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AIRPORT DISASTER DRILL
CLERMONT MERCY HOSPITAL
BATAVIA, OHIO

NIOSH INVESTIGATORS:
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I. SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a request from the East Fork Joint Ambulance District to assess the hazard to participants of an airport disaster drill. A smoke generating device - 5D smoke bomb - planned for use in the drill had been associated with health problems during previous smoke training exercises.

A two-member team of NIOSH investigators conducted an environmental assessment during the airport disaster drill on April 28, 1986. Air samples were collected for hydrochloric acid (HCl), and chlorinated hydrocarbons. HCl and chlorinated hydrocarbons have been measured in hazardous concentrations in smoke from zinc chloride devices during other NIOSH health hazard evaluations.

A trace of HCl was detected on one of two air samples and no chlorinated hydrocarbons were detected on two air samples. One participant stated that he had experienced irritation when the same device had been used during a previous indoor drill.

About 40 "victims" and 7 separate fire departments/rescue squads participated in the drill. The 5D smoke bomb, used to create smoke, only burned for about 2 minutes. It is rated to have a 5-minute burn time.

Based on these results, the NIOSH investigators concluded that a health hazard did not exist for participants in the airport disaster drill. The investigators believe however, that a hazard could exist under certain conditions based on data collected during other NIOSH investigations of these types of devices. These conditions include: use of larger and/or multiple smoke generating devices, igniting a smoke generating device inside an aircraft with people inside who are not properly protected, or use of a large smoke generating device too near a stationary disaster drill participant. Recommendations are included in section VIII to prevent/address such conditions.

KEYWORDS: SIC 9224 (Fire Protection) HCl, chlorinated hydrocarbons, smoke generating devices, zinc chloride, airport disaster drill.

II. INTRODUCTION

On April 28, 1986, NIOSH received a request from a trustee of the East Fork Joint Ambulance District to evaluate chemical exposures from a 5D Smoke Bomb, which was to be used to create smoke, during an airport disaster drill, to be conducted at the Clermont County Airport, Batavia, Ohio. The trustee was aware that this type of device - a zinc chloride producing, smoke generating device - had been implicated in several episodes of sickness and death, resulting from smoke training exercises.[1-10] One report described health problems of participants of an airport disaster drill.[3] These devices are also being evaluated by NIOSH in other health hazard evaluations, in which, hazardous levels of HCl and other chemicals have been measured.[11,12]

A NIOSH team of investigators conducted an environmental assessment of personal exposures from the 5D Smoke Bomb during an airport disaster drill on April 28, 1986.

Results, recommendations, and status reports were distributed to interested parties via letters on June 17, and November 24, 1986.

III. BACKGROUND

The airport disaster drill was conducted at the Clermont County Airport, Batavia, Ohio, during the late afternoon of April 28, 1986. Fire departments and/or rescue squads from approximately seven local fire companies and an air rescue helicopter team participated in the drill. In addition, approximately 40 volunteers served as "victims" of an airplane crash. Some victims remained stationary while others were ambulatory. The victims used make-up to enhance the effect. A small airplane was also used to represent a crashed airplane. Four people were placed inside the plane to simulate difficulties in removing non-ambulatory victims .

To create smoke, the participants used a zinc chloride smoke generating device called a 5D Smoke Bomb. This device is 14 inches long, about 1 inch in diameter, and has a wick at each end. According to advertising literature the 5D Smoke Bomb has a burn time of 5-minutes and generates 100,000 cubic feet of smoke. Additionally, several small (firecracker sized) smoke bombs were used to supplement smoke generated by the 5D smoke bomb.

The entire drill lasted about 1 hour. The 5D Smoke Bomb burned for about 2.0 minutes, rather than the 5-minutes it was advertised to burn.

IV. METHODS

For the environmental assessment, airborne samples for HCl and chlorinated hydrocarbons were collected. Other NIOSH investigations had identified these chemicals as components of smoke from other zinc chloride smoke generating devices made by the same manufacturer.[11-12] A NIOSH investigator, wearing a full face respirator, wore one set of air samplers. This individual stayed downwind of the smoke generating device, and in the smoke stream. In this manner, it was hoped to collect an air sample that would represent the maximum exposure any participant would experience. A second set of samplers was attached to the outside of the airplane. For each type of sample, the collection media of choice (charcoal tube for chlorinated hydrocarbons, washed silica gel for HCl) was attached via flexible tubing to a battery operated pump.

The chlorinated hydrocarbon samples were analyzed using a gas chromatograph equipped with a flame ionization detector. The limit of detection was calculated to be 0.01 milligram of material per sample. HCl samples were analyzed using ion chromatography according to NIOSH Method no. 7903.[13] The laboratory limit of detection was calculated to be 1 microgram (ug) per sample and the limit of quantitation was calculated to be 5 ug per sample.

