Section 5
Summary

Chapters 2 through 4 of this report detailed the statistical methodology for developing safe distance distributions, the consequence models used in this analysis, and the health criteria that define the safe distance. This chapter summarizes the results.

5.1 Safe Distance Distributions and Protective Action Distances

The statistical accident scenario and consequence analysis set forth here resulted in a set of up to 100,000 hypothetical incidents for each material appearing in the Table. This set of incidents accounts for variability in container type, incident type, accident severity (i.e., release amount), location, time of day, time of year, and meteorology. Each of these scenarios was evaluated by using detailed emission rate and atmospheric dispersion models to calculate downwind chemical concentration footprints. The safe distance for an incident is the distance downwind from the source at which the chemical concentration falls below the health criteria. The safe distance estimates for the entire set of hypothetical incidents considered in the analysis provide a distribution of safe distances corresponding to a wide spectrum of potential transportation-related releases. In the remainder of the analysis, these incidents are categorized according to whether they occur during the day or at night and whether they involve small (≤55 gal) or large (>55 gal) spills.

Examples of safe distance distributions for two chemicals are given in Figures 5.1-5.8. The first four figures show safe distance distributions for chlorine, a Hazard Zone B gas. Distributions are separated according to spill size (large or small) and time of day (day or night). Figures 5.5 through 5.8 provide corresponding results for a water-reactive material, aluminum phosphide, which emits phosphine when spilled into water. In all eight figures, the 50, 70, 80, 90 and 95 percentiles are identified. The PADs in the guidebook correspond with the 90-percentile values for the individual categories. Tables 5.1 and 5.2 provide safe distance estimates at several percentiles for the chlorine and aluminum phosphide distributions shown in the figures. Tables 5.3 and 5.4 provide corresponding data for two additional chemicals, phosphorous chloride (a Hazard Zone B liquid) and ethylene oxide (a Hazard Zone D gas). Results for phosphorous chloride in Table 5.3 are for land-based releases only. A separate set of safe distance distributions was developed for spills of phosphorous chloride into water.

As demonstrated in these examples, the safe distance distributions exhibit substantial tails, denoting the presence of low-probability/high consequence events. A comparison of the 50- and 90-percentile values reveals that the 90-percentile values are often a factor of 4 above the 50-percentile values. Clearly, use of the 90-percentile for the PAD affords a substantial level of protection for most incidents. The 95 and 99 percentiles do show that the PADs will not be sufficient for all incidents, however. The 99-percentile events, corresponding to worst-case releases in worst-case meteorology, can result in safe

