Standard on the Use of Fog Nozzles in Fighting Confined Structure Fires.

1.1 Scope

This standard applies only to Class A confined structure fires as defined in this standard, and does not apply to open structure fires as herein defined.

1.2 Purpose

The standard explains how to use fog nozzles with maximum efficiency and effectiveness as defined in this standard in fighting confined structure fires. This standard deals with the tactical use of fog nozzles with respect to rate-of-flow, distribution, and safety in applying water. These tactics are based upon a scientific foundation that promotes the greatest efficiency and highest effectiveness in structural fire fighting.

1.3 Definitions

Structure. Any building erected for the purpose of shelter or enclosure of persons, animals, or property of any kind.

Confined structure fire. A fire burning in any room of a structure in which the roof or ceiling is intact.

Open Structure fire.

A fire burning in any room of a structure in which the fire has burned through the ceiling and roof of the room.

Note: A fire may be confined in one part of a structure but open in another part.

Fog Nozzle.

A fog nozzle produces “little drops of water”, that is, circular drops with a diameters ranging from 0.01 inches to 0.04 inches.

Rate-of-Flow

The amount of water projected by a nozzle is measured in gallons per minute (gpm-English) or by Liters per minute (Lpm-metric).

Efficiency

Efficiency is measured by the amount of water needed to control a fire. The less water needed, the more efficient is the nozzle or the attack.

Effectiveness

Effectiveness is measured by the amount of time needed for fire control. The less time needed, the more effective the nozzle or the attack.

Enthalpy of Vaporization of Water

The ability of water to absorb heat as it changes state from a liquid to a gas (steam) at 212º F (100º C) is measured by btus/lb (J/g)

Note: The enthalpy of vaporization of water is so much greater than that of most other substances, which is the principal reason why it is used to fight fires.

Pulse a Nozzle

Pulse a fog nozzle by moving the handle to the lowest rate-of-flow position and continuing without stopping a reverse motion to stop the flow of water.

Chapter Two

2.1 The Direct Attack

2-1-1 Type of Fire

Early flame spread: a small fire occupying only a small part of a room with a column of fire extending to the ceiling.

2.1.2 Type of fog nozzle

The tactic is to use the lowest rate-of-flow provided by the fog nozzle, and to spread the stream wide enough to the width of the fire. This shortens the reach of the stream and mitigates any splattering.

2.1.3 Access

This tactic requires direct access to the fire, usually with the attack made through an inside door.

2.1.4 Duration

Shut off the nozzle immediately when the flames disappear in a few seconds.

Note: A fog nozzle with a ball type shut-off valve cannot be used with this tactic. This nozzle has only one rate-of-flow, a maximum flow when the ball is fully opened. This flow is much to large for a small fire, and causes a large amount of water damage.

2.1.5 No direct access

When furniture (or other objects) block direct access to a small fire, then an attack can be made by directing the stream of water toward the ceiling so that the water will spread along the ceiling and fall down on the fire.

Note: This method of attack is called “Straight stream off Ceiling” or the “SSOC” method.

2.1.6 Distribution

The nozzle must be moved so that water hits all the burning surfaces with enough velocity to vaporize the water to steam.

Note: The enthalpy of vaporization of liquid water to steam at 212^{o} F (100^{o} C) is an endothermic process that absorbs the heat being produced by the fire. This cools the fire below its ignition temperature 300^{o} F to 400^{o} F or 148.8^{o} C to 204.4^{o} C, hence it stops the combustion process. In other words, it extinguishes the fire! The temperature of the steam remains at 212^{o} F (100^{o} C)

Chapter Three

3.1 Full Fog Attack

3.1.1 Type of Fire

Rapid flame spread throughout the room, near flashover or post flashover.

3.1.2 Type of Fog Nozzle

The nozzle must be capable of flowing 30 to 60 gpm (113.5 Lpm to 227.1 Lpm) for small, or average, size rooms. Larger rooms (3,000 ft^{3} 915 m) require flows around 75 gpm (283,8 Lpm).

Note: For Task Force Tips use the 1st or 2nd or 3rd click stops

3.1.3 Access

This tactic may be used through an inside door, or an outside window or outside door.

Note: If an inside door is used, then a vent opening (window) should be made prior to the attack. Provided, of course, the fire has not already vented.

3.1.4 Distribution

Water must be distributed evenly throughout the fire area. This task must be completed quickly, that is, within a few seconds.

Note: The easiest way to distribute the water is by a clockwise rotation of the nozzle held just inside the room through a window or door. In research done at Iowa State University, a counterclockwise rotation proved to be inferior in time, steam action, and with movement of condensed steam toward the nozzleperson.

3.1.5 Reach

Before the attack, adjust the nozzle so that the stream just reaches across the room.

Note: This adjustment of reach to about 30^{o} fog stream eliminates splattering so that thermal balance is restored to the fire area very quickly

3-l-6 Shut-off

Shut-off the nozzle when condensing steam (white) appears and expands outward in all directions.

3-1-7 Ventilation

This attack does not need any artificial ventilation since the expansion of liquid water to steam at a ratio of 1,700/1 (at 212^{o} F or 100^{o} C) is a blast that smothers the fire by depriving the fire of oxygen.(See note 3 – 1 – 3)

Note: With the ceiling or roof intact the steam will remain in the fire room for up to 2 minutes giving it time to smother the fire.

3.1.8 Indirect Effect

This attack has an indirect effect in areas adjacent to the fire room, such as another room, hallway, or attic. Thus fire may be controlled, or extinguished, in these adjacent areas even though no water was applied directly in any of these areas.

