Identifying the Triggers for Population Protection

of the Residents of Care Facilities in Union Township

By: Steven Auffart
Lieutenant
Union Township Fire Department
860 Clough Pike Cincinnati Ohio 45245

A proposed research project submitted to the Ohio Fire Executive Program

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CERTIFICATION STATEMENT

I hereby certify that the following statements are true:

1. This paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

2. I have affirmed the use of proper spelling and grammar in this document by using the spell and grammar check functions of a word processing software program and correcting the errors as suggested by the program.

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ABSTRACT

The problem was the Union Township Fire Department did not have a basis for determining the triggers for evacuation or in-place sheltering of care facilities that are located in Union Township and outside areas to which they provide fire and paramedic coverage. As a result the Fire Department has not been able to develop standard operating guidelines or an officer training program. This report utilized action research to answer the following questions 1.What recommendations are currently made by local, state and federal plans and guidelines? 2. What recommendations are made by research studies and reports to support or refute current plans, procedures, and guidelines? 3. What is the comfort level of the officers of Union Township Fire Department in making population protection decisions during a hazardous substance release and how can it be improved?

The procedures utilized to answer these questions consisted of a literature review and a survey. The survey was created and provided to every officer of the Union Township Fire Department using an online survey program. The results of this survey showed while most officers felt comfortable making these decisions they all felt improvement could be made. The literature produced data showing that conditions experienced during hazardous materials incidents where of greater importance than specific materials. The recommendations made by the author are to use data gathered to develop standard operating guidelines and an officer training program based on those guidelines.

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INTRODUCTION

Statement of the Problem

Hazardous substances move through the United States every day including Union Township, a community located in southwestern Ohio. In 2002, Ohio transported a combined total of 187,112 tons of hazardous substances delivered to locations inside of and outside of Ohio's borders *(BTS.gov).* These statistics do not account for shipments that traverse Ohio on their route to other states. This puts Ohio at risk for hazardous material incidents that endanger lives and property. The latest data available (BTS.gov) shows in 2006 there were 2,672 Hazmat incidents reported in the State of Ohio.

A report from 2005 (LTC 2005) showed Ohio had two million people over the age of 60 making Ohio the sixth highest state in terms of population aging. Clermont County is ranked seventeenth in Ohio (Scripps 2000) with thirteen percent (23,101) of the population at 60 years of age or older. The population of Union Township (UT) is similar to the state of Ohio and Clermont County in percentage of residents who are 60 year of age or older: that is, 6,165 in 2005 with a projected increase to 7,367 by 2010. In terms of the type of housing specific to this report—that is, residential care facilities and nursing homes—(Scripps) showed that in 2005 (the latest statistics available) the state of Ohio had 1493 residential care facilities and nursing homes with a combined total of 30,000 beds. In 2008, The Union Township Fire Department provided service to three nursing homes and residential care facilities with a combined total of 501 beds.

Union Township like every other community in the nation is faced with the threat of the release of a hazardous substance every day. While it would be difficult to show that the residential care facilities and nursing homes in Union Township are at significantly higher risk from a hazardous substance incident than any other building, these facilities are a high risk.

These facilities are multi-story with high-density occupancy. The people being housed have varying degrees of disability; many also suffer from one or more health conditions. These facilities present unique issues that have to be factored in when making decisions about population protection during a hazardous substance release, particularly whether to evacuate or shelter in place. It has become apparent that a hazardous substance release can occur anywhere, at anytime, often without warning; and can potentially affect one or more of the care facilities in Union Township. Although the Union Township Fire Department understands and is aware of this potential problem, the department has no SOPs and provides no guidelines to aid officers in making decisions during these types of incidents. The problem this study will address is how to determine the criteria for either evacuations or sheltering-in-place of residents in care facilities in Union Township utilizing scientific and fact based research.

Purpose of the Study

The purpose of this study is *to* use scientific and fact based research to identify specific components of hazardous substance release incidents and how these components impact on decisions that are made to protect the area population. The findings from this study will be presented to the Union Township Fire Department Administration with the intention of designing the most detailed and efficient plans, procedures, and training programs possible.