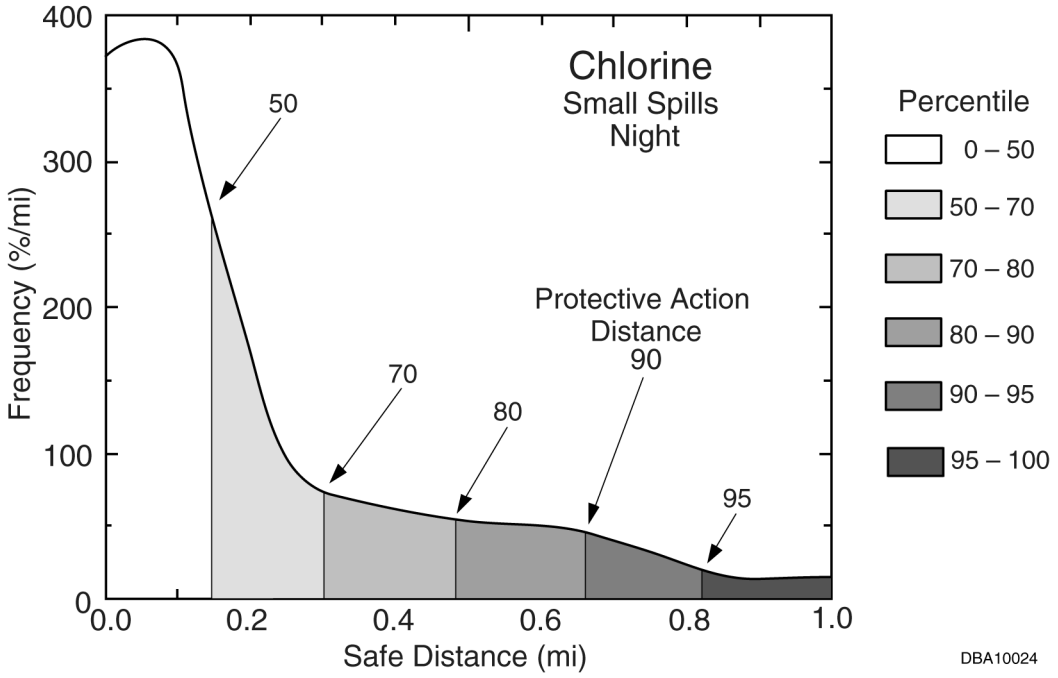

Figure 5.1 Frequency of Safe Distances for Small Nighttime Chlorine Spills as Determined in the 2000ERG Analysis

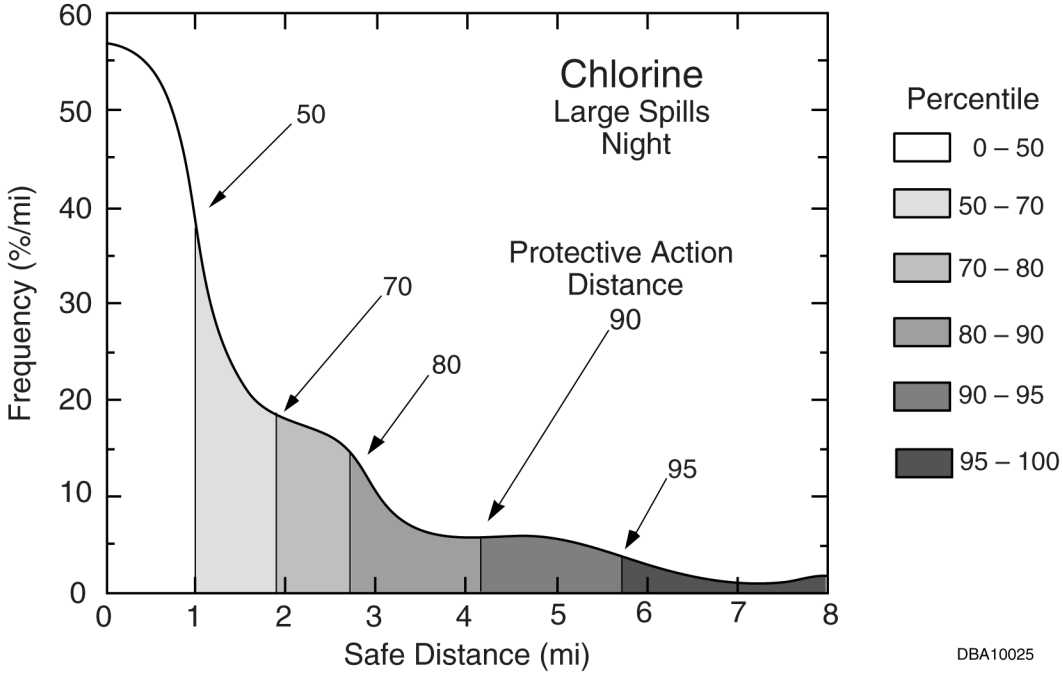

Figure 5.2 Frequency of Safe Distances for Large Nighttime Chlorine Spills as Determined in the 2000ERG Analysis

