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# SITE-SPECIFIC EMERGENCY RESPONSE CONCEPT PLANS FOR THE CHEMICAL STOCKPILE DISPOSAL PROGRAM: A COMPARATIVE SUMMARY

S. A. Carnes

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S. A. Carnes

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AMC | U. S. Army Materiel Command |
| ANAD | Anniston Army Depot |
| APG | Aberdeen Proving Ground |
| CAIRA | Chemical Accident/Incident Response and Assistance Plan |
| CEHIC | Center for Environmental Health and Injury Control, U. S. Department of Health and Human Services |
| CSDP | Chemical Stockpile Disposal Program |
| CY | calendar year |
| D2PC | U.S. Army atmospheric dispersion code |
| DA | U.S. Department of the Army |
| DHHS | U.S. Department of Health and Human Services |
| EPA | U. S. Environmental Protection Agency |
| EPZ | emergency planning zone |
| ERCP | Emergency Response Concept Plan |
| FEMA | Federal Emergency Management Agency |
| FPEIS | final programmatic environmental impact statement |
| FY | fiscal year |
| GB | chemical nerve agent |
| H | bis (2-chloroethyl) sulfide; a vesicant or blister agent |
| HD | a purified version of H |
| IRZ | immediate response zone |
| kg | kilogram (equals approximately 2.2 lbs) |
| km | kilometer (equals approximately 0.6 mile) |
| lb | pound |
| LBAD | Lexington-Blue Grass Army Depot |
| m | meter |
| MDB | munitions demilitarization building |

| | |
|---|---|
| MHI | munitions handling igloo |
| min | minute |
| ML | most likely meteorological conditions (3 m/s wind speed, D atmospheric stability) |
| MOU | Memorandum of Understanding |
| MPF | metal parts furnace |
| mph | miles per hour |
| NAAP | Newport Army Ammunition Plant |
| ND | no deaths (the distance beyond which fatalities would not be expected) |
| ORNL | Oak Ridge National Laboratory |
| PAZ | protective action zone |
| PBA | Pine Bluff Arsenal |
| PM Cml Demil | Program Manager for Chemical Demilitarization |
| PUDA | Pueblo Depot Activity |
| PZ | precautionary zone |
| REP | radiological emergency planning (concept used in emergency planning for fixed-site nuclear power facilities |
| SCBA | self-contained breathing apparatus |
| TEAD | Tooele Army Depot |
| UMDA | Umatilla Depot Activity |
| USANCA | U.S. Army Nuclear and Chemical Agency |
| USNRC | U.S. Nuclear Regulatory Commission |
| VS | very stable meteorological conditions (1 m/s wind speed, E atmospheric stability) |
| VX | nerve agent |

## ABSTRACT

Site-specific emergency response concept plans were developed to help initiate enhanced emergency preparedness for continued storage of the stockpile and the Chemical Stockpile Disposal Program (CSDP) at the eight Army installations storing the unitary chemical stockpile—Aberdeen Proving Ground, Anniston Army Depot, Lexington-Blue Grass Army Depot, Newport Army Ammunition Plant, Pine Bluff Arsenal, Pueblo Depot Activity, Tooele Army Depot, and Umatilla Depot Activity.

This document summarizes the emergency response plans for all the sites and highlights similarities and differences among them. Section 2 summarizes site-specific differences in stockpile hazard and risk by showing differences in planning-basis accident categories and distributions of topographical features, meteorological conditions, and populations at risk. Section 3 presents a summary of the methodology used to identify the emergency planning zones for each site and the actual recommended boundaries of those zones for the eight sites. Section 4 identifies feasible and recommended protective actions for the sites and explains reasons for differences in them. Finally, Section 5 notes the dependence of protective action effectiveness on the development and implementation of command and control and warning systems that can be implemented in a timely manner; it also identifies the differences in recommended lead times (i.e., from the onset of an accidental release) needed at the sites for effective implementation of protective actions.

# 1. INTRODUCTION

## 1.1 PURPOSE OF THE SITE-SPECIFIC CONCEPT PLANS

Site-specific emergency response concept plans were developed to help initiate enhanced emergency preparedness for continued storage of the stockpile and the Chemical Stockpile Disposal Program (CSDP) at the eight U.S. Army installations storing the unitary chemical stockpile—Aberdeen Proving Ground (APG) (Carnes et al. 1989b); Lexington-Blue Grass Army Depot (LBAD) (Carnes et al. 1989c); Newport Army Ammunition Plant (NAAP) (Carnes et al. 1989d); Pine Bluff Arsenal (PBA) (Carnes et al. 1989e); Pueblo Depot Activity (PUDA) (Carnes et al. 1989f); Tooele Army Depot (TEAD) (Carnes et al. 1989g); and Umatilla Depot Activity (UMDA) (Carnes et al. 1989h). This document summarizes those plans and highlights differences among them.

The main purpose of the concept plans is to act as a preliminary aid to decision-making regarding the implementation of enhanced emergency planning and preparedness at the eight sites. The Army recognizes that there is no set plan that is applicable to all program sites. Variations in population distribution, political boundaries, topographical features, risk, and accident potential all create a situation in which options and alternatives are both needed and potentially available. It is the responsibility of state and local governments to shape the emergency preparedness mitigation program. The Army can provide resources and expertise but cannot impose an arbitrary program on the local communities.

To achieve that purpose the major thrust of the concept plans is to identify major decisions that need to be made and to provide preliminary data and analyses that can help in making informed decisions. Where feasible, they identify decision options and present the advantages and disadvantages regarding each option. Where information is compelling, recommendations are offered, but in the spirit that other outcomes will not be automatically dismissed or ignored.

The two major decisions that are addressed in the concept plans are defining the boundaries of emergency planning zones (EPZs) and selecting protective action strategies to protect human health and safety. The definition of planning zones follows the basic concept set forth in the Emergency Response Concept Plan (ERCP) (Jacobs Engineering Group, Inc., and Schneider EC Planning and Management Services 1987) of an inner immediate response zone and a larger protective action zone; there is also an outer zone, termed the precautionary zone in the ERCP, where sufficient time should be available to implement appropriate protective action without significant prior planning. The protective action strategies and decisions have been discussed in two preliminary technical reports (Chester 1988; Sorensen 1988). Additional work that is under way expands on the analysis of protective actions as well as on other matters that will have a bearing on the technical basis for planning. As these materials are completed, they will be made available to federal, state, and local officials engaged in the emergency planning process.

## 1.2 BACKGROUND AND OVERVIEW OF THE EMERGENCY PLANNING AND PREPAREDNESS PROGRAM

This program is outlined in the *Final Programmatic Environmental Impact Statement for the Chemical Stockpile Disposal Program* (U.S. Army 1988). As defined in that document, major activities to be undertaken include the following:

- development of a new command/control, communication, and decision-making structure;
- development of an improved technical planning basis;
- development of improved emergency operating procedures;
- development of improved exercise design and evaluation;
- conducting emergency exercises;
- establishment of an oversight review board;
- coordination with appropriate state and federal agencies; and
- development of a program to implement other emergency preparedness improvements.

This program is to be implemented at the eight storage/disposal sites to reduce adverse health and environmental effects in the event of the accidental release of chemical agent. The program will be based on the ERCP, which identified options for improving preparedness for accidents under all programmatic disposal alternatives. The programmatic Record of Decision, issued by Under Secretary of the Army James R. Ambrose on February 23, 1988, specified that on-site disposal was the alternative to be pursued at each site. The site-specific concept plans address the framework for improving emergency preparedness for storage and disposal activities at the sites in a much more specific and focused manner than was possible in the ERCP.

After the programmatic Record of Decision was rendered, the U.S. Department of the Army (DA) and the U.S. Federal Emergency Management Agency (FEMA) developed a Memorandum of Understanding (MOU), signed in August 1988, the purpose was to establish a framework of cooperation to identify their agencies' respective roles and responsibilities for emergency response preparedness involving the storage and ultimate disposal of chemical warfare materials and to establish joint program efforts in emergency response planning, training, and information exchange. The MOU also identified roles and responsibilities for the U.S. Department of Health and Human Services (DHHS) and the U.S. Environmental Protection Agency (EPA) and set up a FEMA/DA Joint Steering Committee to review the status of joint programs, discuss and resolve issues, consult on major policy issues, and provide the necessary direction to meet the Army's overall program goals.

With the assistance of FEMA, other federal agencies, and contractor organizations, the Army is in the process of upgrading the off-site or civilian emergency plans and procedures at each of the sites, analyzing training needs, evaluating communication system needs, and investigating warning system needs. These activities, however, are fragments of a larger picture. The overall emergency planning and preparedness program for the stockpile and its disposal is comprehensive and multifaceted.

Although some of the activities can be and are being pursued simultaneously, there are interdependencies among many of the activities that dictate a temporal flow to the program, as depicted in Fig. 1.1. Phase I of the program (scheduled to occur between January 1987 and June 1990) is to provide an interim upgrade of off-post emergency planning using existing community resources and to develop and conduct chemical accident medical training courses for emergency workers; Phase I also includes studies analyzing equipment needs for communications and public alerting, and an initial analysis of program training needs. Phase II of the program (scheduled to occur between April 1988 and January 1991) includes the preparation of various technical studies to support local decision making and form the basis for program guidance and the definition of standards and criteria to be used to determine the adequacy of comprehensive emergency plans and preparedness for the program; ongoing and scheduled technical studies and the dates by which results are anticipated to be available to emergency planning program participants are shown in Table 1.1. Phase III of the program (scheduled for April 1988—June 1993) constitutes the implementation of the program. It includes the preparation of site-specific concept plans; the determination of planning,

