

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

1	PURPOSE .....	3
2	APPLICABILITY AND SCOPE .....	3
2.1	Applicability of Standards .....	4
2.2	Use of Industry Codes and Standards .....	4
2.3	Mandatory versus Non-Mandatory. ....	4
2.4	Construction Work Versus Other Activity-Level Work .....	4
2.5	Retroactivity of Requirements.....	5
3	DEFINITIONS .....	5
4	FIRE PREVENTION .....	8
4.1	Housekeeping .....	8
4.2	Combustible Control.....	8
4.3	Flammable/Combustible Liquid Control Areas .....	9
4.4	Control of Ignition Sources.....	10
4.5	Signs, Signals, and Barricades .....	11
4.6	Fire Protection Program .....	11
4.7	Fire Hazards Analyses.....	12
4.8	Facility Fire Protection Assessments.....	13
5	FIRE PROTECTION.....	13
5.1	Automatic Suppression .....	13
5.2	Water-Based Fire Suppression Systems:.....	14
5.3	Water Mist Suppression Systems.....	16
5.4	Gaseous Fire Suppression Systems .....	16
5.5	Chemical Fire Suppression Systems.....	16
5.6	Manual Suppression .....	16
5.7	Detection System .....	17
5.8	Fire Alarm System.....	17
5.9	Notification.....	18
5.10	Two-Way Communication System.....	19
5.11	Barriers (Compartmentation Requirements).....	19
6	MEANS OF EGRESS .....	20
6.1	Escape-ways .....	20
6.2	Refuge Stations .....	22

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

6.4	Emergency Lighting .....	23
6.5	Ventilation.....	24
6.6	Underground Main Fan Controls .....	27
6.7	Fire Protection Design of Underground Ventilation Systems.....	27
6.8	Smoke Spread.....	28
6.9	Subsurface Entry.....	30
6.10	Self-Rescuers.....	30
6.11	Self-Contained Self-Rescuers.....	30
6.12	Fire Drills .....	30
7	FIRE DEPARTMENT RESPONSE .....	31
8	UNDERGROUND FACILITY RESCUE.....	35
8.1	Mine Rescue Teams .....	35
8.2	Availability of Mine Rescue Teams.....	35
8.3	Mine Rescue Station .....	36
8.4	Equipment and Maintenance Requirements .....	36
8.5	Physical Requirements for Mine Rescue Team .....	36
8.6	Training for Mine Rescue Teams.....	36
8.7	Underground Facility Emergency Notification Plan .....	36
9.	UNDERGROUND FACILITIES SERVICES	
9.2	Drainage System	
9.3	Containment System	

# DOE-STD-1066-2017, Underground Fire Protection Criteria DRAFT A

---

## 1 PURPOSE

The DOE underground facilities are a unique collection of tunnels, shafts, and accelerators, in which research, experiments and dedicated activities are performed that are not common to general industry. These facilities are unique and unlike the building codes and standards, these facilities may include underground facilities, such as accelerators, that are constructed by conventional means, that is open cut excavations. Many of the requirements in 29 CFR 1910 and 29 CFR 1926 are typical aspects of effective safety and health programs and are applicable and implemented consistently in surface and underground facilities and approved programs, plans, and directives. However, the atypical nature of the DOE underground facilities necessitates some alternatives to 29 CFR 1910 and 29 CFR 1926 through the selection of more appropriate standards or voluntarily-imposed, locally-developed requirements. The selection of alternative standards and development of local requirements is the result of subject matter expert judgment and management review and approval. This standard also establishes that clarifications and alternatives to the selected requirements for DOE underground facilities may, on a case-by-case basis, be approved and utilized for the duration of specific experiments, tests, or operations following analysis of hazards and implementation of mitigating features, that is, engineered features and/or administrative controls. [1.1.2]

## 2 APPLICABILITY AND SCOPE

This standard applies to the full set of existing and future underground facilities located on DOE sites and DOE facilities located in leased facilities. This is applicable to activities associated with operations as well as construction work. This does not establish nuclear safety requirements. [1.1.3]

This standard identifies the requirements for safe and healthy performance of activities in the DOE underground facilities. It is expected that facility-specific implementation, due to unique characteristics of a particular underground facility, will be through facility-specific operating procedures, standard operating procedures, or other authorized means. [1.1.4]

# DOE-STD-1066-2017, Underground Fire Protection Criteria DRAFT A

---

## 2.1 Applicability of Standards.

The requirements contained in this standard have been selected for use in design, construction, maintenance, operations, and decommissioning of all underground facilities. The selected requirements have been derived from 29 CFR 1910 and 29 CFR 1926 and other regulations, codes, standards, and guidance; for example 30 CFR 57 , national consensus standards, and DOE directives among others. By virtue of being made part of this standard, the requirements are deemed applicable to DOE underground facilities and will provide a proven and accepted means for the design, construction, fabrication, operation, use, and maintenance of underground facilities and activities. [1.3.1.1]

## 2.2 Use of Industry Codes and Standards.

Application of industry codes and standards, where available, provides established performance levels, accepted levels of reliability, and service factors based on equipment usage and performance. However, there are few industry consensus standards directly applicable for the development of structures, systems, and components used in unique underground facilities and operations. Therefore, tailoring of national consensus standards is appropriate for the DOE underground facility applications. [1.3.2.1]

Citations to the sources of the requirements are shown in brackets { } following the statement of the requirement. In some cases, the requirements are not verbatim extracts from the source documents but have been tailored to be consistent with DOE nomenclature, facilities, and/or activities. Requirements without citations have been developed locally to address a specific aspect of the DOE underground facilities. [1.3.2.2]

## 2.3 Mandatory versus Non-Mandatory.

Codes and standards are made mandatory either by regulation or through contractual means. Those requirements derived from mandatory codes and standards shall also be mandatory in this standard. Those requirements derived from non-mandatory codes and standards shall be considered applicable to the extent necessary for prudent, safe, and environmentally conscientious operations. [1.3.3.1]

Those codes and standards referenced by this Performance Document (PD) and the requirements therein shall be considered part of the requirements of this PD only to the extent each such reference is invoked. When a reference to a code or standard is preceded by the phrase “in accordance with”, it shall mean that full compliance with the cited reference is expected to the extent applicable to the DOE underground facility construction and operations. Citation of a selected appropriate requirement from a standard does not imply compliance with other requirements in the standard. [1.3.3.3]

## 2.4 Construction Work versus Other Activity-Level Work.

The activities conducted in the DOE underground facilities cover a wide range of work, from construction to maintenance to general industry to administrative. To ensure the appropriate selection of requirements from either 29 CFR 1910 and/or 29 CFR 1926, it is necessary to properly evaluate and determine the nature of the work being performed. Construction work is not limited to new construction, but can include repair of existing facilities or replacement of structures and their components. The organization performing the work is not the basis for determining the nature of the work. [1.3.4.1]

# DOE-STD-1066-2017, Underground Fire Protection Criteria DRAFT A

---

## 2.5 Retroactivity of Requirements.

The DOE underground facilities are a collection of existing tunnels and shafts constructed over a period of many years. Modifications to these existing tunnels and shafts are routinely being implemented to accommodate new research, experiments and other activities. The requirements of this standard shall be incorporated into the design, construction, and operation of new or modified areas in the existing tunnels and shafts. When requirements of this standard apply to existing underground facilities and the underground facility is not in conformance with those requirements, then a back-fit analysis of any underground facility in operational mode or operational standby mode shall be performed to determine whether the benefits of achieving compliance are warranted considering the hazard mitigation, programmatic impacts, future use, and cost. [1.3.5]

## 2.6 Performance Based (Fire Modeling)

This standard sets forth the requirement of new underground facilities to have the life safety systems designed to the performance-based methodically. The use of computer fire models and occupant evacuation models is strongly encourage for these unique facilities. The SFPE Engineering Guide to Performance-Based Fire Protection should be consulted when performing such analysis. Models could be used to extend the travel distances outlined in Section 6 and Ventilation and smoke control in Sections 6.5

## 3 DEFINITIONS

**Alcove:** An opening into the rib of a drift to allow the placement of equipment so that it does not interfere with personnel or vehicular traffic. [1.2.3]

**Back:** The surface of the tunnel excavation above the spring line; also, roof. {USACE EM 1110-2-2901} [1.2.4]

**Construction:** A combination of erection, installation, assembly, demolition, or fabrication activities involved to create a new facility or to alter, add to, rehabilitate, dismantle, or remove an existing facility. It also includes the alteration and repair (including dredging, excavating, and painting) of buildings, structures, or other real property, as well as any construction, demolition, and excavation activities conducted as part of environmental restoration or remediation efforts. {10 CFR 851.3(a)} [1.2.9]

**Drift:** An approximately horizontal passageway or portion of a tunnel. {USACE EM 1110-2-2901} [1.2.10]

**Escape-way:** A passageway in the underground infrastructure by which persons may leave an underground facility or access a refuge station in an emergency. {30 CFR 57.2} [1.2.11]

**Excavation:** Any man-made cut, cavity, trench, or depression in a tunnel invert, formed by earth removal. {29 CFR 1926.650(b)} [1.2.12]

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

**Exit Discharge:** The part of the escape-way that discharges directly to the outside or to a street, walkway, refuge station, public way or open space with access to the outside. {29 CFR 1910.34}

**Face:** The advanced end or wall of a tunnel, drift, or excavation at which work is progressing. {USACE EM 1110-2-2901}

**Fire Hazard:** Any situation, process, material, or condition that, on the basis of applicable data, can cause a fire or explosion or that can provide a ready fuel supply to augment the spread or intensity of a fire or explosion, all of which pose a threat to life or property. {NFPA 1, 2012}

**Fixed:** Fastened in place and not relocated while in operation.

**Ground Support:** Installation of any type of engineering structure around or inside the excavation, such as steel sets, wooden cribs, timbers, concrete blocks, or lining, which will increase its stability. This type of support is external to the rock mass. {USACE EM 1110-2-2901} DOE also considers the placement of rock bolts and rock anchors at a fairly uniform spacing to consolidate the rock and reinforce the rock's natural tendency to support itself, also used in conjunction with shotcrete on the rock surface, as ground support.

**Hazard of Contents** {NFPA 520 reference NFPA 1 for further clarification}

**High Hazard:** Contents that are likely to burn with extreme rapidity or form which explosions are likely.

**Low Hazard:** Contents of such low combustibility that no self-propagating fire therein can occur.

**Ordinary Hazard:** Contents that are likely to burn with moderate rapidity or to give off a considerable volume of smoke.

