Report of the Shelter-in-Place Work Group

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December 3, 2001

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The CSEPP Shelter-in Place Work Group would like to acknowledge and thank the **National Institute for Chemical Studies** (NICS) for granting permission to use the copyrighted Shelter-in-Place logo on the cover of this document.

"The prudent see danger and take refuge,
but the simple keep going and suffer for it."

Proverbs 27:12

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EXECUTIVE SUMMARY

This report has been prepared by the Shelter-in-Place Work Group (SIPWG) for the Chemical Stockpile Emergency Preparedness Program (CSEPP). Created during the December 2000 CSEPP Planning Conference held in Dallas, TX, the SIPWG was specifically formed to address four topics that were identified by conference participants as critical unresolved planning issues in CSEPP. The planning community defined these issues as the following:

- Evacuation vs. sheltering
- How should an all-clear be sounded for people sheltered in place?
- Policy for egress from Shelter-in-Place
- Handling of people after leaving shelter (decontamination, transportation)

At the first meeting of the SIPWG in February 2001, these four issues were consolidated to three taskings by Joe Herring of Federal Emergency Management Agency (FEMA) Headquarters as follows:

1. How to develop an approach to Protective Action Recommendation (PAR)/Protective Action Decision (PAD) decision-making
2. When and how a sheltered population should end a shelter-in-place protective action
3. How to handle or process populations that sheltered-in-place

The SIPWG met directly and via conference calls multiple times throughout 2001 in pursuit of these issues. It is the intent of the SIPWG that this report fulfills the following goals:

- Assess the current "state of the art" for shelter-in-place (SIP) as a protective action
- Identify the steps required to ensure that SIP is used appropriately and effectively as a protective action strategy.
- Identify needed changes to current CSEPP guidance and policies

Summaries of the recommendations contained in this report are as follows:

1. The SIPWG recommends that the goal stated in *CSEPP Policy Paper Number 1*, the avoidance of fatalities to the maximum extent practicable, be reflected in all protective action strategies, and in CSEPP Guidance wherever appropriate.
2. The SIPWG recommends that every CSEPP community develop a balanced Protective Action Strategy Plan (PASP) in the planning phase, document it in their plans, and formalize it with Memoranda of Understanding (MOUs) between all the involved jurisdictions and the Army installation.
3. The SIPWG recommends that FEMA and the Army develop the following:
    - Criteria for evaluating community housing stock to determine infiltration rates
    - Criteria for estimating evacuation times

- A more refined routine to more accurately depict the appropriate time to terminate SIP.

4. The SIPWG recommends the use of dispersion modeling to develop a Protective Action Strategy Plan in the planning phase, and the use of dispersion modeling, in concert with other data, to make protective action decisions in the response phase.
5. The SIPWG recommends that each CSEPP community develop a rigorous alert and notification standard operating guideline, and that the *CSEPP Planning Guidance* be amended, where appropriate, to clearly state "The public in affected subzones of the Immediate Response Zone will be alerted, and notified of protective action instructions, within 8 minutes after the Army provides a notification that includes the Chemical Event Notification Level and Protective Action Recommendation to the off-post warning point."
6. The SIPWG recommends that CSEPP communities use a "heads-up" notification *only* if it does not delay issuance of the installation's PAR, and if it has been clearly defined in alert and notification procedures.
7. The SIPWG recommends that a CSEPP policy paper be issued requiring MOAs that address clearly defined issues such as alert and notification, information exchange, and protective action decision–making.
8. The SIPWG recommends that CSEPP reaffirm guidance that modeling is an acceptable way to decide when and how to terminate SIP when definitive monitoring data is not available in time to minimize fatalities among a sheltered population.
9. The SIPWG recommends that a single model should be used at each site to help decide when and how to end SIP, and that this model should estimate when the plume concentration outdoors becomes less than the concentration inside shelters and provide information to minimize fatalities. The SIPWG further recommends that FEMA and the Army expand the routine used in the proof-of-concept model known as TSIP (Terminate Shelter in Place) by linking it to the D2PC and D2-Puff dispersion models in order to automate its calculation of the optimum shelter termination times for each sub-zone. This combined dispersion model should then be fielded at one CSEPP site as a pilot project. The SIPWG further recommends that if the pilot project proves successful, the final dispersion model with the incorporated TSIP routine should be integrated into the CSEPP automated management information system.
10. The SIPWG recommends that FEMA and the Army publish guidance endorsing the best practices contained in Section 3 of this report.
11. The SIPWG recommends that the proof-of-concept model known as TSIP be developed as a stand-alone training and planning tool if program finances permit.
12. The SIPWG recommends that communities expand their planning efforts—individually and cooperatively—to consider all the population management issues that may arise when SIP is terminated.
13. The SIPWG recommends review and revision of the *CSEPP Planning Guidance* to differentiate more clearly between "exposure" and "contamination," and to clearly

state that decontamination may not be required for asymptomatic persons exposed to low levels of nerve agent vapor.

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Table of Contents

1.0 Introduction

1.1 Purpose

The purpose of this report is to address critical unresolved planning issues identified by CSEPP planners in December 2000 related to using Shelter-in-Place (SIP) as a protective action strategy. It identifies best practices, and recommends changes and additions to CSEPP's published planning guidance and policies.

1.2 Background

This report was prepared by the Shelter-in-Place Work Group (SIPWG) for the Chemical Stockpile Emergency Preparedness Program (CSEPP). The work group was created at the December 2000 CSEPP Planning Conference held in Dallas, TX. It was formed to address four topics that were identified by conference participants as critical unresolved planning issues in CSEPP. The planning community defined these issues as the following:

- Evacuation vs. sheltering
- How should an all-clear be sounded for people sheltered in place
- Policy for egress from Shelter-in-Place
- Handling people after they leave the shelter (decontamination, transportation)

At the December 2000 CSEPP Planning Conference, volunteers were solicited to serve on this work group. Table 1 presents the full membership of the SIPWG:

Table 1: SIPWG Members

Name and Organization
Marianne Rutishauser, Tooele Co., UT (Chairperson)
Bill Blewett, Soldier Biological Chemical Command (SBCCOM)
Don Broughton, Madison Co., KY
Meg Capps, Umatilla Co., OR
Paul Carnithan, SBCCOM
Clark Combs, Kentucky DEM
Joe Correa, Federal Emergency Management Agency (FEMA) HQ
George Cossey, Arkansas EMA
Shyrlee Fox, FEMA Region VI
Bob Grogan, Ft. McClellan-Argonne National Laboratory (ANL)

Name and Organization
Randy Hecht, FEMA Region IV
Kevin Kammerer, SBCCOM
Jack Long, Innovative Emergency Management, Inc. (IEM)
Mike Myirski, SBCCOM
John Sorensen, Oak Ridge National Laboratory (ORNL)
Mark Scott, National Institute for Chemical Studies
Robert Sharp, ANL
Barbara Vogt, ORNL
Tom Warnock, FEMA HQ
Rob Weiss, SBCCOM
Charles Williams, Alabama EMA
Richard Winter, UMCD-ANL
George Yantosik, ANL

The SIPWG held its first meeting in February 2001 at the Edgewood Area of Aberdeen Proving Ground, MD. At that meeting the four issues from the Planning Conference were consolidated by Joe Herring of FEMA Headquarters to three taskings, as follows:

1. How to develop an approach to PAR/PAD decision-making
2. When and how should a sheltered population end a shelter-in-place protective action
3. How to handle or process populations that sheltered in place

1.3 Methodology

At the February 2001 meeting, the SIPWG evaluated existing CSEPP guidance and policy, and agreed to use the following guiding principles in its approach to problem solving:

1. Recognition that the primary focus of protective actions for CSEPP is to avoid fatalities. This is consistent with *CSEPP Policy Paper Number 1*.
2. Recognition that protective action decision–making is an extremely time-critical process. In essence, a decision made quickly without waiting for complete information is preferable to a decision made too late to help.
3. Recognition that public warning must be completed rapidly to save lives. The time intervals in current Army and CSEPP guidance that strive for the shortest possible warning times should be interpreted literally. Such times represent the maximum limits of acceptable performance. Faster is better.
4. Recognition that a balanced strategy incorporating both evacuation and SIP is the most effective protective action strategy for all CSEPP communities. The concept of operations that implements this strategy should be promulgated by on- and off-post officials and documented in on-post and off-post emergency plans.

5. Recognition that a SIP strategy must always include a strategy for ending SIP.
6. Recognition that any protective action decision must consider those who will implement a different protective action. There will always be some people who cannot evacuate, whom emergency managers must consider as being sheltered-in-place and who must be given adequate information to protect themselves. Some will always evacuate even if SIP is recommended. Emergency managers must consider both groups in their planning.
7. Recognition that dispersion modeling is an approved and effective tool for making protective action decisions.[1]
8. Recognition that monitoring results will not likely be available to support the protective action decision–making process, except perhaps at or near the point of release to help quantify the source term.
9. Recognition that written Memoranda of Understanding (MOUs) and Memoranda of Agreement (MOAs) are essential to institutionalizing a successful protective action decision–making process.

The February 2001 meeting ended with the division of the SIPWG into three subcommittees to deal with its three primary taskings: How to Develop an Approach to PAR/PAD Decision-Making; How Should an All-Clear Be Sounded for People Sheltered in Place; and Handling of People After Leaving Shelter. The membership of these subcommittees is presented below:

Table 2: SIPWG Subcommittee 1

Subcommittee 1: How to Develop an Approach to PAR/PAD Decision-Making
Marianne Rutishauser, Tooele County, UT, Chairperson
Clark Combs, Kentucky DEM
Shyrlee Fox, FEMA Region VI
Bob Grogan, Argonne National Laboratory
Mike Myirski, SBCCOM
John Sorensen, ORNL

Table 3: SIPWG Subcommittee 2

Subcommittee 2: When and How Should a Sheltered Population End a Shelter-in-Place Protective Action?
George Yantosik, ANL, Chairperson
Bill Blewett, SBCCOM
Don Broughton, Madison County, KY
Robert Sharp, ANL
Richard Winter, ANL

[1] "Off-post authorities should depend mainly on air dispersion modeling to determine plume passage and when to recommend ventilation and/or egress from shelter-in-place." (*The Chemical Stockpile Emergency Preparedness Program Off-Post Monitoring Integrated Product Team Report*, January 1999, p. 23.)

Table 4: SIPWG Subcommittee 3

Subcommittee 3: How to Handle or Process Populations that Sheltered in Place
Tom Warnock, FEMA HQ, Chairperson
Paul Carnithan
Jack Long, IEM
Barbara Vogt, ORNL
Rob Weiss, SBCCOM
Charles Williams, Alabama EMA

The SIPWG and its individual subcommittees met via multiple conference calls through the first half of 2001, met again in conjunction with the Public Affairs Integrated Product Team meeting in Denver, CO, in June 2001, and met at the CSEPP National Conference in Portland, OR, in July 2001. Following the CSEPP National Conference, the three subcommittee chairs and support contractor met for a final time in Salt Lake City, UT, from October 30–November 2, 2001 to prepare this report.

The SIPWG attempted to obtain input from as many sources as possible. Minutes from all of its meetings and conference calls were posted on the CSEPP Planners' Web Site (www.csepp-planners.net) as soon as approved. At the 2001 CSEPP National Conference, the SIPWG presented its preliminary findings as part of the day-long pre-conference planning meeting, and again during two separate conference breakout sessions. Following each of these breakout sessions, a survey was distributed to the CSEPP community to determine the extent of agreement with the SIPWG's preliminary conclusions. This survey was also posted on the CSEPP Planners' Web Site for one month following the conclusion of the CSEPP National Conference. Responses from the survey have been considered in this report.

The methodology employed by the SIPWG involved identifying best practices currently used in the CSEPP communities, considering how to improve other current practices, and searching for innovative new practices to enhance CSEPP emergency preparedness. These areas were identified as a result of the broad cross-section of the CSEPP community represented on the SIPWG, as well as by the SIPWG's aggressive outreach efforts. Other efforts by the SIPWG involved comprehensive review of past CSEPP technical studies and documentation, the current CSEPP planning guidance, Army doctrine and related publications, and published CSEPP policy papers.

Early on, the SIPWG identified a need for a strong public education component for any SIP strategy. In particular, it stressed the importance of this component because of the possibly "non-intuitive" nature of SIP; i.e., there was concern that the public might tend to be more accepting of evacuation as a protection strategy unless educated on the concepts involved with SIP. Consequently, the SIPWG closely coordinated its activities with the Public Affairs Integrated Process Team (IPT), meeting jointly on one occasion, sending representatives to Public Affairs IPT meetings, and designating a liaison officer (Mr. John Yacquiant, U.S. Army Soldier Biological Chemical Command [SBCCOM]) with the IPT.

Subcommittee 2's tasking, to determine the optimum time and manner to terminate SIP, coincided closely with a FEMA project being undertaken by Argonne National Laboratory to help determine the optimum time and manner to terminate SIP. This project is discussed in detail in Section 3.