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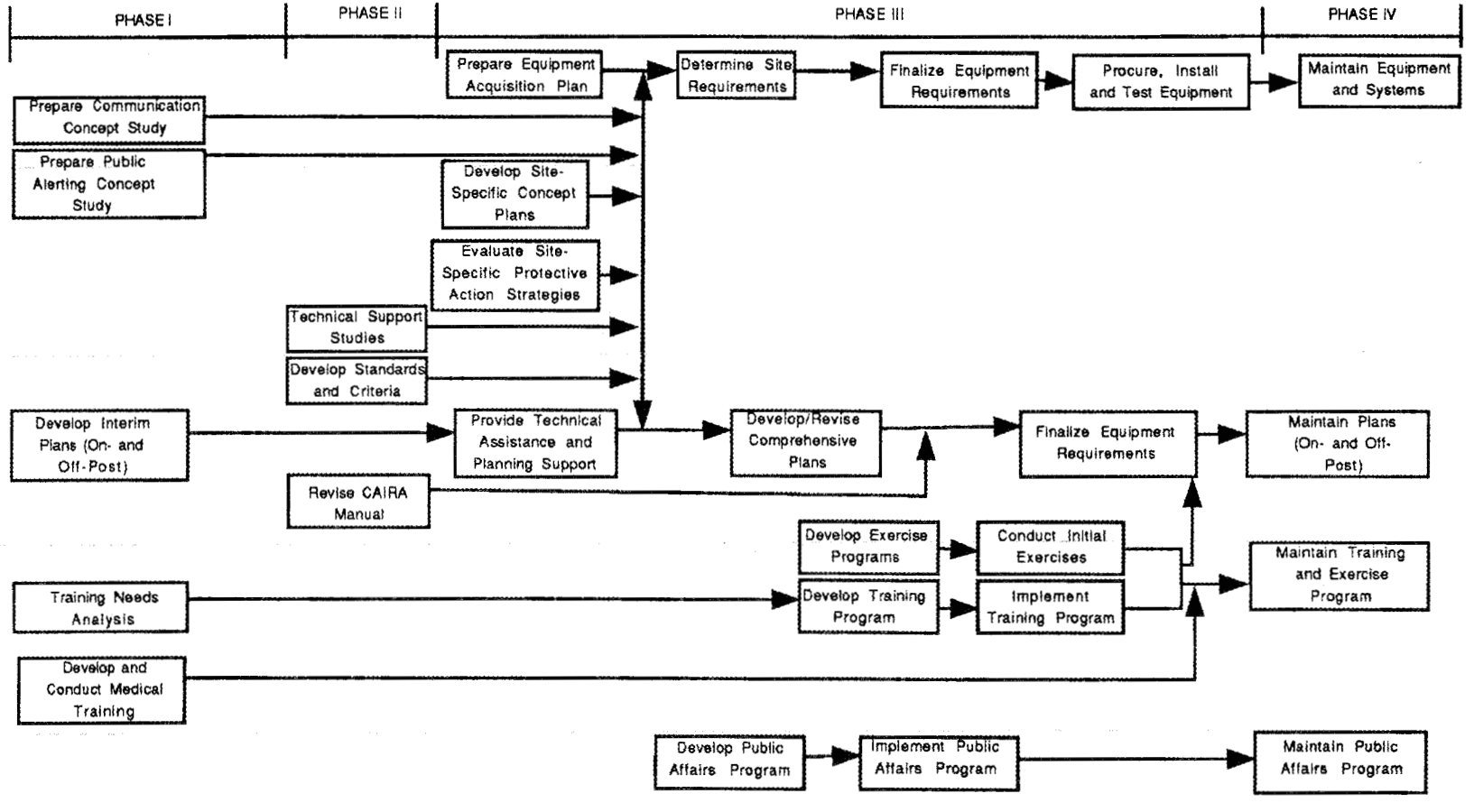


**Fig. 1.1. Chemical Stockpile Disposal Program emergency planning and preparedness program activities.**

**Table 1.1 Technical Support Studies**

| Study | Status | Results expected |
|---|---|---|
| Accident Assessment | In progress | FY 1989 |
| Protective Action Effectiveness | In progress | FY 1990 |
| Public Education/Risk Communication Strategy Plan | In progress | FY 1990 |
| Decision Making System | In progress | FY 1990 |
| Atmospheric Dispersion Model Review | In progress | FY 1990 |
| Reentry Planning | In progress | FY 1990 |
| Review of Protective Equipment for Civilian Workers | Scheduled | FY 1990 |
| Public Education Program Technical Support | Scheduled | FY 1990 |
| Develop Warning System Evaluation Methodology | Scheduled | FY 1990 |
| Protocols for Biological Monitoring | Scheduled | FY 1990 |
| Evacuation Studies | Scheduled | FY 1990-91 |
| Evaluation of Site-Specific Protective Action Strategies[1] | Scheduled | FY 1990-91 |
| Development of a Computer-Based Emergency Information System | Scheduled | FY 1990-91 |
| Agent Contamination of Porous Media | Scheduled | FY 1991 |
| Agent Contamination of Agricultural Resources | Scheduled | FY 1991 |

[1] This is shown as a separate activity in a draft management plan for the CSDP Emergency Planning and Preparedness Program.

equipment and training needs required to satisfy the standards and criteria established during Phase II; the acquisition, installation and testing of equipment and training of emergency response organizations and personnel in its use; and the implementation of comprehensive planning, training, and exercise programs. Phase IV, comprising maintenance and support of the major preparedness programs, is planned to start in June 1991 and last until the lethal agent stockpile is eliminated (scheduled for April 1997).

## 1.3 OBJECTIVES OF EMERGENCY PREPAREDNESS

The emergency preparedness and planning concepts summarized here and developed in the site-specific concept plans are guided by three fundamental program objectives, including

- loss reduction,
- community participation, and
- functional equivalency.

Loss reduction, as measured primarily by avoidance of fatalities given an accidental release of chemical agent, is obviously the most important objective of the concept plan and implementation process. Thus, whenever feasible, decisions should be based on concern for public safety. A second goal is to obtain a preparedness strategy and capability that is publicly acceptable and, thus, workable. Thus, the goal of community participation is that the citizens affected by the emergency preparedness mitigation become part of the planning process. Finally, since there are a total of eight storage/disposal sites, the allocation of resources cannot be biased toward any given site. Each site, however, has different needs and may opt for different approaches. It is therefore important that each site receive enhancements that are more or less equivalent from a functional perspective, and that they not be resources that are functionally equivalent. The equitable distribution of resources should also contribute to public acceptance of the emergency preparedness program.

## 1.4 ALTERNATIVE LEVELS OF ENHANCED PREPAREDNESS

One means of viewing enhancement is to define three different preparedness levels:

- minimum,
- current state-of-the-art practice, and
- maximum protection.

While no functional criteria for defining these three levels have been specified, they can be qualitatively defined as follows. The minimum effort would be to upgrade preparedness by making the most of available resources within each community and installation. Limited improvements in equipment would be feasible where it is deemed that equipment is obsolete.

The current state-of-the-art practice would involve implementing a preparedness level similar to that found for commercial nuclear power plants around the country. The basis for this level of preparedness is defined in NUREG 0654/FEMA REP 1 (USNRC 1980).

The maximum protection level would involve developing a system that would prevent as much loss as possible under all envisionable, but credible, accident scenarios. This would likely have a very high price tag (and may, in fact, assume unlimited resources) and may be very intrusive on a community's everyday functioning.

## 1.5 OVERVIEW OF EACH SITE-SPECIFIC CONCEPT PLAN

Section 1 of each plan presents information regarding the overall emergency response planning program. It orients the reader to the total program and the role of the concept plan in the overall effort.

Section 2 of each plan presents information on the distribution of credible accidents that could occur at an installation. Accidents are described with respect to cause, type of release,

duration of release, and downwind hazard consequences. From the distribution, planning basis accidents are developed. These represent accident categories that describe similar classes of events.

Section 3 of the plan examines characteristics of the site. Relevant characteristics include site topography, local meteorological conditions, population distributions, and special or institutional populations such as schools and hospitals.

Section 4 addresses the delineation of emergency planning zones, including the immediate response, protective action, and precautionary zones. A base case is developed for each zone, along with a rationale for the boundaries. Alternative boundaries are also presented with arguments for the deviation from the base case.

Section 5 identifies protective action options for the population surrounding the proposed disposal site. The analysis defines what are considered to be legitimate options for varying distances from the facility or potential accident site. Protective actions for the general population are differentiated from those applicable to institutional populations.

The last section defines the direction for the program. Program standards, major uncertainties, program decisions, and program schedule are discussed in turn. Designing command/control and warning systems that are capable of providing warning and protective action recommendations within a very short period of time is identified as an essential program standard. The timing of the program is intimately tied to decision outcomes. Although estimates can be made regarding the timing of certain activities (e.g., the timing of Phases I—IV noted previously), the actual schedule is unknown until decisions are actually made.

## 1.6 OVERVIEW OF THE SUMMARY AND COMPARISON OF CONCEPT PLANS

This report summarizes the eight site-specific concept plans. Section 2 summarizes site-specific differences in stockpile hazard and risk by portraying differences in planning-basis accident categories and distributions of topographical features, meteorological conditions, and populations at risk. Section 3 presents a summary of the methodology used to identify the emergency planning zones for each site and the actual recommended boundaries of those zones for the eight sites. Section 4 identifies feasible and recommended protective actions for the sites and explains reasons for their differences. Finally, Section 5 notes the dependence of protective action effectiveness on the development and implementation of command and control and warning systems that can be implemented in a timely manner; it also identifies the differences in recommended lead times (i.e., from the onset of an accidental release) needed at the sites for effective implementation of protective actions.

# 2. SITE-SPECIFIC RISK DISTRIBUTION

Emergency planning, which includes the selection of protective actions, warning, and communication systems, organizational planning, and public education and information, should be based on the hazards posed by the installation's stockpile and its disposal. These hazards, in turn, are based largely on characteristics of the stockpile, the distribution of potential accidental releases associated with interim storage and disposal activities and associated external events (e.g., earthquake and airplane crash), the distribution of natural features that can affect an agent release (e.g., topographical features and meteorological characteristics), and the distribution of people and resources (e.g., homes, schools, and hospitals) potentially affected by an accidental release.

## 2.1 PLANNING-BASIS ACCIDENT CATEGORIES

Planning-basis accident categories were developed for each of the eight installations. The categories were based on the distribution of accidental releases for each site as identified in the risk analysis prepared for the Final Programmatic Environmental Impact Statement (FPEIS) for the CSDP (MITRE Corporation 1987). Even though it is possible that this risk analysis did not identify every accident that could occur (which is true of any risk or hazard analysis), these distributions represent a reasonable range of accidental releases for planning purposes.

The planning-basis accident categories were developed principally on the basis of variation in lethal downwind distance among identified accidental releases at the sites and the duration of those releases. These variables circumscribe the variation in potential hazard for which planning should take place. The downwind distances are those that would result from the release occuring during slow wind speeds and stable meteorological conditions (1 m/s, E stability). The duration accounts for both instantaneous type releases (resulting in a puff of agent) and long-term continuous releases (resulting in a plume). Table 2.1 presents the ranges for variables of interest for all identified releases for all of the sites.

After screening the full distribution of potential accidents at each plant, planning-basis accident categories were developed to simplify the emergency planning process (see Table 2.2).

