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# Smokes and Obscurants: A Health and Environmental Effects Data Base Assessment

## A First-order, Environmental Screening and Ranking of Army Smokes and Obscurants

### Phase I Report

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**Phase I Report**

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The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

## EXECUTIVE SUMMARY

This report provides an initial evaluation and integration of a comprehensive health and environmental studies data base of Army smoke and obscurant (S&O) material. The objective was to support the U.S. Army's need for environmental assessments. In addition this data base should provide information for environmental impact of S&O devices by various Army agencies for field test, evaluation, and training. The procedure utilized was a first-order screening and ranking of the major smoke types and smoke-generating devices. This was done for each according to the magnitude of the impact area, the characteristic environmental concentrations, the relative inhalation toxicity, the relative toxicity when ingested by animals, the aquatic toxicity, the environmental mobility when freshly deposited, and the ultimate mobility and fate in the environment.

The major smoke types considered were various forms of white phosphorus (WP), red phosphorus (RP), hexachloroethane-derived smokes (HC), fog oil (SGF-2), diesel fuel smokes (DF), and some infrared obscuring agents (IR), EA-5763 and EA-5769. Various properties of the smoke-generating devices were taken into account, such as the type of delivery (either bursting/instantaneous or diffusing/continuous), effective fill weights, and initial cloud volumes in air. It was found that except for an RP bomblet, all bursting devices (grenades, mortars, guns, rockets, and howitzers) have a relatively small impact on ground areas but diffusing devices (smoke pots, diesel fuel exhaust, and fog oil generators) could affect larger areas, tens to hundreds of acres.

The characteristic environmental concentrations of devices were found to be highest from grenades, but these also were very localized. HC diffusing (howitzers) and WP bursting (mortars, guns, rockets, and howitzers) were also devices with high environmental concentrations. The acute (one-hour) inhalation toxicities were highest in HC smoke followed by IR obscurants, WP, RP, DF, and fog oil (SGF-2). We developed an air concentration quotient (C.Q.) for relative inhalation toxicity of various devices and found that grenades (IR and RP) were potentially the most dangerous. The artillery-produced smokes (mortars, guns, rockets, and howitzers) were significantly toxic when the S&O was HC and WP. The phosphorous smokes from wedges (RP/W and WP/FW) were far less toxic than

smokes from other devices. HC smoke pots were on the borderline of inhalation toxicity while fog oil (SGF-2) and diesel fuel had insignificant toxicity.

The foliage ingestion quotient (F.I.Q.) was used to screen one potential ecological effect. This indicated that the WP, RP, IR, and HC smokes were significantly toxic to animals when deposited on foliage they consumed. Another potential ecological effect was addressed by the use of an aquatic toxicity quotient (A.T.Q.). Here the HC smoke and IR obscurant (EA-5763 and EA-5769) were found to be toxic to fishes while fog oil and diesel fuel were borderline in their aquatic toxicity. WP and RP smoke types had insignificant A.T.Q.s.

Environmentally transformed by-products of S&O materials were screened for water solubility in an effort to predict their fates. In freshly deposited smokes, the WP, RP, and HC inorganic forms were found to be highly mobile, but the water soluble (aromatic) organic components of SGF-2 and DF were only slightly mobile. Substances in IR smokes were found to be more or less immobile. After a few weeks, transformations usually decreased the mobility of WP, RP, and HC by more than three orders of magnitude. The WP and RP smoke products should end up in phosphate pools. DF by-products increase in mobility and become susceptible to biodegradation. HC in soil became very immobile. The ultimate fate of HC in soil or water is partly to join the large chloride pools and partly to become a component of less mobile, pH-regulated, zinc complexes. Bioavailability and potential toxicity of P and HC smokes would then decrease in the long term.

In conclusion, this screening and ranking procedure has determined what and when smoke-producing devices could be environmental problems and to what degree relative to each other. In general, the devices impacting the largest area (DF and SGF-2) had insignificant environmental effect due to dilution, while those with the least area of impact (grenades) had largest environmental effect. We found that by considering the inhalation, foliar ingestion, and aquatic toxicities, combined with the area of impact, the environmentally most troublesome devices were the HC smoke pot followed by the HC grenade and HC artillery and, in fourth place, the IR grenade. All other devices were orders of magnitude less important environmentally.

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## BACKGROUND AND OBJECTIVES

The U.S. Army has developed smokes and obscurants (S&O) for its needs in the battlefield since World War I. The inventory of S&O at present consists of materials derived from phosphorus (P), hexachloroethane (HC), fog oils (SGF-2), diesel fuel (DF), and new infrared (IR) screening agents. Recent Army S&O development programs have resulted in improvements in materiel performance, adaptation of S&O material to changed battlefield requirements, invention of new S&O agents, and requirements for safe and environmentally acceptable products. The U.S. Army Medical Biocengineering Research and Development Laboratory (USAMBRDL) has responded to the Army's needs with health and environmental studies of S&O material. Such studies serve to support the numerous field testing, evaluation, training, and supply agencies which must handle and utilize the S&O material in a safe and environmentally sound manner.

While the CRDC "Programmatic Life Cycle Environmental Assessments"<sup>1-5</sup> have listed and summarized many key studies of smokes and obscurants, the extensive Army research effort on the health and environmental effects has never been integrated into a comprehensive evaluation. To fill this gap, USAMBRDL has sponsored the present data base compilation and assessment.

The purpose of this report is to provide an initial evaluation and integration of the comprehensive data base on health and environmental studies of smokes and obscurants. The methodology consisted of a screening and ranking procedure that used a data base that had been extracted from numerous reports and other literature. The most labor-intensive effort was to transform and quantify data from our literature survey study results into a computer-compatible data base management system. A substantial contribution of this study therefore was the bibliographic file listed in this report. In order to accomplish the data base assessment within a reasonable time and with "milestone" reports, the effort was planned in phases. Phase I Data Base Assessment was extensive, but shallow, intending to encompass all S&O and to provide to interested users a screening and ranking system. Phase II would deal with intensive evaluations and fill knowledge gaps identified in Phase I.

## APPROACH

Conclusions and data from numerous reports were evaluated and entered into a machine-processable data base (data base management system). The data were divided into several categories. These include S&O device characteristics relevant to environmental issues, physical/chemical properties, and various health and environmental quantities described later. Cross-indexing was provided to permit machine searches traceable to the original articles according to an accession number. The subdivisions of the above categories evolved into a limited set as the evaluation and comprehension of the data base proceeded. A major consideration in this evolutionary process was the guideline of Phase I objective--to provide an initial screening and ranking of first order. The difficulty in adhering to this objective was to decide which information was more properly placed in Phase II; obviously, some intensive assessment was necessary to accomplish Phase I. Consequently, a minor effort was expended toward the Phase II goal--to provide an intensive S&O assessment and to fulfill and identify research needs.

### ENVIRONMENTALLY RELEVANT S&O DEVICE CHARACTERISTICS

The first consideration was to define broad categories of smoke type. This is somewhat artificial because a given composition may be modified within a smoke type, and because there may be operational needs to combine smoke types to achieve a particular smoke/obscurant effect. He did not consider the environmental issues of combined smoke types in this study. The categories of smoke type included in this report are also limited to those currently important, which excludes outmoded S&O, S&O not recommended for further use, and some S&O material in an early stage of research and development. The categories included are given in Table 1, Army Smoke Types for Environmental Screening.

The smoke materials listed (see Table 1) include all the S&O likely to be in an inventory. Phosphorus smokes have evolved into prominence. HC smokes are being phased out, but are common in smoke pots. Fog oil smoke generators should remain in prominence for protection of secured positions (rear area of the battlefield), but SGF-2 should be the only oil recommended

TABLE 1. ARMY SMOKE TYPES FOR ENVIRONMENTAL SCREENING.

- 
- A. Phosphorus smokes (P)
    - 1. White phosphorus (WP)
      - White phosphorus/felt wedges (WP/FW)
      - Plasticized white phosphorus (PWP)
      - White phosphorus wicks (WPW)
    - 2. Red phosphorus (RP)
      - Red phosphorus/butyl rubber (RP/BR)
      - Red phosphorus wedges (RPW)
  - B. Hexachloroethane smokes (HC)
  - C. Fog oil (SGF-2)
  - D. Diesel fuel (DF)
  - E. Infrared (IR) smokes (EA-5763 and EA-5769)
- 

for use. Diesel fuel would be the common smoke type used on moving vehicles. IR smokes are new, but only two are included in this report (EA5763, EA5769), and their composition is revealed here only as oily brass particles.

The devices used as delivery systems for smoke and obscuring agents are usually also the containers for storage and transport of the smoke type. The exceptions are the fog oil and diesel fuel normally stored and transported in bulk containers, and pumped into a heated, forced-air chamber when utilized to generate smoke. The device characteristics that were applied to health and environmental screening were the effective fill weight (Q), the minimum area of impact (A), the burn time ( $t_b$ ), the average rate of burn ( $dQ/dt$ ) in the case of continuous smoke generators, and the minimum vertical extent (h) of the smoke. Details of the smoke concentration distribution, median particle size, and size-distributions were not used in the screening. Estimations of effects such as acute inhalation response and concentrations in the environment resulting from deposition, were determined as first-approximations by the derivation of suitable quotients or indices.

The first-order estimates were not considered extremely limiting for these ranking purposes. Inhalation response to particle-size is about the same for all smokes because their physical sizes will be about the same in

order to be effective obscurants. To a good approximation, the fraction of suspended mass retained, for example in the deep lung (pulmonary) region, would be the same for all S&O agents. Furthermore, physically meaningful indices were defined.

The effective fill weight (Q) divided by the minimum area of impact (A) defines the upper bound of deposition that could occur over the area under any circumstances:

$$\text{Maximum available deposition} = \frac{Q}{A}. \quad (1)$$

Carrying this argument further, dividing the effective fill weight (Q) by the minimum effective volume (Ah) defines the maximum environmental air concentration (C) averaged over the minimum area of impact (A), which could occur, e.g., from bursting devices:

$$C = \frac{Q}{Ah}. \quad (2)$$

The first difficulty is in determining A. The minimum impact area is important, however, because it can serve as a ranking index in itself. The minimum area of impact is usually small and serves to demonstrate that each device has a small potential ecological cost when viewed on a global scale. Consequently, ranking the devices by impact area (A) was a useful first-order exercise. In the case of bursting devices C must be defined differently as derived next.

For bursting devices, the material is spread instantaneously and can be viewed as having a Gaussian distribution in the second instant, at which time atmospheric diffusion begins. The area  $A_B$  can be estimated for bursting munitions as a circle of radius (R) containing 95% of the material, which has Gaussian width  $\sigma_y$  and height  $\sigma_z$ :

$$R = 2 \sigma_y, \quad (3)$$

$$A_B = 4\pi \sigma_y^2, \quad (4)$$

$$h = \sigma_z. \quad (5)$$

We found that for nearly all bursting devices the parameters  $\sigma_y$  and  $\sigma_z$  were available from the data base, and for approximation purposes:

$$\sigma_z = \sigma_y 3. \quad (6)$$

Hence, the maximum concentration ( $C_B$ ), given for bursting devices in equation (2) was calculated from the given  $Q$  in the data base and equations (4) through (6).

For burning munitions such as smoke pots, a different approach was used because a burning device would be diluted and diffused by the wind during the burn. The minimum impact area ( $A'$ ) for burning devices was defined as the area covered in the horizontal plane by a substance diffusing under stable conditions (Pasquill stability category F) with calm conditions (wind speed 0.5 m/s) during the burn time. For all burning devices the burn time ( $t_B$ ) (usually several minutes) was available from the data base with the exception of fog oil and diesel fuel continuous generators. For the continuous generators a convenient burn time of one hour was used, and the burn rate ( $dQ/dt$ ) was considered constant so that calculation of  $Q_c$  for continuous release was the product of  $dQ/dt$  and  $t_c$ , where  $t_c = 1$  hour:

$$Q_c = \frac{dQ}{dt} t_c \quad (7)$$

The minimum impact area for continuous releases ( $A'$ ) depended upon the plume width ( $\sigma_y$ ), plume height ( $\sigma_z$ ), wind speed ( $u$ ), and burn time ( $t_B$ ):

$$\sigma_y = 0.04 X, \quad (8)$$

$$\sigma_z = 0.016X, \quad (9)$$

$$X = u t_B, \quad (10)$$

$$u = 0.5 \text{ m/s}. \quad (11)$$

where relations (8) and (9) are the Briggs' estimates for close-in diffusion under calm winds in F stability category from the "Handbook on Atmospheric Diffusion."<sup>6</sup> The minimum impact area ( $A'$ ) for the Gaussian plume is a triangular area containing 90% of the material (see Appendix A) estimated by

$$A' = 2 \pi \sigma_y u t_c, \quad (12)$$

and the average environmental air concentration for diffusing smokes by

$$C_D = Q/A'\sigma_z. \quad (13)$$

Because the definitions of the minimum impact area for bursting ( $A_B$ ) and for burning ( $A'$ ) devices are different, care should be exercised in their comparison. On the one hand bursting devices have a closely defined impact area, whereas burning devices have a minimum impact area, which was estimated as a worst case diffusion problem that applies realistically only in calm winds at night.

The choice of  $t_c = 1$  hour was made to approximate the times of exposure to fog oil and diesel fuel, but in actual cases it would vary. (Actual times could be adjusted as a multiple of hours.) In quotients to be discussed later, one-hour exposure concentrations were compared to  $C$ . This exposure time may seem incongruous to the burn times ( $t_B$ ) of devices that last only a few minutes. But in that case we envision a puff-like cloud that persists depending on wind speed and could take up to an hour to disperse in very calm winds, a worst case.

#### CONSIDERATIONS GIVEN TO PHYSICAL/CHEMICAL PROPERTIES OF S&O

A major difficulty was to determine the likely chemical residuals and their physical properties in the environment. We attempted to reconcile the expressions given in the data base for chemical reactions during combustion of S&O devices. It became evident that, particularly for phosphorus and HC devices, there was no way to unify the various results. Excellent laboratory studies that proceeded to complete combustion under controlled conditions did not represent well the few field observations of combustion product concentrations. We made our own estimates of the critical components and their ultimate fates, to the degree justifiable for a first-order ranking and verifiable where possible. This list of residuals was explored for chemical/physical properties.

Properties considered useful for first-order assessments were the octanol-water partition coefficient, the solubility in water at normal

temperatures, the vapor pressure at normal temperatures, and others. The utility of these properties has been established, for example, in estimating partitioning coefficients for a simplified compartmental model of the environment. These concepts were defined by Laskowski *et al.*<sup>7</sup> for the terrestrial environment in a noteworthy compendium of methods, "Environmental Risk Analysis for Chemicals," edited by Conway.<sup>8</sup> The environmental fate should be evaluated using the pollutant limit values method of Rosenblatt, Dacre, and Cogley<sup>9</sup> in the same book (*loc. cit.*). We utilized the "Handbook of Chemical Property Estimation Methods" by Lyman, Reehl, and Rosenblatt<sup>10</sup> to determine octanol-water partitioning coefficients, solubilities, and vapor pressure for certain organic fractions identified as constituents in SCF-2 fog oil, and in the middle petroleum distillates found in diesel fuel.

These methods did not lead to a successful ranking of S&O materials in terms of soil adsorption coefficients, volatilization, bioconcentration factors, and biodegradation. The major reason for the incomplete application of the methods and failure to establish preliminary pollutant limit values was the nature of the inorganic constituents in phosphorus and HC smokes. Both of these smokes we found were dominated by highly soluble, very low vapor pressure inorganic products that ultimately transform and lose their identity in large elemental pools within the natural water and soil systems. The utility, and even the meaning, of soil adsorption and volatilization became obscured.

Methods very useful for ranking pesticides and other persistent pollutants were not applicable to S&O chemicals that become part of nutrient cycles or are transformed into bound components of the soil/sediment systems. For example, for pesticides the soil adsorption coefficient is highly correlated to the organic matter concentration, but for phosphoric acid the soil adsorption occurs on clay minerals and depends upon other elemental concentrations.<sup>11,12</sup> The phosphoric acid is transformed into calcium, iron, and aluminum phosphates whose solubility in the water or soil environment depends highly on pH.

The first-order rankings of S&O chemicals for mobility in the environment were by solubility of the initially deposited material as a measure of potential acute deposition effects and by solubility of the transformed products as a measure of potential long-term chronic effects.

## HEALTH AND ENVIRONMENTAL INDICATORS

The suspended smoke materials were expected to adversely affect living systems through two pathways. The first was the exposure of mammals to respirable particles that may be toxic via the inhalation pathways. Since all smokes have about the same particle-mass size distributions the respirable fraction would be about the same for each. We ranked the potential acute effect of smoke/obscurant inhalation according to the one-hour lethal concentrations to rats. The choice of rats was made because their inhalation response is similar to humans (although this response is generally less sensitive than mice) and because rats are usually the animals of choice in toxicology bioassay studies.

The method required some estimations, however. The data base contained non-standardized information. We chose the  $LC_{50}$  at one-hour (lethal concentration of 50% of the population exposed for one-hour and observed at 14 days following exposure). The data base contained incomplete data such as  $LC_{20}$  or  $LC_{30}$ , etc., and often data were expressed as doses (concentrations multiplied by time). It is usually assumed that Haber's Law describes inhalation response.<sup>13</sup> That is, the effects are the same for a given combination of concentration and time of exposure as long as the product (Ct) remains constant. We found that the method of Haber's Law (Ct = constant) gave 65% errors in estimating inhalation effects of smokes.

