Protective Actions – PADding With PEAC™

by Vance Bennett

One of the important tools PEAC™ provides is the ability to make more informed decisions about protecting the public. Called "PAD" (for protective action distances) on the original PEAC™ this generated a number of interesting comments from users who came up with innovative interpretations of that acronym. No need to elaborate, after all, this is a G-rated newsletter.

Incident Commanders in hazmat incidents often have to decide whether or not to implement actions to protect the public from the effects of the release. 13-15% of all hazmat incidents require some type of protective action. In over 90% of these incidents, a firefighter or police officer was the individual who ordered the evacuation.[1] Few of these individuals were well-versed in the subject but they all had to make a difficult decision under stressful circumstances.

An Incident Commander has three options to choose from when deciding how to protect the public in a hazmat incident: 1. Do nothing; 2. Ask a threatened population to stay in an available shelter (called shelter-in-place or in-place protection); 3. Leave the area (evacuate).

Historically, evacuation has been the most common tactic used to protect the public from a hazardous substance release. Evacuation has a long history of success in the USA. It is the primary tactic used to protect the public in natural disasters such as hurricanes and has been used successfully in hundreds of hazmat incidents. It is the option that most people would intuitively select—leaving makes more sense to people than staying.

Although the safety record of evacuations for chemical emergencies is exemplary, it is not without potential hazards. Evacuating a population because of a hazmat release always has the potential of putting them in harm's way. Windshifts and changes in the release rate can cause unexpected exposures.

Evacuations also have an economic cost. People have their lives disrupted. Businesses are forced to close. People have to spend money to relocate their families. In large incidents, this can cost millions of dollars. In addition, some populations may be difficult or impossible to evacuate.

Because of these issues, shelter-in-place is often a preferred tactic.

In-place protection is a relatively new tactic in the USA but is a common tactic in much of Europe. The Civil Defense program in the USA used a form of in-place protection as the main method of protecting citizens from the effects of nuclear weapons. As an emergency response tactic, in-place protection was first studied seriously in the USA as a method of protecting the public from the effects of ionizing radiation released from a nuclear powerplant accident. The chemical industry in the USA has pioneered the promotion of in-place protection as a viable protective action in hazmat incidents, mostly via the CAER (Community Awareness and Emergency Response) program. [2]

The effectiveness of in-place protection was demonstrated in a compelling manner in an ammonia release in Houston, TX in 1976. A tractor-semitrailer carrying liquid anhydrous ammonia was involved in a single-vehicle accident on a freeway. The vehicle (an MC 331) was westbound on an elevated ramp connecting I-610 with US-59. The vehicle left the ramp, struck a support column of an overpass and fell approximately 15 feet onto US-59. The force of the tank striking the column severed the front head of the tank. The entire 7,509 gallons of anhydrous ammonia then shot out of the 86 inch opening in the tank at an estimated pressure of 90 psi. Several people were killed or injured by the release. A subsequent investigation by the NTSB showed that people who remained in vehicles or buildings until the vapor cloud dissipated fared better than people who attempted to escape through the cloud.[3]

In-place protection has come to be considered a practical alternative to evacuation especially when it would be difficult to evacuate a specific population such as prison inmates or hospital patients.

The theory behind this option is simple—a structure provides protection against vapor/gas intrusion and it has an enclosed supply of uncontaminated air to breath. The theory assumes that the concentration of the contaminant inside the structure will be less than the concentration outside of the structure. Studies have shown that sheltering in place will reduce chemical exposures from $1/39^{th}$ to $1/101^{th}$ of the outdoor exposures. These studies have also found that although vapors and gases can enter a structure through building surfaces, cracks and pores these "flaws" can act as a filter as they absorb the contaminants before they enter the building.[4]

There is no "cookbook" that can provide a definitive answer about which protective action to select. Either protective action will inconvenience people and pose its own set of risks.