2.0 Approach to Protective Action Decision–Making

2.1 Background

For the past year, Subcommittee 1 of the SIPWG has been reviewing available methodologies, tools, and guidance documents to formulate recommendations for protective action decision–making. Their intent is to assist emergency managers and planners in developing a better foundation for their decision-making process, and protective action strategy plans that have the following characteristics:

1. Balanced and comprehensive
2. Developed in the planning stage
3. Agreed upon by on- and off-post officials
4. Well-documented and solidified with an agreement
5. Reflected in local on- and off-post emergency operations plans

The development of a protective action strategy plan is critical to making timely protective action decisions and communicating them to local officials and the public, so that appropriate protective action can be implemented before the arrival of a plume. To ensure effective and timely communication from on-post to off-post, it is essential that the information to be exchanged be defined in advance in a Memorandum of Agreement. These points will be discussed in more detail in the SIPWG's recommendations for "best practices" provided later in this report.

Public Law 99-145, the Congressional mandate for the Chemical Stockpile Disposal Program, includes a provision that the Department of Defense ensure "maximum protection for the environment, the general public, and the personnel who are involved in the destruction of the lethal chemical agents and munitions…." This is reflected in *CSEPP Policy Paper Number 1*,which further states: "the most important objective of the [CSEPP] emergency preparedness and implementation process is avoiding fatalities to the maximum extent practicable, should an accidental release of chemical agent occur."

The SIPWG has adopted this objective, the avoidance of fatalities to the maximum extent practical, as the foundation of this report and recommends it be reflected in all protective action strategy plans.

2.2 Best Practices

According to *CSEPP Planning Guidance*, "three of the most critical parts of the CSEPP effort are:

1. The accurate assessment of the chemical emergency and its potential impact;
2. the timely notification of (Army and local) officials; and,
3. the recommendation for appropriate protective actions."[2]

[2]. *CSEPP Planning Guidance*, May 1996, Section 6.0.

The responsibility for these actions is specified in Army Pamphlet 50-6, *Chemical Accident or Incident Response and Assistance (CAIRA) Operations* (DA Pam 50-6), which states:

> "Each installation commander has the responsibility and authority for initial response to CA/I that occur on-post and for the protection of on-post personnel and mitigation of CA/I consequences. Installations also alert and inform community officials of the nature and extent of the CA/I and recommend appropriate measures for protection of the civilian population."[3] Army Regulation 50-6 takes this even further in Chapter 11-4.a: "Responsible commanders will report any chemical event declared a community emergency by the fastest, most efficient means available to State and local emergency response officials responsible for the affected areas."

The work group concurs with *CSEPP Planning Guidance*, Section 8.5, Protective Action Decision–Making, which states that:

> "State and local officials are responsible for deciding what protective actions to recommend to the public in the event of a release of chemical agent. Because of the limited time available to make this complex decision during an emergency, it is important that the protective action issue be thoroughly examined during the readiness phase." It further states, "…the emergency decision process included in the local emergency plan should be incorporated into the installation's chemical event emergency notification procedures. Thus, the protective action recommendations conveyed by the installation as part of the initial (and subsequent) notification process would be based on the decision criteria developed by the off-post officials. This method does not transfer the local official's decision-making authority to the Army; instead, it assigns the installation responsibility for implementing the decision-making process developed by off-post officials."

The importance of the above-stated objectives and responsibilities is reflected in the following SIPWG recommendations for "best practices."

2.2.1 Best Practice Recommendation 1:

A reasonable Protective Action Recommendation (PAR) or Protective Action Decision (PAD) that is issued quickly based on pre-approved criteria (the Protective Action Strategy Plan) and current community conditions is better than a "perfect" PAR/PAD issued too late to be effective. Any delay in protective action decision–making can occur at the expense of fatalities in areas closest to the storage site.

[3] Department of the Army, *Pamphlet 50-6*, Chapter 3-2.c.

2.2.2 Best Practice Recommendation 2:

A decision on protective actions, broadcast of the alert, and notification of the preferred protective action instructions will be completed for populations in the Immediate Response Zone (IRZ) by local officials within 8 minutes after receipt of a PAR from the Army. The *CSEPP Planning Guidance* states that:

> "The time that elapses from the occurrence of an accident creating a hazard, to the recognition of danger to the public, and then to the decision to warn the public is of paramount importance to the success of a public alert and notification system (ANS).[4] It goes on to state that … 'the IRZ warning system must be capable of providing both an alerting signal and instructional message within a total of 8 minutes from the time that a decision has been made that the public is in danger."

This section of the *Guidance* does not state that the PAD is the responsibility of local officials. It is only implied that a PAR has been received from the installation by local officials and the PAD has been made, before instructions can be broadcast to the public.

Therefore, the SIPWG concludes that CSEPP Alert and Notification Guidance (Appendix F of *CSEPP Planning Guidance*) for the Immediate Response Zone should be interpreted as being the "outer limit" of an acceptable performance standard. The *CSEPP Planning Guidance* should also be understood to mean that a decision on protective action, and the broadcast of the alert and notification of the preferred protective actions, will be completed by local officials within 8 minutes after receipt of a PAR from the Army.

2.2.3 Best Practice Recommendation 3:

CSEPP communities should be able to meet alert and notification requirements and initiate response activities in a timely manner 24 hours per day. The Army requires that each installation must provide this information to the off-post in a timely manner, along with its chemical event emergency notification level and recommended protective actions. ("A timely manner" is defined as within 5 minutes from initial detection of an actual or likely chemical agent release at Anniston Army Depot (ANAD), Blue Grass Army Depot (BGAD), Newport Army Ammunition Plant (NAAP), and Pine Bluff Arsenal (PBA). It is defined as within 10 minutes from initial detection at Aberdeen Proving Ground (APG), Pueblo Depot Activity (PUDA), Deseret Chemical Depot (DCD), and Umatilla Depot Activity (UMDA).[5]) To accomplish this directive, the Army requires that the information characterizing the situation be fed into an Army Emergency Operations Center (EOC). The EOC must be staffed on a 24-hour basis, and must be able to receive reports, analyze data, assess the seriousness of the event, estimate the impact, alert the command and local officials, recommend protective actions, and notify the Army Operations Center (AOC).[6]

The *CSEPP Planning Guidance* states that, "Local plans must have procedures for receiving and acknowledging this information (24 hours per day) and acting

[4] *CSEPP Planning Guidance*, May 1966, Appendix F Alert and Notification.
[5] *CSEPP Planning Guidance*, May 1966, Section 8.4.1 (pt. 4-1).
[6] Department of the Army, *Pamphlet 50-6*, Chapter 3-5.c.(3).(a).

appropriately on it."[7] Prompt and effective response is most critical in the Immediate Response Zone because of the potentially limited warning and response time available. If this capability is not already in place, the SIPWG recommends that, minimally, every IRZ community should be capable of receiving CA/I information 24 hours per day at their designated warning point. This requires the development of alert and notification standard operating guidelines; and the training of all staff required to give or take these notifications. It is also suggested that this training be provided on a regular basis as a refresher, and that allowances be made for areas of high turnover. This training becomes even more critical if a community utilizes a heads-up notification, as recommended below.

2.2.4 Best Practice Recommendation 4:

The SIPWG recommends that a "heads-up" notification from on-post to off-post officials be utilized if it does not delay the installation's PAR and it can be clearly defined in the alert and notification standard operating guidelines referred to in Best Practice Recommendation 3 above. This should be included in the Memorandum of Agreement and covered during a rigorous training program. This heads-up notification must not be confused with a Protective Action Recommendation notification. A heads-up notification will not include verified event data or Protective Action Recommendations, and will not start or stop the on- or off-post clock for initial warning requirements for a CA/I event. A heads-up notification will, however, allow off-post officials to come to an enhanced state of readiness in a CSEPP emergency; i.e., it will serve to notify off-post decision makers, initiate a partial activation of the off-post Emergency Operations Center (EOC), and allow off-post review of current daily work plans and Maximum Credible Events (MCEs).

2.2.5 Best Practice Recommendation 5:

A balanced Protective Action Strategy Plan (PASP) that includes provision for populations evacuating and sheltering-in-place must be developed during the planning phase.

The requirement to develop a protective action strategy plan is very clearly defined in *CSEPP Planning Guidance*, Appendix D, Protective Action Decision Making. While the basic protective action options consist of only two basic choices—evacuation or some form of in-place sheltering—the process of identifying the conditions under which each would provide optimal protection is very complex and time consuming, and does not lend itself to real-time decision-making at the time of an emergency. Thus, this must be done in the planning phase.

Several methods can be used to help make decisions, including checklists, decision matrices, decision trees, or decision tables. Checklists present various attributes of a decision problem and allow for systematic consideration of each attribute. Decision matrices frame decision outcomes by two or three key attributes of the decision. Decision trees and tables pose a series of yes/no questions or set of criteria which lead

[7] *CSEPP Planning Guidance*, May 1966, Section 8.4.

decision makers down branches of the tree or cells of the table to a desired outcome. We will apply both a checklist and a decision tree approach to explore decision-making options further.

Table 5: Protective Action Checklist

Attribute	Shelter	Evacuation
Infiltration	Tight housing	Leaky housing
Plume duration	Short	Long
Time of day	Night	Day
Population density	High	Low
Road conditions	Poor	Good
Population mobility	Immobile	Mobile
Traffic flow	Constrained	Unconstrained
Public perception of shelter	Good	Poor
Toxic load	High	Low

Table 5 illustrates a checklist approach to evacuation and sheltering. The first column lists various decision attributes. The second and third columns list the attribute values that favor either sheltering or evacuation. For some of the attributes, more quantitative values could be assigned. For example, one might shelter with plume duration of less than 30 minutes and evacuate with a plume duration of over 120 minutes.

The advantage of this approach is that it is relatively easy to do. Among the disadvantages are that it may not lead to a clear-cut decision in every planning case, it may not serve to minimize fatalities, and the relative influence of each checklist item is not accounted for.

A sample decision tree for minimizing fatalities and deciding between SIP and evacuation is found below in Figure 1. Decision trees pose a series of Yes/No questions to the user. Answers to these questions determine a path through the tree to an outcome. Our protective action decision trees have three outcomes:

1. Evacuate
2. Shelter
3. Conduct a detailed analysis

The third outcome is necessary because under certain conditions answering yes/no questions cannot lead to the identification of a preferable option.

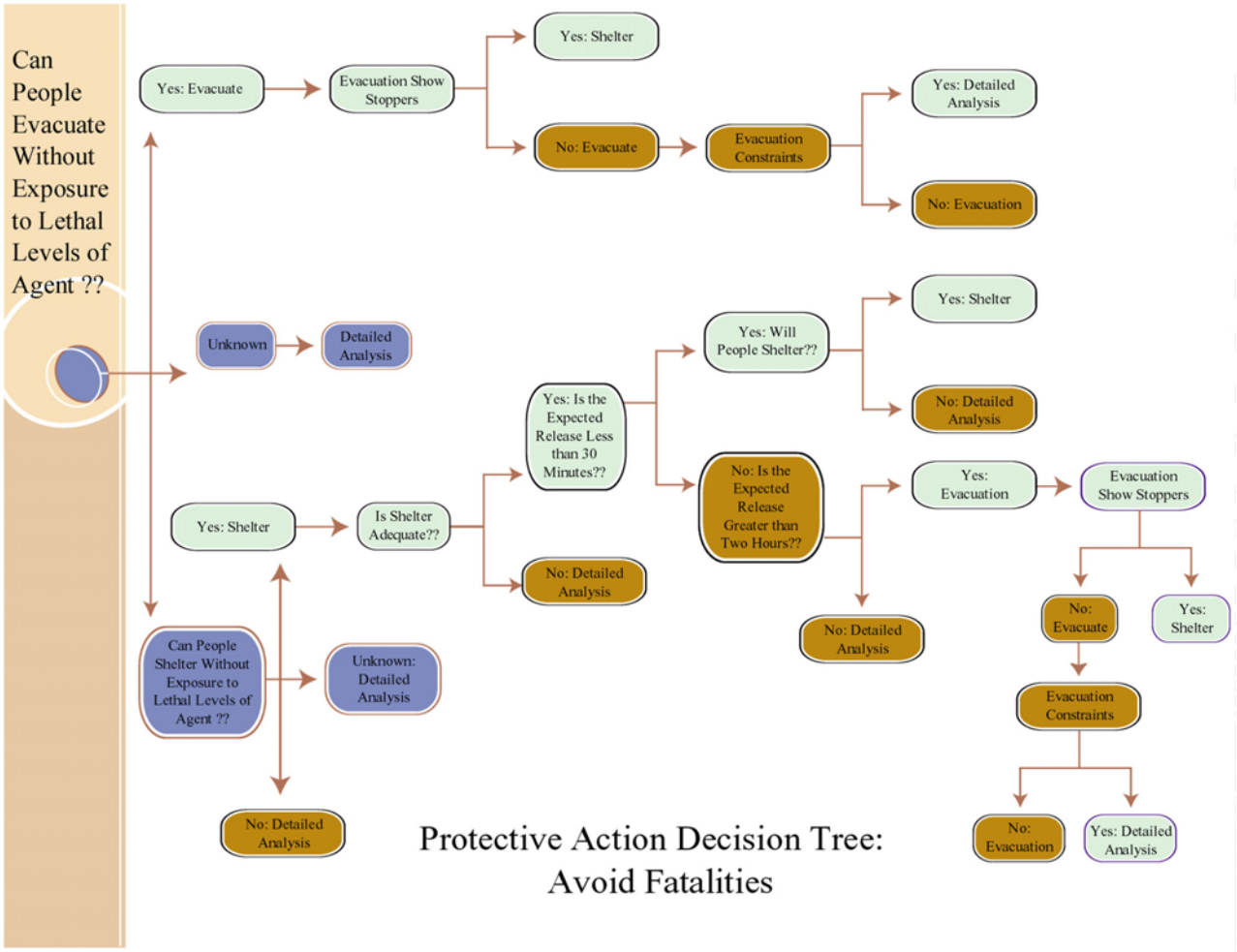

Figure 1: Decision Tree

This decision tree supports the premise that evacuation is the preferred protective action when it minimizes fatalities, even if this means evacuation during the passage of a plume. In some circumstances, SIP will also result in exposure to lethal levels of chemical agent. Some decision-making cases will be clear-cut. For example, a slow-moving plume coupled with a good warning system, low population density, and a good evacuation road network leads to an evacuation decision, while a fast-moving plume of short duration (short "tip-to-tail" time) leads to an easy SIP decision. However, some cases require a detailed analysis. These include incidents where the duration of the hazard is greater than 30 minutes but less than two hours, or incidents in which some, but not all, people will be able to evacuate without receiving an exposure that would possibly impair their ability to drive.