**Table 2.1 Range of values for relevant accident variables**

| Installation | Probability | | Duration (min) | | No death downwind (1 m/s E stability) distance (km) | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| APG | $10^{-8}$ | $10^{-5}$ | 10 | 360 | 1.4 | 17.5 |
| ANAD | $10^{-10}$ | $10^{-5}$ | 0 | 360 | 0.7 | >100.0 |
| LBAD | $10^{-10}$ | $10^{-5}$ | 0 | 360 | 0.8 | 17.5 |
| NAAP | $10^{-9}$ | $10^{-5}$ | 10 | 360 | 0.7 | >100.0 |
| PBA | $10^{-10}$ | $10^{-4}$ | 0 | 360 | 0.6 | >100.0 |
| PUDA | $10^{-10}$ | $10^{-4}$ | 12 | 360 | 0.7 | 56.2 |
| TEAD | $10^{-10}$ | $10^{-4}$ | 0 | 360 | 0.6 | >100.0 |
| UMDA | $10^{-10}$ | $10^{-4}$ | 0 | 360 | 0.6 | >100.0 |

**Table 2.2 Planning-basis accident categories for Chemical Stockpile Disposal Program installations**

| Category | Installation | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | APG | ANAD | LBAD | NAAP | PBA | PUDA | TEAD | UMDA |
| Small release | No off-site fatalities | No off-site fatalities | No off-site fatalities | No off-site fatalities | No off-site fatalities | No off-site fatalities | No off-site fatalities | No off-site fatalities |
| Moderate short-term release | Fatalities confined within 10 km | Fatalities confined within 15 km | Fatalities confined within 10 km | Fatalities confined within 25 km | Fatalities confined within 15-20 km | Fatalities confined within 15 km | Fatalities confined within 15-20 km | Fatalities confined within 10 km |
| Moderate long-term release | Fatalities confined within 10 km | Fatalities confined within 15 km | Fatalities confined within 10 km | Fatalities confined within 25 km | Fatalities confined within 15-20 km | Fatalities confined within 15 km | Fatalities confined within 15-20 km | Fatalities confined within 10 km |
| Large short-term release | Fatalities confined within 25 km | Fatalities confined within 35 km | Fatalities confined within 25 km | Fatalities possible beyond 25 km | Fatalities possible beyond 15-20 km | Fatalities confined within 60 km | Fatalities possible beyond 15-20 km | Fatalities possible within 30 km |
| Large long-term release | NA[a] | Fatalities confined within 35 km | Fatalities confined within 25 km | NA | Fatalities possible beyond 15-20 km | Fatalities confined within 60 km | Fatalities possible beyond 15-20 km | Fatalities possible within 30 km |
| Very large release | NA | Fatalities possible beyond 35 km | NA | NA | NA | NA | NA | Fatalities possible beyond 100 km |
| Other | NA | NA | NA | Earthquake-based continuous release with fatalities beyond 25 km | NA | NA | NA | NA |

[a] NA = not applicable

## 2.2 DISTRIBUTION OF TOPOGRAPHICAL FEATURES AND METEOROLOGICAL CHARACTERISTICS

Given an accidental release of chemical agent, surrounding topography and meteorological conditions will affect the dispersion of the agent. The site-specific concept plans identify how significant topographic features may affect an agent release and the distribution of prevailing meteorological conditions near the storage areas and proposed plant sites.

### 2.2.1 Topographical Features

As would be expected, there is substantial variability among the eight sites with respect to both the existence and magnitude of topographic features that could affect an agent release. For each concept plan, topographic features in the area surrounding the site are identified, and those features that could affect a release are addressed. Table 2.3 summarizes only those features that could affect a release. It should be noted that the effects of these features are most pronounced for ground-level releases with little initial upward velocity occuring during light winds and stable atmospheric conditions. Under other conditions, horizontal and vertical mixing would be such that the effects of topographic features would be reduced.

### 2.2.2 Atmospheric Dispersion of Agent and Site Meteorology

Each concept plan presents a discussion of the use of the D2PC atmospheric dispersion code (Whitacre et al. 1986) as a useful analytical tool for planning purposes. It is acknowledged that this code may be inappropriate for use in real-time conditions of an agent release (ongoing technical efforts to develop a dispersion code for real-time use are acknowledged).

The distribution of meteorological conditions around each site is presented. These conditions include wind speed, wind direction, and atmospheric stability class. For sites for which data on recent conditions in nearby areas are not available, it is acknowledged that such data are being collected for future environmental documentation for the CSDP and should be considered for subsequent emergency planning efforts. Although dominant meteorological conditions (e.g., wind direction) are identified, they should not be assumed for emergency planning purposes— planning must take place for all directions from the storage area/proposed plant site.

## 2.3 POPULATION AT RISK

Each concept plan identifies population distribution in the vicinity of the installation in terms of residential or nighttime population, daytime population, institutional population (e.g., schools and hospitals), and other special populations such as transients and people located in the vicinity for recreational purposes. The most recent data are presented for residential population (in radial sectors at relevant distances), and data for schools and hospitals are reported for each installation. The data are presented for varying distances for the installations since the hazard potential at some installations is greater at some than at others.

It is stressed that these and other data (e.g., places of employment and nursing homes) should be reviewed and/or collected by local agencies to ensure accuracy. Summary data concerning these populations for each site are presented in Tables 2.4–2.7. Communities within specified distances from the installation are also identified, with their populations and distances from the installation. The population near CDSP installations is distributed as

follows: 19,765 at <5 km; 89,211 at 5-10 km; 383,483 at 10-20 km; and 1,348,894 at 20-35 km.

**Table 2.3 Topographic features near Chemical Stockpile Disposal Program installations relevant to emergency response**

| Installation | Major topographic features |
|---|---|
| APG | Although there are no topographic features that would affect agent dispersion, the water bodies surrounding the site (e.g., Chesapeake Bay, Bush River, and Gunpowder River) would affect meteorology and thereby affect the agent release. Ravines associated with creeks and their inlets may exert some minor pooling and channeling effects under stable meteorological conditions. |
| ANAD | The lethal downwind distance of a release would be substantially less than predicted under stable meteorological conditions because of the rolling and heavily vegetated hills in the immediate vicinity of the site. In addition, the northeast-southwest trending valleys and ridges and the broad valley of the Coosa River would direct agent dispersion in those directions. |
| LBAD | Although there are no features in the immediate area of the site that would affect agent dispersion, the Kentucky River and its bluffs, the Red River and its smaller bluffs, and the mountains in the Daniel Boone National Forest would affect agent dispersion. The rivers and their bluffs would reduce the further dispersion of agent in those directions, and the mountains would tend to act as a barrier and result in pooling in the foothills area. |
| NAAP | Other than the valley associated with the Wabash River, there are no significant topographic features that would affect an agent release. Under stable meteorological conditions and light winds, the valley would pool a release and allow the agent to move up or down the valley. |
| PBA | Other than the valley associated with the Arkansas River and the dense vegetation immediately surrounding the site, there are no significant topographic features that would affect an agent release. Under stable meteorological conditions, the vegetation would reduce the amount of agent available for further downwind dispersion, and the valley would pool a release and allow the agent to move up or down the valley. |
| PUDA | There are no topographic features that would significantly affect agent dispersion. For non-buoyant ground-level releases under stable meteorological conditions and light winds, the general upslope of the terrain from east to west would tend to cause an upslope flow from the east-southeast during the day and a downslope from the west at night. |
| TEAD | The mountains surrounding TEAD-S would function as a barrier that could contain much of the agent within the Rush Valley, particularly for non-buoyant ground-level releases during stable meteorological conditions and light winds. For very large releases, agent could travel into Tooele Valley and Cedar Valley. |
| UMDA | The topographic feature in the immediate vicinity of the site that could affect an agent release is Coyote Coulee, a gulch running in a southwest-northeast direction; for a small release under stable atmospheric conditions, this feature would tend to act as a barrier and channel the release in the direction of the town of Umatilla, whereas a larger release under similar conditions would tend to bifurcate, with part moving toward Umatilla and the remainder moving toward Hermiston. At a greater distance, the Columbia River and the mountains south and north that parallel the river would tend to channel winds along its west-southwest to east-northeast orientation. |

**Table 2.4 Estimated population around the Chemical Stockpile Disposal Program installations**

| Installation | Incremental population at specified distances (km) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0-1 | 1-2 | 2-5 | 5-10 | 10-20 | 20-35 | 35-50 | 50-100 |
| APG[a] | 0 | 0 | 13,092 | 30,962 | 159,807 | 930,177 | NA[b] | NA |
| ANAD[a] | 0 | 0 | 1,771 | 20,478 | 81,361 | 93,007 | 123,933 | 1,233,892 |
| LBAD[a] | 0 | 20 | 1,637 | 25,192 | 30,268 | 72,852 | NA | NA |
| NAAP[c] | 43 | 118 | 774 | 3,564 | 16,511 | 80,862 | 196,387 | 836,055 |
| PBA[a] | 0 | 0 | 1,090 | 5,494 | 66,977 | 39,092 | 211,282 | 497,080 |
| PUDA[c] | 0 | 6 | 62 | 346 | 5,246 | 110,574 | 11,921 | 366,382 |
| TEAD[a] | 0 | 0 | 2 | 99 | 967 | 22,910 | 152,737 | 1,001,652 |
| UMDA[c] | 0 | 10 | 295 | 3,730 | 20,236 | 4,599 | NA | NA |

[a] Estimated 1986 population.
[b] NA = not appropriate.
[c] 1980 data.

**Table 2.5 Population distribution near Chemical Stockpile Disposal Program installations**

| Installation | Downwind distance category | | | | Total population within 35 km |
|---|---|---|---|---|---|
| | <5 km (%) | 5-10 km (%) | 10 - 20 km (%) | 20-35 km (%) | |
| APG | 1.2 | 2.7 | 14.1 | 82.0 | 1,134,038 |
| ANAD | 1.2 | 10.1 | 41.5 | 47.2 | 196,925 |
| LBAD | 1.3 | 19.4 | 23.3 | 56.1 | 129,969 |
| NAAP | 0.9 | 3.5 | 16.2 | 79.4 | 101,872 |
| PBA | 1.1 | 4.7 | 60.9 | 33.3 | 113,041 |
| PUDA | 0.1 | 0.3 | 4.5 | 95.1 | 116,234 |
| TEAD | 0.0 | 0.5 | 4.6 | 94.8 | 20,404 |
| UMDA | 1.1 | 12.9 | 70.1 | 15.9 | 28,870 |
| Average | 0.9 | 6.8 | 29.4 | 63.0 | 230,169 |
| Standard deviation | 0.5 | 6.3 | 23.6 | 27.6 | 345,653 |
| Total | | | | | 1,841,353 |

**Table 2.6 Students and staff around the Chemical Stockpile Disposal Program installations**

| Installation | Distance from installation (km) | Students | Staff |
|---|---|---|---|
| APG | 10 | 8,559 | 842 |
| ANAD[a] | 35 | 10,603 | 181 |
| LBAD | 25 | 27,669 | 3,232 |
| NAAP | 25 | 7,599 | 851 |
| PBA[b] | 15 | 16,334 | 1,244 |
| PUDA[c] | 25 | 2,014 | 164 |
| TEAD | 35 | 6,757 | NA[d] |
| UMDA | 35 | 5,855 | 659 |

[a] Staff for colleges and university not included.
[b] Staff for five schools in Watson Chapel School District not included.
[c] Staff for one private school not included.
[d] Not available.

