Shelter-in-Place Protective Action Guide Book

Chemical Stockpile Emergency Preparedness Program

May 12, 2006

Work sponsored by the U.S. Department of the Army and the U.S. Department of Homeland Security

Department of the Army
Department of Homeland Security
Chemical Stockpile Emergency Preparedness Program

MEMORANDUM

TO: The CSEPP Community

SUBJECT: Approval of Shelter-in-Place Protective Action Guide Book

EFFECTIVE DATE: 26 June 2006

We have reviewed the attached product developed by Argonne National Laboratory in conjunction with the Protective Actions IPT and find that the guidebook is in accordance with current CSEPP policy, guidance, and the needs of the program. The guidebook is approved.

This guidebook supplements the CSEPP Planning and Programmatic Guidance and is considered to be an integral part of the planning guidance document. This guidebook shall be used in conjunction with Sections III-A, III-B, III-D, III-E, and V-A of the Planning Guidance and Sections V-A, V-B, and V-E of the Programmatic Guidance.

A copy of this memorandum shall accompany any distribution of the product to indicate that the product is final and approved by CSEPP management. The memorandum may be included in print or electronic format as appropriate.

Dennis Legel
Office of the Deputy Assistant

Secretary of the Army
For the Elimination of Chemical Weapons
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for
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CSEPP
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Shelter-in-Place Protective Action Guide Book

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for
The Chemical Stockpile Emergency Preparedness Program (CSEPP)

May 12, 2006

About Argonne National Laboratory

Argonne is a U.S. Department of Energy Laboratory managed by The University of Chicago under contract W-31-109-Eng-38. The Laboratory's main facility is outside Chicago, at 9700 South Cass Avenue, Argonne, Illinois 60439. For information about Argonne see www.anl.gov.

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This document is also available at no cost on the CSEPP Portal at http://www.csepportal.net for users with authorized access to this site.

Contents

Acronyms and Abbreviations

ACH	air changes per hour
ACP	access control point
AEGL	acute exposure guideline level
ANL	Argonne National Laboratory
AR	Army Regulation
ATEL	Acute Threshold Effect Levels
CSEPP	Chemical Stockpile Emergency Preparedness Program
D2-Puff™	Army computer model to predict chemical warfare agent plumes
DHS	Department of Homeland Security
EAS	emergency alert system
EOC	Emergency Operations Center
ERZ	emergency response zone
GB	non-persistent nerve agent
HD	mustard agent
ICS	Incident Command System
IEM	Innovative Emergency Management, Inc.
IPT	Integrated Process Team
JIC	Joint Information Center
JIS	Joint Information System
km	kilometer
MCE	maximum credible event
MOA	Memorandum of Agreement
NIMS	National Incident Management System
ORNL	Oak Ridge National Laboratory
PAD	protective action decision
PAR	protective action recommendation
Pro Act	Protective Action (as in Protective Action IPT)
SIMCELL	Simulation Cell used in CSEPP exercises
SIP	shelter-in-place (refers primarily normal, expedient, and enhanced shelter)
TAR	tone alert radio
TCP	traffic control point
VX	persistent nerve agent

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SIP can save your life

SIP is good

IF you do not have time to evacuate

IF you are unable to evacuate

SIP is better

IF you act promptly

IF you select a good shelter

IF you improve shelter air tightness

SIP is best

IF you end SIP when outside air is predicted to be cleaner than shelter air

SIP = Shelter-in-Place

Summary

This guide book contains information and advice about planning for and implementing temporary shelter-in-place (SIP) as protection from airborne toxic chemical hazards that might result from an accident or incident at an Army chemical weapons stockpile storage site. The guide book provides planners and decision-makers with guidance on how to make temporary SIP effective, and it includes examples to help users understand the guidance.

The following are the most important points covered in the guide book:

- Temporary SIP can save lives, especially if shelter is obtained quickly, the shelter openings are closed, and shelters are vacated as soon as the outside air is predicted to be cleaner (see Section 1.4.2).
- Concepts and plans to use temporary SIP should favor the avoidance of fatalities, employing a comprehensive protective action strategy to obtain this outcome (see Sections 1.4.3.4 and 1.5.1).
- Plans to implement temporary SIP should address specific actions to support the sheltered population when they end SIP, to include their relocation to a designated facility for accountability or medical screening when this is appropriate. The relocation route and facility might be other than the route and facility for those who evacuated initially (see Sections 2.1.1 and 5.1).
- Public education programs should explain and emphasize the value of temporary SIP and especially how prompt and proper actions to end SIP can save lives (see Section 2.2).
- Estimates of the quantity of agent released and the description of the type of release from eyewitnesses at the accident site, monitoring data from instruments at and near the accident site, and the latest meteorological information, are essential to any method of deciding about ending temporary SIP (see Sections 1.4.4, 3.1, and 5.1).
- The content of notification messages to instruct the public about emergency protective actions should be concise, simple, relatively brief, and absolutely consistent with language in public education materials (see Sections 3.3 and 5.3).
- The timing of the end of temporary SIP, as reflected in protective action recommendations, protective action decisions, and the drafting and broadcast of notification messages, should be practiced interactively among jurisdictions on a regular basis. This process should be demonstrated realistically from beginning to end during every Chemical Stockpile Emergency Preparedness Program exercise (see Section 2.3.2).

Introduction

1.1 Purpose

This guide book was prepared for the Chemical Stockpile Emergency Preparedness Program (CSEPP) Protective Action Integrated Process Team (Pro Act IPT) to help CSEPP planners and decision-makers use shelter-in-place (SIP)[1] effectively. The guide book also contains information that users can refer to when developing training and exercise products and revising public education materials.

1.2 Context for this Guide Book

One of the objectives of the Pro Act IPT is to provide advice to CSEPP planners and decision-makers about SIP and to disseminate this advice in the form of a guide book. A Pro Act IPT steering committee that represents state, county, and Army installation perspectives on SIP was formed to work toward this objective on behalf of the IPT, in collaboration with Argonne National Laboratory (ANL). This committee collected information about SIP plans and procedures from each CSEPP jurisdiction for consideration in the guide book and shared this information with ANL. The committee worked with ANL by exchanging ideas, providing input and guidance on specific issues and points of advice, and reviewing and commenting on drafts as sections of the book were prepared. Finally, the committee validated the final draft version of the guide book and provided it to the full IPT membership for their consideration.

This version of the guide book was developed concurrently with the development of the new *CSEPP Planning Guidance* (CSEPP 2006) and *CSEPP Programmatic Guidance* (CSEPP 2006a) that replaces the *Planning Guidance for the CSEPP* dated 17 May 1996 (CSEPP 1996). The guide book is intended to supplement the planning guidance with advice on implementation.

It is important for planners and decision-makers to understand the information in this guide book in the context of an all-hazards approach to protective actions. Many of the processes mentioned herein (e.g., managing the response in accordance with the National Incident Management System [NIMS]) do indeed apply across-the-board to all hazards. There are some protective action concepts and procedures that are unique to hazards associated with hazardous vapors, such as those from Army chemical warfare agents:

- The need for a shelter configuration that offers protection against vapor hazards versus a structure that offers protection against physical injury from severe weather;
- The importance of obtaining shelter without delay, and enhancing and sustaining this protection;
- The need to ventilate or exit a shelter promptly when the hazardous vapors outside are predicted to be less hazardous than vapors that might have infiltrated the shelter as the plume passed; and
- The potential need to relocate after SIP on a different route and to a different destination than might be used for an initial evacuation.

The above distinctions need to be emphasized in all plans, agreements, public education efforts, training programs, and exercises.

[1] The acronym SIP used in this guide book is pronounced "sip."

1.3 Organization of this Guide Book

This guide book is divided into six sections. Section 1 provides background information and lists basic assumptions used in the guide book. Section 2 discusses plans, coordination, and agreements to support a SIP protective action strategy, along with public education programs, training, and exercises. Section 3 discusses the making of recommendations and decisions about taking temporary SIP, the announcement of directions to the public to implement these decisions, the expected response to these directions, and what not to do when taking SIP. Section 4 discusses what a sheltered population should and should not do while in shelter. Section 5 discusses the making of recommendations and decisions about ending SIP, the announcement of directions to the public to implement these decisions, the expected response to these directions, and what not to do when ending SIP. Section 6 lists the references cited in this guide book.

Appendix A discusses how computer modeling is used to determine when to end temporary SIP. Appendix B presents a hypothetical case study illustrating the use of temporary SIP. Appendix C lists resources that contain material related to the subject of this guide book.

1.4 Background

To obtain the maximum benefit from this guide book, the user needs to (1) know the effects of chemical warfare agent vapors on human beings, as expressed in acute exposure guideline levels (AEGLs); (2) appreciate the significant benefits of SIP; (3) be aware of the challenges associated with SIP; and (4) understand the importance of a prompt characterization of the release when making decisions about SIP. This background information is provided to help the user appreciate the advice discussed in subsequent sections of the guide book.

1.4.1 Acute Exposure Guideline Levels

Acute exposure guideline levels (AEGLs) are used as the toxicity criteria for mustard and nerve agents for emergency planning and response within the CSEPP. The U.S. Environmental Protection Agency-sponsored National Advisory Committee on Acute Exposure Guideline Levels developed AEGLs for these agents, as well as for hundreds of hazardous materials that are around us every day. AEGLs consider the sensitivity of the general population (including susceptible individuals) to short-term, one-time exposure to airborne concentrations of these chemical warfare agents at various levels, the duration of the exposure, and the extent to which human bodies can withstand some nerve agent exposure.[2] AEGLs representing threshold exposure limits are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. This period is the range of time considered for SIP strategies in this guide book. AEGLs provide three thresholds of anticipated health effects:

- AEGL-1 is the threshold above which notable discomfort, irritation, or certain asymptomatic, non-sensory effects (e.g., eye effects) could be experienced. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

[2] The airborne concentration is expressed as parts per million (ppm) or milligram/cubic meter (mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience certain health effects.

- AEGL-2 is the threshold above which irreversible or other serious, long-lasting adverse health effects, or an impaired ability to escape, could be experienced.
- AEGL-3 is the threshold above which life-threatening health effects or death could be experienced.[3]

1.4.2 Benefit of Temporary Shelter-in-Place Protection

SIP will always provide some protection against airborne chemical agent vapors, although not always as much protection as evacuation before the vapor plume arrives at the location of the shelter. Protection is obtained in part because the human body can metabolize some nerve agent during the time spent in shelter should exposure to infiltrated nerve agent vapor occur. In addition, the peak concentration of agent vapors in a shelter will almost certainly be lower than that outside the shelter while the plume passes. Also, the shelter provides some protection from cumulative exposure if persons do not remain in the shelter once the outside air is cleaner than the inside air.

SIP as discussed in this guide book involves prompt sheltering of a population in enclosed structures to minimize initial exposure to a plume of hazardous vapors, followed by the timely ending of SIP when the air outside is predicted to be less hazardous than the concentration of vapors that infiltrated the shelters.

Temporary SIP is a public protection tool used by communities in the United States and around the world. SIP is touted as good protection when the chemical release is expected to last for a short time, or when the chemical has a low health hazard and its release does not warrant an evacuation, or when there is not enough time to evacuate (NICS undated and NICS 2001). SIP is supported by modeling and laboratory experiments that assess the protection offered by SIP and is endorsed by experts in emergency response (Chan et al. 2004; Sorensen, Shumpert, and Vogt 2002; Blewett and Arca 1999; Blewett et al. 1996; and Chester 1988). The *CSEPP Planning Guidance* (CSEPP 2006), the *CSEPP Programmatic Guidance* (CSEPP 2006a), and Army guidance on chemical accident response (U.S. Army 2003) identify SIP as an appropriate protective action. There is also real evidence to illustrate the value of shelter to protect against hazardous chemical vapors released as a result of an accident (NewScientist.com 2005).

Figure 1 illustrates the benefit of SIP. It shows the profile of a hypothetical outside concentration of a plume of hazardous vapor from a nominal chemical release of 30 minutes duration and relative concentrations of hazardous vapor inside shelters with varying Air Changes per Hour (ACH) at a specific location in an emergency response zone (ERZ)[4] (Myirski 2000). Note the protection that shelters can provide while the vapor plume is passing (the difference indicated by the height of the curves for each ACH) and how much difference shelters with low ACH can make. See that a relatively tight shelter (e.g., 0.1 ACH) does protect against exposure to peak concentrations of hazardous vapor as the plume passes a shelter, and it also provides some protection from cumulative exposure if persons do not remain in the shelter once the outside air is cleaner than the inside air.

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[3] Information about AEGLs for nerve and mustard agent can be found in Acute Exposure Guideline Levels for Selected Airborne Chemicals, Volume 3 (see www.nap.edu). The author of the SIP Guide Book also considered information about AEGLs presented at the AEGL Conference in August 2002 (Hauschild 2002), information published by the U.S. Army Surgeon General (USACHPPM 2003), and in the CSEPP policy paper on the adoption of AEGLs (CSEPP 2003).

[4] ERZ in this guide book refers to a locally defined sub-zone of a CSEPP emergency planning zone.

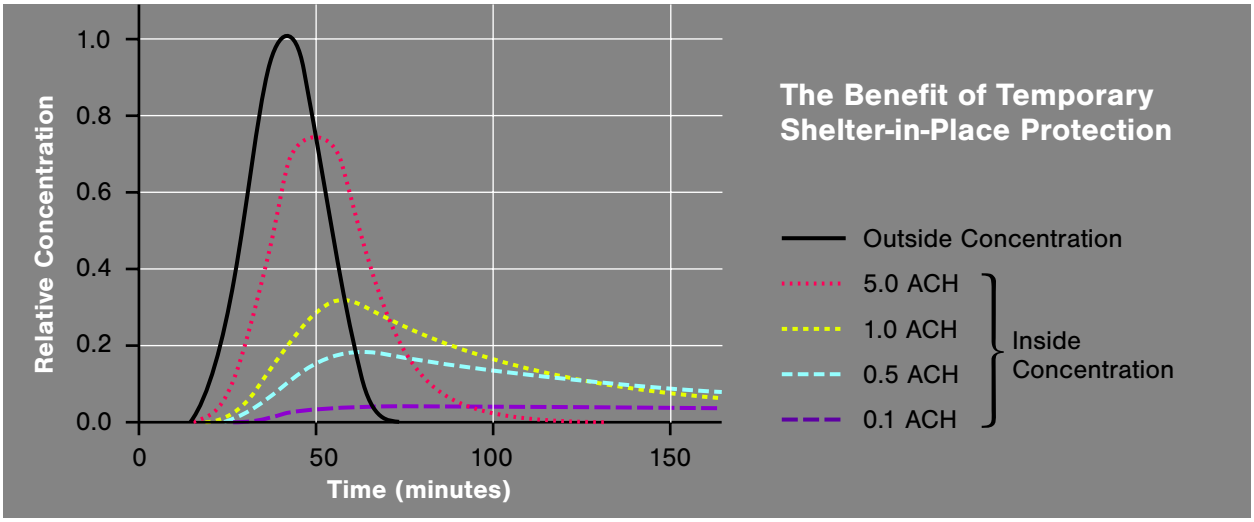
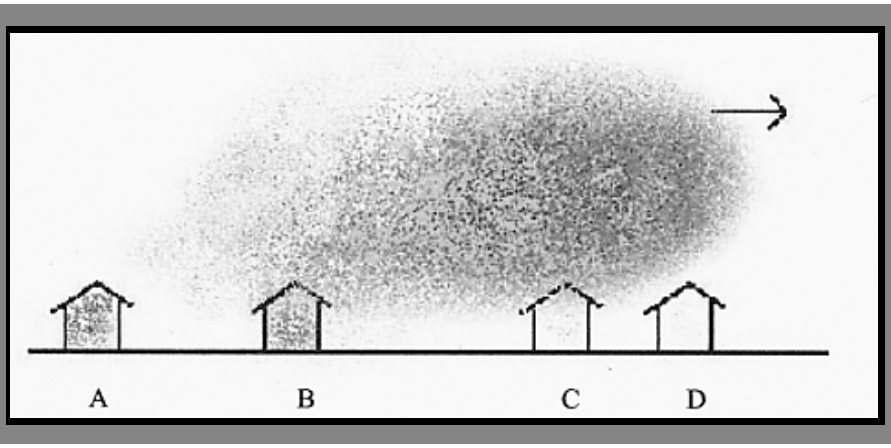


Figure 1 Benefit of Temporary Shelter-in-Place Protection

1.4.3 Challenges of Shelter-in-Place Protection

SIP usually offers only temporary protection because hazardous vapors accumulate in shelters when air is exchanged between the shelter and the exterior environment as the vapor plume passes. The hazardous vapor concentrations indoors and outdoors are equal when the outdoor concentration curve intersects with a curve representing a shelter with a particular ACH (see Figure 1). Afterward, the concentration of agent inside the shelter is greater than that outside the shelter. This intersection is the best time for a person in the shelter to end SIP. If people remain in the shelter after this time, they will continue to be exposed to the higher concentration of agent vapors in the shelter (CSEPP 2001, Appendix 1). Note that a tighter shelter slows the escape of hazardous vapors that build up inside, turning an initial advantage into a liability. If a person never ends SIP, or even waits until the last of the vapor plume has dissipated or departed from the ERZ in which the shelter is located, he or she might receive almost the same agent dosage that would have been received had the person not taken shelter at all during the event. Figure 1 suggests that a concept and method that results in ending SIP earlier than when the plume tail has departed from the ERZ or has dissipated lessens the toxic effects in the sheltered population.

Figure 2 is a snapshot in time of shelters within an ERZ with a plume of invisible hazardous vapor (illustrated in gray shades) traveling from left to right. Shelters closer to the source of the release will be exposed sooner, and to higher concentrations, than shelters farther downwind, because the vapor plume expands and becomes more diluted by clean air as it moves downwind. In Figure 2, the hazardous plume passed the first shelter on the left (A), leaving a higher concentration inside the shelter than outside. For persons in shelter A, who experienced the highest inside and outside vapor concentrations, ending SIP at or a little before the time of the snapshot would result in a lower toxic effect than remaining inside. Staying in this shelter any longer could be fatal in some scenarios. For the shelter that is second from the left (B), the inside concentration is approximately equal to the outside concentration but will soon be greater than the outside concentration once the vapor plume moved further downwind. Therefore, ending SIP at about the time of the snapshot would minimize exposure to persons in shelter B. Delay in ending SIP beyond the time of the snapshot could have dire consequences for them.



The challenge of shelter-in-place: Selecting the one best time to end SIP for all shelters throughout an ERZ.