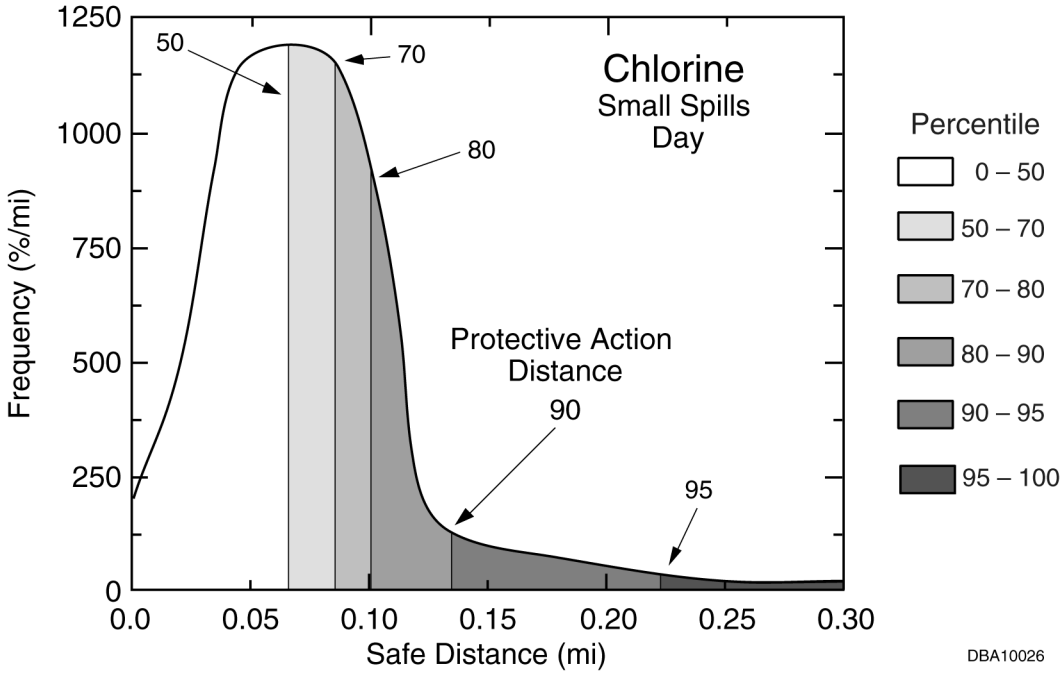

Figure 5.3 Frequency of Safe Distances for Small Daytime Chlorine Spills as Determined in the 2000ERG Analysis

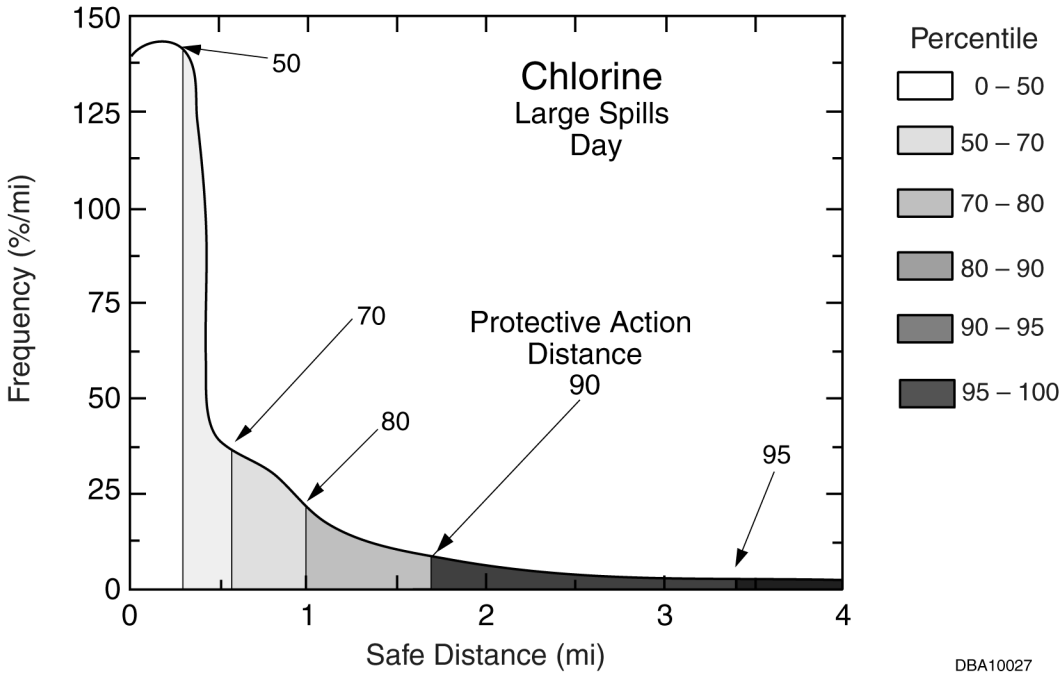

Figure 5.4 Frequency of Safe Distances for Large Daytime Chlorine Spills as Determined in the 2000ERG Analysis