2.2.6 Best Practice Recommendation 6:

Accurate and useful data and state-of-the-art analytical tools must be utilized, where required, to conduct a detailed analysis for the development of the protective action strategy plan. A suite of tools that can help planners decide between evacuation and SIP strategies should be available or developed. If some of these tools are already available, they should continue to be used, improved, or updated. These tools should provide the following functionalities:

- Current Evacuation Time Estimates. No decision between evacuation and SIP can be conducted rationally without such analyses. In recognition of their value as planning and decision-making tools, evacuation time studies have been required in the Radiological Emergency Preparedness Program (REP) since 1979. In 2001, the Nuclear Regulatory Commission (NRC) issued an advisory[8] recommending that all nuclear power plant licensees update their evacuation time estimates for communities within plume exposure pathways, to reflect fluctuations in population based on the release of Year 2000 Census data. REP requires a "reasonable assurance" that public health and safety can be provided, while CSEPP requires a standard of "maximum protection." Therefore, it is the SIPWG's recommendation that all CSEPP community evacuation time studies be updated based on Year 2000 Census data, unless it can be reasonably shown that existing evacuation time estimates are current or there has not been any significant change to the population or to the evacuation route network. These analyses should be conducted with a CSEPP-approved evacuation model.
- Evaluating Housing Stocks. This analytical tool should reflect reasonably accurate air exchange rates for each planning zone.[9] One of the essential factors in sheltering-in-place effectively centers on the level of protection offered by the sheltering structure. Buildings with low infiltration rates will afford residents higher levels of protection for a longer time during a plume passage than those with high infiltration rates. Oak Ridge National Laboratory's *Report ORNL/TM - 13742* states that "Housing unit age is used as a surrogate indicator of air

[8] NRC Regulatory Issue Summary 2001-16, *Update of Evacuation Time Estimates (ETE's)*, August 1, 2001.

[9] **"**Assessment of Housing Stock Age in the Vicinity of Chemical Stockpile Sites," *ORNL/TM-13742*, Vogt, et al, April 1999.

infiltration rates because research has shown that prior to the late 1960's, few building codes required weatherization measures in most private home construction. With the advent of the energy crisis in the early 1980's, building code standards changed and weatherization was required in new home construction to reduce air infiltration and thus decrease energy consumption." Included in the ORNL report are maps depicting the number and percent of pre-1950 and pre-1970 residential units in each Year 1990 Census block group around the eight CSEPP stockpile locations. These divisions correspond with structure types rated by energy efficiency as follows:

Type 1 – Energy-efficient, constructed after 1970

Type 2 – Modern construction, built between 1950–1970

Type 3 – Oldest construction, built 1920–1950

Type 4 – Mobile homes, trailers, sheds, etc., regardless of age

Updating the percentages based on the Year 2000 Census data now available based on the air exchange rates associated with shelter types grouped by energy efficiency ratings in a planning zone could lead to a useful protection factor (pf) for sheltering by planning zone. Listed below are air exchange rates by shelter type taken from recent published reports.

- **Normal** (Type 2, typical leaky structure built 1950–1970) usually have 1.0 to 1.5 Air Changes per Hour (ACH). However, very leaky structures can have as much as 5.0 ACH. Homes could be pro-rated in increments based on age (as homes get older or change construction type, they get closer to 5.0 ACH).
- **Enhanced** (Type 1 weatherized shelters or homes built since the 1970s) usually have 0.5 ACH
- **Expedient** (occupants tape and seal an inner room at time of release) usually have 0.2–0.3 ACH
- **Pressurized** (only filtered air is exchanged with outside air) have 0 ACH

- Evaluating Elapsed Time. A measurement of the total time that elapses—from the discovery of the incident, through accident assessment, to the determination that the public is in danger, to the decision to issue a protective action recommendation dissemination of the PAR, and assessment of the PAR by off-post officials, the making of a PAD, to public alert and notification, and time required for populations at risk to effect a protective action—must be considered when developing a protective action strategy.
- Comparing Cumulative Exposure Between Populations Evacuating or Sheltered-in-Place. A CSEPP-approved tool must be utilized that allows planners to assess the expected dosage reduction from implementing alternative protective actions under different scenarios. These scenarios should be specified with respect to source term values, meteorological conditions, and the emergency response

system. By integrating the probability of protection, with the dosage reduction from the action, one can calculate the expected dosage for that scenario specific application of the protective action. By comparing evacuation with SIP, it is possible to determine the expected dosages and health consequences to the population at risk, allowing a determination of the optimum PAR.

- Considering the Distance of a Population from the Source, Based on a Representative Location Within the Planning Zone. This representative location could be the foremost point in a zone, the midpoint, an average point, a demographic center or a point that considers terrain. Shelters closer to the source of the release will usually be exposed sooner, and to higher concentrations, than shelters further downwind. Designating a representative point in each subzone is a community official's decision and should be well thought-out. The criteria used for making this decision should be documented in the community Concept of Operations.

- Definining Source Term Values. The initial protective action decision to evacuate or SIP may justifiably be based on an appropriate MCE in the absence of detailed information about the accident. Initial responses can also be based on assumptions from the work plan MCE for a chemical operation. If the protective action decision is based on either of these MCEs, it is imperative that the actual mode, quantity, and duration of the release be ascertained as soon as possible, and that updated information be provided to off-post officials.

- Considering Meteorological Conditions. Wind speed, wind direction, and atmospheric stability class are the key variables that are used within dispersion models to predict the dispersion of hazardous vapors. The more accurately the meteorological conditions are described in the model, the more accurately dispersion can be modeled to show representative plume concentration histories at various locations. Army installations storing chemical warfare agents (CWA) are already equipped with meteorological towers, as are some off-post communities, so that useful meteorological data can be obtained in near-real time. Where wind speed and direction vary significantly over relatively short distances (e.g., around complex terrain features), the dispersion model should allow for the inclusion of enough meteorological information (e.g., from multiple elevations and/or locations) to accurately describe the conditions that will affect model output.

- AssessingDose-Response Relationships. The toxic effects model and methodology used to determine the toxic effect from a chemical agent release is of special importance in determining when to end SIP. Currently the linear, cumulative dosage model (i.e., using the No Effects, No Deaths, and 1% Lethality values) is used in the CSEPP-approved D2PC dispersion model. The Acute Exposure Guideline Level (AEGL) toxic effect model (e.g., AEGL-2, AEGL-3), which is not linear for the nerve agents (i.e., the toxic effect is a non-linear function of the concentration history profile), is a dose assessment method that will be used in CSEPP following the EPA comment and approval process, as defined in *CSEPP Policy Paper Number 20*, dated November 15, 2001.

Constructing a protective action decision strategy will require detailed analysis of those scenarios where neither evacuation nor SIP are obvious choices, and must occur during the planning phase.[10] Such detailed analysis will likely require the use of one or more models and a structured approach to the analysis. One model developed in CSEPP to assist planners in protective action decision–making is PADRE (Protective Action Dosage Reduction Estimator). The PADRE Conceptual Model shown in Figure 2 is intended to illustrate the logic behind conducting a detailed analysis, and is not intended as an endorsement by the SIPWG to utilize a particular model to build a protective action strategy plan.

[10] Boechler, Michael, "Creating a Balanced Response: An Application of Data Mining to Determine When to Shelter or Evacuate." *Journal of the American Society of Professional Emergency Planners*, (**8**): 53-61, 2001.

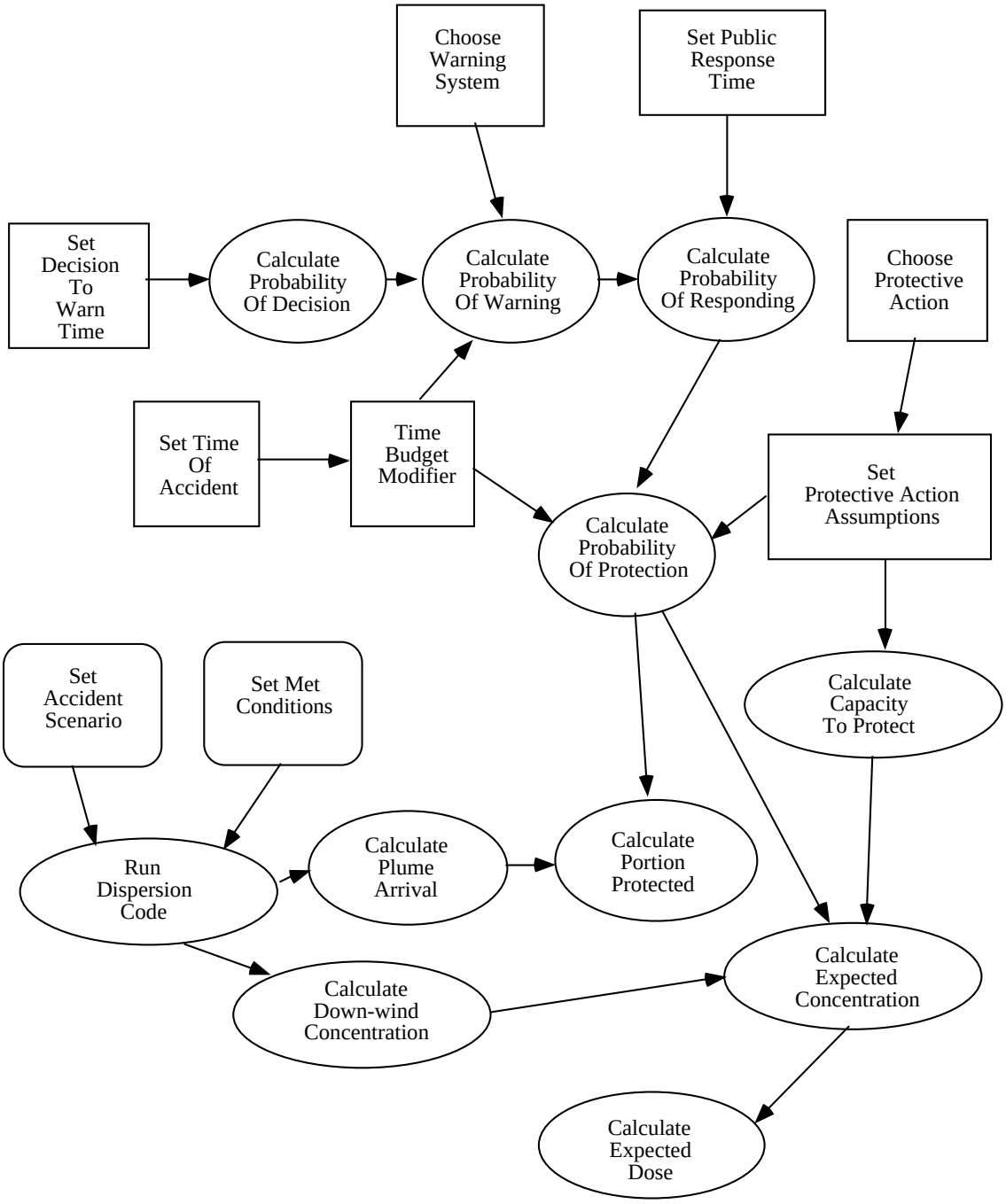

Figure 2: PADRE Conceptual Model

A detailed analysis will lead a planner to an optimum PAD to recommend either SIP or evacuation. However, in the planning and response phases of a chemical event, decision-makers must always consider the following points:

- A SIP PAD must always include provisions for terminating SIP. In essence, SIP is a two-part decision that is not complete until the "terminate SIP" recommendation is made, and a decision is broadcast. Conversely, a SIP PAD will inevitably result in some individuals who choose to evacuate. Planners should consider these individuals, and should make the necessary accommodations for evacuees even in instances where evacuation is not recommended.
- An evacuation PAD will always include some individuals who cannot or will not evacuate. "SIP" and "Terminate SIP" recommendations must always be prepared for those who, for whatever reason, will not be evacuating. This is not a novel concept for emergency managers. Rarely, if ever, is there 100% compliance with a protective action recommendation. A critical consideration is to have well defined policies and procedures for dealing with non-compliers.

