

(2) The employer shall assure that drainage of water spray systems is directed away from areas where employees are working and that no emergency egress is permitted through the drainage path.

[45 FR 60712, Sept. 12, 1980]

OTHER FIRE PROTECTION SYSTEMS

**§ 1910.164 Fire detection systems.**

(a) *Scope and application.* This section applies to all automatic fire detection systems installed to meet the requirements of a particular OSHA standard.

(b) *Installation and restoration.* (1) The employer shall assure that all devices and equipment constructed and installed to comply with this standard are approved for the purpose for which they are intended.

(2) The employer shall restore all fire detection systems and components to normal operating condition as promptly as possible after each test or alarm. Spare detection devices and components which are normally destroyed in the process of detecting fires shall be available on the premises or from a local supplier in sufficient quantities and locations for prompt restoration of the system.

(c) *Maintenance and testing.* (1) The employer shall maintain all systems in an operable condition except during repairs or maintenance.

(2) The employer shall assure that fire detectors and fire detection systems are tested and adjusted as often as needed to maintain proper reliability and operating condition except that factory calibrated detectors need not be adjusted after installation.

(3) The employer shall assure that pneumatic and hydraulic operated detection systems installed after January 1, 1981, are equipped with supervised systems.

(4) The employer shall assure that the servicing, maintenance and testing of fire detection systems, including cleaning and necessary sensitivity adjustments are performed by a trained person knowledgeable in the operations and functions of the system.

(5) The employer shall also assure that fire detectors that need to be cleaned of dirt, dust, or other particulates in order to be fully operational

are cleaned at regular periodic intervals.

(d) *Protection of fire detectors.* (1) The employer shall assure that fire detection equipment installed outdoors or in the presence of corrosive atmospheres be protected from corrosion. The employer shall provide a canopy, hood, or other suitable protection for detection equipment requiring protection from the weather.

(2) The employer shall locate or otherwise protect detection equipment so that it is protected from mechanical or physical impact which might render it inoperable.

(3) The employer shall assure that detectors are supported independently of their attachment to wires or tubing.

(e) *Response time.* (1) The employer shall assure that fire detection systems installed for the purpose of actuating fire extinguishment or suppression systems shall be designed to operate in time to control or extinguish a fire.

(2) The employer shall assure that fire detection systems installed for the purpose of employee alarm and evacuation be designed and installed to provide a warning for emergency action and safe escape of employees.

(3) The employer shall not delay alarms or devices initiated by fire detector actuation for more than 30 seconds unless such delay is necessary for the immediate safety of employees. When such delay is necessary, it shall be addressed in an emergency action plan meeting the requirements of § 1910.38.

(f) *Number, location and spacing of detecting devices.* The employer shall assure that the number, spacing and location of fire detectors is based upon design data obtained from field experience, or tests, engineering surveys, the manufacturer's recommendations, or a recognized testing laboratory listing.

[45 FR 60713, Sept. 12, 1980]

**§ 1910.165 Employee alarm systems.**

(a) *Scope and application.* (1) This section applies to all emergency employee alarms installed to meet a particular OSHA standard. This section does not apply to those discharge or supervisory alarms required on various fixed extinguishing systems or to supervisory alarms on fire suppression, alarm or

detection systems unless they are intended to be employee alarm systems.

(2) The requirements in this section that pertain to maintenance, testing and inspection shall apply to all local fire alarm signaling systems used for alerting employees regardless of the other functions of the system.

(3) All pre-discharge employee alarms installed to meet a particular OSHA standard shall meet the requirements of paragraphs (b)(1) through (4), (c), and (d)(1) of this section.

(b) *General requirements.* (1) The employee alarm system shall provide warning for necessary emergency action as called for in the emergency action plan, or for reaction time for safe escape of employees from the workplace or the immediate work area, or both.

(2) The employee alarm shall be capable of being perceived above ambient noise or light levels by all employees in the affected portions of the workplace. Tactile devices may be used to alert those employees who would not otherwise be able to recognize the audible or visual alarm.

(3) The employee alarm shall be distinctive and recognizable as a signal to evacuate the work area or to perform actions designated under the emergency action plan.

(4) The employer shall explain to each employee the preferred means of reporting emergencies, such as manual pull box alarms, public address systems, radio or telephones. The employer shall post emergency telephone numbers near telephones, or employee notice boards, and other conspicuous locations when telephones serve as a means of reporting emergencies. Where a communication system also serves as the employee alarm system, all emergency messages shall have priority over all non-emergency messages.

(5) The employer shall establish procedures for sounding emergency alarms in the workplace. For those employers with 10 or fewer employees in a particular workplace, direct voice communication is an acceptable procedure for sounding the alarm provided all employees can hear the alarm. Such workplaces need not have a back-up system.

(c) *Installation and restoration.* (1) The employer shall assure that all devices,

components, combinations of devices or systems constructed and installed to comply with this standard are approved. Steam whistles, air horns, strobe lights or similar lighting devices, or tactile devices meeting the requirements of this section are considered to meet this requirement for approval.

(2) The employer shall assure that all employee alarm systems are restored to normal operating condition as promptly as possible after each test or alarm. Spare alarm devices and components subject to wear or destruction shall be available in sufficient quantities and locations for prompt restoration of the system.

(d) *Maintenance and testing.* (1) The employer shall assure that all employee alarm systems are maintained in operating condition except when undergoing repairs or maintenance.

(2) The employer shall assure that a test of the reliability and adequacy of non-supervised employee alarm systems is made every two months. A different actuation device shall be used in each test of a multi-actuation device system so that no individual device is used for two consecutive tests.

(3) The employer shall maintain or replace power supplies as often as is necessary to assure a fully operational condition. Back-up means of alarm, such as employee runners or telephones, shall be provided when systems are out of service.

(4) The employer shall assure that employee alarm circuitry installed after January 1, 1981, which is capable of being supervised is supervised and that it will provide positive notification to assigned personnel whenever a deficiency exists in the system. The employer shall assure that all supervised employee alarm systems are tested at least annually for reliability and adequacy.

(5) The employer shall assure that the servicing, maintenance and testing of employee alarms are done by persons trained in the designed operation and functions necessary for reliable and safe operation of the system.

(e) *Manual operation.* The employer shall assure that manually operated

actuation devices for use in conjunction with employee alarms are unobstructed, conspicuous and readily accessible.

[45 FR 60713, Sept. 12, 1980]

#### APPENDICES TO SUBPART L TO PART 1910

NOTE: The following appendices to subpart L, except appendix E, serve as nonmandatory guidelines to assist employers in complying with the appropriate requirements of subpart L.

#### APPENDIX A TO SUBPART L TO PART 1910—FIRE PROTECTION

##### *§ 1910.156 Fire brigades.*

1. *Scope.* This section does not require an employer to organize a fire brigade. However, if an employer does decide to organize a fire brigade, the requirements of this section apply.

2. *Pre-fire planning.* It is suggested that pre-fire planning be conducted by the local fire department and/or the workplace fire brigade in order for them to be familiar with the workplace and process hazards. Involvement with the local fire department or fire prevention bureau is encouraged to facilitate coordination and cooperation between members of the fire brigade and those who might be called upon for assistance during a fire emergency.

3. *Organizational statement.* In addition to the information required in the organizational statement, paragraph 1910.156(b)(1), it is suggested that the organizational statement also contain the following information: a description of the duties that the fire brigade members are expected to perform; the line authority of each fire brigade officer; the number of the fire brigade officers and number of training instructors; and a list and description of the types of awards or recognition that brigade members may be eligible to receive.

4. *Physical capability.* The physical capability requirement applies only to those fire brigade members who perform interior structural fire fighting. Employees who cannot meet the physical capability requirement may still be members of the fire brigade as long as such employees do not perform interior structural fire fighting. It is suggested that fire brigade members who are unable to perform interior structural fire fighting be assigned less stressful and physically demanding fire brigade duties, e.g., certain types of training, recordkeeping, fire prevention inspection and maintenance, and fire pump operations.

Physically capable can be defined as being able to perform those duties specified in the training requirements of section 1910.156(c).

Physically capable can also be determined by physical performance tests or by a physical examination when the examining physician is aware of the duties that the fire brigade member is expected to perform.

It is also recommended that fire brigade members participate in a physical fitness program. There are many benefits which can be attributed to being physically fit. It is believed that physical fitness may help to reduce the number of sprain and strain injuries as well as contributing to the improvement of the cardiovascular system.

5. *Training and education.* The paragraph on training and education does not contain specific training and education requirements because the type, amount, and frequency of training and education will be as varied as are the purposes for which fire brigades are organized. However, the paragraph does require that training and education be commensurate with those functions that the fire brigade is expected to perform; i.e., those functions specified in the organizational statement. Such a performance requirement provides the necessary flexibility to design a training program which meets the needs of individual fire brigades.

At a minimum, hands-on training is required to be conducted annually for all fire brigade members. However, for those fire brigade members who are expected to perform interior structural fire fighting, some type of training or education session must be provided at least quarterly.

In addition to the required hands-on training, it is strongly recommended that fire brigade members receive other types of training and education such as: classroom instruction, review of emergency action procedures, pre-fire planning, review of special hazards in the workplace, and practice in the use of self-contained breathing apparatus.

It is not necessary for the employer to duplicate the same training or education that a fire brigade member receives as a member of a community volunteer fire department, rescue squad, or similar organization. However, such training or education must have been provided to the fire brigade member within the past year and it must be documented that the fire brigade member has received the training or education. For example: there is no need for a fire brigade member to receive another training class in the use of positive-pressure self-contained breathing apparatus if the fire brigade member has recently completed such training as a member of a community fire department. Instead, the fire brigade member should receive training or education covering other important equipment or duties of the fire brigade as they relate to the workplace hazards, facilities and processes.

It is generally recognized that the effectiveness of fire brigade training and education depends upon the expertise of those

providing the training and education as well as the motivation of the fire brigade members. Fire brigade training instructors must receive a higher level of training and education than the fire brigade members they will be teaching. This includes being more knowledgeable about the functions to be performed by the fire brigade and the hazards involved. The instructors should be qualified to train fire brigade members and demonstrate skills in communication, methods of teaching, and motivation. It is important for instructors and fire brigade members alike to be motivated toward the goals of the fire brigade and be aware of the importance of the service that they are providing for the protection of other employees and the workplace.

It is suggested that publications from the International Fire Service Training Association, the National Fire Protection Association (NFPA-1041), the International Society of Fire Service Instructors and other fire training sources be consulted for recommended qualifications of fire brigade training instructors.

In order to be effective, fire brigades must have competent leadership and supervision. It is important for those who supervise the fire brigade during emergency situations, e.g., fire brigade chiefs, leaders, etc., to receive the necessary training and education for supervising fire brigade activities during these hazardous and stressful situations. These fire brigade members with leadership responsibilities should demonstrate skills in strategy and tactics, fire suppression and prevention techniques, leadership principles, pre-fire planning, and safety practices. It is again suggested that fire service training sources be consulted for determining the kinds of training and education which are necessary for those with fire brigade leadership responsibilities.

It is further suggested that fire brigade leaders and fire brigade instructors receive more formalized training and education on a continuing basis by attending classes provided by such training sources as universities and university fire extension services.

The following recommendations should not be considered to be all of the necessary elements of a complete comprehensive training program, but the information may be helpful as a guide in developing a fire brigade training program.

All fire brigade members should be familiar with exit facilities and their location, emergency escape routes for handicapped workers, and the workplace "emergency action plan."

