Attachment 2

ADDITIONAL GUIDANCE FOR THE ASSESSMENT OF FINDINGS USING SIGNIFICANCE DETERMINATION PROCESS ENTRY

General Guidance

Fire Scenario Considerations:

In order to perform a screening risk significance estimate of the fire protection DID findings the inspector must develop a reasonable fire scenario, based on in situ conditions and allowed operational practices. It is the inspector's responsibility to develop a fire scenario for the fire area, zone, or room of concern. This will include evaluating the available fuel, its distribution, and its relationship to post-fire SSD mitigation systems, equipment, and components, and potential ignition sources. Do not assume that all equipment is arbitrarily lost by a postulated fire. The inspector is required to consider a more realistic impact of fire on the equipment. This fire scenario should consider the relative location of fire sources and their relationship to SSD and accident mitigation equipment, the heat release rates of these combustibles, and if the amount of material available to sustain a fire for an appreciable duration.

The following may be used as guidance to assist with the development of a postulated fire scenario:

a. The maximum transient fuel loads allowed by administrative controls can be considered an initiating fuel package.

b. The presence of external ignition sources (e.g., welding, cutting, grinding, temporary wiring) allowed by administrative controls can be present and can be considered a potential ignition source.

c. Plant electrical equipment (e.g. motor control centers, switchgear, relay panels, termination cabinets, motors, MG sets, transformers) can be a source of ignition and part of the fuel load.

d. Fires in electrical cabinets that have ventilation openings or are unsealed at the top can expose and ignite the cables above the cabinets.

e. Faults in high and medium voltage switchgear can breach a metal cabinet and cause faults in adjacent switchgear.

f. Exposure fires involving transient combustibles have an equal probability of occurring anywhere in the space being evaluated or inspected. Fires involving fixed (in situ) combustibles can occur at the site of the combustible material and propagate accordingly within and along a contiguous fuel package.

g. Hydrocarbon fuels (e.g., plastic) when burning can give off dense smoke within a short period of time (fill room or rooms from floor to ceiling with smoke). Smoke transport by HVAC and through fire barrier leakage may impact fire brigade and operator actions that have to occur in areas adjacent to the room or area under consideration.

h. If unprotected (no fire resistive barrier) SSD and recovery equipment/components that are in the fire's plume or located in the ceiling region are damaged.

Fire Scenario Evaluation Guidance:

The first step in determining changes to overall reactor plant fire risk is to identify a fire scenario for a given fire area, zone, or room of concern. This will require that the general location of the post-fire SSD systems, equipment, and components and any recovery (EOP type) systems, equipment, and components be identified within the given fire area, zone, or room of concern. Proximity of combustibles and their relationship to SSD and recovery equipment must be identified. For example, is the SSD and recovery equipment of concern located near the ceiling, and are the in situ fuel packages (combustibles), such as cables in cable trays, located within this same region of the room[1]?

SSD and/or systems, equipment, and components are considered to be targets that are subject to fire damage. These targets can be in the ceiling jet layer (upper hot gas layer portion of the room) that forms directly beneath the ceiling, or in the fire's plume region, or in the sub-layer that is beneath the ceiling jet layer.

Generally, a fire presents the greatest challenge when it is located directly beneath a target such as the case of a floor-based exposure-type fire involving transient combustibles. For fixed (insitu) combustibles, actual geometry of the fuel packages (along the wall, in the corner, near the ceiling) between the fire source and the target should be assessed in order to determine if the targets of concern are located within the fire plume or in the ceiling jet region. Note that a fire that burns up against a wall burns at twice the intensity of those that burn in the center of the room. Fires that burn in the corner of a room burn at four time the intensity of those that burn in the center of the room. A fire that burns near the ceiling will develop a ceiling jet and a hot gas layer more quickly than fires that burn in the center of the room.

Assuming ignition, the characteristics of the fuel packages should be evaluated (for example, the state of the fuel (solid, liquid, gas), type and quantity, configuration and location, rate of heat release, rate of fire growth, and production rate of combustion products). As a fire begins to grow in intensity in the initial fuel package, it can produce sufficient convective, conductive, and radiant energy to ignite adjacent fuel packages (e.g., floor based fire exposes one bank of cable trays in the upper regions of a room then this burning bank of cable trays ignites a second and adjacent bank of cable trays within the same upper region). This is one way a fire scenario can develop.

Basic ignition of secondary fuel packages is generally attributed to convection, conduction, radiation, or a combination of these energy (heat) transfer methods. Conduction occurs when the fuel packages are in direct contact with each other and heat is directly transferred from one package to the other. Convection occurs when heat in the fire plume carries heat to the secondary fuel packages and radiation typically transfers heat to adjacent fuel packages (e.g., two adjacent fuel packages at the floor level and not in contact with one another). Radiation is dependent on the size of the flame, temperature, emissivity of the flame, absorptivity of the fuel package (combustible) surface, geometric viewing factor between the flames and the fuel package surface, and its ignition characteristics.

Specific Guidance

The inspectors should be aware that installation criteria including location and spacing of detection devices and of automatic and manual suppression systems provided in this document do not reflect site specific commitments to the applicable codes-of-record. The inspectors should inspect the

[1] It should be noted that this type of assessment of the fuel configuration and distribution is not the same as the fuel loading (BTUs/sq. ft) calculations performed for the plant-specific Fire Hazards Analysis (FHA).

critical attributes of the fire detection system against the design and installation criteria specified by the code-of-record.