2.2.7 Best Practice Recommendation 7:

The SIPWG recommends using dispersion modeling in concert with other tools in the planning phase to build a protective action strategy plan. Dispersion modeling is very valuable in the planning phase to help develop decision criteria, and for choosing between evacuation and SIP.

2.2.8 Best Practice Recommendation 8:

The SIPWG recommends using dispersion modeling—but only in concert with other data and in accordance with local protective action strategy plans —in the response phase to make the initial evacuation vs. SIP protective action recommendations and decisions.

2.2.9 Best Practice Recommendation 9:

The SIPWG recommends using Memoranda of Agreement to ensure that all parties involved have a clear understanding of the subject matter, and to ensure that plans, procedures, and protocols are institutionalized rather than personalized. The *CSEPP MOA/MOU Guide*, May 1999, states the following reasons to have agreements:

- They require considerable effort to initiate, negotiate, and maintain; therefore, they improve the quality of emergency preparedness and response, and ensure that response efforts are coordinated and complimentary.
- They help communities to arrange for specialized resources.
- They minimize litigation.
- They satisfy regulatory requirements or guidance.

It is the recommendation of the SIPWG, and a CSEPP program requirement, that information exchange be detailed in a Memorandum of Agreement between the

appropriate on- and off-post officials. The SIPWG suggests that MOAs should include, but may not be limited to, the following provisions:

- The Chemical Emergency Notification Levels (CENLs)
- The format and timing for exchange of information
- The provision for all notifications required, feedback, and updates
- The exercise of all information exchange daily activities that will mimic and reinforce emergency response exchanges

The SIPWG also recommends that the PASP be solidified with a Memorandum of Agreement, between the appropriate on- and off-post officials.

2.3 Recommended Changes and Additions to CSEPP Planning Guidance

2.3.1 CSEPP Planning Guidance Recommendation 1:

CSEPP Policy Paper Number 1 states that the most important objective of the CSEPP for achieving the mandate of maximum protection to the environment, the public, and all response personnel is the avoidance of fatalities to the maximum extent practicable. The SIPWG concludes that this is a reasonable and achievable objective and recommends that this goal be reflected in updates to *CSEPP Guidance* where appropriate.

2.3.2 CSEPP Planning Guidance Recommendation 2:

The SIPWG recommends that CSEPP Alert and Notification Guidance[11] for the IRZ should be interpreted as being the "outer limit" of an acceptable performance standard. The *CSEPP Guidance* should also be revised to state that a decision on protective action(s), and the broadcast of alert and notification of the preferred protective actions, will be completed by local officials within 8 minutes after receipt of a PAR from the Army. The SIPWG recommends that the *CSEPP Planning Guidance* be amended to state these requirements specifically.

2.3.3 CSEPP Planning Guidance Recommendation 3:

It is the SIPWG's recommendation that a PASP be developed or updated that is "balanced" between evacuation and SIP strategies, where appropriate, based on a goal to minimize fatalities. It is the SIPWG's further recommendation that the strategy plan also consider the following:

1. Current evacuation time estimates
2. Current housing stock evaluations
3. Elapsed time
4. Comparison of cumulative exposure between same populations evacuating or sheltered-in-place

[11] Appendix F of the *CSEPP Planning Guidance.*

5. Consideration of the distance of the population from the accident source
6. Source term values
7. Met data
8. Dose-response relationships provided by dispersion modeling

The SIPWG recommends that the above be clearly defined in *CSEPP Planning Guidance* Appendix D, Planning Guidelines for Protective Action Decision–Making, and Appendix E, Planning Guidelines for Protective Actions and Responses, as appropriate.

2.3.4 CSEPP Planning Guidance Recommendation 4:

It is the SIPWG's recommendation that specific criteria for evacuation time studies in support of CSEPP community emergency plans be added to the *CSEPP Planning Guidance*. Such guidance should contain, at a minimum, the same requirements and level of detail as found in Appendix D of *NUREG-0654/FEMA REP-1*, guidance for the Radiological Emergency Preparedness Program, updated to represent current evacuation models and capabilities.

The SIPWG recommends that specific criteria for evaluating housing stock in support of CSEPP community emergency plans be added to *CSEPP Planning Guidance*.

2.4 Recommended Changes and Additions to CSEPP Policies

2.4.1 Policy Paper Recommendation 1:

The SIPWG recommends that a policy paper be issued requiring the development of a PASP that includes a "decision matrix" and a concept of operations, and that specifies that Memoranda of Agreement be drafted for each CSEPP community.

2.4.2 Policy Paper Recommendation 2:

The SIPWG recommends that a policy paper be issued requiring the update of all CSEPP community evacuation time estimates based on the Year 2000 Census data, unless it can be reasonably shown that existing evacuation time studies are current or that there has not been any significant change to the population or evacuation route network. As census data are updated, evacuation time estimates should be updated if significant changes are documented.

2.4.3 Policy Paper Recommendation 3:

The SIPWG recommends that a policy paper be issued requiring the development of, or updates to, all CSEPP community housing stock evaluations around the eight CSEPP sites based on Year 2000 Census data, or other data as available and appropriate.

It is the SIPWG's recommendation that a policy paper be issued clarifying the use of dispersion modeling for protective action decision–making during the planning, response and recovery phases.

2.4.4 Policy Paper Recommendation 4:

The SIPWG recommends that a policy paper be issued requiring the use of MOAs in specific areas to be defined cooperatively by FEMA and Army officials.

3.0 When and How to Terminate Shelter-in-Place

3.1 Background

The SIPWG Subcommittee 2 looked for the best ways to decide when and how a sheltered population should end SIP, and for best practices to support a shelter termination strategy. This work was done in parallel with a FEMA request of Argonne National Laboratory to find a concept and methodology for deciding the best time and way to end SIP, especially with the goal of minimizing fatalities. In addition, the SIPWG worked directly with the CSEPP Public Affairs IPT to share information and develop best practices relevant to effective SIP strategies. Information exchanged with the CSEPP Public Affairs IPT is being reflected in the draft Fact Sheets on SIP and in public education materials that this IPT is sponsoring. The information presented in this section, therefore, represents the combination of the products of the SIPWG, Argonne's work on the FEMA shelter project, and input from the CSEPP Public Affairs IPT.

As part of a balanced approach to protective action decision–making, SIP is a credible alternative to evacuation for protecting the population on and around Army chemical stockpile storage sites from accidental agent releases of short duration. To be effective, this strategy requires immediate SIP to minimize initial exposure to agent vapor, followed by timely and appropriate termination of SIP to minimize additional exposure to agent vapor accumulations in the shelter when the air outside becomes less hazardous. (See Appendix 1 to this report for a graphic illustration of this concept.)

This SIP strategy must satisfy the direction in *CSEPP Policy Paper Number 1*, which states that: "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." However, a major challenge facing emergency managers has been how to decide the best time and way to end SIP to obtain these ideals. The January 1999 *CSEPP Off-Post Monitoring IPT Report* said: "Off-post authorities should depend mainly on air dispersion modeling to determine plume passage and when to recommend ventilation and/or egress from SIP." Last year FEMA began a project to look for ways to make the best SIP termination decisions. The first result of this project was a March 16, 2001 report by Argonne titled: *Temporary Shelter-In-Place as Protection Against a Release of Airborne Hazardous Material: Report of a Literature Search*. This report did not identify definitive answers, but it established the baseline for further work that did lead to a possible solution.

The major conditions that influence the exposure of a sheltered population are the source term values of the agent released, meteorological conditions, shelter air exchange rates, the distance of the shelter from the source, and the dose-response relationship of the hazardous material. The circumstances that contribute to overall exposure associated with a SIP strategy involve exposure during the time before

taking shelter, exposure while sheltered due to vapor infiltration, and additional exposure (if any) following the termination of SIP. Options to end SIP are to resume normal activities with no restrictions, to ventilate the shelter but remain indoors, to exit from the shelter and remain nearby, or to relocate to a designated facility. These are discussed more thoroughly below.

Conditions that influence when to terminate SIP are:

- **Source term values** based on eyewitness information and accident site monitoring. The initial protective action decisions to evacuate or SIP may justifiably be based on an appropriate MCE in the absence of detailed information about the accident. However, safe-sided assumptions about the event (i.e., those generally thought to be conservative), can skew the timing of the termination of SIP, and significantly erode the protection offered by sheltering. Therefore, if initial responses are based on assumptions from the work plan MCE for a chemical operation, it is imperative that the actual mode, quantity, and duration of the release be ascertained as soon as possible. Source-term observational data (from eyewitnesses at the accident site) and source term monitoring data (from monitors at and immediately downwind from the accident site) should be the primary inputs to define the source-term values for dispersion modeling to decide when to end SIP.
- **Meteorology.** Wind speed, wind direction, and atmospheric stability class are the key variables that are used within dispersion models to predict the dispersion of hazardous vapors. The more accurately the meteorological conditions are described in the model, the more accurately the dispersion can be modeled to show representative plume concentration histories at various locations.
- **Shelter Air Exchange Rates.** The duration that a given shelter will provide useful protection for a given release scenario will depend in part on the shelter's air infiltration rate. Site specific information about shelter air change rates should be considered whenever possible.
- **Distance of Shelters from the Source.** Shelters closer to the source of the release will usually be exposed sooner, and to higher concentrations, than shelters further downwind. Therefore, the optimum time to end shelter protection will usually be sooner for closer shelters than for shelters that are further out. This variable, in the form of plume concentration history as a function of time, can be addressed in some way in both of the currently approved CSEPP dispersion models.
- **Dose-Response Relationship.** The toxic effects model and methodology used to determine the toxic effect from a CWA release is of special importance in determining when to end SIP. Currently the linear, cumulative dosage model (i.e., using the No Effects, No Deaths, and 1% Lethality values) is used in the CSEPP approved D2PC dispersion model. The Acute Exposure Guideline Level (AEGL) toxic effect model (e.g., AEGL-2, AEGL-3), which is not linear for the nerve agents (i.e., the toxic effect is a non-linear function of the concentration history profile) is a method that will be used in the CSEPP following the EPA comment

and approval process, as defined in *CSEPP Policy Paper Number 20*, dated November 15, 2001.

The timing of sheltering actions taken by the affected population will also influence the optimum time to end SIP, i.e., consideration must be given to toxic effects that occur before, during, and after the population is sheltered. Poor timing of sheltering actions can result in greater toxic effects than remaining outdoors with no protection. Circumstances that contribute to exposures associated with SIP include:

- **Exposure before taking shelter.** The potential exists for some toxic load to accumulate before persons enter their shelter if they are still outside after the hazardous vapors reach their location.
- **Exposure during SIP** due to vapor infiltration.
- **Exposure following SIP** while ventilating shelters, simply remaining outside shelters, or relocating.

Recommendations on how to end SIP will depend on several variables. Ventilation of the shelter is important if the shelter is within the hazard wedge or risk envelope, and 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 the following:

- **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 is the usual interpretation of "All Clear."
- **Ventilate the shelter but remain indoors.** In some cases 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 might be the only option for disabled persons or special populations who lack the mobility to exit the shelter. This option also might apply when the weather is so dangerous that remaining outside for an extended period is inadvisable, or when there is believed to be some other hazard outdoors to be avoided.
- **Exit the shelter and remain nearby.** In order to decrease the overall exposure, it might be appropriate to instruct the public not to take the time to open windows, remove tape, turn on ventilation equipment, etc., prior to 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 since 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 might also be the best option for persons who lack transportation to relocate.

- **Relocate to a designated facility.** Local officials may direct that upon the termination of SIP, sheltered populations should relocate to designated facilities to be accounted for and medically screened for agent exposure symptoms. In this case, the instructions would be to exit from shelters and proceed immediately to a place where this follow-up can occur. 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 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.

One of the products of the FEMA tasking to Argonne National Laboratory was the invention of the Terminate Shelter-In-Place (TSIP) routine incorporated in a TSIP proof-of-concept model, which is described in a draft report titled: *When and How to End Shelter-In-Place Protection From a Release of Airborne Hazardous Material: Report on a Decision-Making Concept and Methodology*. The TSIP routine is an attempt to provide a more comprehensive way to decide when and how to end SIP than by using the current plume tail–time concept.

The essence of the TSIP routine is that the optimal time and way to end SIP involves examining the relationships among the conditions and circumstances listed above to find the combination of these variables that gives the smallest area where a sheltered population might receive a certain level of toxic effect. For example, it can find the combination of times, conditions, and circumstances that produce the smallest area where fatalities are possible. In this case, the best time and action to end SIP to minimize fatalities is that combination of variables which produces the smallest area where this level of effect is expected.

The methodology to apply the concept is to use a computer model to examine the relationships among these conditions and circumstances (many of which are pre-planned default inputs), and display the best time and action to end SIP quickly, in a user-friendly format. A computer model that was developed to prove the concept and demonstrate the methodology (called the TSIP Model) is described in the draft Argonne report, and the use of the TSIP Model is illustrated in a case study in an appendix to the draft report. When configured as a decision tool, the routine in the TSIP Model would use information about the plume from the same dispersion model that would be used to determine tail time under the current guidance, as an input to calculate and display the smallest area of the chosen threshold effect.