Figure 2 The Challenge of Shelter-in-Place Protection

For the two shelters on the right (C and D), the inside concentration is less than the outside concentration at the time of the snapshot, and so ending SIP at this time could result in more exposure than remaining inside until the outside concentration equals the inside concentration. However, the vapors in the plume outside the shelters on the right are not as concentrated as they were when the plume was passing the shelters on the left, so the potential for life-threatening exposure is less. If no one in the ERZ ends SIP until the vapor plume has dissipated or passed all shelters in the ERZ (minimizing outdoor exposure for even the farthest locations from the source), the sheltered population will suffer additional exposure from infiltrated vapors (indoor exposure). The bottom line is that no one time to end SIP is best for all four shelters (Yantosik et al. 2003)

One approach to deciding the best time to end SIP would be to compare the calculated exterior/interior concentrations at every potential shelter in the total area threatened by the vapor plume and then end SIP on a shelter-by-shelter basis when the outside concentration is less than that predicted inside each shelter. Although the modeling calculations needed to support this approach could be constructed, this approach is unworkable because there is no certainty that individual calculations for each of the potentially thousands of shelters could be made quickly enough, even in the unlikely circumstance that data needed to support the calculations could be obtained and maintained current. In addition, there are no communications systems currently available to the CSEPP that would provide for rapid dissemination of shelter-specific protective action information. Finally, educating the population to be comfortable with ending SIP incrementally on a shelter-by-shelter basis, or even within a group of shelters in a neighborhood, would be a daunting task.[5]

1.4.3.1 Determining When to End SIP for Each ERZ

In practice, because it is not feasible to construct a suitable arrangement for ending SIP on a shelter-by-shelter basis throughout a threatened area, the CSEPP advocates that decisions to end SIP be based on entire ERZs on and around chemical agent storage sites (CSEPP 2006). Thus, the challenge is how to decide the single best time to end SIP for an entire ERZ, not just a specific location or individual shelter in an ERZ.

[5] On an exception basis, the best time to end SIP can be calculated for a few select structures in an ERZ where large numbers of persons or special populations might take shelter, and at which extraordinary communications and transportation capabilities would be available.

1.4.3.2 Shelters Do Not Provide Equal Protection

Another challenge facing decision-makers is that individual shelters in an ERZ differ somewhat in the protection they provide against infiltration of hazardous vapors, as measured in ACH. The ACH experienced in a shelter depends on the structural integrity, weatherproofing enhancements, and expedient measures taken by the occupants. A tight shelter might have as few as 0.2 ACH, whereas leaky shelters might have 5.0 ACH, and the exact number of shelters at any given ACH in an ERZ cannot be known with certainty.

1.4.3.3 Effects of Nerve Agent Exposure Are Nonlinear

Another important challenge in deciding when to end SIP involves taking into consideration that the effects of nerve agent exposure are not linear with dosage. In general, the toxic effects of nerve agents, and mustard agent to a much lesser degree, are a nonlinear function of the duration of the exposure and the concentrations experienced during exposure. Therefore, the decision about when to end SIP should consider the ability of the human body to metabolize nerve agent over time in order to take maximum advantage of temporary SIP.

1.4.3.4 SIP Strategy Should Favor Avoidance of Fatalities

Several possible strategies are available to protect sheltered populations threatened by the release of hazardous chemicals. CSEPP Policy Paper Number 1 (CSEPP 1991) states, "The most important objective of the emergency preparedness and implementation process is the avoidance of fatalities to the maximum extent practicable, should an accidental release of chemical agent occur." This concern for avoiding fatalities was reiterated in CSEPP Policy Paper 20 (CSEPP 2003), which says, "Consistent with CSEPP Policy Paper 1, priority should be to prevent exposures above AEGL-3, which could result in severe, incapacitating, and possible lethal outcomes. To accomplish this, protective actions should be directed toward preventing or minimizing exposures above AEGL-2, i.e., above the threshold where some temporary but potentially escape-impairing effects could occur." (See also U.S. Army 2003.) Thus, the timely ending of SIP to avoid potential fatalities must be an integral component of a SIP strategy in the CSEPP. Other protective action strategies, such as minimizing total population exposure or minimizing the total number of people exposed (Sorensen, Shumpert, and Vogt 2002), can actually result in an increased potential for fatalities.

On the other hand, when the maximum-predicted effects of exposure to hazardous vapor in an ERZ present only a very low health hazard (i.e., less than AEGL-2), no action is required to protect the public (CSEPP 2003). Therefore, if SIP is used at the discretion of officials to shelter a population from this low threshold of predicted effects, timing the end of SIP for persons in these areas is not considered critical.

1.4.3.5 Potential for Exposure Before, During, and After SIP

The potential exists for some toxic burden to accumulate in the body before persons enter their shelter if they are still outside when the hazardous vapors reach their location. Some additional toxic burden can accumulate in the body while persons are in the shelter as a result of the infiltration of hazardous vapors. Finally, the potential for adding to the toxic burden following SIP occurs (1) when persons remain in the building while the shelter ventilates, (2) when persons exit from shelter but remain just outside the building during the ventilation period, or (3) while persons are relocating to an area away from the effects of the plume. All of these circumstances can affect the best time to end SIP.

1.4.3.6 Mitigation of Vapor Hazards in Shelters

Recirculating air filters can reduce agent vapor concentrations within a shelter (Janney et al. 2000). Also, some agent vapor can be adsorbed by a shelter and its contents in certain circumstances (Blewett and Arca 1999). The effects of mitigating factors of the vapor concentrations within a shelter, such as adsorption, can range significantly from one shelter to another and are difficult to quantify.

1.4.3.7 Homogeneity of Population Distribution in an ERZ

Yet another challenge is to consider the distribution of the population in an ERZ when making decisions about ending SIP, to ensure that appropriate consideration is given to high population concentrations in the ERZ. When current CSEPP ERZs were defined, the criteria did not include consideration for optimizing the decision to end SIP. If an ERZ is large, especially in length with respect to the direction of potential agent vapor travel, and if the population distribution in the ERZ is not reasonably homogeneous, then it is particularly difficult to choose a good time to end SIP for the entire ERZ regardless of the method used. Of particular interest and concern are ERZs that are adjacent to the Army installation and greater than 5 km long (Yantosik et al. 2003). See Section 2.1.1 for a way to address this challenge.

1.4.4 Importance of Characterizing the Release

Accurate and timely information about the release of hazardous material is essential to any initial protective action decision (PAD). Should a potentially threatened population evacuate immediately, take temporary shelter, or do nothing? Accurate information about the event is equally important when deciding about ending temporary SIP, regardless of the method used to make this decision.

At Army chemical stockpile storage sites, initial PADs (evacuate or SIP) may justifiably be based on an appropriate worksite maximum credible event (MCE) in the absence of detailed information about the release for an accident at a worksite (U.S. Army 1993). However, using initial assumptions about the event to decide about ending SIP can result in bad timing of that decision if these assumptions are very inaccurate and thus decrease the protection offered by SIP. Safe-sided assumptions about the event (i.e., those that are generally thought to be conservative) can also have this negative effect.[6] Therefore, estimates of the quantity of agent released, the description of the type of release from eyewitnesses at the

[6] For example, a default assumption of a fire burn time of 60 minutes may be conservative in calculating plume distances. But if the fire is extinguished in 30 minutes, SIP might be extended by ~30 minutes too long to obtain the best protection, unless plume model projections are updated with the appropriate release duration term.

accident site, monitoring data from instruments at and near the accident site, and the latest meteorological information are essential to any method of deciding about ending SIP. This information must be collected quickly and analyzed promptly, so that a sheltered population can be notified in time to take advantage of the best time to end SIP (Yantosik et al. 2003).

1.5 Context for Managing SIP Protection

1.5.1 Comprehensive Protective Action Strategy

Protective actions are activities in which a population at risk engages to obtain the best outcome in an accident or incident involving chemical warfare agents at Army chemical storage sites. The best outcome is one in which there are the fewest fatalities for the conditions and circumstances, on the basis of timely and appropriate actions by Army and off-post officials, first responders, and the population at risk (CSEPP 1991 and CSEPP 2006). Other desirable outcomes are the least numbers of severe or incapacitating exposures, protection for chemical workers, and protection for the environment without additional risk of fatalities in the affected community.

Protective actions are expected to provide the best outcomes if (1) they are derived from a comprehensive protective action strategy that is embedded in plans, agreements, training, exercises, public education, and emergency response throughout the CSEPP community and (2) the response is managed in accordance with the NIMS.

A comprehensive protective action strategy consists of an appropriate mix of no action, immediate evacuation, and temporary SIP, with appropriate follow-on actions to end SIP at the best time and in the best way to minimize fatalities. Initial recommendations, decisions, and direction to take a specific protective action in an ERZ will need to be based on previously agreed upon assumptions, dispersion modeling, and related calculations. Evacuation is generally preferred if there is time to do so (Sorensen, Shumpert, and Vogt 2002). Although these initial recommendations, decisions, and directions might be based on incomplete information, the alternative of waiting for complete information (such as definitive monitoring results) will almost certainly jeopardize a good outcome. Subsequent recommendations, decisions, and directions to modify initial protective actions (e.g., evacuate a larger area or end SIP in a specific area) need to be developed and promulgated as thoughtfully and quickly as initial protective actions.

A comprehensive protective action strategy acknowledges that some percentage of a population at risk will act contrary to direction — that is, some who are instructed to take shelter might evacuate, and some who are instructed to evacuate might take shelter. This needs to be addressed in plans and emergency instructions.

A comprehensive protective action strategy accommodates special populations who might require extraordinary alert and notification actions or need help with protective actions. Their needs should be addressed in the planning for and execution of protective actions.

A comprehensive protective action strategy should provide contingencies for unexpected conditions, such as a release of chemical agent vapors that is not detected immediately. Lastly, a comprehensive protective action strategy addresses populations that are transient or are otherwise unique, and thus would benefit from special attention. These concerns need to be addressed in plans and agreements and taken into account as the response evolves.

Information about developing a comprehensive protective action strategy may be found in the Report of the Shelter-in-Place Work Group (CSEPP 2001).

Vapor releases are the primary concern in this guide book. The potential for chemical agent in liquid form to migrate outside of the chemical storage area is too remote to consider. Similarly, the potential for agent aerosol to infiltrate shelters is not believed to be a concern. These conclusions are based on information provided by Michael Myirski, an Army expert on dispersion modeling of chemical warfare agent releases. He said:

> In the absence of dependable quantitative calculations about the potential for aerosol deposition associated with a chemical accident, there is little choice but to use qualitative estimates to judge the potential for aerosol deposition. Initial judgments should be based on the best available information about the release, atmospheric conditions at the accident site and down wind, and the expert knowledge of Army hazard analysts. These informed judgments should be adjusted immediately as new information becomes available. This is not unreasonable, considering that the generation of aerosol deposition beyond the installation boundary is such a remote possibility, and the conditions that would generate aerosol deposition are easily identified.[7] The absence of these indicators justifies ignoring aerosol deposition completely when making temporary SIP decisions. If aerosol deposition is indicated, Army hazard analysts should make an informed judgment based on the best available information. Reports from surface monitoring teams can help if they are obtained quickly. Regardless, the analysis of any release should consider the potential for an aerosol deposition hazard, and Army protective action recommendations (PARs) should always include an assessment of this potential (Yantosik, Lerner, and Maloney 2001).

A study by the Science Applications International Corporation also concluded that aerosol deposition off-post was unlikely (SAIC 1996).

There are a few situations where the preference for initial evacuation or temporary SIP is clear (Sorensen, Shumpert, and Vogt 2002):

- Evacuation is preferable when this can be done before the arrival of the hazardous plume.
- Shelter is preferred when conditions make timely evacuation impossible.
- Sheltering is preferable when releases are of very short duration, even if concentrations are high.
- Evacuation is preferable when releases are expected to be of extremely long duration and especially if high concentrations are expected.

Either protective action is feasible when no fatalities are predicted.

When a chemical event occurs, initial protective action decisions for each affected ERZ should consider the following factors:

- The ERZs predicted to be affected at each AEGL threshold.
- The time when the hazard is predicted to reach each affected area.

[7] An unusual combination of factors is needed to make aerosol deposition a possible health risk beyond the immediate accident site. It requires many explosively configured munitions filled with persistent agent (VX or mustard) to create large particles or aerosols upon detonation, a fire hot enough to cause the munitions to detonate, and atmospheric conditions that will transport the aerosol significant distances.

- The time it will take to evacuate the affected area, considering the availability of evacuation routes, expected traffic concentrations, and weather conditions.
- The time it will take to implement SIP in the affected area.
- The degree of protection offered by local housing stock, local business establishments, and other occupied structures in the affected area.
- The type of the chemical agent involved.
- The expected time for the population in each ERZ to remain in a temporary shelter environment. This is likely to be a brief period (one-half to four hours).
- Provisions for special events in which large numbers of people are assembled in the open (such as at parades or in stadiums) or in enclosed structures (such as gymnasiums or churches).

Initial protective actions might need to be modified over time if additional releases occur or if traffic or weather conditions become a factor in continuing the initial action. Also, additional instructions might need to be broadcast to benefit those who were unable or unwilling to evacuate or take shelter initially.

Use of the Incident Command System (ICS) is essential to the success of the response, given the many jurisdictions potentially involved. The advice in this guide book should be understood to be applied in an ICS supported by all of the jurisdictions involved in the response. The operation of an effective Joint Information System (JIS) to support the response is also important to obtain a good outcome for the population at risk.

1.5.2 Evacuation Option

Evacuation involves the expeditious movement of individuals from an area of actual or potential hazard to a safe area. It is the most effective of all protective actions, if it is completed before the arrival of the toxic plume. Evacuation may be precautionary or responsive. A precautionary evacuation refers to an evacuation implemented when the decision-maker has information indicating an increased potential for a release of toxic material, but there is no indication of an actual release. A precautionary evacuation might also be appropriate as a reaction to a release that is not expected to significantly affect an ERZ, but there is a real potential for a change in the direction of plume travel to put the population in that ERZ at some risk of exposure at or above the AEGL-2 threshold. A responsive evacuation, in contrast, refers to an evacuation implemented in an ERZ to protect against hazards predicted to significantly affect that area.

Both types of evacuation entail similar planning tasks: estimating the number of potential evacuees, with particular emphasis on special populations; identifying the most appropriate evacuation routes and safe destinations; estimating the time needed for evacuation; establishing needed Traffic Control Points (TCPs) and Access Control Points (ACPs); and anticipating potential problems. These tasks must be fully coordinated with all other emergency functions ongoing at the same time.

1.5.3 Shelter-in-Place Option

SIP involves the shielding of individuals from the hazard. Shelters may be congregate (for many people) or individualized (a home). Shelters may be existing structures, with or without upgraded protective measures, or facilities specifically designed to provide shelter from toxic chemicals (Rogers et al. 1990).

In CSEPP, there are four types of SIP: normal, expedient, enhanced, and pressurized.

Normal SIP involves taking cover in a building; closing all accessible doors, windows, and vents; turning off heating, ventilation, and air conditioning systems; closing fireplace vents after putting the fire out; and extinguishing all open flames and sources of carbon monoxide. Locking doors and windows is not necessary except when locking devices are already installed and locking them will make a tighter seal. The effectiveness of the protection provided by the structure is improved by going into an interior room, preferably one with no exterior windows or doors.

Expedient SIP includes all normal SIP protection mentioned above, plus other simple and fast measures that can be taken to further reduce air infiltration into the building and especially the room(s) selected for shelter (Sorensen and Vogt 2001b). Such measures include using duct tape, plastic sheeting, or other simple means to seal potential agent vapor infiltration routes, such as door and window openings, electrical outlets, and vents in the shelter room.[8]

Enhanced SIP refers to taking shelter in a structure to which weatherization techniques have been applied before the emergency to permanently reduce the air infiltration rate. As with normal SIP, enhanced SIP is improved by using an interior room with the fewest openings to the outdoors.

Pressurized SIP refers to taking shelter in a structure (or a room in a structure) where air infiltration is effectively prohibited by creating positive pressure within the occupied space. Positive pressure may be created by drawing outside air into the shelter through a filter that removes chemical agent. This process creates a positive pressure in the shelter so that clean air is leaking out instead of contaminated air leaking in. Such shelters are usually equipped with minimum essential food and water to enable the occupants to remain there for 24 hours or longer. Examples include pressurized rooms in schools and hospitals.

Normal, expedient, and enhanced sheltering are short-term, temporary measures. As described in Section 1.4.2, it is important to end normal, expedient, and enhanced shelter at an appropriate time for maximum effectiveness. Limiting the sheltering period is not a consideration in a pressurized shelter. Although people cannot remain in a pressurized shelter indefinitely, they should be able to remain there for longer than the expected duration of even a worst-case accident. Therefore, pressurized shelters are excluded from recommendations, decisions, and instructions about ending SIP, except that public education programs and announcements to end SIP need to make this distinction.

All temporary shelter measures entail similar planning tasks: identifying the most appropriate relocation routes and safe destinations, establishing relocation TCPs and ACPs, and anticipating potential problems. These tasks must be well coordinated with all other emergency functions ongoing at the same time.

[8] Self-adhering plastic laminate and painter's tape can be effective alternatives to sheet plastic and duct tape in some applications. Also, painter's tape might be easier for some to use and is less likely to damage wall coverings (Metz et al. 2004).

1.6 Basic Assumptions Used in this Guide Book

Several assumptions were made to ensure that general advice about SIP was treated adequately in the guide book. These assumptions are summarized below. Some exceptions to these assumptions are also discussed, to ensure that the scope of the guide book is broad enough to cover the needs of the user.

- The primary objective of temporary SIP is to avoid fatalities.
- The population distribution is homogeneous throughout an ERZ.
- All releases are detected immediately when they occur.
- Decision makers follow the best practices (as described in this guide book and CSEPP 2001) to ensure an effective SIP strategy.
- The Army recommends protective actions in an ERZ when the predicted risk to the affected population reaches the AEGL-2 threshold.
- The alert and notification of the population is timely and is expected to reach all of the population in all of the ERZs at risk.
- The population in all of the ERZ at risk takes temporary SIP promptly as instructed.
- Shelters in the ERZ have air exchange rates within the range used for CSEPP planning for normal, expedient, and enhanced shelters. Shelters include personal residences, commercial businesses, and public facilities. The latter might involve dozens or hundreds of persons, but the guidance should be essentially the same as that for a one-room house. Shelter in pressurized facilities is considered on an exception basis only in the guide book.
- Vapor releases are the primary concern. Aerosol releases are considered on an exception basis only in this guide book. The extremely remote potential for aerosol infiltration into shelters is not considered at all.
- Hypothetical releases of agent vapors were assumed to be from a single location and were assumed to be instantaneous, continuous, or some combination of both.
- The expected time to remain in temporary shelter is likely to be brief (one-half to four hours).

2 Preparing a Temporary SIP Protection Strategy

2.1 Plans, Coordination, and Agreements for a Temporary SIP Strategy

Because of the limited time available to make complex decisions during an emergency, it is important that methods to implement temporary SIP be carefully planned in advance. Expect that time will be limited for staff activation, consideration, discussion, coordination, or confirmation of circumstances before a decision must be made. Plans should include a method for quickly determining the preferred protective actions and the areas to which they apply, on the basis of information expected to be available minutes after the event occurs.

Army and off-post planners and decision-makers must have a common understanding about when a threatened population should evacuate or take temporary SIP. These protective actions need to be fully integrated throughout the risk area. Similarly, planners and decision-makers should have a common understanding about when and how a threatened population should end SIP. These understandings should be documented in plans and agreements. Most jurisdictions have achieved this level of understanding with regard to initial protective action decisions, and most plans and agreements reflect this. Plans and agreements for ending temporary SIP are not as well defined. The following is offered to help planners and decision-makers balance their plans in this regard.