Fire Detection and Alarm Systems.

a. Automatic Fire Detection Effectiveness

The following is supplemental guidance and may be used by the inspector to assist in making qualitative judgements relating to the general effectiveness of certain automatic fire detection features used to detect an incipient fire within the fire area, zone, or room under consideration.

A review of the layout and placement of the detection (initiating) devices within those fire areas, zones, or rooms under consideration will be required in order to evaluate the effectiveness of the detection system.

Generally, two basic types of fire detection devices are used. They are products of combustion (POC) type detector or thermal detectors. For example, the majority POC detectors are ionization or photoelectric spot (smoke) type and they are listed by Underwriter's Laboratories (UL) to be placed on a smooth ceiling, with a height that does not exceed 15 feet 9 inches and a maximum spacing of 30 feet between detectors.

With respect to thermal detectors, generally there are two types fixed temperature and rate compensated. The UL listing for a fixed temperature and rate compensated is related to an area of coverage. For example, a fixed temperature detector can be used to protect a maximum of 225 square feet and a rate compensated detector can be used to protect a maximum of 2500 square feet with a 50 foot spacing factor.

b. Spot Type Thermal Detector Placement - Minimum Design Inspection Factors

Spot type detectors shall be located on the ceiling not less than 4 inches from the side wall or on the side walls between 4 and 12 inches from the ceiling.

Reduced spacing shall be considered and may be required due to structural obstructions and characteristics of the area being protected. For smooth ceilings the distance between detectors shall not exceed their UL listed spacing and there shall be a detector within one half of the listed spacing, measured at right angle, from all walls or partitions extending to within 18 inches of the ceiling, or all points on the ceiling shall have a detector within a distance equal to 0.7 times the listed spacing.

The maximum linear spacing on smooth ceilings for spot type heat (rate of rise or compensated) detectors are determined by full scale fire tests. These tests assume that the detectors are to be installed in a pattern of one or more squares, each side of which equals the maximum spaced as determined in the test. The distance from the detector to the fire shall be maintained always at the test spacing multiplied by 0.7. (See table below)

TEST SPACING	*MAXIMUM TEST DISTANCE FROM FIRE TO DETECTOR*
50 X 50 FEET	35 FEET
40 X 40 FEET	28 FEET
30 X 30 FEET	21 FEET

25 X 25 FEET	17.5 FEET
20 X 20 FEET	14 FEET
15 X 15 FEET	10.5 FEET

On ceilings 10 feet to 30 feet high heat detector spacing shall be reduced in accordance with the table below:

CEILING HEIGHT (FT)	*UP TO*	*PERCENT OF UL LISTED SPACING*
0	10	100
10	12	91
12	14	84
14	16	77
16	18	71
18	20	64
20	22	58
22	24	52
24	26	46
26	28	40
28	30	34

A ceiling shall be treated as a smooth ceiling if the beams project no more than 4 inches below the ceiling. If the beams project more than 4 inches below the ceiling, the spacing of spot type heat detectors shall be at right angles to the direction of the beam travel and shall not be more than 2/3 of the smooth ceiling spacing. If the beams project more than 18 inches below the ceiling and are more than 8 feet on center each bay formed by the beams shall be treated as a separate area and have at least one detector installed within the bay.

Location and spacing of heat detectors should consider beam depth, ceiling height, beam spacing, HVAC vents and effects, obstructions, and fire size.

If the ratio of beam depth (D) to ceiling height (H) (D/H) is greater than 0.10 and ratio of beam spacing (W) to ceiling height (H) (W/H) is greater than 0.40, heat detectors should be placed in each beam pocket.

If either the ratio of beam depth to ceiling height is less than 0.10 or the ration of beam spacing to ceiling height is less than 0.40, heat detectors should be installed on the bottom of the beams.

c. Spot Type POC Detector Placement - Minimum Design Inspection Factors

Spot type detectors shall be located on the ceiling not less than 4 inches from the side wall or on the sidewall between 4 and 12 inches down from the ceiling to the top of the detector.

On smooth ceilings, spacing of 30 feet shall be permitted to be used as an initial criteria. All points on the ceiling shall have a detector within a distance equal to 0.7 times the selected spacing. General guidance for spacing of spot type smoke detectors on smooth ceilings 10 feet to 30 feet high[8] is provided in the table below:

Fire Size (Btus/second) and Growth Rate	*Maximum Ceiling height (feet)*	*Maximum Spacing (ft)*
100 btus/sec - fire growing at a slow rate	10	22
	15	15
	18	12
250 btus/sec - fire growing at a slow rate	10	40
	15	35
	18	30
MEDIUM RATE		
100 btus/sec - fire growing at a medium rate	10	18
	15	12
	18	N/A
MEDIUM RATE		
250 btus/sec - fire growing at a medium rate	10	35
	15	28
250 btus/sec - fire growing at a medium rate	20	24
	25	18
	28	12
FAST RATE		
100 btus/sec - fire growing at a fast rate	10	12
	15	N/A
FAST RATE		
250 btus/sec - fire growing at a fast rate	10	28
	15	20

[8] It is assumed that the ratio of the gas temperature rise to the optical density of the smoke is a constant and that the detector will actuate at a constant value of temperature rise equal to 20°F, which is considered indicative of concentration of smoke from a number of common fuels that would cause detection by a relatively sensitive detector.