Research Questions

The following questions will be answered by this action research:

1. What recommendations are currently made by local, state and federal plans and guidelines?
2. What recommendations are made by research studies and reports to support or refute current plans, procedures and guidelines?
3. What is the comfort level of the officers of Union Township Fire Department in making population protection decisions during a hazardous substance release and how can it be improved?

BACKGROUND AND SIGNIFICANCE

Union Township is located in Clermont County along the I-275 corridor in the Ohio River Valley in Southwestern Ohio. The township is approximately 31.5 square miles in area with a residential population of approximately 46,962. Lying just east of Union Township is the Village of Amelia (also located in Clermont County) with an area of approximately 1 square mile and a residential population of approximately 3,516. Both communities fall under the jurisdiction of the Union Township Fire Department.

The Union Township Fire Department is a full time ISO 3 fire department providing emergency services including but not limited to fire suppression, EMS, hazardous materials response, and rescue. The department was established in 1990 and is comprised of 69 line personnel, 3 chief officers, and 2 administrative assistants. The five fire stations respond to approximately 7000 emergencies annually.

Union Township is a mixed community with light industry, retail facilities, educational institutions, and single and multifamily dwellings and most important to this report three adult care facilities. Two of the facilities are considered assisted living (OAC 173-39-02.16) and the third is classified as a nursing home (ORC 3721.01). All three facilities are multi-story, high density occupancies with a combined capacity of 501 residents who have varying degrees of disability and can suffer from multiple health conditions. The latest data found, though not specific to the Union Township facilities, is a report published in 2006 on Ohio adult care facilities. This report showed that 75.8% of nursing home residents under the age of 60 required assistance with activities of daily living (ADLs) with 93.5% of residents over the age 60 requiring assistance with ADLs. It also included statistics indicating 60.7% of residents under the

age of 60 and 67.6% of those over the age of 60 suffered from cognitive impairment. This study also reported data from residential care facilities showing 63.8% of residents required some assistance with ADLs and 28.3% suffered from cognitive impairment in some form. It can be surmised that the residents of the facilities within Union Township will be somewhat representative of the same statistics. Geographically two facilities are located within a quarter mile of a major state route and a third is within a quarter mile of Interstate 275. These roadways are a main transportation artery thus there is a strong probability of involvement in a hazardous substance incident.

The Ohio Fire Code Section F 104.11 states the authority at emergency scenes involving protection of life and property lies with the fire chief or other fire officer. ORC 3737.80 states during hazardous materials incidents the fire chief or his designee is responsible for coordination of initial on scene activities. The Clermont County EOP Hazmat annex states command at hazmat incidents will initially be managed by a senior fire officer or firefighter and that the incident commander will implement an appropriate public protective action. The Ohio EOP states the decision to evacuate or shelter in place during a hazmat incident rests with local elected officials and the on-scene responders. In 2006 the Union Township Fire Department Hazardous Materials Unit—using NIMs definitions—self-typed as a Type 2 hazardous materials team and is designated as Clermont County's response team. While there have been no incidents to date involving the adult care facilities in Union Township, it is apparent that when an incident does occur the officers will be required to make population protection decisions.

LITERATURE REVIEW

In some cases, advising people to stay indoors and attempting to reduce the flow of outside air into a structure until the danger passes might be the most effective protective option. In-Place Sheltering will have to be used when the incident produces a toxic cloud or plume that moves at a speed greater than evacuation can be implemented and/or evacuation would put people at greater risk than sheltering in place. Evacuation effectiveness is determined by estimating the time required to evacuate a particular area in relation to the projected initial exposure to the toxic cloud. The incident commander will perform an initial size up utilizing available tools such as CAMEO. Appropriate public protective actions will also be based on the hazard level and existing as well as predicted weather conditions (CC EOP, 2002)

The decision as to which action is to be taken—i.e., sheltering in place or evacuation—is based on the specific material involved, its properties, toxicity, and the time of plume arrival. Evacuations involve moving people out of the area of a hazardous materials incident, particularly when the incidents are long term and people can be moved prior to the arrival of the toxic plume (Ohio EOP). An emergency management system, such as ALOHA or other plume models, is available with criteria for making these decisions. Evacuations are not always needed; sometimes in place protection is the best option. In some chemical hazards, using wet towels and shutting off air circulation systems while the cloud moves past may be faster than executing an evacuation (SLG 101, 9/06).