**Invert:** The bottom of the tunnel. {USACE EM 1110-2-2901}

**Jumbo:** A mobile machine containing work platforms and drills, used for drilling and loading blast holes, scaling the face, or performing other work related to excavation (mining). {USACE EM 1110-2-2901}

**Mining:** The process of digging below the surface of the ground to produce a passageway such as a tunnel. {USACE EM 1110-2-2901}

**Mobile Equipment:** Wheeled, skid-mounted, track- or rail-mounted equipment capable of moving or being moved. {30 CFR 57.2}

**Niche:** A small opening into the rib of a drift or tunnel to allow placement of equipment such that it does not interfere with personnel or vehicular traffic.

**Permanent:** Structures, systems, and components (SSC), facility, appurtenance, activity, modification, variance, or similar that is implemented without a restriction on the duration of usage.

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

**Permissible:** A machine, material, apparatus, or device which has been investigated, tested, and approved and is maintained in permissible condition. {30 CFR 57.2}

**Pillar:** A column of in situ alluvium or rock bounded on two or more sides by open drifts that are relied upon for the structural integrity of the adjoining drifts.

**Portable:** The machine or device can be, and usually is, carried about in the course of normal operation.

**Portal:** The entrance from the ground surface to a tunnel. {USACE EM 1110-2-2901}

**Refuge Station:** A safe haven for all people in an underground facility when evacuation from the facility is not possible.

**Rib:** The sides of a tunnel. {USACE EM 1110-2-2901}

**Roof:** The rock overlying the underground facility together with any structural reinforcement in the form of rock bolts, a surface layer of shotcrete, and/or other reinforcement. {NFPA 520}

**Shaft:** An excavation with a depth much greater than its horizontal cross-section. A shaft is considered vertical if its alignment is within 20 degrees of vertical.

**Shaft Hoist:** A power driven windlass or drum used for raising rock or other material from the underground facility, and for lowering or raising persons and material. {30 CFR 57.2}

**Spring Line:** The point where the curved portion of the back meets the top of the rib. {USACE M 1110-2-2901}

**Standard:** A standard which requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment. {29 CFR 1910.2(f)}

**Temporary:** A short-term or temporally-limited action.

**Travelway:** A passage, walk, or way designated and regularly used for persons to go from one place to another. {30 CFR 57.2}

**Trench:** A narrow excavation (in relation to its length) made below the surface of the tunnel invert. {29 CFR 1926.650(b)}

**Tunnel:** An elongated, narrow, essentially linear excavated underground opening with a length greatly exceeding its width or height. Usually horizontal but may be driven at angles up to 30 deg. {USACE EM 1110-2-2901}

**Underground Facility:** A tunnel or network of drifts resulting from the extraction of subsurface-located material from underground areas in a manner that the surface area is not disturbed except in the vicinity of the entrances (portals or hoist houses) and ventilation openings. {NFPA 520, 3.3.13}

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

- Common Space: The area of the developed underground facility space other than buildings, including but not limited to roadways, railways, loading docks and entrances.
- Developed Space: An area of the underground facility that has been altered for the performance of mission-oriented process operations or experiments.
- Undeveloped Space: An area of the underground facility that has been mined, including installation of ground support and invert, but has not been altered for the performance of mission-oriented process operations or experiments.
- Process Operation/Experiment Area: An area of the underground facility in which materials that are likely to burn with extreme rapidity or from which explosions are likely, are staged or used that is separated from the underground infrastructure or undeveloped space by fire-resistive construction.
- Underground Infrastructure: The area of the developed underground facility other than process operation/experiment areas. The underground infrastructure includes the escape-ways and refuge stations, normal hazard supporting-activity areas, and inactive, legacy process operation/experiment areas. [1.2.40]

## 4 FIRE PREVENTION

### 4.1 Housekeeping

Workplaces, passageways, storerooms, service rooms, and escape-ways shall be kept clean and orderly.

The floor of every workplace shall be maintained in as clean and, so far as possible, dry condition. Where wet processes are used, drainage shall be maintained and false floors, platforms, mats, or other dry standing places shall be provided where practicable.

Every floor, working place, and passageway shall be kept free from protruding nails, splinters, holes, or loose boards, as practicable. {30 CFR 57.20003}

### 4.2 Combustible Control

Combustible Waste in underground areas:

- (a) Waste materials, including liquids, shall not accumulate in quantities that could create a fire hazard.
- (b) Waste or rags containing flammable or combustible liquids that could create a fire hazard shall be placed in covered metal containers. {30 CFR 57.4104}

For at least 200 feet inside the underground facility portal or collar, timber used for underground support in intake openings and in exhaust openings that are also designated as escape-ways shall be:

- (a) Provided with a fire suppression system, other than fire extinguishers and water hoses, capable of controlling a fire in its early stages; or



# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

- (b) Covered with shotcrete, gunite, or other material with equivalent fire protection characteristics; or
- (c) Coated with fire-retardant paint or other material to reduce its flame spread rating to 25 or less and maintained in that condition. {30 CFR 57.4560}

### 4.3 Flammable/Combustible Liquid Control Areas

#### 4.3.1 Storage of Flammable Liquids at Underground Facilities

Flammable liquids shall not be stored underground, except:

- (1) Small quantities stored in tightly closed cabinets away from any heat source. The small quantities shall be stored in safety cans or in non-glass containers of a capacity equal to or less than a safety can. Each cabinet shall be labeled “flammables”.
- (2) Acetylene and liquefied petroleum gases stored in containers designed for that specific purpose.

Gasoline shall not be stored underground in any quantity. {30 CFR 57.4460}

Storage containers of flammable liquids must comply with the minimum of NFPA 30, 2015 Edition.

#### 4.3.2 Storage of Combustible Liquids at Underground Facilities [9.11.2]

Storage containers of combustible liquids must comply with the minimum of NFPA 30, 2015 Edition. Combustible liquids, including oil or grease shall be stored in non-glass containers or storage tanks. The containers or storage tanks shall be:

- (1) Capable of withstanding working pressures and stresses and compatible with the type of liquids stored.
- (2) Maintained in a manner that prevents leakage;
- (3) Located in an area free of combustible materials or in areas where any exposed combustible materials are coated with one inch of shotcrete; one-half inch of gunite, or other noncombustible material with equivalent fire protection characteristics; and
- (4) Separated from explosives or blasting agents, shaft stations, and ignition sources including electric equipment that could create sufficient heat or sparks to pose a fire hazard. Separation shall be sufficient to prevent the occurrence or minimize the spread of fire.

Storage tanks shall be vented or otherwise constructed to prevent development of pressure or vacuum as a result of filling, emptying, or atmospheric temperature changes. Vents for storage of Class II or IIIA liquids shall be isolated or separated from ignition sources.

At permanent storage areas for combustible liquids, means shall be provided for confinement or removal of the contents of the largest storage tank in the event of tank rupture.

All piping, valve, and fitting shall be:

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

- (1) Capable of withstanding working pressures and stresses;
- (2) Compatible with the type of liquids stored; and
- (3) Maintained in manner which prevents leakage. {30 CFR 57.4462}

### 4.3.3 Storage Cabinets

The storage cabinets in underground facilities for flammable liquids, shall meet the applicable requirements of Section 9.5 of NFPA 30. [9.11.3.1]

### 4.4 Control of Ignition Sources

Heat sources capable of producing combustion shall be separated from combustible materials if a fire hazard could be created. {30 CFR 57.4500}

Battery-charging stations shall be ventilated with a sufficient volume of air to prevent the accumulation of hydrogen gas.

Smoking, use of open flames, or other activities that could create an ignition source shall be prohibited at the battery charging station during battery charging.

Readily visible signs prohibiting smoking or open flames shall be posted at battery-charging stations during battery charging. {30 CFR 57.4502}

Underground belt conveyors shall be equipped with a detection system capable of automatically stopping the drive pulley if slippage could cause ignition of the belt. {30 CFR 57.4503}

Internal combustion powered equipment shall be so located that the exhausts are well away from combustible materials. When the exhausts are piped to outside the underground facility under construction, a clearance of at least 6 inches shall be maintained between such piping and combustible material. {29 CFR 1926.151(a)(2)}

Smoking shall be prohibited at or in the vicinity of operations which constitute a fire hazard, and shall be conspicuously posted: "No Smoking or Open Flame." {29 CFR 1926.151(a)(3)}

Portable battery powered lighting equipment, used in connection with the storage, handling, or use of flammable gases or liquids, shall be of the type approved for the hazardous locations. {29 CFR 1926.151(a)(4)}

Clearance shall be maintained around lights and heating units to prevent ignition of combustible material. {29 CFR 1926.151(d)(7)}

No person shall smoke or use an open flame where flammable or combustible liquids, including greases, or flammable gasses are:

- A. Used or transported in a manner that could create a fire hazard; or
- B. Stored or handled. {30 CFR 57.4100}

Readily visible signs prohibiting smoking and open flame shall be posted where a fire or explosion hazard exists. {29 CFR 1926.800(m)(ii)}

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

Internal combustible engines shall be switched off before refueling if the fuel tanks are integral parts of the equipment. This requirement does not apply to diesel-powered equipment. {30 CFR 57.4103} [9.3.7]

### 4.4.1 Portable Space Heaters [9.13]

Only electric portable space heaters approved by a nationally recognized testing laboratory or equivalent and with appropriate tip-over protection are acceptable for use in DOE underground facilities.

### 4.5 Signs, Signals, and Barricades

Unused chutes, manways, or other openings shall be tightly covered, bulk-headed, or fenced off, and shall be posted with warning signs indicating “Keep Out” or similar language. Completed or unused sections of the underground facility shall be barricaded. {29 CFR 1926.800(b)(3)}

Dead-end headings and unused headings that cannot be used as escape-ways shall be posted with warning signs indicating “No Exit” or “Not an Exit.” {NFPA 101 7.10.8.3}

Each exit sign within buildings, structures, or rooms inside of tunnels, escape-ways, and process operation/experiment area, must be sufficiently illuminated. Externally illuminated signs shall be illuminated by not less than 5 foot-candles (54 lux) at the illuminated surface and shall have a contrast ratio of not less than 0.5. {NFPA 101, 7.10.6.3} Internally illuminated signs shall meet the requirements stated in NFPA 101, Section 7.10.7.