Two studies of relevant inhalation response in rats were found to give the same basic results: a study by Dalbey and Lock<sup>14</sup> using "Phillips Referee-grade" diesel fuel, and a study by Ballou<sup>15</sup> using red phosphorus smoke. We reanalyzed their data and found that  $LC_{50}$  values could be calculated from intermediate results  $LC_X$  (e.g.,  $LC_{20}$ ,  $LC_{80}$ ) using the relation:

$$LC_{50} = (LC_X) \exp ((50-X)/B), \quad (14)$$

where B is an experimental constant. We found values of  $B = 60.3$  for diesel fuel and  $B = 57.2$  for red phosphorus. These B-values are the same within 3%. Furthermore, Dalbey and Lock's data confirmed that B is not a function of exposure time. Next we found that the  $LC_{50}$  time-dependence was statistically highly correlated to exposure time ( $R^2 = 0.97$ ) by the relation:

$$\log_e (LC_{50}) = -at + b, \quad (15)$$

where a and b are constants for given experiments. From this we derived the interpolation equation at exposure time  $t_1$ :

$$(LC_{50})_1 = (LC_{50})_2 \exp [a(t_2 - t_1)], \quad (16)$$

where a is the same constant as in equation (15) and the subscripts refer to two different exposure times,  $t_2$  and  $t_1$ . The constant for diesel fuel is  $a = 0.239 \text{ h}^{-1}$ , while  $a = 0.295 \text{ h}^{-1}$  for phosphorus smoke. The constants were close enough to combine for ranking purposes, and we used this one interpolation scheme (Table 2) for all smokes. (The values in natural logarithms for the other constants,  $b = 3.291$  for diesel fuel and  $b = 1.706$  for phosphorus smoke, were not used.) Solutions to equations (14) and (16), as given in Table 2, were used to interpolate LC 50 for all smokes and obscurants. The mean deviation from Haber's Law was 65%.

A determination of deposition was made by a common method. We used a deposition velocity concept, with a value of  $v_d = 0.1 \text{ cm/sec}$  (3.6 m/h). This is a commonly accepted estimate for particles of unit density in the size range 0.3 to 3  $\mu\text{m}$  diameter.<sup>6,16</sup> Deposition flux (F) was estimated from C ( $\text{mg/m}^3$ ):

$$F = v_d C. \quad (17)$$

For ranking purposes we took a typical concentration for smoke of  $C = 1000 \text{ mg/m}^3$ , which was within a factor of three of the range of values computed for WP-devices using equations (2) and (13). Also, typical fog oil concentration values were found to be 15 to 2000  $\text{mg/m}^3$ .<sup>17</sup> The deposition of smoke at 1000  $\text{mg/m}^3$  concentration was estimated at 3600  $\text{mg/m}^2$  for a one-hour release, and at one release per day represents a concentration of 48 mg/kg when incorporated into 5 cm of soil and a concentration of 3.6 mg/liter when incorporated into water of 1-m depth. A soil depth of 5 cm represents a zone of soil that is considered well-mixed in natural ecosystems, but typical plow layers for cultivated fields would be 15 cm in depth, reducing this estimated concentration.

TABLE 2. INTERPOLATION TO INHALATION LC<sub>50</sub> VALUES FOR OTHER PERCENTAGES OF LETHALITY AND OTHER TIMES OF EXPOSURE RELATIVE TO ONE HOUR.

Ratio of LC <sub>50</sub> relative to given percent lethality		Ratio of LC <sub>50</sub> at one-hour exposure to LC <sub>50</sub> at given exposure time, t	
LC <sub>20</sub>	1.67	t = 2 h	1.3
LC <sub>30</sub>	1.41	3 h	1.7
LC <sub>40</sub>	1.19	4 h	2.2
LC <sub>50</sub>	1.00	5 h	2.9
LC <sub>60</sub>	0.85	6 h	3.8
LC <sub>70</sub>	0.71	7 h	5.0
LC <sub>80</sub>	0.60	8 h	6.6

Estimations of foliar deposition often use the Chamberlain normalized specific concentration (NSC); an example was given by Shinn.<sup>18</sup> Using the accepted NSC value of 30-60 m<sup>2</sup>/kg (dry weight of foliage) for a one-hour exposure per day, we obtained an estimate of foliar retention of 100-220 g/kg dry weight for an airborne smoke concentration of 1000 mg/m<sup>3</sup>. Direct foliar consumption by cattle would transfer pollutant at 0.020 mg/kg body weight per day per 1 mg pollutant/kg; likewise 0.060 mg/kg body weight for rats.<sup>7</sup>

Smoke product accumulation in cattle would be 2.2-4.3 g/kg each day and in rats 6.5-13 g/kg each day if they were eating foliage exposed to 1000 mg/m<sup>3</sup> for one hour, estimated by the NSC method. The sensitivity of smokes via the ingestion pathway was estimated by the oral LD<sub>50</sub> for rats, the ingested dose (mg/kg) causing 50% lethality in rats. These data were readily available in the data base. The ranking of smokes for oral toxicity was obtained by dividing the calculated smoke ingested value, 6.5 g/kg, by the LC<sub>50</sub> for each smoke substance.

Aquatic toxicity was estimated on the basis of the above estimate of water concentration, 3.6 mg/liter, compared to the TLm<sub>96</sub>, the 50% lethal

concentration for 96-hour exposures of common bioassay fishes. Aquatic ranking of smokes was obtained by taking the ratio of dissolved concentration to  $TLm_{96}$ , provided the dissolved concentration was feasible in terms of its solubility in water.

## RESULTS

### RANKING BY DEVICE IMPACT AREA AND ENVIRONMENTAL CONCENTRATION

As much information as possible was obtained for each device so that each could be ranked on the basis of its particular effective fill weight, impact area, and maximum environmental concentration. The device properties are provided in Appendix B, because of the extent of those data. It was possible to categorize the data, however, and to rank these categories in terms of minimum impact area. The relative importance of each category according to impact area is given in Table 3. The values in Table 3 represent the ranges given for several similar devices within a category, rounded off, and indicate whether the device is diffusing or bursting. (It should be recalled that diffusing and bursting areas are calculated differently, so caution should be exercised.) The general result was that phosphorus devices with wedges (RP/W and WP/FW) and the RP bomblet had the largest areas of the bursting devices. Except for the bomblet, all bursting devices would impact a relatively small area (less than three acres or the equivalent of three football fields). Continuous sources like the smokepots, diesel fuel exhaust systems, and fog oil generators, however, would impact large areas (ten to hundreds of acres).

The determination of environmentally important concentrations (C) of smokes and obscurants estimated by equations (2) or (13), was also done for each device; see Appendix B for details. Just as in the case of the rankings of impact area, it was possible to categorize the data and to rank these categories. The relative importance of each smoke and obscurant category is given in Table 4. We found unexpectedly that grenades, especially IR and RP/BR, produce the highest environmental concentrations, but it should be recalled (Table 3) that these are very local. HC diffusing (howitzers) and

TABLE 3. MINIMUM AREA IMPACTED IN S&O DEVICE CATEGORIES, RANKED.

Device type	Ground area (m <sup>2</sup> ) <sup>a</sup>
1. IR bursting, RP/BR bursting (grenades)	50
2. WP bursting (mortars, guns, rockets, howitzers)	100-800
3. HC diffusing (howitzers)	50-1200
4. HC diffusing (grenade)	1000
5. RP/W bursting (mortars and howitzers)	1000-11000
6. WP/FW bursting (rockets and howitzers)	9500-12000
7. HC and SGF-2 diffusing (smoke pots)	9500-65000
8. RP bursting (bomblet)	180000
9. DF diffusing (diesel fuel exhaust, each hour)	300000-800000
10. SGF-2 diffusing (fog oil generator, each hour)	500000-800000

<sup>a</sup> By comparison, one acre and one football field (U.S.) occupy 4050 m<sup>2</sup> and 4230 m<sup>2</sup>, respectively.

TABLE 4. CALCULATED ENVIRONMENTAL CONCENTRATIONS OF S&O DEVICES, RANKED.

Device type	Concentration (mg/m <sup>3</sup> )
1. RP Bursting (bomblet)	2
2. DF Diffusing (diesel fuel exhaust, each hour)	10
3. SGF-2 Diffusing (fog oil generator, each hour)	5-10
4. WP/FW Bursting (howitzer and rockets)	5-25
5. HC and SGF-2 Diffusing (smoke pots)	10-110
6. RP/W Bursting (mortars and howitzers)	25-220
7. HC Diffusing (grenade)	220
8. HC Diffusing (howitzers)	450-660
9. WP Bursting (mortars, guns, rockets, howitzers)	1800-3500
10. IR and RP/BR Bursting (grenades)	>10000

WP bursting (mortars, guns, rockets, and howitzers) ordnance produce the second highest environmental concentrations, but again over a small area from 100 to 1200 m<sup>2</sup>.

#### RANKING BY INHALATION TOXICITY AND AIR CONCENTRATION QUOTIENT

The inhalation toxicity of smoke and obscurant materials was the primary effect considered from short-term, acute exposures (up to one hour). We ranked the smoke materials as mixtures; that is, the chemical composition of the smoke mixture was not further subdivided for inhalation toxicity ranking. The various smoke types are ranked in Table 5 according to the one-hour LC<sub>50</sub> for rats.

The LC<sub>50</sub> values (inhalation) given in Table 5 were each estimated from more than one reference. The LC<sub>50</sub> value for SGF-2 was estimated from one LC<sub>20</sub> value<sup>15</sup> and from several studies of similar oils that put limits on the LC<sub>50</sub> estimate for SGF-2. The LC<sub>50</sub> value for DF smoke came from arithmetic averages of values from the original Daibey and Lock data<sup>14</sup> and a number of other values<sup>19</sup>; all these values had a range from 10300 to 38000 mg/m<sup>3</sup> with a ratio of the standard deviation to the mean (coefficient of variation) of 0.44. The LC<sub>50</sub> value for RP and RP/BR was an average of two estimates of RP/BR (Refs. 2, 15), and the presence of butyl rubber (BR) was assumed to be insignificant. The LC<sub>50</sub> value for WP and WP/FW was an average of four estimates, which had a range from 1300 to 4800 mg/m<sup>3</sup> (Refs. 2, 20) and no evident effect of the felt wedges (FW). The coefficient of variation was 0.61 for these values combined. The LC<sub>50</sub> values for EA-5763 and EA-5769 found in an unclassified appendix<sup>3</sup> could not justifiably be separated so they were averaged. The LC<sub>50</sub> value for HC smoke was estimated from the study attributed to Basman *et al.*,<sup>4</sup> but also compared with the data for mice,<sup>21</sup> considering that mice were usually more sensitive in similar studies by a factor of 2 to 3. In general, we felt that the relative ranges and coefficients of variation found for DF and WP were probably characteristic of all the smokes. The LC-50 values given in Table 5 could not be estimated with uncertainties less than about 50% because of normal variation.

TABLE 5. RELATIVE INHALATION TOXICITY OF SMOKES AND OBSCURANTS IN TERMS OF THE ONE-HOUR LC<sub>50</sub> FOR RATS, RANKED IN ORDER OF INCREASING TOXICITY.

	LC <sub>50</sub> (mg/m <sup>3</sup> )	Relative toxicity
1. SGF-2 fog oil	60000	1
2. Diesel fuel smoke	26000	2
3. RP and RP/BR	4000	15
4. WP and WP/FW	2500	24
5. IR (EA 5763, EA 5769)	970	62
6. HC smoke	333	180

A preferred way to express the relative inhalation toxicity of smoke and obscurant devices is by means of the concentration quotient, (C.Q.), which is defined as the ratio of the environmental air concentration (C) to the particular LC<sub>50</sub> value for inhalation toxicity to rats. The C.Q. values calculated for each device are given in Appendix B. The device categories given in Table 4 were re-ranked in terms of C.Q. and the values of C.Q. are given in Table 6. The S&O categories that had C.Q. values near unity and greater were the devices with potentially significant inhalation toxicity. Of these devices the S&O grenades were the most dangerous, especially the RP/BR and IR grenades. This is explained by the small volume of their clouds relative to fill weight. The artillery-produced smokes were the most toxic when in the form of HC and WP. The phosphorus smokes with wedges (RP/W and WP/FW) were far less toxic. HC smokepots were on the borderline of inhalation toxicity significance, while SGF-2 and DF were insignificant in terms of inhalation.

#### RANKING BY ORAL TOXICITY AND INGESTION QUOTIENT

The effect of S&O materials in the environment would depend on the pathway of toxicity. Direct ingestion would be unlikely for humans unless the material were deposited on crops. Animals that feed upon plants,

TABLE 6. AIR CONCENTRATION QUOTIENTS (C.Q.) FOR RELATIVE INHALATION TOXICITY OF S&O DEVICES, RANKED IN ORDER OF INCREASING TOXICITY.

Device type	C.Q. <sup>a</sup>
1. SGF-2 diffusing (fog oil generator, each hour)	0.0002
2. DF diffusing (diesel fuel generator, each hour)	0.0003
3. RP bursting (bomblet)	0.0003
4. SGF-2 diffusing (smoke pot)	0.0004-0.002
5. WP/FW bursting (howitzer and rockets)	0.002-0.01
6. RP/W bursting (mortars and howitzers)	0.006-0.06
7. HC diffusing (smoke pots)	0.04-0.25
8. HC diffusing (grenade)	0.7
9. WP bursting (mortars, guns, rockets, howitzers)	0.7-1.4
10. HC diffusing (howitzers)	1.4-2.0
11. RP/BR bursting (grenade)	3.4
12. IR bursting (grenade)	>10

<sup>a</sup> C.Q. is the ratio of the environmental air concentration, C, to the one-hour lethal concentration (LC<sub>50</sub>) for rats exposed by inhalation. Values near unity or greater indicate potentially significant toxicity problems.

however, could be acutely exposed if they consume the S&O material deposited on their forage. The relative toxicity of smoke types by ingestion was ranked in order of the oral LD<sub>50</sub> values to rats, a concentration (mass of toxic material per body weight, mg/kg) found to be lethal to one-half the rats in an exposed population. Deposition was calculated on page 15 for a smoke concentration of 1000 mg/m<sup>3</sup> using the deposition velocity, Eq. (17), and foliar retention was estimated using Chamberlain's NSC. Direct consumption by rats indicated a value estimated of accumulated smoke material of 6.5 g/kg (low range) if they ingested foliage exposed to smoke concentrations of 1000 mg/m<sup>3</sup> for one-hour. We ranked the smokes for acute environmental effects to animals by determining the foliage ingestion quotient, (F.I.Q.) which is defined as the ratio of the amount of contaminant ingested by rats

(6.5 g/kg) to the LD<sub>50</sub> value for oral toxicity to rats. This screening method would indicate potential toxicity problems if the F.I.Q. values approach or exceed unity. The results show that the WP, RP, IR, and HC smokes are all significantly toxic when deposited on foliage consumed by animals; see Table 7. We determined the oral LD<sub>50</sub> values in this case by examining the smoke product likely to be the agent present when foliar consumption occurred soon after the exposure.

The oral LD<sub>50</sub> value for all phosphorus smokes was estimated as that for orthophosphoric acid.<sup>22</sup> When WP or RP are combusted, the reaction product P<sub>2</sub>O<sub>5</sub> rapidly hydrolyzes.<sup>11,23</sup> In the environment the formation of cyclic metaphosphates is unlikely, and the linear polyphosphates usually found can be expected to hydrolyze very rapidly in the presence of normal amounts of moisture.<sup>23</sup> All the linear polyphosphates H<sub>n+2</sub> (P<sub>n</sub> O<sub>3n+1</sub>) will hydrolyze to the orthophosphate (n = 1) form, H<sub>3</sub> PO<sub>4</sub>. For acute environmental effects (other than inhalation) we used the various properties of orthophosphoric acid in screening and ranking. The LD<sub>50</sub> value for HC smokes was based on the estimate for zinc chloride,<sup>22</sup> which comprises about 80% of the combustion products. (The other significant combustion products are far less toxic than zinc chloride.) The LD<sub>50</sub> value for SGF-2 was estimated as mid-range between that given for diesel fuel<sup>24</sup> and that for the polyethylene glycol (PEG-200; see Ref. 1) with the justification that the aromatic hydrocarbon compounds of SGF-1 are similar to the middle distillates found to be toxic in diesel fuel and fuel oil, but the higher concentrations of aliphatic compounds are known to ameliorate the toxic effects. Subjective comparisons of SGF-2 with fuel oil and PEG-200 were found.<sup>1,17,24,25</sup> The LD<sub>50</sub> value for EA-5763 and EA-5769 was estimated from the by-products we assumed to occur,<sup>3</sup> such as from copper and zinc in the brass.

#### RANKING BY AQUATIC TOXICITY QUOTIENT

The effect of a smoke and obscurant material on the aquatic environment would depend upon the solubility of the material in water, the toxicity to aquatic life, and upon the amount of material deposited into water bodies. We estimated that the deposition of S&O from a cloud with an air concentration of 1000 mg/m<sup>3</sup> passing over a water body 1 meter deep for one hour would result in S&O concentrations of about 3.6 mg/liter in the water. The aquatic

TABLE 7. FOLIAGE INGESTION QUOTIENT (F.I.Q.) FOR RELATIVE ORAL TOXICITY OF SMOKES AND OBSCURANTS TO RATS, RANKED IN ORDER OF INCREASING TOXICITY.