In addition, fire brigade members who are expected to control and extinguish fires in the incipient stage should, at a minimum, be trained in the use of fire extinguishers, standpipes, and other fire equipment they are assigned to use. They should also be

aware of first aid medical procedures and procedures for dealing with special hazards to which they may be exposed. Training and education should include both classroom instruction and actual operation of the equipment under simulated emergency conditions. Hands-on type training must be conducted at least annually but some functions should be reviewed more often.

In addition to the above training, fire brigade members who are expected to perform emergency rescue and interior structural fire fighting should, at a minimum, be familiar with the proper techniques in rescue and fire suppression procedures. Training and education should include fire protection courses, classroom training, simulated fire situations including "wet drills" and, when feasible, extinguishment of actual mock fires. Frequency of training or education must be at least quarterly, but some drills or classroom training should be conducted as often as monthly or even weekly to maintain the proficiency of fire brigade members.

There are many excellent sources of training and education that the employer may want to use in developing a training program for the workplace fire brigade. These sources include publications, seminars, and courses offered by universities.

There are also excellent fire school courses by such facilities as Texas A and M University, Delaware State Fire School, Lamar University, and Reno Fire School, that deal with those unique hazards which may be encountered by fire brigades in the oil and chemical industry. These schools, and others, also offer excellent training courses which would be beneficial to fire brigades in other types of industries. These courses should be a continuing part of the training program, and employers are strongly encouraged to take advantage of these excellent resources.

It is also important that fire brigade members be informed about special hazards to which they may be exposed during fire and other emergencies. Such hazards as storage and use areas of flammable liquids and gases, toxic chemicals, water-reactive substances, etc., can pose difficult problems. There must be written procedures developed that describe the actions to be taken in situations involving special hazards. Fire brigade members must be trained in handling these special hazards as well as keeping abreast of any changes that occur in relation to these special hazards.

6. *Fire fighting equipment.* It is important that fire fighting equipment that is in damaged or unserviceable condition be removed from service and replaced. This will prevent fire brigade members from using unsafe equipment by mistake.

Fire fighting equipment, except portable fire extinguishers and respirators, must be

inspected at least annually. Portable fire extinguishers and respirators are required to be inspected at least monthly.

7. *Protective clothing.* (A) *General.* Paragraph (e) of §1910.156 does not require all fire brigade members to wear protective clothing. It is not the intention of these standards to require employers to provide a full ensemble of protective clothing for every fire brigade member without consideration given to the types of hazardous environments to which the fire brigade member might be exposed. It is the intention of these standards to require adequate protection for those fire brigade members who might be exposed to fires in an advanced stage, smoke, toxic gases, and high temperatures. Therefore, the protective clothing requirements only apply to those fire brigade members who perform interior structural fire fighting operations.

Additionally, the protective clothing requirements do not apply to the protective clothing worn during outside fire fighting operations (brush and forest fires, crash crew operations) or other special fire fighting activities. It is important that the protective clothing to be worn during these types of fire fighting operations reflect the hazards which are expected to be encountered by fire brigade members.

(B) *Foot and leg protection.* Section 1910.156 permits an option to achieve foot and leg protection.

The section recognizes the interdependence of protective clothing to cover one or more parts of the body. Therefore, an option is given so that fire brigade members may meet the foot and leg requirements by either wearing long fire-resistive coats in combination with fully extended boots, or by wearing shorter fire-resistive coats in combination with protective trousers and protective shoes or shorter boots.

(C) *Body protection.* Paragraph (e)(3) of §1910.156 provides an option for fire brigade members to achieve body protection. Fire brigade members may wear a fire-resistive coat in combination with fully extended boots, or they may wear a fire-resistive coat in combination with protective trousers.

Fire-resistive coats and protective trousers meeting all of the requirements contained in NFPA 1971–1975 “Protective Clothing for Structural Fire Fighters,” are acceptable as meeting the requirements of this standard.

The lining is required to be permanently attached to the outer shell. However, it is permissible to attach the lining to the outer shell material by stitching in one area such as at the neck. Fastener tape or snap fasteners may be used to secure the rest of the lining to the outer shell to facilitate cleaning. Reference to permanent lining does not refer to a winter liner which is a detachable extra lining used to give added protection to the wearer against the effects of cold weather and wind.

(D) *Hand protection.* The requirements of the paragraph on hand protection may be met by protective gloves or a glove system. A glove system consists of a combination of different gloves. The usual components of a glove system consist of a pair of gloves, which provide thermal insulation to the hands, worn in combination with a second pair of gloves which provide protection against flame, cut, and puncture.

It is suggested that protective gloves provide dexterity and a sense of feel for objects. Criteria and test methods for dexterity are contained in the NIOSH publications, “The Development of Criteria for Firefighters’ Gloves; Vol. I: Glove Requirements” and “Vol. II: Glove Criteria and Test Methods.” These NIOSH publications also contain a permissible modified version of Federal Test Method 191, Method 5903, (paragraph (3) of appendix E) for flame resistance when gloves, rather than glove material, are tested for flame resistance.

(E) *Head, eye, and face protection.* Head protective devices which meet the requirements contained in NFPA No. 1972 are acceptable as meeting the requirements of this standard for head protection.

Head protective devices are required to be provided with ear flaps so that the ear flaps will be available if needed. It is recommended that ear protection always be used while fighting interior structural fires.

Many head protective devices are equipped with face shields to protect the eyes and face. These face shields are permissible as meeting the eye and face protection requirements of this paragraph as long as such face shields meet the requirements of §1910.133 of the General Industry Standards.

Additionally, full facepieces, helmets or hoods of approved breathing apparatus which meet the requirements of §1910.134 and paragraph (f) of §1910.156 are also acceptable as meeting the eye and face protection requirements.

It is recommended that a flame resistant protective head covering such as a hood or snood, which will not adversely affect the seal of a respirator facepiece, be worn during interior structural fire fighting operations to protect the sides of the face and hair.

8. *Respiratory protective devices.* Respiratory protection is required to be worn by fire brigade members while working inside buildings or confined spaces where toxic products of combustion or an oxygen deficiency is likely to be present; respirators are also to be worn during emergency situations involving toxic substances. When fire brigade members respond to emergency situations, they may be exposed to unknown contaminants in unknown concentrations. Therefore, it is imperative that fire brigade members wear proper respiratory protective devices during these situations. Additionally, there are many instances where toxic products of

combustion are still present during mop-up and overhaul operations. Therefore, fire brigade members should continue to wear respirators during these types of operations.

Self-contained breathing apparatus are not required to be equipped with either a buddy-breathing device or a quick-disconnect valve. However, these accessories may be very useful and are acceptable as long as such accessories do not cause damage to the apparatus, restrict the air flow of the apparatus, or obstruct the normal operation of the apparatus.

Buddy-breathing devices are useful for emergency situations where a victim or another fire brigade member can share the same air supply with the wearer of the apparatus for emergency escape purposes.

The employer is encouraged to provide fire brigade members with an alternative means of respiratory protection to be used only for emergency escape purposes if the self-contained breathing apparatus becomes inoperative. Such alternative means of respiratory protection may be either a buddy-breathing device or an escape self-contained breathing apparatus (ESCBA). The ESCBA is a short-duration respiratory protective device which is approved for only emergency escape purposes. It is suggested that if ESCBA units are used, that they be of at least 5 minutes service life.

Quick-disconnect valves are devices which start the flow of air by insertion of the hose (which leads to the facepiece) into the regulator of self-contained breathing apparatus, and stop the flow of air by disconnecting the hose from the regulator. These devices are particularly useful for those positive-pressure self-contained breathing apparatus which do not have the capability of being switched from the demand to the positive-pressure mode.

The use of a self-contained breathing apparatus where the apparatus can be switched from a demand to a positive-pressure mode is acceptable as long as the apparatus is in the positive-pressure mode when performing interior structural fire fighting operations. Also acceptable are approved respiratory protective devices which have been converted to the positive-pressure type when such modification is accomplished by trained and experienced persons using kits or parts approved by NIOSH and provided by the manufacturer and by following the manufacturer's instructions.

There are situations which require the use of respirators which have a duration of 2 hours or more. Presently, there are no approved positive-pressure apparatus with a rated service life of more than 2 hours. Consequently, negative-pressure self-contained breathing apparatus with a rated service life of more than 2 hours and which have a minimum protection factor of 5,000 as determined by an acceptable quantitative fit test per-

formed on each individual, will be acceptable for use during situations which require long duration apparatus. Long duration apparatus may be needed in such instances as working in tunnels, subway systems, etc. Such negative-pressure breathing apparatus will continue to be acceptable for a maximum of 18 months after a positive-pressure apparatus with the same or longer rated service life of more than 2 hours is certified by NIOSH/MSHA. After this 18 month phase-in period, all self-contained breathing apparatus used for these long duration situations will have to be of the positive-pressure type.

Protection factor (sometimes called fit factor) is defined as the ratio of the contaminant concentrations outside of the respirator to the contaminant concentrations inside the facepiece of the respirator.

$$PF = \frac{\text{Concentration outside respirator}}{\text{Concentration inside facepiece}}$$

Protection factors are determined by quantitative fit tests. An acceptable quantitative fit test should include the following elements:

1. A fire brigade member who is physically and medically capable of wearing respirators, and who is trained in the use of respirators, dons a self-contained breathing apparatus equipped with a device that will monitor the concentration of a contaminant inside the facepiece.

2. The fire brigade member then performs a qualitative fit test to assure the best face to facepiece seal as possible. A qualitative fit test can consist of a negative-pressure test, positive-pressure test, isoamyl acetate vapor (banana oil) test, or an irritant smoke test. For more details on respirator fitting see the NIOSH booklet entitled "A Guide to Industrial Respiratory Protection" June, 1976, and HEW publication No. (NIOSH) 76-189.

3. The wearer should then perform physical activity which reflects the level of work activity which would be expected during fire fighting activities. The physical activity should include simulated fire-ground work activity or physical exercise such as running-in-place, a step test, etc.

4. Without readjusting the apparatus, the wearer is placed in a test atmosphere containing a non-toxic contaminant with a known, constant, concentration.

The protection factor is then determined by dividing the known concentration of the contaminant in the test atmosphere by the concentration of the contaminant inside the facepiece when the following exercises are performed:

- (a) Normal breathing with head motionless for one minute;
- (b) Deep breathing with head motionless for 30 seconds;

(c) Turning head slowly from side to side while breathing normally, pausing for at least two breaths before changing direction. Continue for at least one minute;

(d) Moving head slowly up and down while breathing normally, pausing for at least two breaths before changing direction. Continue for at least two minutes;

(e) Reading from a prepared text, slowly and clearly, and loudly enough to be heard and understood. Continue for one minute; and

(f) Normal breathing with head motionless for at least one minute.

The protection factor which is determined must be at least 5,000. The quantitative fit test should be conducted at least three times. It is acceptable to conduct all three tests on the same day. However, there should be at least one hour between tests to reflect the protection afforded by the apparatus during different times of the day.

The above elements are not meant to be a comprehensive, technical description of a quantitative fit test protocol. However, quantitative fit test procedures which include these elements are acceptable for determining protection factors. Procedures for a quantitative fit test are required to be available for inspection by the Assistant Secretary or authorized representative.

Organizations such as Los Alamos Scientific Laboratory, Lawrence Livermore Laboratory, NIOSH, and American National Standards Institute (ANSI) are excellent sources for additional information concerning qualitative and quantitative fit testing.