The concept for the implementation of temporary SIP, and the plans to implement the concept, should be developed from the perspective of the population to be protected. If they do not fit the needs of the population with respect to their culture, environment, situation, and capabilities, the population cannot be fully protected.

2.1.1 Scope of Plans to Support a Strategy to End SIP

To ensure that plans to support a strategy to end temporary SIP are complete, it is suggested that the following subjects be included in emergency response plans.

- Plans should cover special events involving the assembly of a large number of persons. When many persons are expected to gather in a location that might be impacted by a release of chemical agent from an Army chemical stockpile storage site, planning for safety and security of the venue should routinely include planning for the unlikely occurrence of a chemical accident or incident at the storage site. This task would involve expanding existing homeland security planning to protect persons against an accident or incident within the venue, to include evacuation or temporary SIP (or some combination thereof) as protection against an external threat. A component of planning for this contingency should include direct notification and specific protective action recommendations to the Incident Commander responsible for emergencies affecting the venue. It might also be helpful to address the emergency information needs of the population attending the event in expanded emergency announcements broadcast in conjunction with basic emergency public information immediately following an accident or incident.
- Plans should describe and discuss the concept and methodology to decide when and how to end SIP in a timely and

appropriate manner. The concept and methodology should incorporate consideration for all of the important variables that bear on decisions to end SIP and implement the CSEPP policy (CSEPP 1991) so that fatalities will be avoided to the maximum extent possible. Dispersion modeling should be used to estimate the hazard for protective action decision-making purposes (CSEPP 1999). (See Appendix A for a discussion about modeling to determine when to end SIP.)

- Plans should discuss public education information, to ensure compatibility of the materials with the planning concepts. Of particular importance is a common language in plans and public education information.
- Plans should include protocols for sharing information about ending SIP among jurisdictions, as described in formal agreements. This responsibility includes feeding information to the JIS and to the Joint Information Center (JIC).
- Plans should take into consideration that a response to instructions to take SIP will not be instantaneous (Sorensen, Shumpert, and Vogt 2002). Some of the population might seek confirmation or additional information from neighbors, relatives, or the media before taking action. Some time is needed to get everyone inside; close windows and doors; and shut off heating, ventilation, and air conditioning systems. Additional time will be required to apply expedient measures to seal off the room(s) selected for shelter. There is a potential for persons to be exposed to outdoor concentrations of chemical agent vapors before they take shelter and some possibility of infiltration of hazardous vapors into the shelter before it is closed. Several analyses suggest that it will take 5–10 minutes on average to implement normal SIP once persons make the decision to do so. Data from a limited set of trials indicate that the time to apply expedient improvements to the room (e.g., tape and seal openings) is likely to average an additional 17 minutes (Rogers et al. 1990).
- Plans should include procedures for the timely broadcast of instructions to end SIP, consistent with the public education effort and preplanned emergency instructions. Procedures should address the potential need to broadcast instructions about ending SIP selectively within certain large ERZs or in special facilities, especially if that will minimize the potential for fatalities. Broadcasting instructions about ending SIP should also be considered in ERZs where the original PAD was to evacuate, to accommodate those persons who could not or would not evacuate.
- Plans should consider the need to establish facilities for screening and accounting for persons who had taken temporary SIP different from those facilities planned for initial evacuees. Similarly, plans should provide for directing persons who are relocating after SIP on to different routes than those used for initial evacuation. The route to take when relocating might not be the same that would have been taken during an initial evacuation, because formerly sheltered persons might catch up with the vapor plume that had already passed them by. Also, formerly sheltered persons with the potential for exposure might benefit from medical screening and accountability more than persons who evacuated initially and should not be in line for these services behind the initial evacuees. Persons ending SIP should be encouraged to follow EAS messages and emergency public announcements concerning relocation directions, even if the announced best direction to take might be toward the original source of the plume. Sheltered

populations will likely follow this advice if the public education program prepares them for this possibility and if the announced directions are clear and the rationale explained.

- Plans should address the establishment of TCPs and ACPs in support of ending temporary SIP. Locations for TCPs and ACPs should be determined in advance on the basis of the methods to be used to end SIP. It is important that the timely ending of SIP not be delayed pending the establishment of TCPs and ACPs. Staffing and equipment to set them up should be identified in advance. Note that the location of TCPs and ACPs to support relocation following SIP might differ from locations set up to expedite initial evacuation.
- Plans should provide for creating additional smaller sub-zones within the ERZ that will enhance the timing to end SIP if an ERZ is large, especially in length with respect to the direction of potential agent vapor travel, or if the population distribution in the ERZ is not reasonably homogeneous. An alternative might be to announce the end of SIP incrementally in easily definable areas within an ERZ, such as a community or a facility. Of particular interest and concern are ERZs that are adjacent to the Army installation and greater than 5 km long. This parameter is especially important if there is a small area of very dense population at either end of the ERZ.
- In addition, the Army plan should describe how to expedite the collection of eyewitness information and the results of monitoring at or near an accident site, to obtain real-time data about source term values in time for this information to be used for deciding about ending SIP. Any method to decide when and how to end SIP will depend on the most current information available about meteorology and the source term. Using worst-case assumptions about these variables in lieu of near real-time data will likely skew the estimate of the optimal time to end SIP, regardless of the decision tool used. Underestimating the source term value can also skew the estimate of the optimal time to end SIP. Thus, the Army must make every effort to obtain and use the best meteorological and source term information to support PARs and PADs to end SIP. The Army plan also should address how to collect eyewitness information and monitoring results to determine the potential for aerosol deposition, if the circumstances of the release suggest that this is a possibility. These Army plans should be explained to off-post officials to ensure their understanding of how the Army will decide PARs to end SIP.
- The Army plan should address the need to calculate PADs to end SIP for the on-post population (employees, contractors, visitors, and residents) as soon as possible after deciding the initial on-post PADs, regardless of the initial PADs implemented on-post.
- The Army should provide for the calculation of PARs to end SIP off-post as soon as possible after issuing initial PARs (SIP or evacuate) to off-post officials. These calculations should be based on updated reports from the accident site to quantify the source terms more accurately than using a default source term.

2.1.2 Coordination of Plans to Support a Strategy to End SIP

Revision of plans that address the strategy to end SIP in one jurisdiction should be coordinated and synchronized with plans from other jurisdictions to ensure compatibility throughout the CSEPP community. Of particular importance is assurance that the use of modeling and the concept for using the results are consistent between and among plans. A single model and a common concept should be used. This model should consider all of the conditions, circumstances, and options that will provide the best decision for each ERZ. This same coordination should occur whenever the model is updated or revised. The best decisions are those that:

- Are based on the concept that the best time to end SIP is when the plume concentration outside falls below that inside shelters.
- Consider the dose-response relationship that is most relevant to the effects of the agent on a sheltered population.
- Consider the potential for exposure before, during, and after SIP.
- Assign priority to minimizing fatalities.

Plans and agreements that pertain to temporary SIP should incorporate the NIMS concept. Plans should also describe how to operate a JIS to ensure consistency among ERZs in ending SIP and how a JIC will be operated in support of a SIP protection strategy, primarily in producing and disseminating urgent public health and safety advisories about ending SIP.

2.1.3 Use of Agreements to Support a Strategy to End SIP

Army and off-post authorities should formally agree on what information concerning the ending of temporary SIP will be exchanged among organizations during an emergency to ensure that this action will be timed and implemented effectively. The decision process should be documented in agreements among all jurisdictions. Agreements should also address instances when one jurisdiction will act on behalf of another to communicate protective action instructions to the public about the ending of SIP. An example would be circumstances under which the Army installation will initiate activation of public alert and notification systems in off-post jurisdictions.

Agreements should cover protocols and practical details about how the information will be communicated, comparable to arrangements currently in place for making initial protective action recommendations (PARs) and PADs. This exchange could be addressed in separate agreements or incorporated into existing agreements, such as those pertaining to alert and notification or mutual aid.[9] The following should be considered:

- The Army should agree to provide projections of optimal times to end SIP for each ERZ affected by the release as soon as possible after making the initial PAR, regardless of whether the initial PAR was to evacuate or SIP. These estimates should be used by local officials to anticipate PARs and PADs about ending SIP.
- All emergency response officials should immediately share PADs made within their jurisdiction with all other jurisdictions involved in the response to the accident. This responsibility includes sharing of Army PADs with off-post officials (and vice versa). As a result, all jurisdictions will be able to anticipate the impact that a PAD in one ERZ will have on other ERZs with respect to mutual assistance in relocating and medically screening persons

[9] See Lerner et al. 1999.

who were sheltered-in-place. Off-post officials should also inform the Army when the direction to SIP was broadcast in each ERZ and how long the officials believe it took or will take the population to execute this PAD. This information will enable the Army to provide better PAR updates about ending SIP.

- The Army should agree to provide PARs to end SIP for each ERZ affected by the appropriate, agreed-upon toxic hazard levels of concern as soon as possible, to ensure that off-post officials have time to consider the PARs and implement corresponding PADs. These updated PARs to end SIP should be provided regardless of whether the initial PARs were to evacuate or SIP, because some individuals might have taken shelter instead of evacuating. These PARs should be based on current information about conditions at the accident site and information from off-post officials about the implementation of PADs to evacuate or SIP in each ERZ.
- Officials can reach agreement in principle on what off-post PAD is most likely to be needed for certain conditions and circumstances, but agreements that mandate a default protective action regardless of conditions and circumstances are of questionable value. There can always be an exception for which the default protective action would be totally inappropriate.
- The approach used to decide how the Army will translate computer model outputs to produce PARs to end SIP.

2.2 Public Education to Support a Temporary SIP Strategy

The potential for an accident or incident involving the Army stockpile of chemical warfare agents is remote, as evidenced by studies of the risks of an accident and the excellent safety record for storing these hazardous chemicals to date. Chemical workers and trained emergency responders are available to reduce or mitigate the effects should a release occur. Personnel are on-duty around-the-clock to promptly alert and notify populations threatened by a release. And protective actions by the public, if taken promptly, can substantially minimize the potential for lethal exposure. Despite these arrangements, the natural but irrational fear that many have about the threat posed by a chemical accident or incident needs to be factored into public education strategies. It might not be possible to educate everyone about the true risks involved to the extent that they are less fearful. However, giving people real options to protect themselves should reduce panic responses that could increase the risk of exposure or injury. Evacuation is a natural response, but temporary SIP is a proven protective action that is easily understood and accomplished, if explained properly and planned for. Temporary SIP is a viable alternative to evacuation in many cases, and in some circumstances is preferable to evacuation. The public education program in all CSEPP communities should emphasize this point.

A comprehensive public education program needs to present information about vapor infiltration into shelters, yet be convincing that temporary SIP is a huge benefit, especially if this protection is ended at the appropriate time. The education program should include specific information about how the public will be told when to end SIP, and that this instruction might come very soon after the initial direction to take shelter. It also is important that the actual SIP notification messages are consistent with the public education program that explains the SIP protective action messages, to ensure the public will not be confused or misunderstand what they are being instructed to do.

Authors of public education materials need to be very careful about the language used and how the information might be understood (or misunderstood) by the public. For example, it is

very important to define "contamination" and "contaminated" whenever these words are used and to distinguish between "inhalation" and "percutaneous" (skin contact) effects. Similarly, "relocation" (after SIP) differs from "evacuation" (initial protective action), and so these words should be used consistently in the proper context (CSEPP 2001). The public also needs to be educated about what actions to take to end SIP. It is too simplistic to announce "All Clear."

A program of pre-emergency public education should convey the following to ensure timely and effective use of SIP during an actual emergency:

- **The hazard most likely will be an invisible and odorless vapor.** This vapor is transported downwind as a plume that expands and is diluted by clean air as it travels. The primary concern posed by these vapors is the injury that results when these vapors are inhaled. The plume eventually dissipates completely. The plume will move more rapidly during windy weather, and it will also be diluted and dissipate more quickly.
- **Army chemical warfare agent vapors act neutrally buoyant when outdoors in moving air masses.** Although these vapors are slightly heavier than air when initially released to the atmosphere, it is not necessary to take shelter in the highest available space in a structure. Rather, a threatened population should seek shelter in a space that provides the least leakage of outside air into the shelter.
- **Vapor infiltration can reduce the protection of a shelter over time.** A population can reduce the risk of exposure to hazardous vapor by going indoors and shutting off ventilation to the outside. However, every building leaks air, and outside vapors will infiltrate shelters in the path of the plume. Thus, as outside air infiltrates the shelter, the protection afforded by the shelter gradually decreases. Eventually, sometime after the highest concentration of the vapor plume has passed the shelter, outside air will be cleaner than the air inside the shelter. Officials will consider this fact when instructing the sheltered population to ventilate or leave their shelters.
- **The public will be notified about the SIP protective actions they should take.** The Army will notify local officials promptly if a chemical accident occurs. In turn, these local officials will alert and notify the affected population quickly and instruct them on initial protective actions. Persons who have taken shelter will subsequently be told when and how to end SIP when officials have decided it is time to do so.
- **SIP is a temporary, two-step process.** First, a population must quickly take the best shelter available. Then, the population must end this protective action when instructed. Timing is important in both steps of this process. Taking SIP immediately when instructed will minimize exposure to toxic vapors, especially when one also ventilates or leaves the shelter promptly when advised to do so.
- **SIP protection must include an exit strategy.** When taking shelter, one should bring a radio or TV tuned to the local emergency alert system (EAS) station in order to receive instructions about when and how to end SIP. This direction might be modified to accommodate tone alert radios (TARs) in those jurisdictions where TARs are installed, provided that the TAR signal can be received in the shelter room, and that officials can include all essential end SIP instructions in a brief TAR message. On balance, it is better to depend on TARs for the initial alert and (maybe) notification instructions, and then radio or TV EAS should be used as a complement to TARs messages for updates and instructions to end SIP. When local officials have decided that SIP should be ended in an area, the sheltered population may be instructed to resume normal activity without restrictions, ventilate shelters but remain indoors, exit from shelters but remain nearby, or relocate

to a designated facility for accountability or medical screening.

- **Protective devices available to the public in some communities, such as re-circulating filters and respiratory protection, have some utility.** Officials should discuss when and how to use these devices. They should include information about limitations on their use, special precautions that might be needed during their use, and what needs to be done with them when ending SIP. The latter is necessary so that ending SIP is not delayed while persons in shelters try to figure out the answers to these questions.
- **Hazardous vapors that might have infiltrated the shelter will eventually dissipate.** This occurs as cleaner outside air infiltrates and replaces any residual hazardous vapors in the building. This exchange can be expedited by opening doors and windows. Further details about this process are outside the scope of this guide book.

Public education programs should provide practical information about choosing and preparing a shelter room, what to bring into the shelter, and what to take when relocating following SIP. Ideally, the shelter should be selected in advance as part of smart emergency planning. The location within the building should be chosen to minimize the exchange of inside air with outside air. Ten square feet per occupant should be sufficient to provide breathable air for the duration of temporary SIP (NICS 1999). A room with at least one electrical outlet and a light fixture is very desirable. It is also recommended to pre-position essentials so that they are immediately available. Essential items include materials to seal shelter openings, such as duct tape, sheet plastic, and scissors. Medications or dietary supplements needed to sustain health, eyeglasses (preferred to contact lenses), sufficient clothing to avoid extreme discomfort, a means to monitor emergency alert system (EAS) messages with fresh batteries[10], chairs or pillows to sit on, a flashlight with fresh batteries, and a watch or clock also are important. A few other items that might be useful, provided these can be obtained without any delay in taking shelter, include:

- Fresh water, snack bars, candy, or crackers;
- A cellular or cordless telephone to make emergency calls;
- A notepad with a pen or pencil to jot down emergency instructions, phone numbers, or relocation routes; and
- A wireless laptop computer to monitor web sites that might contain information about protective actions in response to the emergency.

If a baby or small child might be a shelter occupant, some spare diapers, formula or baby food, and toys would be appropriate. Avoid suggesting the need for a multi-day supply of anything, because people might delay taking shelter to locate supplies that are not essential for the brief time they will be in shelter. Supplies already stocked in the shelter location to support other contingencies are acceptable, as are supplies stored in the transport vehicle to be used when relocating. This guidance on materials to have available in shelters discussed in this guide book differs somewhat from generic all-hazards guidance. This distinction should be a cited in the CSEPP public education program.

Pets are an important consideration for many who are instructed to take temporary SIP. The public education program should acknowledge this consideration and recommend that pets be brought indoors if this can be done quickly, and that appropriate accommodations be provided. A primary consideration is access to water while pets are sheltered. The population should also be educated on options to accommodate pets that accompany persons who relocate after ending SIP for accountability or medical screening. One

[10] A TAR can be very useful in a shelter, but only if specific instructions will be broadcast on that system. If the EAS is the only way protective action updates will be broadcast, then a TAR is of little use in a shelter.

option is to leave pets in the temporary shelter room for a few days with adequate water and some food. This situation is comparable to that of a responsible pet owner leaving the pet with an adequate supply of water (three days is not unreasonable) and some food whenever the pet is left at home unattended. An automatic watering dish is an excellent precaution. Thus, persons who are away from home if a chemical event occurs can be confident that their pet will have water (and maybe food) if they are prohibited from reentering the threatened ERZ for a while.

Transient persons passing through an ERZ and new residents in a community in an ERZ deserve special consideration in emergency planning and in the public education program. Planners and decision-makers should not assume that everyone in an ERZ who is notified to take SIP or evacuate an area (or to relocate to a screening facility or reception center) will have an appreciation for what they are being asked to do or know how to do it. In the absence of opportunities to educate the transient population in advance of an emergency, public education information should be incorporated into handouts at strategic locations for immediate distribution as needed (e.g., motels, large businesses, shopping malls, and sporting events), and persons who are in a position to interact directly and immediately with large numbers of transient populations in these venues should be given advice on how to inform and assist transients in an emergency. Such materials might also be given to officers at TCPs and ACPs. New arrivals might be reached by local government agencies or utility companies that could provide emergency education materials, along with other services for new residents upon their arrival. It also might be helpful to address the information needs of the transient population and new arrivals in expanded emergency announcements broadcast in conjunction with basic emergency public information immediately following an accident or incident.

The CSEPP has always addressed special populations who need help with protective actions. The CSEPP also considers the presence of relatively large numbers of persons in a community who speak a common language other than English and routinely offers public education information and emergency public information in their language. However, small numbers of persons in a community who do not speak a language common to the community at-large, who lack knowledge about technological hazards upon which to base personal protective actions, or who are homeless are at a disadvantage when it comes to learning how to protect themselves during a chemical emergency. Public education programs should seek out these groups and individuals and provide them with the information, resources, and options that will help ensure their safety. Government, cultural, educational, and social organizations can be a conduit to provide these services.