Fire Size (Btus/second) and Growth Rate	*Maximum Ceiling height (feet)*	*Maximum Spacing (ft)*
	20	14

Ceiling construction where beams are 8 inches or less in depth shall be considered equivalent to a smooth ceiling. If the beams are more than 8 inches in depth the spacing of spot type detectors in the direction perpendicular to the beams shall be reduced. If the beams are less than 12 inches in depth and less than 8 feet on center spot type detectors shall be permitted to be installed on the bottom of beams.

If the beams project more than 18 inches below the ceiling and are more than 8 feet on center each bay formed by the beams shall be treated as a separate area and have at least one detector installed within the bay.

Location and spacing of heat detectors should consider beam depth, ceiling height, beam spacing, and fire size. To detect a flaming fire (strong plumes), detectors should be installed as follows:

> Condition 1: If the ratio of beam depth (D) to ceiling height (H) (D/H) is greater than 0.10 and ratio of beam spacing (W) to ceiling height (H) (W/H) is greater than 0.40, heat detectors should be placed in each beam pocket.
>
> Condition 2: If either the ratio of beam depth to ceiling height is less than 0.10 or the ration of beam spacing to ceiling height is less than 0.40, heat detectors should be installed on the bottom of the beams.

To detect smoldering fires (weak or no plumes), detectors shall be installed as follows:

- If air mixing into the beam pockets is good (e.g., air flow parallel to long beams) and condition (1) exists as above, detector shall be located in each beam pocket.

- If air mixing into the beams pockets is limited or condition (2) exists above, detectors should be located on the bottom of the beams.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the fire detection system to perform its intended function:

- The detection system for the fire area, zone, or room under consideration is inoperable.

- Insufficient number of detectors as required by the spacing and placement criteria established by the code-of-record.

- The placement and spacing of 25 percent of the detectors within the fire area, zone, or room under consideration do not meet the spacing/placement conditions specified by the code-of-record or by their UL listing.

The following is an example of a observed condition that may represent a moderate impact (degradation) on the ability of the fire detection system to perform its intended function:

– The placement and spacing of 10 percent of the detectors within the fire area, zone, or room under consideration do not meet the spacing/placement conditions specified by the code-of-record or by their UL listing.

The following is an example of a normal operating state:

– The layout and placement of fire detection devices within the fire area, zone, or room under consideration meet industry codes and the conditions specified by the code-of-record or by their UL listing.

Fixed/Automatic Fire Suppression Systems.

a. <u>Automatic Sprinkler System Water Curtains</u>

The following evaluation guidance should be used for making qualitative judgments relating to the effectiveness of a water curtain's (connected to an automatic sprinkler system's) ability to promptly detect and prevent a fire within the fire area, fire zone, or compartment under consideration from spreading through the otherwise unprotected opening.

General Assumptions

– If the water curtain is supplied by a preaction sprinkler or deluge system, it will be necessary to evaluate the detection system (which controls the actuation of the pre-action sprinkler/deluge system) in order to evaluate the effectiveness of the automatic water curtain. This assumption does not apply to water curtains connected to automatic wet pipe or dry pipe systems.

– Where required, the proper design and operation of the detection system is essential to the success or failure of the water curtain.

– The design and installation of the draft curtain surrounding the unprotected opening is essential to successful operation of the water curtain.

– It is assumed that the system was constructed from listed components and the design and installation met the NFPA code of record (COR) and followed the applicable technical guidance presented in the COR appendices.
– It is assumed that the system met start-up testing requirements and is maintained in accordance with the vendor's manual and the COR .

Evaluation Guidance

In order for the water curtain to be effective, the system must possess the following three attributes: (1) the system must actuate in the early stage of the fire. For pre-action and open-head water-based systems, single-zoned thermal detectors (of the appropriate temperature rating) or single/cross zoned smoke detectors are generally found acceptable. Slow-acting detection systems such as cross-zoned thermal detectors are typically too slow to be effective in actuating a water curtain in a timely manner (2) The system must deliver the minimum amount of water to close off the opening (3) The draft stop enclosure (in order to support the first two objectives) must remain tight to the opening and be designed deep enough to stop the natural buoyant flow of heat and smoke through the unprotected opening diverting it to the detectors and sprinkler heads (thus ensuring their operation.) The draft stop also forms the deflector for the sprinkler head discharge to form the cascading water wall. Failure of any of these three criteria may greatly reduce the effectiveness of the water curtain to perform its intended function.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the water curtain to perform its intended function:

– The system for the fire area, zone, or compartment under consideration is inoperable.

– The system's supply valve is closed.

– For systems requiring detection to actuate, the detection system is inoperable or too slow to react (see Section 3.01).

– The system does not provide adequate coverage or discharge for the unprotected opening.

– The draft stop enclosure is not tight enough, or deep enough to ensure proper operation.

– Sprinkler heads are missing, wrong type, or are damaged.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the water curtain to perform its intended function:

– Sprinkler heads are out of position or are slightly obstructed by other plant equipment.

– Degradation to the detection system is medium (see Section 3.01).

– Minor gap between the draft stop and the ceiling.