Undeveloped spaces shall be identified for general traffic direction and emergency purposes by signage in reflective lettering that is at least 4 inches high with 1/2-inch wide stroke. {NFPA 520, 5.7.1}

Every drift and alcove shall be identified by name, letter, or number with a large direction arrow associated with the word EXIT in letters not less than 6 inches high with 3/4-inch wide stroke pointing in the direction of nearest exit from the underground facility. {NFPA 520, 5.7.2}

All drifts, alcoves, and escape-ways shall be shown on maps that are available to all persons using the facility, posted in all areas underground, and made available to security personnel, Fire and Rescue Department, and other agencies with emergency jurisdiction. {NFPA 520, 5.7.3.1}

Maps shall be reviewed every 6 months and updated, as necessary, to reflect changes. {30 CFR 57.11053}

### 4.6 Fire Protection Program

Each DOE underground facility shall implement a documented, facility-specific Fire Protection Program.

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

The facility-specific Fire Protection Program will include:

- (a) Fire safety information for all employees and contractors, including familiarization with procedures for fire prevention, emergency alarm response, and reporting of fires.
- (b) Documented facility inspections conducted at least monthly, including provisions for remedial action to correct conditions.
- (c) A description of general housekeeping practices and the control of transient combustibles.
- (d) Control of flammable and combustible liquids and gases and oxidizers in accordance with the applicable site documents.
- (e) Control of ignition sources including, but not limited to, grinding, welding, and cutting.
- (f) Fire reports, including an investigation and statement on the corrective action to be taken.
- (g) Fire Prevention Surveillance/Inspection.
- (h) The restrictions of smoking to designated and supervised areas of the facility.
- (i) Construction, demolition, and renovation activities that conform to the requirements of NFPA 241. {NFPA 801, 4.3}

Smoking is prohibited inside all government buildings/facilities and all government-owned vehicles. Smoking is permitted only in areas designated by Facility Managers in the DOE underground facilities as determined by the facility's assigned safety professional. [9.10.3]

### 4.7 Fire Hazards Analyses

Any underground facility under NFPA 801 shall have a FHAs be prepared using a graded approach for all underground facilities. The FHA must be in accordance with **Section 7.1**.

#### 4.7.1 Emergency Power [9.17]

Where required by the Fire Hazard Analysis, the following shall be classified as emergency power loads:

- (a) Fire detection systems
- (b) Fire alarm systems
- (c) Exit sign illumination
- (d) Emergency lighting
- (e) Fire command center lighting
- (f) Emergency voice/alarm communication system {IBC 405.9.1}
- (g) Systems identified in the DSA or SAD  
{NFPA 520, 6.6.2}

#### 4.7.2 Standby Power [9.17.3]

Where required by the Fire Hazard Analysis, the following shall be classified as standby power loads:

- (a) Electric-driven fire pumps

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

- (b) Mechanical air-handling systems and smoke control systems for all refuge stations and exit pathways
- (c) Standby lighting required for refuge stations and smoke control mechanical equipment rooms
- (d) Two-way communications systems
- (e) Elevator/Hostways
- (f) Sump pumps
- (g) Systems identified in the DSA or SAD {NFPA 520, 6.7.2}

### 4.8 Facility Fire Protection Assessments

Fire safety assessments shall be prepared for all underground facilities.

If an unoccupied underground facility is being reoccupied, or is being occupied for the first time, then prior to occupancy, ensure a Fire Protection Design Analysis or a Preliminary FHA is performed, followed by an Facility Fire Protection Assessment (FFPA) at least annually, with the FFPA due date one year from the Design Analysis, Preliminary FHA, or previous FFPA, as applicable. [9.6.2]

## 5 FIRE PROTECTION

### 5.1 Automatic Suppression

To determine the appropriate fire suppression system based on the available hazards, a design analysis shall be performed for underground facilities to be occupied part time. Similarly, a design analysis or a fire hazards analysis shall be performed for underground facilities to be occupied full time (40 hours/week for the life of the mission). Both types of analyses shall ensure the fire prevention and fire protection requirements, including fire suppression, have been evaluated and the appropriate design features identified. Each analysis shall be initiated at the beginning of the design process or when configuration and/or operational changes are made. The analysis shall consider the facility's specific design, layout, life safety issues, and anticipated operating needs. The evaluation shall consider acceptable means for separation or control of hazards, the control or elimination of ignition sources, and the suppression of fires. It shall consider the storage and use of radioactive materials, as their release under fire or explosion conditions can result in a more severe hazard. {NFPA 801, 4.2}

A fire protection engineer shall determine the fire suppression system type, suppression agent, automatic and/or manual operation, area of system coverage, and system actuation type based on the hazard and its location. The various types of suppression systems to be considered include water-based systems (including sprinklers, foam systems, deluge systems, and water mist systems), dry or wet chemical systems, and gaseous systems. Once the suppression system type has been identified, the appropriate codes and standards shall be identified and followed.

All self-propelled, diesel-powered underground equipment shall be equipped with at least one portable, multipurpose (ABC) dry chemical extinguisher having a nominal

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

capacity of 10 lbs. of extinguishing agent and a minimum rating of 4A:10B:C. {NFPA 122, 7.3.1}

Mobile equipment shall be protected by installation of an automatic, pre-engineered, on-board dry chemical system in accordance with NFPA 17, Section 9.9. The inspection, testing and maintenance of these systems shall be in accordance with the manufacturer's recommendations and per the requirements of NFPA 17. [9.7.1.6]

Fire-resistant hydraulic fluids shall be used in hydraulically actuated underground machinery and equipment unless such equipment is protected by a fire suppression system or by multi-purpose fire extinguishers(s) rated at sufficient capacity for the type and size of hydraulic equipment involved, but rated at least 4A:40B:C. {29 CFR 1926.800(m)(8)}

Non-Flammable Hydraulic Fluids – Approval tests for hydraulic fluids evaluate the fire hazard of a fluid intended for use in industrial equipment by determining its chemical heat release rate from spray fires and the fluid's critical heat flux for ignition. Based on these two parameters, a Spray Flammability Parameter (SFP) is calculated. The SFP is then used as the basis for classifying the fluid as an approved fluid. The SFP is essentially a measure of how hard it is to ignite a liquid and how severely it will burn once ignited. Hydraulic fluids that have an SFP less than  $5 \times 10^4$  when tested according to FM Approved Standard 6930, Flammability Classification of Industrial Fluids, are considered FM Approved. The use of non-ignitable hydraulic fluids approved by other nationally approved testing laboratories is also acceptable.

**Note:** Where it is not possible to use an approved, non-ignitable hydraulic fluid, use a hydraulic fluid with as high a flash point as possible and provide additional safeguards to adequately protect the hazard. See FM Global Property Loss Prevention Data Sheet 7-98, "Hydraulic Fluids," for guidance. [9.12.3.4]

## 5.2 Water-Based Fire Suppression Systems:

- (a) Where it has been determined that water-based fire suppression systems and components are to be provided, the following requirements shall apply:
  1. The water supply shall be a reliable and adequate water supply and distribution system, as documented through appropriate analysis. {DOE O 420.1C, CRD, 3.c1}
  2. Be approved by the AHJ. {NFPA 520, 6.4.1}
  3. The system and components for Safety Significant and Safety Class fire suppression systems shall meet the design, maintenance, and operations requirements stated in the applicable safety basis documents.
  4. The fire water supply shall consist of at least one water storage tank that has been designed, fabricated, installed, and tested in accordance with NFPA 22.

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

5. The water storage tank shall be designed such that the water supply dedicated for fire suppression activities meets the calculated sprinkler system demand, including hose allowances, for a period of 2 hours.
6. Where required by the DSA/SAD, the fire water supply and distribution system shall consist of at least one electric motor driven and one diesel engine driven fire pump. The fire pumps shall be designed, fabricated, installed, and tested in accordance with NFPA 20.
7. The fire water supply and distribution system piping shall be designed, fabricated, installed, and tested in accordance with NFPA 24 and applicable safety basis documents.
8. If possible, consideration shall be given to configure the fire water supply and distribution piping system to provide alternate water flow paths to portions of the suppression systems. {DOE-STD-1066-201299, 6.2.2}
9. Listed and/or approved control valves shall be installed at selected points to provide control over individual protected areas (e.g., drifts, chambers, etc.) and to limit the number of systems made inoperable by a single line break. {DOE-STD-1066-2012, 6.2.3}
10. Domestic water shall be supplied by a separate service line and not be a combined fire protection and potable water service or a combined process water and potable water system. Where combined fire and domestic-process water systems are used, distribution piping should be routed and provided with valves such that the domestic and process systems can be isolated without shutting off the fire system supply. For industrial or processes that cannot be reduced during a fire, the peak domestic water demand should be based on 2.5 times the calculated average daily demand plus any special demands. {DOE-STD-1066-2012, 6.1.1 and 6.1.3}
11. For individual automatic water based fire suppression systems the fire water supply shall be demonstrated to be capable of supplying the largest hydraulically calculated fire suppression system demand, including a 500 gpm allowance for a hose stream for manual fire suppression, plus any concurrent domestic water system usage (where provided) for a minimum period of 2 hours.
12. DOE-STD-1066, 6.2.2 and 6.2.3 require that the fire water supply and distribution system piping be in a looped configuration with sectional control valves whenever feasible to provide alternate flow paths to parts of the system in the event of a single line break. As this is not always possible or feasible in underground configurations, an alternate method is to consider the provision of alternate flow paths to individual suppression systems, where practical or feasible, as opposed to a looped system configuration for the entire system.

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

### 5.3 Water Mist Suppression Systems

Where it has been determined that suppression application utilizing a water mist system, the water and atomizing media supplies shall be capable of supplying the largest system demand in accordance with Chapter 10 of NFPA 750. The water and atomizing media supplies shall consist of a main and a reserve supply.

### 5.4 Gaseous Fire Suppression Systems

Where it has been determined that gaseous fire suppression systems and components are to be provided, the suppressant agent supply shall be capable of supplying the largest system demand, at the required agent system pressure in accordance with NFPA 2001. The suppressant agent supply shall consist of a main and a reserve supply.