Smoke type	Rat LD <sub>50</sub> (Oral) (mg/kg)	F.I.Q. <sup>a</sup>
1. SGF-2	21000	0.3
2. DF	14000	0.5
3. RP and RP/RP	1530	4.2
4. WP and WP/FW	1530	4.2
5. IR (EA-5763 and EA-5769)	800	8.1
6. HC smoke	350	19

<sup>a</sup> The F.I.Q. uses the value of 6500 mg/kg as an estimate of the amount of smoke products consumed by a rat when the foliage receives deposition from smoke at an air concentration of 1000 mg/m<sup>3</sup> for one-hour. The F.I.Q. is the ratio of 6500 mg/kg to the oral LD<sub>50</sub> for rats. Values near or greater than unity indicate potential toxicity problems.

toxicity quotient, (A.T.Q.) was defined as the ratio of 3.6 mg/liter to the TLM<sub>96</sub> for bioassay fishes. The TLM<sub>96</sub> is the lethal concentration in water (mg/liter) for half of the fish after 96-hours of exposure. The A.T.Q. must be adjusted if the value 3.6 mg/liter exceeds the amount soluble in water; in that case A.T.Q. is the ratio of the amount soluble to the TLM<sub>96</sub>. Aquatic toxicity from the major smoke types would be significant when the A.I.Q. approaches or exceeds unity. The HC smoke and IR smoke (EA-5763 and EA-5769) were found to be the most toxic to fishes while fog-oil and diesel fuel had borderline aquatic toxicity and WP and RP smoke types were of insignificant toxicity, see Table 8.

The TLM<sub>96</sub> values for WP and RP were values for orthophosphoric acid,<sup>22,26</sup> and the values for HC were for zinc chloride.<sup>21</sup> The SGF-2 and DF were found to have about the same short-term solubility<sup>17</sup> and were given the same TLM<sub>96</sub> estimates based upon toxicity of middle distillates present.<sup>17</sup> TLM<sub>96</sub> values for IR were available in unclassified appendices.<sup>3</sup>

TABLE 8. AQUATIC TOXICITY QUOTIENT (A.T.Q.) FOR RELATIVE TOXICITY OF SMOKES AND OBSCURANTS TO BIOASSAY FISHES, RANKED IN ORDER OF INCREASING TOXICITY.

Smoke type	TL <sub>m96</sub> (mg/liter)	A.T.Q. <sup>a</sup>
WP and WP/FW	100-1000	0.0036-0.036
RP and RP/BR	100-1000	0.0036-0.036
SGF-2	2-50	0.72-1.8
DF	2-50	0.72-1.8
IR (EA-5763 and EA-5769)	0.02-0.10	0.3-1.55 <sup>b</sup>
HC	0.1-10	0.36-36

<sup>a</sup> A.T.Q. uses the value 3.6 mg/liter as an estimate of the amount of smoke products deposited in water 1-m deep from a one-hour exposure to an air concentration of 1000 mg/m<sup>3</sup>. The A.T.Q. is the ratio of 3.6 mg/liter to the TL<sub>m96</sub> for common bioassay fishes. Values near unity or greater are of significant aquatic toxicity.

<sup>b</sup> The low solubility of IR smoke requires that the A.T.Q. is a ratio of the amount soluble to the TL<sub>m96</sub> in that case.

#### RANKING BY SHORT-TERM AND LONG-TERM MOBILITY IN THE ENVIRONMENT

The intermediate fate of smoke and obscurant materials in the environment was screened on the basis of the solubility in water of the initial chemical form when deposited on soil or water. Ranking on the basis of this factor would presume that initial mobility in soil and sediments should indicate potential problems. The initial solubility of WP or RP smokes was estimated as that of orthophosphoric acid,<sup>27</sup> the initial solubility of HC smoke as that of zinc chloride,<sup>28</sup> the initial solubility of fog oil and diesel fuel smoke as measured in a non-agitated, non-emulsified mixture,<sup>17</sup> and the initial solubility of IR smoke from brass constituents.<sup>3</sup> The results indicate that WP, RP, and HC inorganic forms that are highly soluble would be highly mobile, the dissolved organic components (presumably aromatics) in SGF-2 and DF would be slightly mobile, while IR (EA-5763 and EA-5769) would be

TABLE 9. MOBILITY OF FRESHLY DEPOSITED SMOKE AND OBSCURANT MATERIALS IN SOIL AND SEDIMENTS, RANKED ACCORDING TO INCREASING SOLUBILITY.

Smoke type	Solubility (mg/liter)	Relative rank
IR (EA-5763 and EA-5769)	0.03	1
SGF-2	14-52	$10^2 - 10^3$
DF	14-52	$10^2 - 10^3$
HC	$4.3 \times 10^6$	$10^8$
WP and RP forms	$5.5 \times 10^6$	$10^8$

very immobile; see Table 9.

The ultimate fate of S&O materials in the environment was estimated from the solubility in water of chemical forms thought to result long after deposition on soil or water. Again ranking by this procedure should indicate if transformed smoke components could become mobile. The HC smoke initially would consist of highly soluble zinc chloride and unreacted aluminum chloride plus insoluble forms such zinc and aluminum oxides. The chlorides hydrolyze rapidly<sup>21</sup> and form hydrochloric acid and zinc oxychlorides in the presence of normal moisture. In the soil and sediments these forms undergo ion-exchange readily. Studies attributed to Fuller<sup>21</sup> provided estimates for zinc ion as the soluble form in soils and zinc hydroxide as the soluble form in water. The chloride ions were disregarded because they enter a fairly large pool in natural soils and waters (e.g., sodium and potassium chlorides).

The IR materials (EA-5763 and EA-5769) and SGF-2 fog oil were given the same long term solubility as their estimated initial solubility. The solubility of DF was obtained from a measured solubility of DF after a few weeks in the environment.<sup>17</sup> The fate of orthophosphoric acid in low concentrations in soil and sediment is governed by the pH and type of clay mineral present.<sup>12</sup> The distribution of orthophosphate species as a function of pH is well known. Epitaxial adsorption on clay mineral surfaces and solid phase formation reactions show that apatites are formed as well as iron and aluminum phosphates. From Edzwald's adaptation of Stumm and Leckie<sup>12</sup> these

TABLE 10. LONG-TERM MOBILITY OF TRANSFORMED SMOKE AND OBSCURANT MATERIALS IN SOIL AND SEDIMENTS AT pH 7, RANKED ACCORDING TO INCREASING SOLUBILITY.

Smoke type	Solubility (mg/liter)	Relative rank
HC in soil	$6.5 \times 10^{-4}$	1
IR (EA-5763 and EA-5769)	$3 \times 10^{-2}$	50
SGF-2	14-52	$10^4-10^5$
HC in water	99	$10^5$
DF	360	$6 \times 10^5$
WP and RP	1500	$10^6$

all have about the same solubility near pH 7. We used the solubility of  $\text{FePO}_4$ , which was slightly higher than the others, as an indicator species for the long-term fate of combusted WP and RP. The result was that of the S&O, the HC in soil and IR (EA-5763 and EA-5769) have insignificant long-term mobility compared to SGF-2, HC in water, DF, WP, and RP; see Table 10.

The S&O materials with the highest short-term solubility, (WP, RP, and HC) fresh after deposition, had decreased solubility by more than three orders of magnitude in the long term due to estimated transformation in the environment; compare Tables 9 and 10. This rapid transformation and demobilization, particularly of P and HC smokes essentially renders them less harmful to plant and animal life. More work is needed on the environmental fate of S&O materials and their potential toxicity in their transformed states. The screening showed that smoke combustion products and their dynamics in soil and water systems were relatively complicated and not well unified, although studied in some detail.

## RANKING BY OVERALL ENVIRONMENTAL IMPORTANCE

We ranked the overall environmental importance of device categories by multiplying the minimum area of impact by the C.Q., F.I.Q., and A.T.Q. This empirical index is the product of area, relative inhalation toxicity, relative foliar ingestion toxicity, and relative aquatic toxicity with equal weighting. Numerically, it had units of area, and in the case of a given range of values the geometric mean was used. It was found that HC smoke pots are environmentally the worst problem by an order of magnitude above HC grenades and HC howitzers. These in turn are an order of magnitude worse than the IR grenades. All other devices are two orders of magnitude less important in overall environmental effects, see Table 11.

TABLE 11. OVERALL ENVIRONMENTAL IMPORTANCE FOR SMOKE AND OBSCURANT DEVICES, RANKED FROM LEAST TO MOST.

	Importance value <sup>a</sup>
1. WP/FW (rockets and howitzers)	1.1
2. SGF-2 (smoke pot)	2.5
3. RP (bomblet)	2.8
4. RP/W (mortars and howitzers)	3.3
5. RP/BR (grenade)	8
6. SGF-2 (generator)	13
7. WP (mortars, guns, rockets, howitzers)	14
8. DF (diesel fuel exhaust)	24
9. IR (EA-5763 and EA-5769, grenade)	$3 \times 10^3$
10. HC (howitzers)	$3 \times 10^4$
11. HC (grenade)	$5 \times 10^4$
12. hc (smoke pots)	$2 \times 10^5$

<sup>a</sup> Importance value is the product of area, C.Q., F.I.Q., and A.T.Q. with units in square meters.

## REFERENCES<sup>a</sup>

1. Muhly, R. L. 1983. "Programmatic Life Cycle Environmental Assessment for Smokes/Obscurants. Vol. 1 of 5. Fog Oil, Diesel Fuels, and Polyethylene Glycol (PEG 200)." Report ARCSL-EA-83001-Vol-1, AD-A134846. Chemical Research and Development Center, Aberdeen Proving Ground, MD. S1059.
2. Yon, R. L., R.S. Wentsel, and J.M. Bane. 1983. "Programmatic Life Cycle Environmental Assessment for Smokes/Obscurants, Vol. 2. Red, White, and Plasticized White Phosphorus." Report ARCSL-EA-83002-Vol-2, AD-A135910. Chemical Research and Development Center, Aberdeen Proving Ground, MD. S1060.
3. Wenz, D. J., and R. S. Wentsel. 1983. "Programmatic Life Cycle Environmental Assessment for Smokes/Obscurants. Vol. 3 of 5. infrared." Report ARCSL-EA-83005, AD-C033575. Chemical Research and Development Center, Aberdeen Proving Ground, MD. S1078.
4. Cichowicz, J. J. 1983. "Programmatic Life Cycle Environmental Assessment for Smokes/Obscurants. Vol. 4 of 5. HC Smoke." ARCSL-EA-83007, AD-A141973/O. U.S. Army Armament, Munitions, and Chemical Command, Chemical Research and Development Center, Aberdeen Proving Ground, MD 21010. S1040.
5. Cichowicz, J. J., and R. S. Wentsel. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 5 of 5. Dyes/Colored Smokes." ARCSL-EA-83010, AD-134846. U.S. Army Armament, Munitions, and Chemical Command, Chemical Research and Development Center, Aberdeen Proving Ground, MD 21010. S1042.
6. Hanna, S.R., G.A. Briggs, and R.P. Hosker, Jr. 1982. "Handbook on Atmospheric Diffusion." DOE/TIC-11223 Technical Information Center, U.S. Department of Energy. Atmospheric Turbulence and Diffusion Laboratory, National Oceanic and Atmospheric Administration. S1189.

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<sup>a</sup>Four-digit numbers preceded by the letter S (at the end of each citation) refer to the Accession Number; see Bibliography.

7. Laskowski, D.A., C.A.I. Goring, P.H. McCall, and R.L. Swann. 1982. "Terrestrial environment." In R.A. Conway, ed. Environmental Risk Analysis for Chemicals. Chapter 6. Van Nostrand Reinhold Co., New York, NY. S1197.
8. Conway, P.E., ed. 1982. Environmental Risk Analysis for Chemicals. Van Nostrand Reinhold Co., New York, NY. S1190.
9. Rosenblatt, D. H., J. C. Dacre, and D. R. Cogley. 1982. "An environmental fate model leading to preliminary pollutant limit values for human health effects." In R.A. Conway, ed. Environmental Risk Analysis for Chemicals. pp. 474-505. Van Nostrand Reinhold, New York, NY. S1120.
10. Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt. 1982. Handbook of Chemical Property Estimation Methods, Environmental Behavior of Organic Compounds. McGraw-Hill Book Company, New York, NY. S1193.
11. Spanggord, R. J., R. T. Podoll, R. T. Rewick, T. S. Chou, R. B. Wilson, J. Backovsky, and D. L. Roberts. 1983. "Environmental Fate of WP/F and RP/BR Military Screening Smokes. Phase I. Literature Review. Final Report (DRAFT)." Phase I. Final Report. Report DAMD17-83-C-2320. SRI International, Menlo Park, CA. S1166.
12. Edzwald, J. P. 1977. "Phosphorus in aquatic systems: The role of the sediments." In I.H. Suffet, ed. Fate of Pollutants in the Air and Water Environments, Part 1. pp. 183-214. John Wiley & Sons, New York, NY. S1144.
13. Kennedy, G. L., and H.J. Trochimowicz. 1982. "Inhalation toxicology." In A. Wallace Hayes, ed. Principles and Methods of Toxicology. pp. 185-207. Raven Press, New York, NY. S1195.

14. Dalbey, W. and S. Lock. 1983. "Inhalation Toxicology of Diesel-Fuel Obscurant Aerosol in Sprague-Dawley Rats. Chemical Characterization and Toxicological Evaluation of Airborne Mixtures. Final Report. Phase I. Acute Exposure." Report ORNL/TM-8867, AD-A132650. Oak Ridge National Laboratory, TN. S1004.
15. Ballou, J. E. 1981. "Chemical Characterization and Toxicologic Evaluation of Airborne Mixtures." Report DAMD17-79-C-9160, AD-A102678. Battelle Pacific Northwest Labs, Richland, WA. S1055.
16. Committee on the Atmosphere and the Biosphere. 1981. Atmosphere-Biosphere Interactions: Toward a Better Understanding of the Ecological Consequences of Fossil Fuel Combustion. National Academy Press, Washington, DC. S1218.
17. Liss-Suter, D. 1978. "A Literature Review - Problem Definition Studies on Selected Toxic Chemicals. Vol. 8. Environmental Aspects of Diesel Fuel and Fog Oils SGF No. 1 and SGF No. 2 and Smoke Screens Generated from Them." Report DAMD17-77-C-7020, AD-A056021. Franklin Inst. Research Lab., Science Information Services Dept., Philadelphia, PA. S1035.
18. Shinn, J.H. 1979. "Problems in the assessment of air pollution effects on vegetation." In J.R. Pfafflin and E.N. Ziegler, eds. Advances in Environmental Science and Engineering, Vol. 2. pp. 88-105. Gordon and Breach Publishers, New York, NY. S1182.
19. Callahan, J.F., C.L. Crouse, G.E. Affleck, R.L. Farrand, R.W. Dorsey, M.S. Ghuman, R.J. Pellerin, D.H. Heitkamp, C. Lilly, J.J. Feeney, and J.T. Weim. 1983. "The Acute Inhalation Toxicity of Diesel Fuels (DF2 and DF1) Used in Vehicle Engine Exhaust Smoke Systems (VEESS)." Technical Report ARCSL-TR-82064. Chemical Systems Laboratory, U.S. Army Armament Research and Development Command, Aberdeen Proving Ground, MD. S1050.

20. Berkowitz, J.B., A.J. Colella, R.G. Thomas, G.S. Young, W.J. Lyman, R.G. Vranka, R.C. Anderson, W.D. Steber, and A.L. Preston. 1981. "Research and Development for Health and Environmental Hazard Assessment. Task Order 5. Occupational and Environmental Hazards Associated with the Formulation and Use of White Phosphorus-Felt and Red Phosphorus-Butyl Rubber Screening Smokes" Report DAMD17-79-C-9139, AD-A116956. Arthur D. Little, Inc., Acorn Park, Cambridge, MA. 02140. S1003.
21. Hill, H.G., J.E. Villaume, and K. Wastl. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 5 of 8. Occupational Health and Safety and Environmental Aspects of Zinc Chloride." Final Report, Report DAMD-17-77-C-7020, AD-A056020. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. S1081.
22. Lewis, Sr., Richard J., and R.L. Tatken, eds. 1982. Registry of Toxic Effects of Chemical Substances, 1980 Edition. Vols. 1 and 2. U.S. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Atlanta, GA. S1199.
23. Katz, S., A. Snelson, R. Butler, R. Narayanan, W. Bock, and S. Relwani. 1979. "Physical and Chemical Characterization of Military Smokes. Part III. White Phosphorus-Felt Smokes." Report DAMD17-78-C-8085, AD-A115657. IIT Research Institute, Chicago, Illinois 60616. S1058.
24. Liss-Suter, D., J.E. Villaume, and P.N. Craig. 1984. "A Literature Review - Problem Definition Studies on Selected Toxic Chemicals. Vol. No. 4 of 8. Occupational Health and Safety Aspects of Diesel Fuel and Fog Oils SGF No. 1 and SGF No. 2 and Smoke Screens Generated from Them." Final Report, Report DAMD17-77-C-7020, AD-A055903. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. S1085.