For some hazardous materials it is safer to keep citizens indoors with windows closed rather than evacuate; frequently, the plumes move past homes quickly. Modern homes have adequate air supply to safely allow residents to remain inside for extended—but not unlimited—periods of time (NRT-1).

Variable factors that are part of an evacuation decision include: wind speed and direction, temperature, humidity, air dispersion conditions, and time of day. Evacuation during incidents involving the airborne release of acutely toxic chemicals is not always possible. Releases can occur and move so quickly that there would be no time to evacuate residents. The sick and elderly may suffer more injury by being evacuated than by sheltering in place. Evacuation may be the sensible option for incidents lasting an hour or more, or when resultant fires cannot be controlled rapidly. Further factors that affect evacuation decisions include: the amount of material released, physical and chemical properties of the material released, health hazards, atmospheric conditions, dispersion medium, rate of release, and potential duration (EPA, 87).

A study performed by ORNL showed outside air will infiltrate the interior of buildings. One factor identified was age of the structure: e.g., homes built before the 1950s will likely be unsuitable shelters. The study also showed infiltration rates increase in direct proportion to temperature fluctuations or wind speed. Analysis also suggests that an important consideration is whether the potential exists for outdoor concentrations to enter a structure before it can be closed up (ORNL, 2002).

[Argonne, 2001] further supports the idea of infiltration, contending that air enters structures through small leakage sites. Data also suggests once outside air enters a structure, it will mix with inside air thus causing a buildup of outside contaminants. These findings are also supported by (EPA, 2004), indicating that infiltration of outside air is affected by temperature and wind speed.

Some information was found that refutes findings of the above studies (Persily, 98). Even though this study is not specifically related to the topic, it addresses the air tightness of buildings

which makes it relevant. Results of this study show no direct correlation between age of the structure and degree of infiltration. A comparison between commercial buildings and residential structures showed commercial buildings were not necessarily significantly tighter than residential structures. Two other factors mentioned were building wall construction and number of stories.

The physical state of a hazardous material influences the choice as well as the effectiveness of protective actions. Sheltering in place does not provide optimum protection from gases and aerosols because they can easily infiltrate structures. Protective action decisions are also influenced by whether there the hazardous material has the potential for flammability and/or explosion. This study states that the release of chemicals that have potential to ignite or explode should result in evacuations even if the chemical is both flammable and toxic (NICS, 2001)

Officials should recommend shelter-in-place only when there is reasonable assurance that allowing the population to remain within the structure is safer than moving them to another location (John H. Sorenson, 2004). Other decision-making considerations include but is not limited to chemical charecteristics and meteorlogical conditions. Chemical charecterisitcs to be considered are: form, density, vapor pressure, and degree of health hazard. The study further states sheltering is generally not suitable for flammable or explosive atmospheres. However, some researchers opine that sheltering could still be preferable in locations or where conditions do not allow rapid, safe evacuation.

A pertinent criteria that can be utilized by emergency responders as exposure thresholds are AEGL's. These are acute exposure guideline levels established by the EPA (EPA [AEGL's]) that take into consideration the general population including ages birth to elderly and those who are at risk due to adverse health conditions.

The NIOSH Pocket Guide to Chemical Hazards (NIOSH, 2005) provides information to emergency responders regarding exposure thresholds set forth by OSHA and NIOSH. The standards presented in this guide are based on conditions found in work environments where the public involved are healthy, mobile and capable of self-evacuation.