### 5.5 Chemical Fire Suppression Systems

Where it has been determined that chemical fire suppression systems and components are to be provided, the following requirements shall apply:

1. For dry chemical fire suppression systems, the suppressant agent supply shall be capable of supplying the largest system demand in accordance with Chapter 5 of NFPA 17. The suppressant agent supply shall consist of a main and a reserve supply.
2. For wet chemical fire suppression systems, the suppressant agent supply shall be capable of supplying the largest system demand in accordance with Chapter 5 of NFPA 17A. The suppressant agent supply shall consist of a main and a reserve supply.

### 5.6 Manual Suppression

#### 5.6.1 Portable Fire Extinguishers [9.7]

All areas or process equipment in underground facilities, where combustible materials are present, processed, or handled, shall be provided with approved portable multipurpose fire extinguishers that comply with NFPA 10. {NFPA 122, 6.1.1}

The number of such extinguishers, their type, size, and distribution shall be in accordance with NFPA 10, except that the extinguishers shall have a nominal capacity of 10 lbs. or greater of agent and minimum rating of 4A:10B:C. {NFPA 122, 6.1.2}

Extinguishers employing agents having a B:C rating, shall be permitted to be used on electrical hazards. {NFPA 122, 6.1.3}

At least one hand-portable fire extinguisher, having a nominal capacity of 20 lbs. or greater, and a minimum rating of 10A:60B:C shall be located outside of, but not more than 10 ft. from, the opening into each flammable and combustible liquid storage or dispensing area and maintenance shop. {NFPA 122, 6.1.4}



# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

Where portable fire extinguishers are provided within flammable and combustible liquid storage or dispensing areas and maintenance shops, travel distance to a portable extinguisher shall not exceed 30 ft. {NFPA 122, 6.1.5}

### 5.7 Detection System

A fire protection engineer shall determine the need and type of fire detection system, based on equipment compartment and room sizes and contours, airflow patterns, obstructions, and other characteristics of the protected area and determine the placement, type, sensitivity, durability, and where applicable, the number of detectors. {NFPA 72, Chapter 10}

Refrigeration system machinery rooms installed underground shall be provided with a refrigerant detector. {IFC, 908.6}

Underground machinery rooms shall contain a refrigerant detector with an audible and visual alarm. The detector, or a sampling tube that draws air to the detector, shall be located in an area where refrigerant from a leak will concentrate. The alarm shall be actuated at a value not greater than the corresponding TLV-TWA values shown in the *International Mechanical Code* for the refrigerant classification. Detectors and alarms shall be placed in approved locations. The detector shall transmit a signal to an approved location. {IFC, 606.8}

Where required by IFC 6004.2.2.10, a gas detection system shall be provided for indoor storage and use of highly toxic and toxic compressed gases. {IFC, 908.3}

Initiation shall be by a manual means or by any required automatic fire detection or suppression system. {NFPA 520, 6.1.2.1}. Process Operation/Experiment Areas without fire suppression systems or fire systems that are required to have a fire alarm system shall be provided with manual initiation in accordance with NFPA 72. {NFPA 520, 6.1.2.2} [9.12.1.5]

In accelerator applications line type heat detection should be considered in the tunnel magnet areas and air sampling smoke detection in the power alcoves. The fire alarm system, in many cases, is directly connected to other equipment. Consideration should be given to when needed, to integrating to the oxygen deficiency hazard Control equipment.

### 5.8 Fire Alarm System [9.12.2]

Every effort shall be made to separate low voltage (less than 50 volts) from the high voltage (greater than 50 volts) by using an interface relay outside the high voltage equipment cabinets.

A fire alarm system shall be provided in each developed process, operation/experiment area, or developed portion of the underground infrastructure. {NFPA 520, 6.1.1}

Where required, the fire alarm system shall be installed and maintained in accordance with NFPA 72 and per the manufacturer's recommendations. {NFPA 520, 6.1.1.2}

Notification of the fire alarm system shall be by general alarm throughout the process operation/experiment area and underground infrastructure. {NFPA 520, 6.1.3.1}

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

A **facility fire command center** shall be located on the surface near the entrance of the underground facility. An annunciator panel shall be provided. {NFPA 520, 6.1.4.1}

Audible and visual signals shall be provided for each underground zone. {NFPA 520, 6.1.4.2}

The fire alarm system(s) shall automatically transmit supervisory, trouble and alarm signals from each fire alarm panel installed in the underground facility to the site fire alarm panel located in the **Site Fire Command Center** on the surface. {NFPA 520, 6.1.3.2} The site fire alarm panel will automatically transmit fire, supervisory and trouble alarm signals to Fire Dispatch.

An approved map of the underground facility shall be located at or near the fire alarm annunciator panel(s) in the facility fire command center. {NFPA 520, 6.1.4.3}

The map shall identify, by letter, name, or number, each drift/alcove/niche adjacent to each process operation/experiment area. {NFPA 520, 6.1.4.4}

Process operation/experiment areas shall have a manual fire alarm system installed and maintained in accordance with NFPA 72. {NFPA 45, 6.5.2}

### 5.9 Notification

The fire alarm system, where provided, shall be designed so that all personnel endangered by the fire condition or a contingent condition will be alerted. {NFPA 45, 6.5.3}

The fire alarm system shall alert local emergency responders. {NFPA 45, 6.5.4}

A fire alarm system shall annunciate at the fire alarm control unit and shall initiate occupant notification upon activation. Where a fire alarm system is required, it shall be activated by one or more of the following:

- Automatic detectors (fire, flame, smoke, and/or video detectors)
- Automatic sprinkler system water flow devices
- Manual fire alarm boxes
- Automatic fire-extinguishing system activation {IFC, 907.5}

Where the tunnel accessed by a shaft or shafts is greater than 60 feet below the surface or the distance to the portal is greater than 60 feet, the underground facility shall be equipped throughout the developed and common spaces with a manual fire alarm system, including an emergency voice/alarm communication installed in accordance with NFPA 72. {IFC, 907.2.19}

The alarm code and reporting instructions shall be conspicuously posted at all telephones and at employee entrances. {29 CFR 1926.150(e)(2)}

If persons are assigned to work areas beyond the warning capabilities of the system, provisions shall be made to alert them in a manner to provide for their safe evacuation in the event of a fire. {30 CFR 57.4360(b)}

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

Emergency telephone numbers shall be posted at all telephones. {30 CFR 57.18012}

A suitable communication system shall be provided at the underground facility to obtain assistance in the event of an emergency. {30 CFR 57.18013}

Emergency alarms for the detection and notification of an emergency condition in Group H occupancies shall be provided. {IFC, 908.1} Group H Occupancies are defined in the IBC.

A manual fire alarm system shall be actuated by manual pull stations that activates audible and visual appliances throughout the underground facility. It automatically sends a local signal to the **Fire Command Center** and sends a remote signal to Fire Dispatch via the Site Fire Alarm System. Optional manual fire alarm systems may include verbal announcements over a public address system, verbal announcements utilizing a squawk-box system, and in undeveloped areas, the use of radios to inform personnel of a fire condition and to provide information regarding where to evacuate, i.e., to the hoist to the surface or to the nearest refuge station. A combination of these types of systems is also acceptable. These optional manual fire alarm systems will require additional verbal notification to the **Fire Command Center** and to **Fire Dispatch**. [9.12.2.19]

### 5.10 Two-Way Communication System

Provide an approved two-communication system dedicated for the fire department. The communication system shall be capable of communication throughout all developed spaces and shall provide communication with the fire command center {NFPA 520 8.1.1}.

### 5.11 Barriers (Compartmentation Requirements)

Process operation/experiment areas shall be separated from the underground infrastructure by 2-hour rated fire barriers. {NFPA 520, 4.2.2}

Barriers constructed with a fire resistance rating shall be installed in accordance with NFPA 221. {NFPA 520, 4.2.5}

Opening protection shall be installed in accordance with NFPA 80, "Standard for Fire Doors and Other Opening Protectives." {NFPA 520, 4.2.6}

Noncombustible materials shall be used in the construction of all new walls, fixed partitions, insulation, ceilings, and floors. {NFPA 520, 4.2.8}

Fire retardant coating on otherwise combustible materials shall not be permitted. {NFPA 520, 4.2.9}

All new wall and ceiling finishes, along with movable partitions, shall conform to the requirements of Chapter 10 of NFPA 101. {NFPA 520, 4.3}

All fire-rated barriers, fire-rated doors, and fire dampers shall be inspected, tested, and maintained per the manufacturer's recommendations and per the appropriate NFPA code or standard.

Rooms used to store equipment for stand-by or emergency power generation shall be separated from the remainder of the underground infrastructure by walls with at least a two-hour fire resistance rating. {NFPA 520, 4.4.3}

# DOE-STD-1066-2017, Underground Fire Protection Criteria DRAFT A

---

## 6 MEANS OF EGRESS

### 6.1 Escape-ways

The number of occupants for exit width calculations shall be based on either 150 percent of the highest occupant load of 2,000 sq. ft. per person net floor area, or whichever is greater {NFPA 520 5.3}.

No temporary building or structure shall be erected where it will adversely affect any escape-way. {29 CFR 1926.151(b)(1)}

Storage shall not obstruct, or adversely affect escape-ways. {29 CFR 1926.151(d)(1)}

A clearance of 24 inches shall be maintained around the path of travel of fire doors, unless a barricade is provided in which case, no clearance is needed. Material shall not be stored within 36 inches of a fire door opening. {29 CFR 1926.151(d)(7)} [6.1.1]

**Figure X** provides an illustration of process operation/experiment area, underground infrastructure, escape-ways, refuge station, and exit discharge. [6.1.2]

Means of egress from rooms, buildings, and structures within process operation/experiment areas shall be in accordance with the applicable occupancy chapter of NFPA 101. {NFPA 520, 5.1.1}

Every underground facility shall have two or more separate, properly maintained escape-ways to the surface from the lowest levels which are so positioned that damage to one shall not lessen the effectiveness of the others. A refuge station shall be provided while a second opening to the surface is being developed. A second escape-way is recommended, but not required, during the development of a new area underground. {30 CFR 57.11050(a)} [6.1.3]

The travel distance to a portal, a refuge area, or the entrance to an exit passageway system shall be not more than 2,000 feet.