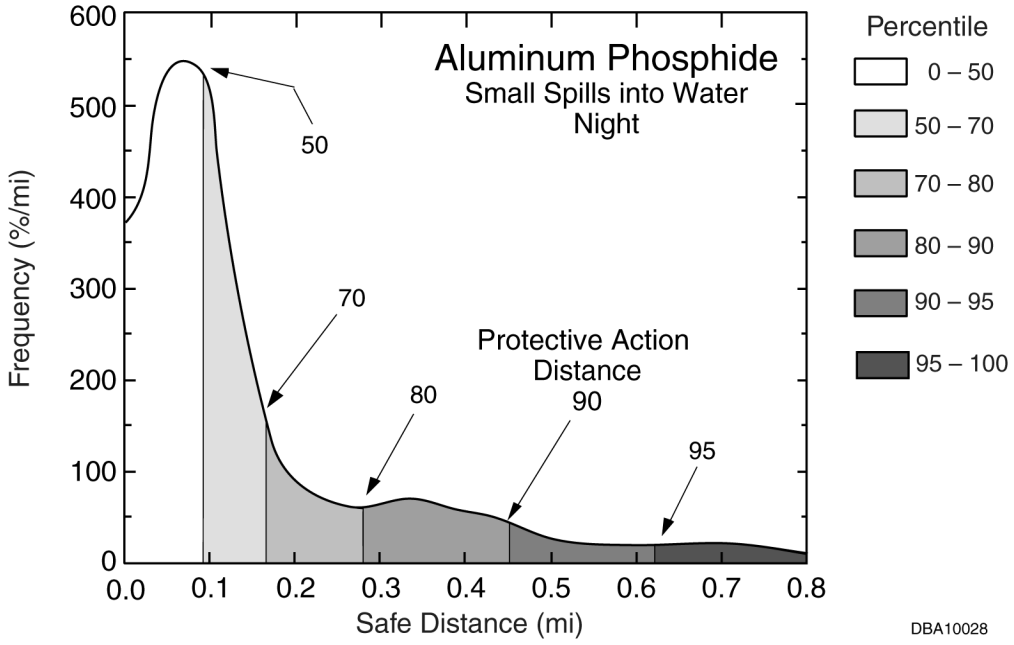

Figure 5.5 Frequency of Safe Distances for Small Nighttime Aluminum Phosphide Spills into Water as Determined in the 2000ERG Analysis

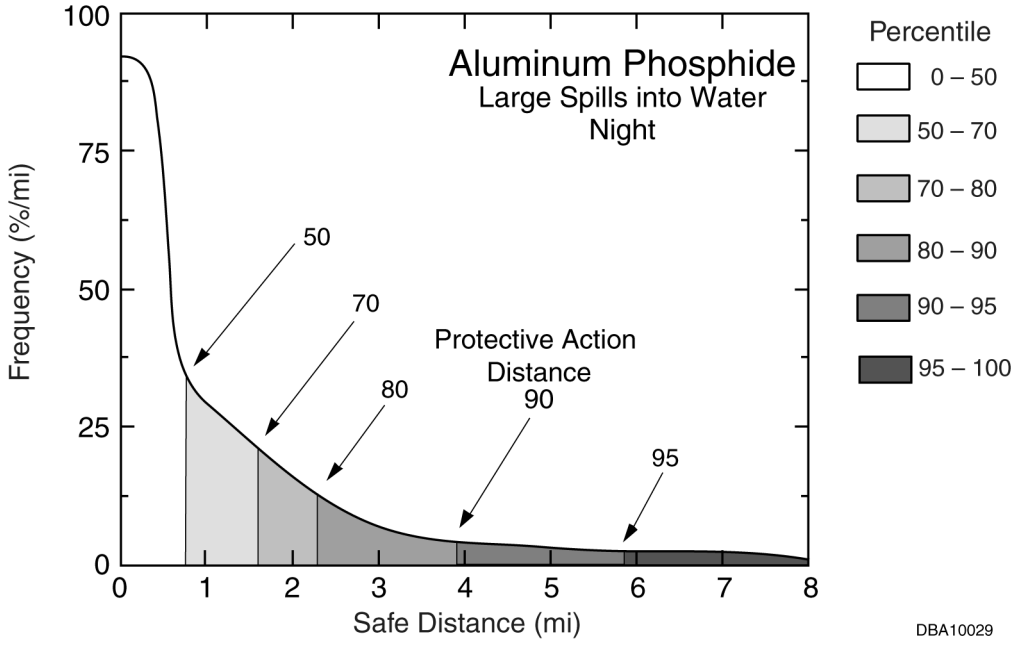

Figure 5.6 Frequency of Safe Distances for Large Nighttime Aluminum Phosphide Spills into Water as Determined in the 2000ERG Analysis

