

**THE ENGINEER AND THE TECHNICIAN:
DESIGNING FIRE PROTECTION SYSTEMS**

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Executive Summary

In this document, The Society of Fire Protection Engineers (SFPE) describes reasonable and prudent roles and responsibilities of engineers and technicians when designing fire protection systems.

SFPE recognizes that defining fire protection system design and layout in terms of the roles and responsibilities of engineers and technicians is a sensitive undertaking. Each has capabilities and responsibilities that contribute to the relationships in a design project. This revised White Paper describes the critical relationships from the perspective of the engineering community. Engineers or technicians overstep their roles if they participate in aspects of designs for which they are not qualified by education, training, or knowledge. This revised White Paper explains the relative roles of those who contribute to public safety, including engineers and technicians.

SFPE welcomes input from organizations interested in clarifying or revising laws and regulations and from other organizations, individuals, and companies with common concerns.

Evolution of Licensing and Certification

During the 1970s and early 1980s in the interest of public safety, state and local governments adopted and enforced record numbers of building and fire codes that mandated automatic fire sprinkler systems. The need for personnel qualified in system design and layout grew accordingly.

At that time, the principal, nationally recognized, qualification criteria for technicians, technologists, and engineers in this profession were found in the membership requirements of SFPE. In the United States, no nationally recognized programs existed for licensing and certifying those who designed or laid out fire protection systems.

Beginning in the 1980's, several professional organizations contributed significantly to the process of establishing roles and responsibilities of engineers and technicians in fire safety.

SFPE and the National Council of Examiners for Engineering and Surveying (NCEES) work together to support fire protection engineering as a recognized professional engineering discipline.

- SFPE has defined and established qualifications for professional engineers in terms of the minimum education, training, and experience necessary for a fire protection engineer.
- NCEES, an independent federation of state engineering licensing officials, works closely with SFPE to maintain a national, professional engineer licensure program for fire protection engineers.

The National Society of Professional Engineers (NSPE) through its National Institute for Certification in Engineering Technologies (NICET) offers a program for certifying fire protection technicians.

Licensing and certification alone are insufficient to assure quality; thus professional organizations have developed codes of ethics and professional responsibility. See Appendix A: Code of Ethics/Professional Responsibility.

Describing the Project Team Members & Their Tasks

The Project Team

Throughout this document, references to the Engineer and the Technician are intended to convey the following:

The Engineer

The fire protection Engineer is any licensed engineer who is qualified by education, training, and experience to undertake a given role and its responsibilities. Such roles could include designing an overall fire protection system or specifying building construction, exit and egress means, or mechanical systems.

The Engineer is qualified to:

- Consider the broad range of hazards and protection schemes required to develop a workable, integrated solution to a fire safety problem. A specific fire protection system is only part of the solution.
- Develop design concepts for fire protection systems.
- Develop performance criteria upon which contractors base their bids, which includes not only determining applicable codes and standards but also preparing:
 - Conceptual or detailed engineering documents
 - Hazard analyses
 - Performance-based options
 - Future project considerations
- Lay out automatic sprinkler, fire alarm, and special hazard systems for which he/she has the education and experience.
- Lay out fire protection systems, affixing his/her seal or stamp only to documents prepared under his/her direct supervision and control.

The Engineer takes steps to assume or insure the financial responsibilities of his/her work, and to maintain competency through continued education as required by the licensing of the state in which he/she is licensed, or equivalent.

The Technician

The fire protection Technician is an individual who has achieved NICET Level III or IV certification [1] and who has the knowledge and skills necessary to lay out fire protection systems.

Based on engineering contract documents, which include the system(s) design drawings and nationally recognized codes and standards¹, the Technician is qualified to:

- Perform the basic layout of these systems, in accordance with the Engineer's design concepts.
- Prepare shop drawings in accordance with the Engineer's design concepts.
- Provide financial responsibility to the customer and comply with continued educational requirements of NICET.

See also Appendix B: Table of Comparisons.

The Authority Having Jurisdiction (AHJ)

The Authority Having Jurisdiction, also commonly referred to in the fire protection community as the AHJ, is the individual or agency that has responsibility for reviewing and accepting the design provided. The AHJ may be one or more of the following:

- Municipal Permitting Organization
- Fire Prevention Officer of the Fire Department
- Insurance Company
- Governmental Organization
- Code Official
- University Fire Marshal

It is understood that an AHJ will not review or approve shop drawings for systems for which the AHJ is not qualified by training, education and experience.