25. Katz, S., A. Snelson, R. Butler, R. Farlow, and R. Welker. 1980. "Physical and Chemical Characterization of Military Smokes. Part II. Fog Oils and Oil Fogs." Report DAMD17-78-C-8085, AD-A093205. IIT Research Inst., Chicago, IL. S1038.
26. Christensen, H.E., T.T. Luginbyhl, and B.S. Carroll, eds. 1980. Registry of Toxic Effects of Chemical Substances. U.S. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Atlanta, GA. S1125.
27. National Institutes of Health; Environmental Protection Agency. 1984. Chemical Information System. On-Line Search. NIH-EPA/Chemical Information System, CIS, Inc.--Fein Marquait Associates, Baltimore, MD. S1172.
28. Windholz, M., S. Budavari, L.Y. Stroumtsos, and M.N. Fertig, eds. 1976. The Merck Index, 9th Edition. Merck & Co. Inc., Rahway, NJ. S1188.
29. Pennsyle, R.O., and R. Winkler. 1982. Computer Program For Smoke/Obscurant Hazard Prediction (HAZRD2). U.S. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD. DAAK11-80-C-0091. S1133.

## APPENDIX A

### THE JUSTIFICATION OF MINIMUM IMPACT AREA, A', ESTIMATED FOR DIFFUSING MILITARY SMOKES

The concentration (C) for a ground-level continuous source in a uniform flow field of speed  $\mu$ , is usually represented by a "Gaussian plume", for example see the "Handbook on Atmospheric Diffusion":<sup>6</sup>

$$C(x,y,z) = C(x,0,0) \exp -\frac{1}{2} (y/\sigma_y)^2 \exp -\frac{1}{2} (z/\sigma_z)^2$$

where  $C(x,0,0)$  is the centerline concentration at groundlevel given by

$$C(x,0,0) = \frac{Q_c/t_c}{\pi \sigma_y \sigma_z u}$$

Here  $Q_c$  is the mass of material dispersed over a time period  $t_c$ , and  $\sigma_y$ ,  $\sigma_z$  are the characteristic width and height of the plume. To a good approximation,  $\sigma_y$  and  $\sigma_z$  are linear functions of downwind distance,  $x$ , for burn times on the order of minutes. The downwind distance traveled is  $x = ut_c$ , and the ground area covered can be estimated as a triangle of length  $x$  and base  $4\pi\sigma_y$ . The value  $\pi$  is retained from integration of the concentration distribution in the vertical from ground level to infinity and in the crosswind,  $y$ -direction from minus infinity to plus infinity. If we solve for the concentration,  $C$ , at ground level ( $z = 0$ ) and at  $y = 5/3 \sigma_y$  where the concentration is one-fourth of the centerline concentration we obtain

$$C = \frac{Q}{A' \sigma_z}$$

Thus the area  $A'$  defines 90% of the plume width ( $y/\sigma_y = \pm 5/3$ );

$$A' = 2\pi\sigma_y ut_c$$

and is the area containing greater than one-fourth the centerline concentration.

## APPENDIX B.

TABLES OF CALCULATED ENVIRONMENTAL  
VARIABLES FOR SPECIFIC SMOKE AND OBSCURANT DEVICES<sup>28</sup>

TABLE B-1. WHITE PHOSPHORUS-TYPES.

Device	Munition	Type	A (m <sup>2</sup> )	C (mg/m <sup>3</sup> )
1. 4.2-inch mortar	M2	WP	516	3100
2. 4.2-inch mortar	M328AW	WP/PWP	541	3140
3. 60-mm mortar	M302	WP	166	1820
4. 81-mm mortar	M57	WP	366	2820
5. 81-mm mortar	M375	WP	228	2320
6. 90-mm gun	M313	WP	243	2490
7. 105-mm gun	M416	WP	455	2990
8. 120-mm gun	M357	WP	516	3100
9. 105-mm howitzer	M60	WP	354	2900
10. 155-mm howitzer	M110	WP	778	3470
11. 155-mm howitzer	XM825	WP/FW	12000	24
12. 5-inch rocket	MK4	WP/PWP	718	3390
13. 57-mm rocket	M308	WP	96	1900
14. 75-mm rocket	M311	WP	198	2350
15. 2.75-inch rocket	M259	WP/W	9500	6

TABLE B-2. RED PHOSPHORUS-TYPES

Device	Munition	Type	A (m <sup>2</sup> )	C (mg/m <sup>3</sup> )
1. grenade	L8A1	RP/BR	50	13600
2. 81-mm mortar	XM819	RP/W	940	139
3. 155-mm howitzer	XM803	RP	11300	26
4. bomblet (submunition)	CBU-88	RP	283000	1.3

TABLE B-3. INFRARED-TYPES

Device	Munition	Type	A (m <sup>2</sup> )	C (mg/m <sup>3</sup> )
1. grenade	XM-76	IR	50	10000

TABLE B-4. HEXACHLOROETHANE-TYPES

Device	Munition	Type	t <sub>c</sub> (sec)	A (m <sup>2</sup> )	C (mg/m <sup>3</sup> )
1. smoke pot	M1	HC	390	9506	77
2. smoke pot	M5	HC	1020	65025	13
3. smoke pot	M4A2	HC	750	35156	29
4. grenade	M8	HC	126	992	218
5. 105-mm howitzer	105M84	HC	120	52	450
6. 155-mm howitzer	M116M1	HC	138	1190	664

TABLE B-5. FOG-OIL AND DIESEL-TYPES

Device	Class	Type	t <sub>c</sub> (sec)	A (m <sup>2</sup> )	C (mg/m <sup>3</sup> )
1. generator, fog-oil	M3A3	SGF-2	3600	810000	5.9
2. generator, fog-oil	XM52	SGF-2	3600	810000	8.9
3. smoke pot, fog-oil	AN-M7	SGF-2	630	26200	66
4. exhaust, diesel	VEES	DF	3600	810000	8.3

## BIBLIOGRAPHY

### FULL RECORDS, BY ACCESSION NUMBER

The following bibliographic list is organized by accession number. Each citation is preceded by its accession number and is followed by a list of identifiers and a list of descriptors. The identifiers are marked with an "=" and describe the type of obscurant(s) or class of information discussed in the citation. The descriptors are marked with a "+" and may be regarded as key words.

#### S1001

U.S. Dept of the Army, U.S. Chemical School. 1984. Commander's Manual. Series FM 3-54 C/CM, LCCN gp 90002235. U.S. Government Printing Office, Washington, DC.

=General

+Munitions; Life Cycle-Use

#### S1002

Holmberg, R.W., J.H. Moneyhun, and T.M. Gayle. 1983. "Chemical Characterization and Toxicologic Evaluation of Airborne Mixtures: Generating, Monitoring, and Controlling Petroleum Aerosols for Inhalation-Chamber Studies. Task Summary Report." Report ORNL/TM-8903, AD-A134214. Oak Ridge National Lab, TN

=Diesel Fuel Smokes: Fog Oil

+Physical Properties-Aerosol; Analytical Methods; Reaction Products; Munitions-Ground; Life Cycle-Use

#### S1003

Berkowitz, J.B., A.J. Colella, R.G. Thomas, G.S. Young, W.J. Lyman, R.G. Vranka, R.C. Anderson, W.D. Steber, and A.L. Preston. 1981. "Research and Development for Health and Environmental Hazard Assessment. Task Order 5. Occupational and Environmental Hazards Associated with the Formulation and Use of White Phosphorus-Felt and Red Phosphorus-Butyl Rubber Screening Smokes" AD-A116956. Arthur D. Little, Inc., Acorn Park, Cambridge, MA. 02140. DAMD17-79-C-9139.

=Phosphorous Smokes

+Chemical Properties; Physical Properties; Life Cycle; Reaction Products; Human Health; Munitions; Mammalian Toxicity; Carcinogenicity; Water Pollution; Munition Composition; Regulations: Transport & Diffusion-Models; Phytotoxicity; Aquatic Toxicity; Mutagenicity

#### S1004

Dalbey, W., and S. Lock. 1983. "Inhalation Toxicology of Diesel-Fuel Obscurant Aerosol in Sprague-Dawley Rats. Chemical Characterization and Toxicological Evaluation of Airborne Mixtures. Final Report. Phase I. Acute Exposure." Report ORNL/TM-8867, AD-A132650. Oak Ridge National Laboratory, TN.

=Diesel Fuel Smokes

+Mammalian Toxicity-Acute, Inhalation

S1005

Weimer, J.T., G.E. Affleck, R.L. Rarrand, F.K. Lee, and R.J. Pelerin. 1980. "The Acute and Chronic Effects of Repeated Exposures to United Kingdom Red Phosphorus Screening Smokes in Rats, Mice, Guinea Pigs, and Rabbits." Report ARSCL-TR-79053, AD-B051834L. Chemical Systems Laboratory, Attn: DRADAR-CLJ-R, Aberdeen Proving Ground, Maryland 21010.

=Phosphorous Smokes

+Mammalian Toxicity; Mutagenicity; Munition Composition; Transport & Diffusion

S1006

Garvey, D.M., G. Fernandez, C.W. Bruce, and R.G. Pinnick. 1981. "In Situ Measurements of Phosphorus Smokes During Smoke Week III." Proc. of the Smoke/ Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, Maryland 20783. US Army Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico 88022. 1:183-213.

=Phosphorous Smokes

+Analytical Methods; Transport & Diffusion-Field Data

S1007

Buchanan, M.V., I.B. Rubin, and J.H. Moneyhun. 1983. "Compositional Changes in Red and Violet Smoke Mixes after Combustion." Report CONF-830459-1. Smoke/ Obscurants Symp., Adelphi, MD, April 26, 1983. Oak Ridge National Laboratory, TN.

=Dyes & Colored Smokes

+Reaction Products; Munition Composition

S1008

Kipley, W., and V. Need. 1961. "Quantitative Analysis of a Green Smoke Composition." Report RDTR 22, AD-267653. Naval Ammunition Depot.

=Dyes & Colored Smokes

+Analytical Methods

S1009

Shaffer, R.E. (Inventor). 1978. "Composition for Screening Infra-Red Radiation." US Patent No. 4100102, July 11, 1978. Application No. 35380, June 10, 1960. Coden: USXXAM. Class: 252305000. C09K-003/30. US Dept of the Army.

=IR/Experimental Smokes

+

S1010

Holmberg, R.W., and J.H. Moneyhun. 1982. "System for the Continuous Generation of Phosphorus Aerosol from Red Phosphorus-Butyl Rubber." Report CONF-820468-1. Smoke/ Obscurants Symp. VI, Adelphi, MD, April 27, 1982. Oak Ridge National Lab, TN.

=Phosphorous Smokes

+

S1011

Holmberg, R.W., and J.H. Moneyhun. 1980. "Symposium on Diesel Fuel Obscurants. Ft. Detrick, MD 13 Nov 1980." Report CONF-801156-2. Oak Ridge National Lab, TN.

=Diesel Fuel Smokes

+

S1012

Slack, A.V. 1968. Phosphoric Acid. Vol. 1., Parts I and II. Fertilizer Science and Technology Series, Marcel Dekker, Inc., New York.

=Phosphorous Smokes

+Chemical Properties; Physical Properties; Life Cycle-Manufacture; Analytical Methods; Reaction Products; Transport & Diffusion

S1013

Jenkins, R.A., and J.S. Wike. 1980. "Chemical Characterization of Diesel Fuel Obscurants." Report CONF-801156-1. Symp. on Diesel Fuel Obscurants. Ft. Detrick, MD, November 13, 1980. Oak Ridge National Lab, TN.

=Diesel Fuel Smokes

+Chemical Properties; Physical Properties-Aerosol; Munitions-Ground; Munition Composition; Transport & Diffusion-Field Data; Analytical Methods

S1014

McGriffin, J. 1962. "Chemical Analysis of Yellow Smoke Mixture Visibility. Investigation of Smokes and Flares." Report RDTR 30, AD-283297. Naval Ammunition Depot Crane, IN.

=Dyes & Colored Smokes

+Munition Composition; Analytical Methods

S1015

Born, G. (Inventor). 1983. "Screening Smoke with a Broad Absorption Band." Patent: Germany Offen DE 3147850 A1, Coden: GWXXBX 6pp. (in German). Messerschmitt-Boelkow-Blöhm G.m.b.H. (Fed. Rep. Ger.).

=IR/Experimental Smokes

+

S1016

Jenkins, R.A., T.M. Gayle, J.S. Wike, and D.L. Manning. 1982. "Sampling and chemical characterization of concentrated smokes." ASTM Spec. Tech. Publ. No. 04-786000-17. Toxic Materials in the Atmosphere: Sampling and Analysis. American Society for Testing and Materials, Philadelphia, PA. 786:153-66.

=Diesel Fuel Smokes

+Analytical Methods; Physical Properties-Aerosol

S1017

Scheunemann, W. 1981. "IR optical properties of screening smoke particles." Journal Article Int. Jahrestag. - Fraunhofer-Inst. Treib- Explosivst. (Chem. Mech. Technol.). Bundesinst. Chem. Tech. Untersuch., Swisttal-Heimerzheim, Fed. Rep. Ger. 235-51pp. (in German).

=IR/Experimental Smokes

+

S1018

Krone, U. 1981. "Preparation and manufacture of a new batch of pyrotechnical screening smokes: NT screening smoke." Journal Article Int. Jahrestag. - Fraunhofer-Inst. Treib-Explosivst. (Chem. Mech. Technol.). Nico-Pyrotechnik Hanns-Juergen Diederichs K.-G., Trittau, Fed. Rep. Ger. 211-33pp. (in German).

=General; IR/Experimental Smokes

+

S1019

McGriffin, J. 1962. "Chemical Analysis of Red Smoke Mixture for Visibility. Investigation of Smokes and Flares." Report RDTK 26, AD-288745. Naval Ammunition Depot, Crane, IN.

=Dyes & Colored Smokes

+Munition Composition; Analytical Methods

S1020

Ripley, W. 1963. "Investigation of MK 25 Mod 2 Smoke-Flare Composition." Report NAD-CR-RDTR-33, AD-411543. Naval Ammunition Depot, Crane, IN.

=Dyes & Colored Smokes

+Munition Composition; Chemical Properties; Physical Properties; Reaction Products; Analytical Methods

S1021

Ripley, W., and C. Armour. 1960 "Chemical Analysis of a Typical Phosphorus Smoke and Flare Composition." Report RDTR 16, AD-632684. Naval Ammunition Depot, Crane, IN.

=Phosphorous Smokes; Dyes & Colored Smokes

+Munition Composition; Munitions-Mortar; Analytical Methods

S1022

Johnson, D.M., and C.W. Gilliam. 1974. "Pollution Abatement: Reclamation of Red Phosphorus Smoke Composition." Report NAD-CR-RDTR-267, AD-778341. Naval Ammunition Depot, Crane, IN.

=Phosphorous Smokes

+Life Cycle-Demil; Reaction Products; Munition Composition; Chemical Properties; Physical Properties

S1023

Martonen, T. 1983. "Deposition of inhaled particulate matter in the upper respiratory tract, larynx, and bronchial airways: a mathematical description." J. Toxicol. and Environ. Health. 12:787-800.

=General

+Mammalian Toxicity-Metabolism, Inhalation, Models; Human Health

S1024

Farmer, W.M. 1981. "The instrument cluster concept in obscurant field testing." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 1:127-145.

=General

+Analytical Methods; Transport & Diffusion-Field Data

S1025

Smalley, H.M. 1983. "Dugway Proving Ground smoke and obscurant field measurement technology." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:39-44.

=General

+Life Cycle-R & D; Transport & Diffusion-Field Data; Physical Properties-Aerosol; Analytical Methods

S1026

Bock, W., R. Butler, S. Katz, N. Rajendran, and A. Snelson. 1981. "Physical and chemical characterization of smoke produced from white phosphorus/felt wedge." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 2:737.

=Phosphorous Smokes

+Physical Properties-Aerosol; Reaction Products

S1027

Jenkins, R.A., R.W. Holmberg, J.H. Moneyhun, and J.S. Wike. 1981. "Chemical and physical characterization of a diesel fuel obscurant for inhalation toxicology studies." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 2:739-758.

=Diesel Fuel Smokes

+Chemical Properties; Physical Properties-Aerosol; Analytical Methods; Reaction Products

S1028

Miller, R.D., R.S. Ryczak, and A. Ostrofsky. 1979. "Phosphorus Removal in a Pilot Scale Trickling Filter System by Low-Level Lime Addition to Raw Wastewater." Technical Report 7901, AD A065041. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

=Phosphorous Smokes

+Water Pollution; Regulations

S1029

Handel, G. 1976. "The properties of atmospheric aerosol particles as functions of relative humidity at thermodynamic equilibrium with the surrounding moist air." Adv in Geophys, 19:73-188

=General

+Physical Properties-Aerosol; Analytic Methods

S1030

Deiner, A., and C. Polley. 1972. "Analysis of Smoke Dyes. Part 1. The Analysis of 1,4-Diamino-2,3-Dihydroanthraquinone (Leuco 1,4-Diaminoanthraquinone)." Report EA-TR-4603, AD-892281L. Edgewood Arsenal MD.

=Dyes & Colored Smokes

+Life Cycle-Production, Physical Properties, Chemical Properties, Reaction Products.

S1031

Smith, M.P. 1981. "Substitution of nontoxic dye in M18 colored smoke grenades." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 2:773-781.