V. EVALUATION CRITERIA

A. Environmental Criteria

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards.[14-17] Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits (REL), by contrast, are based primarily on concerns relating to the prevention of occupational disease.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA value where there are recognized toxic effects from high short-term exposures.
The exposures evaluated in this study are not typical 40-hour per week "occupational exposures". As indicated, TWA criteria were established for full shift exposures and short-term criteria are generally established to supplement TWAs. Neither TWAs or short term criteria are ideal for 15-minute to 1-hour exposures, that may occur only once per year. The short-term values are better for comparison. Ceiling values are designed as maximum exposures levels that should not be exceeded. The investigators believe ceiling values are the best available exposure criteria for these types of exposures. An additional type of criteria to consider for periodic short-term exposures to hazardous chemicals are the IDLH (immediately dangerous to life and health) values. IDLH values represent atmospheres that could be instantaneously harmful to persons who are not wearing suitable protective equipment. NIOSH recommends that persons entering IDLH atmospheres wear self contained breathing apparatuses (SCBA).

B. Hydrochloric Acid

Hydrochloric acid is a colorless gas with an irritating pungent odor. It may cause irritation of the respiratory tract with burning, choking, and coughing. Severe breathing difficulties may occur which may be delayed in onset.[14,15,17]

OSHA and ACGIH both have ceiling criteria of 7 mg/m^3 for HCl. NIOSH has no short term criteria for HCl, but lists an IDLH value of 2000 mg/m^3 in the NIOSH Pocket Guide.[14-18]

VI. RESULTS

A. Air Sampling

One of two samples contained HCl but the amount (less than 1.7 mg/m3) was too low to be quantitated. None of the chlorinated hydrocarbon samples contained any peaks that were not found on the blank samples.

B. General Information

Prior to the disaster drill the NIOSH investigators were told that a smoke generating device, larger than the 5D smoke bomb, was to have been used. The identity of the larger device could not be determined.

The 5D Smoke Bomb used for the drill did not function properly. It burned for about 2 minutes as opposed to the advertised burn-time of 5-minutes. While burning, the 5D smoke bomb produced a stream of smoke that was carried by the prevailing winds through and beyond the disaster area. The other devices used produced small puffs of smoke which the investigators believed were insignificant compared to the amount of smoke produced by the smoke bomb.

According to some of the involved parties, there had been a discussion of putting a smoke device inside the airplane where four of the "victims" were located. Based on visual observations and air sampling data collected during other health hazard evaluations, had this been done, very high concentrations of HCl, could have existed.[11,12] One of the participants reported that he had experienced irritation when one of the zinc chloride smoke generating devices, was used previously during an indoor training exercise.

VII. DISCUSSION AND CONCLUSION

Based on these results the NIOSH investigators believe that a health hazard did not exist for participants of this airport disaster drill. The investigators noted however, the potential for hazardous exposures under certain conditions: placing a smoke generating device too close to "victims", placing a smoke generating device inside an airplane with people, and/or using several large smoke generating devices.

One of the problems noted during this investigation was the minimal information on smoke cloud components, potential health effects, and proper techniques for use, contained on the 5D smoke bomb product labels. The smoke generating devices are often supplied without any information other than that contained on product labels. This information warns of respiratory irritation if used indoors - without respiratory protection. The supplemental information that is available from the manufacturer lists zinc chloride as the principal smoke cloud component, with free carbon products as secondary components. There is no information as to other smoke cloud components. There is also little, if any, direction on how the devices should be used. These combined factors are probably partially responsible for individuals selecting these devices for use in training exercises such as airport disaster drills.

The subject device was chosen because the individual selecting it assumed it was safe. A statement such as "may irritate breathing passages if used without respiratory protection" does not provide sufficient warning. The literature contains little information on environmental assessments of smoke cloud components during previous investigations of smoke training exercises. This is surprising considering that these devices have sold for about 30 years and there are a number of articles describing a variety of health effects for smoke training participants.[1-10] When previous investigations included environmental sampling, the same types of chemicals were identified.[9] The literature includes one article describing adverse health effects for airport disaster drill participants. During that drill, zinc chloride smoke generating devices were also used. Participants included 82 "victims" and 28 medical personnel. Reported health effects included cough and hoarse or sore throat as early symptoms with later symptoms including nausea, fatigue, and/or headache. The authors, of that article, suggested that a strong potential for serious injury existed from exposure to zinc chloride aerosol. They recommended that zinc chloride aerosols not be used as smoke screens where human exposure is possible.[3]

VIII. RECOMMENDATIONS

1. No smoke generating device should be considered completely safe. While alternative non-zinc chloride, smoke generation devices are available, that appear to be less toxic, the potential toxicity of a specific device should be evaluated before it is actually used.

2. For any smoke generating device selected, information should be obtained about the smoke cloud components. Some information should be available from the manufacturer, but it is also advisable to determine if a specific device has been tested by an an independent group.

3. A dry-run, during which the selected smoke device is used without any people being involved should be conducted before any persons are actually exposed to smoke. The dry run should be conducted immediately before the actual drill. This will enable participants to visualize how much smoke is produced and how the prevailing winds affect the smoke. They can then modify the actual training exercise as needed.

4. During airport disaster drills, smoke generating devices should not be ignited inside an airplane if humans are inside the plane, unless the individuals wear suitable respiratory protection (i.e. SCBA).

5. Zinc chloride smoke generating devices should not be used indoors unless participants are wearing SCBAs (self contained breathing apparatuses), due to the potential for generating an IDLH atmosphere.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Clermont Mercy Hospital
2. Superior Signal Company
3. East Fork Joint Ambulance District
4. International Fire Fighters Union
5. OSHA, Region V

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