Note: The attack in the fire room is a direct attack not only on the burning fuels, but also a direct attack upon the flames as well that extinguishes the flames by dilution.

3.1.9 Venting

A fire confined to a room will break out window glass (single pane or double pane) at a temperature range of 550° F (287.7° C) to 650° F (343.3° C)

Note: The breaking of a glass window provides an important clue in size up to the temperature of the fire.

3.1.10 The Royer-Nelson rate-of-flow formula

The Royer-Nelson formula created by Keith Royer and Bill Nelson of the Fire Service Institute of Iowa State University is:

$$NFF \times t = \frac{Vol}{200} \qquad NFF \times t = \frac{Vol}{1.5}$$

Where "NFF" is the needed fire flow is gallons per minute (Lpm metric), and t = time in minutes or fraction of a minute, Vol = volume of a confined space in cubic feet (cubic meters in metric) and 200 is a constant (1.5 in metric)

The constant 200 (1.5 metric) is based upon two scientific facts:

1. One gallon of water at 212° F (100° C) expands instant to 227 cubic feet of steam (1.7 cubic meters). This number is rounded down to "200" (1.5 cubic meters) to allow for a 90% rate of conversion to steam.
2. One gallon of water with a margin of safety absorbs all the heat produced by the oxygen in 200 cubic feet (1.5 cubic meters) of normal air.

Note: It is quite remarkable that both of these facts converge on the same number "200" (1.5 metric) with an accuracy of 10%, that is, allowing for a 90% conversion of liquid water to steam.

3– 1 – 11: Thornton's Rule

Thornton's Rule applies to structure fires including confined structure fires in which the rate of heat release is limited by the amount of oxygen available. Thornton's Rule is stated by Dr. Vytenis Brabauskas in the 17th Edition of the NFPA Handbook, Appendix A as follows.

> "Recently, however, increasing engineering use is made of the observation that the heat of combustion per kg of oxygen consumed is nearly constant for most organic fuels. It can be shown that
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> $\Delta h^{l}_{c}/r^{o} =$ 13,1 Mj/kg for O_2

is near constant."

Note: The heat release from a fire involving conventional organic fuels is 13.1 kj/gram of oxygen consumed with an accuracy of + or – 5% or better. Incomplete combustion and variation in fuel have only a minor effect on this result. Appropriate corrections can be made as necessary.

Chapter Four
4- 1 The 3 D Pulse Fog Attack

4 – 1- 1 Type of Fire

The fire is in a confined space in which rollover at the ceiling level threatens firefighters in the room with a flashover or backdraft.

4 – 1 – 2 Type of Nozzle

The tactic is to project a small amount of water overhead using a fog nozzle at the minimum r.o.f.

4– 1 – 3 Purpose

This tactic is designed to produce a contraction of the overhead fire gases by cooling to counter the expansion of steam.

Note: No more than one or two gallons of water can be projected into the overhead to achieve this contraction. The result is that firefighters will not be engulfed in steam.

4 – 1 – 4 Distribution

This tactic is limited to a time of four seconds with a rate- of- flow of 30 gpm, or 0.5 gallons per second

4 – 1 – 5 Distribution

The nozzle stream pattern must be widened to 60^{o}, and the nozzle must be pointed upward at an angle of 45^{o}.

Note: No water should hit the walls or ceiling, Instead all the water should be projected into the overhead gases.

4 -1 – 6 Rescue

In case a victim(s) is in a room in which rollover threatens flashover, use a 3D pulse fog attack in the room to give time to make a reascue.

Chapter Five
5 – 1 The WIN Attack

5 – 1 – 1 Type of fire

The fire is burning out a 2nd floor window, but it not possible gain access by an inside stairway, or by an outside ladder.

5– 1 – 2 Type of nozzle

A fog nozzle that is capable of flowing 125 gpm, or more, in a straight stream

5 – 1 – 3 Distribution

Start on the ground outside in line with one wall of the room and walk toward the opposite wall, all the while projecting water into the window, and stop in line with the opposite wall.

Note: The firefighter may walk in a straight line or in a circular like path.

5– 1 – 4 Duration

This tactic may be repeated if necessary.

Note: Standing still outside a window and projecting water inside is highly ineffective and does little to control the fire. It is not possible to move the nozzle to distribute the water inside while standing still. This tactic is known as “outstanding firefighting”, and is a method of attack that doesn’t work.

Standard on the Use of Fog Nozzles to Fight Open Structure Fires

Chapter One Aerial Attack

1 – 1 Scope

This standard applies only to open structure fires, and does not apply to confined structure fires.

1 - 2 Purpose

This standard explains how to use a master stream fog nozzle attached to an aerial device with maximum efficiency and effectiveness in fighting an open structure fire.

1 – 3 Definitions

The definitions in the preceding standard on fighting confined structure fires are hereby incorporated into this standard.

Aerial

An aerial ladder is one attached to a fire truck that can be raised using power from the truck. This ladder may be an extension ladder, a snorkel, or a tower ladder with or without a bucket attached to the tip.

1 – 4 Type of nozzle.

A master stream nozzle that is attached to an aerial and is capable of flowing a minimum of 400 gpm, on upward.

1 – 5 Distribution.

The only method of attack available is to use a straight stream to make a direct attack upon the fire. The fog nozzle must be moved continually to make a direct attack upon all the burning surfaces.

Note: This tactic requires that a firefighter must be at the tip of the aerial device unless the nozzle can be moved continually by the aerial operator standing at the base of the aerial or on the ground.

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