**Table 2.7 Health-care facilities and nursing homes near the Chemical Stockpile Disposal Program installations**

| Installation | Distance from installation (km) | Number of facilities | Number of beds |
|---|---|---|---|
| APG[a] | 25 | 6 | 1710 |
| ANAD[b] | 35 | 9 | 1094 |
| LBAD | 25 | 6 | 500 |
| NAAP | 35 | 10 | 2187 |
| PBA | 35 | 1 | 498 |
| PUDA | 25 | 3 | 1231 |
| TEAD | 35 | 2 | 111 |
| UMDA | 30 | 2 | 151 |

[a] Does not include number of beds at Edgewood Health Center.
[b] Does not include number of beds at Golden Springs Nursing Facility.

# 3. EMERGENCY PLANNING ZONES FOR THE CSDP INSTALLATIONS

This section presents a summary of the methodology used to identify the emergency planning zones (EPZs) for each site and the actual recommended boundaries of those zones for the eight sites.

## 3.1 EPZ DETERMINATION METHODOLOGY

The EPZ should be determined by a series of factors, including the distribution of potential accidents, population, and terrain. Building on the three-zone concept presented in the ERCP [i.e., an immediate response zone (IRZ), a protective action zone (PAZ), and a precautionary zone (PZ)], the methodology is based on (1) identifying hazard-generated concentric boundaries for the subzones of the EPZ and (2) adjusting these radial boundaries on the basis of a number of criteria, including

- local topographical features that may interact with meteorology to affect dispersion;
- avoiding the bisection of populated areas (include all of bisected areas);
- using political boundaries where they coincide approximately with radially defined boundaries;
- using features of the human landscape such as a road, highway, or rail line or a natural feature such as a river or creek as the boundary of an IRZ or PAZ if political boundaries do not coincide with radially defined boundaries; and
- using the radially defined boundary when no natural, political, or human boundary exists.

In some cases if the hazard-generated boundary is small (e.g., at PUDA), consideration of time-distance relationships (i.e., wind speed) dictates that the IRZ be increased to 10 km. This is the approximate distance an agent release could travel in 1 h at a wind speed of 3 m/s. In all cases, the outer boundaries of the PZ are not indicated because the time available for response would be sufficient without prior comprehensive and detailed local planning efforts.

External event accidents were excluded from consideration in the determination of the EPZ for three reasons. First, such events are often low probability events that contradict a common sense approach to planning; thus, one does not plan for meteorite strikes or planes falling out of the air as initiating events. Second, the event that causes the accident may also reduce or eliminate response capabilities, as in the case of an earthquake. Third, such events include large consequence events that stretch atmospheric dispersion modeling capacities beyond reasonable limits, resulting in downwind hazard estimates that are fairly unreliable. In any case, detailed planning is not needed when time allows a response to be implemented as an expansion of activities beyond the PAZ.

The radial boundaries for the IRZ and PAZ are thus based on identifying the largest credible nonexternal event accident for each site and, using the D2PC atmospheric dispersion code, determining the lethal downwind distance for that accident under two sets of meteorological conditions—most likely (3-m/s wind speeds and D atmospheric stability) and very stable (1-m/s wind speeds and E atmospheric stability). These distances are then increased by a factor of 50% to account for uncertainty and are used to define radial boundaries for the IRZ and PAZ respectively. These radial boundaries are then adjusted, as noted previously, so that the IRZ boundary is never less than 10 km and so that topographic, population, political, and infrastructure considerations are taken into account.

## 3.2 RECOMMENDED EPZ BOUNDARIES FOR CSDP INSTALLATIONS

The radial boundaries for the eight installations and the accidents on which they are based are shown in Table 3.1. This table identifies the largest credible nonexternal event accidental release and the D2PC downwind lethal distance associated with that release under the two sets of meteorological conditions (plus the 50% uncertainty). These distances are adjusted to account for the time-distance relationship (i.e., an IRZ with an outer boundary never less than 10 km) and for topographic, population, political, and infrastructure considerations. The recommended boundaries for the eight installations, as adjusted by these factors, are depicted in Figures 3.1–3.8. These figures are taken from the site-specific concept plans.

**Table 3.1 Hazard-generated and adjusted radial boundaries for the emergency planning zones at the Chemical Stockpile Disposal Program installations**

| Installation | Accident sequence[a] | Hazard-generated boundary (km) | | Adjusted boundary (km) | |
|---|---|---|---|---|---|
| | | IRZ | PAZ | IRZ | PAZ |
| APG | HOKHF 2[b] | 0.6 | 2.3 | 10.0 | 25.0 |
| ANAD | VOMVC 4 | 11.0 | 50.0 | 15.0 | 35.0 |
| LBAD | VORVC 4 | 6.0 | 22.0 | 10.0 | 25.0 |
| NAAP | HOKVF 6[c] | 2.5 | 10.0 | 10.0 | 25.0 |
| PBA | VOMVC 4 | 11.0 | 50.0 | 15.0 | 50.0 |
| PUDA | VODHC 4 | 1.3 | 5.1 | 10.0 | 15.0 |
| TEAD | VOMVC 4 | 11.0 | 50.0 | 15.0 | 50.0 |
| UMDA | VOPGC 4 | 7.0 | 26.0 | 10.0 | 30.0 |

[a] HOKHF 2 = on-site handling accident involving bulk containers of mustard, resulting from a forklift collision with a short-duration fire; VOMVC 4 = vehicle collision involving VX mines, resulting in a fire and detonation; VORVC 4 = vehicle collision involving VX rockets, resulting in a fire, detonation, and ignition of rocket propellant; HOKVF 6 = on-site handling accident involving bulk containers of VX, resulting from a forklift collision, with short-duration fire; VODHC 4 = vehicle collision involving mustard mortar shells, resulting in a fire and detonation; and VOPGC 4 = vehicle collision involving 155-mm GB projectiles, resulting in a complex release involving detonation and fire.

[b] OKHF 6 and HFKHF 3 result in identical downwind distances.

[c] HFKVF 3 and POKVC 42 result in identical downwind distances.

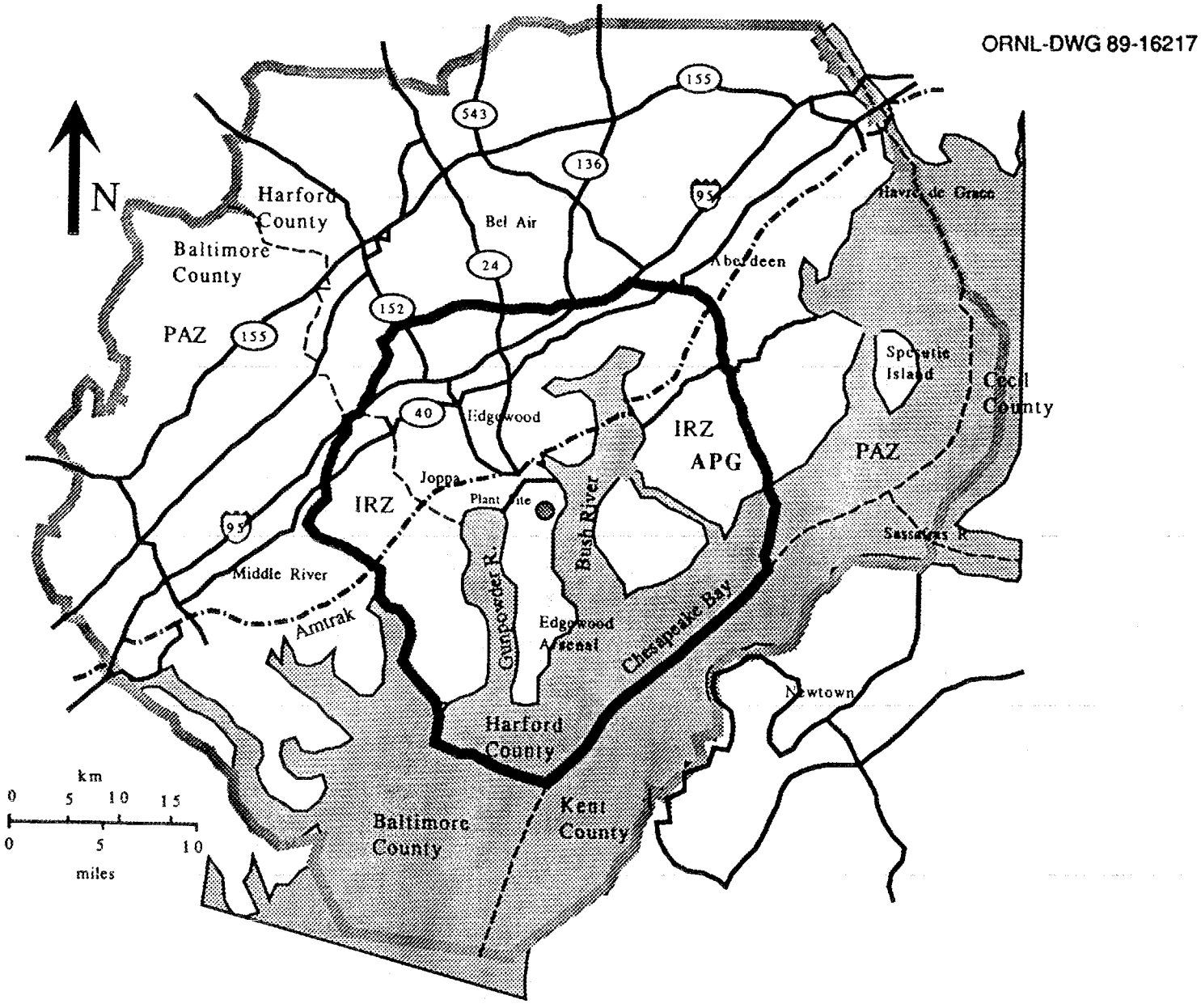


Fig. 3.1. Emergency planning zone concept for Aberdeen Proving Ground.