Local CSEPP calendars contain useful emergency information. Consider recommending that persons who are given these calendars be asked to place one in their designated shelter room for reference while sheltered and one in the vehicle they might use to evacuate or relocate. Perhaps two or three copies of a one-page set of evacuation and SIP instructions on stiff paper stock could be added to the calendar. These can be removed and placed in designated shelter rooms and vehicles.

CSEPP Fact Sheets that are available to support a public education program cover some of the above advice and are listed in Appendix C. Another resource for information about public education materials is the CSEPP Public Affairs Planning Guidance Compendium Workbook listed in Appendix C. Public information and education also is discussed in the CSEPP Planning Guidance and CSEPP Programmatic Guidance (CSEPP 2006 and CSEPP 2006a).

A local CSEPP web site can be set up to complement existing public education programs and is another tool that can be used to help the public prepare for an emergency. This web site can also be a source for near real-time emergency public information about protective action instructions to evacuate or take shelter by ERZ

and when and how to end SIP in ERZs or parts thereof.

Public education programs should reinforce actions that will increase the effectiveness of SIP and discourage actions and responses that are counterproductive or increase the risk of exposure or injury associated with SIP. (See Section 4.1 for additional information about what the public should do while in shelter. See Sections 3.5, 4.2, and 5.5 for additional information about what the public should not do when taking SIP, while in shelter, and when ending SIP.)

2.3 Training and Exercises to Support a Temporary SIP Strategy

2.3.1 Training

All emergency responders who have a role in implementing a SIP protective action strategy should be trained in their role. Some tasks, such as hazard analysis, will require persons to be formally trained in hazard analysis operations. Other key responders, to include chemical workers and security guards at Army installations, Emergency Operations Center (EOC) operators, and off-post warning point staff, should be given rigorous initial on-the-job training and regular refresher training. This training might be a combination of instructions by supervisors; self-paced review of policy, guidance, and plans; and regular practice involving interaction with their peers. If the training is documented and tracked, it is more likely to be accomplished.

Regardless of the formal and on-the-job training provided, it would benefit all who are responsible for planning and implementing a SIP protective action strategy to view the two CSEPP videos, Residential Shelter-In-Place and Business Shelter-In-Place, along with their accompanying materials (CSEPP 2001a and CSEPP 2004a). These are available at all CSEPP sites.

Individual training, even mental rehearsal, vastly improves people's responses to disasters (Time 2005). Therefore, residents and employees in ERZs should be encouraged to engage in periodic practice or rehearsal of personal protective action decisions and actions. Some examples are:

- Participation in "games" like "CSEPP Stay or Go: Do You Know?"
- A recreational drive to practice evacuation or relocation after SIP to become familiar with the designated routes and locations of facilities for evacuees and those who relocate after SIP. This could be done from both home and business locations.
- A rehearsal of individual family or business SIP. This rehearsal could be keyed to a CSEPP exercise, based on training alert and notification messages on sirens, TARs, and the EAS. A SIP rehearsal could also be part of a series of personal protective action rehearsals for other hazards in the community over the course of a year.
- Public participation in a CSEPP exercise (see Section 2.3.2).

2.3.2 Exercises

CSEPP exercises are excellent opportunities to practice SIP decision-making, alert and notification associated with taking and ending temporary SIP, and the exchange of public health and safety information among jurisdictions and with media outlets. However, the extent-of-play agreements for these exercises often exclude these operations (e.g., ending the exercise too soon) or allow simulation of these activities.

Simulation Cell (SIMCELL) input to players in EOCs, TCPs, ACPs, medical treatment facilities, and the JIC should be robust enough to represent the a wide spectrum of reactions by the affected population to emergency instructions and information disseminated by players during the exercise. This input should challenge the players to cope with the full impact of protective actions, both evacuation and especially temporary SIP.

Simulating feedback from the public and the media through the public inquiries system operated by the JIC and the mock media operated by the SIMCELL[11] could be done by having volunteers (individuals or families in homes and employment sites) participate in the exercise as an extension of the SIMCELL. They would be given instructions and information in real-time on the basis of player actions (i.e., simulating the actual alert and notification instructions via siren, TARs and EAS messages to evacuate or take SIP, and then to end SIP, along with public service announcements produced by players). Their notional response would be based on this information, their circumstances, and their prior knowledge of public education materials. Responses would be used by the exercise SIMCELL staff and the mock media to generate SIMCELL input to players, providing credible feedback to the players on how the public responded to player instructions and information. These volunteers could also offer commentary for consideration in the post-exercise analysis of the player response about the effectiveness of alert and notification and usefulness of related emergency public information.

To demonstrate the Protection and Emergency Public Information tasks called for in the exercise guidance, participating organizations should commit (in the formal extent-of-play agreement) to demonstrating the tasks associated with the outcomes expected for informing, instructing, and supporting the populations at risk (see CSEPP 2004, section 4.2.4). Activation of alert and notification systems and the EAS should be demonstrated as realistically as possible, to include repeated activation with update messages. The messages that would have been broadcast if the exercise had been an actual emergency must be provided in real time to exercise evaluators at the various venues.

Other important capabilities that should be demonstrated during CSEPP exercises include:

- Collecting and assessing eyewitness information from the accident site and monitoring results from the vicinity of the accident site, to support recommendations and decisions about ending SIP.
- Deciding when and how to end SIP and coordinating the decisions and their implementation across all jurisdictions involved.
- Translating decisions to end SIP into clear and timely instructions and emergency information.
- Providing supplemental emergency information and explanation about temporary SIP through media other than sirens, TARs, and the EAS.

[11] This means that tasks associated with Protection and Emergency Public Information, especially tasks A.5.3.E, A.5.4.E, A.5.5.F, C.5.2.E, C.5.3.E, C.5.5.F, C.5.6.E, A.7.1.E, C.7.1.E, A/C.7.3.J, A/C.7.4.J, and A/C.7.6.J, would be demonstrated fully during every CSEPP exercise (CSEPP 2004).

Another useful strategy might be to take advantage of the annual community CSEPP exercise as a day when families and businesses practice their plans for SIP. This strategy could be promoted as a public education program initiative. Test messages could be broadcast on sirens, TARs, and EAS stations to prompt the voluntary walk-through of taking SIP and ending SIP in homes and businesses.

3 Initiating Temporary SIP Protection

3.1 Making Recommendations to Take Temporary SIP Protection

A release of hazardous chemical vapors that threaten a population is very unlikely, but if it should occur, it will probably be with little warning. Therefore, protective actions must be implemented quickly to be effective. Because decisions are implemented through instructions to the public (both on-post and off-post), the time needed for public warning drives the decision process. Every minute counts.

It is expected that a responsible Army employee or contractor[12] will recognize immediately when an actual or likely release is a concern. The responsible party will then report the essential elements of information about the condition to an Army official authorized to categorize the significance of the event and provide PARs to off-post warning points. This report should be made immediately, as soon as it can be done safely.

Essential elements of information about the release must be reported expeditiously and succinctly. The sequence of reporting this information should be made standard and reinforced by written standard operating procedures, training, and exercises. Reports from the field about the conditions and circumstances of the release should include the following as a minimum:

- Identity and location of the person making the report,
- Time and location of the release,
- Type of agent involved,
- Number and type of munitions or containers involved,
- Presence of fire or explosions,
- Presence of visible liquid agent and approximate area of coverage,
- Number of persons in the vicinity of the release, and
- Actual or probable injured or exposed persons and assistance needed.

If the reporter has information about the probable cause of the release or the potential for additional releases, this information should be added to the report.

Figure 3 illustrates an example of an initial report of a chemical accident from a chemical work site to the EOC. Note that this cryptic report will need to be interpreted in the EOC based on the time of the event and the context of the work ongoing at igloo C-208. The work involves the loading and transport of GB-filled rockets in pallets normally containing 15 rockets each. Not more than two pallets of rockets are allowed to be outside of the igloo at any one time. Modeling of the worst-case hazard based on this initial input might well prompt protective actions over a very large area. It will be difficult to predict an acceptable time to end SIP in these ERZs based on this initial report.

Figure 4 illustrates a portion of a generic notification form used to ensure the rapid and accurate initial notification of the off-post warning point by the Army.

Note that the most important information is covered in the beginning of the report to the off-post warning point. In some cases, the off-post warning point might be an off-post EOC if that facility is manned at the time. The actual forms might include additional information as required by local agreements. The content of the initial notification in this example was based on the initial report from the accident site described in Figure 3. Note that the Army is recommending SIP in three ERZs in this example.

[12] The responsible party would likely be a security guard or chemical worker in the storage area or demilitarization facility, all of whom are trained to recognize events that require reporting to an Army official authorized to make a PAR.

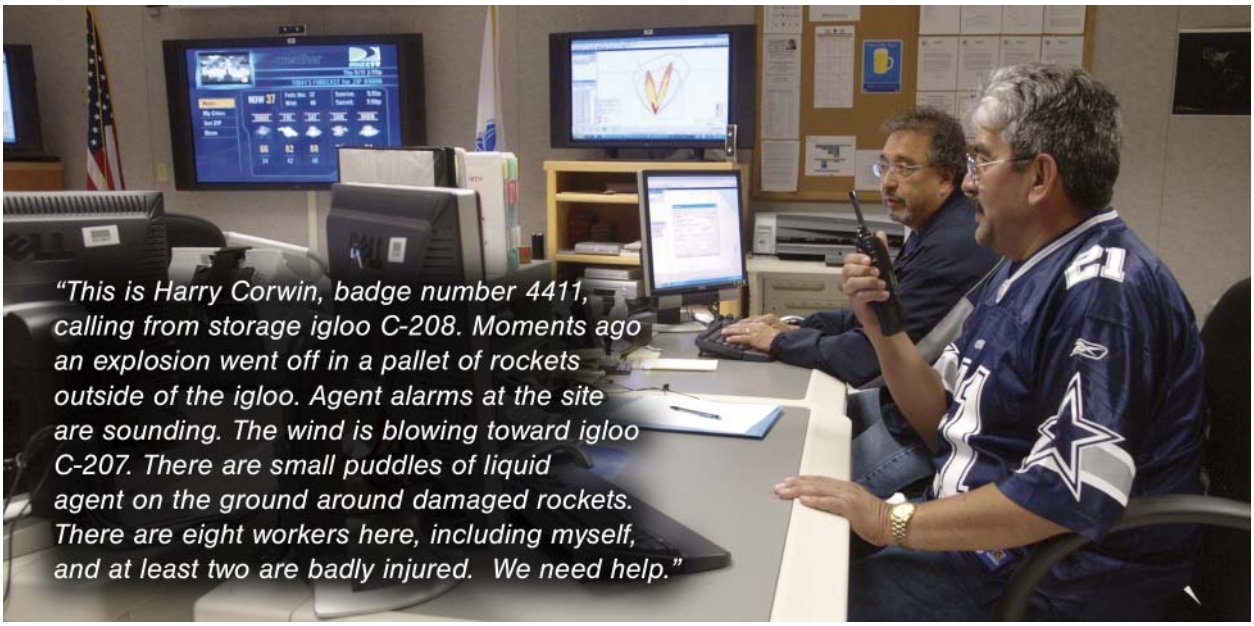


Figure 3 Initial Report from the Accident Site

Eyewitness reporting should continue with immediate updates as new information becomes available. It is imperative to obtain accurate information about the quantity and type of release as soon as possible and to update it if conditions change, because this has implications for when and how a sheltered population should end temporary SIP.

Figure 5 presents an example of an update report from the accident site about twelve minutes after the explosion; the report clarifies the conditions and circumstances at the site. Note that the additional information will help produce a better model of the extent of the hazard downwind and off-post and allow preliminary discussions about when to end SIP among those who are taking this protective action.

When a chemical event occurs, protective action decisions must be made for persons on the installation and for the surrounding off-post community. The installation commander has the responsibility and authority for initial chemical event response on-post, the protection of on-post personnel, and the mitigation of the event's consequences (U.S. Army 2003).

An Army official is expected to send PARs for off-post populations to off-post warning points

CHEMICAL EVENT NOTIFICATION FORM

ACTUAL X EXERCISE ____ REPORT DATE/TIME 10/10/05 1000

Reporter John Andrews Initial Report X Update Report ____

EVENT CLASSIFICATION LEVEL

Community Emergency X Post-Only Emergency _____

Limited Area Emergency ____ Non-Surety Emergency: _____

AGENT GB **DATE/TIME OF RELEASE** 10/10/05 0955

TYPE OF RELEASE Explosion **WIND DIRECTION** From 90 degrees

PROTECTIVE ACTION RECOMMENDATIONS BY ZONE

Evacuate Zones None

Shelter Zones A B D

End Shelter Zones and Times _____

Remarks Event was reported at igloo C-2007. No aerosol deposition is expected off-post.

Figure 4 Initial Notification of Off-Post Officials

promptly after a responsible party identifies the occurrence of an event that is predicted to affect these populations (CSEPP 2006). PARs are made by the Army on the basis of the actual or likely release of chemical warfare agents outside of engineering controls.[13] PARs are advisories provided to off-post warning points to enable off-post officials to make PADs to protect off-post populations.

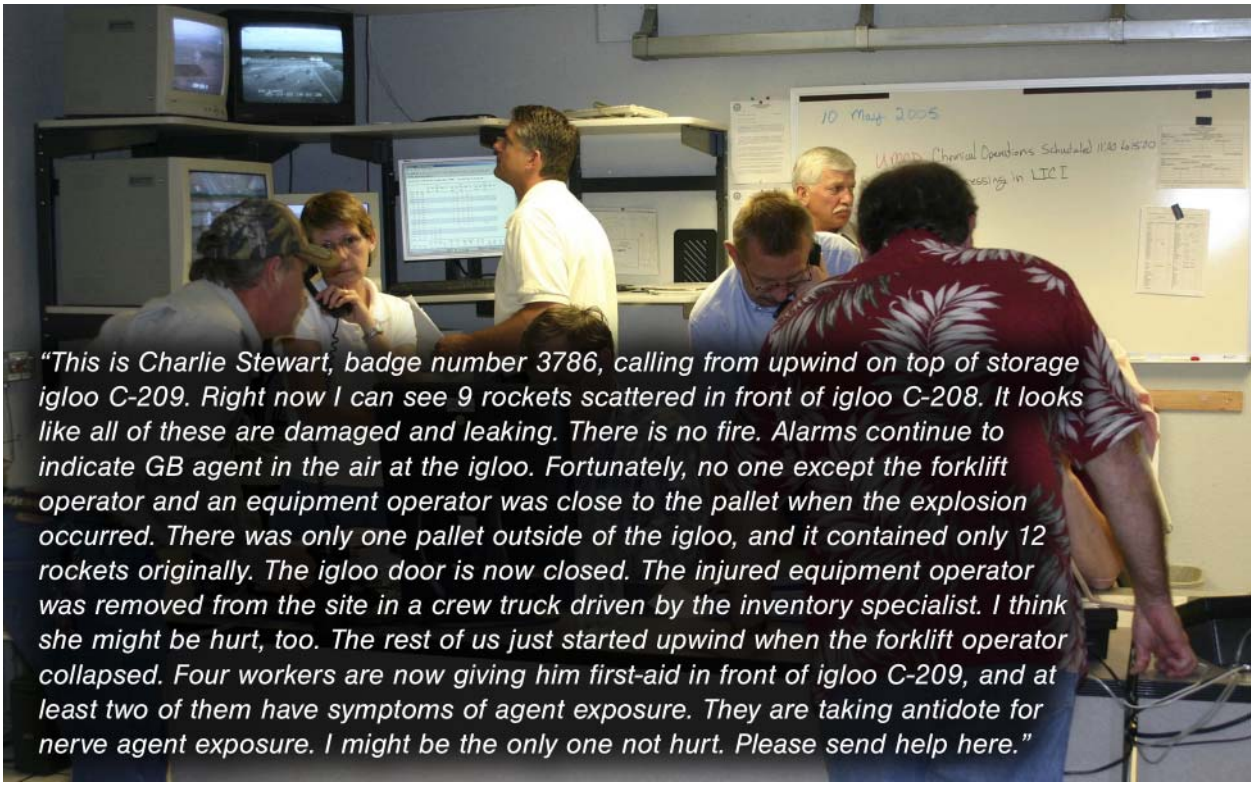


Figure 5 Update Report from the Accident Site

3.2 Making Decisions to Take Temporary SIP Protection

An Army official should make an initial PAD to protect the on-post population within minutes after a responsible party identifies the occurrence of an event that is predicted to affect the post population. The affected post population should be alerted and notified of the protective actions to take as soon as possible after the PAD is made.

Off-post officials are expected to make PADs, broadcast alert signals, and complete the initial notification (instructions for the affected populations to evacuate or take SIP) within eight minutes after the off-post warning points receive Army PARs. This warning includes the broadcast of a complete EAS message within these eight minutes if an EAS message is the primary notification mechanism (CSEPP 2006).

Off-post officials should inform the Army immediately whenever they decide to direct protective actions in any ERZ or change a previous decision about a protective action. This information is needed so the Army can continue to monitor the potential for changes in hazard predictions for zones where protective actions are ongoing and update PARs accordingly.

[13] A release can range from a minor vapor leak or liquid spill that is a hazard only to workers in the vicinity to a catastrophic a release involving fire or explosion that can affect the health and safety of the post population and the population in nearby communities.

The above reflects the strategy that a reasonable PAR or PAD that is issued quickly on the basis of the best-available information, pre-approved criteria (a Protective Action Strategy Plan), and current community conditions is better than a "perfect" PAR or PAD issued too late to be effective. Any delay in protective action decision-making and implementation can significantly increase the potential for fatalities in areas closest to the storage site (CSEPP 2001).

3.3 Announcing Direction to Take Temporary SIP Protection

Direction to take temporary SIP is usually made by direct notification of the public through alert and notification systems and by EAS messages and reinforced by immediate information given to media outlets. Such instructions should:

- Identify the authority for the protective action instructions.
- Identify the areas where this protective action is required.
- Briefly describe the nature of the threat.
- Stress the importance of prompt compliance.
- Include brief instructions for expedient shelter.
- Reference public education materials that have been distributed.
- Be consistent with public education materials that have been distributed.
- Reference use of sheltering kits, recirculating filters, and respiratory protection devices if they have been distributed.
- Stress the importance of monitoring radio or TV broadcasts to receive exit shelter instructions.

Figure 6 contains a sample of an EAS message instructing a certain population to take temporary SIP immediately.