When the hazardous materials incident involves a substance that is considered toxic by inhalation (TIH), the DOT Emergency Response Guidebook (DOT/ERG, 2008) should be utilized to determine the Initial Isolation Zone or Protective Action Zone based on the wind direction and concentrations of material.

PROCEDURES

This survey will be distributed to all of the officers of the Union Township Fire Department. Respondents will receive the survey via departmental mail in envelopes; similar to the procedure used for the LPI surveys. Officers will have one month to complete and return the survey. Once the survey is received, results will be compiled by analyzing percentage of answers to survey questions. The results will then be segmented by the number of years a respondent has been an officer. The question this survey will answer is: *What is the confidence level of the officers of the Union Township Fire Department regarding shelter in place/evacuation decisions involving nursing homes?*

The sampled population will consist of the twenty two officers of the department. It is my intention to receive response from all twenty two respondents. The selection of respondents was made to determine whether officers receive enough guidance to determine whether the affected population should shelter in place or be evacuated and what evacuation procedures would be implemented.

RESULTS

It was suspected by the author that the literature review would yield results that would identify specific indicators for choosing when to evacuate as opposed to shelter in place. This assumption was proven to be incorrect as research showed decisions should be based on generalizations not specific hazards.

Results of Research Question 1

Guidelines and plans located for the literature review discussed the threat of a vapor cloud or plume as a result of a hazardous materials release. All went on to discuss that the plume could be stationary or transient and that this could be determined by atmospheric conditions and topography. As a means to determine the movement of the ensuing plume a specialized computer program would need to be utilized. Time is the trigger identified by this research as the trigger for evacuations or sheltering place. For evacuation to be effective an affected population must moved from a location prior to arrival of a toxic cloud so as to minimize exposure. In the event that an evacuation cannot take place prior to the arrival of the plume shelter in place is suggested as the most prudent decision. A factor cited as most likely to affect this decision is populations with physical limitations as the ability for these people to take action in a timely manner would be greatly diminished.

Results of Research Question 2

The studies and reports found as a result of the literature review for question two generally supported the guidelines and plans noted in question one however more detail was provided. Several studies where analyzed regarding air movement into buildings from the outside environment. These studies prove that sheltering in place is a reasonable option however

its effectiveness is only short term. The agreed threshold before outside air is circulated through most buildings is found to be approximately four hours.

In order to answer Research Question 3: What is the comfort level of the officers of Union Township Fire Department in making population protection decisions during a hazardous substance release and how can it be improved? A survey (Appendix A) was developed using Questionpro.com and was made available to every officer of the Union Township Fire Department. There was a response rate of 50%: ten respondents completed the survey and one answered no questions. Of the total respondents surveyed, 70% were lieutenants, 10% were captains and 20% were the rank of assistant chief or higher.

Question 1 queried whether or not the department has a shelter in place procedure for residents of care facilities. 30% of respondents answered yes; 30% answered no; and 40% were unsure.

Question 2 queried whether or not the department has an evacuation procedure in place for residents of care facilities. 30% of respondents answered yes; 50% answered no; and 20% were unsure.

Question 3 queried whether officers had ever received training specifically regarding protection of residents of care facilities. 40% of respondents answered yet; 60% answered no.

Question 4 queried the level of confidence that officers would have in their decision-making ability as to how best to protect residents of a care facility located in the isolation zone if that officer was placed in the role of incident commander during a hazardous materials incident. 80%

of the respondents stated that they were confident; 20% indicated that they were not at all confident.

Question 5 queried as to what could be done to increase confidence in making the decision to either shelter in place or evacuate the residents of care facilities. 100% of respondents stated that they wanted a combination of training, written guidelines and procedures.