¹ Such as those published by the National Fire Protection Association, or the model building codes (BOCA – Building Officials and Code Administrators; ICBO – International Council of Building Officials; SBCCI – Southern Building Code Congress International; and ICC - International Code Council

Tasks

Throughout this document, references to The Design Concept and to Layout and Shop Drawing Development are intended to convey the following:

The Design Concept

The Engineer develops the conceptual ideas and limitations of the system. For example:

- Sprinkler system: The density and water flow and pressure requirements for the sprinkler system design, classification of the commodities to be protected, and confirmation of the hydraulic data and preliminary hydraulic design.
- Alarm system: Appropriate building system interfaces, effect of construction on system design, selection of devices and systems, device location and spacing, control panel location, and preliminary riser diagrams.

Layout and Shop Drawing Development

The Engineer or the Technician develops the layout of the system, based upon the design concept. For example:

- Sprinkler system: The layout of risers, cross mains, branch lines, sprinkler heads, sizing of pipe, hanger locations and hydraulic calculations in accordance with the design concepts.
- Alarm system: The location of input and output devices; preparing riser diagram details; battery calculations.

Fundamental Objective of Fire Protection Engineering

The application of recent and rapidly evolving fire protection technology to the design of buildings or facilities continues with the advent of performance-based design and a growing use of design-build construction.

The fire protection engineering profession must accommodate a changing environment while maintaining our fundamental objective: *applying scientific and engineering principles to protect people and the environment from destructive fire.*

Roles for Assuring Public Safety

For fire protection engineering design, the roles and responsibilities of the Engineer and the Technician are considered reasonable and prudent in the following relationships (listed in order of preference).

Preferable

- The Engineer executes the design concept for fire protection systems.
- The Technician or Engineer executes the layout and shop drawings.
- An engineer reviews the shop drawings. Note – this review does not necessitate approval and sealing of the shop drawings with a P.E. stamp. See sample review stamp in Appendix C.
- The AHJ approves the shop drawings and the acceptance test results. The owner should note that the role of the AHJ is generally limited to minimum code compliance, and the AHJ will not assume the Engineer's responsibilities for Design Concepts.
- An engineer provides construction period services, which include witnessing final acceptance tests.

Acceptable

- The engineer executes the Design Concept.
- The Technician or Engineer executes the layout and the shop drawings.
- The Engineer or AHJ reviews the shop drawings.

- The AHJ approves the shop drawings.
- The owner's representative or an engineer provides construction period services, including witnessing final acceptance tests.

For Limited Projects Only

Note: A limited project may be defined

- *By legislation, regulation, or philosophy of the AHJ.*
- *As pre-engineered projects.*
- *As minor modifications to existing facilities.*

- The Technician executes the design concept, the layout, and the shop drawings.
- An engineer or AHJ reviews the shop drawings.
- The AHJ approves the shop drawings.

Recommended Scope of Work

The legitimate scope of work for the Technician is a subset of the legitimate scope of work for which the Engineer can take full responsibility.

Working with Technicians

At his/her discretion, the Engineer can take full responsibility for the work of the Technician, provided the work of the Technician is under the direct control and supervision of the Engineer. However, the Engineer can also provide review for compliance with the design concept where layout and shop drawing development is not under the supervision of the Engineer.

Meeting the Owner's Needs

To ensure that a contractor proposes and installs a fire protection system that functions according to the owner's needs, the Engineer should provide one or more of the following:

- Clear performance criteria for the fire protection system
- Complete design concepts
- Design of the interface with other building features, such as a smoke management system

Responsibility of Owners/Agents/Operators

Ultimately, the building or facility owner, or his agent or operator, is responsible for the design, construction, and operation of a functional and safe facility. To meet this goal, the owner engages various professionals—e.g., attorneys, accountants, architects, engineers, who work in the owner's best interests. The project team may also include technicians or paraprofessionals to contribute to completion of the task.

The owner and professionals understand the functional needs of the facility; potential future changes; and acceptable levels of reliability, risk, and cost, all of which are not necessarily covered in the minimum requirements of codes.

Example of Specifications from Owner/Agent/Operator

The owner/agent/operator should specify system performance and reliability criteria through engineers or others qualified in such matters. For example, the owner of a proposed warehouse should specify:

- The types of commodities to be stored long term in the facility
- The minimum required design density and area of coverage
- The level of valve and water flow supervision
- The redundancy of water supplies
- The water flow test data
- The interconnection of alarm and control systems with other building systems

These criteria help to assure that:

- The owner purchases systems which meet his/her functional goals.
- All contractors are bidding on the same basic system.
- Contractors do not propose varying levels of performance.