ORNL-DWG 89-16548

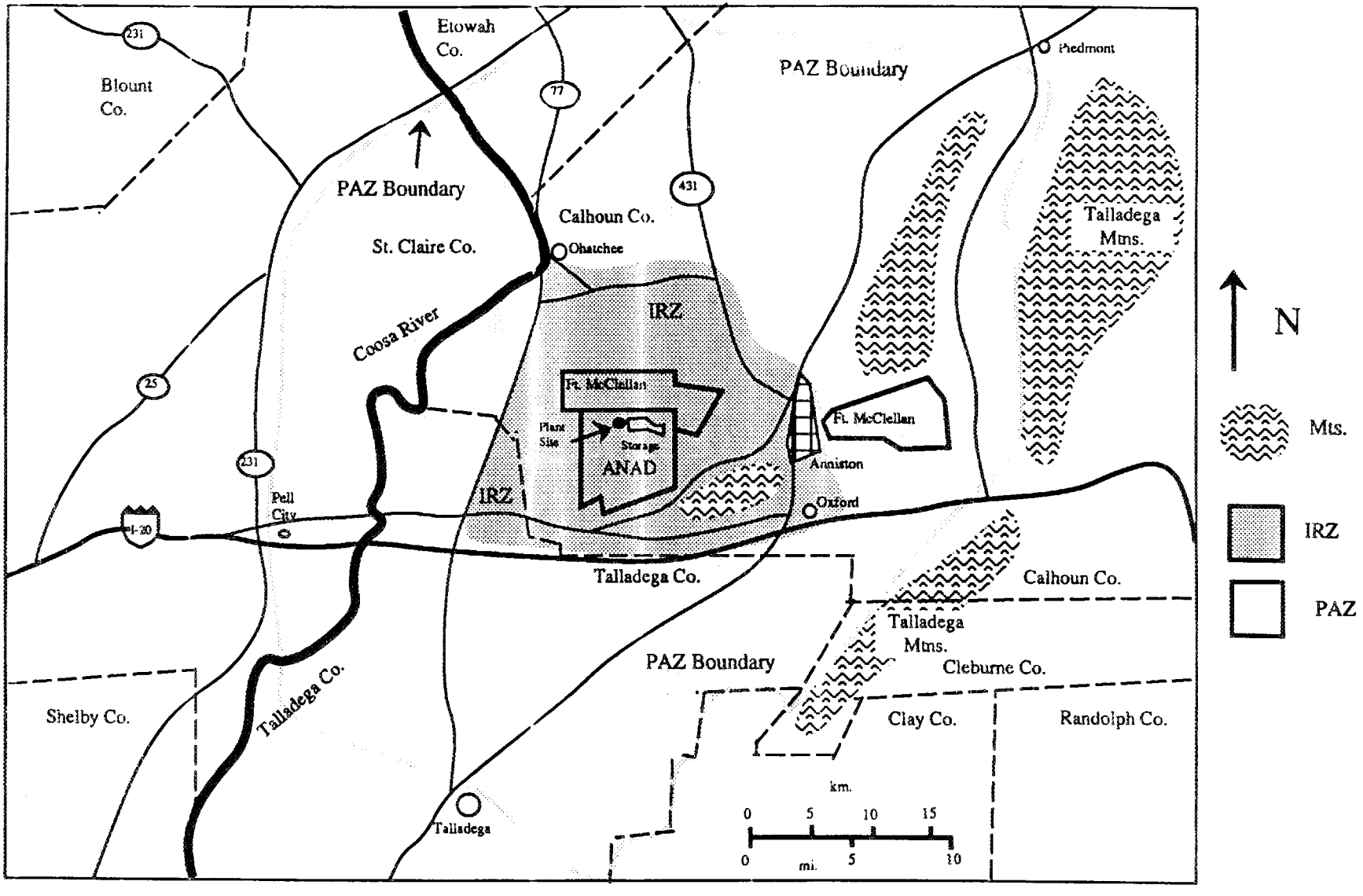


Fig. 3.2. Emergency planning zone concept for Anniston Army Depot.

ORNL-DWG 89-16601

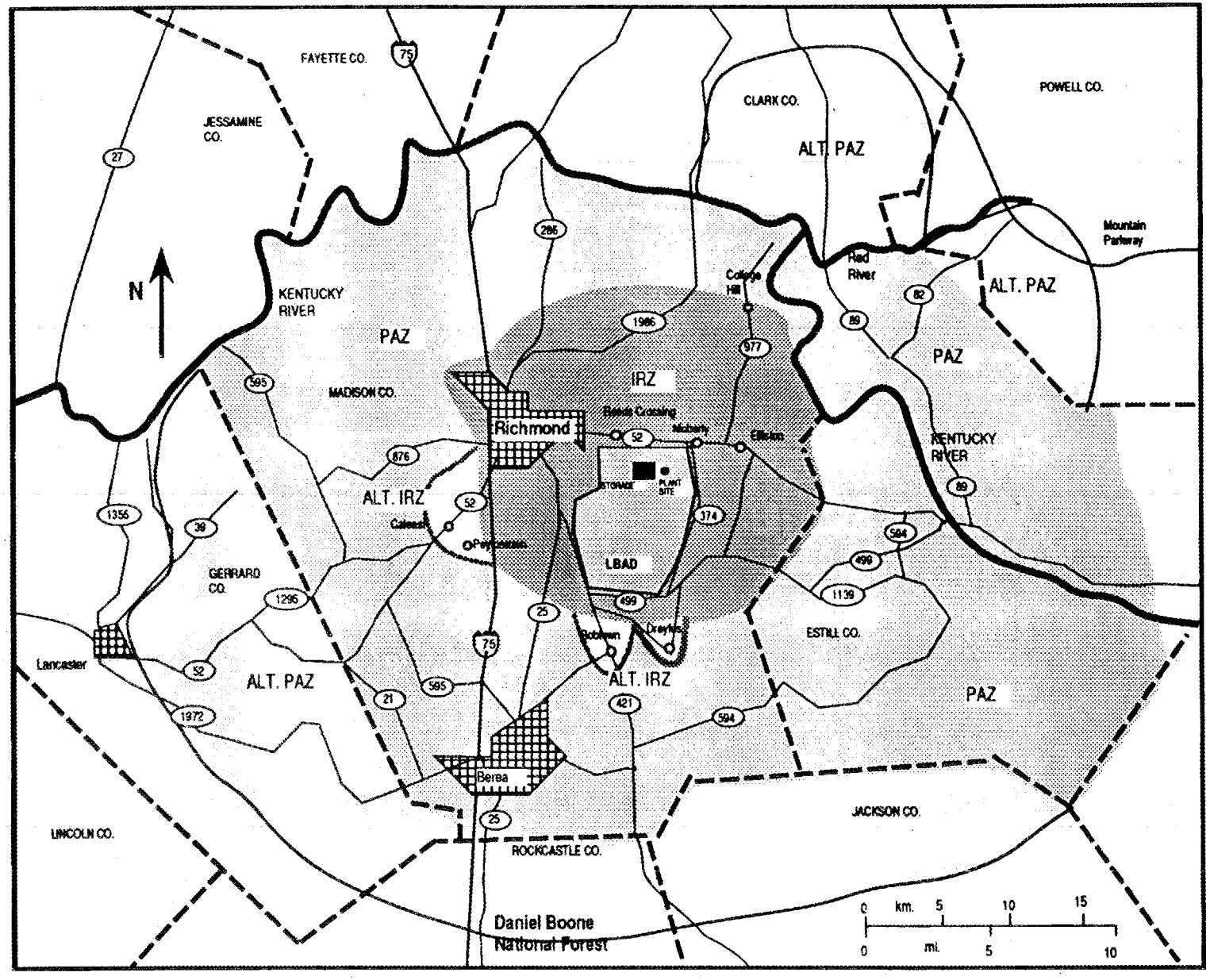


Fig. 3.3. Emergency planning zone concept for Lexington-Blue Grass Army Depot.