#### § 1910.157 *Portable fire extinguishers.*

1. *Scope and application.* The scope and application of this section is written to apply to three basic types of workplaces. First, there are those workplaces where the employer has chosen to evacuate all employees from the workplace at the time of a fire emergency. Second, there are those workplaces where the employer has chosen to permit certain employees to fight fires and to evacuate all other non-essential employees at the time of a fire emergency. Third, there are those workplaces where the employer has chosen to permit all employees in the workplace to use portable fire extinguishers to fight fires.

The section also addresses two kinds of work areas. The entire workplace can be divided into outside (exterior) work areas and inside (interior) work areas. This division of the workplace into two areas is done in recognition of the different types of hazards employees may be exposed to during fire fighting operations. Fires in interior workplaces, pose a greater hazard to employees; they can produce greater exposure to quantities of smoke, toxic gases, and heat because of the capability of a building or structure to con-

tain or entrap these products of combustion until the building can be ventilated. Exterior work areas, normally open to the environment, are somewhat less hazardous, because the products of combustion are generally carried away by the thermal column of the fire. Employees also have a greater selection of evacuation routes if it is necessary to abandon fire fighting efforts.

In recognition of the degree of hazard present in the two types of work areas, the standards for exterior work areas are somewhat less restrictive in regards to extinguisher distribution. Paragraph (a) explains this by specifying which paragraphs in the section apply.

2. *Portable fire extinguisher exemptions.* In recognition of the three options given to employers in regard to the amount of employee evacuation to be carried out, the standards permit certain exemptions based on the number of employees expected to use fire extinguishers.

Where the employer has chosen to totally evacuate the workplace at the time of a fire emergency and when fire extinguishers are not provided, the requirements of this section do not apply to that workplace.

Where the employer has chosen to partially evacuate the workplace or the effected area at the time of a fire emergency and has permitted certain designated employees to remain behind to operate critical plant operations or to fight fires with extinguishers, then the employer is exempt from the distribution requirements of this section. Employees who will be remaining behind to perform incipient fire fighting or members of a fire brigade must be trained in their duties. The training must result in the employees becoming familiar with the locations of fire extinguishers. Therefore, the employer must locate the extinguishers in convenient locations where the employees know they can be found. For example, they could be mounted in the fire truck or cart that the fire brigade uses when it responds to a fire emergency. They can also be distributed as set forth in the National Fire Protection Association's Standard No. 10, "Portable Fire Extinguishers."

Where the employer has decided to permit all employees in the workforce to use fire extinguishers, then the entire OSHA section applies.

3. *Portable fire extinguisher mounting.* Previous standards for mounting fire extinguishers have been criticized for requiring specific mounting locations. In recognition of this criticism, the standard has been rewritten to permit as much flexibility in extinguisher mounting as is acceptable to assure that fire extinguishers are available when needed and that employees are not subjected to injury hazards when they try to obtain an extinguisher.

It is the intent of OSHA to permit the mounting of extinguishers in any location that is accessible to employees without the use of portable devices such as a ladder. This limitation is necessary because portable devices can be moved or taken from the place where they are needed and, therefore, might not be available at the time of an emergency.

Employers are given as much flexibility as possible to assure that employees can obtain extinguishers as fast as possible. For example, an acceptable method of mounting extinguishers in areas where fork lift trucks or tow-motors are used is to mount the units on retractable boards which, by means of counterweighting, can be raised above the level where they could be struck by vehicular traffic. When needed, they can be lowered quickly for use. This method of mounting can also reduce vandalism and unauthorized use of extinguishers. The extinguishers may also be mounted as outlined in the National Fire Protection Association's Standard No. 10, "Portable Fire Extinguishers."

4. *Selection and distribution.* The employer is responsible for the proper selection and distribution of fire extinguishers and the determination of the necessary degree of protection. The selection and distribution of fire extinguishers must reflect the type and class of fire hazards associated with a particular workplace.

Extinguishers for protecting Class A hazards may be selected from the following types: water, foam, loaded stream, or multipurpose dry chemical. Extinguishers for protecting Class B hazards may be selected from the following types: Halon 1301, Halon 1211, carbon dioxide, dry chemicals, foam, or loaded stream. Extinguishers for Class C hazards may be selected from the following types: Halon 1301, Halon 1211, carbon dioxide, or dry chemical.

Combustible metal (Class D hazards) fires pose a different type of fire problem in the workplace. Extinguishers using water, gas, or certain dry chemicals cannot extinguish or control this type of fire. Therefore, certain metals have specific dry powder extinguishing agents which can extinguish or control this type of fire. Those agents which have been specifically approved for use on certain metal fires provide the best protection; however, there are also some "universal" type agents which can be used effectively on a variety of combustible metal fires if necessary. The "universal" type agents include: Foundry flux, Lith-X powder, TMB liquid, pyromet powder, TEC powder, dry talc, dry graphite powder, dry sand, dry sodium chloride, dry soda ash, lithium chloride, zirconium silicate, and dry dolomite.

Water is not generally accepted as an effective extinguishing agent for metal fires. When applied to hot burning metal, water will break down into its basic atoms of oxy-

gen and hydrogen. This chemical breakdown contributes to the combustion of the metal. However, water is also a good universal coolant and can be used on some combustible metals, but only under proper conditions and application, to reduce the temperature of the burning metal below the ignition point. For example, automatic deluge systems in magnesium plants can discharge such large quantities of water on burning magnesium that the fire will be extinguished. The National Fire Protection Association has specific standards for this type of automatic sprinkler system. Further information on the control of metal fires with water can be found in the National Fire Protection Association's *Fire Protection Handbook*.

An excellent source of selection and distribution criteria is found in the National Fire Protection Association's Standard No. 10. Other sources of information include the National Safety Council and the employer's fire insurance carrier.

5. *Substitution of standpipe systems for portable fire extinguishers.* The employer is permitted to substitute acceptable standpipe systems for portable fire extinguishers under certain circumstances. It is necessary to assure that any substitution will provide the same coverage that portable units provide. This means that fire hoses, because of their limited portability, must be spaced throughout the protected area so that they can reach around obstructions such as columns, machinery, etc. and so that they can reach into closets and other enclosed areas.

6. *Inspection, maintenance and testing.* The ultimate responsibility for the inspection, maintenance and testing of portable fire extinguishers lies with the employer. The actual inspection, maintenance, and testing may, however, be conducted by outside contractors with whom the employer has arranged to do the work. When contracting for such work, the employer should assure that the contractor is capable of performing the work that is needed to comply with this standard.

If the employer should elect to perform the inspection, maintenance, and testing requirements of this section in-house, then the employer must make sure that those persons doing the work have been trained to do the work and to recognize problem areas which could cause an extinguisher to be inoperable. The National Fire Protection Association provides excellent guidelines in its standard for portable fire extinguishers. The employer may also check with the manufacturer of the unit that has been purchased and obtain guidelines on inspection, maintenance, and testing. Hydrostatic testing is a process that should be left to contractors or individuals using suitable facilities and having the training necessary to perform the work.



Anytime the employer has removed an extinguisher from service to be checked or repaired, alternate equivalent protection must be provided. Alternate equivalent protection could include replacing the extinguisher with one or more units having equivalent or equal ratings, posting a fire watch, restricting the unprotected area from employee exposure, or providing a hose system ready to operate.

7. *Hydrostatic testing.* As stated before, the employer may contract for hydrostatic testing. However, if the employer wishes to provide the testing service, certain equipment and facilities must be available. Employees should be made aware of the hazards associated with hydrostatic testing and the importance of using proper guards and water pressures. Severe injury can result if extinguisher shells fail violently under hydrostatic pressure.

Employers are encouraged to use contractors who can perform adequate and reliable service. Firms which have been certified by the Materials Transportation Board (MTB) of the U.S. Department of Transportation (DOT) or State licensed extinguisher servicing firms or recognized by the National Association of Fire Equipment Distributors in Chicago, Illinois, are generally acceptable for performing this service.

8. *Training and education.* This part of the standard is of the utmost importance to employers and employees if the risk of injury or death due to extinguisher use is to be reduced. If an employer is going to permit an employee to fight a workplace fire of any size, the employer must make sure that the employee knows everything necessary to assure the employee's safety.

Training and education can be obtained through many channels. Often, local fire departments in larger cities have fire prevention bureaus or similar organizations which can provide basic fire prevention training programs. Fire insurance companies will have data and information available. The National Fire Protection Association and the National Safety Council will provide, at a small cost, publications that can be used in a fire prevention program.

Actual fire fighting training can be obtained from various sources in the country. The Texas A & M University, the University of Maryland's Fire and Rescue Institute, West Virginia University's Fire Service Extension, Iowa State University's Fire Service Extension and other State training schools and land grant colleges have fire fighting programs directed to industrial applications. Some manufacturers of extinguishers, such as the Ansul Company and Safety First, conduct fire schools for customers in the proper use of extinguishers. Several large corporations have taken time to develop their own on-site training programs which expose employees to the actual "feeling" of fire fighting.

Simulated fires for training of employees in the proper use of extinguishers are also an acceptable part of a training program.

In meeting the requirements of this section, the employer may also provide educational materials, without classroom instruction, through the use of employee notice campaigns using instruction sheets or flyers or similar types of informal programs. The employer must make sure that employees are trained and educated to recognize not only what type of fire is being fought and how to fight it, but also when it is time to get away from it and leave fire suppression to more experienced fire fighters.

#### *§1910.158 Standpipe and hose systems.*

1. *Scope and application.* This section has been written to provide adequate coverage of those standpipe and hose systems that an employer may install in the workplace to meet the requirements of a particular OSHA standard. For example, OSHA permits the substitution of hose systems for portable fire extinguishers in §1910.157. If an employer chooses to provide hose systems instead of portable Class A fire extinguishers, then those hose systems used for substitution would have to meet the applicable requirements of §1910.157. All other standpipe and hose systems not used as a substitute would be exempt from these requirements.

The section specifically exempts Class I large hose systems. By large hose systems, OSHA means those 2½" (6.3 cm) hose lines that are usually associated with fire departments of the size that provide their own water supply through fire apparatus. When the fire gets to the size that outside protection of that degree is necessary, OSHA believes that in most industries employees will have been evacuated from the fire area and the "professional" fire fighters will take control.

2. *Protection of standpipes.* Employers must make sure that standpipes are protected so that they can be relied upon during a fire emergency. This means protecting the pipes from mechanical and physical damage. There are various means for protecting the equipment such as, but not limited to, enclosing the supply piping in the construction of the building, locating the standpipe in an area which is inaccessible to vehicles, or locating the standpipe in a stairwell.

3. *Hose covers and cabinets.* The employer should keep fire protection hose equipment in cabinets or inside protective covers which will protect it from the weather elements, dirt or other damaging sources. The use of protective covers must be easily removed or opened to assure that hose and nozzle are accessible. When the employer places hose in a cabinet, the employer must make sure that the hose and nozzle are accessible to employees without subjecting them to injury. In

order to make sure that the equipment is readily accessible, the employer must also make sure that the cabinets used to store equipment are kept free of obstructions and other equipment which may interfere with the fast distribution of the fire hose stored in the cabinet.

4. *Hose outlets and connections.* The employer must assure that employees who use standpipe and hose systems can reach the hose rack and hose valve without the use of portable equipment such as ladders. Hose reels are encouraged for use because one employee can retrieve the hose, charge it, and place it into service without much difficulty.

5. *Hose.* When the employer elects to provide small hose in lieu of portable fire extinguishers, those hose stations being used for the substitution must have hose attached and ready for service. However, if more than the necessary amount of small hose outlets are provided, hose does not have to be attached to those outlets that would provide redundant coverage. Further, where the installation of hose on outlets may expose the hose to extremely cold climates, the employer may store the hose in houses or similar protective areas and connect it to the outlet when needed.