Emergency instructions must be consistent with public education materials (and vice versa). Instructions during an emergency should describe actions and choices that have been previously introduced in public education materials and use the exact terms and phrases used in these materials. Avoid terms and phrases

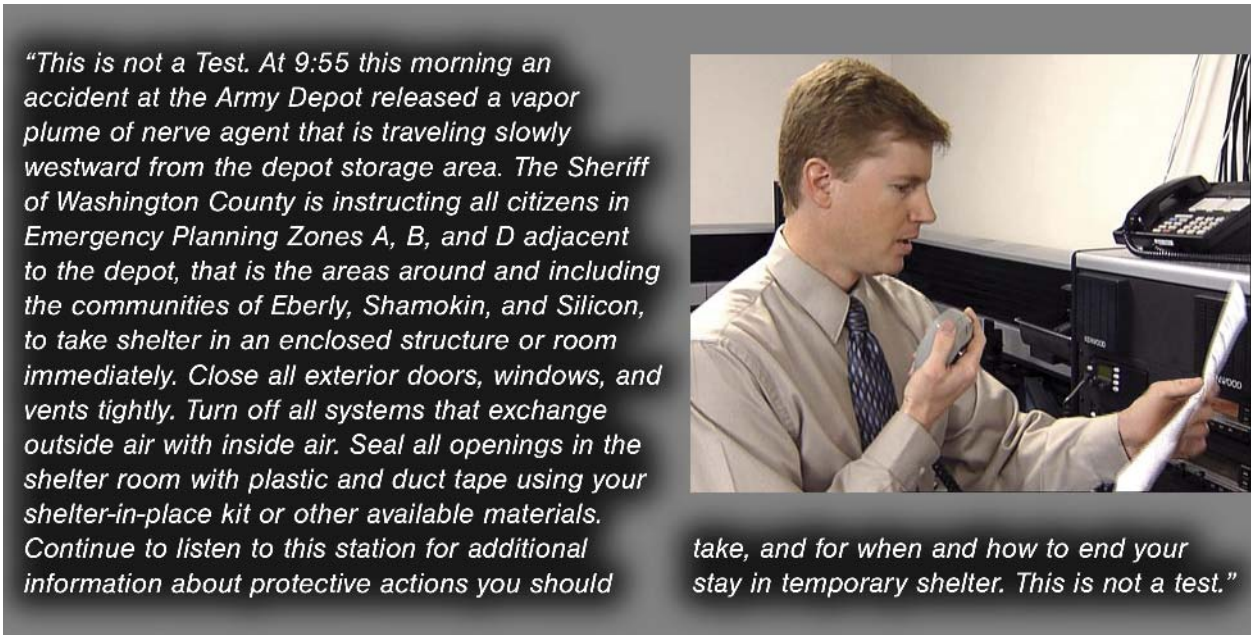


Figure 6 Sample EAS Message — Take Temporary SIP

that are ambiguous as to the specific protective action to take to, such as "Go inside and listen for instructions on your radio." If the intent is that they go inside and take expedient shelter, say so. Because of the short time available for messages on the EAS, sirens, and TARs, there is no opportunity for these messages to explain the practical meaning of such terms as "shelter-in-place" or "relocate." Their meaning must be explained and the groundwork established for action ahead of time through an effective and comprehensive public education program.

Actual emergency instructions must be as clear and concise as possible, regardless of the scope and effectiveness of the public education program, because the affected population will probably include some who were not reached by the SIP public education program, such as transients and new arrivals to the community.

TARs or siren messages that instruct the listener to go inside a building and tune to an EAS station for information do not in themselves constitute protective action instructions — and doing so does not necessarily enhance the protection of the listener. In many cases, especially in ERZs close to the source of the release, it can delay the appropriate response, whether it is to evacuate (while there is still time) or take the most effective SIP possible in the least amount of time (expedient shelter). It also puts a premium on the ability of officials to generate timely and appropriate EAS messages and the public to access EAS messages.

Local officials and other credible community leaders should provide supplemental emergency information and explanation through media outlets to reinforce emergency instructions about taking SIP that are broadcast on alert and notification systems. Of necessity, EAS messages must be brief to fit the broadcast technology. Supplemental emergency information should be incorporated in concurrent news bulletins that reiterate information in public education materials. Emphasis should be placed on how to improve the air-tightness of shelters and what to do and not do while in shelter. Supplemental emergency broadcasts should also explain to the sheltered population that their best protection is in a tight shelter during the time that the highest concentrations of the invisible vapor plume passes their shelter. The broadcasts should then explain that they should end their stay in shelter promptly when instructed, to minimize potential exposure to vapors that might have infiltrated their shelter. Special populations might need additional information or direction in expanded emergency broadcasts.

In anticipation that not everyone will hear the initial emergency notification instructions, and some who hear the message will not or cannot follow the instructions, these instructions should be repeated regularly, although modified over time as necessary. These instructions should be rebroadcast at least every 12 minutes for the first hour and subsequently at least every 20 minutes, until officials determine that this is no longer needed (CSEPP 2006).

CSEPP exercise experiences suggest that media outlets are not often used to reinforce emergency instructions early in the response. Army spokespersons should quickly confirm to media outlets that (1) an accident or incident occurred and (2) an effective emergency response in ongoing, as well as describe (briefly) what protective actions are being put in place on-post. The most effective Army spokesperson, the one who by position is the most credible, is the Commander. Similarly, civilian officials should quickly confirm to the media that they are aware of the event and are in direct communication with the Army. They should describe what protective action instructions have been provided to the affected communities to reinforce EAS messages. (A word of caution: Army PARs are for internal use between Army and off-post officials only. These should never be included in the content of alert and notification messages or media releases. To do so risks introducing confusion about the actions to take at a critical time in the response, because off-post officials might, for good reason, adopt a PAD that differs from the Army PAR for certain ERZs.)

3.4 Expected Response to Direction to Take Temporary SIP Protection

A reasonable assumption is that most of the threatened population will take immediate steps to protect themselves as recommended by officials, especially if the public education program is effective. This includes assuming that the majority will take shelter soon after being notified to do so, that they will improve the protection of the shelter by expedient means, and that they will continue to listen for updated instructions. There may be some in the affected areas that will remain unaware of the emergency and what to do to protect themselves, and some of the affected population will not or cannot follow protective action instructions. Therefore, officials should consider posting TCPs and ACPs for both evacuation and SIP in each ERZ to the extent that this is safe and practical, regardless of the emergency instructions that are broadcast.

3.5 What Not to Do When Taking Temporary SIP Protection

It is vitally important that persons not delay when taking temporary SIP. They have no way of knowing how much time elapsed from when the agent was released until they learned what protective action to take, and so every minute counts. They should not waste time completing chores, especially outdoors. They should not delay taking shelter and improving the air-tightness of the shelter in order to scout around for food, water, toys, and other items not essential during temporary SIP. The need for survival supplies in the shelter is minimal, other than vital medication that must be taken frequently.

Persons taking shelter should not waste time using materials to improve the air-tightness of the shelter that are marginally effective if they have the option of using plastic sheeting with duct tape. Placing a towel under the door might reduce air infiltration somewhat, depending on the size of the opening, but it is not a substitute for the proven plastic and duct tape combination (Sorensen and Vogt 2001a).

4 Maintaining Temporary SIP Protection

4.1 What to Do While in Temporary Shelter

Instructions to the public while in shelters should be repeated at frequent intervals. The sheltered population should be encouraged to sustain this protection and remain alert for directions on when and how to end their SIP. Instructions should also direct persons to take SIP immediately if they have not yet done so and reiterate basic SIP instructions. Instructions should include information on how to use SIP kits, if provided, or how to improvise other expedient measures to improve the protection of the shelter.

Such instructions should:

- Identify the authority that is directing the protective action.
- Identify the areas in which this protective action is required.
- Stress the importance of continuing compliance.
- Reiterate brief instructions for expedient shelter.
- Reference public education materials that have been distributed.
- Be consistent with public education materials that have been distributed.
- Reference use of sheltering kits, recirculating filters, and respiratory protection devices if they have been distributed.
- Stress the importance of monitoring radio or TV broadcasts to receive exit shelter instructions. Mention tone alert radios only if update information will be broadcast on them.

Persons in shelters should monitor emergency public information (EAS messages and other emergency broadcasts) for information about when and how to end SIP and take notes about when to end SIP and what direction to travel for accountability and medical screening. If the capability exists, use a wireless connection to the Internet to monitor web sites that provide information about when and how to end SIP.

A telephone can be used in a shelter for a dire medical emergency or life-threatening situation (such as a fire). Local plans and public education materials should cover whom to call in the event of a medical emergency while sheltered and the likely range of responses. Emergency public information broadcasts (other than EAS messages) should reinforce the above information for the duration of the shelter period in a given ERZ.

It is safe to drink water and use the water system in the shelter. In fact, it is important that persons in shelters remain hydrated if possible. Snacking on available food is also encouraged, especially if it was in a sealed wrapper.

Persons in temporary shelter should remain calm and breathe normally to reduce exposure from inhaled vapors. The odds are good that persons in temporary shelters will avoid any physiological effects of agent exposure, especially if they end SIP when the air outside is predicted to be cleaner. Sheltered persons should remove or add outer garments to try to remain comfortable if the room gets warm or cool as might be expected for the season.

While in temporary shelter, persons should plan how they will end this protection when instructed to do so. This plan includes mentally reviewing the means of transport they will use and the route they will follow. Is there an extra can of fuel in the shed? Will it be needed if the available vehicle is low on fuel? Will looking for it delay relocation to a safer location?

Figure 7 Family in Shelter Noting Instructions to End SIP

4.2 What Not to Do While in Temporary Shelter

Do not use a telephone (land line or cell phone) while in temporary shelter except for a dire medical emergency or life-threatening situation (such as a fire). Telephone use should be limited to avoid saturating the service and thus interfering with communications essential to managing the response and responding to individual life-threatening situations.

It is recommended that a sealed shelter not be opened to allow entry or exit after the integrity of the shelter seal is established because there is some increased risk of infiltration of hazardous vapors. Thus, individuals in shelters have to decide for themselves if it is an acceptable risk to them to briefly open an entry to the shelter to allow someone to enter or exit after shelter integrity is established.

Occupants should not leave the shelter (or the room within the shelter that provides for the least air infiltration) for any reason other than an immediate life-threatening medical emergency, until instructed to do so. (If the choice is to leave the shelter to obtain treatment for a heart attack, or remain untreated in the shelter, obtaining medical treatment for the heart attack is probably the lesser risk if transportation is available to support this option.) The potential does exist for sheltered persons to exhibit some symptoms of nerve agent exposure, but this does not justify leaving the shelter before advised to do so. However, it would be useful to report this situation to local authorities.

Persons in temporary shelters should minimize strenuous activity that would increase breathing rates. Also, they should not operate flame-producing devices or appliances that produce carbon monoxide to produce light or heat in the shelter building.

5 Ending Temporary SIP Protection

5.1 Making Recommendations to End Temporary SIP Protection

Timing for ending SIP is most crucial for areas close to the source of the release, where dangerous concentrations are more likely to be encountered. The procedure for ending SIP should be able to distinguish between close-in areas and areas farther away from the release source, regardless of the boundaries of the ERZ used for initial protective action decisions.

If the release is caused by a large fire or a number of explosions involving VX or mustard agent-filled explosively configured munitions (a highly unlikely scenario), there is a potential for some agent to be transported as an aerosol and deposited as surface contamination on-post downwind from the accident site, as well as off-post in the vicinity of the installation. Even so, the greater immediate threat posed by this situation is the vapor hazard. This potential will need to be assessed by Army officials as a factor in recommending the exit of persons from nearby temporary shelters.

Army and off-post officials should begin to consider when to end SIP almost immediately after any protective action is recommended or implemented. The situation should be reviewed carefully at least every 15 minutes, on the basis of the latest information from the accident site, revised plume model results, and information about the progress in implementing ongoing protective actions (Wilson and Morrison 2000).

Responding rescue and site reconnaissance teams at the accident site can provide updates of initial reports that will help officials make decisions about when to end SIP. In the scenario described in Section 3.1, a report from the reconnaissance team 37 minutes after the explosion might confirm 9 damaged rockets that are leaking on a concrete surface, with liquid agent around the leaking rockets that will probably evaporate in the next half hour if nothing is done to mitigate the leaks. Debris can be seen that confirms the apparent detonation of two rocket warheads. One rocket cannot be accounted for yet. This

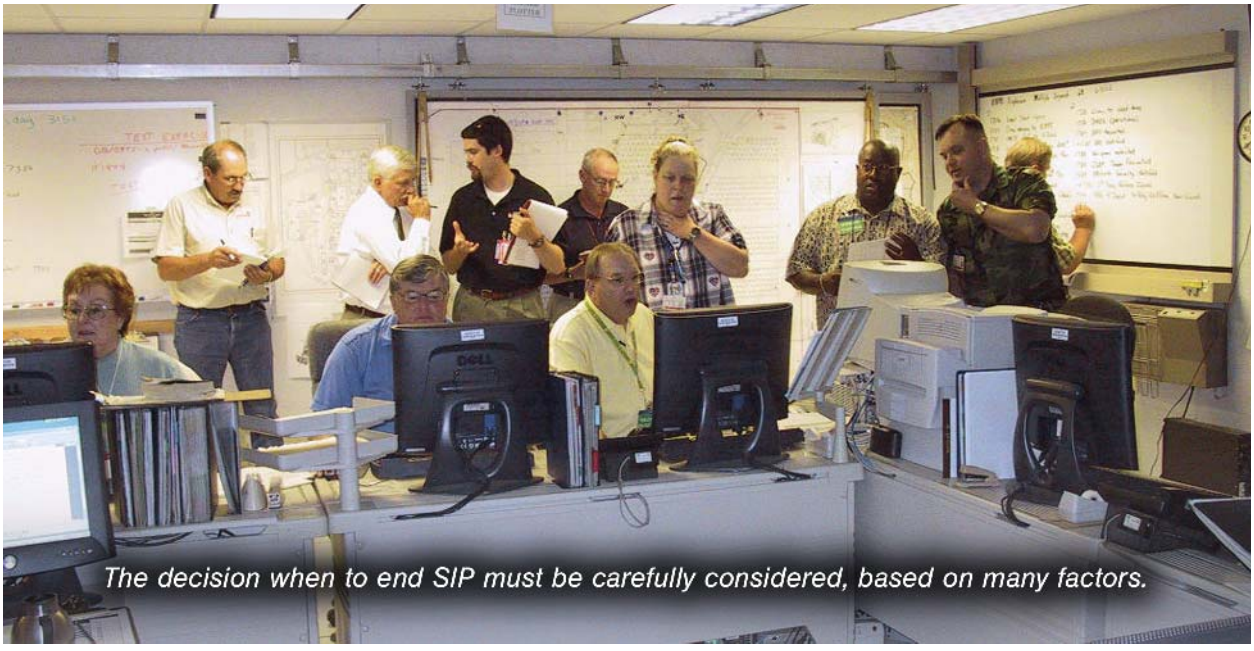


Figure 8 Deciding When to Recommend the End of SIP

additional information about the quantity of agent released and the type of release, along with current and predicted weather information available at the EOC, can be modeled to produce a definitive decision about when and how to end SIP. In this case, the optimum time to end SIP in ERZs next to the installation boundary might be 90 minutes after the explosion. The missing rocket will be found under a vehicle at the site during the more detailed reconnaissance done by Explosive Ordnance Disposal experts an hour later. It had been damaged and had leaked at least some liquid nerve agent.

Figure 8 shows hazard analysts and operations officers in the Army EOC discussing options to end SIP in ERZs that were affected by the accident.

Recommendations by the Army on when and how to end SIP will depend on several variables. Ventilation of the shelter is important if (1) the shelter is within the risk envelope and (2) the occupants are going to remain inside because they cannot exit. If they are going to exit or relocate, ventilation is not that important, and the additional time involved might result in additional harmful exposure in the process. In addition, some people might be reluctant to leave their homes unsecured and may delay their exit and relocation while they secure their valuables or collect their valuables to take with them. Options for how to end SIP are:

- Resume normal activities with no restrictions. Resuming normal activity with no restrictions would be an appropriate action for persons who were never in danger, but who were sheltered as a precaution. This option is the usual interpretation of "All Clear."
- Ventilate the shelter but remain indoors. In exceptional situations, the best action to end SIP might be to remain indoors but ventilate the building by opening doors and windows, removing tape and plastic installed during expedient sheltering, and turning on ventilation equipment. This option might be the only one for persons who lack the mobility to exit the shelter. This option also might apply when the weather is so dangerous that going outside the shelter is not an option, or when there is believed to be some other life-threatening hazard outdoors to be avoided.
- Exit the shelter and remain nearby. To decrease the overall exposure, it might be appropriate to instruct the public not to take the time to open windows, remove tape, and turn on ventilation equipment, among other tasks, before leaving the building. Rather, they should simply go outside and let the building ventilate itself gradually. The potential for aerosol deposition should be a minor consideration because it is such a remote possibility and not likely to be a safety factor at great distances from the source, even if an agent aerosol is generated by the event. This option might also be the best option for persons who lack transportation to relocate.
- Relocate to a designated facility. Local officials may direct that upon ending SIP, sheltered populations should relocate to designated facilities to be accounted for and medically screened for agent exposure symptoms. This would be most appropriate if the area where SIP was directed was within the footprint of the highest concentrations of the vapor plume, and SIP was not predicted to reduce potential exposure to the sheltered population in this area below the AEGL-2 threshold. In this case, the instructions would be to exit from shelters and proceed immediately to a place where this follow-up can occur if transportation is available. Instructions should identify the routes to take to avoid re-encountering the plume and to avoid traffic bottlenecks. Designated routes and facilities for relocation might not be the same as those for an initial evacuation. In dire circumstances, such as if the duration of the release is longer than originally expected and SIP is no longer a good choice, sheltered persons might be asked to relocate immediately to a safer place.

The end SIP time calculations made by the vapor plume model are calculated in one-minute increments, but the publicly announced end SIP time for each ERZ involves several considerations. One is the significance to public health and safety associated with each minute of time outside of the optimal time calculated by the model. If ending SIP at a time more than a minute or two outside of the calculated time is critical, then an extraordinary effort must be made to broadcast an exact time to end SIP and ensure timely implementation by including the current time in the broadcast — sort of a countdown to end SIP. Review of a sample of model runs to test the sensitivity of this timing suggests that ending SIP sooner than predicted is very risky, but an additional few minutes does not make a significant difference. A delay of fifteen minutes or more seems to begin to reduce the expected benefits associated with temporary SIP. This period might depend on the scenario, however, and is further complicated by the fact that this one time needs to be applied throughout an entire ERZ. Another consideration is the accuracy of timepieces available to those in temporary shelters. If most watches and clocks are assumed to be accurate to within a few minutes, then this is not an important consideration.

It seems reasonable to announce times to end SIP rounded up to the next quarter hour of the time calculated by the model. This offers the advantage of a time that is easier to communicate and remember. Informal conversations with CSEPP decision-makers over the years suggest that they would be comfortable with this approach. More than one remarked that parsing the end SIP time in notification messages to the exact nearest minute (if it were not necessary) could generate additional apprehension among the sheltered population. Therefore, it is suggested that Army recommendations to off-post officials to end SIP, and announcements to the public to end SIP, be based on the next quarter hour to the time calculated by the model.

An Army official should send updated PARs for off-post populations to off-post warning points immediately after the official determines the best time and way to end SIP in ERZs that were originally directed to take any protective action, regardless of whether the PAR was to evacuate or take SIP. This is illustrated in Figure 9.

Figure 9 shows the same form described in Section 3.1 now used for an update notification of the off-post warning point based on new information from the accident site. Again, the most important information is covered in the beginning of the message. This figure addresses the end SIP time only in ERZ B.