ORNL-DWG 89-16567

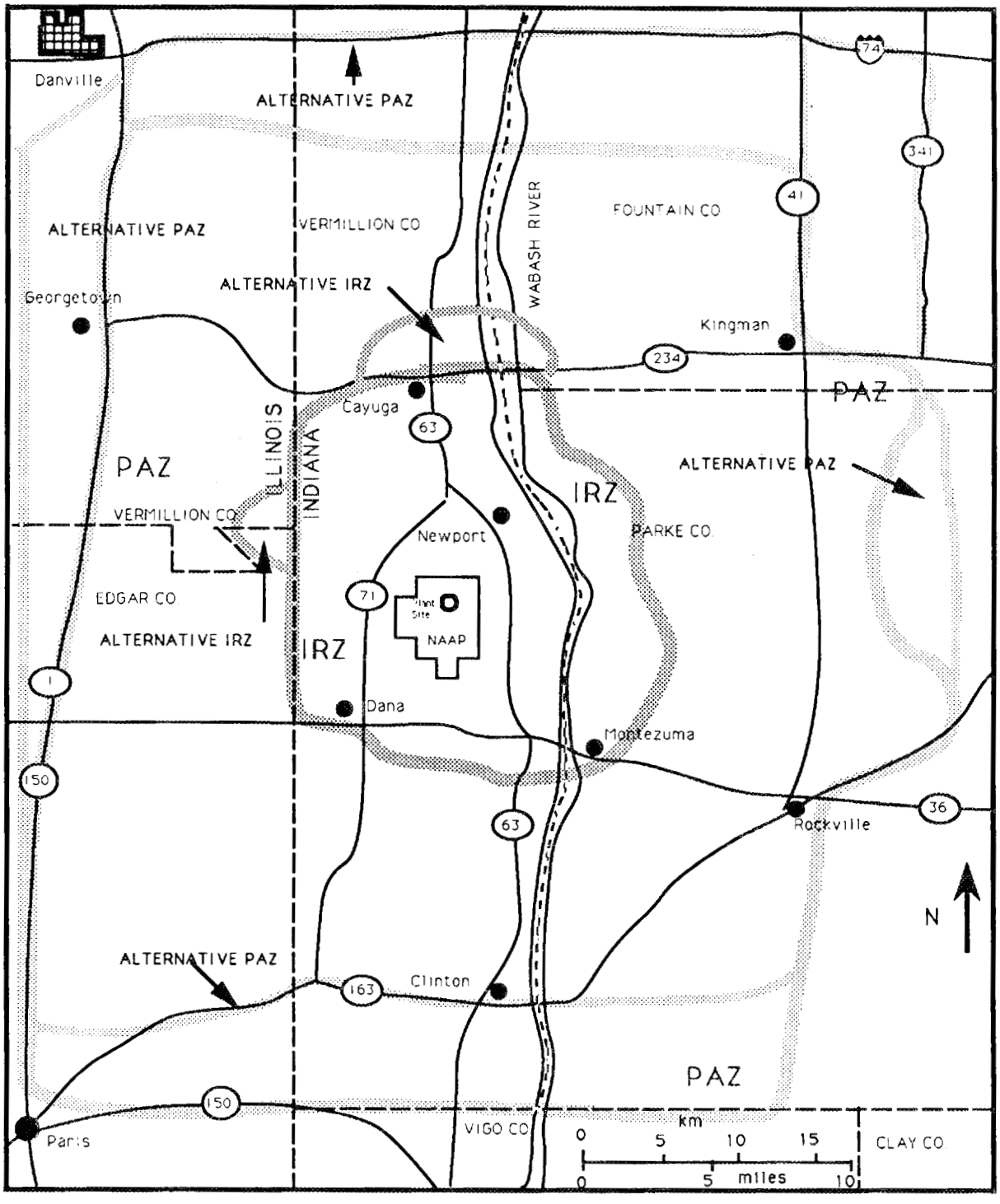


**Fig. 3.4. Emergency planning zone concept for Newport Army Ammunition Plant.**

ORNL-DWG 89-16561

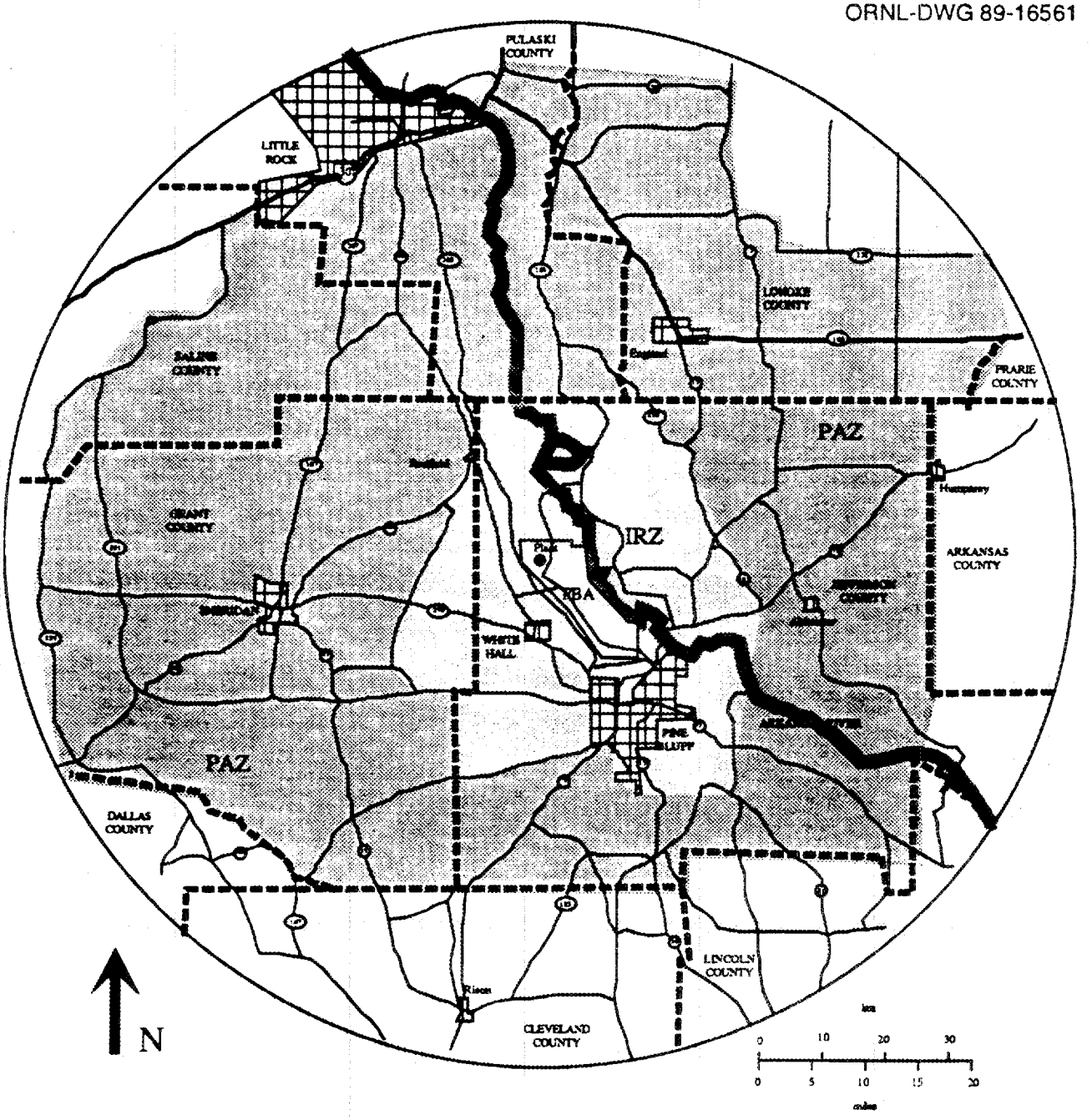


**Fig. 3.5. Emergency planning zone concept for Pine Bluff Arsenal.**

ORNL-DWG 89-16574

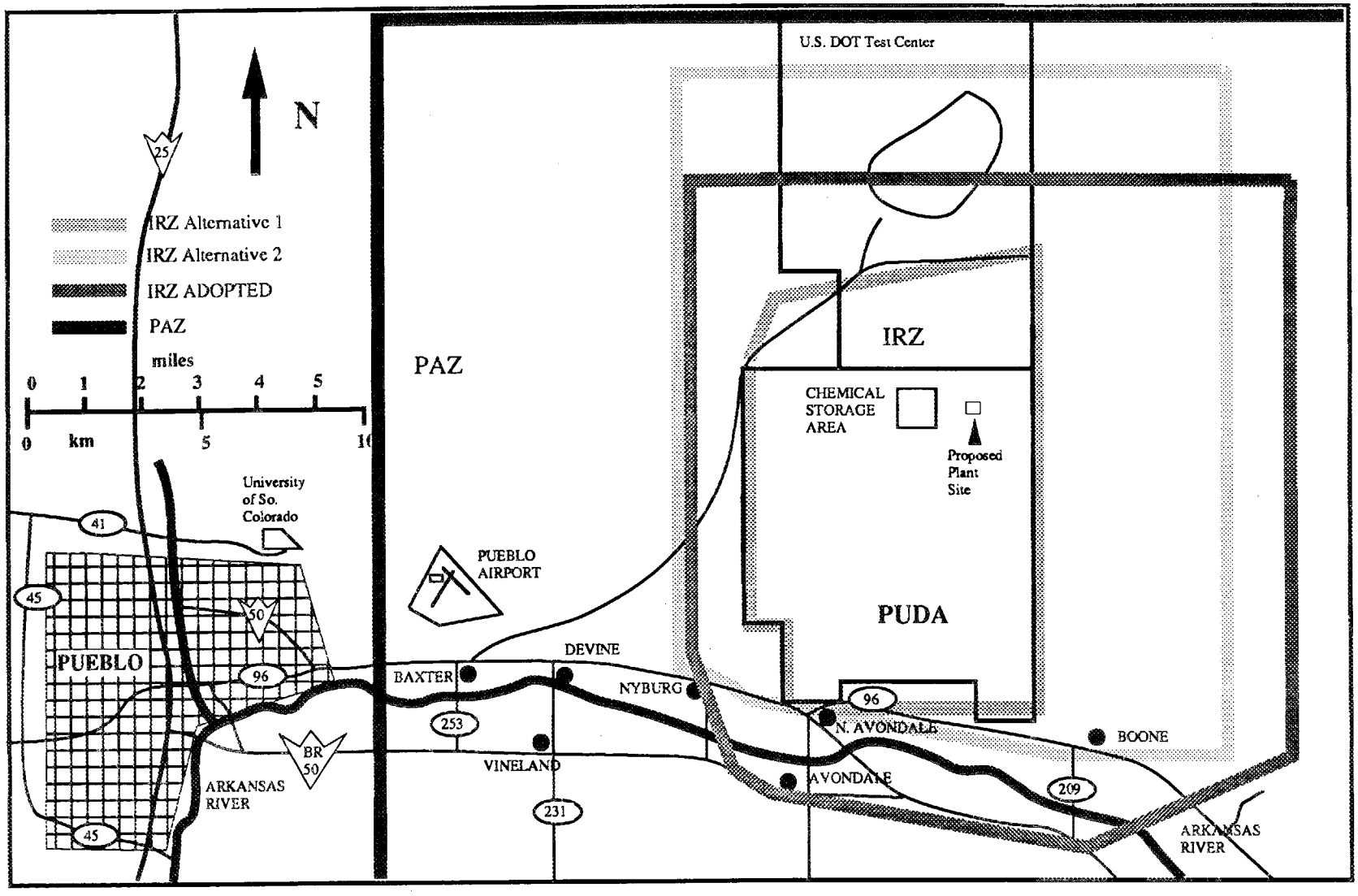


Fig. 3.6. Emergency planning zone concept for Pueblo Depot Activity.

ORNL-DWG 89-16589

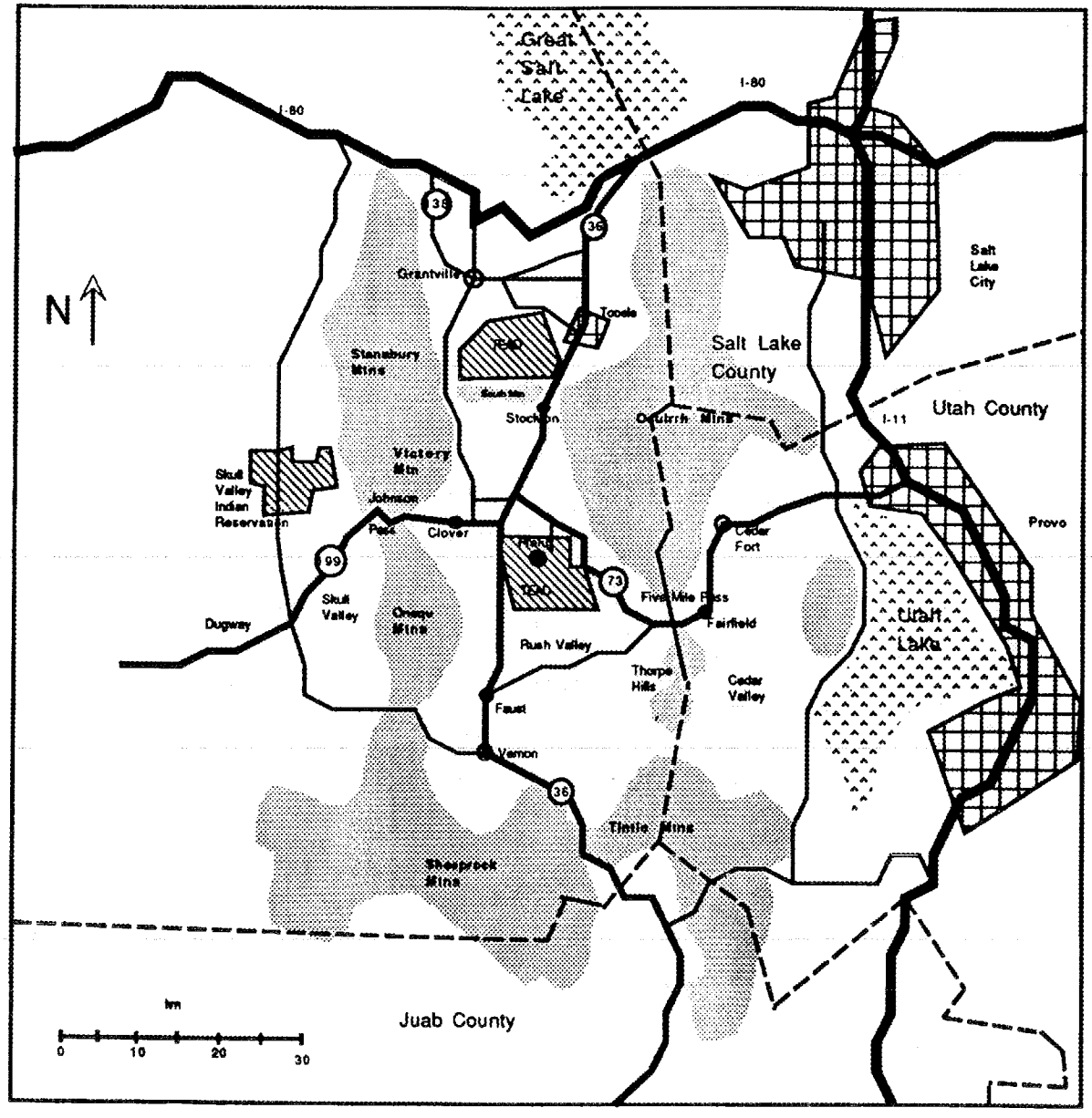


Fig. 3.7. Emergency planning zone concept for Tooele Army Depot.