There is approved lined hose available that can be used to replace unlined hose which is stored on racks in cabinets. The lined hose is constructed so that it can be folded and placed in cabinets in the same manner as unlined hose.

Hose is considered to be unserviceable when it deteriorates to the extent that it can no longer carry water at the required pressure and flow rates. Dry rotted linen or hemp hose, cross threaded couplings, and punctured hose are examples of unserviceable hose.

6. *Nozzles.* Variable stream nozzles can provide useful variations in water flow and spray patterns during fire fighting operations and they are recommended for employee use. It is recommended that 100 psi (700kPa) nozzle pressure be used to provide good flow patterns for variable stream nozzles. The most desirable attribute for nozzles is the ability of the nozzle person to shut off the water flow at the nozzle when it is necessary. This can be accomplished in many ways. For example, a shut-off nozzle with a lever or rotation of the nozzle to stop flow would be effective, but in other cases a simple globe valve placed between a straight stream nozzle and the hose could serve the same purpose. For straight stream nozzles 50 psi nozzle pressure is recommended. The intent of this standard is to protect the employee from "run-away" hoses if it becomes necessary to drop a pressurized hose line and retreat from the fire front and other related hazards.

7. *Design and installation.* Standpipe and hose systems designed and installed in ac-

cordance with NFPA Standard No. 14, "Standpipe and Hose Systems," are considered to be in compliance with this standard.

*§ 1910.159 Automatic sprinkler systems.*

1. *Scope and application.* This section contains the minimum requirements for design, installation and maintenance of sprinkler systems that are needed for employee safety. The Occupational Safety and Health Administration is aware of the fact that the National Board of Fire Underwriters is no longer an active organization, however, sprinkler systems still exist that were designed and installed in accordance with that organization's standards. Therefore, OSHA will recognize sprinkler systems designed to, and maintained in accordance with, NBFU and earlier NFPA standards.

2. *Exemptions.* In an effort to assure that employers will continue to use automatic sprinkler systems as the primary fire protection system in workplaces, OSHA is exempting from coverage those systems not required by a particular OSHA standard and which have been installed in workplaces solely for the purpose of protecting property. Many of these types of systems are installed in areas or buildings with little or no employee exposure. An example is those warehouses where employees may enter occasionally to take inventory or move stock. Some employers may choose to shut down those systems which are not specifically required by OSHA rather than upgrade them to comply with the standards. OSHA does not intend to regulate such systems. OSHA only intends to regulate those systems which are installed to comply with a particular OSHA standard.

3. *Design.* There are two basic types of sprinkler system design. Pipe schedule designed systems are based on pipe schedule tables developed to protect hazards with standard sized pipe, number of sprinklers, and pipe lengths. Hydraulic designed systems are based on an engineered design of pipe size which will produce a given water density or flow rate at any particular point in the system. Either design can be used to comply with this standard.

The National Fire Protection Association's Standard No. 13, "Automatic Sprinkler Systems," contains the tables needed to design and install either type of system. Minimum water supplies, densities, and pipe sizes are given for all types of occupancies.

The employer may check with a reputable fire protection engineering consultant or sprinkler design company when evaluating existing systems or designing a new installation.

With the advent of new construction materials for the manufacture of sprinkler pipe, materials, other than steel have been approved for use as sprinkler pipe. Selection of pipe material should be made on the basis of

the type of installation and the acceptability of the material to local fire and building officials where such systems may serve more than one purpose.

Before new sprinkler systems are placed into service, an acceptance test is to be conducted. The employer should invite the installer, designer, insurance representative, and a local fire official to witness the test. Problems found during the test are to be corrected before the system is placed into service.

4. *Maintenance.* It is important that any sprinkler system maintenance be done only when there is minimal employee exposure to the fire hazard. For example, if repairs or changes to the system are to be made, they should be made during those hours when employees are not working or are not occupying that portion of the workplace protected by the portion of the system which has been shut down.

The procedures for performing a flow test via a main drain test or by the use of an inspector's test valve can be obtained from the employer's fire insurance company or from the National Fire Protection Association's Standard No. 13A, "Sprinkler System, Maintenance."

5. *Water supplies.* The water supply to a sprinkler system is one of the most important factors an employer should consider when evaluating a system. Obviously, if there is no water supply, the system is useless. Water supplies can be lost for various reasons such as improperly closed valves, excessive demand, broken water mains, and broken fire pumps. The employer must be able to determine if or when this type of condition exists either by performing a main drain test or visual inspection. Another problem may be an inadequate water supply. For example, a light hazard occupancy may, through rehabilitation or change in tenants, become an ordinary or high hazard occupancy. In such cases, the existing water supply may not be able to provide the pressure or duration necessary for proper protection. Employers must assure that proper design and tests have been made to assure an adequate water supply. These tests can be arranged through the employer's fire insurance carrier or through a local sprinkler maintenance company or through the local fire prevention organization.

Anytime the employer must shut down the primary water supply for a sprinkler system, the standard requires that equivalent protection be provided. Equivalent protection may include a fire watch with extinguishers or hose lines in place and manned, or a secondary water supply such as a tank truck and pump, or a tank or fire pond with fire pumps, to protect the areas where the primary water supply is limited or shut down. The employer may also require evacuation of the work-

place and have an emergency action plan which specifies such action.

6. *Protection of piping.* Piping which is exposed to corrosive atmospheres, either chemical or natural, can become defective to the extent that it is useless. Employers must assure that piping is protected from corrosion by its material of construction, e.g., stainless steel, or by a protective coating, e.g., paint.

7. *Sprinklers.* When an employer finds it necessary to replace sprinkler system components or otherwise change a sprinkler's design, employer should make a complete fire protection engineering survey of that part of the system being changed. This review should assure that the changes to the system will not alter the effectiveness of the system as it is presently designed. Water supplies, densities and flow characteristics should be maintained.

8. *Protection of sprinklers.* All components of the system must be protected from mechanical impact damage. This can be achieved with the use of mechanical guards or screens or by locating components in areas where physical contact is impossible or limited.

9. *Sprinkler alarms.* The most recognized sprinkler alarm is the water motor gong or bell that sounds when water begins to flow through the system. This is not however, the only type of acceptable water flow alarm. Any alarm that gives an indication that water is flowing through the system is acceptable. For example, a siren, a whistle, a flashing light, or similar alerting device which can transmit a signal to the necessary persons would be acceptable. The purpose of the alarm is to alert persons that the system is operating, and that some type of planned action is necessary.

10. *Sprinkler spacing.* For a sprinkler system to be effective there must be an adequate discharge of water spray from the sprinkler head. Any obstructions which hinder the designed density or spray pattern of the water may create unprotected areas which can cause fire to spread. There are some sprinklers that, because of the system's design, are deflected to specific areas. This type of obstruction is acceptable if the system's design takes it into consideration in providing adequate coverage.

#### *§1910.160 Fixed extinguishing systems, general.*

1. *Scope and application.* This section contains the general requirements that are applicable to all fixed extinguishing systems installed to meet OSHA standards. It also applies to those fixed extinguishing systems, generally total flooding, which are not required by OSHA, but which, because of the agent's discharge, may expose employees to hazardous concentrations of extinguishing agents or combustion by-products. Employees who work around fixed extinguishing systems must be warned of the possible hazards

associated with the system and its agent. For example, fixed dry chemical extinguishing systems may generate a large enough cloud of dry chemical particles that employees may become visually disoriented. Certain gaseous agents can expose employees to hazardous by-products of combustion when the agent comes into contact with hot metal or other hot surface. Some gaseous agents may be present in hazardous concentrations when the system has totally discharged because an extra rich concentration is necessary to extinguish deep-seated fires. Certain local application systems may be designed to discharge onto the flaming surface of a liquid, and it is possible that the liquid can splatter when hit with the discharging agent. All of these hazards must be determined before the system is placed into operation, and must be discussed with employees.

Based on the known toxicological effects of agents such as carbon tetrachloride and chlorobromomethane, OSHA is not permitting the use of these agents in areas where employees can be exposed to the agent or its side effects. However, chlorobromomethane has been accepted and may be used as an explosion suppression agent in unoccupied spaces. OSHA is permitting the use of this agent only in areas where employees will not be exposed.

2. *Distinctive alarm signals.* A distinctive alarm signal is required to indicate that a fixed system is discharging. Such a signal is necessary on those systems where it is not immediately apparent that the system is discharging. For example, certain gaseous agents make a loud noise when they discharge. In this case no alarm signal is necessary. However, where systems are located in remote locations or away from the general work area and where it is possible that a system could discharge without anyone knowing that it is doing so, then a distinctive alarm is necessary to warn employees of the hazards that may exist. The alarm can be a bell, gong, whistle, horn, flashing light, or any combination of signals as long as it is identifiable as a discharge alarm.

3. *Maintenance.* The employer is responsible for the maintenance of all fixed systems, but this responsibility does not preclude the use of outside contractors to do such work. New systems should be subjected to an acceptance test before placed in service. The employer should invite the installer, designer, insurance representative and others to witness the test. Problems found during the test need to be corrected before the system is considered operational.

4. *Manual discharge stations.* There are instances, such as for mechanical reasons and others, where the standards call for a manual back-up activation device. While the location of this device is not specified in the standard, the employer should assume that the device should be located where employ-

ees can easily reach it. It could, for example, be located along the main means of egress from the protected area so that employees could activate the system as they evacuate the work area.

5. *Personal protective equipment.* The employer is required to provide the necessary personal protective equipment to rescue employees who may be trapped in a totally flooded environment which may be hazardous to their health. This equipment would normally include a positive-pressure self-contained breathing apparatus and any necessary first aid equipment. In cases where the employer can assure the prompt arrival of the local fire department or plant emergency personnel which can provide the equipment, this can be considered as complying with the standards.

*§ 1910.161 Fixed extinguishing systems, dry chemical.*

1. *Scope and application.* The requirements of this section apply only to dry chemical systems. These requirements are to be used in conjunction with the requirements of § 1910.160.

2. *Maintenance.* The employer is responsible for assuring that dry chemical systems will operate effectively. To do this, periodic maintenance is necessary. One test that must be conducted during the maintenance check is one which will determine if the agent has remained free of moisture. If an agent absorbs any moisture, it may tend to cake and thereby clog the system. An easy test for acceptable moisture content is to take a lump of dry chemical from the container and drop it from a height of four inches. If the lump crumbles into fine particles, the agent is acceptable.

*§ 1910.162 Fixed extinguishing systems, gaseous agent.*

1. *Scope and application.* This section applies only to those systems which use gaseous agents. The requirements of § 1910.160 also apply to the gaseous agent systems covered in this section.

2. *Design concentrations.* Total flooding gaseous systems are based on the volume of gas which must be discharged in order to produce a certain designed concentration of gas in an enclosed area. The concentration needed to extinguish a fire depends on several factors including the type of fire hazard and the amount of gas expected to leak away from the area during discharge. At times it is necessary to "super-saturate" a work area to provide for expected leakage from the enclosed area. In such cases, employers must assure that the flooded area has been ventilated before employees are permitted to re-enter the work area without protective clothing and respirators.

3. *Toxic decomposition.* Certain halogenated hydrocarbons will break down or decompose when they are combined with high temperatures found in the fire environment. The products of the decomposition can include toxic elements or compounds. For example, when Halon 1211 is placed into contact with hot metal it will break down and form bromide or fluoride fumes. The employer must find out which toxic products may result from decomposition of a particular agent from the manufacturer, and take the necessary precautions to prevent employee exposure to the hazard.

