NIOSH

ALERT

JULY 1985

Request for Assistance in Preventing Hazards in the Use of Water Spray (Fog) Streams to Prevent or Control Ignition of Flammable Atmospheres

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

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REQUEST FOR ASSISTANCE IN PREVENTING

HAZARDS IN THE USE OF WATER SPRAY (FOG) STREAMS

TO PREVENT OR CONTROL IGNITION OF FLAMMABLE ATMOSPHERES

WARNING!

FIRE DEPARTMENTS AND TEAMS RESPONDING TO INCIDENTS INVOLVING FLAMMABLE GAS OR VAPOR MIXTURES ARE CAUTIONED THAT THE USE OF WATER SPRAY (FOG) STREAMS TO PREVENT IGNITION OR CONTROL FLAME PROPAGATION MAY BE EXTREMELY DANGEROUS:

- SIGNIFICANT FIRES OR EXPLOSIONS CAN OCCUR DESPITE THE USE OF WATER SPRAY. UNDER CERTAIN CONDITIONS, THE USE OF WATER SPRAY MAY IN FACT INCREASE THE SEVERITY OF SUCH FIRES AND EXPLOSIONS.

- IT IS UNLIKELY THAT HANDLINES USING STANDARD FIRE DEPARTMENT WATER SPRAY (FOG) NOZZLES UNDER FIELD CONDITIONS CAN PREVENT IGNITION.

- IT IS UNLIKELY THAT HANDHELD HOSE STREAMS CAN PRODUCE A WATER SPRAY WITH SUFFICIENTLY SMALL DROPLET SIZE AND UNIFORMLY HIGH WATER CONCENTRATIONS TO RENDER INERT A FLAMMABLE ATMOSPHERE.

- THE USE OF WATER SPRAY CANNOT BE RELIED UPON TO QUENCH A FIRE IN A FLAMMABLE ATMOSPHERE.

INTRODUCTION

In response to requests for assistance by Federal, state, and local health agencies who have jurisdiction, the National Institute for Occupational Safety and Health (NIOSH) conducts selected investigations of occupational fatalities. Recently NIOSH was called to investigate an incident which occurred as a hazardous materials (HAZMAT) team responded to a "man down" emergency in a storage tank recently emptied of toluene. In the attempt to gain immediate access to the tank to rescue the victim, members of the team began to saw an opening in the side of the tank while blanketing the area being cut with water fog, both inside and outside the tank. An explosion occurred which instantly killed one HAZMAT team member and injured 15 others.

July 1985

BACKGROUND

Water, in the form of "water spray" or "fog patterns," is frequently used by fire departments and other response teams to prevent or control fire when dealing with flammable materials. The use of water sprays in this way derives from several factors:

- traditional use of water by firefighters to extinguish fires,
- belief that water sprays may provide critical ventilation,
- ready availability and relative ease of application of water sprays, and
- effectiveness of water sprays in controlling some of the hazards of flammable materials.

In investigating the circumstances of the incident summarized above, investigators from NIOSH also reviewed various reported uses of water sprays to control hazardous materials.* This review identified at least 20 different suggested uses of water in the control of hazardous materials. In at least some of the situations described, the use of water fog actually posed a significant additional risk to the safety of firefighters or other personnel. One example is the attempt to prevent, control, or diminish a gas-air or vapor-air explosion using water spray or fog delivered by handlines.

Accordingly, this alert, directed to fire departments and HAZMAT teams specifically, warns that certain uses of water may be hazardous. These dangerous uses of water should be avoided.

REPORTED USES OF WATER SPRAYS

Studies by numerous laboratories have identified four prime mechanisms through which water spray could influence the ignition and propagation of a fire or explosion in a flammable atmosphere. Water spray has been used to:

- ventilate or otherwise reduce the concentration of the fuel to a level below that which is flammable,
- raise the required ignition energy beyond that available,
- render the flammable atmosphere inert, or
- quench or prevent the propagation of an incipient or developed flame front.

*The National Institute for Occupational Safety and Health (NIOSH) intends to publish a more detailed report on water spray at a later date.

The water spray requirements for each of these control mechanisms differ, as do their methods of application. Experience with use of water sprays for these purposes, including potential hazards, is briefly summarized below.

1. Concentration Reduction

Various techniques involving use of water spray have proven successful in laboratory and field trials and in some actual incidents. For example, air entrained in water spray has been shown to dilute, ventilate, or move flammable vapors or gases. In addition, water droplets in spray may absorb soluble vapors or gases under certain conditions.

However, in some experimental cases the water spray did not reduce the concentration of flammable vapors below the threshold of flammability, and ignition occurred. In those instances, the flame traveled through the water spray resulting in a more severe fire or explosion than would have occurred without the water spray.

2. Raising Required Ignition Energy

The results of several laboratory studies indicate that water sprays directed on "hot spots" caused by frictional cutting can significantly reduce the likelihood of ignition. By using a fine water spray directed on the hot path of a mining bit cutting into rock, researchers have prevented ignition of a flammable methane-air mixture. The water density of the covering spray, the size of droplets, and the work surface being cooled were critical factors in the success of this control measure.

Other studies using an explosive as the source of ignition of flammable ethylene-air or hydrogen-air mixtures showed that the strength of the charge necessary to obtain an explosion was considerably increased with the use of a water spray. In both situations, however, higher levels of ignition energy still caused ignitions, i.e., the water spray was not sufficiently effective to prevent ignition.

3. Rendering a Flammable Atmosphere Inert

Water as steam can render a flammable atmosphere inert. For example, when the concentration of water in the atmosphere was about 26% by volume, a highly flammable methane-air mixture was rendered inert. This concentration of water in the atmosphere is approximately 10 times that which the atmosphere can normally contain at room temperatures. This approach is normally impractical for field use because it requires production of a droplet size 30-100 times finer than that produced by standard fire department water spray (fog) equipment.

4. Quenching Flame Propagation

Quenching, or cooling a flame below the temperature required to propagate it in a flammable atmosphere, can be achieved only if the water droplets can be made small enough so that the distance between them is below a critical dimension. To produce a sufficiently fine mist in a fixed spray system usually requires a pressure in excess of 1,000 psig. Further, some systems even require the use of a high explosive to break up and disperse the water droplets.

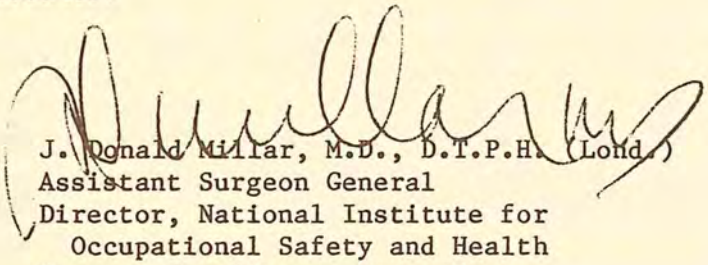
Fire departments and other teams responding to incidents involving flammable gas or vapor mixtures are urged to approach the control of flammable atmospheres with extreme caution. The use of a water spray (fog) does not eliminate the need for other recognized control methods to dilute the flammable atmosphere and to prevent ignition due to sparks, arcs, or open flames.

REQUEST FOR ASSISTANCE

NIOSH requests that the technical information and warning contained in this ALERT be disseminated to personnel of fire departments, HAZMAT teams personnel, fire training academies, and other emergency response organizations.

Should further information be desired, please contact the Division of Safety Research, 944 Chestnut Ridge Road, Morgantown, West Virginia 26505-2888, Telephone (304) 291-4809.

We greatly appreciate your assistance.



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