Deciding which (if any) protective action option(s) to select can be a daunting task for an IC. The decision can potentially affect thousands of people and cause economic disruption to a large part of a community. It's vital for an IC to have some reasonable criteria to use. Many hazmat response training programs and standard guidance to disaster planners use the same general set of factors to consider. Over the years, responders and planners have settled on six factors that should govern the selection of a protective action. Those factors are: the nature of the material, the population affected, response resources available, time factors involved, weather and responder's ability to communicate with the public,[5]

A key consideration in choosing a protective action involves comparing the time it will take to implement a protective action with how long the release will last. The amount of time it takes to implement a protective action includes the time needed to: detect the hazard, assess the hazard, warn the public, prepare to take action and actually carry out the action.[6] These times can vary greatly from one incident to another. The time that it takes to assess the incident depends upon two factors: the time it takes to detect the incident and the time it takes to assess the threat. Case studies have shown that this process will take 15-60 minutes for most incidents.[7] Releases that are small or difficult to see (e.g. those occurring at night) can go on for over an hour before anyone initiates response actions.[8] Evacuations in chemical emergencies typically take at least an hour to carry out as evacuees will account for family members, gather personal effects, decide on an evacuation destination, etc. before they leave. As a practical matter, the hazard may have passed long before responders hear about the incident, arrive at the scene, assess the hazards and decide on a course of action.

In general, a short-duration release will call for in-place protection while a release that's expected to last longer or remain in the area longer will often require evacuation. A key factor to consider for evacuations is how long it takes to actually move people out of an affected area. Studies of past incidents show that it often takes over an hour to carry out an effective evacuation.[9][10] An evacuation in a chemical emergency may put the people you want to protect in the hazard area in the peak of the release.

For shorter duration incidents responders should consider the use of in-place protection instead of evacuation. The primary time-factor to consider for in-place protection relates to the potential effectiveness of the shelter and how long it's exposed to the vapor/gas cloud.[11]. Although the ability of a structure to be an effective shelter against a chemical release depends upon how "tight" the structure is, for short-duration incidents even the leakiest of shelters will provide adequate protection. In the incident involving a release of anhydrous ammonia on a freeway in Houston, TX, the individuals who left their vehicles had lower chances of survival than those who remained in their vehicles. In many instances, people survived what would have been a lethal concentration of ammonia simply by staying in their cars. Even though a motor vehicle provides little long-term protection against a vapor or gas release it provided enough protection in this short duration incident for the occupants to survive.

How long should you leave people inside a structure? The conventional wisdom says "no longer than two hours" but like most conventional wisdom it's simply too simple to be useful (or even true). The two hour figure was based on the earliest studies on the subject that used theoretical models to determine when a concentration of a vapor or gas in a structure would exceed the concentration outside. Later studies of actual releases have found this initial recommendation was invalid. Case studies and controlled studies have shown that even the leakiest buildings can be effective shelters for hours or even days.

This is probably the most difficult decision you may have to make in a response to a hazardous materials release. PEAC™ can provide you with the ability to make a more informed choice but you will still have to sort through incomplete or conflicting information to arrive at a decision that will likely please nobody. Good luck…

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[1] *Public Health Consequences of Hazardous Substance Releases*, H. Irene Hall, et al, ATSDR Hazardous Waste Conference 1993

[2] *Deciding Between In-Place Protection and Evacuation in Toxic Vapor cloud Emergencies*, Theodore S. Glickman and Alyce M. Ujihara, Journal of Hazardous Materials, 1990

[3] *Special Investigation Report – Survival in Hazardous Materials Transportation Accidents*, NTSB, 06 December 1979

[4] *Sheltering in Place as a Public Protective Action*, National Institute for Chemical Studies, June, 2001

[5] *Protecting the Public in a Hazardous Material Emergency*, National Institute for Chemical Studies, December 1988

[6] *Evaluating Protective Actions for Chemical Agent Emergencies*, Oak Ridge National Lab, April 1990, page xxi

[7] *Evaluating Protective Actions for Chemical Agent Emergencies*, Oak Ridge National Lab, April 1990, pages 40-41

[8] *Evaluation of Warning and Protective Action Implementation Times for Chemical Weapons Accidents*, Oak Ridge National Lab, April 1988, page 3

[9] *Evaluation of Warning and Protective Action Implementation Times for Chemical Weapons Accidents*, Oak Ridge National Lab, April 1988, page 17

[10] *Evaluating Protective Actions for Chemical Agent Emergencies*, Oak Ridge National Lab, April 1990,

pages 50-53

[11] *Sheltering in Place as a Public Protective Action*, National Institute for Chemical Studies, June, 2001