*§1910.163 Fixed extinguishing systems, water spray and foam.*

1. *Scope and application.* This section applies to those systems that use water spray or foam. The requirements of §1910.160 also apply to this type of system.

2. *Characteristics of foams.* When selecting the type of foam for a specific hazard, the employer should consider the following limitations of some foams.

a. Some foams are not acceptable for use on fires involving flammable gases and liquefied gases with boiling points below ambient workplace temperatures. Other foams are not effective when used on fires involving polar solvent liquids.

b. Any agent using water as part of the mixture should not be used on fire involving combustible metals unless it is applied under proper conditions to reduce the temperature of burning metal below the ignition temperature. The employer should use only those foams that have been tested and accepted for this application by a recognized independent testing laboratory.

c. Certain types of foams may be incompatible and break down when they are mixed together.

d. For fires involving water miscible solvents, employers should use only those foams tested and approved for such use. Regular protein foams may not be effective on such solvents.

Whenever employers provide a foam or water spray system, drainage facilities must be provided to carry contaminated water or foam overflow away from the employee work areas and egress routes. This drainage system should drain to a central impounding area where it can be collected and disposed of properly. Other government agencies may have regulations concerning environmental considerations.

*§1910.164 Fire detection systems.*

1. *Installation and restoration.* Fire detection systems must be designed by knowledgeable engineers or other professionals, with expertise in fire detection systems and when the systems are installed, there should be an acceptance test performed on the sys-

tem to insure it operates properly. The manufacturer's recommendations for system design should be consulted. While entire systems may not be approved, each component used in the system is required to be approved. Custom fire detection systems should be designed by knowledgeable fire protection or electrical engineers who are familiar with the workplace hazards and conditions. Some systems may only have one or two individual detectors for a small workplace, but good design and installation is still important. An acceptance test should be performed on all systems, including these smaller systems.

OSHA has a requirement that spare components used to replace those which may be destroyed during an alarm situation be available in sufficient quantities and locations for prompt restoration of the system. This does not mean that the parts or components have to be stored at the workplace. If the employer can assure that the supply of parts is available in the local community or the general metropolitan area of the workplace, then the requirements for storage and availability have been met. The intent is to make sure that the alarm system is fully operational when employees are occupying the workplace, and that when the system operates it can be returned to full service the next day or sooner.

2. *Supervision.* Fire detection systems should be supervised. The object of supervision is detection of any failure of the circuitry, and the employer should use any method that will assure that the system's circuits are operational. Electrically operated sensors for air pressure, fluid pressure, or electrical circuits, can provide effective monitoring and are the typical types of supervision.

3. *Protection of fire detectors.* Fire detectors must be protected from corrosion either by protective coatings, by being manufactured from non-corrosive materials or by location. Detectors must also be protected from mechanical impact damage, either by suitable cages or metal guards where such hazards are present, or by locating them above or out of contact with materials or equipment which may cause damage.

4. *Number, location, and spacing of detectors.* This information can be obtained from the approval listing for detectors or NFPA standards. It can also be obtained from fire protection engineers or consultants or manufacturers of equipment who have access to approval listings and design methods.

*§1910.165 Employee alarm systems.*

1. *Scope and application.* This section is intended to apply to employee alarm systems used for all types of employee emergencies except those which occur so quickly and at such a rapid rate (e.g., explosions) that any

action by the employee is extremely limited following detection.

In small workplaces with 10 or less employees the alarm system can be by direct voice communication (shouting) where any one individual can quickly alert all other employees. Radio may be used to transmit alarms from remote workplaces where telephone service is not available, provided that radio messages will be monitored by emergency services, such as fire, police or others, to insure alarms are transmitted and received.

**2. Alarm signal alternatives.** In recognition of physically impaired individuals, OSHA is accepting various methods of giving alarm signals. For example, visual, tactile or audible alarm signals are acceptable methods for giving alarms to employees. Flashing lights or vibrating devices can be used in areas where the employer has hired employees with hearing or vision impairments. Vibrating devices, air fans, or other tactile devices can be used where visually and hearing impaired employees work. Employers are cautioned that certain frequencies of flashing lights have been claimed to initiate epileptic seizures in some employees and that this fact should be considered when selecting an alarm device. Two way radio communications would be most appropriate for transmitting emergency alarms in such workplaces which may be remote or where telephones may not be available.

**3. Reporting alarms.** Employee alarms may require different means of reporting, depending on the workplace involved. For example, in small workplaces, a simple shout throughout the workplace may be sufficient to warn employees of a fire or other emergency. In larger workplaces, more sophisticated equipment is necessary so that entire plants or high-rise buildings are not evacuated for one small emergency. In remote areas, such as pumping plants, radio communication with a central base station may be necessary. The goal of this standard is to assure that all employees who need to know that an emergency exists can be notified of the emergency. The method of transmitting the alarm should reflect the situation found at the workplace.

Personal radio transmitters, worn by an individual, can be used where the individual may be working such as in a remote location. Such personal radio transmitters shall send a distinct signal and should clearly indicate who is having an emergency, the location, and the nature of the emergency. All radio transmitters need a feedback system to assure that the emergency alarm is sent to the people who can provide assistance.

For multi-story buildings or single story buildings with interior walls for subdivisions, the more traditional alarm systems are recommended for these types of workplaces. Supervised telephone or manual fire alarm or pull box stations with paging systems to transmit messages throughout the

building is the recommended alarm system. The alarm box stations should be available within a travel distance of 200 feet. Water flow detection on a sprinkler system, fire detection systems (guard's supervisory station) or tour signal (watchman's service), or other related systems may be part of the overall system. The paging system may be used for nonemergency operations provided the emergency messages and uses will have precedence over all other uses of the system.

**4. Supervision.** The requirements for supervising the employee alarm system circuitry and power supply may be accomplished in a variety of ways. Typically, electrically operated sensors for air pressure, fluid pressure, steam pressure, or electrical continuity of circuitry may be used to continuously monitor the system to assure it is operational and to identify trouble in the system and give a warning signal.

[45 FR 60715, Sept. 12, 1980; 46 FR 24557, May 1, 1981]

#### APPENDIX B TO SUBPART L TO PART 1910—NATIONAL CONSENSUS STANDARDS

The following table contains a cross-reference listing of those current national consensus standards which contains information and guidelines that would be considered acceptable in complying with requirements in the specific sections of subpart L.

Subpart L section	National consensus standard
1910.156 .....	ANSI/NFPA No. 1972; Structural Fire Fighter's Helmets. ANSI Z88.5 American National Standard, Practice for Respirator Protection for the Fire Service. ANSI/NFPA No. 1971, Protective Clothing for Structural Fire Fighters. NFPA No. 1041, Fire Service Instructor Professional Qualifications.
1910.157 .....	ANSI/NFPA No. 10, Portable Fire Extinguishers.
1910.158 .....	ANSI/NFPA No. 18, Wetting Agents. ANSI/NFPA No. 20, Centrifugal Fire Pumps. NFPA No. 21, Steam Fire Pumps. ANSI/NFPA No. 22, Water Tanks. NFPA No. 24, Outside Protection. NFPA No. 26, Supervision of Valves. NFPA No. 13E, Fire Department Operations in Properties Protected by Sprinkler, Standpipe Systems. ANSI/NFPA No. 194, Fire Hose Connections. NFPA No. 197, Initial Fire Attack, Training for. NFPA No. 1231, Water Supplies for Suburban and Rural Fire Fighting.
1910.159 .....	ANSI/NFPA No. 13, Sprinkler Systems.

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Subpart L section	National consensus standard
1910.160 .....	<p>NFPA No. 13A, Sprinkler Systems, Maintenance.</p> <p>ANSI/NFPA No. 18, Wetting Agents.</p> <p>ANSI/NFPA No. 20, Centrifugal Fire Pumps.</p> <p>ANSI/NFPA No. 22, Water Tanks.</p> <p>NFPA No. 24, Outside Protection.</p> <p>NFPA No. 26, Supervision of Valves.</p> <p>ANSI/NFPA No. 72B, Auxiliary Signaling Systems.</p> <p>NFPA No. 1231, Water Supplies for Suburban and Rural Fire Fighting.</p> <p>ANSI/NFPA No. 11, Foam Systems.</p> <p>ANSI/NFPA 11A, High Expansion Foam Extinguishing Systems.</p> <p>ANSI/NFPA No. 11B, Synthetic Foam and Combined Agent Systems.</p> <p>ANSI/NFPA No. 12, Carbon Dioxide Systems.</p> <p>ANSI/NFPA No. 12A, Halon 1301 Systems.</p> <p>ANSI/NFPA No. 12B, Halon 1211 Systems.</p> <p>ANSI/NFPA No. 15, Water Spray Systems.</p> <p>ANSI/NFPA 16 Foam-Water Spray Systems.</p> <p>ANSI/NFPA No. 17, Dry Chemical Systems.</p> <p>ANSI/NFPA 69, Explosion Suppression Systems.</p>
1910.161 .....	ANSI/NFPA No. 11B, Synthetic Foam and Combined Agent Systems.
1910.162 .....	ANSI/NFPA No. 17, Dry Chemical Systems.
1910.163 .....	<p>ANSI/NFPA No. 12, Carbon Dioxide Systems.</p> <p>ANSI/NFPA No. 12A, Halon 1211 Systems.</p> <p>ANSI/NFPA No. 12B, Halon 1301 Systems.</p> <p>ANSI/NFPA No. 69, Explosion Suppression Systems.</p>
1910.164 .....	<p>ANSI/NFPA No. 11, Foam Extinguishing Systems.</p> <p>ANSI/NFPA No. 11A, High Expansion Foam Extinguishing Systems.</p> <p>ANSI/NFPA No. 11B, Synthetic Foam and Combined Agent Systems.</p> <p>ANSI/NFPA No. 15, Water Spray Fixed Systems.</p> <p>ANSI/NFPA No. 16, Foam-Water Spray Systems.</p> <p>ANSI/NFPA No. 18, Wetting Agents.</p> <p>NFPA No. 26, Supervision of Valves.</p> <p>ANSI/NFPA No. 71, Central Station Signaling Systems.</p> <p>ANSI/NFPA No. 72A, Local Protective Signaling Systems.</p> <p>ANSI/NFPA No. 72B, Auxiliary Signaling Systems.</p> <p>ANSI/NFPA No. 72D, Proprietary Protective Signaling Systems.</p> <p>ANSI/NFPA No. 72E, Automatic Fire Detectors.</p> <p>ANSI/NFPA No. 101, Life Safety Code.</p>
1910.165 .....	ANSI/NFPA No. 71, Central Station Signaling Systems.

Subpart L section	National consensus standard
Metric Conversion ....	<p>ANSI/NFPA No. 72A, Local Protective Signaling Systems.</p> <p>ANSI/NFPA No. 72B, Auxiliary Protective Signaling Systems.</p> <p>ANSI/NFPA No. 72C, Remote Station Protective Signaling Systems.</p> <p>ANSI/NFPA No. 72D, Proprietary Protective Signaling Systems.</p> <p>ANSI/NFPA No. 101, Life Safety Code.</p> <p>ANSI/ASTM No. E380, American National Standard for Metric Practice.</p>

NFPA standards are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.  
ANSI Standards are available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

[45 FR 60715, Sept. 12, 1980, as amended at 58 FR 35309, June 30, 1993]

#### APPENDIX C TO SUBPART L TO PART 1910—FIRE PROTECTION REFERENCES FOR FURTHER INFORMATION

I. *Appendix general references.* The following references provide information which can be helpful in understanding the requirements contained in all of the sections of subpart L:

A. *Fire Protection Handbook*, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

B. *Accident Prevention Manual for Industrial Operations*, National Safety Council; 425 North Michigan Avenue, Chicago, IL 60611.