The following is an example of a normal operating state:

– The system design (including detection where applicable and the draft stop) installation, and maintenance are within industry codes and standards requirements.

b. Automatic Sprinkler System

The following is supplemental guidance[9] and may be used by the inspector to assist in making qualitative judgements relating to the general effectiveness of certain automatic sprinkler system features used to control a fire within the fire area, zone, or room under consideration*:*

– Sprinklers shall be installed in accordance with their UL listing.

– Ordinary-temperature-rated sprinklers shall be used throughout Nuclear power plant buildings. Where maximum ceiling temperatures exceed 100°F, sprinklers with

[9] Refer to Automatic Sprinkler System Handbook, Sixth Edition, for additional guidance

temperature ratings in accordance with the maximum ceiling temperatures[10] noted below shall be used:

Maximum Ceiling Temperature (F)	Sprinkler Temperature rating (F)	Sprinkler temperature classification	Sprinkler temperature rating	Glass bulb colors
100	135 to 170	Ordinary	Uncolored	Orange or Red
150	175 to 225	Intermediate	White	Yellow or Green
225	250 to 300	High	Blue	Blue
300	325 to 375	Extra High	Red	Purple
375	400 to 475	Very Extra High	Green	Black

– Early suppression fast response sprinklers shall be used only in wet pipe sprinkler systems.

– The distance from sprinklers to walls shall not exceed one-half of the allowable distance between sprinklers. Sprinklers shall be located a minimum of 4 inches from wall.

– Non-continuous obstructions at or very near the ceiling and close to the sprinkler such as columns, cable trays, light fixtures, large pipes, HVAC ducts shall be treated as vertical obstructions. The minimum separation between vertical obstructions and a sprinkler shall be as follows:

Minimum distance from vertical obstruction	
Maximum dimension of obstruction	*Maximum horizontal distance sprinkler shall be placed away from obstruction*
½ to 1 inch	6 inches
Greater than 1 inch and less than 4 inches	12 inches
Greater than 4 inches	24 inches

– The minimum separation of a sprinkler from a horizontal obstruction (beams, HVAC ducts) shall be determined by the height of the sprinkler deflector above the bottom of the obstruction shall be as follows:

Position of sprinkler deflector when located above bottom of obstruction	
Distance from sprinkler to side of obstruction	Maximum allowable distance of deflector above bottom of obstruction

[10] The maximum ceiling temperature is equated to the temperature that would be experienced at the ceiling on the hottest summer day (Summer High)

Position of sprinkler deflector when located above bottom of obstruction	
less than 1 ft.	0 in.
1 ft to less than 1 ft-6 in.	1 in.
1 ft-6 in. to less than 2 ft.	1 in.
2 ft. to less than 2 ft-6 in.	2 in.
2 ft-6 in. to less than 3 ft.	3 in.
3 ft. to less than 3 ft-6 in.	4 in.
3 ft-6 in. to less than 4 ft..	6 in.
4 ft. to less than 4 ft.-6 in.	7 in.
4 ft-6 in. to less than 5 ft	9 in.
5 ft. to less than 5 ft.-6 in.	11 in.
5 ft.-6 in. to less than 6 ft.	14 in.

– Under obstructed construction, the distance between the sprinkler deflector and the ceiling shall not be less 6 inches and more than 12 inches.

– Sprinklers shall be positioned with respect to lighting fixtures, cable trays, pipes, ducts and obstructions more than 24 inches wide and located entirely below the sprinkler so that the minimum distance from the near side of the obstruction to the center of the sprinkler is not less than the value specified below:

Position of sprinklers in relation to obstruction located entirely below the sprinklers	
Distance of deflector above the bottom of the bottom of the obstruction	Minimum distance to side of obstruction (ft)
Less than 6 inches	1 ½ feet
6 inches to less than 12 inches	3 feet
12 inches to less than 18 inches	4 feet
18 inches to less than 24 inches	5 feet
24 inches to less than 30 inches	6 feet

– Where the bottom of the obstruction is located 24 inches or more below the sprinkler deflector: (a) Sprinklers shall be positioned so that the obstruction is centered between adjacent sprinklers; (b) The obstruction shall be limited to a maximum width of 24 inches. Where the obstruction is greater than 24 inches wide, one or more lines of sprinklers shall be installed below the obstruction; and (c) The obstruction shall not extend more than 12 inches to either side of the midpoint between sprinklers. When the extensions of the obstruction exceed 12 inches, one or more lines of sprinklers shall be installed below the obstruction.

- In the special case of an obstruction running parallel to and directly below a branch line:(a) The sprinkler shall be located at least 36 inches above the top of the obstruction; (b) The obstruction shall be limited to a maximum width of 12 inches; and (c) The obstruction shall be limited to a maximum of 6 inches to either side of the centerline of the branch line.

- A minimum of 18 inches of clear space below the sprinkler deflector shall be maintained.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the sprinkler system to perform its intended function:

- The system is out of service or inoperable

- The system is actuated by the fire detection system and the fire detection system is inoperable or its critical detection attributes (detector placement and spacing) capabilities does not meet the code-of-record.

- Sprinkler head distance from the ceiling exceeds the limits specified above.

- Two or more adjacent sprinkler heads in a combustible free zone are affected obstructions (horizontal, vertical, or obstructions located below) and are without adjacent obstruction heads below obstruction.

- The placement and spacing of 25 percent of the sprinklers within the fire area, zone, or room under consideration do not meet the spacing/placement conditions of their UL listing or that specified by the code-of-record.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the sprinkler system to perform its intended function:

- Improper assessment of system performance or evaluation of internal system corrosion.