=Dyes & Colored Smokes

+Life Cycle-R & D, Manufacture, Use; Socioeconomics-Cost; Munitions-Grenade; Munition Composition; Clinical Properties; Physical Properties

S1032

Douda, B.E. 1973. "Pyrotechnic Exploratory Development and Pollution Abatement." AD-907284L. Naval Ammunition Depot Crane, IND. NAD-CR-RDTR-231.

=Dyes & colored smokes

+Life Cycle-R&D

S1033

Shaw, G.C., and P.S. Shadlesky. 1973. "Smoke/Flame Pyrotechnic Marker Compositions." Report TWR-7776, AD-919460. Thiokol Corp, Wasatch Div., Brigham City, Utah.

=Dyes & colored smokes

+Life Cycle - R&D

S1034

Carlson, H.R., D.E. Anderson, M.E. Milham, T.L. Tarnove, and R.H. Frickel. 1976. "Infrared Extinction Spectra of Some Common Liquid Aerosols." Report ED-TR-77006, AD-A034659. Edgewood Arsenal Aberdeen Proving Ground, MD.

=Phosphorous Smokes; Fog Oil Smokes; Diesel Fuel Smokes; IR/Experimental Smokes

+Physical Properties-Aerosol; Analytic Methods

S1035

Liss-Suter, D. 1978. "A Literature Review - Problem Definition Studies on Selected Toxic Chemicals. Vol. 8. Environmental Aspects of Diesel Fuel and Fog Oils SGF No. 1 and SGF No. 2 and Smoke Screens Generated from Them." AD-A056021. Franklin Inst. Research Lab., Science Information Services Dept., Philadelphia, PA. DAMD17-77-C-7020.

=Diesel Fuel Smokes; Fog Oil Smokes  
+Chemical Properties; Physical Properties-Aerosol; Mammalian Toxicity; Aquatic Toxicity; Food Chain-Uptake; Munitions; Carcinogenicity; Mutagenicity; Teratogenicity; Phytotoxicity; Air Pollution; Water Pollution; Soil Contamination; Analytical Methods; Life Cycle

S1036

Erickson, M.L., H.D. McKinney, and L. Davenport. 1980. "White Phosphorus Dry Fill Line." Report ARCSL-TR-80015, AD-A089981. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD.

=Phosphorous Smokes  
+Munitions - Mortar, Artillery, Life Cycle-Production

S1037

Stuebing, E.W., R.H. Frickel, and G.O. Rubel. 1980. "Recent Research on Phosphorus Smoke." AD-A090442. Document Location NTIS. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD.

=Phosphorous Smokes  
+Transport & Diffusion-Models, Field Data; Reaction Products

S1038

Katz, S., A. Snelson, R. Butler, R. Farlow, and R. Welker. 1980. "Physical and Chemical Characterization of Military Smokes. Part II. Fog Oils and Oil Fogs." AD-A093205. IIT Research Inst., Chicago, IL. DAMD17-78-C-8085. Project 3E162777A846.

=Fog Oil Smokes  
+Chemical Properties; Physical Properties-Aerosol; Transport & Diffusion-Field Data, Models; Munition Composition; Munitions-Ground; Life Cycle-Use, Inventory, T&S; Reaction Products; Analytical Methods

S1039

Hunt, L., C. Lee, R. Summer, and D. Trapp. 1982. "The Employment of Smoke for Signature Reduction and Site Obscuration for Improving TNF Survivability and Security (U)." Report DNA-TR-81-141. SAI, P.O.Box 2351, La Jolla, CA 92038. DNA-001-81-C-0255.

=General; Phosphorus Smokes; Fog Oil Smokes; HC Smokes  
+Life Cycle - R&D; Use; Demil; T&S/Munitions-Artillery, Grenade, Mortar, Ground

S1040

Cichowicz, J.J. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 4 of 5. HC Smoke." ARCSL-EA-83, AD-A141972/0. U.S. Army Armament, Munitions, and Chemical Command, Chemical Research and Development Center, Aberdeen Proving Ground, MD 21010.

=HC Smokes; Zinc Chloride

+Munition Composition; Reaction Products; Munitions-Ground; Chemical Properties; Physical Properties; Transport & Diffusion-Models; Regulations; Air Pollution; Human Health; Mammalian Toxicity; Phytotoxicity; Aquatic Toxicity; Life Cycle; Water Pollution

S1041

Katz, S., A. Snelson, R. Farlow, R. Welker, and S. Maifer. 1980. "Physical and Chemical Characterization of Fog Oil and Hexachloroethane Smokes. Part 1. Hexachloroethane Smokes." AD-A080936. IIT Research Institute, 10 West 35th Street, Chicago, IL 60616. DAMD17-78-C-8085.

=HC Smokes; Zinc Chloride

+Munitions-Ground; Munition Composition; Transport & Diffusion-Field Data; Physical Properties-Aerosol; Reaction Products; Analytical Methods

S1042

Cichowicz, J.J., and R.S. Wentzel. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 5 of 5. Dyes/Colored Smokes." AD-A141973. U.S. Army Armament, Munitions, and Chemical Command, Chemical Research and Development Center, Aberdeen Proving Ground, MD 21010.

=Dyes & Colored Smokes

+Chemical Properties; Physical Properties; Munitions; Munition Composition; Transport & Diffusion-Models; Life Cycle; Aquatic Toxicity; Mammalian Toxicity; Food Chain-Bioconcentration; Carcinogenicity; Mutagenicity; Reaction Products; Regulations; Teratogenicity

S1043

Novak, E.W., L.B. Lave, J.J. Stukel, and S. Miller. 1983. "A Health Risk Assessment of the Use of Hexachloroethane Smoke on an Army Training Area." U.S. Army Corps of Engineers, Construction Engineering Research Laboratory, Technical Report N-164. U.S. Army Medical Bioengineering Research and Development Laboratory, Attn:SGRD-UBG-M.

=HC Smokes; Zinc Chloride

+Chemical Properties; Life Cycle; Physical Properties-Aerosol; Transport & Diffusion-Models, Field Data; Munitions; Mammalian Toxicity; Aquatic Toxicity; Carcinogenicity; Human Health; Food Chain-Bioconcentration; Air Pollution; Regulations; Reaction Products

S1044

Nelson, J.G. 1982. "A Critique of Transport and Diffusion Models for Man-Made Obscurants." Workshop on the Parameterization of Mixed Layer Diffusion, Los Alamos National Laboratories, October 20-23, 1981. U.S. Army Research Office, U.S. Army Atmospheric Sciences Laboratory, Aberdeen Proving Ground, Maryland 21005

=HC Smokes; Fog Oil Smokes; IR/Experimental Smokes; Phosphorous Smokes  
+Reaction Products; Transport & Diffusion-Models; Physical Properties-Aerosol; Air Pollution

S1045

Farmer, W.M. 1982. "Relationships between battlefield obscurant parameters measured over large and small distance scales." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:53-60.

=General

+Analytical Methods; Transport & Diffusion-Field Data, Models

S1046

Farmer, W.M., F.A. Schwartz, R.D. Morris, J.O. Hornkohl, and M.A. Binkley. 1981. "Field characterization of phosphorus smokes using spectral transmittance and real-time concentration measurements." Proc. of the Soc. of Photo-Optical Instr. Eng. 277:48-57.

=Phosphorous Smokes; General

+Analytical Methods; Physical Properties-Aerosol; Transport & Diffusion-Field Data

S1047

Krist, K.L., and W.M. Farmer. 1981. "Measurement of battlefield obscurant parameters with the point characterization instrumentation system." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:45-52.

=General

+Analytical Methods; Transport & Diffusion-Field Data

S1048

Nelson, J.G. 1981. "Applications overview of battlefield obscurant parameters measured in U.S. Army tests." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:34-38.

=General

+Analytical Methods; Transport & Diffusion-Field Data, Models; Physical Properties-Aerosol

S1049

Shirkey, R.C. 1981. "Effect of atmospheric and man-made obscurants on visual contrast." Proc. of the Soc. of Photo-Optical Instr. Eng. 305:37-44.

=General

+Munitions-Grenade; Transport & Diffusion-Models

S1050

Callahan, J.F., C.L. Crouse, G.E. Affleck, R.L. Farrand, R.W. Dorsey, M.S. Ghuzman, R.J. Pellerin, D.H. Heitkamp, C. Lilly, J.J. Feeney, and J.T. Weim. 1983. "The Acute Inhalation Toxicity of Diesel Fuels (DF2 and DF1) Used in Vehicle Engine Exhaust Smoke Systems (VESS)." Technical Report ARCSL-TR-82064. Chemical Systems Laboratory, U.S. Army Armament Research and Development Command, Aberdeen Proving Ground, MD 21010.

=Diesel Fuel Smokes

+Munitions-Ground; Mammalian Toxicity-Acute, Metabolism; Reaction Products

S1051

Dalbey, W.E., S. Lock, S. Garfinkel, and F.J. Stenglein Jr. 1981. "Inhalation Toxicology." ORNL-5927. Biology Division Progress Report for Period of June 1, 1980 - July 31, 1982 pp. 148-150. Oak Ridge National Laboratory, Oak Ridge, TN 37830. W-7405-eng-26.

=Diesel Fuel Smokes

+Mammalian Toxicity-Acute, Inhalation, Metabolism

S1052

Coleman, R.A., A.E. Sherr, and R.J. Tucker. 1979. "The Development of Infrared Region Smoke Agents. Final Report." American Cyanamid Company, Bound Brook, New Jersey. DAAA25-76-C-0443.

=IR/Experimental Smokes

+Life Cycle-R&D; Mammalian Toxicity-Acute, Chronic, Inhalation

S1053

Dvore, D.S., and R. Vaglio-Laurin. 1982. "Atmospheric diffusion of small instantaneous point releases near the ground." Atmos. Environ. 16(12):2791-2798.

=General

+Transport & Diffusion-Models, Field Data

S1054

McKivigan, J.L. 1981. "Life Cycle Environmental Assessment 155 mm, Improved Smoke Projectile, XM825." U.S. Army Armament Research and Development Command, Chemical Systems Laboratory, Aberdeen Proving Ground, MD 21010.

=Phosphorous Smokes

+Munitions-Artillery; Reaction Products; Regulations; Aquatic Toxicity; Transport & Diffusion-Models; Mammalian Toxicity-Acute, Inhalation; Soil Contamination

S1055

Ballou, J.E. 1981. "Chemical Characterization and Toxicologic Evaluation of Airborne Mixtures." Project 3S162780AB43. AD-A102678. Battelle Pacific Northwest Labs, Richland, WA. DAMD17-79-C-9160.

=Phosphorous Smokes; Fog Oil Smokes

+Mammalian Toxicity-Inhalation, LD50, Metabolism; Chemical Properties; Physical Properties-Aerosol; Reaction Products; Analytical Methods

S1056

Elkins, R.E., and R.H. Kohl. 1981. "Proceedings of the Smoke/Obscurants Symposium V, held at Harry Diamond Laboratories, Adelphi, MD, April 28-30, 1981. Vol. 1." Report DRCPM-SMK-T-001-81-VOL-1, AD-A104760 (see also Vol 2, AD-A104761). Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD.

=General; Phosphorous Smokes; HC Smokes; Fog Oil Smokes; Diesel Fuel Smokes

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S1057

Vigus, E.S., and A. Deiner. 1981. "Evaluation of Replacement Red Smoke Dyes for 1-N Methylaminoanthraquinone." Technical Report ARCSL-TR-81054, AD-A107286. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD.

=Dyes & Colored Smokes  
+Life Cycle-R & D

S1058

Katz, S., A. Snelson, R. Butler, R. Narayanan, W. Bock, and S. Relwani. 1979. "Physical and Chemical Characterization of Military Smokes. Part III. White Phosphorus-Felt Smokes." AD-A115657. IIT Research Institute, 10 West 35th Street, Chicago, Illinois 60616. DAMD17-78-C-8085.

=Phosphorous Smokes  
+Chemical Properties; Physical Properties-Aerosol; Life Cycle-R & D; Munition Composition; Reaction Products; Analytical Methods

S1059

Muhly, R.L. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 1 of 5. Fog Oil, Diesel Fuels, and Polyethylene Glycol (PEG 200)." Report ARCSL-EA-83001-Vol-1, AD-A134846. Chemical Research and Development Center, Aberdeen Proving Ground, MD.

=Fog Oil Smokes; Diesel Fuel Smokes; PEG  
+Chemical Properties; Physical Properties; Transport & Diffusion-Models; Munitions; Human Health; Mammalian Toxicity; Carcinogenicity; Mutagenicity; Aquatic Toxicity; Phytotoxicity; Life Cycle; Air Pollution; Water Pollution

S1060

Yon, R.L., R.S. Wentzel, and J.M. Bane. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants, Vol. No. 2 of 5. Red, White, and Plasticized White Phosphorus." Report ARCSL-EA-83004-Vol-2, AD-A135910. Chemical Research and Development Center, Aberdeen Proving Ground, MD.

=Phosphorous Smokes  
+Chemical Properties; Physical Properties; Munitions; Transport & Diffusion-Models; Regulations; Life Cycle; Human Health; Mammalian Toxicity-Inhalation, LD50, Wildlife; Aquatic Toxicity; Water Pollution; Air Pollution; Soil Contamination

S1061

McIntyre, F.L., and G.L. McKown. 1976. "Explosive Classification Testing of Experimental Colored Smoke Compositions and End Items." Report EA-2400, Project DA-5761313, AMC-4932, AD-B014090. General Electric Co., Engineering and Sciences Lab, Bay Saint Louis, MO. NASS-27750.

=Dyes & Colored Smokes  
+Life Cycle-R & D; Munitions-Grenades

S1062

Durica, A. 1976. "Pyrotechnics." Translation of Tehnologija Eksplozivnih Materija (Yugoslavia). AD-B014883L. 8:325-326 (1972). Army Foreign Science and Technology Center, Charlottesville, VA.

=Dyes & Colored Smokes; General  
+Munition Composition; Life Cycle-Manufacture, Use; Chemical Properties; Physical Properties; Munitions-Artillery

S1063

Sedat, G. 1976. "Fiche de Resultats d'Etudes sur les Compositions Fumigenes Coulables et Jour/Nuit Coulables pour l'Annee 75-76 (Three Papers Containing the Results of a Study of Castable Smoke Compositions and Day/Night Castable Compositions)." (Text in French). AD-B015235L. Direction des Constructions et Armes Navales Toulon (France).

=Dyes & Colored Smokes

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S1064

Stoyanov, L., E. Stoichkova, and G. Suykov. 1976. "Smoke Camouflage: Present and Future." Translation of Voenna Tekhnika (Bulgaria), Report AST-1620I-001-76, FSTC-0024-76, AD-B015571L. 2:12-13 (1975). Army Foreign Science and Technology Center, Charlottesville, VA.

=General

+Munition Composition; Life Cycle-Use

S1065

Hardy, C.R., A. Jarvis, and G.E. Pike. 1976. "The Development of a Screening Smoke Composition. Part 2. Thermal Analysis." Report CDE-TP-206, AD-B019770L. Chemical Defense Establishment Porton Down (England).

=General; IR/Experimental

+

S1066

Webster III, H.A., and D.S. Haas. 1978. "Test of Smoke/Flame Compositions in MK 99 Marine Smoke and Illumination Signal." Report NWSC/CR/RDTR-82, AD-B029040L. Naval Weapons Support Center, Crane, IN.

=Dyes & Colored Smokes

+Life Cycle-R & D; Munition Composition

S1067

U.S. Army Test & Evaluation Command. 1978. "Inventory Smoke Munition Test. Phase IIa. Vol. I." 607pp. Final Report DPG-FR-77-314-Vol-1, AD-B031191. Aberdeen Proving Ground, MD 21005. Attn: DRCPM-SMK-T.

=HC Smokes; Phosphorous Smokes

+Physical Properties-Aerosol; Munitions-Ground, Mortar, Artillery; Life Cycle-R & D, Use; Analytic Methods; Transport & Diffusion-Field Data, Models

**S1068**

Tarnove, T.L. 1980. "Studies of the Chemistry of the Formulation of Phosphorus-Derived Smokes and Their Implications for Phosphorus Smoke Munitions." Report ARCSL-TR-80049, AD-B053301L. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD.

=Phosphorous Smokes

+Chemical Properties; Reaction Products; Analytical Methods

**S1069**

Brown, B.J., G.E. Affleck, E.G. Cummings, R.L. Farrand, and W.C. Starke. 1981. "The Subchronic Effects of Repeated Exposure to White Phosphorus/Felt Screening Smokes in Rats." Report ARCSL-TR-80068, AD-B058048L. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD.

=Phosphorous Smokes

+Mammalian Toxicity-Chronic, Inhalation; Reaction Products

**S1070**

Chin, A., and L. Borer. 1981. "Studies of the Effluents from Burning Navy Green Smoke Devices." Report NWSA/CR/RDTR-156, AD-B061993L. Naval Weapons Support Center, Applied Sciences Dept, Crane, IN.

=Dyes & Colored Smokes

+Reaction Products; Analytic Methods

**S1071**

Cragin, J.H. 1982. "Chemical Obscurant Tests During Winter. Environmental Fate." Report CRREL-SR-82-19, AD-B068594L. Cold Regions Research and Engineering Lab, Hanover, NH.