C. Various associations also publish information which may be useful in understanding these standards. Examples of these associations are: Fire Equipment Manufacturers Association (FEMA) of Arlington, VA 22204 and the National Association of Fire Equipment Distributors (NAFED) of Chicago, IL 60601.

II. *Appendix references applicable to individual sections.* The following references are grouped according to individual sections contained in subpart L. These references provide information which may be helpful in understanding and implementing the standards of each section of subpart L.

##### A. § 1910.156. Fire brigades:

1. *Private Fire Brigades*, NFPA 27; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269 .

2. *Initial Fire Attack, Training Standard On*, NFPA 197; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269 .

3. *Fire Fighter Professional Qualifications*, NFPA 1001; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269 .

4. *Organization for Fire Services*, NFPA 1201; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269 .

5. *Organization of a Fire Department*, NFPA 1202; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269 .

6. *Protective Clothing for Structural Fire Fighting*, ANSI/NFPA 1971; .

7. *American National Standard for Men's Safety-Toe Footwear*, ANSI Z41.1; American National Standards Institute, New York, NY 10018.

8. *American National Standard for Occupational and Educational Eye and Face Protection*, ANSI Z87.1; American National Standards Institute, New York, NY 10018.

9. *American National Standard, Safety Requirements for Industrial Head Protection*, ANSI Z89.1; American National Standards Institute, New York, NY 10018.

10. *Specifications for Protective Headgear for Vehicular Users*, ANSI Z90.1; American National Standards Institute, New York, NY 10018.

11. *Testing Physical Fitness*; Davis and Santa Maria. *Fire Command*. April 1975.

12. *Development of a Job-Related Physical Performance Examination for Fire Fighters*; Dotson and Others. A summary report for the National Fire Prevention and Control Administration. Washington, DC. March 1977.

13. *Proposed Sample Standards for Fire Fighters' Protective Clothing and Equipment*; International Association of Fire Fighters, Washington, DC.

14. *A Study of Facepiece Leakage of Self-Contained Breathing Apparatus by DOP Man Tests*; Los Alamos Scientific Laboratory, Los Alamos, NM.

15. *The Development of Criteria for Fire Fighters' Gloves; Vol. II: Glove Criteria and Test Methods*; National Institute for Occupational Safety and Health, Cincinnati, OH. 1976.

16. *Model Performance Criteria for Structural Fire Fighters' Helmets*; National Fire Prevention and Control Administration, Washington, DC. 1977.

17. *Firefighters*; Job Safety and Health Magazine, Occupational Safety and Health Administration, Washington, DC. June 1978.

18. *Eating Smoke—The Dispensable Diet*; Utech, H.P. The Fire Independent, 1975.

19. *Project Monoxide—A Medical Study of an Occupational Hazard of Fire Fighters*; International Association of Fire Fighters, Washington, DC.

20. *Occupational Exposures to Carbon Monoxide in Baltimore Firefighters*; Radford and Levine. Johns Hopkins University, Baltimore, MD. *Journal of Occupational Medicine*, September, 1976.

21. *Fire Brigades*; National Safety Council, Chicago, IL. 1966.

22. *American National Standard, Practice for Respiratory Protection for the Fire Service*; ANSI Z88.5; American National Standards Institute, New York, NY 10018.

23. *Respirator Studies for the Nuclear Regulatory Commission; October 1, 1977—September 30, 1978. Evaluation and Performance of Open Circuit Breathing Apparatus*. NU REG/CR-1235.

Los Alamos Scientific Laboratory; Los Alamos, NM. 87545, January, 1980.

B. §1910.157. *Portable fire extinguishers:*

1. *Standard for Portable Fire Extinguishers*, ANSI/NFPA 10; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269

2. *Methods for Hydrostatic Testing of Compressed Gas Cylinders*, C-1; Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA 22202.

3. *Recommendations for the Disposition of Unserviceable Compressed Gas Cylinders*, C-2; Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA 22202.

4. *Standard for Visual Inspection of Compressed Gas Cylinders*, C-6; Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA 22202.

5. *Portable Fire Extinguisher Selection Guide*, National Association of Fire Equipment Distributors; 111 East Wacker Drive, Chicago, IL 60601.

C. §1910.158. *Standpipe and hose systems:*

1. *Standard for the Installation of Sprinkler Systems*, ANSI/NFPA 13; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2. *Standard of the Installation of Standpipe and Hose Systems*, ANSI/NFPA 14; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

3. *Standard for the Installation of Centrifugal Fire Pumps*, ANSI/NFPA 20; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

4. *Standard for Water Tanks for Private Fire Protection*, ANSI/NFPA 22; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

5. *Standard for Screw Threads and Gaskets for Fire Hose Connections*, ANSI/NFPA 194; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

6. *Standard for Fire Hose*, NFPA 196; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

7. *Standard for the Care of Fire Hose*, NFPA 198; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

D. §1910.159. *Automatic sprinkler systems:*

1. *Standard of the Installation of Sprinkler Systems*, ANSI/NFPA 13; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2. *Standard for the Care and Maintenance of Sprinkler Systems*, ANSI/NFPA 13A; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

3. *Standard for the Installation of Standpipe and Hose Systems*, ANSI/NFPA 14; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

4. *Standard for the Installation of Centrifugal Fire Pumps*, ANSI/NFPA 20; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.



5. *Standard for Water Tanks for Private Fire Protection*, ANSI/NFPA 22; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

6. *Standard for Indoor General Storage*, ANSI/NFPA 231; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

7. *Standard for Rack Storage of Materials*, ANSI/NFPA 231C; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

E. §1910.160. *Fixed extinguishing systems—general information:*

1. *Standard for Foam Extinguishing Systems*, ANSI/NFPA 11; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2. *Standard for Hi-Expansion Foam Systems*, ANSI/NFPA 11A; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

3. *Standard on Synthetic Foam and Combined Agent Systems*, ANSI/NFPA 11B; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

4. *Standard on Carbon Dioxide Extinguishing Systems*, ANSI/NFPA 12; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

5. *Standard on Halon 1301*, ANSI/NFPA 12A; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

6. *Standard on Halon 1211*, ANSI/NFPA 12B; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

7. *Standard for Water Spray Systems*, ANSI/NFPA 15; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

8. *Standard for Foam-Water Sprinkler Systems and Foam-Water Spray Systems*, ANSI/NFPA 16; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

9. *Standard for Dry Chemical Extinguishing Systems*, ANSI/NFPA 17; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

F. §1910.161. *Fixed extinguishing systems—dry chemical:*

1. *Standard for Dry Chemical Extinguishing Systems*, ANSI/NFPA 17; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2. *National Electrical Code*, ANSI/NFPA 70; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

3. *Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapor from Commercial Cooking Equipment*, NFPA 96; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

G. §1910.162. *Fixed extinguishing systems—gaseous agents:*

1. *Standard on Carbon Dioxide Extinguishing Systems*, ANSI/NFPA 12; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2. *Standard on Halon 1301*, ANSI/NFPA 12B; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

3. *Standard on Halon 1211*, ANSI/NFPA 12B; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

4. *Standard on Explosion Prevention Systems*, ANSI/NFPA 69; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

5. *National Electrical Code*, ANSI/NFPA 70; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

6. *Standard on Automatic Fire Detectors*, ANSI/NFPA 72E; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

7. *Determination of Halon 1301/1211 Threshold Extinguishing Concentrations Using the Cup Burner Method*; Riley and Olson, Ansul Report AL-530-A.

H. §1910.163. *Fixed extinguishing systems—water spray and foam agents:*

1. *Standard for Foam Extinguisher Systems*, ANSI/NFPA 11; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2. *Standard for High Expansion Foam Systems*, ANSI/NFPA 11A; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

3. *Standard for Water Spray Fixed Systems for Fire Protection*, ANSI/NFPA 15; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

4. *Standard for the Installation of Foam-Water Sprinkler Systems and Foam-Water Spray Systems*, ANSI/NFPA 16; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

I. §1910.164. *Fire Detection systems:*

1. *National Electrical Code*, ANSI/NFPA 70; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2. *Standard for Central Station Signaling Systems*, ANSI/NFPA 71; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

3. *Standard on Automatic Fire Detectors*, ANSI/NFPA 72E; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

J. §1910.165. *Employee alarm systems:*

1. *National Electrical Code*, ANSI/NFPA 70; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

2. *Standard for Central Station Signaling Systems*, ANSI/NFPA 71; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

3. *Standard for Local Protective Signaling Systems*, ANSI/NFPA 72A; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

4. *Standard for Auxiliary Protective Signaling Systems*, ANSI/NFPA 72B; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

5. *Standard for Remote Station Protective Signaling Systems*, ANSI/NFPA 72C; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

6. *Standard for Proprietary Protective Signaling Systems*, ANSI/NFPA 72D; National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

7. *Vocal Emergency Alarms in Hospitals and Nursing Facilities: Practice and Potential*. National Bureau of Standards. Washington, D.C., July 1977.

8. *Fire Alarm and Communication Systems*. National Bureau of Standards. Washington, D.C., April 1978.

[45 FR 60715, Sept. 12, 1980, as amended at 58 FR 35309, June 30, 1993]

APPENDIX D TO SUBPART L TO PART 1910—AVAILABILITY OF PUBLICATIONS INCORPORATED BY REFERENCE IN SECTION 1910.156 FIRE BRIGADES

The final standard for fire brigades, Section 1910.156, contains provisions which in-

corporate certain publications by reference. The publications provide criteria and test methods for protective clothing worn by those fire brigade members who are expected to perform interior structural fire fighting. The standard references the publications as the chief sources of information for determining if the protective clothing affords the required level of protection.

It is appropriate to note that the final standard does not require employers to purchase a copy of the referenced publications. Instead, employers can specify (in purchase orders to the manufacturers) that the protective clothing meet the criteria and test methods contained in the referenced publications and can rely on the manufacturers' assurances of compliance. Employers, however, may desire to obtain a copy of the referenced publications for their own information.

The paragraph designation of the standard where the referenced publications appear, the title of the publications, and the availability of the publications are as follows:

Paragraph designation	Referenced Publication	Available From
1910.156(e)(3)(ii) .....	"Protective Clothing for Structural Fire Fighting," NFPA No. 1971 (1975).	National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.
1910.156(e)(4)(i) .....	"Development of Criteria for Fire Fighter's Gloves; Vol. II, Part II: Test Methods" (1976).	U.S. Government Printing Office, Washington, D.C. 20402. Stock No. for Vol. II is: 071-033-0201-1.
1910.156(e)(5)(i) .....	"Model Performance Criteria for Structural Firefighter's Helmets" (1977).	U.S. Fire Administration, National Fire Safety and Research Office, Washington, D.C. 20230.

The referenced publications (or a microfiche of the publications) are available for review at many universities and public libraries throughout the country. These publications may also be examined at the OSHA Technical Data Center, Room N2439-Rear, United States Department of Labor, 200 Constitution Ave., N.W., Washington, D.C. 20210 (202-219-7500), or at any OSHA Regional Office (see telephone directories under United States Government-Labor Department).

[45 FR 60715, Sept. 12, 1980, as amended at 58 FR 33509, June 30, 1993; 61 FR 9239, Mar. 7, 1996]

APPENDIX E TO SUBPART L TO PART 1910—TEST METHODS FOR PROTECTIVE CLOTHING

This appendix contains test methods which must be used to determine if protective clothing affords the required level of protection as specified in § 1910.156, fire brigades.