Neither of the dispersion models currently authorized for use in CSEPP (D2PC and D2-Puff) considers all of the conditions and circumstances that determine when it is theoretically best to end SIP. They give the user information about plume tail time, but the passing of the tail of the plume is not necessarily the optimum time to end SIP. The optimum time to end SIP must consider both the concentration outside shelters and inside shelters, which the routine in the TSIP Model does. The answer obtained using plume tail time to decide on ending SIP might be very good in some

scenarios. On the other hand, since there is a some slack in the definition and interpretation of appropriate tail time, and since tail time does not consider exposures before and after a population takes shelter, the answer for other scenarios could result in more deaths in the area close to the source of the release than had this area's population not taken shelter at all.

The routine in the TSIP Model allows the user to directly choose the effects threshold level of concern for deciding when to end SIP, an important feature that distinguishes the TSIP routine from the tail time concept. This allows the TSIP routine to implement CSEPP's mandate to focus protective actions primarily on avoiding fatalities.

Because the TSIP routine considers the protection afforded by shelters in deciding when to end SIP, consideration must be given to the variation in ventilation characteristics of the buildings within any area or subzone. To meet this challenge, the routine in the TSIP Model can look at a single air change rate as representative for the area, a choice determined by local officials. Alternately, the routine can look at a range of shelter protection to make an optimum decision. Either is better than ignoring shelter protection factors entirely.

3.2 Best Practices

The following have been determined by the SIPWG to be best practices for an effective SIP termination strategy.

3.2.1 SIP Termination Strategy Best Practice 1:

Use of Modeling to Support a Shelter Termination Strategy. A single model should be used to help decide when and how to end SIP. This model should consider all of the conditions, circumstances, and options that will provide the best decision. In addition, the best decision is one that has the following characteristics:

- Based on when the plume concentration outside becomes less than inside shelters.
- Considers the dose-response relationship that is most relevant to the effects of the agent on a sheltered population.
- Considers exposure before, during, and after SIP.
- Provides information to minimize fatalities.

3.2.2 SIP Termination Strategy Best Practice 2:

Use of Elements of a Public Education Program to Support a Shelter Termination Strategy. Public education must explain the vapor infiltration concern; yet convince the potentially affected population that SIP is a viable action 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 the public should be informed that instructions to terminate SIP might come very soon after the initial direction to take shelter. It is also important that the actual SIP notification messages are consistent with the public education program that explains the SIP

protective action messages, so the public will not be confused or misunderstand what they are being asked to do. The public also needs to be educated about what actions to take to end SIP. It is too simplistic to announce "All Clear." A public education program should convey the following to ensure timely and effective public response to end SIP during an actual emergency:

- **The hazard of concern is primarily a vapor.** The hazard will most likely be an invisible and odorless vapor that is transported downwind as a plume that expands and dilutes as it travels, and eventually dissipates.
- **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 that are in the path of the plume. Thus, as outside air infiltrates the shelter, the protection afforded by the shelter gradually declines. 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 SIP protective actions.** The Army will notify local officials promptly if a chemical accident occurs. These officials will alert and notify the affected population quickly, and instruct them on initial protective actions. Persons who have taken shelter will be told when and how to end SIP when officials have decided that 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, provided that one also ventilates or leaves the shelter immediately when told to do so.
- **SIP must include an exit strategy.** When taking shelter one should bring a radio 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.) 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, to ventilate shelters but remain indoors, to exit from shelters but remain nearby, or to relocate to a designated facility for reasons such as accountability or medical screening.

3.2.3 SIP Termination Strategy Best Practice 3:

Use of Emergency Instructions to Support a Shelter Termination Strategy. An effective shelter termination strategy must include emergency instructions that meet the following criteria:

- **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. Due to 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 terms such 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 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. 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 public while in shelters should be repeated at frequent intervals.** They 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 in the sub-zone to take SIP immediately if they have not yet done so, and reiterate basic SIP instructions. This includes how to use SIP kits if provided, or how to improvise other expedient measures to improve the protection of the shelter.
- **Instructions to the sheltered population should include the time that is optimal for ending SIP,** the preferred way to end SIP for the sub-zone, 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.

3.2.4 SIP Termination Strategy Best Practice 4:

Use of Agreements to support a Shelter Termination Strategy. Army and off-post authorities should formally agree on what information concerning SIP will be exchanged among organizations during an emergency to ensure that this action will be timed and implemented effectively. Agreements should cover protocols and practical details about how the information will be communicated, comparable to arrangements currently in place for making initial 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. The following areas should be considered:

- **The Army should provide projections of optimum shelter termination times for each sub-zone 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 SIP termination PARs and PADs.

- **All emergency response officials should immediately share PADs made within their jurisdiction with all other jurisdictions involved in the response to the accident.** This includes sharing of Army PADs with off-post officials, and vice versa. This will enable all jurisdictions to anticipate the impact that a PAD in one sub-zone will have on other sub-zones regarding mutual assistance with relocating and medically screening persons who were sheltered-in-place. Off-post officials should also inform the Army when the direction to SIP was broadcast in each sub-zone, and how long the officials believe it took or will take the population to execute this PAD. This will enable the Army to provide better PAR updates.
- **The Army should provide PARs to end SIP for each sub-zone affected by the appropriate, agreed-upon toxic hazard levels of concern as soon as possible,** so 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 sub-zone.

3.2.5 SIP Termination Strategy Best Practice 5:

Use of Plans to Support a Shelter Termination Strategy. The Army and each off-post jurisdiction should expand their CSEPP and CAIRA plans to cover the essential elements of a temporary SIP effort. The following should be incorporated in these plans.

- **All 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 that fatalities will be avoided to the maximum extent possible.
- **All plans should discuss education of the public** to understand and respond to instructions to end SIP.
- **All plans should include protocols for sharing SIP termination information with other jurisdictions** as described in formal agreements. This includes feeding information to the Joint Information System and to the Joint Information Center.
- **All plans should include procedures for the timely broadcast of instructions to end SIP,** consistent with the public education effort and pre-planned emergency instructions. This should include consideration for broadcasting the direction to end SIP selectively within certain large sub-zones or in special facilities, especially if that will minimize the potential for fatalities. Consideration also should be given to broadcasting instructions to end SIP in sub-zones where the original PAD was to evacuate, to accommodate those persons who could not or would not evacuate.

- **All plans should provide for support of the sheltered population upon termination of SIP.** This includes the selection of relocation routes to avoid areas that might remain potentially hazardous, and the establishment of relocation and medical screening facilities that might be different from those set up to support an initial evacuation effort.
- **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 terminating 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 also should cover the need to calculate SIP termination PADs for the on-post population** (employees, contractors, visitors, and residents) immediately upon deciding the initial on-post PADs, regardless of the initial PADs implemented on-post. Similarly, the Army plan should provide for the calculation of SIP termination PARs immediately 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 an MCE.

3.2.6 SIP Termination Strategy Best Practice 6:

Use of Exercise Enhancements to Support a Shelter Termination Strategy. It would be beneficial to practice SIP termination decision-making and the dissemination of public instructions and emergency information during CSEPP exercises. The scenario design and extent-of-play agreements in CSEPP exercises should be expanded accordingly. Key SIP elements to exercise include the following.

- Collecting and assessing eyewitness information from the accident site, and monitoring results from the vicinity of the accident site, to support SIP termination recommendations and decisions.
- Deciding when and how to end SIP.
- Translating SIP termination decisions in to clear and timely public instructions and emergency information.
- Broadcasting public instructions via alert and notification systems (e.g., sirens, TARs, and EAS).
- Providing supplemental emergency information and explanation through media other than sirens, TARs, and EAS.
- Simulating feedback from the public and the media, through the public inquiries system and the mock media. Feedback should reflect probable public concerns

and questions based on the local public education program and information generated by players during the exercise response.

3.3 Recommended Changes and Additions to CSEPP Planning Guidance

3.3.1 CSEPP Planning Guidance Recommendation 1:

The *CSEPP Planning Guidance* calls for immediate initial PARs and PADs (within minutes of the detection of a chemical accident), with subsequent immediate alert and notification of the populations at risk (pp. 8–13, F-4, F-5, F-9, and F-10). The general guidance also requires the update of PARs and PADs when circumstances change or when notification instructions to the public need to be expanded, but does not discuss the methods to decide when and how to terminate temporary SIP. The update of PADs is an important consideration, because alert and notification processes are expected to "continue at regular intervals, initiated at least every 12 minutes for the first hour and every 20 minutes thereafter, until the danger to the public is determined to be past." (p. F-10) Therefore, the SIPWIG recommends a change in the PAD to terminate SIP needs to be reflected in changes to the regular alert and notification broadcasts in time for the affected population to respond appropriately.

Protective action decision–making for chemical stockpile emergencies is discussed in Chapters 7 and 8 of the *CSEPP Planning Guidance*. The guidance emphasizes that evacuation is the preferred protective action if it can be accomplished prior to arrival of the agent hazard. It acknowledges, however, that SIP may be preferable in close-in areas under circumstances where time does not permit evacuation before the arrival of the agent hazard[12]. Furthermore, the guidance acknowledges that:

> "… Some chemical emergency scenarios require making decisions for the IRZ [immediate response zone] in less than ideal circumstances. These constraints may require that some jurisdictions plan for more automatic decision-making. Automatic responses such as taking shelter at once, sealing a room, etc., may be needed" (p. 7-2).

The most detailed treatment of protective action decision–making in the CSEPP planning guidance occurs in Appendix D. It advises that:

> "Shelter feasibility is determined by the infiltration rate into the structure and the duration that the structure is in the plume. In general, sheltering is not a good protective action when the accident is of a long duration or if the structure has a high infiltration rate. Moreover, people must vacate or air out the shelter when the plume has passed in order to minimize exposure to chemical vapors that entered the shelter while it was in the plume".

According to Appendix D, these considerations should be taken into account by planners, along with input from hazard analyses and other information, in

[12] *CSEPP Planning Guidance*, May 1966, Appendix D, Protective Action Decision Making, Decision Criteria, page D-4.

constructing a decision matrix that maps accident conditions to protective action recommendations. The decision matrix would link a given set of releases and meteorological conditions to a set of protective actions for the various population groups (e.g., general public, schools, and institutions) in particular preset zones. Public officials could use this matrix to reach decisions quickly in an emergency without time-consuming analysis or weighing of competing factors.

Other than recommending that this planning and coordinating process be performed ahead of time, however, Appendix D does not advise on how to link particular release scenarios or duration estimates to particular protective actions. In particular, it does not directly address the issue of determining when to evacuate or ventilate following a SIP instruction other than to do so after the plume has passed. The SIPWG, therefore, recommends that Appendix D be changed to address these issues.

3.3.2 CSEPP Planning Guidance Recommendation 2:

The Army's guidance on SIP in *Chemical Accident or Incident Response and Assistance (CAIRA) Operations* (DA PAM 50-6) is also vague about the best way to decide when and how to end SIP. This pamphlet says that plans should be made for both monitoring and dispersion modeling to be a part of the hazard assessment supporting the emergency response process (paragraph 3-4c(3)). It also says, "If sheltering is recommended, off-post authorities must be kept advised regarding plume passage." It also says that: "… installations will … provide periodic updates on … changes in protective action recommendations." (Paragraph 3-5c(5)). However, this pamphlet does not address the use of monitoring or dispersion modeling specifically to decide when and how to terminate SIP." Therefore, the SIPWG recommends that this guidance be revised to address use of dispersion modeling for making decisions about when and how to terminate SIP.

3.3.3 CSEPP Planning Guidance Recommendation 3:

The SIPWG has concluded that modeling is an acceptable way to decide when and how to end SIP when definitive monitoring data is not available in time to execute a protective action strategy to minimize fatalities among the sheltered population. Therefore, the SIPWG recommends that CSEPP reaffirm guidance to this effect to clarify any ambiguities in existing CSEPP guidance that suggest otherwise.

3.3.4 CSEPP Planning Guidance Recommendation 4:

The SIPWG has concluded that the best decision to end SIP is one that is based on when the plume concentration outside becomes less than inside shelters, considers the dose-response relationship that is most relevant to the effects of the agent on a sheltered population, considers exposure before, during, and after SIP, and provides information to minimize fatalities. Therefore, the SIPWG recommends that CSEPP adopt these criteria as part of the standard for a SIP decision tool model.

3.3.5 CSEPP Planning Guidance Recommendation 5:

The SIPWG has concluded that the best practices listed in this section concerning public education, emergency instructions, agreements, plans, and exercises are

essential to the success of an effective SIP termination strategy. Therefore, the SIPWG recommends that these best practices be adopted and used to decide when and how to end SIP. The SIPWG further recommends that FEMA and the Army publish guidance to this effect, and provide technical support, as needed, to help the storage site commanders and local officials apply these best practices in ways most suitable for their site and jurisdiction.

3.4 Recommended Changes and Additions to CSEPP Policies

The SIPWG believes that despite the current absence of specific CSEPP policy on the best way to decide when and how to end SIP, and the lack of direction to implement the best practices needed to support a SIP termination strategy, improvements can be made if the recommendations in this section of the report are adopted at each site and within each CSEPP jurisdiction, without a formal mandate to do so. However, if local initiatives are not taken to improve ways to decide when and how to end SIP, and to apply the best practices to implement an effective SIP termination strategy, then appropriate CSEPP policy statements should be published.