DISCUSSION

In a review of the local, state and Federal guidelines and it is discovered that the recommendations made in these emergency operation plans (CC EOP, 2002; Ohio EOP; SLG 101,9/06; NRT-1; EPA, 87) for evacuation or shelter-in-place decisions are based on several factors. These factors include: chemical characteristics, calculated plume arrival time versus evacuation time, atmospheric conditions, as well as the physical limitations and medical needs of the affected population. It is also important to have plans and procedures in place, as well as conduct regular training of all emergency responders on these plans and procedures. Another recommendation is that incident commanders make on-scene decisions utilizing available tools and plume modeling programs to determine size, concentration and speed of the hazard,

Extensive research into studies on this topic revealed that there is overall agreement that there are no hazard specific guidelines that triggers shelter-in-place over evacuation or vice versa. Due to discovering that there are no significant differences in the guidelines provided by these sources, it was decided to include a representative sample of the information rather than cite a large volume of reference materials. The sample accurately summarizes the recommendations made in all of the reference materials available to city, state and Federal agencies for designing emergency operation plans and guidance. The major defining factor across all guidelines was that there is a four-hour time frame for sheltering in place. After that period of time, it is no longer an effective method of protection.

It became apparent through the survey of emergency personnel in the Union Township Fire Department that there was a strong need for training, written guidelines and standard operating procedures on the criteria used to decide whether an evacuation or shelter-in-place action was needed. Even though over half of the responses indicated that they were comfortable

with the standard operating procedures currently available, all were in agreement that this additional training would improve their confidence level in the actions to be taken.

RECOMMENDATIONS

Based on information gathered, the following recommendations can be made:

1. Evaluate and update current standard operating procedures for hazardous materials incidents as it relates to population protection;
2. Create more extensive and detailed standard operating procedures for hazardous materials incidents as it relates to population protection (appendix B);
3. Develop and implement an officer training program covering population protection procedures during hazardous materials events;
4. Make existing computer programs related to hazardous materials incidents available to all Union Township Fire stations, fire personnel and the Union Township Dispatch Center.

These changes would give the Union Township Fire Department and personnel the information needed to quickly and efficiently make on-site decisions about evacuation or shelter-in-place of the affected population during a hazardous materials incident. Development of standard operating procedures based on research of existing codes and recommendations could help in situations where litigation arises from emergency actions taken.

DEFINITION OF TERMS

CAMEO- Computer Aided Management of Emergency Operations) a chemical database.

ALOHA- A computer program for modeling of air plumes, explosions, and fire thermal impacts.

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APPENDIX A- SAMPLE STANDARD OPERATING GUIDELINE

Union Township Fire Department- Standard Operating Guidelines

Chapter 2- Fire Response

Hazardous Materials (Population protection)

Purpose

This procedure is intended for incidents involving the release of a hazardous material.

Scope

This procedure shall apply to all personnel without exception.

Procedure

Upon arrival at the scene the company officer will:

1. Perform initial size up of the situation.
   A. Establish command.
   B. Determine type of incident and what resources are needed
   C. Provide update over radio including pertinent information regarding situation.
2. Dispatch
   A. Contact dispatch to initiate plume modeling.
   B. Communication with outside agencies may require activation of the radio patch or use of
3. Establish perimeter
   A. Remove anyone from immediate area.
   B. Deny entry.
4. Operations (plume model completed)

A. Evacuate if can be completed prior to plume arrival or expected to persist in an area greater than four hours.

B. Shelter in place if evacuation cannot be completed prior to plume arrival or short term event is expected.

Note

Adult care facilities and nursing homes have been identified as at risk locations, therefore population protection procedures for these areas should be initiated immediately.

APPENDIX B- TRAINING PROGRAM OUTLINE

Hazardous Materials Computer Program Training

Purpose

To provide initial and continuing education covering computer aided hazardous materials modeling programs.

Objectives

Provide review of properties of chemicals and hazardous materials.

Provide review of management of hazardous materials accidents.

Provide training on operation of ALOHA, CAMEO, MARPLOT, WISER, and NARAC to all Fire Department employees.

Provide training on operation of ALOHA, CAMEO, MARPLOT, WISER, and NARAC to all Dispatch personnel.

APPENDIX 3 – TITLE OF APPENDIX

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