=Phosphorous Smokes; IR/Experimental Smokes

+Reaction Products; Physical Properties-Aerosol; Transport & Diffusion-Field Data; Analytical Methods; Regulations; Human Health

**S1072**

Horsey, E.R., N. Hotter, and H.J. Bielski. 1977. "Abstracts of Chemical Systems Laboratory Technical Publications 1 July - 30 September 1977." Report ARCSL-SP-77012, AD-C012418L. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD.

=General

Chemical Properties; Physical Properties

**S1073**

Giglio, D.A., and J. Steedman. 1977. "Proceedings of the 1977 Smoke Symposium Held at Harry Diamond Laboratories on 25-26 January 1977." AD-C015516. Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD.

=General; Phosphorous Smokes; HC Smokes; Fog Oil Smokes; Diesel Fuel Smokes

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S1074

Hess, G.M. 1979. "Aerosol Laser Passive Countermeasures." Report D180-24922-1 (Distributed only to U.S. Govt. Agencies), AD-C018650L. Boeing Aerospace Co., Seattle, WA.

=IR/Experimental Smokes

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S1075

Newell, R.S., H.L. Lamuth, C.V. Levere, E.E. Westbrook, and L.R. Lowe. 1981. "Requirements for Smoke Screens to Defeat Sensors in the Infrared Spectrum." (Distributed only to US Govt Agencies), AD-C026933L. Prepared in cooperation with Battelle Columbus Labs, OH. AAI Corp., Baltimore, MD. DAAK11-79-C-0123.

=IR/Experimental Smokes

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S1076

Holt, L.J. 1982. "The CBU-88/E Bomb Cluster Smoke Development Program." Report NWC-TP-6040, AD-C029375L. Naval Weapons Center, China Lake, CA.

=IR/Experimental Smokes; Phosphorous Smokes

+

S1077

Barr, W.A. 1982. "Chemical Systems Laboratory Information Exchange Meetings, 30 September and 9 November, 1982." Report ARCSL-SP-83008, AD-C030723. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD.

=General

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S1078

Wenz, D.J., and R.S. Wentzel. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 3 of 5. Infrared." Report ARCSL-EA-83005, AD-C033075. Chemical Research and Development Center, Aberdeen Proving Ground, MD.

=IR/Experimental Smokes; Phosphorous Smokes

+Chemical Properties; Transport & Diffusion-Models; Mammalian Toxicity-Acute, Chronic, Inhalation, LD50; Aquatic Toxicity; Munitions-Grenade, Ground, Tank, Mortar, Aerial; Life Cycle-<sup>1</sup> & D; Air Pollution; Regulations

S1079

Liss-Suter, D., R. Mason, and P.N. Craig. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 1 of 8. Occupational Health and Safety Aspects of Diesel Fuel and White Smoke Generated from It." Final Report, AD-A056018. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. DAMD-17-77-C-7020.

=Diesel Fuel Smokes

+Chemical Properties; Physical Properties; Human Health-Epidemiology; Mammalian Toxicity-Acute, LD50, Metabolism; Carcinogenicity; Analytical Methods; Reaction Products; Regulations

S1080

Wasti, K., K.J.R. Abaidoo, and J.E. Villaume. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 2 of 8. Occupational Health and Safety Aspects of Phosphorus Smoke Compounds." Final Report, AD-A056019. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. DAMD-17-77-C-7020.

=Phosphorous Smokes

+Munition Composition; Chemical Properties; Physical Properties; Human Health-Clinical, Epidemiology; Mammalian Toxicity-Acute, Chronic, LD50, Inhalation, Metabolism; Carcinogenicity; Analytical Methods; Reaction Products; Regulations

S1081

Hill, H.G., J.E. Villaume, and K. Wasti. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 5 of 8. Occupational Health and Safety and Environmental Aspects of Zinc Chloride." Final Report, AD-A056020. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. DAMD-17-77-C-7020.

=HC Smokes; Zinc Chloride

+Chemical Properties; Physical Properties; Aquatic Toxicity; Mammalian Toxicity; Carcinogenicity; Phytotoxicity; Human Health; Food Chain-Uptake, Bioconcentration; Regulations; Reaction Products; Water Pollution; Soil Contamination; Transport & Diffusion-Models

S1082

Dacre, J.C., W.D. Burrows, A.F. Hegyeli, C.W.R. Wade, T.A. Miller, and D.R. Cogley. 1979. "Problem Definition Study on Potential Environmental Pollutants. V. Physical, Chemical, Toxicological, and Biological Properties of Seven Substances Used in Pyrotechnic Compositions." Technical Report 7704, AD-A090631. U.S. Army Medical Research and Development Command, ATTN: SGRU-UBG, Fort Detrick, Frederick, MD, 21701.

=HC Smokes; Dyes & Colored Smokes

+Chemical Properties; Physical Properties; Human Health-Epidemiology; Mammalian Toxicity-Acute, Chronic, LD50, Wildlife, Aquatic Toxicity; Phytotoxicity; Mutagenicity; Carcinogenicity; Analytical Methods; Regulations; Life Cycle-Manufacture Use, Inventory

S1083

Crook, J.W., P. Hott, H.T. Weimer, R.L. Farrand, A.E. Cooper, J.H. Manthei, R. Nelson, and D.H. Heitcamp. 1981. "The Acute Toxicity of Polyethylene Glycol 200 in Laboratory Animals." Report ARCSL-TR-81058, AD-A106519. Chemical Systems Laboratory, ATTN: DRDAR-CLJ-R, Aberdeen Proving Ground, MD, 21010.

=PEG 200

+Chemical Properties; Physical Properties-Aerosol; Mammalian Toxicity-Acute, Inhalation, LD50, Metabolism; Mutagenicity; Analytical Methods; Life Cycle-R&D

S1084

Henry, M.C., C.D. Rowlett, and J.J. Barkley Jr. 1981. "Mammalian Toxicologic Evaluation of Hexachloroethane Smoke Mixture and Red Phosphorus." AD-A109593. Litton Bionetics Inc., 5516 Nicholson Lane, Kensington, MD 20795, DAMD17-78-C-8086.

=HC Smokes; Phosphorous Smokes

+Chemical Properties; Munition Composition; Reaction Products; Life Cycle-Manufacture; Analytical Methods; Mammalian Toxicity-Acute

S1085

Liss-Suter, D., J.E. Villaume, and P.N. Craig. 1984. "A Literature Review - Problem Definition Studies on Selected Toxic Chemicals. Vol. No. 4 of 8. Occupational Health and Safety Aspects of Diesel Fuel and Fog Oils SGF No. 1 and SGF No. 2 and Smoke Screens Generated from Them." Final Report, AD-A055903. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. LAMD17-77-C-7020.

=Fog Oil Smokes

+Chemical Properties; Physical Properties-Aerosol; Human Health-Clinical, Epidemiology; Mammalian Toxicity-Acute, Chronic, LD50, Metabolism; Carcinogenicity; Mutagenicity; Munitions-Ground; Munition Composition; Analytical Methods; Regulations

S1086

Drummond, J.D. 1981. "Analyses of Smoke Week I for HC, WP, and Foreign WP." Report ERADCOM/ASL-CR-81-0008-1, AD-E800272. AD-A098590/3. New Mexico State Univ., Physical Science Lab., Las Cruces, NM.

=HC Smokes; Phosphorous Smokes

+Analytical Methods

S1087

McKemey Jr, R.L. 1971. "Development of Experimental Intermetallic-Forming Starter System for the M1 Smoke (HC) Canister. Final Report. May-Aug 1971." Report AFATL-TR-71-136, AD-892269/2. Air Force Armament Lab., Eglin AFB, FL.

=HC Smokes

+Munitions - Ground, Artillery; Physical Properties; Life Cycle - R & D; Munition Composition; Analytical Methods; Socioeconomics-Costs; Reaction Products

S1088

Hansen, F.V., R. Pena, and R.K. Umstead. 1980. "Deliberate Air Pollution: The Art of Smoke Screening." AD-A090399. Army Electronics Research and Development Command, Atmospheric Sciences Lab., White Sands Missile Range, NM.

=HC Smokes; Phosphorous Smokes; Fog Oil Smokes  
+Transport & Diffusion-Models

S1089

Sullivan, J.D., and R.G. Reitz. 1980. "Fuel-Air Explosions in a Fog Oil Smoke Environment. Final Report." Report ARBRL-MR-02985, AD-E430393. AD-A083294/9. Army Armament Research and Development Command, Ballistics Research Lab., Aberdeen Proving Ground, MD.

=Fog Oil Smokes  
+Transport & Diffusion-Models, Field Data

S1090

Marchetti, R.M. 1979. "A Transport and Diffusion Model for Smoke Munitions." Report AMSAA-TR-272, AD-A079489. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD.

=Phosphorous Smokes; HC Smokes  
+Munitions-Artillery; Transport & Diffusion-Models

S1091

Fry Jr., R.R. 1977. "Method for Preparing a Smoke Agent (Patent)." Report PAT-APPL-843 390, PATENT-4 151 233, AD-DOC6361/0. Department of the Army, Washington, DC.

=General  
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S1092

Gremillion, A.F., and D.A. Lieblong. 1979. "Study and Evaluation of Several Smoke-Generating Materials for Use in Hazard-Free Cartridges for 81-mm Mortar Inert Training Ammunition. Final Report." AD-A070824. BEI Electronics Inc, Little Rock, AR.

=HC Smokes; Dyes & Colored Smokes  
+Munitions-Mortar; Munition Composition; Reaction Products; Life Cycle-R&D

S1093

Pennsyle, R.O. 1979. "Methodology for Estimating Smoke/Obscurant Munition Expenditure Requirements. Technical Report. May-Dec 1978." Report ARCSL-TR-79022, AD-A069157. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD.

=General  
+Munitions-Ground, Artillery; Transport & Diffusion-Models; Life Cycle-Inventory, Use

S1094

Kitchens, J.F., W.E. Harward III, D.M. Lauter, R.S. Wentzel, and R.S. Valentine. 1978. "Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Vol. III. Pyrotechnic Related Chemicals. Final Report. October 1977-April 1978." Report ARC-49-5730-03. AD-A066309. Atlantic Research Corp., Alexandria, VA.

=Phosphorous Smokes; Dyes & Colored Smokes; HC Smokes  
+Chemical Properties; Physical Properties; Transport & Diffusion; Munitions-Grenade, Ground; Reaction Products; Aquatic Toxicity; Mammalian Toxicity; Life Cycle-Manufacture, Inventory, Use

S1095

McIntyre, F.L. 1975. "Explosive Classification Testing for Pyrotechnic Bulk Composition and End Items. Technical Report. 24 September 1973-June 74." Report EA-4D51, EM-CR-74054, AD-B004013/9. General Electric Co., Engineering and Science Services Lab, Bay Saint Louis, MS.

=General  
+Analytic Methods; Life Cycle-T&S; Munitions-Artillery, Ground

S1096

Dolce, T.J., and D.F. Metz. 1977. "An Analysis of the Smoke Cloud Data from the August 1975 Jefferson Proving Ground Smoke Test. Technical Report." Report AMSAA-TR-201, AD-A045874/5. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD.

=Phosphorous Smokes; HC Smokes  
+Munitions-Artillery, Ground; Transport & Diffusion-Field Data, Models

S1097

Needels, C.J. 1977. "The Simulation of Tactical Smoke on the Modern Battlefield. Final Report." Master's thesis, AD-A043839/0. Army Command and General Staff Coll., Fort Leavenworth, KS.

=General  
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S1098

Smith, M.D., and C.S. Ferrett Jr. 1977. "Advanced Technology for Pyrotechnic Mixtures and Munitions. Technical Report. September 1972-August 1976." Report ARCSL-TR-77043, EM-TR-77030, AD-A042790. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD.

=Dyes & Colored Smokes  
+Munitions-Grenade; Life Cycle-Manufacture; Socioeconomics-Cost; Chemical Properties; Physical Properties

S1099

Shidlovsky, A.A. 1965. "Fundamentals of Pyrotechnics. Technical Memo." Report PA-TM-1615, AD-462474. Feltman Research Labs. Picatinny Arsenal, Dover, NJ.

=General  
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S1100

Weeks, M.H. 1960. "The Toxicity of Combustion Products of Pyrotechnics. Technical Memo. 7 August - 26 October 1959." Report CWL-TM-26-12, AD-474403/3. Army Chemical Warfare Labs, Army Chemical Center, MD.

=Dyes & Colored Smokes; Phosphorous Smokes  
+Reaction Products; Mammalian Toxicity-Acute, Inhalation; Munition Composition; Analytical Methods

S1101

Lewis, J.W. 1965. "Human Factors Evaluation of the E24 CS Munition. Technical Memo." Report CRDL-TM-2-34, AD-474350/6. Chemical Research and Development Labs, Edgewood Arsenal, MD.

=General  
+Munitions - Grenade

S1102

McLain, W.H., and R.W. Evans. 1965. "A New Smoke Screening Chemical for Use in Aerial Smoke Tanks. Summary Progress Report No. 6 (Final)." Final Report DRI-2304 448-6512-F, AD-479680. University of Denver, Mechanics Division, Denver Research Institute, CO. DA 18-035-AMC-127(A).

=Phosphorous Smokes; Fog Oil Smokes; Experimental Smokes  
+Munition Composition; Life Cycle - R&D; Munitions - Aerial; Physical Properties; Chemical Properties; Mammalian Toxicity

S1103

Gordon, M.G. 1975. "Smoke Seminar, 20 August 1974. Special Publication." Report ED-SP-75003, AD-A015987. Edgewood Arsenal, Aberdeen Proving Ground, MD.

=IR/Experimental Smokes  
+Munitions-Aerial, Artillery; Life Cycle-R&D, Manufacture, Use, Demil; Physical Properties-Aerosol; Transport & Diffusion-Models; Analytical Methods

S1104

Garber, M.N., and W.W. Reaves. 1973. "Plastic Bonded Smoke (Patent)." Report PAT-APPL-93 207, PATENT-3 726 225, AD-DO01119/7. Department of the Army, Washington, DC.

=Phosphorous Smokes  
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S1105

Kohl, R.H. 1980. "Proceedings of the 1979 Chemical System Laboratory Scientific Conference on Obscuration and Aerosol Research. Contract Report." Report No.: ARCSL-CR-81023; AD-A113733/0. Kohl (Ronald H.) and Associates, Tullahoma, TN.

=General; Phosphorous Smokes; HC Smokes; Fog Oil; Diesel Fuel;  
IR/Experimental  
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S1106

Turner, R.E., P.G. Eitner, C.D. Leonard, and D.G.S. Snyder. 1980. "Battlefield Environment Obscuration Handbook. Vol. I. Final Report. December 1979 - December 1980." Report No.: SAI-80-009-AA-VOL-1 ; AD-A102822/4. Science Applications, Inc., Ann Arbor, MI.

=General; Phosphorous Smokes; HC Smokes; Diesel Fuel Smokes; Fog Oil Smokes; IR/Ex.

+Transport & Diffusion-Models, Field Data; Life Cycle-Use (Scenarios); Socioeconomics-Demography; Physical Properties; Munitions-Grenade, Mortar, Tank, Ground; Munition Composition; Reaction Products

S1107

Zirkind, R. 1979. "A Battlefield Obscuration Model (Smoke & Dust). Final Report. July 1977 - October 1979." AD-A080459/1. General Research Corp., McLean, VA. Operations Analysis Group.

=General

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S1108

U.S. Department of the Army. 1983. "Obscuring smoke munition." Army Research, Development, & Acquisition, August, 1983, Vol. 24, Issue 4, p.26

=General

+Life Cycle-Use

S1109

Bulger, J.P. 1982. "Obscurants: countermeasures to modern weapons." Military Review. 62(5):45-53.

=General

+Life Cycle-Manufacture, Use; Munitions-Grenade, Mortar, Aerial, Ground; Transport & Diffusion-Field Data, Models

S1110

U.S. Department of the Army. 1982. "Smoke and Obscurants Program. "Keep on Smokin'." Army Research, Development, & Acquisition. 23(3):1-3.

=General

+Life Cycle-Use

S1111

Smith, M.D., and F.M. Stewart. 1982. "Environmentally acceptable smoke munitions." Proc. Int. Pyrotech. Semin. 8:623-35. U.S. Army Armament Research and Development Command, Chemical Systems Laboratory, Aberdeen Proving Ground, MD, 21010.

=Phosphorous Smokes; Dyes & Colored Smokes

+Munitions-Grenade, Ground; Munition Composition; Life Cycle-R&D, Manufacture, Inventory; Socioeconomics-Cost

S1112

Burrows, D. et al. 1973. "Mammalian Toxicology and Toxicity to Aquatic Organisms of White Phosphorus and "Phossy Water", a Waterborne Munitions Manufacturing Waste Pollutant - A Literature Evaluation." Prepared for: U.S. Army Medical Research and Development Command. Associated Water and Air Resources Engineers Inc.

=Phosphorous Smokes

+Aquatic Toxicity; Mammalian Toxicity; Life Cycle-Demil

S1113

Manthei, J.H., F.K. Lee, M. Donnelly, and J.T. Weimer. 1980. "Preliminary Toxicity Screening Studies of 11 Smoke Candidate Compounds." Report ARCSL-TR-79056, AD-C021764L.

=IR/Experimental Smokes

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S1114

Cooper, A.E., and E.J. Owens. . "A Review of the Toxicology of Screening Smokes." Private document provided by U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

=General

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S1115

Dalbey, W., S. Lock, B. Holmberg, J. Moneyhun, and M. Guerin. 1981. "Acute exposures of rats to an inhaled aerosol of diesel fuel." Proc. of the Smoke/Obsecurants Symp. V, Harry Diamond Laboratories, Adelphi, MD. 2:759-771.