In addition to separate escape-ways, a refuge station shall be provided for every employee who cannot reach the surface from his working place through at least two separate escape-ways within a time limit of 1 hour when using the normal exit method. These refuge stations must be positioned so that the employee can reach one of them within 30 minutes from the time he leaves his workplace. {30 CFR 57.11050(b)}

An alternative local refuge station or refuge capability may be used in lieu of a second escape-way when a hazards analysis demonstrates a minimal level of risk and with the approval of the AHJ.

The travel distance to a portal, a refuge station, or an exit shall not be more than 2,000 ft. {NFPA 520, 5.2.3}

Any portion of a designated escape-way which is inclined more than 30 degrees from the horizontal and that is more than 300 feet in vertical extent shall be provided with an emergency hoisting facility. {30 CFR 57.11055}

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

When a shaft is used as a portion of the escape-way, the underground facility shall make advance arrangements for power-assisted hoisting capability to be readily available in an emergency, unless the regular hoisting means can continue to function in the event of an electrical power failure at the underground facility. Such hoisting means shall be designed so that the load hoist drum is powered in both directions of rotation and so that the brake is automatically applied upon power release or failure. {29 CFR 1926.800(g)(1)}

Any doors in an escape-way must be unlocked when the underground facility is occupied. {29 CFR 1910.36(d)}

Employees must be able to open an escape-way door from the inside at all times without keys, tools, or special knowledge. A device such as a panic bar that locks only from the outside is permitted on exit discharge doors. {29 CFR 1910.36(d)(1)}

Escape-way doors must be free of any device or alarm that could restrict emergency use of the escape-way if the device or alarm fails. {29 CFR 1910.36(d)(2)}

A side-hinged door must be used to connect any room to an escape-way. {29 CFR 1910.36(e) (1)}

The door that connects any room to an escape-way must swing in the direction of escape travel if the room is designed to be occupied by more than 50 people or if the room is a high hazard area (i.e., contains contents that are likely to burn with extreme rapidity or explode). {29 CFR 1910.36(e) (2)}

Escape-ways must support the maximum permitted occupant load for the underground facility. {29 CFR 1910.36(f) (1)}

The capacity of an escape-way may not decrease in the direction of travel to the exit discharge. {29 CFR 1910.36(f) (2)}

The ceiling of an escape-way must be at least 7 feet 6 inches high. Any projection from the ceiling must not reach a point less than 6 feet 8 inches from the floor. {29 CFR 1910.36(g) (1)}

An escape-way and escape-way access must be at least 36 inches wide at all points. {NFPA 101, 7.3.1.2(2)}

Objects that project into the escape-way must not reduce the width of the escape-way to less than the minimum width requirements. {29 CFR 1910.36(g) (4)}

Where a specific, approved life safety evaluation of the space is provided, the egress width shall be permitted to be modified. {NFPA 520, 5.4.1}

Each individual that enters an underground facility is required to carry a MSHA-approved cap lamp and/or flashlight to provide adequate illumination during an emergency in escape-ways that do not have sufficient natural light or are not equipped with an emergency lighting system adequate to safely travel through the escape-way. {29 CFR 1926.800(g)(4)}

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

The minimum luminance for cap lamps and flashlights shall be 1 foot-candle at a distance of 3 meters along the centerline of the escape-way and 0.1 foot-candle along a one meter band throughout the escape-way. {IESNA, Chapter 29}

Surface buildings or other similar structures within 100 feet of underground facility openings used for intake air or within 100 feet of underground facility openings that are designated escape-ways in exhaust air shall be

- (a) Constructed of noncombustible materials; or
- (b) Constructed to meet a fire resistance rating of no less than one hour; or
- (c) Provided with an automatic fire suppression system; or
- (d) Covered on all combustible interior and exterior structural surfaces with noncombustible material or limited combustible material, such as 5/8 inch, type "X" gypsum wallboard {30 CFR 57.4533} [6.1.3.29]

### 6.2 Refuge Stations

Each refuge station shall provide 10 ft<sup>2</sup> of floor area for each person it is intended to serve. {NFPA 520, 5.8.2.1} The total number shall be based on 125 percent of the number of occupants anticipated to refuge in the refuge station.

Each refuge station shall have an engineered fresh air system that provides fresh air through a borehole from the surface. {NFPA 520 5.8.2.2.1} The surface borehole shall be permitted to be an exhaust ventilation shaft provided that the direction of airflow can be reversed during an emergency by controls located in the refuge station. {NFPA 520 5.8.4} In lieu of a borehole, the refuge station may be provided with fresh air via the compressed air system so long as the air intake is separated from the ventilation exhaust and entrances to the underground facility, and there are redundant paths for the compressed air to the refuge station, or provided with an engineered breathing air system. {30 CFR 57.11052(d)}

Air quantity shall be either at least 20 scfm (standard cubic feet per minute) per person or the minimum required to prevent smoke infiltration, whichever is greater. {NFPA 520, 5.8.2.2.2} Or, as an alternative, the air quantity can be determined by Industrial Hygiene to meet minimum air quality requirements for the maximum number of occupants that may refuge in the refuge station.

Refuge stations shall be provided with positive pressure of 0.05 in./w.g. (inches/water gauge) relative to the adjacent space. {NFPA 520, 5.8.2.3}

Entrance and exit from the refuge station shall be through a vestibule equipped with doors that have self-closing devices. {NFPA 520, 5.8.2.4}

Refuge stations shall be provided with food, drinking water, emergency lighting, blankets, toilet facilities, and first aid kits in quantities appropriate to the intended usage. {NFPA 520, 5.8.2.5} For underground facility refuge stations, a minimum of 7 days of provisions shall be provided for the maximum number of occupants that may use the refuge station during an emergency.

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

Refuge stations shall be provided with suitable hand tools and stopping materials {30 CFR 57.11052(d)} and equipment required to install stopping materials.

Telephone or other voice communication shall be provided between the surface and refuge stations and such systems shall be provided and shall be independent of the underground facility power supply. {30 CFR 57.11054}

Refuge stations shall be separated from the remainder of the underground facility by walls with at least a 2-hour fire resistance rating. {NFPA 520, 5.8.2.7}

Refuge stations shall be permitted to be used during normal operations for other purposes provided that they are always available for refuge purposes. {NFPA 520, 5.8.3}

The functionality of refuge stations and associated features shall be tested annually. [6.1.4.11]

Compressed, gaseous breathing air, supplied by the compressed air system, shall meet the applicable minimum grade requirements for Type I gaseous air set forth in the Compressed Gas Association Commodity Specification for Air, G-7.1, 1966 (Grade D or higher quality). [10.4]

The breathing air compressor shall be constructed and situated in accordance with 29 CFR 1910.134(i) (5).

### 6.3 Illumination

Normal illumination in the underground infrastructure shall meet the following levels {29 CFR 1926.56(a)}

- A. 5 foot-candles in areas routinely used for access ways
- B. 5 foot-candles for general construction areas
- C. 10 foot-candles for tunnel and shaft headings during drilling, mucking, and scaling
- D. 10 foot-candles for mechanical and electrical rooms, alcoves, or niches
- E. 30 foot-candles for offices
- F. Vehicle lights, cap lamps, and flashlights may be used to meet minimum required illumination levels

Normal illumination in process operation/experiment areas shall follow the guidance in IESNA Lighting Handbook for general purpose and task lighting.

There is no minimum required illumination level for undeveloped areas.

### 6.4 Emergency Lighting

The requirements for cap lamps and/or flashlights shall be in accordance with 30 CFR 57, Subpart P. [3.10] Emergency lighting fixtures for means of egress from developed spaces shall be provided for underground facilities. {NFPA 101, 7.9.1.1} Where

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

maintenance of illumination depends on changing from one energy source to another, a delay of not more than 10 seconds shall be permitted. {NFPA 101, 7.9.1.3}

Emergency lighting shall be provided for critical operations areas, such as areas where personnel are required to operate valves, dampers, fans, and other controls in an emergency. {NFPA 801, 5.11.2}

Emergency lighting fixtures, where required, shall meet the system performance requirements stated in NFPA 101, Section 7.9.2, and the periodic testing requirements of NFPA 101, Section 7.9.3.

Emergency lighting systems/fixtures are not required in undeveloped spaces.

During development of new process operation/experiment areas or underground infrastructure, emergency lighting may not be available; in such locations, each worker shall have in their possession an acceptable portable hand lamp (flashlight) or cap lamp for emergency use. {29 CFR 1926.800(g) (4)}

Cap lamps and/or flashlights may be used as emergency lighting provided that the specific applications have been reviewed by ESH&Q and approved by the AHJ. [6.3.6]

Lighting in accelerator environments creates a difficulty with survivability of the electronic ballast. Consideration should be given to remotely locate electronic ballast and uninterruptible power supplies. Light fixtures should be radiation-hard fluorescent type or equivalent.

## 6.5 Ventilation

The direction of mechanical air flow shall be reversible. {29 CFR 1926.800(k)(4)} This is applicable to main ventilation systems and is not applicable to process operation/experiment areas or underground infrastructure covered under Paragraph 4.1.1.5. [4.1.1.3]

A minimum of 200 cubic feet of fresh air per minute shall be supplied for each worker underground. {29 CFR 1926.800(k)(2)} This is not applicable to process operation/experiment areas or underground infrastructure **covered under Paragraph 4.1.1.5.** [4.1.1.4]

Process Operations/Experiment Areas in drifts shall comply with ANSI/ASHRAE STD 62.1, or ACGIH Industrial Ventilation Handbook. [4.1.1.5]

Each brake horsepower of a diesel engine requires at least 100 cubic feet of air per minute for suitable operation in addition to the air requirements for personnel. [4.1.3.1]

### 6.5.1 Ventilation Plan

Ventilation plans for fire emergencies, fire protection features are required for ventilation as part of special experiment related activities, and fire protection features required for underground ventilation systems.

Stand-off Distances to Underground Facility Openings and Fan Installations  
{30 CFR 57.4131 and 29 CFR 1926.800(m)(7)}



# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

- (a) On the surface, no more than one day's supply of combustible materials shall be stored within 100 feet of underground facility openings or within 100 feet of fan installations used for underground ventilation.
- (b) Where this is not feasible because of space limitations at the underground facility, such materials may be located within the 100-foot limit, provided that:
  - (i.) They are located as far as practicable from the opening, and
  - (ii.) Either a fire-resistant barrier of not less than one-hour rating is placed between the stored material and the opening, or additional precautions are taken which will protect the materials from ignition sources.
- (c) The one-day supply shall be kept at least 25 feet away from any underground facility opening except during transit into the underground facility.
- (d) Dry vegetation shall not be permitted within 25 feet of underground facility openings.
- (e) Any structure located underground or within 100 feet (30.48 m) of an opening to the underground facility shall be constructed of material having a fire-resistance rating of at least one hour.