- The placement and spacing of 10 percent of the detectors within the fire area, zone, or room under consideration do not meet the spacing/placement conditions of their UL listing or that specified by the code-of-record.

- Based on the specified ceiling temperature limits, the sprinkler head temperature ratings exceed the maximum temperature set-points recommended.

The following is an example of a normal operating state:

- The sprinkler system layout and head placement within the fire area, zone, or room under consideration meets or exceeds the minimum industry code requirements and the conditions of the sprinkler head UL listing and testing approvals.

c. <u>Automatic Spray Systems</u>

The following evaluation guidance is to be used for making qualitative judgments relating to the effectiveness of an automatic water spray system's ability to promptly detect and control a fire within the fire area, fire zone, or compartment under consideration.

General Assumptions

- It is assumed that the system was constructed from UL-listed components and the design and installation met the NFPA code of record (COR).

- It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program .

Evaluation Guidance

Water spray extinguishing systems are specialized fire extinguishing systems. Water spray systems are typically used to protect such specific hazards as grouped cable trays. Detection and subsequent actuation is often provided by special means such as linear thermal detector wire (e.g., Protecto wire, Thermistor wire.) Single-zoned thermal detectors (of the appropriate temperature rating) or single/cross-zoned smoke detectors are also acceptable. Slow-acting detection systems such as cross-zoned thermal detectors are typically too slow to be effective in actuating a water spray system in a timely manner. In addition, a water spray system must deliver the minimum water spray density on the hazard.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the automatic water spray system to perform its intended function:

- The system for the fire area, zone, or compartment under consideration is inoperable.

- The system's water supply valve is closed.

- The detection system is inoperable or reacts too slowly.

- The system does not provide adequate water spray density or coverage for the in situ hazard.

- Waterspray nozzles are missing, wrong type, or damaged.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the automatic water spray system to perform its intended function:

- Spray nozzle is out of position or slight obstruction.

- The detection system is degraded to a medium degree.

The following is an example of a normal operating state:

- The system design (including detection) installation, and maintenance are within industry codes and standards requirements.

d. Automatic Halon System

The following evaluation guidance is to be used for making qualitative judgments relating to the effectiveness of an automatic Halon system's ability to promptly detect and control a fire within the fire area, fire zone, or compartment under consideration.

General Assumptions

– It is assumed that the system was constructed from UL-listed components and the design and installation met the NFPA code of record (COR).

– It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program .

Evaluation Guidance

In order for the Halon system to be effective, the total flooding system must possess the following attributes: (1) The system must actuate in the early stage of the fire. Single-zoned thermal detectors (of the appropriate temperature rating) or single/cross-zoned smoke detectors are acceptable. Slow-acting detection systems such as cross-zoned thermal detectors are typically too slow to be effective in actuating a Halon system in a timely manner (2) The system must deliver the minimum amount of agent in the specified time. Surface-burning fires (e.g., flammable liquids) typically require 5 percent to 8.2 percent.[11] Deep-seated fires (e.g., cables, Class A combustibles) typically require a minimum 6 percent held in the enclosure for 10 to15 minutes,[12] and (3) the enclosure must remain tight to contain the halogenated agent.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the automatic halon system to perform its intended function:

– The system for the fire area, zone, or compartment under consideration is inoperable.

– The system's supply valve is closed or the supply tanks do not contain adequate agent.

– The detection system is inoperable or too slow to react

– The system does not provide adequate concentration or soak time for the in situ hazard.

– The enclosure is not tight enough, or has more leakage paths than originally tested (e.g., no ventilation system isolation, removed or missing dampers).

– Discharge nozzles missing, wrong type or are damaged.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the automatic halon system to perform its intended function:

– Discharge nozzle is out of position or is slightly obstructed.

– The detection system is degraded to a medium degree (see Section 3.01).

– The enclosure's ability to maintain gas concentration is minimally degraded (e.g., worn-out fire door weather stripping, minimal penetration seal degradation — minor cracks).

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[11]See NFPA 12A "Standard on Halon 1301 Fire Extinguishing Systems"

[12]See NUREG/CR-3656 "Evaluation of Suppression Methods for Electrical Cable Fires" Section3.3 "Halon 1301 Suppression of Fully Developed Cable Fires," 1986

The following is an example of a normal operating state:

- The system design (including detection) installation and maintenance are within industry codes and standards requirements.

e. Automatic Carbon Dioxide (CO_2) Systems

The following evaluation guidance is to be used for making qualitative judgments relating to the effectiveness of an automatic carbon dioxide system's able to promptly detect and control a fire within the fire area, fire zone, or compartment under consideration.

General Assumptions

- It is assumed that the tightness of the enclosure and the ability to control ventilation systems are essential to successful operation of the carbon dioxide system

- It is assumed that the system was constructed from UL-listed components and the design and installation met the vendor's manual and the COR.
- It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program .