ORNL-DWG 89-16579

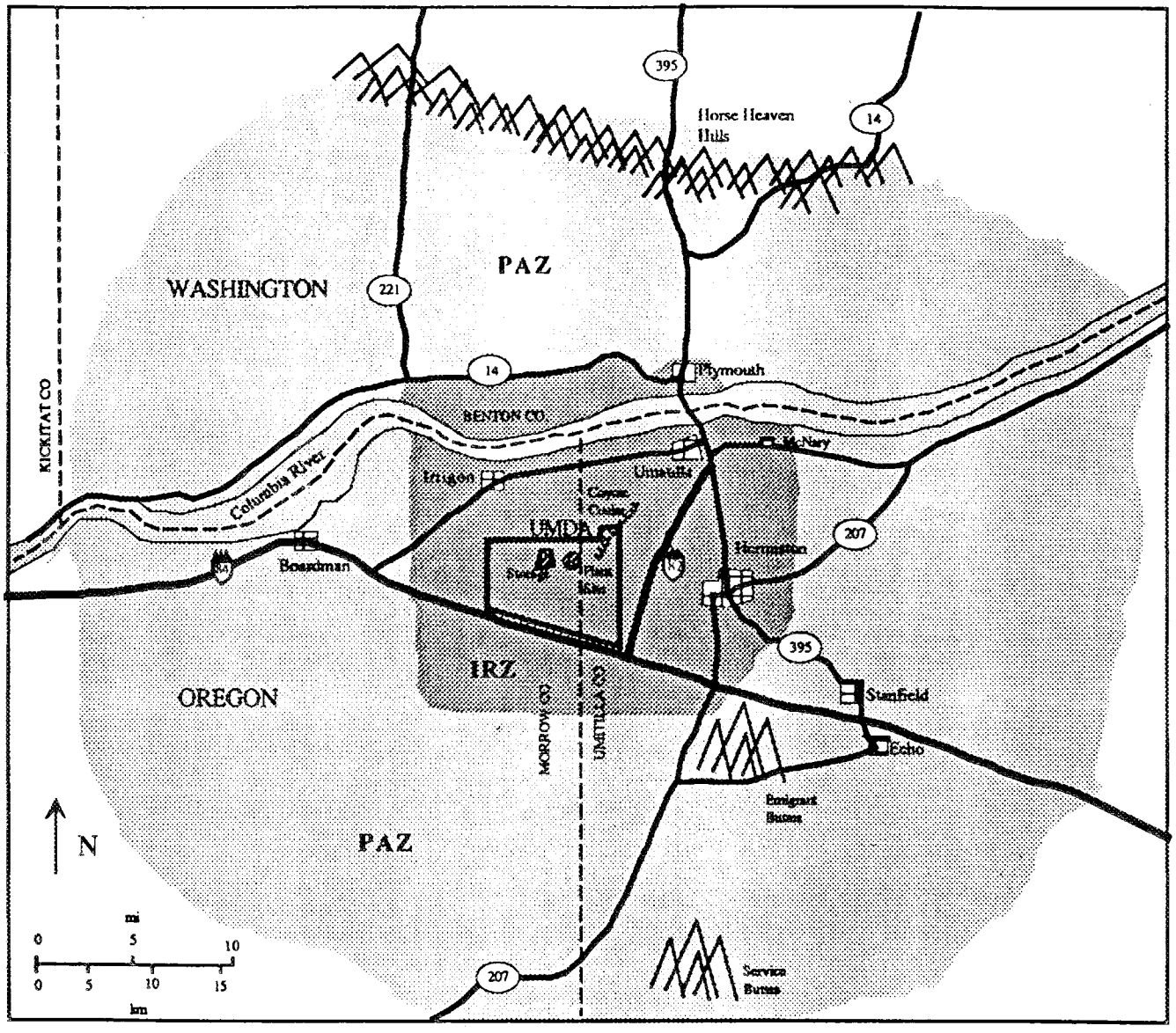


Fig. 3.8. Emergency planning zone concept for Umatilla Depot Activity.

# 4. PROTECTIVE ACTIONS FOR THE CSDP INSTALLATIONS

Different categories of protective actions are considered in the site-specific concept plans. These include (a) evacuation; (b) in-place sheltering; (c) respiratory protection; (d) protective clothing; (e) prophylactic drugs; and (f) antidotes and/or decontamination for mustard-only sites (i.e., APG and PUDA) where prophylactic drugs and antidotes are not available, decontamination was considered in their place]. Within each of these categories, the various options and their advantages and disadvantages are discussed. The discussion draws heavily on the ongoing protective action effectiveness technical support study (see Sect. 1) and includes the judgments of an expert panel that was asked to evaluate the generic effectiveness of protective action options. Finally, potentially suitable protective action options for the general public and the institutional populations of the IRZ and PAZ are identified, and preliminary recommendations are made (i.e., made without the benefit of the completed protective action support study).

## 4.1 PRELIMINARY EVALUATION OF PROTECTIVE ACTIONS

In support of the ongoing protective action effectiveness support study (Rogers et al., in press), a panel of experts[1] was assembled early in CY 1989 to identify evaluative criteria and apply those criteria to various protective actions, including evacuation, sheltering, and respiratory protection. Selection of panel members was based on obtaining comprehensiveness with respect to the physical characteristics of each protective action option, the option's effectiveness in mitigating adverse health effects, and the personal and organizational aspects of the implementation of the option. Although it is beyond the scope of this document to report on the results of that exercise in detail, the following discussion identifies the criteria and the panel's evaluation of protective actions.

### 4.1.1 Evaluative Criteria

The panel identified a variety of criteria for evaluating protective action options. These criteria were subsequently categorized based on their relation to (1) the level of safety provided by the option, (2) the requirements for implementing the option effectively, and (3) the option's level of intrusiveness in the family and community or other relevant level of social organization. Since different factors were deemed important among these three categories for the three different kinds of protective actions (evacuation, sheltering, and respiratory protection), the specific criteria for the categorically different protective action options were different.

### 4.1.2 Protective Action Option Evaluation

The evaluation criteria and summary results of the evaluation are presented in Figs. 4.1 and 4.2. For each evaluation criterion, each panel member ranked each protective action option on a scale from least desirable to most desirable. These scores were averaged and a consensus

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[1] The panel of experts included Amnon Birenzvige of the U.S. Army Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, Md.; Michael Lindell, Department of Psychology, Michigan State University, East Lansing, Mich.; Dennis Mileti, Director, Hazards Assessment Laboratory, Colorado State University, Fort Collins, Colo.; and Frederick Sidell, M.D., U.S. Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, Md. Their fields of expertise are physical means of protection from chemical agent exposure, individual response to disasters, organizational response to disasters, and the health effects of chemical agent exposure respectively.

ORNL-DWG 89-16218

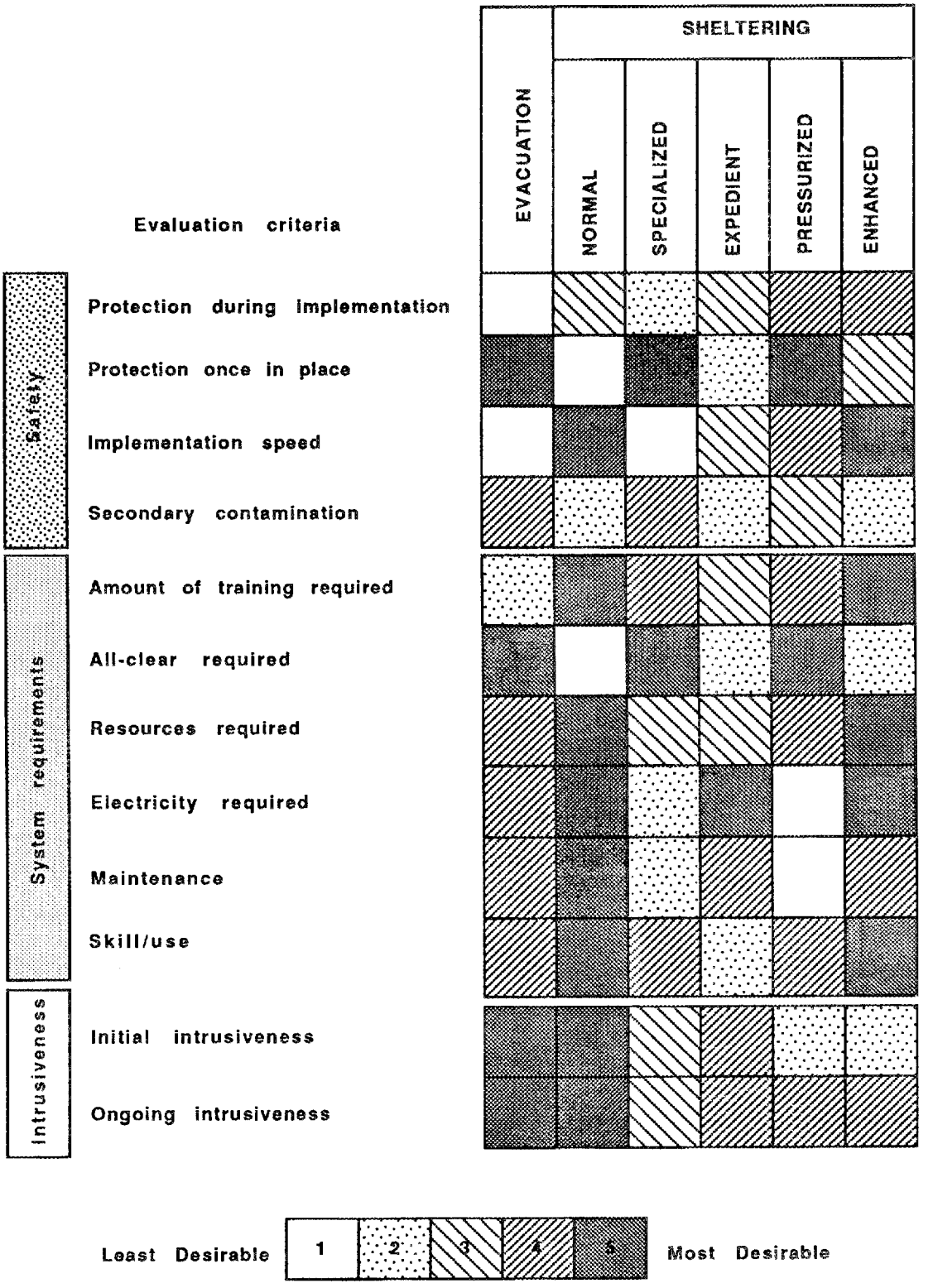


Fig. 4.1. Expert panel evaluation of evacuation and sheltering.