(1) *Puncture resistance test method for foot protection.*

A. *Apparatus.* The puncture resistance test shall be performed on a testing machine having a movable platform adjusted to travel at ¼-inch/min (0.1 cm/sec). Two blocks of hardwood, metal, or plastic shall be prepared as follows: the blocks shall be of such size and thickness as to insure a suitable rigid test ensemble and allow for at least one-inch of the pointed end of an 8D nail to be exposed for the penetration. One block shall have a hole drilled to hold an 8D common nail firmly at an angle of 98°. The second block shall have a maximum ½-inch (1.3 cm) diameter hole drilled through it so that the hole will allow free passage of the nail after it penetrates the insole during the test.

B. *Procedure.* The test ensemble consisting of the sample unit, the two prepared blocks, a piece of leather outsole 10 to 11 irons thick, and a new 8D nail, shall be placed as follows: the 8D nail in the hole, the sample of outsole stock superimposed above the nail, the area of the sole plate to be tested placed on the

outsole, and the second block with hole so placed as to allow for free passage of the nail after it passes through the outsole stock and sole plate in that order. The machine shall be started and the pressure, in pounds required for the nail to completely penetrate the outsole and sole plate, recorded to the nearest five pounds. Two determinations shall be made on each sole plate and the results averaged. A new nail shall be used for each determination.

C. *Source.* These test requirements are contained in "Military Specification For Fireman's Boots," MIL-B-2885D (1973 and amendment dated 1975) and are reproduced for your convenience.

(2) *Test method for determining the strength of cloth by tearing: Trapezoid Method.*

A. *Test specimen.* The specimen shall be a rectangle of cloth 3-inches by 6-inches (7.6 cm by 15.2 cm). The long dimension shall be parallel to the warp for warp tests and parallel to the filling for filling tests. No two specimens for warp tests shall contain the same warp yarns, nor shall any two specimens for filling tests contain the same filling yarns. The specimen shall be taken no nearer the selvage than  $\frac{1}{10}$  the width of the cloth. An isosceles trapezoid having an altitude of 3-inches (7.6 cm) and bases of 1 inch (2.5 cm) and 4 inches (10.2 cm) in length, respectively, shall be marked on each specimen, preferably with the aid of a template. A cut approximately  $\frac{3}{8}$ -inch (1 cm) in length shall then be made in the center of a perpendicular to the 1-inch (2.5 cm) edge.

B. *Apparatus.* (i) Six-ounce (.17 kg) weight tension clamps shall be used so designed that the six ounces (.17 kg) of weight are distributed evenly across the complete width of the sample.

(ii) The machine shall consist of three main parts: Straining mechanism, clamps for holding specimen, and load and elongation recording mechanisms.

(iii) A machine wherein the specimen is held between two clamps and strained by a uniform movement of the pulling clamp shall be used.

(iv) The machine shall be adjusted so that the pulling clamp shall have a uniform speed of  $12 \pm 10.5$  inches per minute ( $0.5 \pm .02$  cm/sec).

(v) The machine shall have two clamps with two jaws on each clamp. The design of the two clamps shall be such that one gripping surface or jaw may be an integral part of the rigid frame of the clamp or be fastened to allow a slight vertical movement, while the other gripping surface or jaw shall be completely moveable. The dimension of the immovable jaw of each clamp parallel to the application of the load shall measure one-inch, and the dimension of the jaw perpendicular to this direction shall measure three inches or more. The face of the movable jaw of each clamp shall measure one-inch by three inches.

Each jaw face shall have a flat smooth, gripping surface. All edges which might cause a cutting action shall be rounded to a radius of not over  $\frac{1}{64}$ -inch (.04 cm). In cases where a cloth tends to slip when being tested, the jaws may be faced with rubber or other material to prevent slippage. The distance between the jaws (gage length) shall be one-inch at the start of the test.

(vi) Calibrated dial; scale or chart shall be used to indicate applied load and elongation. The machine shall be adjusted or set, so that the maximum load required to break the specimen will remain indicated on the calibrated dial or scale after the test specimen has ruptured.

(vii) The machine shall be of such capacity that the maximum load required to break the specimen shall be not greater than 85 percent or less than 15 percent of the rated capacity.

(viii) The error of the machine shall not exceed 2 percent up to and including a 50-pound load (22.6 kg) and 1 percent over a 50-pound load (22.6 kg) at any reading within its loading range.

(ix) All machine attachments for determining maximum loads shall be disengaged during this test.

C. *Procedure.* (i) The specimen shall be clamped in the machine along the nonparallel sides of the trapezoid so that these sides lie along the lower edge of the upper clamp and the upper edge of the lower clamp with the cut halfway between the clamps. The short trapezoid base shall be held taut and the long trapezoid base shall lie in the folds.

(ii) The machine shall be started and the force necessary to tear the cloth shall be observed by means of an autographic recording device. The speed of the pulling clamp shall be 12 inches  $\pm 0.5$  inch per minute ( $0.5 \pm .02$  cm/sec).

(iii) If a specimen slips between the jaws, breaks in or at the edges of the jaws, or if for any reason attributable to faulty technique, an individual measurement falls markedly below the average test results for the sample unit, such result shall be discarded and another specimen shall be tested.

(iv) The tearing strength of the specimen shall be the average of the five highest peak loads of resistance registered for 3 inches (7.6 cm) of separation of the tear.

D. *Report.* (i) Five specimens in each of the warp and filling directions shall be tested from each sample unit.

(ii) The tearing strength of the sample unit shall be the average of the results obtained from the specimens tested in each of the warp and filling directions and shall be reported separately to the nearest 0.1-pound (.05 kg).

E. *Source.* These test requirements are contained in "Federal Test Method Standard 191, Method 5136" and are reproduced for your convenience.

(3) *Test method for determining flame resistance of cloth; vertical.*

A. *Test specimen.* The specimen shall be a rectangle of cloth  $2\frac{3}{4}$  inches (7.0 cm) by 12 inches (30.5 cm) with the long dimension parallel to either the warp or filling direction of the cloth. No two warp specimens shall contain the same warp yarns, and no two filling specimens shall contain the same filling yarn.

B. *Number of determinations.* Five specimens from each of the warp and filling directions shall be tested from each sample unit.

C. *Apparatus.* (i) Cabinet. A cabinet and accessories shall be fabricated in accordance with the requirements specified in Figures L-1, L-2, and L-3. Galvanized sheet metal or other suitable metal shall be used. The entire inside back wall of the cabinet shall be painted black to facilitate the viewing of the test specimen and pilot flame.

(ii) Burner. The burner shall be equipped with a variable orifice to adjust the flame height, a barrel having a  $\frac{3}{8}$ -inch (1 cm) inside diameter and a pilot light.

(a) The burner may be constructed by combining a  $\frac{3}{8}$ -inch (1 cm) inside diameter barrel  $3 \pm \frac{1}{4}$  inches ( $7.6 \pm .6$  cm) long from a fixed orifice burner with a base from a variable orifice burner.

(b) The pilot light tube shall have a diameter of approximately  $\frac{1}{16}$ -inch (.2 cm) and shall be spaced  $\frac{1}{8}$ -inch (.3 cm) away from the burner edge with a pilot flame  $\frac{1}{8}$ -inch (.3 cm) long.

(c) The necessary gas connections and the applicable plumbing shall be as specified in Figure L-4 except that a solenoid valve may be used in lieu of the stopcock valve to which the burner is attached. The stopcock valve or solenoid valve, whichever is used, shall be capable of being fully opened or fully closed in 0.1-second.

(d) On the side of the barrel of the burner, opposite the pilot light there shall be a metal rod of approximately  $\frac{1}{8}$ -inch (.3 cm) diameter spaced  $\frac{1}{2}$ -inch (1.3 cm) from the barrel and extending above the burner. The rod shall have two  $\frac{3}{16}$ -inch (.8 cm) prongs marking the distances of  $\frac{3}{4}$ -inch (1.9 cm) and  $1\frac{1}{2}$  inches (3.8 cm) above the top of the burner.

(e) The burner shall be fixed in a position so that the center of the barrel of the burner is directly below the center of the specimen.

(iii) There shall be a control valve system with a delivery rate designed to furnish gas to the burner under a pressure of  $2\frac{1}{2} \pm \frac{1}{4}$  (psi) ( $17.5 \pm 1.8$  kPa) per square inch at the burner inlet (see (g)(3)(vi)(A)). The manufacturer's recommended delivery rate for the valve system shall be included in the required pressure.

(iv) A synthetic gas mixture shall be of the following composition within the following limits (analyzed at standard conditions):  $55 \pm 3$  percent hydrogen,  $24 \pm 1$  percent methane,

$3 \pm 1$  percent ethane, and  $18 \pm 1$  percent carbon monoxide which will give a specific gravity of  $0.365 \pm 0.018$  (air = 1) and a B.T.U. content of  $540 \pm 20$  per cubic foot ( $20.1 \pm 3.7$  kJ/L)(dry basis) at  $69.8^{\circ}\text{F}$  ( $21^{\circ}\text{C}$ ).

(v) There shall be metal hooks and weights to produce a series of total loads to determine length of char. The metal hooks shall consist of No. 19 gage steel wire or equivalent and shall be made from 3-inch (7.6 cm) lengths of wire and bent  $\frac{1}{2}$ -inch (1.3 cm) from one end to a 45 degree hook. One end of the hook shall be fastened around the neck of the weight to be used.

(vi) There shall be a stop watch or other device to measure the burning time to 0.2-second.

(vii) There shall be a scale, graduated in 0.1 inch (.3 cm) to measure the length of char.

D. *Procedure.* (i) The material undergoing test shall be evaluated for the characteristics of after-flame time and char length on each specimen.

(ii) All specimens to be tested shall be at moisture equilibrium under standard atmospheric conditions in accordance with paragraph (3)C of this appendix. Each specimen to be tested shall be exposed to the test flame within 20 seconds after removal from the standard atmosphere. In case of dispute, all testing will be conducted under Standard Atmospheric Conditions in accordance with paragraph (3)C of this appendix.

(iii) The specimen in its holder shall be suspended vertically in the cabinet in such a manner that the entire length of the specimen is exposed and the lower end is  $\frac{3}{4}$ -inch (1.9 cm) above the top of the gas burner. The apparatus shall be set up in a draft free area.

(iv) Prior to inserting the specimen, the pilot flame shall be adjusted to approximately  $\frac{1}{8}$ -inch (.3 cm) in height measured from its lowest point to the tip.

The burner flame shall be adjusted by means of the needle valve in the base of the burner to give a flame height of  $1\frac{1}{2}$  inches (3.8 cm) with the stopcock fully open and the air supply to the burner shut off and taped. The  $1\frac{1}{2}$ -inch (3.8 cm) flame height is obtained by adjusting the valve so that the uppermost portion (tip) of the flame is level with the tip of the metal prong (see Figure L-2) specified for adjustment of flame height. It is an important aspect of the evaluation that the flame height be adjusted with the tip of the flame level with the tip of the metal prong. After inserting the specimen, the stopcock shall be fully opened, and the burner flame applied vertically at the middle of the lower edge of the specimen for 12 seconds and the burner turned off. The cabinet door shall remain shut during testing.

(v) The after-flame shall be the time the specimen continues to flame after the burner flame is shut off.

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(vi) After each specimen is removed, the test cabinet shall be cleared of fumes and smoke prior to testing the next specimen.