CHEMICAL EVENT NOTIFICATION FORM

ACTUAL: X EXERCISE: ____ REPORT DATE/TIME: 10/10/05 1037

Reporter: John Andrews Initial Report: ___ Update Report: #1

EVENT CLASSIFICATION LEVEL

Community Emergency: X Post-Only Emergency: _____

Limited Area Emergency: ____ Non-Surety Emergency: _____

AGENT: GB **DATE/TIME OF RELEASE:** 10/10/05 0955

TYPE OF RELEASE: Explosion and spill **WIND DIRECTION:** From 90 degrees

PROTECTIVE ACTION RECOMMENDATIONS BY ZONE

Evacuate Zones: None

Shelter Zones: Continue shelter in Zones A and D

End Shelter Zones and Times: Zone B East of SR 63 -- 1130, Zone B West of SR 63 -- 1145

Remarks: Event was reported at igloo C-2007. No aerosol deposition is expected off-post.

Figure 9 Update Notification of Off-Post Officials

5.2 Making Decisions to End Temporary SIP Protection

The confidence (or lack thereof) that decision-makers will have in deciding when to end temporary SIP will likely be based on the confidence they have understanding the concepts and methods used to characterize the release and the plume modeling based on the characterization. Therefore, plans and capabilities associated with these two processes must be refined and practiced more than any other component of the SIP strategy.

Decisions to end temporary SIP protection in off-post ERZs are expected to be based largely on the Army recommendations, assuming that agreements have been reached on the criteria that the Army will use for making the recommendations, and that there are no unusual conditions or circumstances (e.g., traffic or weather conditions) that would suggest otherwise.

Off-post officials are expected to make updated PADs about when and how to end SIP, broadcast alert signals, and complete the update notification about ending SIP within eight minutes after Army PARs about ending SIP are received. This includes the broadcast of a complete EAS message within these eight minutes if an EAS message is the primary notification mechanism (CSEPP 2006).

5.3 Announcing Direction to End Temporary SIP Protection

Direction to end temporary SIP is usually made by direct notification of the public through alert and notification systems and by EAS messages. The messages should be reinforced by immediate information given to media outlets. Including such information on a web site that offers emergency public health and safety information can further expedite the dissemination of these instructions. Such instructions should:

- Identify the authority for the end SIP instructions.
- Identify the areas where SIP should be ended.
- Stress the importance of prompt compliance.
- Include brief instructions for how to end SIP.
- Reference public education materials that have been distributed.
- Be consistent with public education materials that have been distributed.
- Reference use of respiratory protection devices after ending SIP, if they have been distributed for this purpose.
- Stress the importance of monitoring radio or TV broadcasts to receive updates about ending temporary SIP, where to go for accountability medical screening, and preferred relocation routes to take.
- Mention what to take when relocating — need only clothing to protect against the elements, vital medication, personal identification and credit cards, and prescription glasses if needed.

Emergency instructions about ending SIP must be consistent with public education materials (and vice versa). Instructions during an emergency should describe actions and choices that have been previously introduced in public education materials and use the exact terms and phrases used in these materials. Avoid terms and phrases that are ambiguous as to the best action to end SIP, such as "SIP is lifted" or "All Clear." Because of the short time available for messages on the EAS, sirens, and TARs, there is no opportunity for these messages to explain the practical meaning of such terms as "shelter-in-place" or "relocate." Their meaning must be explained and the groundwork laid for action ahead of time through an effective and comprehensive public education program.

Actual emergency instructions about ending SIP must be as clear, concise, and as unambiguous as possible, regardless of the scope and effectiveness of the public education program, because the

affected population will probably include some who were not reached by the SIP public education program, such as transients and new arrivals to the community. In addition, local officials and other credible community leaders should provide supplemental emergency information and explanation through media outlets to reinforce emergency instructions broadcast on alert and notification systems.

Instructions to the sheltered population should include the best time for ending SIP, the preferred way to end SIP, and alternatives if the preferred option is not possible. It should be remembered that instructions to end SIP are appropriate even for areas where evacuation was recommended, in the event that some persons could not or would not evacuate.

Figure 10 is a sample EAS message to instruct a population in one ERZ to end temporary SIP.

This type of message would begin to be broadcast once a decision was made for ending SIP in affected ERZs or parts of ERZs.

Local officials and other credible community leaders should continue to provide supplemental emergency information and explanation through media outlets to reinforce emergency instructions about ending SIP that are broadcast on alert and notification systems. During this period, some explanation should be provided to reinforce the need for the timely end of SIP and the options available for those who lack transportation or who cannot exit the shelter room or building, reinforcing the information provided in the public education program. Because it is likely that SIP will end in different ERZs at different times and for different reasons, this should also be explained.

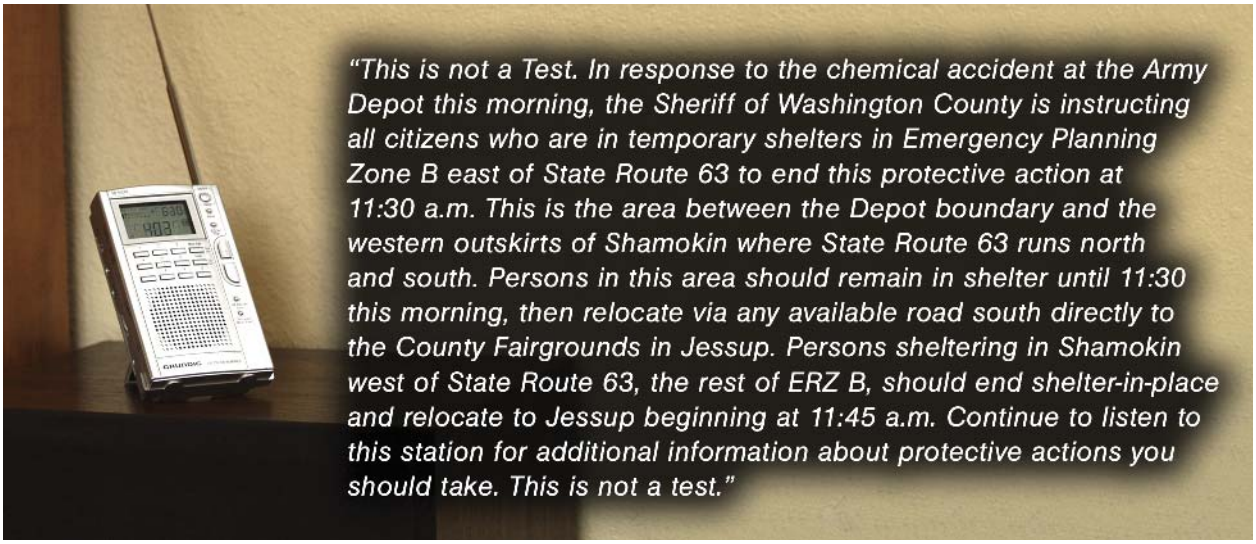


Figure 10 Sample EAS Message — End Temporary SIP

5.4 Expected Response to Direction to End Temporary SIP Protection

Most of the sheltered population can be expected to take immediate and appropriate steps to end SIP, especially if the public education program is effective. However, there probably will be some who will not or cannot follow the instructions. Thus, emergency instructions about ending SIP should be repeated regularly in affected ERZs, although modified as necessary, as long as anyone might remain in that area who needs to hear this information. Decision-makers should post TCPs and ACPs for both evacuation and temporary SIP to the extent that this is safe and practical, regardless of the emergency instructions that are broadcast.

5.5 What Not to Do When Ending Temporary SIP Protection

The "perfect" can be the enemy of the "good" with regard to actions to end SIP. Avoiding further exposure to residual hazardous vapors outweighs the lesser concern about contacting surfaces that might have been exposed to the vapor plume. If a sheltered population attempts to protect absolutely against any possibility of inhalation or contact with even one molecule of agent under any circumstances, the resultant delay in taking the actions that matter most might lead to unnecessary exposure in the most likely circumstances. Therefore, extraordinary precautions to avoid contact with exposed surfaces when ending SIP (e.g., wearing rubber gloves and boots) are not appropriate if they will delay exit from the shelter or relocating.

Collecting personal possessions that will probably be as secure if left behind is probably a waste of valuable time, assuming that the sheltered population is now relocating for accountability and medical screening. It is not necessary to open doors and windows, nor to remove expedient air exchange barriers from the shelter room, if the trade-off is to lose time in relocating.

If nerve agent vapors are the hazard of concern, there is no need to delay the ending of SIP to bathe or shower (or even to change clothes), unless a person is exhibiting agent exposure symptoms.[14] In that case, washing exposed skin and hair and changing outer clothing before ending SIP is reasonable if it can be done quickly just before the announced end SIP time, and if the new clothes have not been exposed to hazardous vapor. If mustard agent vapors are the hazard of concern, it might be prudent to quickly wash exposed skin and hair and change outer clothing to articles that were protected from airborne vapors in the shelter. This is because symptoms of exposure to mustard agent are not usually exhibited immediately upon exposure as is the case for nerve agent.

[14] Decontamination after exposure to vapor alone is probably not important if the person has been exposed to clean air for a period of 10–15 minutes, such as during movement from the site of exposure to a medical facility (Sidell 1995).

6 References

Blewett, W.K., D.W. Reeves, V.J. Arca, D.P. Fatkin, D.P., and B.D. Cannon, 1996, *Expedient Sheltering in Place: An Evaluation for the Stockpile Emergency Preparedness Program*, ERDEC.TR-336, June. (Cited in Section 1.4.2)

Blewett, W.K., and V.J. Arca, 1999, *Experiments in Sheltering in Place: How Filtering Affects Protection Against Sarin and Mustard Vapor*, ECBC.TR-034, June. (Cited in Sections 1.4.2 and 1.4.3.6)

Chan, W.R., P.N. Price, A.J. Gadgil, W.W. Nazaroff, G. Loosmore, and G. Suglyama, 2004, *Modeling Shelter-In-Place Including Sorption on Indoor Surfaces*, Lawrence-Berkeley National Laboratory, 2004. (Cited in Section 1.4.2 and Appendix A)

Chester, C.V., 1988, *Technical Options for Protecting Civilians from Toxic Vapors and Gases*, ORNL/TM-10423, Oak Ridge National Laboratory, Oak Ridge, Tenn., May. (Information on page 9 is cited in Section 1.4.2)

CSEPP: Chemical Stockpile Emergency Preparedness Program. Many of these references are found on the CSEPP Portal.

CSEPP, 2006, *CSEPP Planning Guidance*, March. (Cited in Section 1.2; Section III-A is cited in Section 1.4.3.1; Section III-B is cited in Sections 1.4.2 and 1.5.1; Sections III-D, III-E, and V-A are cited in Section 2.2; and Section V-A is cited in Sections 3.1, 3.2, 3.3, and 5.2)

CSEPP, 2006a, *CSEPP Programmatic Guidance*, March. (Cited in Section 1.2, Section V-E is cited in Section 1.4.2, and Sections V-A and V-B are cited in Section 2.2)

CSEPP, 2004, *Exercise Policy and Guidance for the CSEPP*, Sept. 7. (Section 4.2.4 and Appendix C are cited in Section 2.3.2)

CSEPP, 2004a, *Business Shelter-in-Place*, VHS and DVD format. (Cited in Section 2.3.1)

CSEPP, 2003, Policy Paper Number 20 (Revised), *Adoption of Acute Exposure Guideline Levels*, Feb. 24. (Cited in Sections 1.4.1 and 1.4.3.4)

CSEPP, 2001, *Report of the CSEPP Shelter-in-Place Work Group*, prepared by Shelter-in-Place Work Group, Dec. 3. (Appendix 1 is cited in Section 1.4.3, Section 2.2.5 is cited in Section 1.5.1, Section 3.2 is cited in Section 1.6, Section 4 is cited in Section 2.2, and Section 2.2.1 is cited in Section 3.2)

CSEPP, 2001a, *Residential Shelter-in-Place*, VHS and DVD format. (Cited in Section 2.3.1)

CSEPP, 1999, *Report of the Off-Post Monitoring Integrated Product Team*, prepared by Off-Post Monitoring Integrated Product Team, Jan. (Information on page 23 is cited in Section 2.1.1)

CSEPP, 1996, *Planning Guidance for the CSEPP*, May 17. (Cited in Section 1.2)

CSEPP, 1991, Policy Paper Number 1, *Definition of Maximum Protection*, May 7. (Cited in Sections 1.4.3.4, 1.5.1, and 2.1.1)

National Academies Press, 2003, *Acute Exposure Guideline Levels for Selected Airborne Chemicals, Volume 3.* (Cited in Section 1.4.1)

Innovative Emergency Management, Inc., D2-Puff™ User's Guide. This guide is available from the developer. (Cited in Appendix A)

Innovative Emergency Management, Inc., D2-Puff™ Reference Manual. This manual is available from the developer. (Cited in Appendix A)

Janney, C., M. Janus, L.F. Saubier, and J. Widder, 2000, *Test Report for the System Effectiveness Test of Home/Commercial Portable Room Air Cleaners*, Battelle, Bel Air, Md., April 27. (Cited in Section 1.4.3.6)

Hauschild, V., 2002, Presentation on Acute Exposure Guideline Levels, AEGL Conference, U.S. Army Center for Health Promotion and Preventive Medicine, August. (Cited in Section 1.4.1)

Lerner, K., M.B. Vasco, and G.D. Yantosik, G.D., Argonne National Laboratory, Argonne Illinois,1999, *Chemical Stockpile Emergency Preparedness Program Memorandum of Agreement and Memorandum of Understanding Guide*, May. (Cited in Section 2.1.3)

Metz, W.C, N. Malik, E. Tanzman, and S. Filer, 2004, "Reassessing Materials for Use by Persons With Special Needs to Expediently Shelter In Place," *Journal of Emergency Management* 2(2):, Spring. (Cited in Section 1.5.3)

Myirski, M., 2000, presentation on Shelter-In-Place to CSEPP Planners, 18 July. (Cited in Section 1.4.2)

NICS: National Institute for Chemical Studies

NICS, undated, pamphlet titled *Shelter In Place.* (Cited in Section 1.4.2)

NICS, 2001, *Shelter In Place as a Public Protective Action.* (Cited in Section 1.4.2)

NICS, 1999, *Shelter In Place at Your Office.* November. (Cited in Section 2.2)

NewScientist.com, 2005, *Evacuation Not Best During a Chemical Incident*, 24 June. (Cited in Section 1.4.2)

Rogers, G.O., A.P. Watson, J.H. Sorensen, R.D. Sharp, and S.A. Carnes, 1990, *Evaluating Protective Actions for Chemical Agent Emergencies*, ORNL-6615, Oak Ridge National Laboratory, Oak Ridge, Tenn., April. (Cited in Sections 1.5.3 and 2.1.1)

SAIC: Science Applications International Corporation

SAIC, 1996, *Agent Aerosol/Vapor Distribution Following Munition Explosion*, SAF-452-96-0043. (Cited in Section 1.5.1)

Sidell, F.R., 1995, *Management of Chemical Warfare Agent Casualties: A Handbook for Emergency Medical Services*, Bel Air, Md., Oct. (Cited in Section 5.5)

Sorensen, J.H., B. Shumpert, and B. Vogt, 2002, *Planning Protective Actions Decision-Making: Evacuate or Shelter-In-Place?*, ORNL/TM-2002/144, Oak Ridge National Laboratory, Oak Ridge, Tenn., June. (Cited in Sections 1.4.2, 1.4.3.4, 1.5.1, and 2.1.1)

Sorensen, J.H., and B. Vogt, 2001a, *Expedient Respiratory and Physical Protection: Does a Wet Towel Work to Prevent Chemical Warfare Agent Vapor Infiltration?*, ORNL/TM-2001/153, Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. (Cited in Section 3.5)

Sorensen, J.H., and B. Vogt, 2001b, *Will Duct Tape and Plastic Really Work? Issues Related to Expedient Shelter-In-Place*, ORNL/TM-2001/154, Oak Ridge National Laboratory, Oak Ridge, Tenn., Aug. (Cited in Section 1.5.3)

Time, 2005, "How to Get Out Alive," pp. 59–62, May 2. (Cited in Section 2.3.1)

USACHPPM: U.S. Army Center for Health Promotion and Preventative Medicine

USACHPPM, 2003, *Basic Facts Regarding Chemical Exposure Standards and Guidelines*, Jan. (Cited in Section 1.4.1)

U.S. Army, 1993, Memorandum from the AMC Assistant Deputy Chief of Staff for Chemical and Biological Matters, 1993, AMC CSEPP Guidelines for Early Information Exchange with Off Post Communities, Sept. 8. (Cited in Section 1.4.4)

U.S. Army, 2003, *Chemical Accident or Incident Response and Assistance Operations*, Department of the Army Pamphlet 50-6, March 26. (Paragraph 3-5b on page 23 is cited in Section 1.4.3.4, paragraph 3-4c(5) on page 21 and paragraph 3-5c(5) on page 25 are cited in Section 1.4.2, and paragraph 3-2b on page 15 is cited in Section 3.1)

Vogt, B.M., H. Hardee, J.H. Sorensen, and B.L. Shumpert, 1999, *Assessment of Housing Stock Age in the Vicinity of Chemical Stockpile Sites*, ORNL/TM-13742, Oak Ridge National Laboratory, Oak Ridge, Tenn., April. (Cited in Appendix A)

Wilson, D.J., and B. Morrison, 2000, "Ordering Shelter or Evacuation During an Outdoor Toxic Gas Release Incident: The Canadian Association of Fire Chiefs Decision Flow Chart," presented at Fire-Rescue 2000 Annual Meeting of the Canadian Association of Fire Chiefs, Montreal, Aug. 13–16. (Cited in Section 5.1)

Yantosik, G.D., K. Lerner, K., and D.M. Maloney, 2001, *Temporary Shelter-in-Place as Protection Against a Release of Airborne Hazardous Material; Report of a Literature Search*, Argonne National Laboratory, Argonne, Ill., March 16. (Paragraph 3.5.2 is cited in Section 1.5.1)

Yantosik, G.D., D.M. Maloney, and F. Wasmer, 2003, *Comparison of Two Concepts and Methods to decide When to End Temporary Shelter-In-Place Protection*, Argonne National Laboratory, Argonne, Ill., July 26. (Cited in Sections 1.4.3, 1.4.3.7, and 1.4.4).

Appendix A

Modeling to Determine When to End Temporary Shelter-in-Place Protection

Shelter-in-place (SIP) is a practical option for protecting a population from exposure to the hazardous vapor plume resulting from a chemical release at an Army chemical storage site; however, one cannot assume that once people are inside their shelters they are fully protected. Because chemical vapors seep into structures used as shelters, ending SIP at an appropriate time can be as important as taking shelter. Computer models can help decision makers determine when the population of a zone should exit or ventilate their shelters. The D2-Puff™ model version 5.5[15] includes three algorithms for calculating the best shelter exit time for a sheltered population in each zone that is predicted to be affected by the vapor hazard. The method used by D2-Puff™ can be configured by an administrator.