4.0 Management of People Following Shelter-in-Place

4.1 Background

Subcommittee 3 of the SIPWG was tasked with studying issues related to the management of people following the use of SIP as a protective action. Many of these issues are relevant regardless of the protective action decision implemented.

The subcommittee concentrated its efforts on six topics, developing an issue paper describing the subcommittee's positions on the following topics:[13]

- Decontamination priorities for sheltered populations
- Screening and decontamination sites for sheltered populations who are subsequently relocated
- Impairments to sheltered populations
- Relocation of special facility populations
- Tracking of populations affected by protective actions
- Handling of companion animals

The first two of these topics received significant comment at and following the 2001 CSEPP National Conference in Portland, OR, where the SIPWG presented its conclusions to that point. While general programmatic guidance on the necessity for decontamination for all exposed populations was not initially considered when the SIPWG was formed, it became clear that the topic required revisiting in light of the strong comments received.

The subcommittee felt strongly that a standard of care lower than that applied to evacuated populations could not be applied to sheltered populations. This affected conclusions on decontamination priorities, and led to the subcommittee's recommendation regarding separate screening sites for sheltered populations (see Section 4.2). The subcommittee realized that resource constraints might not allow establishment of additional sites.

According to the survey conducted via the CSEPP Planners' Web Site following the 2001 CSEPP National Conference, the CSEPP planning community generally agreed that companion animal populations should be considered and that tracking of populations subject to a protective action was desirable. The planning community strongly agreed that planners should consider options for those who cannot evacuate or relocate. The subcommittee feels that this includes special populations other than those in overpressurized facilities.

[13] *Shelter-In-Place Working Group Subcommittee #3 Issue Paper*, June 21, 2001.

Results of SIPWG and subcommittee deliberations, as well as input received from the CSEPP planning community, have been used to develop the following best practices and recommendations for revision of guidance.

4.2 Best Practices

4.2.1 Best Practice Recommendation 1:

The SIPWG recommends that off-post communities establish separate screening and decontamination sites for sheltered populations (or segregate those populations at existing sites) to avoid queuing of sheltered (exposed, potentially contaminated) persons behind evacuees less likely to be exposed.

This may not be an issue where a limited populace is involved (Tooele, UT, Benton Co, WA), but it may become an issue where larger populations are involved. While all CSEPP communities will prioritize victims for care and possible decontamination once they arrive a screening site, those who have relocated following shelter may well be many cars back in a traffic jam approaching a traffic control point or screening site that is also handling evacuees. Therefore, it may be necessary to re-direct sheltered populations to different screening sites where they can be more promptly screened for exposure. This does not necessarily predicate adding additional screening sites. Existing screening sites could be designated to handle specific streams of people, either evacuees or those who are relocating following SIP.

4.2.2 Best Practice Recommendation 2:

The SIPWG recommends that off-post communities prepare plans and notification methods and messages to advise those who cannot relocate upon notice to terminate shelter to exit their shelter if possible, or to ventilate their shelter if exit is not possible, promptly upon receiving notification of the properly timed SIP termination.

Persons sheltering-in-place may exhibit agent symptoms that could impair their ability to drive, particularly at night. Some persons with disabilities may not be able to exit their shelter, and some without transportation may not be able to self-relocate. This does not obviate the need for ventilation and/or for exiting shelters at an appropriate time. Ventilation or exiting may be the only option available to some members of the public; and these options are far better than remaining in a closed-up shelter, as portrayed in Appendix 1 of this report. It should be noted that the same provisions apply to those who were unable to comply with a PAD directing evacuation from an affected area. Therefore, emergency plans must include messages directing people to SIP if evacuation is not possible.

Relocation after shelter is the preferred option for sheltered occupants of special facilities, as well. Special facilities, however, may require additional resources for relocation that may not be immediately available during the initial phases of the incident. If relocation is not feasible, populations should exit shelter; if exit is not possible, ventilation should not be delayed. The population can then most safely await relocation resources or re-entry monitoring resources. This does not apply to facilities

protected by a collective protection pressurization system, since there is no contaminated air exchange with the outside when the facility has been overpressurized.

The SIPWG and a majority of those responding to the survey issued following the SIPWG presentation at the 2001 CSEPP National Conference support the conclusion that planners should consider terminate shelter options for those who cannot relocate. As discussed in section 3.2 of this report, it will be incumbent on the Army to provide the off-post community with the information necessary to appropriately terminate SIP for any given area or facility that has been directed to SIP.

4.2.3 Best Practice Recommendation 3:

The SIPWG recommends that off-post communities include planning for companion animals in response-phase planning, include animal control agencies (public and private) in CSEPP planning, and make full use of public and private facilities for animal sheltering. Agreements with private businesses will facilitate sheltering of animals or those with animals.

Current FEMA general guidance for disasters states that, "if you must evacuate your home, it is always best to take your pets with you." *CSEPP Planning Guidance* specifically mentions that service animals are a priority for decontamination. Given such guidance, and the fact that many people will take their companion animals with them regardless of any guidance to the contrary, emergency planners will need to consider the needs of animals in every aspect of screening, decontamination, victim care, and evacuee support. In all cases, however, care of service or companion animals is secondary to care of humans.

Most communities rely on Red Cross shelters for evacuee support. Red Cross shelters do not accept animals other than service animals. Emergency planners should explore additional options, such as agreements with veterinary colleges or commercial animal-related businesses to satisfy animal care and sheltering needs.

Pueblo, Colorado, authorities have developed a very efficient and effective method for the screening, decontamination, and tracking of animal control populations. Developed in concert with animal control authorities, the Pueblo plan does not utilize resources diverted from care of human populations. As an added benefit, work done for CSEPP has provided local animal control personnel with procedures applicable to non-CSEPP events requiring animal decontamination.

The *Veterinary Services and Animal Care Annex to the Indiana State Emergency Operations Plan*, integrates existing emergency management services with qualified groups that know how to deal with animals in disasters. FEMA's "Exemplary Practices in Emergency Management" program has cited this document. Included in the plan are agreements between governmental and non-governmental entities that could serve as a model for similar agreements in CSEPP communities in other states.

The State of Alabama's Emergency Operations Plan contains a well-written annex, *Emergency Support Function (ESF) # 16 Veterinarian Services and Animal Care*, that delineates an all-hazards approach to animal issues in disasters and includes provision for participation by non-governmental agencies.

An issue paper developed by Subcommittee 3 of the SIPWG includes a table of references and contacts that may be of further use to emergency planners in addressing this issue.[14]

The decision to support planning for companion animals is supported by a significant majority of the respondents to the survey issued following the SIPWG's presentation at the 2001 CSEPP National Conference.

4.2.4 Best Practice Recommendation 4:

The SIPWG recommends that off-post communities ensure that emergency managers will have post-incident access to existing tracking systems or develop tracking systems for populations covered by a protective action decision.

While people that pass through screening sites or report to shelters are routinely documented, emergency managers may not have access to those records in the days, weeks, months, or years following an incident. Red Cross records and those of other voluntary organizations may be considered proprietary; records from screening sites may be covered under medical confidentiality restrictions. Emergency managers may require information on those individuals who have taken a protective action for several reasons, including but not limited to the following:

- Accessing control of sheltered or evacuated zones during re-entry
- Tracking potential long-term health effects on those exposed to agent during the incident
- Reunifying groups of people
- Determining who was actually in a hazard area, or who may have been exposed and may be entitled to submit a claim for compensation

The second of these, tracking health effects, may prove the most important in preventing harm from subsequent accidents or future deliberate attacks involving chemical agents. Accident victim data will likely be the only way of finding out what long-term effects may be expected from low levels of agent exposure. The last of these may prove the most difficult to determine; as time passes, the likelihood of fraudulent claims will increase. If these claims cannot be debunked swiftly, less recovery assistance will be available for those who may actually require it.

The need for this information is largely during the recovery phase of the incident, but if it is not secured in the response phase, it is highly unlikely that it will be

[14] *Shelter-In-Place Working Group Subcommittee #3 Issue Paper*, June 21, 2001, p. 4.

available at all. Emergency managers need to ascertain whether victim information gathered during an incident will be available to them after an incident. One option explored by Subcommittee 3 of the SIPWG for gathering data when information will not otherwise be available is the establishment of a toll-free phone number for reunification inquiries. When people call in, their names and contact information could be gathered and entered into a database. The reunification number could be pre-established and advertised heavily both before and during an emergency. Information thus gathered could also be used to address other concerns. The SIPWG realizes that no tracking mechanism is foolproof or can record everyone who shelters, since some people will not pass through screening stations or call reunification numbers. However, any data set obtained is likely to prove useful following an incident. This conclusion is supported by a significant majority of the respondents to the survey issued following the SIPWG's presentation at the 2001 CSEPP National Conference.

4.3 Recommended Changes and Additions to CSEPP Planning Guidance

The SIPWG recommends that *CSEPP Planning Guidance* be revised and clarified to clearly delineate the difference between "exposed" and "contaminated," and be revised and clarified to state clearly that asymptomatic populations exposed to low levels of nerve agent vapor require screening, but may not require decontamination.

Appendix L of the *CSEPP Planning Guidance* states that:

> "Persons who should be decontaminated at the [decontamination] station include…all people that may have been exposed to mustard or nerve agent, regardless of whether they exhibit signs or symptoms of exposure."[15]

The same is implied in Section 8.17 of the *CSEPP Planning Guidance*:

> "A person exposed to low levels of nerve agent vapor may require *only* decontamination and some observation" [italics added][16]

The terms "exposed" and "contaminated" appear to have been used interchangeably in portions of the guidance. The above references are not supported by source documentation and contradict the second decontamination principle listed in Appendix L:

> "Decontaminate only what is necessary. Decontamination requires a significant amount of time and decontamination material. It is essential that limited decontamination assets be focused on high priority operations."[17]

[15] *CSEPP Planning Guidance*, May 1996, Appendix L, Planning Guidelines for Response Phase Decontamination.
[16] *CSEPP Planning Guidance*, May 1996, Section 8.17, Decontamination
[17] *CSEPP Planning Guidance*, May 1996, Appendix L, Planning Guidelines for Response Phase Decontamination.

Department of the Army Pamphlet 385-61, *Toxic Chemical Safety Standards,* March 31, 1997, states that "the fact that items or materials have been in the presence of agent vapor does not automatically result in the item or materials being contaminated with chemical agent."[18] The *Medical Management of Chemical Casualties Handbook,* developed by the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD), states that "skin decontamination is not necessary after exposure to vapor alone but clothing should be removed because it may contain trapped vapor."[19] This document goes on to say, "liquids and solids are the only substances that can be effectively removed from the skin. It is generally not possible to decontaminate vapor. Removal from the atmosphere containing the vapor is all that is required."[20] The same language appears in the *Textbook of Military Medicine* volume entitled *Medical Aspects of Chemical and Biological Warfare* in the chapter on decontamination.[21] The same volume, in the chapter on nerve agents, states that "*skin decontamination is not necessary after exposure to nerve agent vapor"* [italics from source document] and repeats the point several times in discussion on specific treatments by exposure category.[22]

While an arguable case could be made for precautionary decontamination of symptomatic patients (including the fact that most medical facilities will not accept a patient that has not been decontaminated), decontaminating asymptomatic patients exposed only to low concentrations of nerve agent vapor uses valuable resources and may delay care for symptomatic patients. Effects from vapor exposure to nerve agents occur quickly and are at their maximum within minutes.[23] Exposure to mustard agents may justify precautionary decontamination for asymptomatic patients based on the delayed effects of mustard agent. It should be noted that the most effective decontamination is prompt decontamination. The delay resulting from the time necessary to travel to a screening and decontamination site may detract from the effectiveness of decontamination in those cases where it is truly necessary.

Existing source documents directing decontamination appear to be predicated on symptomatic patients and in many cases assume agent contamination. Source documents examined include the following:

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[18] United States Army, Headquarters, *Department of the Army Pamphlet 385-61, Toxic Chemical Safety Standards,* March 31, 1997, (DA PAM 385-61) 5-1b.
[19] USAMRICD, Chemical Casualty Care Division *Medical Management of Chemical Casualties Handbook, 3rd Edition, July 2000*, p. 113.
[20] Ibid. p. 169.
[21] Hurst, COL. Charles D, MD, *Medical Aspects of Chemical and Biological Warfare, Chapter 15: Decontamination*. Chapter drawn from Sidell, Frederick, Ernest Takafuji, and David Franz (eds*.), Medical Aspects of Chemical and Biological Warfare*, 1997, Office of the Surgeon General, Department of the Army.
[22] Sidell, Frederick R. MD, *Medical Aspects of Chemical and Biological Warfare, Chapter 5: Nerve Agents*. Chapter drawn from Sidell, Frederick, Ernest Takafuji, and David Franz (eds*.), Medical Aspects of Chemical and Biological Warfare*, 1997, Office of the Surgeon General, Department of the Army.
[23] Ibid.

- DA PAM 40-8 *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX*, 4 December 1990[24]
- DA PAM 50-6 *Chemical Accident or Incident Response and Assistance (CAIRA) Operations*, 5 May 1991[25]
- Material Safety Data Sheets for GB[26], VX[27], and HD.[28] (Treatment for inhalation exposures only; does not direct decontamination).