### 6.5.2 Fan Installations {30 CFR 57.4504}

Fan houses, fan bulkheads for main and booster fans, and air ducts connecting main fans to underground openings shall be constructed of noncombustible materials.

Areas within 25 feet of main fans or booster fans shall be free of combustible materials, except installed wiring, ground and track support, head frames, and direct-fired heaters. Other timber shall be coated with one inch of shotcrete, one-half inch of gunite, or other noncombustible materials.

### 6.5.3 Underground Shops {30 CFR 57.4761}

To confine or prevent the spread of toxic gases from a fire originating in an underground shop where maintenance work is routinely done on mobile equipment, one of the following measures shall be taken: use of control doors or bulkheads, routing of the underground facility shop air directly to an exhaust system, reversal of mechanical ventilation or use of an automatic fire suppression system in conjunction with an alternate escape route. The alternative use shall at all times provide at least the same degree of safety as control doors or bulkheads.

Control doors or bulkheads. If used as an alternative, control doors or bulkheads shall meet the following requirements:

- (1) Each control door or bulkhead shall be constructed to serve as a barrier to fire, the effects of fire, and air leakage at each opening to the shop.
- (2) Each control door shall be:
  - (i.) Constructed so that, once closed, it will not reopen as a result of a differential in air pressure;
  - (ii.) Constructed so that it can be opened from either side by one person or be provided with a personnel door that can be opened from either side;
  - (iii.) Clear of obstructions; and

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

- (iv.) Provided with a means of remote or automatic closure unless a person specifically designated to close the door in the event of a fire can reach the door within three minutes.
- (3) If located 20 feet or more from exposed timber or other combustible material, the control doors or bulkheads shall provide protection at least equivalent to a door constructed of no less than one-quarter inch of plate steel with channel or angle-iron reinforcement to minimize warping. The framework assembly of the door and the surrounding bulkhead, if any, shall be at least equivalent to the door in fire and air-leakage resistance, and in physical strength.
- (4) If located less than 20 feet from exposed timber or other combustibles, the control door or bulkhead shall provide protection at least equivalent to a door constructed of two layers of wood, each a minimum of three-quarters of an inch in thickness. The wood-grain of one layer shall be perpendicular to the wood-grain of the other layer. The wood construction shall be covered on all sides and edges with no less than 24-gauge sheet steel. The framework assembly of the door and the surrounding bulkhead, if any, shall be at least equivalent to the door in fire and air-leakage resistance, and in physical strength. Roll-down steel doors with a fire-resistance rating of 1 1/2 hours or greater, but without an insulation core, are acceptable provided that an automatic sprinkler or deluge system is installed that provides even coverage of the door on both sides.

Routing air to exhaust system. If used as an alternative, routing the underground facility shop exhaust air directly to an exhaust system shall be done so that no person would be exposed to toxic gases in the event of a shop fire.

Mechanical ventilation reversal. If used as an alternative, reversal of mechanical ventilation shall—

- (1) Be accomplished by a main fan. If the main fan is located underground:
  - (i.) The cable or conductors supplying power to the fan shall be routed through areas free of fire hazards; or
  - (ii.) The main fan shall be equipped with a second, independent power cable or set of conductors from the surface. The power cable or conductors shall be located so that an underground fire disrupting power in one cable or set of conductors will not affect the other; or
  - (iii.) A second fan capable of accomplishing ventilation reversal shall be available for use in the event of failure of the main fan;
- (2) Provide rapid air reversal that allows persons underground time to exit in fresh air by the second escape-way or find a place of refuge; and
- (3) Be done according to predetermined conditions and procedures.

# DOE-STD-1066-2017, Underground Fire Protection Criteria DRAFT A

---

Automatic fire suppression system and escape route. If used as an alternative, the automatic fire suppression system and alternate escape route shall meet the following requirements:

- (1) The suppression system shall be:
  - (i.) Located in the shop area;
  - (ii.) The appropriate size and type for the particular fire hazards involved; and
  - (iii.) Inspected at weekly intervals and properly maintained.
- (2) The escape route shall bypass the shop area so that the route will not be affected by a fire in the shop area.

## 6.6 Underground Main Fan Controls {30 CFR 57.8519} [9.2.5.5]

All underground main fans shall have controls placed at a suitable protected location remote from the fan and preferably on the surface.

A risk assessment and/or fire hazards analysis will help determine the appropriate location of the fan controls (on the surface or at a safe location underground).

## 6.7 Fire Protection Design of Underground Ventilation Systems {NFPA 801, 5.9}[9.2.5.6]

The requirements of NFPA 801 will only be applicable to specialized ventilation systems developed in support of activities in underground facilities and only when handling radioactive materials (example: glove box work) and as deemed applicable by a Fire Hazards Analysis (FHA) and/or Documented Safety Analysis (DSA), or Safety Assessment Document (SAD) {DOE O 420.2C}. NFPA 801, Section 5.9 does not apply to normal underground ventilation systems (refer to Subsection 4.1).

The fire protection design features of the underground ventilation system shall be in accordance with NFPA 90A, NFPA 90B, and NFPA 91. {NFPA 801, 5.9.1.1}

Where shutdown of the ventilation system is not permitted, fire dampers shall not be required for ventilation duct penetrations, and an alternative means of protecting against fire propagation shall be provided. {NFPA 801, 5.9.1.2}

### 6.7.1.1 Smoke Management & Abatement

The movement of smoke between spaces shall be minimized reference NFPA 520 and if needed, NFPA 92 Standard for Smoke Control Systems.

### 6.7.2 Ductwork.

Ductwork from areas containing radioactive materials, passing through nonradioactive areas, shall be of noncombustible construction and shall be protected from possible exposure fires by materials having a fire resistance rating as determined by the FHA. {NFPA 801, 5.9.2.1}

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

Where the corrosive nature of the effluents conveyed precludes the use of metallic ducts, other materials listed for this application shall be permitted. {NFPA 801, 5.9.2.2}

### 6.7.3 Filters.

Air entry filters shall have approved filter media that produce a minimum amount of smoke (UL Class I) when subjected to heat. {NFPA 801, 5.9.3.1}

Roughing or pre-filters, where necessary, shall be constructed of noncombustible materials. {NFPA 801, 5.9.3.2}

Where combustible filters or particulates are present in the ventilation system, additional fire protection features shall be provided as determined by the FHA. {NFPA 801, 5.9.3.3}

HEPA filtration systems shall be analyzed in the FHA. {NFPA 801, 5.9.4.1}

HEPA filtration systems shall be provided with fire detection when required by the FHA. {NFPA 801, 5.9.4.2}

Fixed fire suppression shall be provided for HEPA filtration systems when required by the FHA. {NFPA 801, 5.9.4.3}

### 6.7.4 Special Emergency Control of the Ventilation System [9.2.5.7]

Where an FHA determines the need, ventilation air volume and velocity shall be designed to dilute and carry away flammable or explosive concentrations of vapors before they reach 25 percent of the lower explosive limit. {NFPA 122, 4.8.5/5.1.9} (9)

If the FHA identifies unacceptable risks, further assessment shall include an evaluation of each of ventilation control structure to contain or redirect products of combustion.

An emergency response procedure shall include a procedure for emergency control of the ventilation system. {NFPA 520, 7.1.2(4)}

## 6.8 Smoke Spread [9.14]

Smoke control requirements are generally applicable throughout an underground facility. Because some DOE underground facilities conduct operations or experiments involving radioactive material, there are additional requirements that must be implemented for these unique areas within the underground facilities.

Underground facilities accessed through shafts or portals shall be provided with at least one of the following means to control the spread of fire, smoke, and toxic gases underground in the event of a fire:

- Control doors
- Reversal of mechanical ventilation
- Effective evacuation procedures {30 CFR 57.4760} [9.14.2]

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

The movement of smoke between process operation/experiment areas or between process operations/experiment areas and the underground infrastructure shall be minimized. {NFPA 520, 4.5.1}

It is not intended to require a smoke barrier between process operation/experiment areas or between the process operation/experiment area and the underground infrastructure that is compliant with NFPA 101. It is intended only to minimize the amount of smoke movement between the process operation/experiment areas or between the process operation/experiment area and the underground infrastructure. {NFPA 520, A.4.5.1}

Walls separating a process operation/experiment area from another process operation/experiment area or the underground infrastructure shall be continuous from rib to rib and from invert to back, including continuity through all concealed spaces, and shall provide an approved means of control of smoke spread. {NFPA 520, 4.5.1.1}

Process operation/experiment area perimeter walls are walls with a 2-hour fire resistance rating that separate process operation/experiment areas from the underground infrastructure and are intended to provide a moderate level of smoke protection. Requirements of a fire-resistive wall provide an acceptable level of smoke resistance. As an example, required smoke/fire dampers in such walls can close upon fusible link or heat detection. {NFPA 520, A4.5.1.1}

Where pillars are used, the pillar shall be considered part of the perimeter wall. {NFPA 520, 4.5.1.2}

Smoke barriers within process operation/experiment areas required for specific occupancies by NFPA 101 shall be provided in accordance with Section 8.5 of NFPA 101. {NFPA 520, 4.5.1.3}

Doors in process operation/experiment area perimeter walls shall be in accordance with NFPA 80 and shall be without undercuts, louvers, or grilles. {NFPA 520, 4.5.2}

Dampers and air-transfer openings penetrating process operation/experiment area perimeter walls shall close upon activation by an approved heat detection system, a fusible link, or an approved smoke detection system within the ducts. {NFPA 520, 4.5.3}

### 6.8.1 Requirements for Control of Smoke Spread in Facilities Handling Radioactive Materials [9.14.3]

These requirements are only applicable to specialized ventilation systems developed in support of experiments in the underground facilities and only when handling radioactive materials (example: glove box work), and as deemed applicable by a Fire Hazards Analysis and/or Documented Safety Analysis.