(vii) After both flaming and glowing have ceased, the char length shall be measured. The char length shall be the distance from the end of the specimen, which was exposed to the flame, to the end of a tear (made lengthwise) of the specimen through the center of the charred area as follows: The specimen shall be folded lengthwise and creased by hand along a line through the highest peak of the charred area. The hook shall be inserted in the specimen (or a hole, ¼-inch (.6 cm) diameter or less, punched out for the hook) at one side of the charred area ¼-inch (.6 cm) from the adjacent outside edge and ¼-inch (.6 cm) in from the lower end. A weight of sufficient size such that the weight and hook together shall equal the total tearing load required in Table L-2 of this section shall be attached to the hook.

(viii) A tearing force shall be applied gently to the specimen by grasping the corner of the cloth at the opposite edge of the char from the load and raising the specimen and weight clear of the supporting surface. The end of the tear shall be marked off on the edge and the char length measurement made along the undamaged edge.

Loads for determining char length applicable to the weight of the test cloth shall be as shown in Table L-2.

TABLE L-2<sup>1</sup>

Specified weight per square yard of cloth before any fire retardant treatment or coating—ounces	Total tearing weight for determining the charred length—pound
2.0 to 6.0 .....	0.25
Over 6.0 to 15.0 .....	0.50
Over 15.0 to 23.0 .....	0.75
Over 23.0 .....	1.0

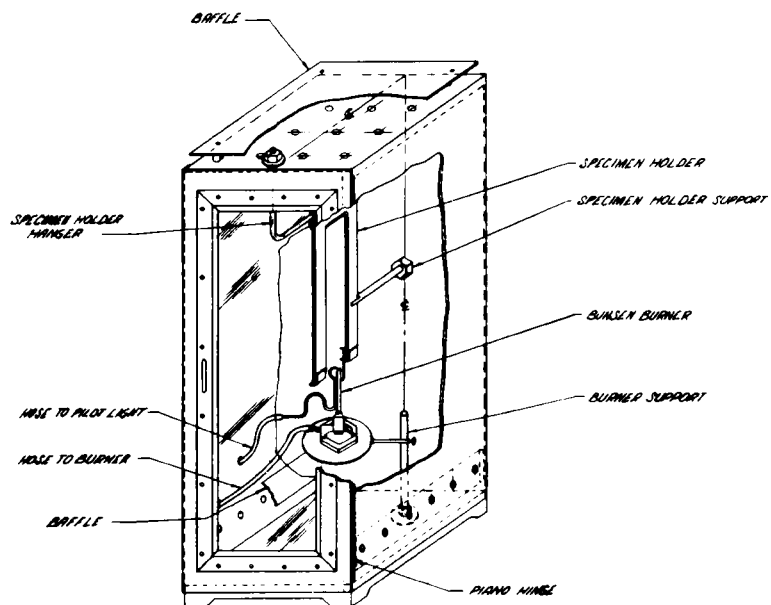
<sup>1</sup>To change into S.I. (System International) units, 1 ounce=28.35 grams, 1 pound=453 grams, 1 yard=.91 metre.

(ix) The after-flame time of the specimen shall be recorded to the nearest 0.2-second and the char length to the nearest 0.1-inch (.3 cm).

E. *Report.* (i) The after-flame time and char length of the sample unit shall be the average of the results obtained from the individual specimens tested. All values obtained from the individual specimens shall be recorded.

(ii) The after-flame time shall be reported to the nearest 0.2-second and the char length to the nearest 0.1-inch (.3 cm).

F. *Source.* These test requirements are contained in "Federal Test Method Standard 191, Method 5903 (1971)" and are reproduced for your convenience.



ILLUSTRATION

FIGURE L-1 - Vertical flame resistance textile apparatus. All given System International (S. I.) Unit: 1-inch = 2/54 cm. dimensions are in inches.

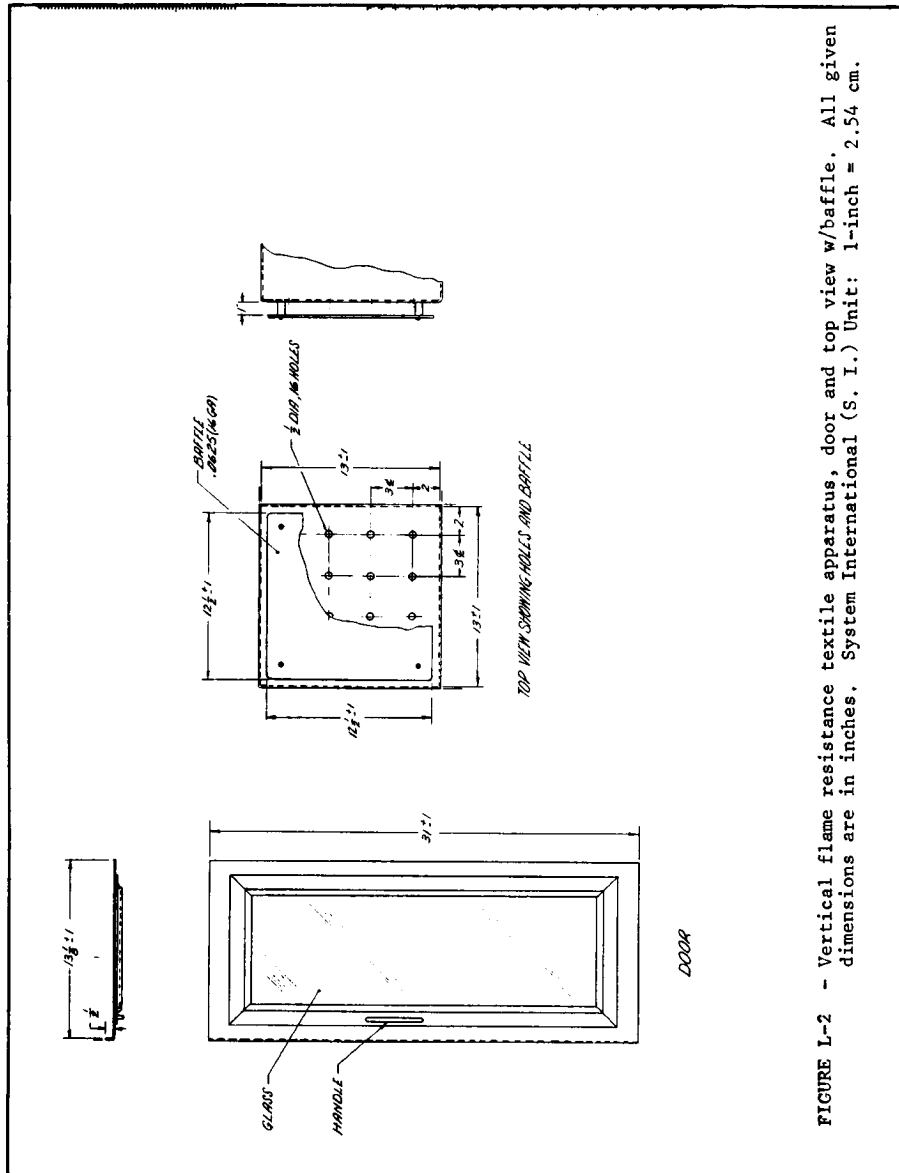
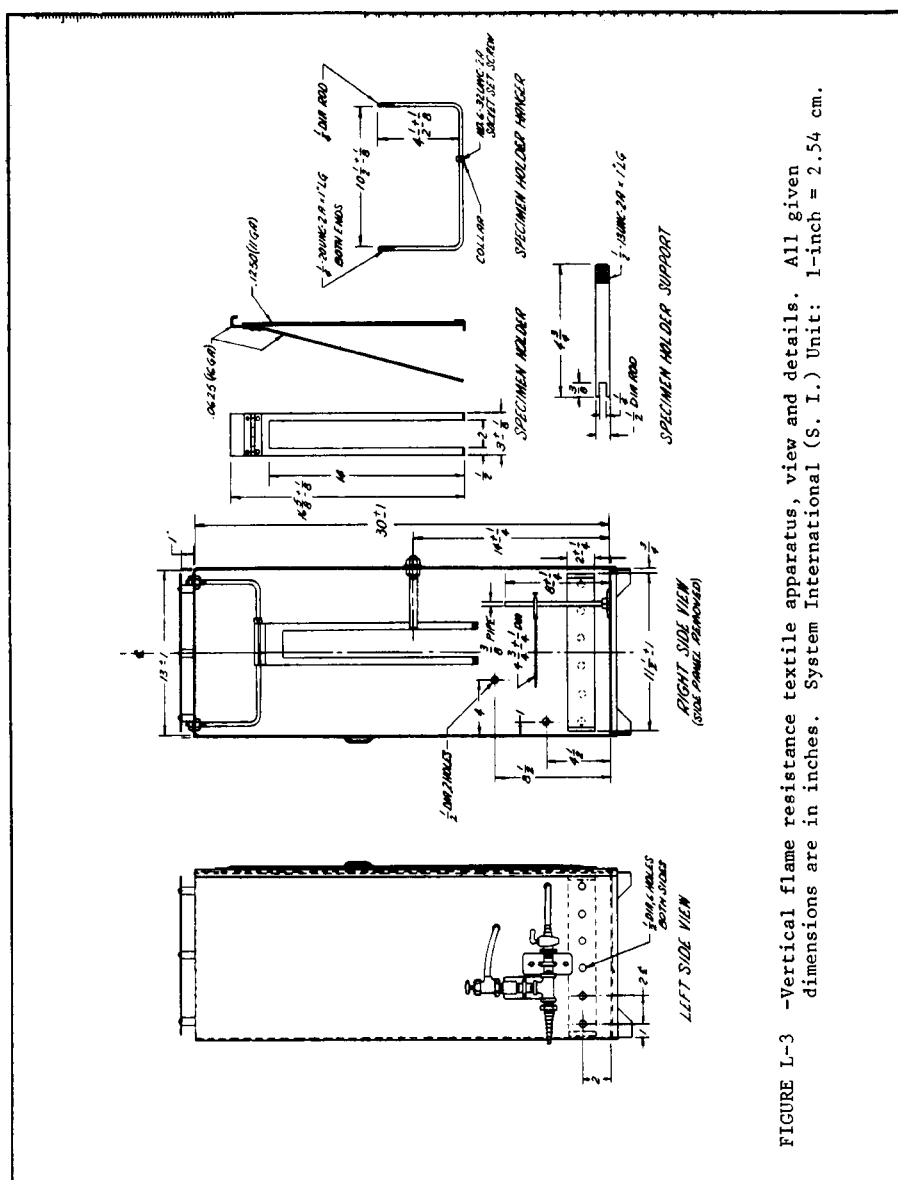
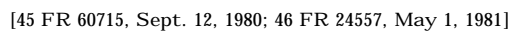


FIGURE L-2 - Vertical flame resistance textile apparatus, door and top view w/baffle. All given dimensions are in inches. System International (S. I.) Unit: 1-inch = 2.54 cm.







This section is not intended to apply to compressed air machinery and equipment used on transportation vehicles such as steam railroad cars, electric railway cars, and automotive equipment.

(ii) All safety valves used shall be constructed, installed, and maintained in accordance with the A.S.M.E. Boiler and Pressure Vessel Code, Section VIII Edition 1968.

(b) *Installation and equipment requirements*—(1) *Installation.* Air receivers shall be so installed that all drains, handholes, and manholes therein are

**§ 1910.169 Air receivers.**

(a) *General requirements*—(1) *Application*. This section applies to compressed air receivers, and other equipment used in providing and utilizing compressed air for performing operations such as cleaning, drilling, hoisting, and chipping. On the other hand, however, this section does not deal with the special problems created by using compressed air to convey materials nor the problems created when men work in compressed air as in tunnels and caissons.