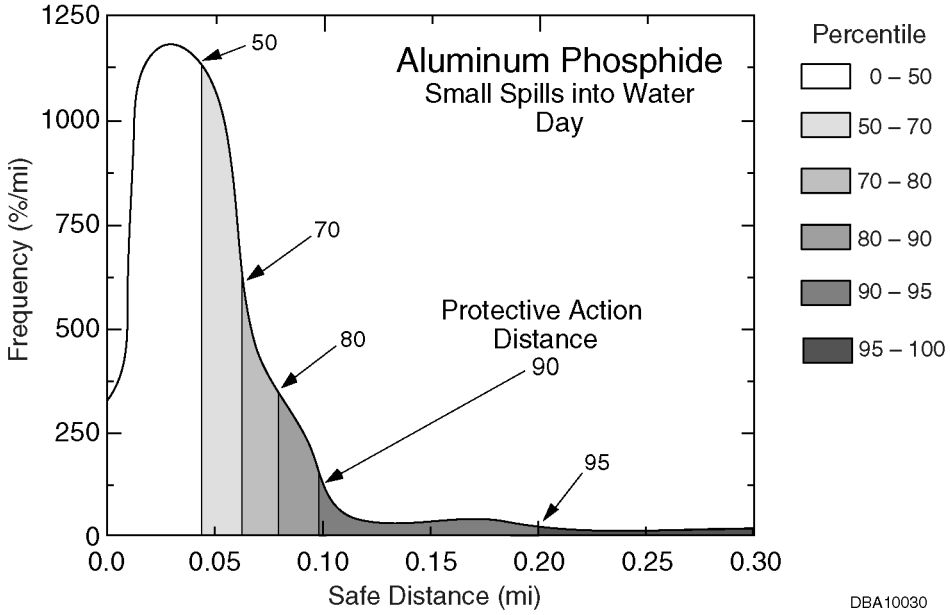

Figure 5.7 Frequency of Safe Distances for Small Daytime Aluminum Phosphide Spills into Water as Determined in the 2000ERG Analysis

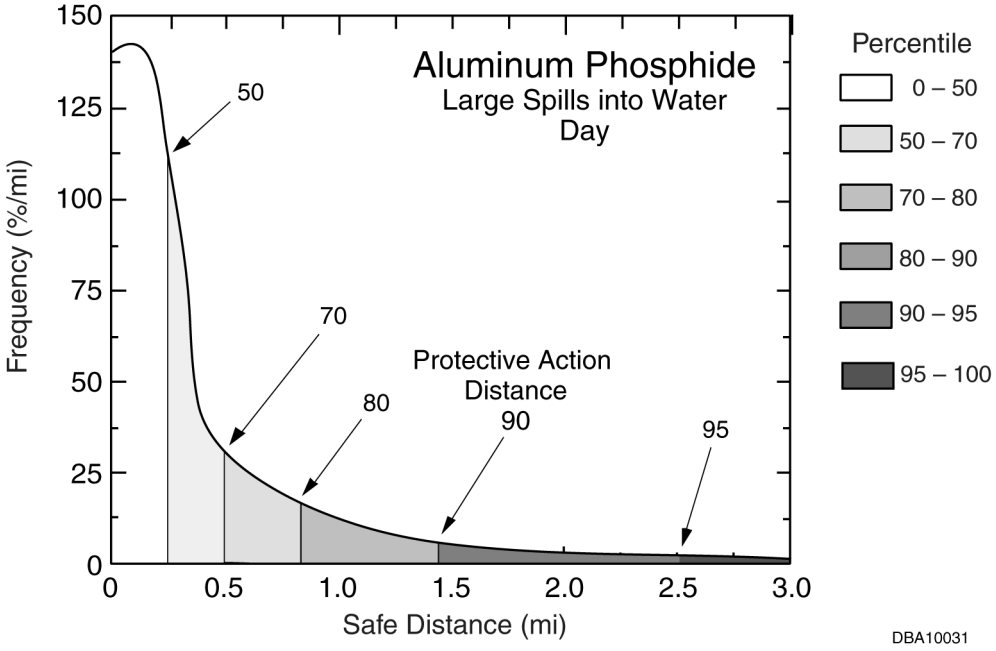

Figure 5.8 Frequency of Safe Distances for Large Daytime Aluminum Phosphide Spills into Water as Determined in the 2000ERG Analysis