Evaluation Guidance

Carbon dioxide extinguishes a fire by displacing the normal atmosphere, thus reducing the oxygen content below the minimum 15 percent necessary for continued diffusion flame production. In order for the carbon dioxide system to be effective, the total flooding system must possess the following attributes: (1) The system must actuate in the early stage of the fire. Single-zoned thermal detectors (of the appropriate temperature rating) or single/cross-zoned smoke detectors are acceptable. Slow-acting detection systems such as cross-zoned thermal detectors are typically too slow to be effective in actuating a CO_2 suppression system in a timely manner (2) The system must deliver the minimum amount of agent in the specified time. Surface-burning fires (e.g., flammable liquids) require between 30 percent to 66 percent.[13] Deep-seated fires (e.g., cables, Class A combustibles) require a minimum 50 percent held in the enclosure for 10 to 15 minutes;[14] and (3) the enclosure must remain tight to contain the CO_2.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the CO2 system to perform its intended function:

- The system for the fire area, zone, or compartment under consideration is inoperable.

- The system's supply valve is closed or the supply tanks do not contain adequate agent.

- The detection system is inoperable or is too slow to react (see Section 3.01).

- The system does not provide adequate concentration or soak time for the in situ hazard.

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[13] See NFPA 12, "Standard on Carbon Dioxide Fire Extinguishing Systems"

[14] See NUREG/CR-3656, "Evaluation of Suppression Methods for Electrical Cable Fires" Section 3.6 "Carbon Dioxide Tests on Fully Developed Cable Fires," 1986.

– The enclosure is not tight enough or has more leakage paths than originally tested (e.g., no ventilation system isolation, removed or missing dampers).

– Discharge nozzles missing, wrong type of are damaged.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the CO_2 system to perform its intended function:

– Discharge nozzle is out of position or there is a slight obstruction.

– The detection system is degraded to a medium degree (see Section 3.01).

– The room enclosure's ability to maintain gas concentration is minimally degraded (e.g., worn-out fire door weather stripping, minimal penetration seal degradation — minor cracks).

The following is an example of a normal operating state:

– The system design (including detection) installation, and maintenance are within industry codes and standards requirements.

Fire Pumps and Water Supply System.

The following evaluation guidance must be used for making qualitative judgments relating to the effectiveness of the fire protection pumps and water supply system's ability to supply automatic and manual fire suppression systems necessary to promptly control a fire within the fire area, fire zone, or compartment under consideration.

General Assumptions

– It is assumed that a minimum two, 100 percent capacity or three, 50 percent capacity fire pumps are installed, with a minimum 100 percent capacity always available.

– It is assumed that one of the redundant minimum 2 hours of fire protection water supply (sized for the largest design flow plus hose stream requirements) is always available.

– It is assumed that the water supply, distribution, and pumping systems were constructed from UL-listed components and the design and installation met the NFPA code of record (COR).

– It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program .

Evaluation Guidance

The success of automatic fire protection systems such as sprinkler systems, and manual firefighting systems, such as standpipes, depend on the water supply system.

The distribution piping network should have been designed so that a single impaired section (e.g., a section isolated for leak repair) will not prevent the system from delivering the required capacity at the required pressure for the individual automatic and manual suppression systems.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the fire protection water supply system to perform its intended function:

- The fire protection water supply system for the automatic/manual suppression systems in the fire area, zone or room of concern is inoperable.

- The primary water supply valves (e.g., tank discharge, pump suction/discharge, main feeds, etc.) are closed.

- The pump controller is inoperable or is not in the auto start position.

- The system does not have an adequate water supply for the largest design basis hazard.

- The distribution piping network has excessive micro biologically induced corrosion (MIC)/debris (clams) such that it cannot meet its largest design-basis flow.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the fire protection water supply system to perform its intended function:

- A diesel-driven fire pump has enough fuel for more than 1-1/2 hours of operation, but less than the COR requirement.

- Minor system corrosion/debris routinely clogs up the strainers.

- Inoperable system pressure maintenance pumps (jockey pumps) cause the main fire pumps to run and pressurize the system.

- There is excessive leakage in the system underground supply piping network so that the reliability of the system may be questionable.

The following is an example of a normal operating state::

- The water supply system design, installation, and maintenance are within industry codes and standards requirements.

- A minimum 100 percent water supply and 100 percent pumping capacity are available.

Manual fire suppression equipment and systems, hose station and standpipes.

The following evaluation guidance is to be used for making qualitative judgments relating to the effectiveness of standpipe and hose system's ability to supply water for fire fighting within the fire area, fire zone, or compartment of concern.

General Assumptions

- It is assumed that the system was constructed from UL-listed components and the design and installation met the NFPA code of record (COR).

- It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program.

Evaluation Guidance

The standpipe and hose systems are extensions of the plant's water-based suppression system. In order for the standpipe and hose systems to be effective, they must possess the following attributes:(1) The system must be able to supply sufficient water at adequate pressures (2) The system should be supplied by connections to the piping network that are independent from automatic suppression systems for that fire area, fire zone, or compartment under consideration. This is important to prevent a single failure (e.g., one closed sectional valve) from defeating both primary (automatic suppression systems) and back-up system (e.g., standpipe) for the fire area, fire zone, or compartment under consideration (3) The hose connections must be spaced such that adequate coverage is provided for all plant areas. Typically, the hose stations are equipped with 100 feet of hose. The system will also typically develop a 30-foot water stream, so a standpipe hose connection will effectively cover an area 130-feet of area from the connection. Obstructions caused by large equipment and barriers should be considered when evaluating the area of coverage.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the standpipe and hose system to perform its intended function:

- The system for the fire area, zone, or room of concern is inoperable.
- The system's supply valve is closed.
- The attached 100 feet of fire hose (plus the 30 foot for water stream) do not cover the complete area including the overhead. (Note: If the hose station is equipped with more than 100 feet of fire hose and a hydraulic analysis has been performed to demonstrate acceptable performance, this does not apply.)
- Damaged, missing, clogged, or incorrect nozzles (non UL/FM electric safe nozzles) are attached to the system.
- There is an improperly calibrated/adjusted pressure reduction device (25 percent and greater calibration/adjustment error).
- A damaged fire hose is in the hose rack.
- The standpipe/hose system distribution piping network has excessive MIC/debris (clams) so that it cannot meet its design-basis flow.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the standpipe and hose system to perform its intended function::

- Hydrostatic testing is missing (less than 3 years) on the installed fire hose.
- There is an improperly calibrated/adjusted pressure reduction device (less than 25 percent calibration/adjustment error).
- The hose station is obstructed.

The following is an example of a normal operating state:

- The system design (including attached fire hose and nozzle where applicable), installation, and maintenance are within industry codes and standards requirements.

Minimum Staffing Levels.

Generic Letter (GL) 77-02, "Nuclear Plant Fire Protection Functional Responsibilities, Administrative Controls and Quality Assurance," addressed plant fire brigade positions by providing guidance supplemental to Appendix A to Branch Technical Position 9.5-1 (sections A.1, B and C) and Regulatory Guide (RG) 1.120 (Sections C.1, C.2 and C.3). The supplemental information provided in GL 77-02 was that:

- The authority and responsibility of each fire brigade position relative to fire protection should be clearly defined.

- These responsibilities of each fire brigade position should correspond with the actions required by the fire fighting procedures.

- The responsibilities of the fire brigade members under normal plant conditions should not conflict with their responsibilities during a fire emergency.

- The minimum number of trained fire brigade members available onsite for each operating shift should be consistent with the activities required to combat the most significant fire. The size of the fire brigade should be based upon the functions required to fight fires with adequate allowance for injuries. No less than five personnel should be assigned to the fire brigade on each shift.

NRC Information Notice (IN) 91-77, "Shift Staffing at Nuclear Power Plants," addressed adequate shift staffing following any event (not necessarily a fire). IN 91-77 stated that:

- The number of staff on each shift is expected to be sufficient to accomplish all necessary actions to ensure a safe shutdown of the reactor following an event. Those actions include implementing emergency operating procedures, performing required notifications, establishing and maintaining communications with the NRC and plant management, and any additional duties assigned by the licensee's administrative controls.

It should be noted that the NRC does not require dedicated fire brigades (fire fighting personnel who have no event related operational responsibilities). However, licensees are responsible for establishing controls to ensure shift staffing is sufficient to accomplish all necessary functions required by an event.

Fire Brigade Drills and Exercises.

Manual fire fighting effectiveness is directly affected by how long (time) it takes for plant operations to accept or acknowledge the fire alarm and confirm that there is a fire. The fire brigade has to react and then report to the fire brigade equipment locker(s) (5 to 10 minutes) and don protective clothing, SCBA, and prepare the appropriate special fire fighting equipment to take with them to the fire area, zone or room under consideration (7 to 15 minutes). The brigade responds to the area of concern (5 to 15 minutes before the complete team is assembled near the area of concern). Once in the area, the fire brigade deploys and readies its equipment to fight the fire (5 to 15 minutes). The brigade effort to control and suppress the fire (7 to 30 minutes under ideal conditions). Once the fire has been placed under control complete fire extinguishment can be accomplished (30 minutes to 3 hours). Therefore, it is assumed that it takes from 34 minutes to 1 hour and 35 minutes for a fire brigade to control a challenging fire under ideal conditions. Time is a factor for fire growth and smoke development.

Time is an important factor that needs to be considered. In addition to time, judgements will have to be made with regard to the skill of the fire brigade under strenuous conditions. Their ability to cope with the stress of a serious fire challenge and implement the guidance provided by the fire fighting (pre-fire plan) strategy are an equally important factors. These integrated factors (time, skill/equipment utilization) are best evaluated by witnessing a unannounced fire brigade drill.

The following are examples of observed conditions that may represent a high negative impact (degradation) on the ability of the fire brigade to effectively carry out its manual fire fighting control and suppression function:

- Delayed response by one or more fire brigade members (e.g., greater than 15 minutes)
- Fire brigade members did not perform satisfactorily as a team
- General weaknesses associated with the proper use of personal protective equipment and fire fighting equipment and its deployment
- More than one fire brigade member did not use proper fire fighting techniques or agents to fight the simulated fire
- More than one fire brigade member did not properly use their full protective equipment including SCBA
- Pre-fire plans and their goals were not fully implemented
- Communications were not satisfactory.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the fire brigade to effectively carry out its manual fire fighting control and suppression function:

- Fire fighting (pre-fire plans) are less than comprehensive and do not establish the minimum guidance needed to support the necessary fire fighting operations.

- Fire brigade equipment not state-of the-art or good practice, specialized fire fighting agents not provided for special hazards or adequately staged, response and transport schemes for fire fighting equipment not well defined, and noted weaknesses in the material condition of fire brigade equipment.

The following are examples of observed conditions represent indicators of effective fire brigade performance (normal operating state):

- Drill scenario was well planned and the observed fire brigade performance was satisfactory when evaluated against the guidance above.
- No apparent weakness in fire brigade equipment or the stagging of this equipment, specialized fire extinguishing agents for special hazards are maintained in the appropriate areas of concern.