A.1 D2-Puff™ Algorithms for Computing Best Exit Shelter Time

The first algorithm implemented in D2-Puff™ compares indoor concentration to outdoor concentration. This method captures the time at which indoor concentration exceeds outdoor concentration for each location in the zone. Then the algorithm averages these times to get the average best shelter exit time for the zone. This is a simple method that is computed very quickly.

The second and third algorithms are more sophisticated. They focus on choosing the time that minimizes average exposure across the zone. One of these algorithms minimizes dosage as measured by the Acute Threshold Effect Levels (ATEL), which was the military standard used in CSEPP until the adoption of Acute Exposure Guideline Levels (AEGLs). The other algorithm minimizes exposure as measured by the newer AEGL standard. Minimizing exposure is preferred to simply comparing indoor and outdoor concentrations because it takes into account the duration of exposure to the agent.

Of the two methods that minimize exposure, the algorithm that minimizes AEGL is preferred. The AEGL methodology gives a better indication of the effects of nerve agent over time because the older ATEL standard is linear (concentration × time or Ct). The effects of nerve agent exposure are not linear. In other words, it is not the case that exposure to a low concentration over a long period produces the same effect as being exposed to a higher concentration for a shorter period.

The D2-Puff™ approach to deciding the best shelter exit time using AEGLs is to use the plume concentration-time history from the model in combination with IEM's AEGL dose-response relationship algorithm. Nonlinear exposure effects are considered in D2-Puff™ by comparing the duration of exposure to the AEGL-3 standard. This is the recommended algorithm for determining the best shelter exit time.

[15] Version 5.5 was the version current when this guide was prepared. Additional information about D2-Puff™ can be found in *D2-Puff™ User's Guide* and *D2-Puff™ Reference Manual*.

A.2 Challenges of Determining Best End Shelter Time for a Zone

Determining the best end shelter time for a zone is more complex than determining the optimum time for people in one shelter to end SIP. Two of the most important challenges to address when determining the best time to end SIP are the length of zone and the different air exchange rates of structures in the zone. The following explains the challenges of determining when to end SIP and how the D2-Puff™ model addresses each of these issues.

A.2.1 Length of a Zone

The length of the zone refers to the dimension of the zone in the downwind direction. The optimum time to end SIP is not the same for people on the leading edge of the zone, where the plume arrives first and leaves first, as it is for people on the trailing edge of the zone. The longer the zone, the greater the difference between the optimum times for ending SIP at the opposite ends of the zone. The length of the zone accounts for the greatest difference in optimum end SIP times for structures within a zone. Because emergency managers typically issue protective action instructions for the zone as a whole rather than for parts of the zone, the challenge for the model is to determine the best time for residents in all locations in the zone to end SIP.

The D2-Puff™ approach to determining the single best time to end SIP for an entire zone, not just a specific location or individual shelter in a zone, is to determine the time when ending SIP will result in the lowest average exposure to chemical agent as compared with the AEGL-3 threshold. The calculation assumes that everyone in the zone ends shelter at the same time. The model calculates the exposure that a person would get at each location in the zone, and the algorithm picks the time that gives the lowest average exposure, as compared to AEGL-3 threshold, as the best exit shelter time.

The goal of the algorithm is to avoid fatalities to the maximum extent practicable. D2-Puff™ does not directly estimate fatalities; however, because AEGL-3 is associated with the possibility of death in some sensitive individuals, using this standard is approximately the same as minimizing deaths.

A.2.2 Different ACH Rates

The issue of different air exchange rates, expressed in this guide book as ACH, refers to the level of protection provided by different structures within a zone. As the chemical agent plume passes over an area, a structure with a lower ACH allows less of the agent to seep in, thus providing better protection for persons inside. Because emergency managers are faced with issuing one shelter exit time for all residents, the challenge becomes determining a time that is appropriate for residents in all types of structures.

The D2-Puff™ approach to deciding the best time to end SIP when not all shelters in an Emergency Response Zone (ERZ) provide the same level of protection against vapor infiltration, and the actual ACH of shelters in a zone cannot be known with certainty, is to use a default of 1.96 ACH for all shelters in the zone[16]. This ventilation rate covers 90% of typical housing.[17] In other words, 90% of typical housing is less leaky and thus provides better protection than structures with an ACH of 1.96.

[16] 1.96 is the default ACH used by D2-Puff™. This value can be changed if the distributions of ACH for the site are determined to be significantly different than generally assumed.

[17] See the Case Study described in Chan (2004) for a way to calculate the protection offered by local housing stock and Vogt et al. (1999) for information about the age of housing stock in the vicinity of chemical storage sites.

Using an ACH that is leakier than 90% of typical housing in essence biases the calculation of the best shelter exit time in favor of the residents in the leakiest shelters. This may seem counterintuitive given that most sites have distributed SIP kits and encourage residents to do whatever they can to reduce the ACH in their home. It may seem more reasonable to base the calculation on the average assumed for the site. However, while the level of protection provided can be quite different for the leaky structure and the tighter one, the optimum shelter exit time for the two structures is actually very close. Biasing the calculation to favor those in leaky structures provides the greatest benefit from SIP to the most vulnerable residents with very little cost in terms of ending shelter prematurely for residents in tighter structures.

The default ACH used by D2-Puff™ is considered to be conservative because it gives a conservative estimate of the reduction in exposure that is provided by shelters. It can be assumed that persons in tighter shelters will get more protection than that calculated by D2-Puff™.

A.3 Examples of Determining Best End Shelter Time for a Zone

The following graphs show results for a hypothetical release[18] that helps illustrate the points just made. Figure A.1 shows how concentrations vary with time at a location 5 km downwind of the release. Curves are drawn for outside concentration and for concentration inside shelters having air exchange rates of 1.96 ACH, 1 ACH, and 0.5 ACH. Notice that the peak concentration in all of the shelters is much less than the peak concentration outside, but that agent lingers in the shelters long after the outside plume has left the area. The best time to leave each shelter is the time when the concentration outside has dropped below the concentration in that shelter. These times are shown in Table A.1. There is only about a 2.5-minute difference between the times for the shelters shown — a very short time considering the ability of people to end SIP at an exact time. Furthermore, such a small time difference does not significantly change the amount of protection the shelters offer.

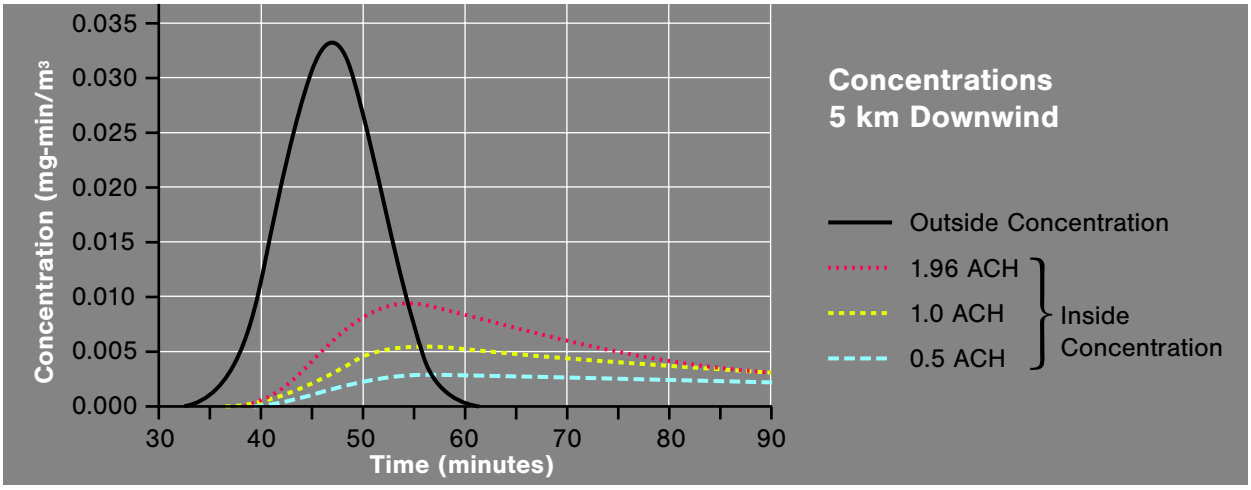


Figure A.1 Concentrations 5 km Downwind

[18] These graphs were drawn for the case of 5 kg of VX released semicontinuously over a 10-minute period. The wind speed was 2 m/s, with Pasquill stability class D. Different release conditions or weather conditions would change the graphs and numbers shown, but it is generally true that shelters with different air exchange rates have similar best times to end SIP and that differences in downwind distance produce larger changes in the time to end SIP than differences in air exchange rates.

	Outside	1.96 ACH	1 ACH	0.5 ACH
Best time to end SIP (hours:minutes:seconds)		0:54:06	0:55:25	0:56:39
Dosage (mg-min/m^3)	0.391	0. 02	0.062	0.036
AEGL	3	2		
Dosage/AEGL-3	.26	0.34	0.20	0.
Dosage Reduction		73%	84%	9 %
Protection Factor		3.7	6.2	.

Values
5 km Downwind

Table A.1 Values 5 km Downwind

Table A.1 and Figure A.2 show the amount of protection provided by the various shelters. Even the comparatively leaky shelter with 1.96 ACH reduces the dosage by 73% and lowers exposure from AEGL-3 to AEGL-2. A shelter with 0.5 ACH is able to reduce dosage by 91% and lower exposure from AEGL-3 to AEGL-1.

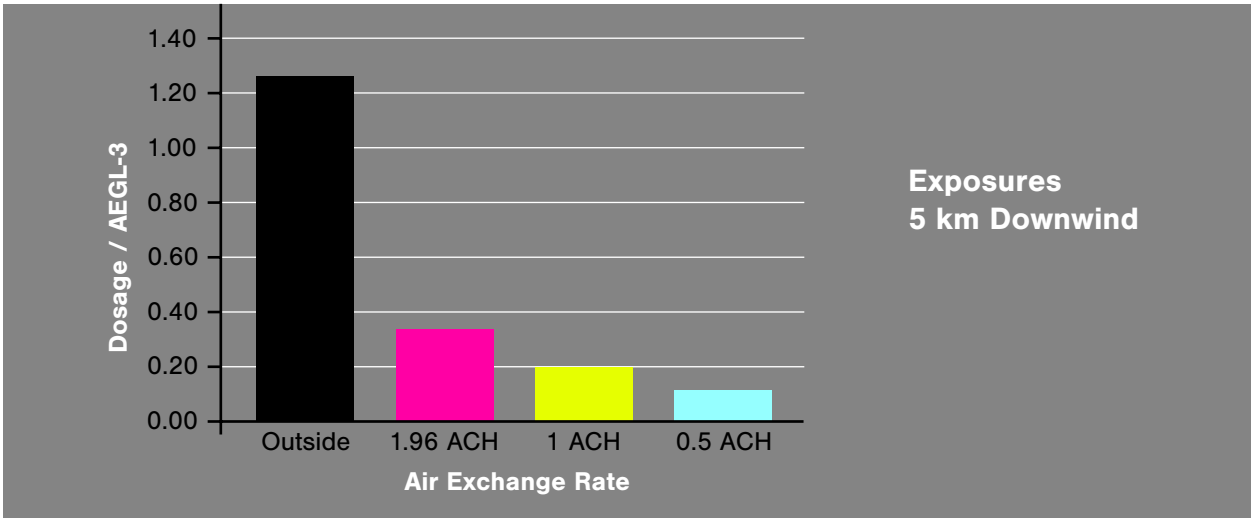


Figure A.2 Exposures 5 km Downwind

Figure A.3, Table A.2, and Figure A.4 show information for the same release but for a location 6 km downwind. The results are very similar to those at 5 km. The main difference is that the best times to exit shelter are about 9 minutes later at 6 km than at 5 km. This illustrates the point that differences in location are more important than differences in air exchange rates when determining times to end SIP. Considering the limited ability of emergency managers to control exactly when people end SIP, a 9-minute difference is not large; however, 10 km downwind the best times to exit shelter are 42–46 minutes later than at 5 km, which is a significant difference.

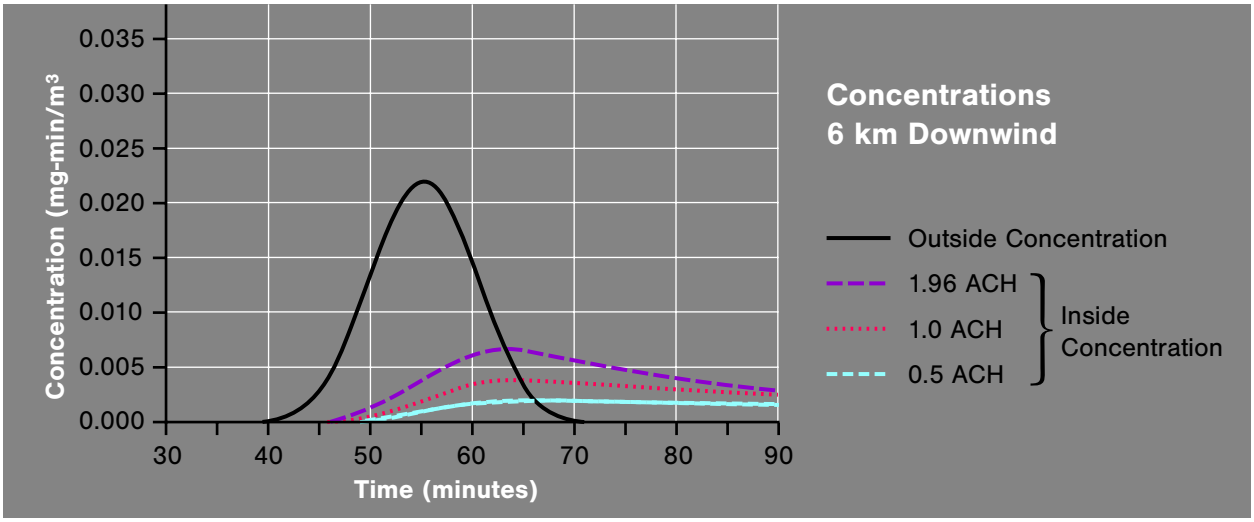


Figure A.3 Concentrations 6 km Downwind

Table A.2 shows that persons in a shelter with 1.96 ACH reach AEGL-2, which is the same AEGL experienced by people outside. However, the dosage in the shelter is reduced by 71% compared to the dosage outside. People outside are exposed in the upper part of the AEGL-2 range, nearly to AEGL-3, while people inside the shelter just barely exceed AEGL-2, thus the shelter gives considerable protection. Fewer people within the shelter would experience symptoms and their symptoms would be milder. Shelters with lower air exchange rates reduce exposure to the AEGL-1 range.

Values
6 km Downwind

	Outside	1.96 ACH	1 ACH	0.5 ACH
Best time to end SIP (hours:minutes:seconds)		1:02:57	1:04:29	1:05:56
Dosage (mg-min/m³)	0.284	0.080	0.049	0.029
AEGL	2	2		
Dosage/AEGL-3	0.89	0.26	0. 6	0.09
Dosage Reduction		71%	82%	90%
Protection Factor		3.5	5.7	0.

Table A.2 Values 6 km Downwind

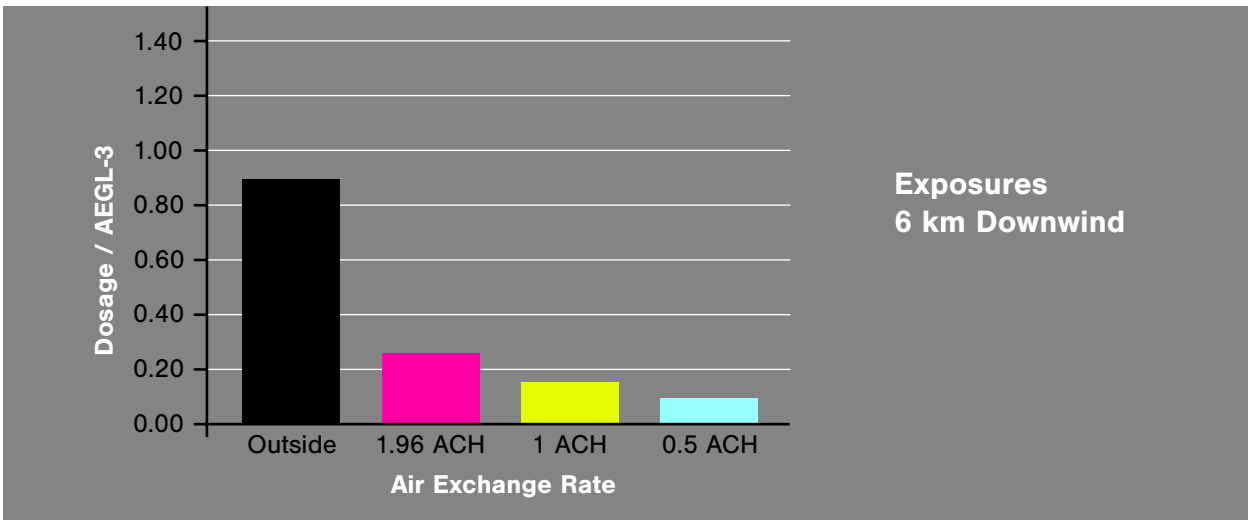


Figure A.4 Exposures 6 km Downwind

Figure A.5 shows how good a job sheltering does at protecting various locations in a zone. The zone is between 4000 meters and 7000 meters from the chemical storage area and the release and weather conditions are the same as were used in Figures A-1 through A-4. The top (dark green) line shows the exposure received outside in this zone at various distances from the storage area. In this case, the average exposure across the zone is minimized if sheltered persons in the zone end SIP 52 minutes after the release (blue line). If everyone in the zone waits until the zone tail time (82 minutes), the exposure shown by the red line results. The lowest line (light green) is the exposure that would be received if persons in each shelter ended SIP at the best time for each shelter. This cannot be done in practice, but the curve is useful as a comparison with an idealized maximum benefit from sheltering.

If no sheltering is done AEGL-3 extends out to 5600 meters. Sheltering everyone until the tail time departs from the ERZ is effective in this example, reducing exposure everywhere in the zone to below AEGL-3. This is not always the case. Sheltering everyone until the best exit time for the zone is even more effective, reducing exposure to less than 75% of AEGL-3 everywhere in the zone and approaching the ideal best benefit from sheltering for people closer than 5000 meters.