=Diesel Fuel Smokes

+Mammalian Toxicity-Acute, Metabolism, Chronic; Physical Properties-Aerosol; Analytical Methods

S1116

Hilado, C.J., and M.T. Lopez. 1977. "Relative toxicity of pyrolysis products of some elastomers." J. Combustion Toxicol 4(1):61-68.

=Phosphorous Smokes

+Reaction Products; Mammalian Toxicity-Acute, Inhalation; Food Chain-Uptake

S1117

Jarvis, A. 1970. "The combustion reactions of a pyrotechnic white smoke composition." Combust. Flame 14:313-320.

=HC Smokes; Zinc Chloride

+Munition Composition; Reaction Products; Analytical Methods

S1118

Burrows, D. et al. 1975. "Toxicity to Aquatic Organisms and Chemistry of Nine Selected Waterborne Pollutants from Munitions Manufacture - A Literature Evaluation." Technical Report TR-7503, AD-A010660. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

=Phosphorous Smokes

+Chemical Properties; Aquatic Toxicity; Water Pollution; Reaction Products

S1119

Rosenblatt, D.H., and W.R. Hartley. 1984. "The Preliminary Pollutant Limit Value Concept." Private document provided by U.S. Army Medical Bioengineering Research and Development Laboratory, Health Effects Research Division, Fort Detrick, MD.

=General

+Human Health-NOEL, LD50; Regulations; Socioeconomics-Demography; Water Pollution; Soil Contamination

S1120

Rosenblatt, D.H., J.C. Dacre, and D.R. Cogley. 1982. "An environmental fate model leading to preliminary pollutant limit value for human health effects." In R.A. Conway, ed. Environmental Risk Analysis for Chemicals. pp. 474-505. Van Nostrand Reinhold, New York, NY.

=General

+Transfer & Diffusion-Models; Water Pollution; Soil Contamination; Food Chain-Transfer Coefficient; Regulations

S1121

Posenblatt, D.H. 1981. "Environmental Risk Assessment for Four Munitions-Related Contaminants at Savanna Army Depot Activity." Technical Report 8110, AD-A116650. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

=General

+Aquatic Toxicity; Soil Contamination; Regulations

S1122

Rosenblatt, D.H., and M.J. Small. 1981. "Preliminary Pollutant Limit Values for Alabama Army Ammunition Plant." Technical Report 8105, AD-A104203. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

=General; Dyes & Colored Smokes

+Soil Contamination; Food Chain-Uptake, Transfer Coefficient; Socioeconomics-Demography; Regulations

S1123

Rosenblatt, D.H., and R.J. Kainz. 1982. "Options and Recommendations for a Polybromobiphenyl Control Strategy at the Gratiot County, Michigan Landfill." Technical Report 8204, AD-A121243. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

=General

+Soil Contamination; Water Pollution; Human Health; Socioeconomics-Demography; Regulations

S1124

American Conference of Governmental and Industrial Hygienists (ACGIH). 1976. "TLV's Threshold Limit Values for Chemical Substances in Workroom Air." In N.I. Sax. Dangerous Properties of Industrial Materials, 4th Edition. Van Nostrand Reinhold, New York, NY.

=General

+Chemical Properties; Physical Properties; Human Health; Mammalian Toxicity-Acute, Chronic, LD50, Inhalation; Carcinogenicity; Mutagenicity; Regulations

S1125

Christensen, H.E., T.T. Luginbyhl, and B.S. Carroll, eds. 1980. Registry of Toxic Effects of Chemical Substances. U.S. Dept of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

=General

+Chemical Properties; Physical Properties; Human Health; Mammalian Toxicity-Acute, Chronic, LD50, Inhalation; Carcinogenicity; Mutagenicity; Regulations

S1126

Sax, N.I. 1975. Dangerous Properties of Industrial Materials, 4th Edition. Van Nostrand Reinhold Co., New York, NY.

=General

+Chemical Properties; Physical Properties; Human Health; Mammalian Toxicity-Acute, Chronic, LD50, Inhalation; Carcinogenicity; Mutagenicity; Regulations

S1127

Leong, K.J., and H.N. MacFarland. 1983. "Hazards from thermodecomposition of epoxy resins " Arch. Environ. Health. 7:675-681.

=Phosphorous Smokes

+Reaction Products; Human Health; Mammalian Toxicity-Inhalation, LD50, Metabolism; Analytical Methods

S1128

Brown, H.S., C.A. Rowan, and D.R. Bishop. 1984. "Development of an air toxics program in Massachusetts." Proc. of the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA June 24-29, 1984. 84(7.3):2-28.

=General

+Regulations; Air Pollution; Carcinogenicity; Mutagenicity; Teratogenicity; Human Health; Analytical Methods; LD50

S1129

Patrick, D.R. 1984. "EPA's process of assessing and managing risks posed by exposure to toxic air pollutants." Proc. of the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA June 24-29, 1984. 84(103.2):2-7.

=General

+Regulations; Carcinogenicity; Air Pollution; Socioeconomics-Demography

S1130

Fossa, A.K., M.M. Riano, P.J. Lavin, and D.R. Vollmre. 1984. "New York State techniques and experience in regulation toxic air contaminants." Proc. of the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA June 24-29, 1984. 84(6.2):2-16.

=General

+Regulations; Air Pollution; Carcinogenicity; Human Health-Inhalation

S1131

Ohmstede, W.D., and E.B. Stenmark. 1979. "A model for characterizing transport and diffusion of air pollution in the battlefield environment." AD-A128458. Proc. of the Joint Conference on Applications of Air Pollution Meteorology (2nd), 24- 29 Mar 80, New Orleans, LA. American Meteorological Society, Boston, MA. pp. 416-423.

=General

+Transport & Diffusion-Models

S1132

Gilliam, C.W., G.S. Bradley, and C.A. Lipscomb Jr. 1973. "Smoke Design Criteria." Report RDTR-238, AD-761615. Naval Ammunition Depot, Research and Development Department, Crane, IN 47522.

=Dyes & Colored Smokes

+Transport & Diffusion-Models

S1133

Pennsyle, R.O., and R. Winkler. 1982. "Computer Program For Smoke/Obscurant Hazard Prediction (HAZRD2)." U.S. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD. DAAK11-80-C-0091.

=General

+Munitions; Transport & Diffusion-Models; Munition Composition

S1134

Petrovic, K., and D. Vitorovic. 1976. "Recognition and qualitative characterization of commercial petroleum fuels and synthetic fuels by a gas chromatographic fingerprinting technique." J. Chromatogr. 119:413-422.

=Fuel Oil Smokes; Diesel Fuel Smokes

+Analytical Methods; Physical Properties; Chemical Properties

S1135

Fitzgerald, M.E., V.A. Cirillo, and F.J. Galbraith. 1962. "Mass spectrometric method for analysis of petroleum distillates in the furnace oil-kerosine boiling range." Analy. Chem. 34(10)1276-1280.

=Fuel Oil Smokes; Diesel Fuel Smokes

+Analytical Methods

S1136

Albro, P.E., and L. Fishbein. 1970. "Absorption of aliphatic hydrocarbons by rats." Biochim. biophys. Acta. 217:437-446.

=Fuel Oil Smokes; Diesel Fuel Smokes

+Mammalian Toxicity - Metabolism; Analytical Methods

S1137

Wagner, W.O., O.J. Dobrogorski, and H.E. Stokinger. 1961. "Antagonistic action of oil mists on air pollutants." Arch. Environ. Health. 2(5):523-534.

=Fuel Oil Smokes; Diesel Fuel Smokes  
+Mammalian Toxicity - Inhalation, Acute, Chronic, LC50; Human Health; Carcinogenicity; Physical Properties - Aerosol; Analytical Methods; Chemical Properties

S1138

Brahmachari, H.D. 1958. "Toxicity of white oil." Current Sci. 27(11):440-441.

=Fog Oil Smokes  
+Mammalian Toxicity

S1139

Ghoshal, A.K., E.A. Porta, and W.S. Hartroft. 1971. "Isotopic studies on the absorption and tissue distribution of white phosphorus in rats." Exp. Mol. Pathol. 14(2):212-219.

=Phosphorous Smokes  
+Mammalian Toxicity - Metabolism, Acute

S1140

Jongen, W.M.F., G.M. Alink, and J.H. Koeman. 1978. "Mutagenic effect of dichloromethane on Salmonella typhimurium." Mutat. Res. 56:245-248.

=Phosphorous Smokes; (Methylene Chloride)  
+Mutagenicity

S1141

Pani, P., E. Gravela, and C. Mazzarino. 1972. "On the mechanism of fatty liver in white phosphorus poisoned rats." Exptl. Mol. Pathol. 16:201-209.

=Phosphorous Smokes  
+Mammalian Toxicity - Metabolism; Analytical Methods

S1142

Lushbaugh, C.C., J.W. Green, and C.E. Redemann. 1950. "Effects of prolonged inhalation of oil fogs on experimental animals." Arch. Ind. Hyg. Occup. Med. 1:237-247.

=Fog Oil Smokes  
+Mammalian Toxicity - Inhalation, Chronic, Metabolism; Human Health; Analytical Methods; Carcinogenicity

S1143

Shoshkes, M., W.G. Banfield Jr., S.J. Rosenbaum, and A.J. Fisk. 1950. "Distribution, effect and fate of oil aerosol particles retained in the lungs of mice." Arch. Ind. Hyg. Occup. Med. 1:20-35.

=General; Fog Oil Smokes; Diesel Fuel Smokes  
+Mammalian Toxicity - Chronic, Acute, Inhalation, Metabolism; Human Health

S1144

Edzwald, J.P. 1977. "Phosphorus in aquatic systems: The role of the sediments." In I.H. Suffet, ed. Fate of Pollutants in the Air and Water Environments, Part 1. pp. 183-214. John Wiley & Sons, New York, NY.

=Phosphorous Smokes

+Aquatic Toxicity; Water Pollution; Soil Contamination; Chemical Properties; Physical Properties; Reaction Products; Transport & Diffusion - Models

S1145

Fitzgerald, J.W. 1975. "Approximation formulas for the equilibrium size of an aerosol particle as a function of its dry size and composition and the ambient relative humidity." J. Appl. Meteorol. 14:1044-1049.

=General

+Physical Properties - Aerosol; Models

S1146

Turner, D., H.G. Baxter, G.M. Davies, A.R. Eyres, G.L. Lees, J. Mitchell, J.T. Sanderson, J. Steel, and J. P. Moore. 1975. "Methods for the determination of the atmospheric concentration of oil mist." Ann. Occup. Hyg. 18(4):293-297.

=Fog Oil Smokes; Diesel Fuel Smokes

+Analytical Methods

S1147

Patterson, E.M., and D.A. Gillette. 1977. "Commonalities in measured size distributions for aerosols having a soil-derived component." J. Geophys. Res. 82:2074-2082.

=General

+Analytical Methods; Physical Properties - Aerosol; Transport & Diffusion - Field Data, Models

S1148

Giddings, J.C., G. Karaiskakis, K.D. Caldwell, and M.N. Myers. 1983. "Colloid characterization by sedimentation field-flow fractionation. I. Monodisperse populations." J. Colloid and Interface Sci. 92(1):66-88.

=General; IR/Experimental Smokes; Colloids

+Analytical Methods; Physical Properties - Aerosol; Transport & Diffusion - Field Data, Models

S1149

Yang F-S, K.D. Caldwell, and J.C. Giddings. 1983. "Colloid characterization by sedimentation field-flow fractionation. II. Particle-size distribution." J. Colloid and Interface Sci. 92(1):81-91.

=General; IR/Experimental; Colloids

+Analytical Methods; Physical Properties - Aerosol; Transport & Diffusion - Field Data, Models

S1150

Buchanan, D.J., M.V. Sigal Jr., C.S. Robinson, K. Pope, J.E. Ferguson, and J.B. Thomison. 1954. "Studies of phosphorus intoxication. I. Changes in blood, urine, and tissues of dogs poisoned with phosphorus." Arch. Ind. Hyg. Occup. Med. 1(9):1-8.

=Phosphorous Smokes

+Human Health; Mammalian Toxicity - Metabolism, Chronic; Analytical Methods

S1151

Lindauer, G.C., and A.W. Castleman Jr. 1971. "Initial size distributions of aerosols." Nucl. Sci. and Eng. 43:212-217.

=General

+Physical Properties-Aerosol; Transportation & Diffusion-Models

S1152

Barker, E.A., E.A. Smuckler, and E.P. Benditt. 1963. "Effects of thioacetamide and yellow phosphorus poisoning on protein synthesis in vivo." Lab. Invest., 12:955-960.

=Phosphorous Smokes

+Mammalian Toxicity

S1153

Diaz-Rivera, R.S., P.H. Collazo, E.R. Pons, and M.V. Torregrosa. 1950. "Acute phosphorus poisoning in man. A study of 56 cases." Medicine. 29:269-298.

=Phosphorous Smokes

+Human Health-Clinical

S1154

Talley, R.C., J.W. Linhart, A.J. Trevino, L. Moore, and A.M. Beller. 1972. "Acute elemental phosphorus poisoning in man: Cardiovascular toxicity." Amer. Heart J., 84:139-140.

=Phosphorous Smokes

+Human Health-Clinical; Mammalian Toxicity

S1155

Fleming, R.B. L., J.W. Miller, and V.R. Swayne Jr. 1942. "Some recent observations on phosphorus toxicology." J. Ind. Hyg. Toxicol. 24:154-158.

=Phosphorous Smokes

+Mammalian Toxicity-Acute, Chronic, Metabolism

S1156

Ryczak, R.S., and R.D. Miller. 1979. "A Review of Phosphorus Removal Technology." Technical Report 7706, AD A040802. U.S. Army Medical Bioengineering Research & Development Laboratory, Fort Detrick, MD 21701.

=Phosphorous Smokes

+Water Pollution; Food Chain-Uptake; Chemical Properties

S1157

Chau, T.L., and W. Lippmann. 1980. "Experimental measurements and empirical modeling of the regional deposition of inhaled particles in humans." Am. Ind. Hyg. Assoc. 41:399-409.

=General

+Human Health-Clinical; Mammalian Toxicity-Inhalation

S1158

Heimann, H. 1946. "Chronic phosphorus poisoning." J. Ind. Hyg. Toxicol. 24(4):142-150.

=Phosphorous Smokes

+Human Health-Clinical, Epidemiology; Mammalian Toxicity-Chronic, Metabolism; Air Pollution

S1159

Cogley, D.R., L.E. Craker, C.D. Torgeson, and D.L. Sirois. 1979. "Biological Testing of Rocky Mountain Arsenal for Phytotoxic Substances. Final Report." AD A076565. Walden Division of Abcor, Inc., Wilmington, MA

=General

+Phytotoxicity; Soil Contamination

S1160

Craker, L.D., and J.C. Dacre. 1975. "Munitions-Related Substances of Potential Concern as Airborne Pollutants: A Phytotoxicological Evaluation." Final Technical Report 7511, AD A052168. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

=General

+Phytotoxicity; Air Pollution; Analytic Methods

S1161

Howley, G.G. 1983. The Condensed Chemical Dictionary, 10th ed. Van Nostrand Reinhold Co., New York, NY.

=General

+Chemical Properties; Physical Properties; Mammalian Toxicity

S1162

Verschuren, K. 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co., New York, NY.

=General

+Chemical Properties; Physical Properties; Mammalian Toxicity; Water Pollution; Air Pollution; Carcinogenicity; Mutagenicity; Teratogenicity; Phytotoxicity; Food Chain-Bioconcentration, Uptake

S1163

Fowler, B.W., and T.B. Owens. 1979. "A Parametric Model for the Effect of White Phosphorus Smoke on Target Detection. I. Model Development." Technical Report 0-82-2, AD-A083787. U.S. Army Missile Command, Redstone Arsenal, AL.

=Phosphorous Smokes

+Transport & Diffusion-Models

S1164

Evans, E.H. 1945. "Casualties following exposure to zinc chloride smoke." The Lancet. 2:368-370.

=HC Smokes; Zinc Chloride  
+Human Health-Epidemiology, Clinical

S1165

Pinnick, R.G., and S.G. Jennings. 1980. "Relationship Between Radiative Properties and Mass Content of Phosphoric Acid, HC, Petroleum Oil, Sulfuric Acid Military Smokes." Technical Report ASL-TR-0052, AD-A084941. U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM.

=General; Phosphorous Smokes; HC Smokes; Diesel Fuel Smokes; Fog Oil Smokes  
+Physical Properties-Aerosol; Transport & Diffusion-Models

S1166

Spangford, R.J., R.T. Podoll, R.T. Rewick, T.S. Chou, R.B. Wilson, J. Backovsky, and D.L. Roberts. 1983. "Environmental Fate of WP/F and RP/BR Military Screening Smokes. Phase I. Literature Review. Final Report (DRAFT)." Phase I. Final Report. SRI international, Menlo Park, CA. DAMD17-83-C-2320.