- Fire fighting (pre-fire plans) strategies are comprehensive and exceed minimum NRC guidance.

Passive Fire Protection Features

The following evaluation guidance is to be used for making qualitative judgements relating to the general effectiveness of passive fire protection features used to protect post-fire safe shutdown capability or prevent a fire from spreading from one fire area, zone or room to another:

- The inspector should determine that the fire wall, ceiling, floor or raceway/equipment fire barrier of concern provides passive fire resistive separation for redundant trains of systems, components, or equipment required for plant shutdown. The barrier should be intact.

- The in-situ fire load could be in a configuration that represents a challenge to the passive fire barrier or fire resistive device under consideration.

- For inspection findings (degradations) related to silicone foam penetration seals[15] see the table at the end of this section.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the fire barrier or passive device to perform its intended function:

- Completely removed or missing fire barrier protecting or separating redundant safe shutdown systems or components.

- Breach in a electrical raceway fire barrier system which is contained with in a fuel package (barrier system is in a cable tray stack)

- Fire barrier system design which is mis-applied or with a indeterminate[16] fire resistive rating.

- Ceiling fire barrier system with unsealed openings.
- Un-analyze unprotected openings in a fire area/barrier wall and these openings fall within the upper half of the wall.

- In operable fire door or damper in a fire area/ barrier wall.

- Blocked open fire door.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the fire barrier or passive device to perform its intended function:

- Fire dampers assemblies installed in a fire barrier which is not qualified to close under the anticipated ventilation system air flow.

- Fire dampers installed in fire barrier assemblies which are not installed with the required thermal expansion clearances as determined by the conditions of its qualification testing.

- Temperature set-point of the fusible link is excessively high or the fusible link has been improperly installed. These links are generally used to activate fire door / damper closure.

- Bent or warped fire door.

- Fire door with a single side through hole.

- Excessive fire door to frame and door to floor clearance gaps.

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[15] The guidance table for penetration seal degradations assumes that the silicone material is mixed and its cell structure is in accordance with the manufacturers recommendations and guidelines.

[16] In order to be able to assess the fire resistive worth of a indeterminate fire barrier assembly and its ability to provide protection under the fire conditions anticipated , the licensee must demonstrate by analysis of fire endurance test data for similar barrier designs that the design under consideration will perform as good as a design that has been qualified by subjecting it to a standard-time-temperature test fire exposure.

– Improperly installed or qualified fire door hardware.

– Raceway or equipment fire barrier assembly which has been mechanically damaged and the fire barrier wall thickness has been reduced by 25 percent over a total of 6 square inches.

– Penetration seal assembly which are not qualified by test or analysis (e.g., thermal penetration mass is greater than that tested) to withstand the fire conditions anticipated in the room, zone or area under consideration.

The following are examples of observed conditions that represent a normal operating state:

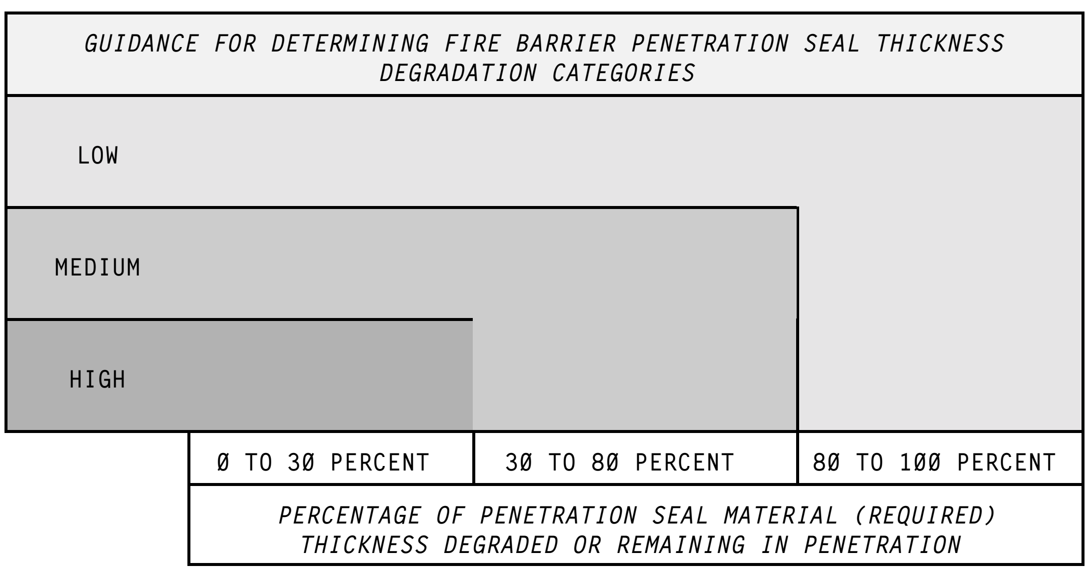
– Fire door installed and maintained in accordance with the code-of-record.

– Fire damper installed and maintained in accordance with the code-of record.

– Fire barrier penetration seal installed in accordance with the construction attributes and conditions qualified by fire tests.

– Raceway and equipment fire barrier assemblies installed in accordance with the construction attributes and conditions qualified by fire tests.

– Fire walls/barrier assemblies installed in accordance with the construction attributes and conditions qualified by fire tests.



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