Based on the documentation cited above, the SIPWG feels that a need exists to clarify and revise guidance documents to promote more accurate population screening and to ensure that decontamination resources are effectively and properly used for those with the greatest need.

4.4 Recommended Changes and Additions to CSEPP Policies

The incorporation of the best practices identified in Section 4.2 and changes or additions to guidance recommended in Section 4.3 will not require changes or additions to policy.

[24] United States Army, Headquarters, Department of the Army Pamphlet 40-8 *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX*, 4 December 1990, D-5.
[25] United States Army, Headquarters, Department of the Army Pamphlet 50-6 *Chemical Accident or Incident Response and Assistance (CAIRA) Operations*, 5 May 1991, E.
[26] U.S. Army Chemical Biological Defense Command Edgewood Research, Development, and Engineering Center (ERDEC), *Material Safety Data Sheet for Lethal Nerve Agent (GB)*, 14 September 1988, revised 28 February 1996.
[27] U.S. Army Chemical Biological Defense Command Edgewood Research, Development, and Engineering Center (ERDEC), *Material Safety Data Sheet for Lethal Nerve Agent (VX)*, 14 September 1988, revised 28 February 1996.
[28] U.S. Army Chemical Biological Defense Command Edgewood Research, Development, and Engineering Center (ERDEC), *Material Safety Data Sheet for Distilled Mustard (HD)*, 22 September 1988, revised 28 February 1996.

5.0 Conclusions and Recommended Actions

5.1 Recommendation 1

Public Law 99-145 issued a Congressional mandate for maximum protection to the environment, the public, and all response personnel on- and off-post. *CSEPP Policy Paper Number 1* states that the most important objective of the CSEPP for achieving this mandate is the avoidance of fatalities to the maximum extent practicable. The SIPWG concludes that this is a reasonable and achievable objective and recommends that this goal be reflected in all CSEPP community protective action strategy plans and in CSEPP guidance where appropriate.

5.2 Recommendation 2

The SIPWG concludes that a balanced PASP, developed in the planning phase, is essential to effective and timely protective action decision–making. The SIPWG recommends that every CSEPP community fully document their PASP. The PASP should include a clear explanation of decision criteria, a Concept of Operations for response activities and be institutionalized with a Memorandum of Agreement. The PASP Concept of Operations should be incorporated into on- and off-post emergency plans.

5.3 Recommendation 3

In order to develop or update the PASP for changing conditions, the SIPWG urges that FEMA and the Army continue to develop and improve an appropriate suite of models and decision-making tools to support protective action decision–making. These models should draw from existing approved modeling efforts, and should include the further development of a routine that more accurately depicts the appropriate time to terminate SIP protective actions. The SIPWG recommends that FEMA and the Army develop criteria for evaluating housing stock and estimating evacuation times. These criteria should be reflected in updates to *CSEPP Planning Guidance*. The SIPWG also recommends that policy papers be issued requiring the evaluation of housing stock and the update of evacuation time estimates based on 2000 Census data or other data or updates as appropriate.

5.4 Recommendation 4

The SIPWG concludes that dispersion modeling is essential to developing a PASP in the planning phase, and for making protective action decisions in the response phase when used in concert with other available data, and as provided for in the local PASP. The SIPWG recommends that the use of dispersion modeling in the planning and response phase be clearly identified in a policy paper.

5.5 Recommendation 5

The SIPWG concludes that existing Army and CSEPP guidance defines two capabilities that must be present at each CSEPP site to meet the requirements for alert and notification, and to initiate timely actions to protect the public.

First, each Army site must be able, on a 24-hour basis, to receive CA/I reports, analyze data, assess the seriousness of the event, estimate the impact, alert the command and local officials, and make protective action recommendations. Likewise, each off-post IRZ community should be capable of receiving CA/I information 24 hours per day at their designated warning point and of initiating actions to protect the public. The SIPWG recommends that each CSEPP site community develop an alert and notification standard operating guideline and a rigorous training program for all officials or staff required to give or receive these notifications at their respective EOCs or designated warning points and timely initiate actions to protect the public.

Second, the SIPWG concludes that the initial notification of a CA/I to off-post officials, which includes a Chemical Emergency Notification Level and a PAR, must be completed by the Army within the applicable five- (5) or ten- (10) minute site-specific window. A PAD and the initial broadcast of that decision, with appropriate implementation instructions, must be completed by local officials for populations in the IRZ within 8 minutes after receipt of a PAR from the Army. The SIPWG recommends that the *CSEPP Planning Guidance* be amended where appropriate to state these requirements specifically. These requirements should also be reflected in exercise review and evaluation guidelines.

5.6 Recommendation 6

The SIPWG concludes that a heads-up notification can be very beneficial. The SIPWG recommends CSEPP sites use a "heads-up" notification *only if* it does not delay the installation's Protective Action Recommendation and it can be clearly defined in alert and notification standard operating procedures.

5.7 Recommendation 7

The SIPWG views Memoranda of Agreement as an essential component of a CSEPP community's plans. MOAs foster cooperation and coordination and serve to institutionalize operating guidelines and procedures. The SIPWG recommends that a policy paper be issued requiring the use of MOAs in clearly defined areas where they can provide the most benefit to the CSEPP, i.e., to enhance cooperation regarding alert and notification, information exchange, joint information center operations, protective action decision–making strategies and plans, mutual aid, and recovery/re-entry activities.

5.8 Recommendation 8

The SIPWG has concluded that modeling is an acceptable way to decide when and how to end SIP when definitive monitoring data is not available in time to execute a protective action strategy to minimize fatalities among the sheltered population. Therefore, the SIPWG recommends that CSEPP reaffirm guidance to this effect to clarify any ambiguities in existing CSEPP guidance that might suggest otherwise.

5.9 Recommendation 9

The SIPWG has concluded that a single model should be used at each site to help decide when and how to end SIP, and that this model should consider all of the

conditions, circumstances and options that will provide the best decision. In addition, the SIPWG has concluded that the best theoretical decision is one that is based on when the plume concentration outside becomes less than inside shelters, considers the dose-response relationship that is most relevant to the effects of the agent on a sheltered population, considers exposure before, during, and after SIP, and provides information to minimize fatalities. Therefore, the SIPWG recommends that CSEPP adopt these criteria as part of the standard for a SIP decision tool model.

The SIPWG also recommends that FEMA and the Army develop the routine used in the TSIP proof-of-concept model as a component of the decision tool to decide when and how to end SIP, in order to incorporate these variables in the decision process. The TSIP routine should be linked to dispersion models D2PC and D2-Puff, and be automated to calculate the best time to end SIP for a given level of toxic effect on the sheltered population for each subzone. This combination will produce a single decision tool capable of producing the best results. The enhanced dispersion model with the TSIP routine should, in turn, be integrated in the management information system used to support the local CSEPP community's emergency responses.

It is recommended that the concept of linking the TSIP routine with the approved dispersion models be applied first at one site as a pilot project. After review of the results of this pilot effort, this concept and methodology should be modified as appropriate and applied at the other seven sites.

5.10 Recommendation 10

The SIPWG has concluded that SIP is a valuable protective action option, but one that requires the development and implementation of the best practices listed in Section 3 to ensure the success of the strategy. The consensus of the SIPWG is that the best practices listed in Section 3 concerning public education, emergency instructions, agreements, plans, and exercises should be adopted, regardless of the tools used to decide when and how to end SIP. Therefore, the SIPWG recommends that FEMA and the Army publish guidance to this effect.

5.11 Recommendation 11

The SIPWG has concluded that the TSIP Model used to prove the routine to decide the best time and way to end SIP can also be configured as a stand-alone training and planning tool. In this configuration, the TSIP Model would remain in the manual mode so that new users can experiment with the effect of changing the important variables in the TSIP routine to understand how they impact SIP decisions. This will also help all users understand how the TSIP routine works when linked with D2PC or D2-Puff. The manual TSIP Model can also help planners understand the effect that improvements in plans and capabilities might have on decisions to end SIP, such as the relative benefits of enhancing the protective value of shelters, or improving the time for a population to take SIP. The training and planning version of the TSIP Model can also help users and planners assess the consequences of a SIP response that is less than optimal, such as the implications of delaying departure from shelters.

Therefore, the SIPWG recommends that the TSIP Model be developed as a stand-alone training and planning tool if program finances permit.

5.12 Recommendation 12

The SIPWG has concluded that the management of populations following the termination of SIP raised additional planning issues requiring consideration. As many of these issues are also applicable when evacuation is used as a protective action, the need to address them is clear. Specifically, these issues include:

- Decontamination priorities for sheltered populations
- Screening and decontamination sites for sheltered populations subsequently relocated
- Impairments to sheltered populations
- Relocation of special facility populations
- Tracking of populations affected by protective actions
- Handling of companion animals

While these issues are broad and complex (and may add complications to existing response plans), some CSEPP communities have addressed one or more already. Additional solutions are available from outside CSEPP. Communities may use those efforts as models, or as a starting point toward the development of their own solutions. Therefore, the SIPWG recommends that communities expand their planning efforts—individually and cooperatively—to consider population management issues that may arise when SIP is terminated.

5.13 Recommendation 13

The SIPWG has concluded that the need exists to clarify and revise guidance documents to promote more accurate population screening and to ensure that decontamination resources are effectively and properly used. Existing CSEPP guidance does not sufficiently differentiate between “exposure” and “contamination” when discussing exposure to low levels of nerve agent vapor. Review of source documentation supports the view that decontamination is not necessary for those exposed only to low levels of nerve agent vapor and exhibiting no symptoms of exposure. Valuable and limited decontamination resources need to be reserved for those most in need. Current guidance may lead to unnecessary use of these resources, and a resultant deficiency in care for some with urgent needs for decontamination. Therefore, the SIPWG recommends review and revision of CSEPP planning guidance to differentiate clearly between “exposure” and “contamination” and clearly state that decontamination may not be required for asymptomatic persons exposed only to low levels of nerve agent vapor.

6.0 Distribution List

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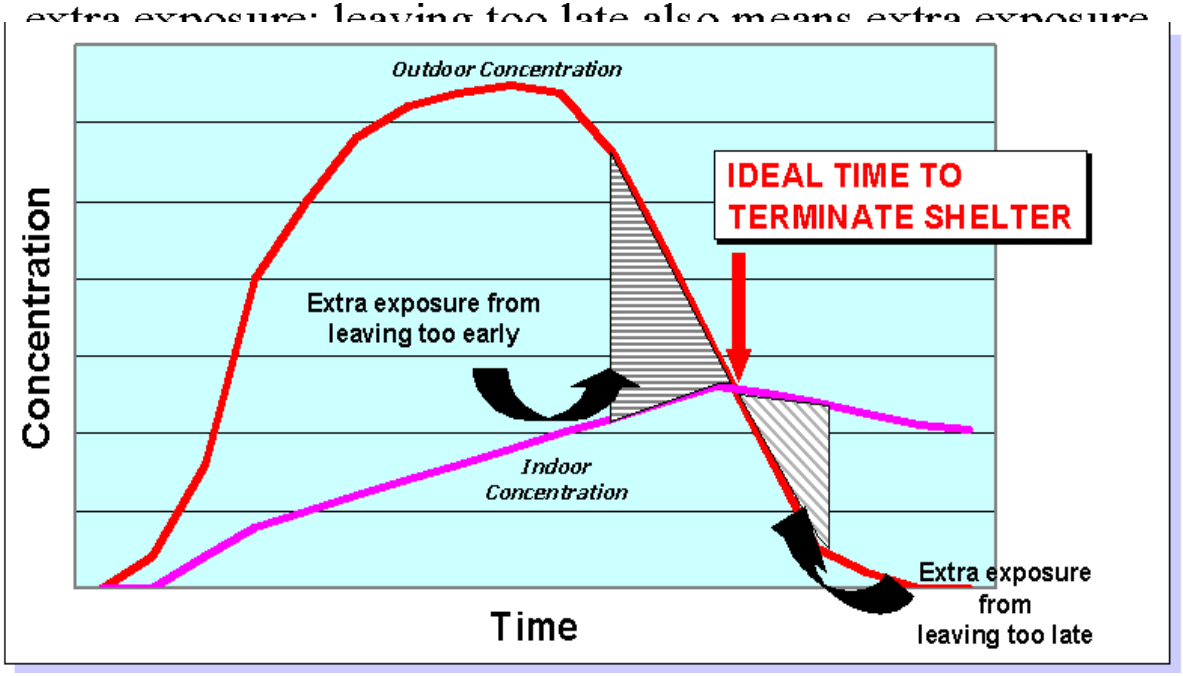
7.0 Glossary