Table 5.1 Safe Distances at Several Percentiles for Chlorine (UN 1017) Releases as Determined in the 2000ERG Analysis

		Percentile					
Release Size	**Time**	**50**	**70**	**80**	**90**	**95**	**99**
Small	Day	0.06	0.08	0.09	**0.13**	0.23	0.66
	Night	0.14	0.30	0.47	**0.66**	0.82	1.31
Large	Day	0.28	0.56	0.98	**1.69**	3.37	7.01
	Night	0.99	1.96	2.92	**4.16**	5.80	8.46

Table 5.2 Safe Distances at Several Percentiles for Aluminum Phosphide (UN 1397) Releases into Water as Determined in the 2000ERG Analysis

		Percentile					
Release Size	**Time**	**50**	**70**	**80**	**90**	**95**	**99**
Small	Day	0.04	0.06	0.07	**0.10**	0.20	0.54
	Night	0.09	0.16	0.28	**0.45**	0.63	1.00
Large	Day	0.23	0.51	0.82	**1.42**	2.51	6.46
	Night	0.79	1.61	2.31	**3.91**	5.84	8.38

Table 5.3 Safe Distances at Several Percentiles for Land-Based Phosphorous Trichloride (UN 1809) Releases as Determined in the 2000ERG Analysis

		Percentile					
Release Size	**Time**	**50**	**70**	**80**	**90**	**95**	**99**
Small	Day	0.05	0.06	0.08	**0.10**	0.16	0.39
	Night	0.09	0.15	0.20	**0.33**	0.47	0.77
Large	Day	0.16	0.26	0.39	**0.66**	1.03	1.93
	Night	0.47	0.82	1.17	**1.65**	2.41	4.68

Table 5.4 Safe Distances at Several Percentiles for Ethylene Oxide (UN 1040) Releases as Determined in the 2000ERG Analysis

		Percentile					
Release Size	**Time**	**50**	**70**	**80**	**90**	**95**	**99**
Small	Day	0.01	0.01	0.02	**0.02**	0.03	0.09
	Night	0.02	0.04	0.06	**0.09**	0.13	0.22
Large	Day	0.06	0.11	0.19	**0.30**	0.41	1.03
	Night	0.19	0.39	0.60	**1.03**	1.50	2.94

distances exceeding the PAD by a factor of 2 to 4. However, using the 99-percentile criterion to define the PAD would result in extreme overreaction to the vast majority of incidents first responders face. The 90-percentile criterion was selected to strike a reasonable balance between adequately protecting the public from exposure to potentially harmful substances and avoiding the needless risks and expense associated with overreaction.

5.2 Presentation of the Table in the Guidebook

Appendix A provides the Table of Initial Isolation and Protective Action Distances as it appears in the *2000 Emergency Response Guidebook*. The PADs in the Table are the 90 percentiles of the safe distance distributions as discussed in the previous section. The PADs have been rounded up the next 0.1 mi and limited to 7 mi. Entries for which the calculated distances exceed 7 m are denoted as 7+ mi (or 11+ km). Initial Isolation Distances are rounded up to the next 100 ft for distances shorter than 2,000 ft and to the next 500 ft for distances longer than 2,000 ft. Initial Isolation Distances are limited to 3,000 ft.

As discussed in Chapter 2, three distinct materials are listed in the Table. The first are TIH materials released in transportation-related incidents. The second are water-reactive materials that emit TIH gases when spilled into water. These entries are denoted by the phrase "when spilled in water." For TIH materials that emit a secondary TIH product when spilled in water, two entries are listed; they correspond to spills in water and on land. The third type of materials are chemical warfare agents released in a malicious manner. These entries are denoted by the phrase "when used as a weapon." Many TIH materials that are classical chemical warfare agents contain additional entries for weapons-related incidents.