Broad specifications, such as, "design (or compliance) with NFPA 13," or "design (or compliance) with NFPA 72," are inadequate.

Other Influences on Design Criteria

State and local building and fire codes assign building officials and fire officials with responsibility for assuring that the owner's structure meets the minimum requirements of codes. These minimum code requirements may or may not mean that the structure meets the owner's requirements or the Engineer's design concept. Code officials often limit the scope of their own efforts and responsibilities to verifying compliance with code requirements and do not consider additional design criteria provided by the Engineer or other agencies. Often, insurance factors influence design criteria.

Roles and Responsibilities of Others

Usually, the owner hires a professional team of architects/engineers to prepare plans and specifications for implementation by contractors and the trades. Design-build projects should include such team members to provide for the public safety.

Contractors prepare bids based on criteria prepared by the architects/engineers or issued by the owner, prepare shop drawings, and install systems.

Elements of the Technician's Typical Working Arrangement

Among the key elements of a typical working arrangement for the Technician are the following:

- The Technician works for a hardware systems contractor and, as such, represents the contractor.
- Neither the contractor nor the Technician is an agent of the owner.
- The Engineer is usually a consultant to the owner. For this reason, SFPE encourages governmental or approval agencies to adopt requirements for the Engineer for all projects and in accordance with certain threshold requirements. (*See For Limited Projects Only.*) In some cases, the contractor may employ an engineer on staff to perform the duties and responsibilities of the Engineer as described above.

Checks and Balances

When the Technician is not directly supervised by the Engineer while carrying out the actual layout of a fire protection system, the interests of public safety require instituting a system of checks and balances. Checks and balances may include having the Engineer review the layout and the Shop Drawing against the contract documents and the Design Concepts.

In many locations, the local AHJ is the sole reviewer of contractor-prepared plans. (See *Other Influences on Design Criteria* above.) Where the local AHJ has neither the Engineer's nor the Technician's level of training and education, the AHJ should choose a suitably qualified reviewer.

The local AHJ plays an important role in the checks and balances necessary to protect the public. The AHJ and the Engineer must work together as part of the design-delivery process when a technician of the contractor or the Engineer performs the layout.

In such cases, the Engineer should *either*:

- Review the shop drawings to ensure that they conform to project specifications and applicable codes and standards.
- Apply a shop-drawing stamp (see Appendix C for example) to the fire protection documents prior to a final review by the AHJ and the start of construction.

or:

- The qualified AHJ should review the shop drawings.

In either case, the AHJ should also ensure that the plans:

- Meet building code requirements.
- Are followed at the project site (sometimes using an engineer to provide construction period services, including witnessing final acceptance tests).

Appendix A: Code of Ethics/Professional Responsibility

Typically, codes of ethics and professional responsibility are developed within professional organizations to serve as guideposts for professional performance and conduct.

Code of The Engineer

The Engineer subscribes to a code of ethics required from a regulatory viewpoint and designated by a state board of registration.

NSPE publishes a model code of professional ethics, commonly followed by state boards of registration.[2] The following are several excerpts from that *Code of Ethics for Engineers* applicable to this document:

“Engineers, in the fulfillment of their duties, shall perform services only in their areas of competence

“Engineers shall at all times recognize that their primary obligation is to protect the safety, health, property and welfare of the public

“Engineers shall undertake assignments only when qualified by education or experience in the specific technical fields involved

“Engineers shall not affix their signatures to any plans or documents dealing with subject matter in which they lack competence, nor to any plan or document not prepared under their direction and control

“Engineers shall assign a professional engineer duties of a nature to utilize full training and experience, in so far as possible, and delegate lesser functions to sub-professionals or to technicians”

The Code of Ethics for Engineers and state registration laws permit the Engineer:

- To practice in any area for which he/she is qualified by education or experience.
- To establish -- at his/her discretion -- the scope of work within which he/she practices on a day-to-day basis.

Safeguards lie within the state registration laws. State registration boards investigate complaints that The Engineer is believed to be practicing outside the scope of his/her competency.

Licensure of The Engineer

State registration boards license the Engineer. NCEES typically prepares the licensing examinations. State boards of registration authorize, and may require, the Engineer to seal and stamp his/her work.

Stamps and Seals

State boards of registration do authorize, and may require, stamps and seals. According to regulations, the Engineer should:

- Affix his/her stamp to plans, reports, and specifications for which he/she is taking responsibility.
- Sign or seal only those documents for fire protection systems which were actually prepared under the direct supervision and control of the Engineer as required by regulations.

