibration methods.
 - 2) Equipment that cannot be successfully calibrated is tagged and removed from service.
 - 3) Calibration records are maintained and stored in a central location.
- e. Impairments to fire protection systems should be reported immediately to the Fire Protection Manager and documented.
- f. Impairments should be given greatest priority when ranking work activities. When multiple impairments exist, they should be prioritized using the scheme recommended by the DOE "Model" Fire Protection Program:
 - 1) First Priority. Assigned to an impairment that creates an imminent hazard to employees, property, or the potential for an environmental release in excess of allowed limits. First priority impairments are considered an emergency.
 - 2) Second Priority. Assigned to an impairment that reduces the protection to employees, property, or the environment, but is not an imminent hazard.
 - 3) Third Priority. Assigned to an impairment that must be corrected, but does not directly reduce the protection to employees, property, or the environment.
- g. The results of fire protection system inspections and tests should be documented and stored. System performance, including trends, should be summarized in the facility's annual Fire Protection Summary Report.
- h. Failures of fire protection systems or their components should be documented.

- i. A root cause evaluation of the failure should be conducted and the root cause documented. This evaluation determines which component or feature of the system failed, how it failed, why it failed, and the action required.

An effective root cause evaluation includes:

- 1) Confirmation of the failure.
- 2) Confirmation of the failure mode.
- 3) Confirmation of the failure mechanism.
- 4) Identification of the root cause.
- 5) Correction of the root cause by eliminating it.
- 6) Confirmation of the effectiveness of the corrective action.⁴

- j. Root causes should be analyzed for trends.

- k. A corrective action tracking system should be developed and implemented as recommended by the DOE "Model" Fire Protection Program. An effective corrective action tracking system includes:

- 1) A narrative of the finding including how the corrective action was identified.
- 2) Structure/building affected.
- 3) Date of the finding.
- 4) Name of the individual who conducted the inspection or test.
- 5) Name of the person responsible for the corrective action.
- 6) Corrective action due date.
- 7). Interim compensatory measures required.
- 8). Priority level of the finding.
- 9) Closure date.

- l. Corrective actions should be introduced to the work activity planning system.

- m. Acceptance testing should be conducted to demonstrate that fire protection systems are capable of performing as they were designed.

⁴*Handbook for Nuclear Power Plant Self-Assessment Programs*, Electric Power Research Institute, Palo Alto, California, 1991.

- n. Written and approved acceptance testing procedures should be followed.
- o. Acceptance testing justification, criteria, and procedures should be in accordance with the NFPA standard related to the type of fire protection system.
- p. Acceptance testing should be conducted after a deficiency is corrected or the configuration of a fire protection system changed.
- q. The results of acceptance tests should be documented and stored in a central location.

IX. Self-Assessment

Assessments shall be conducted by the Assistant Secretary for Environment, Safety, and Health, Program Secretarial Officers, Operations Offices, and contractors at intervals prescribed in DOE Order 5480.7A, **Fire Protection**. The Order also defines the scope of the fire protection program evaluation, which includes fire protection systems. Self-assessment is a continuous process and a management tool used to monitor the effectiveness and quality of implemented programs. Self-assessment is performed in addition to the external assessments prescribed by DOE Order 5480.7A.

- a. A comprehensive self-assessment of the management of fire protection systems should be performed at least annually by the Fire Protection Manager.
- b. On-going self-assessment activities for fire protection systems should be identified by the Fire Protection Manager. Self-assessment activities should also be incorporated into the work activity planning system. Self-assessment activities may include but are not limited to:
 - 1) Annual Summary Assessment Report
 - 2) Review and analysis of incidents involving fire protection systems.
 - 3) Technical evaluation of fire protection system functional performance and reliability.
 - 4) Surveillance of fire protection system operability and degradation.
 - 5) Review of written procedures.
 - 6) Design review of modifications.
 - 7) Examination of fire protection system documentation.
 - 8) Review of administrative systems.

- 9) Quality improvement meetings.