Fresh-air inlets shall be located to reduce the possibility of smoke, toxic materials, or radioactive contaminants being introduced. {NFPA 801, 5.9.5.1}

Fresh-air inlets shall be located where it is most unlikely for radioactive contaminants to be present. {NFPA 801, 5.9.5.2}

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

Smoke, corrosive gasses, and the nonradioactive substances that are released by a fire shall be vented from their place of origin directly to a safe location. {NFPA 801, 5.9.5.3}

Smoke control systems shall be provided for fire areas based on the Fire Hazards Analysis. {NFPA 801, 5.9.5.5}

Separate smoke control systems are preferred; however, smoke ventilation can be integrated into normal ventilation systems using automatic or manually positioned dampers and motor speed control. {NFPA 801, A5.9.5.5}

Smoke exhaust from areas that at any time contain radioactive substances shall not be ventilated outside the process operation/experiment area. {NFPA 801, 5.9.5.6}

Smoke control systems for such areas shall be connected to treatment systems to preclude release of radioactive substances. {NFPA 801, 5.9.5.7}

Where natural convection ventilation is used, the smoke and heat ventilation shall be provided in accordance with the Fire Hazards Analysis. {NFPA 801, 5.9.5.9}

The ventilation system shall be designed, located, and protected such that airborne corrosive products or contamination shall not be re-circulated. {NFPA 801, 5.9.5.10}

The power supply and controls for mechanical ventilation systems shall be located outside the fire area served by the system or protected from fire damage. {NFPA 801, 5.9.5.11}

Fire suppression systems shall be installed to protect filters that collect combustible material, unless the elimination of such protection is justified by the Fire Hazards Analysis. {NFPA 801, 5.9.5.12} [9.14.3.12]

### 6.9 Subsurface Entry

The underground facility shall control access to all openings to prevent unauthorized entry underground.

### 6.10 Self-Rescuers

All personnel entering an underground facility shall carry or have immediate access to a self-rescuer.

The requirements for self-rescuers shall be in accordance with 30 CFR 57.15030 and 30 CFR 57.15031. [3.9]

### 6.11 Self-Contained Self-Rescuers

Self-container self-rescuers shall be staged at locations where personnel have access to them when needed to assist in reaching the surface or to reach a Refuge Station.

### 6.12 Fire Drills

Fire drills for underground facilities in the operational mode or operational standby mode shall be conducted annually. {NFPA 520, Section 7.3.1} Annual fire exit drills are not required for inactive underground facilities. Should an inactive underground facility be

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

assigned a sustained, programmatic mission, then a fire drill shall be performed as part of the re-activation of the underground facility.

Each process operation/experiment area shall conduct additional drills at frequencies prescribed by NFPA 101. {NFPA 520, Section 7.3.2}

Drills shall be held with sufficient frequency to familiarize occupants with the emergency response procedures and emergency plan implementing procedures, and to establish conduct of drills as a matter of routine. Drills shall include suitable procedures to ensure that all underground facility personnel are subject to participate. {NFPA 101, Section 4.7.2}

Each planned fire drill shall be documented in a written drill plan and approved by the Facility Manager responsible for the underground facility. Components of the drill plan will include but not be limited to the following:

- (1) Activation of alarm/emergency communications methods as described in emergency response procedures and emergency plan implementing procedures, including notification of the underground facility occupants. {NFPA 101, Section 4.7}
- (2) Evacuation of the underground facility occupants to the exterior of the underground facility or some other designated location. {NFPA 101, Section 4.7}
- (3) Prior notification of the fire drill to the Fire Protection AHJ. {NFPA 520, Section 7.3.3}

Documented record of such drills shall be maintained for 3 years and shall be readily available for inspection. {NFPA 520, Section 7.3.4} [6.4.5]

## 7 FIRE DEPARTMENT RESPONSE

The Facility Manager will ensure that Emergency Response Procedures are developed and implemented. These procedures will, at a minimum, direct facility occupants in the following tasks in compliance with 29 CFR 1910.38:

- A. Reporting a Fire, or other emergency. {29 CFR 1910.38(c)(1)}
- B. Implementing an emergency evacuation to include escape-ways. {29 CFR 1910.38(c)(2)}
- C. Critical tasks (if any) that must be accomplished prior to evacuation. {29 CFR 1910.38(c)(3)}
- D. Procedure to account for all workers post-evacuation. {29 CFR 1910.38(c)(4)}
- E. Pre-Fire Planning shall be established and maintained, and shall be coordinated with local emergency responders.

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

- F. Fire Department Access, inaccessible or dead-end fire department vehicle access shall be identified.

For underground facilities conducting work with radioactive material, additional rigor should be applied to Emergency Response planning, to include:

- A. Notification of personnel identified in the plan. {NFPA 801, 4.6 (2)}
- B. Evacuation from the fire area of personnel not directly involved in firefighting activities. {NFPA 801, 4.6 (3)}
- C. Coordination with security forces, radiation protection personnel and other designated personnel for the admission of the site fire department and other emergency response agencies. {NFPA 801, 4.6 (4)}
- D. Fire extinguishment activities, particularly those that are unique to the facility handling radioactive materials. {NFPA 801, 4.6 (5)}
- E. The effects of fire-fighting water on such areas, assuming disruption of the contents by accident or by fire hoses. {NFPA 801, 4.6 (6)}
- F. Requirements for training, drills and exercises to verify the adequacy of the emergency response plan, including practice sessions coordinated around previously developed valid emergency scenarios particular to the facility. {NFPA 801, 4.6 (7)}

Procedures must also include direction for any workers responsible for performing rescue or medical duties, and call out specifically those titled persons who have responsibilities captured within those response procedures or emergency plan implementing procedures. {29 CFR 1910.38(c)(5) & (6)}

When an alarm system is present, indicative of a specific hazard, then the facility Professional Miners and Core Personnel must be trained in each purpose of each distinctive signal and the alarm system. {29 CFR 1910.165}

Designated workers will be trained to assist in the safe and orderly evacuation of other workers. {29 CFR 1910.38(e)}

Emergency response procedures or emergency plan implementing procedures will be reviewed with each worker covered by those procedures under any one of the following conditions:

- A. When the plan is developed. {29 CFR 1910.38(f)(1)}
- B. When workers are initially assigned a responsibility under the procedures. {29 CFR 1910.38(f)(1)}
- C. When the worker's responsibilities under the plan change. {29 CFR 1910.38(f)(2)}



# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

D. When the plan is revised. {29 CFR 1910.38(f)(3)}

Underground facilities that are involved in the processes listed below will follow listed design requirements in accordance with 29 CFR 1910.119:

- A process which involves a chemical at or above the specified threshold quantities listed in Appendix A of 29 CFR 1910.119. {29 CFR 1910.119(a)(1)(i)}
- A process which involves a Category I flammable gas (as defined in 29 CFR 1910.1200(c)) or a flammable liquid with a flashpoint below 100 °F on site in one location, in a quantity of 10,000 pounds, except for: {29 CFR 1910.119(a)(1)(ii)}
  - Hydrocarbon fuels used solely for workplace consumption as a fuel (e.g., propane used for comfort heating, gasoline for vehicle refueling), if such fuels are not a part of a process containing another highly hazardous chemical covered by the listed standard. {29 CFR 1910.119(a)(1)(ii)(A)}
  - Flammable liquids with a flashpoint below 100 °F stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration. {29 CFR 1910.119(a)(1)(ii)(B)}

Design requirements shall include responsibility for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. These releases may result in toxic, fire or explosion hazards. {29 CFR 1910.119(e)}

- A. Underground facilities shall develop a written plan of action regarding the implementation of the worker participation required by this section. {29 CFR 1910.119(c)(1)}
- B. Underground facilities shall consult with workers and their representatives on the conduct and development of process hazards analyses and on the development of the other elements of process safety management in this standard. {29 CFR 1910.119(c)(2)}
- C. Underground facilities shall develop a Process Hazards Analysis utilizing a proven methodology as listed in 29 CFR 1910.119. {29 CFR 1910.119(e)(2)}
- D. The underground facility shall inform workers of the known potential fire, explosion, or toxic release hazards related to the contractor's work and the process. {29 CFR 1910.119(h)(2)(ii)}
- E. The underground facility shall explain to workers the applicable provisions of the emergency response procedures. {29 CFR 1910.119(h)(2)(iii)}

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

- F. The underground facility shall establish and implement an emergency response plan and the emergency response plan shall include procedures for handling small releases.

Emergency preparedness drills will be planned and performed in keeping with established directives and procedures governing their conduct, and will use hazards scenarios commensurate with the surveyed, and, if applicable, assessed hazards for that facility. [6.2.8]

The Fire Marshal and/or the Fire Protection AHJ is authorized to enter and examine any underground facility to enforce the provisions of this standard, NFPA codes/standards, or other applicable fire protection requirements as described in this document. {IFC 106.1}

The Fire Marshal and/or the Fire Protection AHJ is authorized to conduct such inspections as are deemed necessary to determine the extent of compliance with the provisions and to approve reports of inspection by approved agencies or individuals. All reports of such inspections shall be prepared and submitted in writing for review and approval. Inspection reports shall be certified by a responsible manager or by the responsible individual. The Fire Marshal and/or the Fire Protection AHJ is authorized to engage such expert opinion as deemed necessary to report upon unusual, detailed, or complex technical issues. {IFC 106.2}

It shall be the duty of the Facility Manager or their designee to notify the Fire Marshal and/or the Fire Protection AHJ when work is ready for inspection. It shall be the duty of the Facility Manager to provide access to and means for inspection of such work that are required by this PD. {IFC 106.2.1}

Work shall not be completed beyond the point indicated in each successive inspection without first obtaining the approval of the Fire Marshal and/or the Fire Protection AHJ. The Fire Marshal and/or the Fire Protection AHJ, upon notification, shall make the requested inspections and shall either indicate the portion of the construction that is satisfactory as completed, or notify the permit holder or his or her agent wherein the same fails to comply with the requirements. Any portions that do not comply shall be corrected, and such portion shall not be covered or concealed until authorized by the Fire Marshal and/or the Fire Protection AHJ. {IFC 106.2.2}

Whenever any installation subject to inspection prior to use is covered or concealed without having first been inspected, the AHJ shall have the authority to require that such work be exposed for inspection. {IFC 106.3}

Approval as the result of an inspection shall not be construed to be an approval of a violation of the provisions of other ordinances of the jurisdiction. Inspections presuming to give authority to violate or cancel provisions of these requirements or other applicable fire codes/standards shall not be valid. {IFC 106.4}

Whenever or wherever any device, equipment, system, condition, arrangement, level of protection, or any other feature is required for compliance or otherwise installed, such