Working with Codes and Standards

In the field of fire protection engineering, as in other fields such as electrical, codes and standards recommend and require statutory design and installation of fire protection systems. These documents represent a body of engineering knowledge and are not expected to meet the individual needs of every project. As deviations from recognized standards or conditions occur regularly, the Engineer should be a member of the design team—particularly in the case of design-build projects—for all but small and simple fire protection designs.

The Engineer designs fire protection systems only if he/she is specifically qualified to do so by education or experience.

A fire protection system, such as an automatic sprinkler system, is often only part of a solution; therefore, the Engineer usually

- Resolves the overall condition with such solutions as fire suppression and detection systems, smoke control systems, exit systems, compartmentation, and performance-based criteria.
- Evaluates the underground water sources.
- Analyzes — or requests a structural engineer to analyze — the load-bearing capacity of structural systems supporting automatic fire sprinkler systems.

Professional Code of Certified Technicians

While technicians are not commonly required by law to subscribe to a code of ethics for professional behavior, NICET has published a code for revoking a certificate if violation of that code is proven.[1]

The Code of Responsibility for NICET Certified Engineering Technicians and Technologists [1] closely parallels, in a highly condensed form, the NSPE *Code of Ethics for Engineers*. Excerpts from NICET's Code follow:

“Certificants should undertake only those assignments for which they are competent by way of their education, training and experience

“Certificants should discharge their duties to their employer or client in an efficient and competent manner with complete fidelity and honesty

“Certificants should not receive, either directly or indirectly, any gratuity, commission or other financial benefit in connection with any work which they are performing unless such benefit has been authorized by their employer or client”

Stamps and Seals

NICET does not authorize seals or stamps for technicians. Drawings, layouts, and other documents prepared in accordance with approved designs/standards may bear the signature, date and NICET certification number of the Technician taking responsibility for the work.

Working with Codes and Standards

Although the technician does not design engineering systems, he/she does implement those codes and standards for which he/she is certified.

Example: For the Technician, the certification examination for automatic sprinkler systems refers to many pertinent NFPA Codes and Standards. The Technician's responsibility involves layout (head spacing, pipe lengths and sizes, etc.) and may include conducting routine, water-flow tests.

Licensed Contractors

State governments license contractors. In recent years, some states have amended their contractor licensing laws to require involving the Technician in the layout of fire protection systems. Commonly and appropriately for the layout of fire protection systems, these state laws require that the licensed contractor engage at least one Level III (works under minimal supervision) engineering technician.

Requirements vary among contractor licensing laws, however, from a particular NICET certification-- such as Automatic Sprinkler System Layout at Level III -- to license requirements in which specific NICET certification is just one part.

Appendix B: Table of Comparisons

Expectations of The NICET Technician	Expectations of The Engineer
<p>Knowledge and skills equivalent to that required to obtain an Associates Degree in Engineering Technology</p>	<p>Minimum of Bachelors Degree in Engineering and Licensing or equivalent</p>
<p>Substantial knowledge of how to layout automatic sprinkler, fire alarm and detection, or special hazards systems in strict compliance with published standards such as those of NFPA.</p> <p>An appreciation of fire and engineering sciences.</p> <p>Knowledge of installation practices.</p>	<p>Knowledge in college-level physics and chemistry, engineering mathematics through calculus and differential equations, thermodynamics, strength of materials, statics, dynamics and related areas.</p> <p>Working understanding of the physical behavior of fluids, mechanical systems, fire combustion and fire chemistry.</p> <p>Working knowledge of the normal fire protection system design and layout standards such as those published by the National Fire Protection Association.</p> <p>Ability to read and understand, and knowledge of existing and emerging engineering theories and technical concepts (such as those published in technical literature). Knowledge of interface or inter-relationship with building design and systems such as HVAC and BAS.</p>
<p>Conducting hydrant flow tests</p>	<p>Developing basis of design concepts, such as: Interpreting fire flow tests Defining combustible load or class Ensuring technically sound computer modeling of fire spread, smoke development or exiting.</p>

References

1. *Engineering Technician and Technology Certification Programs*. 10th Edition. National Institute for Certification in Engineering Technologies. April, 1995.
2. *Code of Ethics for Engineers*. National Society of Professional Engineers. Revised January, 1987.
3. *Installation of Sprinkler Systems*. NFPA 13. National Fire Protection Association.
4. *National Fire Alarm Code*. NFPA 72. National Fire Protection Association.