ORNL-DWG-89-16213

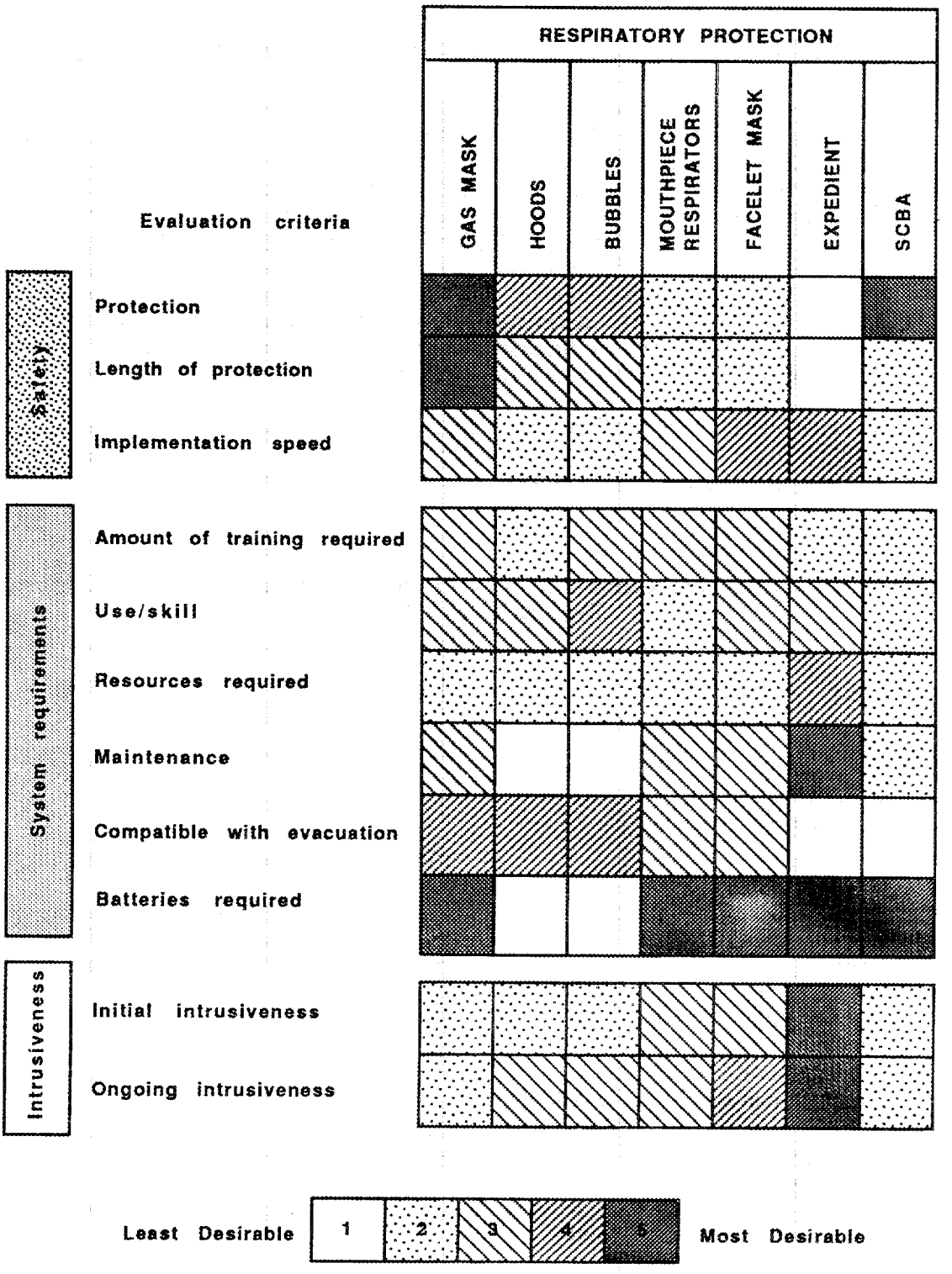


Fig. 4.2. Expert panel evaluation of respiratory protection.

arrived at for each protective action option. These averaged scores are presented in Figs. 4.1 and 4.2.

## 4.2 PROTECTIVE ACTION OPTIONS FOR THE CSDP INSTALLATIONS

The concept plans identify feasible and recommended protective actions for the general public in the IRZ and PAZ and for the institutional populations of the CSDP installations. The results of the protective action effectiveness support study may alter the recommendations in the future or provide more detailed information that distinguishes the relative effectiveness of each option. Furthermore, differentiating actions for the IRZ and PAZ is not always clear-cut: people living near the outer boundary of the IRZ may be able to implement PAZ-protective actions, while people living near the inner boundary of the PAZ may need to implement IRZ-protective actions. In addition, a combination of actions (e.g., using respiratory protection while evacuating or moving to a shelter) may be needed to protect the public from a range of accident scenarios. Finally, decontamination procedures should be implemented whenever mustard exposure is suspected (mustard is not present at NAAP).

The protective action options discussed in the concept plans are identified in Table 4.1. Their feasibility (implying that further consideration is warranted) is identified for adults, children, infants, institutional populations, and the impaired (nonambulatory) in both the IRZ and PAZ.

**Table 4.1 Protective actions considered for Chemical Stockpile Disposal Program installations**

| | |
|---|---|
| **Evacuation** | **Protective clothing** |
| | Specialized shelter |
| **Sheltering** | Expedient shelter[1] |
| Normal shelter | |
| Pressurized room | **Prophylactic drug** |
| Pressurized building | |
| Enhanced shelter | **Antidotes[2]/Decontamination** |
| **Respiratory protection** | **Combination of protective actions** |
| Gas mask | Evacuate with respiratory protection |
| Hoods (children only) | Shelter with respiratory protection |
| Bubbles (infants only) | |
| Mouthpiece respirator | |
| Facelet mask | |
| Expedient respirator | |
| Self-contained breathing apparatus (SCBA) | |

[1] If the potential for exposure to mustard or VX agent exists, the use of expedient protective clothing should be considered.

[2] If exposure to mustard or VX agent aerosol is suspected, decontamination procedures should be implemented as described in the concept plans.

The recommended protective actions for the installations for the general public in the IRZ and PAZ and for the institutional populations are identified in Table 4.2. These

recommendations are based on the feasibility of the actions; the accident distribution at a site; and the topography, meteorology, and population distribution. It is stressed that these recommendations are preliminary and offered mainly to stimulate discussion and debate on the protective action issue. They may change based on new information from the technical support studies or elsewhere.

For installations where evacuation (with respiratory protection) in the IRZ is not recommended, this option may be viable for accidental releases that are sufficiently small and slow-moving; this would especially be the case for persons near the outer edge of the IRZ and/or other locations where population density near the installation is very low and evacuation routes are readily identifiable (e.g., PUDA).

**Table 4.2 Protective action recommendations for Chemical Stockpile Disposal Program installations**

| Installation | IRZ | | PAZ | |
|---|---|---|---|---|
| | General population | Institutional population | General population | Institutional population |
| APG | Expedient sheltering | Positive pressurization[a] | Evacuation | Evacuation |
| ANAD | Expedient sheltering | Positive pressurization | Evacuation | Evacuation |
| LBAD | Expedient sheltering | Positive pressurization | Evacuation | Evacuation |
| NAAP | Expedient sheltering | Positive pressurization | Evacuation | Evacuation |
| PBA | Expedient sheltering | Positive pressurization | Evacuation | Evacuation |
| PUDA | Expedient sheltering | Positive pressurization | Evacuation | Evacuation |
| TEAD | Evacuation/respiratory protection | Positive pressurization | Evacuation | Evacuation |
| UMDA | Evacuation/respiratory protection | Positive pressurization | Evacuation | Evacuation |

[a] Pressurization could be of a "safe room" in a house or building or of the entire building, depending on the particular need.

# 5. PROGRAM CONSIDERATIONS

This section presents additional information on the way the program guidance can be implemented based on the information previously presented on accident distribution, meteorology, topography, population characteristics, and protective action recommendations. Without the adoption and implementation of appropriate standards for command and control decisions and for alert and notification systems, the effectiveness of the recommended protective actions is greatly diminished.

To enable the nearest populations to take a protective action, an overall command and control structure must provide the capability to make a decision on warning and protective action recommendations within a short period of time. Table 5.1 identifies the differences in recommended lead times (i.e., from the onset of an accidental release) needed at the CSDP installations for effective implementation of protective actions. The differences derive principally from the time-distance relationship (i.e., the travel time for an accidental release to reach the nearest populations under variable wind speeds and atmospheric conditions) and the proximity of residential populations to the storage area/proposed CSDP plant site. These or some other agreed-upon lead times should guide the development of a command and control system to warn the public to take protective action. In turn, the command and control system (or decision support system) must incorporate accident detection, accident assessment, and the decision to warn with protective action recommendations.

**Table 5.1 Lead times for public warning**

| Installation | Lead time (min) | |
|---|---|---|
| | IRZ | PAZ |
| APG | 5 | 15 |
| ANAD | 5 | 15 |
| LBAD | 5 | 15 |
| NAAP | 5 | 15 |
| PBA | 5 | 15 |
| PUDA | 10 | 30 |
| TEAD | 10 | 30 |
| UMDA | 10 | 30 |

Ultimately the nature of the emergency planning program at the installations must be established by local decision makers. The general schedule for the program has been presented in the *Management Plan for Emergency Response Activities* (ANL 1989). In order to establish an enhanced readiness capability at the local level, the following are the logical steps:

1. Finalize EPZ boundaries.
2. Decide on interim (based on current capabilities) and final protective action strategies for each population group in the IRZ and PAZ.
3. Agree to new warning system, communication system, and command and control system designs.
4. Begin public education/awareness activities.
5. Estimate resources required to implement protective action strategies.
6. Install new warning, command/control, and communication systems.
7. Install protective action equipment (if needed).
8. Develop final plans and implementation procedures.

The concept plans have identified the basic features of the emergency response planning process associated with the unitary stockpile and its disposal at the stockpile installations. They have identified information needed to make basic decisions and provided some of that information: the kinds of accidents that could occur with associated lethal downwind distances assuming different meteorological conditions and the actual distribution of meteorological conditions, topographic features, and population resources in the areas of the installations. It has further provided methodologies and approaches for determining the EPZ and its sub-zones and evaluating potential protective actions.

The next phase of the planning process must involve local decision makers. The Army and other participating organizations are available to provide assistance to local decision makers in furthering the objective of emergency preparedness, but only the local officials and leaders can make it work.

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