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

device, equipment, system, condition, arrangement, level of protection, or other feature shall thereafter be continuously maintained in accordance with this standard. {IFC 107.1}

Equipment requiring periodic testing or operation to ensure maintenance shall be tested or operated as specified by codes or standards and per the manufacturers recommendations. {IFC 107.2}

Required test and inspection records shall be available to the Fire Marshal and/or the Fire Protection AHJ at all times or such records as the Fire Marshal and/or the Fire Protection AHJ designates shall be filed with the Facility Manager. {IFC 107.2.1}

Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made so as to achieve compliance with this PD. The work or installation shall then be resubmitted to the AHJ for inspection and testing. {IFC 107.2.2}

Maintenance and testing shall be under the supervision of a responsible person who shall ensure that such maintenance and testing is conducted at specified intervals in accordance with the manufacturer's recommendations. {IFC 107.3}

Portable or fixed fire-extinguishing systems or devices, and fire-warning systems, shall not be rendered inoperative or inaccessible, except as necessary during emergencies, maintenance, repairs, alterations, drills or prescribed testing. {IFC 107.4}

Overcrowding or admittance of any person beyond the approved occupancy limit or escort to visitor ratio for an underground facility or beyond the approved capacity of a portion shall not be allowed. The Fire Marshal and/or the Fire Protection AHJ, upon finding any overcrowding conditions or obstructions in aisles, passageways or other means of egress, or upon finding any condition which constitutes a life safety hazard, shall be authorized to cause the event to be stopped until such condition or obstruction is corrected. {IFC 107.6} [9.4.13]

## 8 UNDERGROUND FACILITY RESCUE

### 8.1 Mine Rescue Teams

The requirements for rescue teams during underground construction, stated in 29 CFR 1926.800(g)(5), is implemented for underground facilities by the Mine Rescue Teams in compliance with the applicable sections of 30 CFR 49.

### 8.2 Availability of Mine Rescue Teams

Two Mine Rescue Teams consisting of five members and one alternate shall be available at all times that employees are in the DOE underground facilities in accordance with 30 CFR 49.2(a)(1) and (b) through (g).

When construction activities associated with the mining of a tunnel, drift, alcove, or niche are in progress, (i.e., installation of permanent ground support is not completed), one Mine Rescue Team shall be available within one-half hour ground travel time from the location of the underground mining activity. {29 CFR 1926.800(g)(5)(i)} During other construction and operating activities, the Mine Rescue Teams shall be capable of presenting

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

themselves at the underground facility within a reasonable time after notification of an occurrence which might require their services. {30 CFR 49.2(g)}

### 8.3 Mine Rescue Station

A Mine Rescue Station shall be maintained at the underground facilities in accordance with 30 CFR 49.5(a), (b) and (c).

No underground facility served by a Mine Rescue Team shall be located more than 2 hours ground travel time from the Mine Rescue Station with which the Mine Rescue Team is associated. {30 CFR 49.2(f)}

### 8.4 Equipment and Maintenance Requirements

The Mine Rescue Station shall be provided with at least the equipment listed in 30 CFR 49.6(a).

The underground rescue apparatus and equipment shall be maintained in a manner that will ensure readiness for immediate use in accordance with 30 CFR 49.6(b).

### 8.5 Physical Requirements for Mine Rescue Team

Each member of the Mine Rescue Team shall be examined annually by a physician who shall certify that each member is physically fit to perform underground facility rescue and recovery work in accordance with 30 CFR 49.7(a) and (b).

A form certifying medical fitness shall be completed and signed by the examining physician for each member of a Mine Rescue Team, and these forms shall be filed at the Mine Rescue Station for a period of 1 year.

### 8.6 Training for Mine Rescue Teams

Training for the Mine Rescue Team members shall be in accordance with 30 CFR 49.8(a), (b), and (c) commensurate with the assigned duties and functions and available equipment. In lieu of the 20-hour initial training course prescribed by Mine Safety and Health Administration (MSHA) Office of Educational Policy and Development, a locally-developed training course of equal length and similar subject matter, tailored to the NNSS underground facility environment, may be substituted.

As required by 30 CFR 49.8(d)(1), the training courses shall be conducted by instructors who have been employed in an underground facility for a minimum of 1 year within the past 5 years, and who have received approval through completion of an MSHA or State approved instructor's training course and the program of instruction in the subject matter to be taught.

A record of training for each Mine Rescue Team member shall be on file at the Mine Rescue Station for a period of 1 year in accordance with 30 CFR 49.8(g).

### 8.7 Underground Facility Emergency Notification Plan

In accordance with 30 CFR 49.9(a), each DOE underground facility shall have an Underground Facility Rescue Notification Plan outlining the procedures to follow in notifying the Mine Rescue Teams when there is an emergency that requires their services.

# DOE-STD-1066-2017, Underground Fire Protection Criteria

## DRAFT A

---

A copy of the Underground Facility Rescue Notification Plan shall be posted at the underground facility for the information of personnel performing work in the underground facility as required by 30 CFR 49.9(b).

## 9 UNDERGROUND FACILITIES SERVICES

### 9.1 Drainage System

In hazardous controlled areas shall be provided with drainage system to direct the flow of liquids to an approved location/area designed to provide secondary containment for the high-hazard materials and fire protection water {NFPA 520 4.1.4.3.3}

### 9.2 Containment System

In hazardous controlled areas drains in the area shall be directed to a containment system or other location designed as secondary containment for the hazardous materials and fire protection water. Containment capacity shall be capable of containing the flow sprinkler activation (discharge) for 20 minutes {NFPA 520 4.1.4.3.4}.

# DOE-STD-1066-2017, Underground Fire Protection Criteria DRAFT A

- TWO OR MORE SEPARATE ESCAPEWAYS TO THE SURFACE (6.1.3.4)
- REFUGE STATION IF NORMAL EXIT METHOD CANNOT BE REACHED WITHIN 1 HOUR FROM WORKPLACE (6.1.3.5)
- REFUGE STATION WITHIN 30 MINUTES OF WORKPLACE (6.1.3.5)
- ALTERNATIVE REFUGE CAPABILITY (LOCAL REFUGE STATION OR SHELTER IN-PLACE MATERIALS) (6.1.3.6)
- TRAVEL DISTANCE TO PORTAL, EXIT OR REFUGE STATION NOT MORE THAN 2000 FT (6.1.3.7)
- NO SURFACE BUILDING OR SIMILAR STRUCTURE WITHIN 100 FT OF SURFACE OPENING (6.1.3.27)

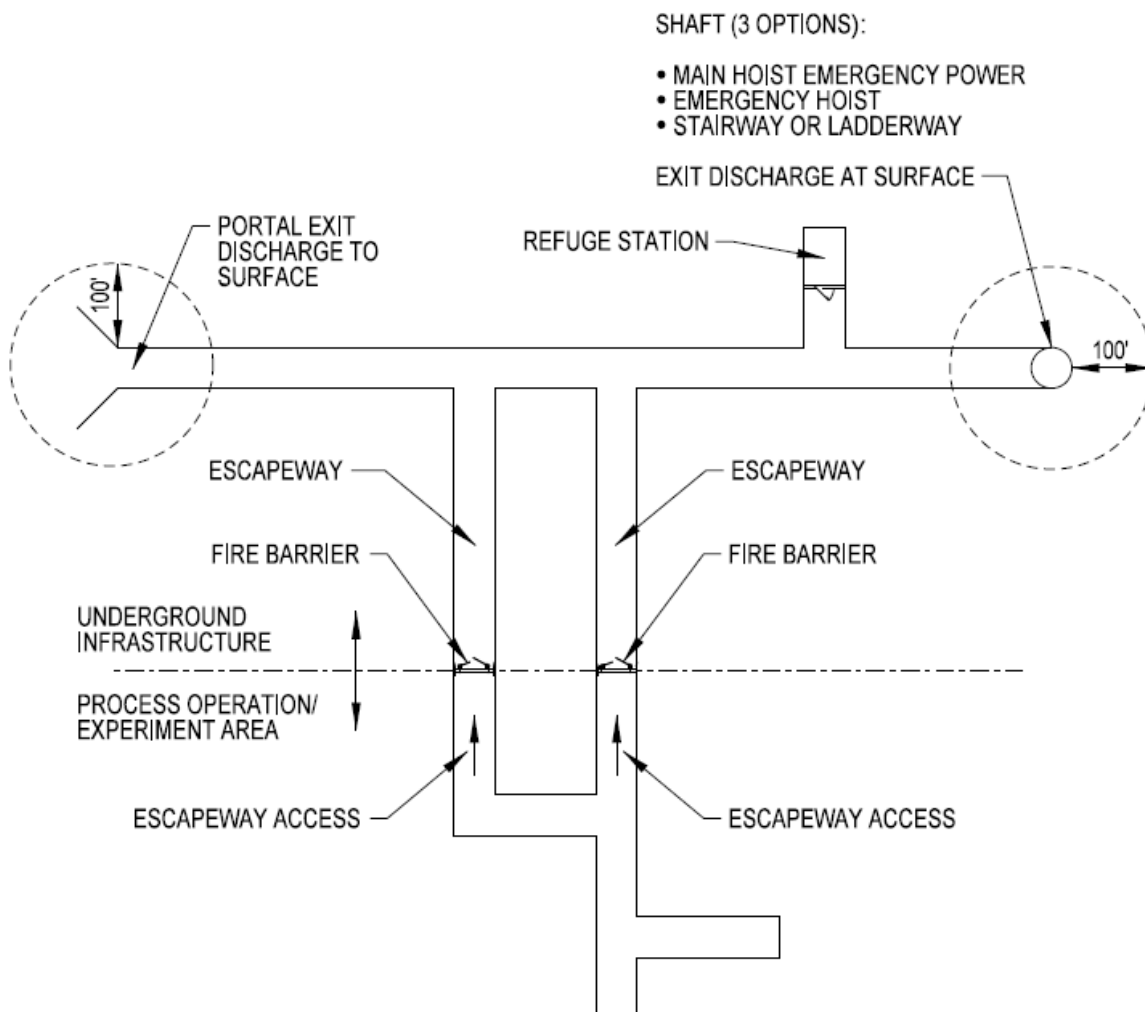


FIGURE 6.1-1 ILLUSTRATION OF ESCAPEWAYS AND REFUGE STATIONS