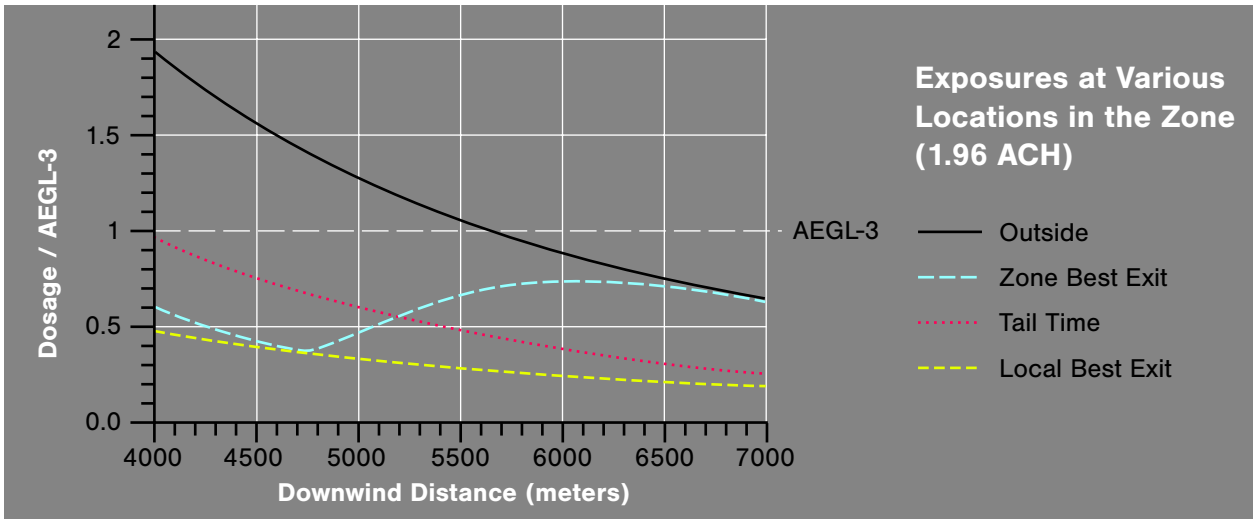


Figure A.5 Exposures at Various Locations in the Zone — 1.96 ACH

When SIP is ended at the single best time for the entire zone, people closer than about 5500 meters get considerable benefit from sheltering, while people farther away get less benefit.

Waiting until the tail time departure from the ERZ to terminate SIP is not advisable. It reduces the exposure for people past 5500 meters, but does so at the cost of considerable increase in exposure to people closer to the source. The only way to increase protection for people beyond 5500 meters without increasing the danger to people closer to the source would be to have the people closer than 5500 meters end shelter at 52 minutes and have the people beyond 5500 meters end shelter at a later time more appropriate for them.

All of the curves in Figure A.5 are based on shelters with 1.96 ACH. Figure A.6 shows the benefit sheltering provides for people with other air exchange rates. Curves are shown for air exchange rates of 1.96, 1.0, and 0.5 ACH. The curves for a zone-wide best time to end SIP are based on everyone ending SIP at 52 minutes. As expected, people in the most air-tight shelters get the best protection. Use of a shelter exit time based on shelters with 1.96 ACH gives good protection to people in shelters having all of these air exchange rates, and the protection is near ideal for shelters closer than 5000 meters to the source.

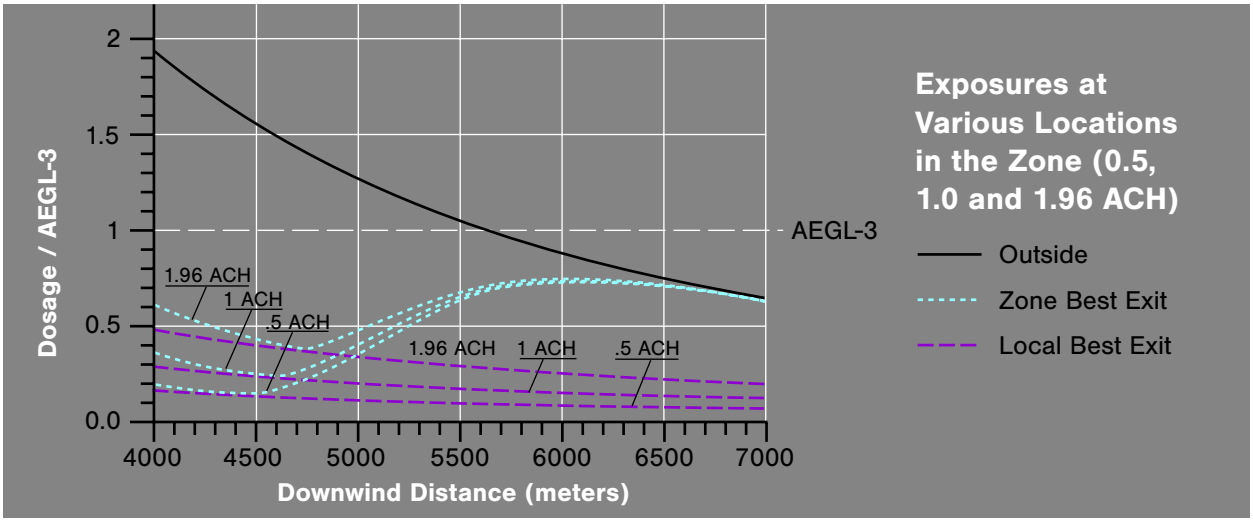


Figure A.6 Exposures at Various Locations in the Zone — 0.5, 1.0, and 1.96 ACH

A.4 Other Factors that Determine Optimum Times to End SIP

The irregular distribution of the population in a zone can influence the best time to end SIP for that zone. People are often clustered around population centers rather than evenly distributed across the entire zone. Deciding when to end SIP in a zone where (1) the population distribution is not evenly dispersed and (2) subdividing the zone is not an option is a difficult challenge regardless of the method used for decision-making, especially if there is a small area of very dense population at either end of the zone. In computing the best time to end SIP for an entire zone, the D2-Puff™ model version 5.5 assumes that the population is distributed evenly in each zone. If subdividing the zone is not an option, it may be better to consider designating each population center as a discrete receptor for which model output can be obtained.

D2-Puff™ considers the potential for exposure during and after SIP when calculating the best

time to end SIP. While exposure before entering the shelter does affect the total amount of exposure for an individual, the model assumes that persons will be sheltered before the plume arrives at their location, thus any slight exposure prior to SIP has little effect on the best time to end SIP.

The effects of potential agent vapor adsorption by shelters and their contents and the reduction of hazardous vapor by using recirculating filters in shelters are difficult to determine for a zone containing many different types of structures. These factors are not considered by D2-Puff™ model version 5.5.

Appendix B

Hypothetical Case Study Illustrating the Use of Temporary Shelter-in-Place Protection

Much of the advice in this guide book can be illustrated by describing a response to an accidental release of chemical agent from an Army chemical stockpile storage site from the perspective of a family living near the depot. The event discussed in this hypothetical case study affects the population in a community that is mostly prepared, as described in this guide book. This means Army and off-post emergency managers and CSEPP planners have coordinated and synchronized plans to respond to an accident or incident at the depot, and officials have signed agreements to ensure the expeditious implementation of the plans. Systems are in place to alert and notify the population living and working on and around the depot. Public education efforts in the community are (1) consistent with plans and the needs of the population at risk and (2) continuously updated and reinforced. Training and exercises to support the community SIP strategy are done regularly and are highly visible to the community at large.

The hypothetical event in this case study is an accidental explosion during the handling of nerve-agent-filled munitions on a weekday morning when the weather is quite cool. The scenario involves a family living in Shamokin, a small town in Washington County close to the western boundary of the depot. This community is in ERZ B. The family home is a small, old but well-maintained two-story wood-frame structure that has had recent weatherization improvements. There is a carport adjacent to the house, but no garage. A tone alert radio (TAR) is installed in the living room. A SIP emergency kit is stored beneath the sofa in this room, but it has never been opened since it was obtained more than a year ago.

The family discussed in this case study includes one stay-at-home parent, one wage-earner who works at a construction site many miles away, four children, and an elderly handicapped great-grandparent. We will call them the Sanderson family. A dog named Nikki lives with them. On this day, three children are in school, two at a grade school in the same ERZ in which they live, and the other is at a junior high school in a different ERZ to practice for a statewide scholastic program. The toddler is at home with the stay-at-home parent and the great-grandparent. The working parent is at the job site. The parent at home usually has a car available. However, a cousin who lives in another state just arrived for a one-week visit and is currently at a nearby convenience store with the family vehicle.

Because the family lives so close to the Army depot they have a heightened awareness of the potential for being affected if a chemical accident should occur. Thus they pay close attention to public education programs about protecting themselves in an emergency. For example, they know they are in ERZ B and will be alert to protective action instructions for that ERZ. The children practice at school how they would be protected if they were there when the release occurred, and the parents were also briefed on the protection the children would be given. As a result, the parents are confident that this protection would be adequate, and know they should not go to the school during an emergency.

The family knows the TAR works because they have heard tones and messages during tests. Family members also heard the alert sounds on a nearby outdoor siren, but were never able to hear clearly the messages that were broadcast. Based on the public education program, the family believes that if the siren or the TAR sounds they need to listen for an EAS message to find out what to do. The family keeps a CSEPP calendar in the kitchen and knows that an evacuation route is posted on the back page. The parents even drove the evacuation route northwest to Bloomington

once on a weekend recreation drive. The adult family members know that annual emergency response exercises are conducted by emergency managers in their community, but they did not get feedback about how the towns-people (and they, themselves) would have fared had the emergency been real. They talked once about rehearsing their family emergency plan the next time tone alert radios and sirens are sounded for a test, but have not done this.

Perhaps most importantly, the family recognizes that their best protection from a chemical release at the depot might be to take temporary SIP in their home, because there might not be time to evacuate (or transportation might not be available), and because they learned they could quickly improve the air tightness of a portion of the house to give them greater protection against harmful vapors while the plume passes by. The family selected the small bedroom on the first floor (the room occupied by the handicapped great-grandparent) and an adjacent bathroom as the shelter location they would use in an emergency because the rooms provide enough space for the whole family and offer the best accommodations for the grand-grandparent.

Do their efforts at preparedness pay off? Let's see.

9:55 AM

The accident occurs, and workers at the site report what they know immediately to the depot EOC, which is staffed by trained operators 24/7.

10:00 AM

After considering the circumstances, an Army official notifies the Washington County off-post warning point about the accident and recommends specific protective actions in several ERZs, to include temporary SIP for all of ERZ B. The Washington County warning point is also staffed 24/7.

10:05 AM

On the basis of previous agreements, and with consideration for any unusual conditions that are present in the community at the moment (e.g., inclement weather or traffic problems), county officials agree with the Army recommendation that persons in ERZ B take temporary SIP. The agreements also provide for the Army to activate off-post TARs and sirens under certain circumstances.

10:06 AM

Washington County officials activate TARs and sirens to alert the population in ERZ B and elsewhere. Schools and other special facilities are notified via a call-down system. Steps are begun to initiate the broadcast of EAS messages that will include instructions for ERZ B. The Sanderson parent and toddler who were outside at the time teaching Nikki to retrieve a ball immediately go inside when they hear the siren. The TAR in their living room also is activated, confirming the need to take shelter.

10:07 AM

School officials in ERZ B automatically begin to shelter students, based on plans and agreements that this is the preferred protective action when school is in session, unless directed otherwise.

10:08 AM

The first EAS message for ERZ B is broadcast. The three Sanderson family members who are at home assemble in the great-grandparent's bedroom and hear the message on the radio. Nikki is brought into the room.

10:09 AM

The adult Sanderson begins to close all doors and windows and turns off the forced hot-air heating system. This takes less than two minutes because it is a cool day, and only one window was open. They also closed all the interior doors throughout the house, even though there is nothing in the public education materials about doing this. A mental note is made to ask about this, if they survive.

10:11 AM

The adult Sanderson begins to apply expedient improvements to make the bedroom and bathroom more airtight, using materials in the SIP emergency kit. The sheet plastic was not pre-cut to the openings that needed to be sealed, so some time was lost at the outset just to cut the plastic to a usable size without the benefit of a ruler or tape measure. The electrical receptacles could have been covered directly with duct tape to save time. Instead, plastic squares were cut to cover the receptacles. The biggest challenge was to cover the two window openings because the drapery hardware had to be removed first. Without the availability of hand tools and a step stool, a folding chair was used to reach the hardware and it was pulled off by hand. A small laceration of the thumb and damage to the wall was the price paid for this effort.

10:13 AM

All school students are now in sheltered rooms. All students and school staff are accounted for.

10:19 AM

The Sanderson family member working away from home attempts to call home to confirm the family is safe; all lines are busy. After several more attempts, he remembers being told that such calls are discouraged because they tie up phone lines and might interfere with response and rescue operations in his family's neighborhood.

10:25 AM

All of the openings in the Sanderson bedroom and bathroom are now closed and sealed with plastic and duct tape, except that the bathroom vent built into the light fixture in the shower stall was overlooked. Days later, when the Sandersons remembered this oversight, they wished they had taken the time to cut the plastic to size in advance and marked the pieces for the various openings. Ideally, each piece of plastic would have been about six inches larger on each side than the opening to be covered, to allow for ease of installation and to ensure openings would be sealed well at their periphery. They also should have rehearsed their whole sheltering process. This would have cut time off of their response, and they might not have overlooked the vent in the bathroom if they had practiced in a less-stressful environment.

10:26 AM

The cousin who was at the convenience store arrives home with two acquaintances and seeks entry. The seal on the door to the bedroom is broken briefly to allow them into the shelter area.

10:27 AM

An emergency news broadcast announces that all students and staff in the Shamokin area school district are accounted for and are safe in shelter. Washington County officials made this announcement to reassure their parents and guardians and remind them not to go to the school. No mention is made about the junior high school in the other ERZ, but that ERZ is east of the depot and has not been identified so far as subject to protective action instructions.

10:32 AM

An update report from the accident site gives Army officials enough information about the event to begin to consider when to end SIP both on-post and off-post in ERZs where temporary SIP might have been taken to protect against effects at or greater than the AEGL-2 threshold.

10:37 AM

Army officials recommend to the Washington County Incident Commander that SIP end at 11:30 am in ERZ B east of State Route 63 and at 11:45 am in ERZ B west of State Route 63. This recommendation includes an explanation that aerosol deposition is not a concern off-post. Thus, the best actions are those that will avoid exposure to any residual vapors that might have infiltrated shelters and to avoid higher concentrations of the plume by relocating away from the direction of the plume travel. In the case of ERZ B, the recommendation is to relocate south toward Jessup, rather than to go northwest toward Bloomington.

10:42 AM

The Washington County Incident Commander, in consultation with Army and elected county officials, decides to relocate the citizens sheltered in ERZ B south to the Washington County Fairground in Jessup for medical screening and accountability at the times recommended by the Army.

10:45 AM

The Washington County Incident Commander begins to direct adjustment to TCPs and ACPs to support the relocation of the sheltered population in ERZ B. However, the Incident Commander asks that public announcements about ending SIP in ERZ B not begin until 11:15 am to discourage persons from leaving too soon and to give time for TCPs and ACPs to get into position.

10:49 AM

Power to the Sanderson's neighborhood goes out because a motor vehicle accident two streets away takes out a power line. The Sandersons are now dependent on a flashlight for light and a battery-powered radio to listen to emergency information broadcasts. Fortunately, the batteries in both are fresh, but they have no spares. Will they last several hours? Also, they find that the extension phone in the bedroom that stopped working last month still does not work.

11:15 AM

EAS messages and other emergency instructions broadcast on radio and TV begin to instruct persons sheltered in ERZ B about when and how to end SIP. These broadcasts are heard by the Sandersons in their shelter, who know they are in ERZ B.

11:30 AM

The Sanderson family and their guests exit their shelter room and the house. They opt to leave the house secured (locked the doors) rather than ventilate the structure. Fortunately, the great-grandparent was not home alone and could be taken to Jessup. Otherwise, she would have had to remain at home and probably do no better than to open her two bedroom windows when instructed to end SIP. Even this would have been a good move.

11:32 AM

When the Sandersons and guests went to their car to relocate, they wondered if it was safe to contact exposed surfaces on and in the car without wearing rubber gloves and boots and considered looking for plastic to put on the car seats. They recalled the public education advice that vapor was the greatest hazard, and that relocation was the priority, so they did not delay in entering the car without special precautions. They did debate about whether to drive with the windows and vents open or closed. They decided to drive with the windows and vents open. Their rationale was that the car was outside and vulnerable to agent vapor infiltration while the plume was passing. Therefore it would be better to drive with the windows open to ventilate any residual vapors in the car.

11:33 AM

The Sandersons are momentarily confused when they begin to drive away from their home. They forgot where to go other than it is someplace besides Bloomington as instructed in the CSEPP calendar. Fortunately, the great-grandparent wrote the end SIP time and relocation destination on a note when they heard the EAS message while in their shelter, and they departed for the Fairground in Jessup with little delay. This destination was confirmed when the EAS message was repeated on the car radio a few moments later.

12:17 PM

The Sandersons and guests arrive at the entrance to the Washington County Fairground in Jessup. At the first checkpoint, they are asked where they came from, when and how they were sheltered, and what route they had driven. Each is checked for agent exposure symptoms. They are relieved when told that because they had no symptoms of exposure, and had been in clean air for at least the last half hour, they almost certainly were not exposed to any agent that would constitute a health problem. The screening might have been different had the hazard been a mustard agent vapor, where symptoms of exposure might not be manifest immediately, as is usually the case with nerve agent.

12:23 PM

The Sandersons and their guests are offered the opportunity to stay in the temporary shelter at the Fairground Exhibition Hall. Nikki, however, would have to go to a temporary kennel being set up by the County Veterinarian Association at the opposite end of the Fairground.

12:43 PM

The Sandersons and their guests register at the Exhibition Hall, providing their names and phone numbers for accountability and for posting to a list to facilitate reuniting family members who were separated by the response to the accident. This temporary shelter provides a safe and secure environment where they will be kept informed about the status of their children who are in school and be reunited with them and their other family members as soon as practical.

This happy ending for the Sanderson family was not unexpected because there was an integrated community emergency response plan that was executed with few problems (it had been practiced and exercised) and the public education program prepared the community residents to protect themselves. The Sanderson family was certainly prepared. They knew what to do and what not to do, and they did a pretty good job of getting it right. They learned later that some of their neighbors who decided to evacuate instead of taking immediate temporary shelter did suffer severe exposure symptoms. Apparently, their neighborhood was directly in the path of the highest plume concentrations. Also, the victims of the automobile accident that cut off electrical power to the neighborhood suffered agent exposure symptoms that contributed directly to the accident. They did not survive. There were some who remained behind after ending SIP because they had no transportation or were reluctant to leave for personal reasons. They ventilated their shelters when told to end SIP, and many went outside. There were very few exposure injuries among this group, and none were incapacitating.

Appendix C

Related Resources

This appendix contains a list of resources related to the subject matter of this guide book.

CSEPP, 2005, *Public Affairs Planning Guidance Compendium Workbook,* (hard copy and CD editions), June.

CSEPP Fact Sheet, 2002, *Shelter-In-Place,* April.

CSEPP Fact Sheet, 2002, *Shelter-In-Place Kit,* April.

CSEPP Fact Sheet, 2003, *Acute Exposure Guideline Levels,* January.

CSEPP Fact Sheet, 2003, *On-Post Residents,* September.

CSEPP Protective Action Toolkit, 2005, is a DVD prepared for the CSEPP Protective Action IPT by ORNL.

National Institute for Chemical Studies provides information about the benefits of SIP, case studies illustrating the value of this protection, and additional advice on how to make SIP work available at www.nicsinfo.org.

U.S. Centers for Disease Control and Prevention fact sheets about sheltering in place are available at www.bt.cdc.gov/planning/Shelteringfacts.pdf.

The CSEPP Portal at www.csepppportal.net contains publications and other information about SIP.