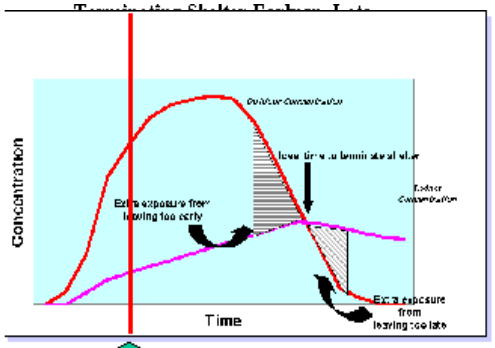
7.1 Acronyms and Abbreviations

ACH	Air Changes per Hour
AEGL	Acute Exposure Guideline Level
ANL	Argonne National Laboratory
ANS	Alert and Notification System
AOC	Army Operations Center
CA/I	Chemical Accident/Incident
CAIRA	Chemical Accident/Incident Response and Assistance
CSEPP	Chemical Stockpile Emergency Preparedness Program
CWA	Chemical Warfare Agents
DA	Department of the Army
D2PC	(Army atmospheric dispersion model)
D2-Puff	(Upgraded Army atmospheric dispersion model)
EAS	Emergency Alert System (formerly Emergency Broadcast System)
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
IEM	Innovative Emergency Management, Inc.
IPT	Integrated Process Team
IRZ	Immediate Response Zone
MCE	Maximum Credible Event
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
NICS	National Institute for Chemical Studies
ORNL	Oak Ridge National Laboratory
PAD	Protective Action Decision
PADRE	Protective Action Dose Reduction Estimator
PAR	Protective Action Recommendation
PASP	Protective Action Strategy Plan
REP	Radiological Emergency Preparedness Program
SBCCOM	Soldier Biological Chemical Command
SIP	Shelter-in-Place
SIPWG	Shelter-in-Place Work Group
TAR	Tone-Alert Radio
TSIP	Terminate Shelter-in-Place
U.S.	United States
USAMRICD	U.S. Army Medical Research Institute of Chemical Defense

Appendix 1: Graphic Representation of Terminate Shelter-in-Place Concept

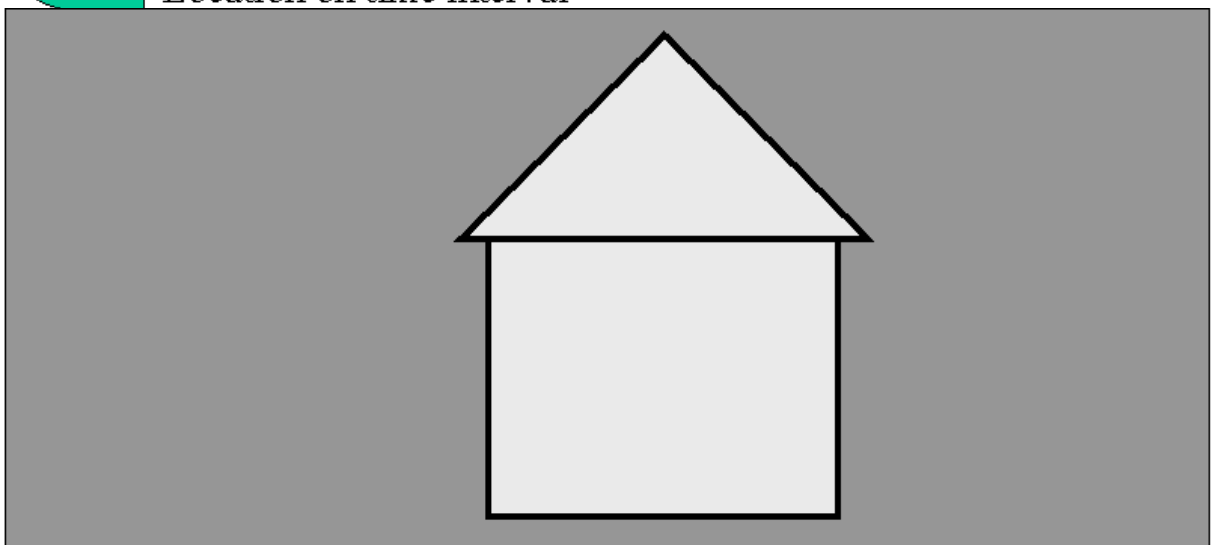
The ideal time to terminate Shelter-in-Place is at the exact point where the agent concentration indoors equals the agent concentration outdoors. Leaving too soon means extra exposure; leaving too late also means extra exposure

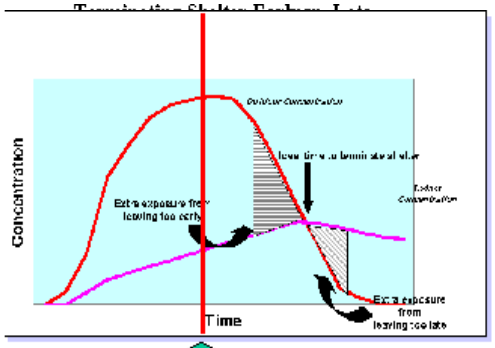




Early on, the vapor concentration inside a shelter is much less than the outside vapor concentration.

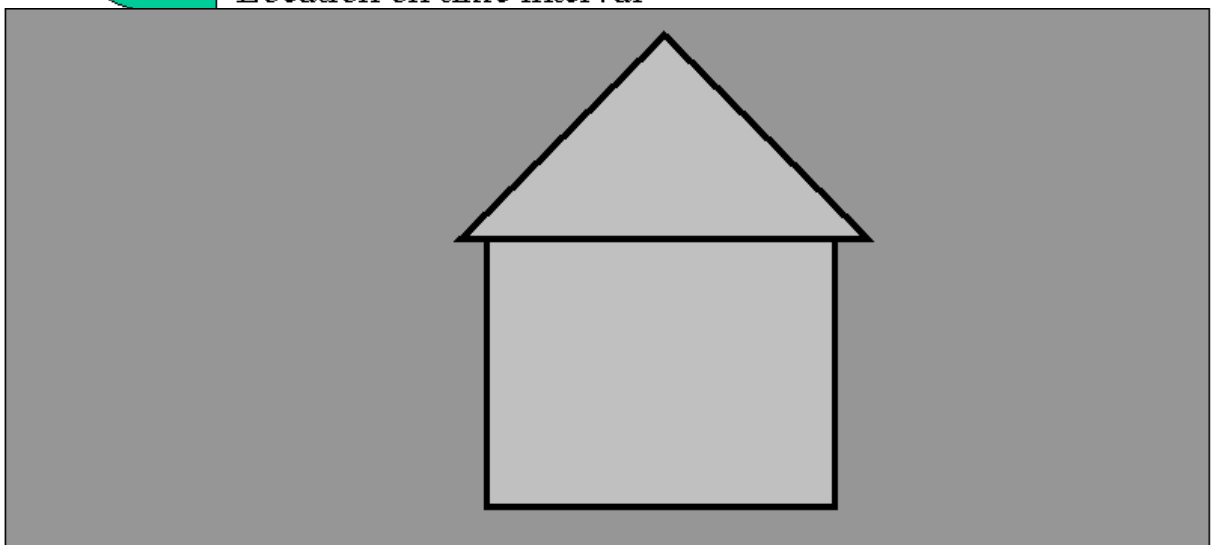
Location on time interval

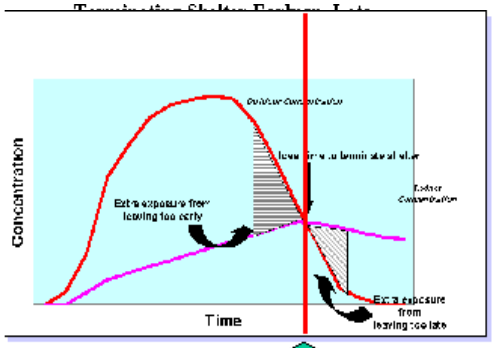




Over time, the vapor concentration inside the shelter increases due to infiltration. However, the shelter continues to offer good protection.

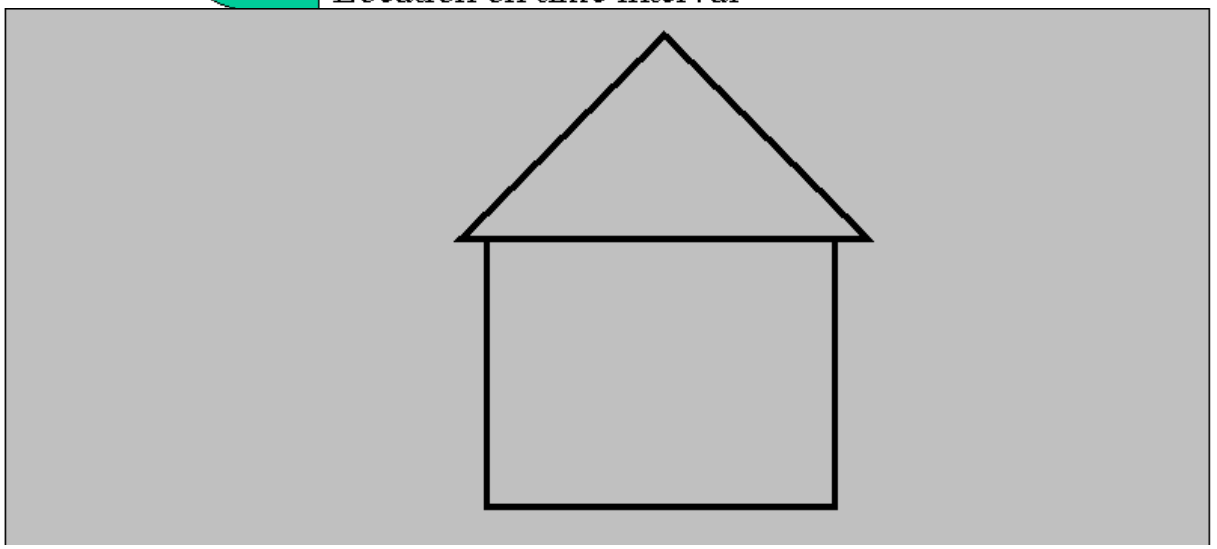
Location on time interval

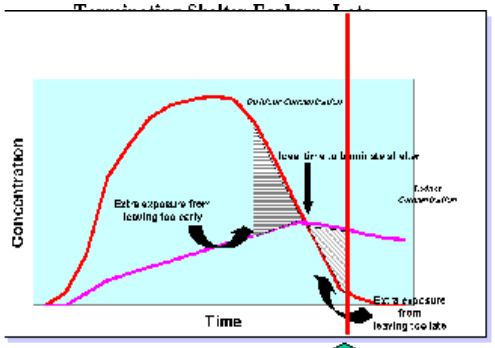




Eventually, the vapor concentration inside the shelter will equal the outside vapor concentration. This is approximately the best time to end shelter in place.

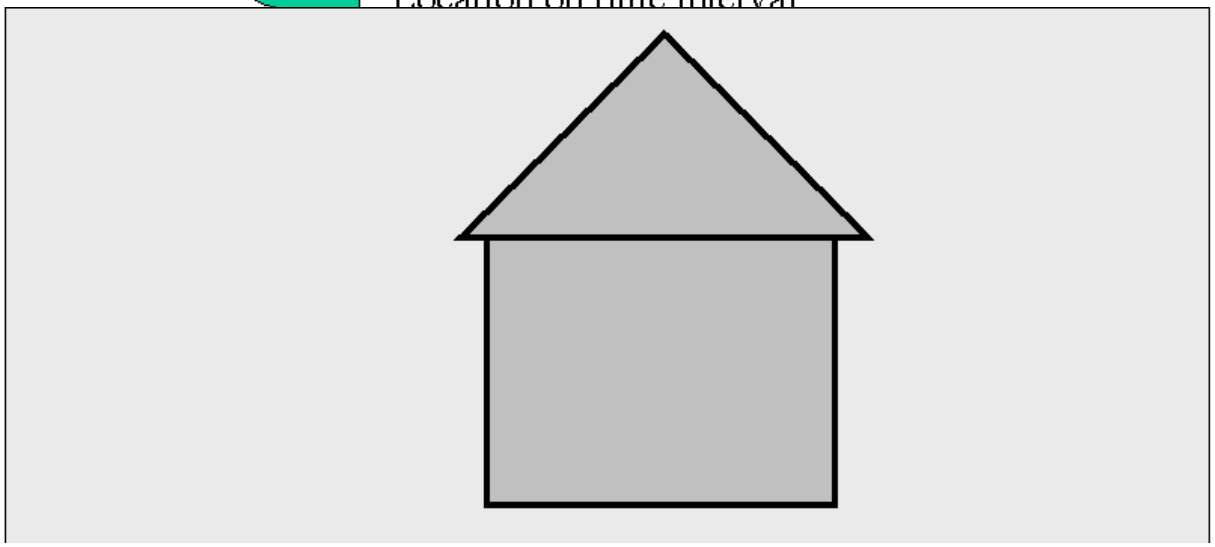
Location on time interval

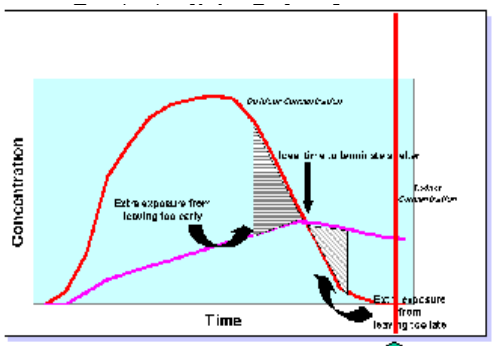




As the outside vapor hazard dissipates, vapor remains trapped inside the shelter.

Location on time interval





Eventually, the outdoor vapor hazard is completely gone but a residual hazard remains indoors until the shelter is ventilated. This is approximately the plume "tail time".