=Phosphorous Smokes  
+Reaction Products; Water Pollution; Air Pollution; Soil Contamination; Food Chain; Physical Properties; Chemical Properties

S1167

Rubel, G.O. 1978. "Predicting the Droplet Size and Yield Factors of a Phosphorus Smoke as a Function of Droplet Composition and Ambient Relative Humidity under Tactical Conditions." Report ARCSL-TR-78057, AD-A064076. Chemical Systems Laboratory, Aberdeen Proving Ground, MD.

=Phosphorous Smokes  
+Physical Properties-Aerosol; Transport & Diffusion-Models; Chemical Properties

S1168

Sullivan Jr., J.H., H.D. Putnam, M. A. Keirn, B.C. Pruitt, Jr. and J.C. Nichols. 04/77. "A Summary and Evaluation of Aquatic Environmental Data in Relation to Establishing Water Quality Criteria for Munition-Unique Compounds. Part 3. White Phosphorus." Final Report, AD-A083625. Water and Air Research Inc., P.O. Box 1121, Gainesville, FL, 32601. DAMD-17-77-C-7027.

=Phosphorous Smokes  
+Water Pollution; Chemical Properties; Analytic Methods; Food Chain; Aquatic Toxicity

S1169

Lai, M. and D. Rosenblatt. 1977. "Identification of Transformation Products of White Phosphorus in Water." Report NSWC/WOL/TR-76-107, AD-A041068. U.S. Army Medical Research and Development Command, Fort Detrick, MD. DAMD17-77-C-7027.

=Phosphorous Smokes  
+Reaction Products; Chemical Properties; Analytic Methods; Water Pollution

S1170

Windholz, M., S. Budavari, R.F. Blumetti, and E.S. Otterbein, eds. 1983. The Merck Index, 10th Edition. Merck & Co. Inc., Rahway, NJ.

=General

+Chemical Properties; Physical Properties; Mammalian Toxicity; Carcinogenicity; Aquatic Toxicity

S1171

Lee, Cheng-Chun; J.V. Dilley, J. R. Hodgson, D.O. Helton, W.J. Wiegand, D.C. Roberts, B.C. Anderson, L.M. Halfpap, and L.D. Kurtz. 1975. "Mammalian Toxicity of Munition Compounds. Phase I. Acute Oral Toxicity, Primary Skin and Eye Irritation, Dermal Sensitization, and Disposition and Metabolism." Formal Report 1, Project MRI 3900-B, AD-B011150. Midwest Research Institute, 425 Volker Blvd., Kansas City, MO, 64110. DAMD-17-74-C-4073.

=Phosphorous Smokes

+Analytic Methods; Chemical Properties; Physical Properties; Mammalian Toxicity

S1172

National Institutes of Health; Environmental Protection Agency. 1984. "Chemical Information System. On-Line Search." NIH-EPA/Chemical Information System, CIS, Inc.--Fein Marquait Associates, 7215 York Road, Baltimore, Maryland 21209.

=General

+Chemical Properties; Physical Properties; Mammalian Toxicity; Aquatic Toxicity; Phytotoxicity; Food Chain-Bioconcentration; Carcinogenicity; Water Pollution; Soil Contamination

S1173

Elkins, R.E., and R.H. Kohl - Editors. 1982. "Proceedings of the Smoke Obscurants Symposium VI, Held at HDL, 27-29 April, 1982. Vols. I, II (Unclassified Sections). Sponsored by PM Smoke/Obscurants." Technical Report DRCPM-SMK-T-001-82. Proc. of the Smoke/Obscurants Symp. VI, Harry Diamond Laboratories, Adelphi, MD. April 27-29, 1982. Unclassified sections.

=General

+Analytic Methods; Life Cycle-R & D; Transport & Diffusion-Models

S1174

Kennedy, B.W. 1981. "Battlefield Induced Contamination Test. Project Summary." Internal Report. U.S. Army Electronics Research and Development Command, Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88002.

=General; HC Smokes; Phosphorous Smokes

+Analytic Methods; Transport & Diffusion-Models

S1175

Committee on Toxicology, National Research Council. 1979. "Criteria for Short-Term Exposures to Air Pollutants." Report NAS/ACT/P-885, AD A087853. National Research Council, 2101 Constitution Avenue, N.W., Washington, DC, 29418. N00014-79-C-0049.

=General; Diesel Fuel Smokes; Fog Oil Smokes

+Air Pollution; Regulations; Human Health-Epidemiology; Phytotoxicity; Mammalian Toxicity

S1176

Daley, P.S. 1984. "Military marches toward new horizons in pollution control." Pollut. Eng. February 1984:31-42.

=General

+Air Pollution; Water Pollution; Regulations; Socioeconomic-Costs

S1177

Holst, G.C. 1984. "NATO smoke trials in France and Norway." Army Res., Dev. and Acquisition Magazine. September-October 1983:24-25.

=General

+Transport & Diffusion-Field Data; Analytic Methods

S1178

Blackman, G.R. 1983. "Cloud Geometry Analysis of the Smoke Week VA Obscuration Trials." Final Report ASL-DR-83-0009. U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88002.

=General

+Analytic Methods; Transport & Diffusion-Field Data

S1179

Whitacre, C.G., P.E. Robinson, W.L. Kneas, and A.L. Freeman. 1977. "Computer Program For Chemical Hazard Prediction." Report ARCSL-TR-77049. Chemical Systems Laboratory, Attn: DRDAR-CLY-A, Aberdeen Proving Ground, MD 21010.

=General

+Transport & Diffusion-Models

S1180

Gomez, R., and M.H. Van Atta. 1984. "Corps of Engineers airland battlefield environment thrust." Army Res., Dev. and Acquisition Magazine. May-June 1984:17-19.

=General

+Life Cycle-R & D, Use

S1181

Wentsel, R. 1983. "Environmental Effect Studies on EA5763." Chemical Research and Development Center, ATTN: DRSMC-CLT-I (A)/Dr. Wentsel, Aberdeen Proving Ground, Maryland 21010.

=Experimental Smokes

+Soil Contamination; Water Pollution; Phytotoxicity; Aquatic Toxicity; Reaction Products; Analytic Methods

S1182

Shinn, J.H. 1979. "Problems in the assessment of air pollution effects on vegetation." In J.R. Pfafflin and E.N. Ziegler, eds. Advances in Environmental Science and Engineering, Vol. 2. pp. 88-105. Gordon and Breach Publishers, New York, NY.

=General

+Air Pollution; Phytotoxicity; Regulations

S1183

Rosenblatt, D.H. 1984. "Guest editorial: The name of the game." Environ. Sci. and Technol. 18(2):39A.

=General

+Air Pollution; Water Pollution; Soil Contamination; Socioeconomics-Cost; Regulations

S1184

U.S. Army Atmospheric Sciences Laboratory and The U.S. Army Project Manager-Smoke Obscurants. 1983. "Atmospheric aerosol and optics data library." Atmos. Aerosol and Optics Data Library Bulletin. 1(2):9-16.

=General

+Transport & Diffusion-Field Data; Physical Properties-Aerosol

S1185

Ratney, R.S., D.H. Wegman, and H.B. Elkins. 1974. "In vivo conversion of methylene chloride to carbon monoxide." Arch. Environ. Health. 18:223-26.

=Phosphorous Smokes

+Human Health-Epidemiology; Regulations; Analytic Methods

S1186

D'Amico, W.P., W.H. Clay, and A. Mark. 1979. "Diagnostic Tests for Wick-Type Payloads and High Viscosity Liquids. Final Report." Final Report ARBRL-MR-02913, AD-E430270, AD-A072812/1. U.S. Army Armament Research and Development Command, Ballistics Research Lab, Aberdeen Proving Ground, MD.

=Phosphorous Smokes

+Munitions-Artillery

S1187

Sax, N.I. 1984. Dangerous Properties of Industrial Materials, 6th Edition. Van Nostrand Reinhold Co. New York, NY.

=General

+Chemical Properties; Physical Properties; Human Health; Mammalian Toxicity-Acute, Chronic, LD50, Inhalation; Carcinogenicity; Mutagenicity; Regulations

S1188

Windholz, M., S. Budavari, L.Y. Stroumstos, and M.N. Fertig, eds. 1976. The Merck Index, 9th Edition. Merck & Co. Inc., Rahway, NJ.

=General

+Chemical Properties; Physical Properties; Mammalian Toxicity; Aquatic Toxicity; Carcinogenicity

S1189

Hanna, S.R., G.A. Briggs, and R.P. Hosker, Jr. 1982. "Handbook on Atmospheric Diffusion." Technical Information Center, U.S. Department of Energy. Atmospheric Turbulence and Diffusion Laboratory, National Oceanic and Atmospheric Administration.

=General

+Transport & Diffusion-Models

S1190

Conway, P.E., ed. 1982. Environmental Risk Analysis for Chemicals. Van Nostrand Reinhold Co., New York, NY.

=General

+Chemical Properties; Physical Properties; Reaction Products; Air Pollution; Water Pollution; Soil Contamination; Carcinogenicity

S1191

Brakhnova, I.T. 1975. Environmental Hazards of Metals. Consultants Bureau, New York, NY.

=General

+Chemical Properties; Physical Properties-Aerosols; Human Health-Epidemiology; Mammalian Toxicity

S1192

Newell, R.S., and J.T. Brown. 1976. "Analysis of Large-Area Screening Systems. Vol. 1. Executive Summary." Executive Summary, AD-807342. Battelle Columbus Laboratories, 505 King Avenue, Columbus, OH, 43201. DAAA15-77-C-0030.

=General; Fog Oil Smokes; IR/Experimental Smokes

+Analytic Methods; Life Cycle-R & D, Use; Transport & Diffusion-Models; Socioeconomics-Cost

S1193

Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt. 1982. Handbook of Chemical Property Estimation Methods, Environmental Behavior of Organic Compounds. McGraw-Hill Book Company, New York, NY.

=General

+Chemical Properties; Physical Properties; Food Chain-Bioconcentration, Uptake, Transfer Coefficient; Mammalian Toxicity; Aquatic Toxicity

S1194

Johnson, F.A., and R.B. Stonehill. 1961. "Chemical pneumonitis from inhalation of zinc chloride." Diseases of the Chest. 40:619-624.

=HC Smokes

+Human Health-Clinical

S1195

Kennedy, G.L., and H.J. Trochimowicz. 1982. "Inhalation toxicology." In A. Wallace Hayes, ed. Principles and Methods of Toxicology. pp. 185-207. Raven Press, New York, NY.

=General

+Air Pollution; Mammalian Toxicity-Inhalation; Analytic Methods

S1196

Sax, N.I. 1979. Dangerous Properties of Industrial Materials, 5th Edition. Van Nostrand Reinhold Co., New York, NY.

=General

+Chemical Properties; Physical Properties; Human Health; Mammalian Toxicity-Acute, Chronic, LD50, Inhalation; Carcinogenicity; Mutagenicity; Regulations

S1197

Laszkowski, D.A., C.A.I. Goring, P.H. McCall, and R.L. Swann. 1982. "Terrestrial environment." In R.A. Conway, ed. Environmental Risk Analysis for Chemicals. Chapter 6. Van Nostrand Reinhold Co., New York, NY.

=General

+Transfer & Diffusion-Models; Water Pollution; Soil Contamination; Food Chain-Transfer Coefficient; Regulations

S1198

Stocum, W.E., and R. G. Hamilton. 1976. "Risk Analysis of Exposure to High Concentrations of Zinc Chloride Smoke." Report SAND-76-0386. Sandia Labs., Albuquerque, NM. Available from National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, VA, 22161.

=HC Smokes

+Reaction Products; Chemical Properties; Human Health-Epidemiology; Life Cycle-Use

S1199

Lewis Sr., Richard J., and R.L. Tatken, eds. 1982. Registry of Toxic Effects of Chemical Substances, 1980 Edition. Vols. 1 and 2. U.S. Dept of Health, and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

=General

+Chemical Properties; Physical Properties; Human Health; Mammalian Toxicity-Acute, Chronic, LD50, Inhalation; Carcinogenicity; Mutagenicity; Regulations

S1200

Van Wazer, J.R. 1961. Phosphorus and Its Compounds, Vol. II. Technology, Biological Functions and Applications. Interservice Publishers Inc., New York, NY.

=Phosphorous Smokes

+Life Cycle-Manufacture; Phytotoxicity; Food Chain; Soil Contamination; Water Pollution

S1201

Hodgman, M.S., R.C. Weast, and S.M. Selby, eds. 1959. Handbook of Chemistry and Physics, 41st Edition. Chemical Rubber Publishing Co., 2310 Superior Ave. N.E., Cleveland, OH.

=General

+Chemical Properties; Physical Properties

S1202

Cohn, S.L. 1981. "Transport and Diffusion Solutions for Obscuration Using the XM-825 Smoke Munition." Report ERADCOM/ASL-TR-0100, AD-A109739/3. U.S. Army Electronics Research and Development Command, Atmospheric Sciences Lab, White Sands Missile Range, NM.

=General

+Transport & Diffusion-Models; Munitions-Artillery

S1203

U.S. Army Test and Evaluation Command. 1978. "Basic Smoke Characterization Test." Report DPG-FR-77-311, AD-B031190L. U.S. Army Dugway Proving Ground, Dugway, UT.

=HC Smokes; Phosphorous Smokes

+Munition-Artillery, Ground; Transport & Diffusion-Field Data; Physical Properties-Aerosol; Analytic Methods

S1204

Campbell, D. 1960. "Expenditure Requirements for the Attack of Specified Target with Pot, Smoke, Floating, an-M7 Gb Filled." AD-316606/3. Chemical Warfare Labs., Army Chemical Center, MD.

=General

+Munition-Ground

S1205

Dumbauld, R.K., S.F. Saterlie, and C.S. Cheney. 1982. "Analysis of Multiple Source Obscurants on the Realistic Battlefield (AMSORB). Vol. I. Mathematical Models and Computer Program Description." AD-A117663/5. Cramer (H.E.) Co. Inc., Salt Lake City, UT.

=HC Smokes; Phosphorous Smokes

+Transport & Diffusion-Models; Munition-Ground, Mortar, Grenade, Artillery, Tank

S1206

Pankow, J.F., and G.L. McKown. 1975. "Effects of Environmental and Processing Conditions on Composition and Sensitivity of HC White Smoke Mix." Report EM-CR-74053, AD-B004012/1. General Electric Co., Engineering and Science Services Lab, Bay Saint Louis, MO. NAS8-27750.

=HC Smokes

+Reaction Products; Chemical Properties; Physical Properties

S1207

Rohrs, L.C. 1957. "Metal-fume fever from inhaling zinc oxide." A.M.A. Arch. Indust. Hyg. 16:42.

=HC Smokes

+Reaction Products; Human Health-Epidemiology, Clinical

S1208

Nau, C.A., J. Neal, and M. Thornton. 1966. "C9 - C12 fractions obtained from petroleum distillates. An evaluation of their potential toxicity." Arch. Environ. Health. 12:382-393.

=Diesel Fuel Smokes; Fog Oil Smokes

+Munition Composition; Analytic Methods; Mammalian Toxicity

S1209

Rinehart, W.E., and T. Hatch. 1964. "Concentration product (CT) as an expression of dose in sublethal exposures to phosgene." Am. Ind. Hyg. Assoc. J. 25:524-553.

=General

+Mammalian Toxicity-Inhalation

S1210

Melzian, B.D. 1982. "Acute toxicity, histopathology, and bioconcentration-retention studies with no. 2 fuel oil and the blue crab, *Callinectes sapidus* Rathbun." (Abstract). Dissertation Abstr. Int. 43(11):3448-B. Univ. Microfilms Int., Order No. DA8306410.

=Fog Oil Smokes

+Food Chain-Bioconcentration; Aquatic Toxicity

S1211

Kinghorn, R.R.F. 1983. An Introduction to the Physics and Chemistry of Petroleum. John Wiley & Sons, New York, NY.

=Diesel Fuel Smokes; Fog Oil Smokes

+Chemical Properties; Physical Properties; Water Pollution; Soil Contamination

S1212

Swiller, A.I., and H.E. Swiller. 1957. "Metal-fume fever." Am. J. Med., 22:173.

=HC Smokes

+Human Health-Clinical

S1213

Johnson, W.W., and H.O. Sanders. 1977. "Chemical Forest Fire Retardants: Acute Toxicity to Five Freshwater Fishes and Scud." Technical Paper 91. U.S. Fish Wildlife Service, Columbia, MO, 65201.

=Phosphorous Smokes

+Aquatic Toxicity; Analytic Methods

S1214

Young, R.N., and A.J. Sethi. 1975. "Compositional changes of a fuel oil from an oil spill due to natural exposure." Water, Air, and Soil Pollut. 5(1975):195-205.

=Diesel Fuel Smokes; Fog Oil Smokes

+Water Pollution; Soil Contamination

S1215

Malins, D.C., W.T. Rouball, and S.I. Stranahan. 1978. "The accumulation of low molecular weight aromatic hydrocarbons of crude oil by coho salmon (*Oncorhynchus kisutch*) and starry flounder (*Platichthys stellatus*)." Arch. of Environ. Contamination and Toxicol. 7(2):237-244.

=Diesel Fuel Smokes; Fog Oil Smokes

+Aquatic Toxicity; Food Chain-Bioconcentration

S1216

Sutton, C., and J.A. Calder. 1974. "Solubility of higher molecular weight n-paraffins in distilled water and seawater." Environ. Sci. Technol., 8(7):645-7.

=Diesel Fuel Smokes; Fog Oil Smokes  
+Chemical Properties; Physical Properties

S1217

Randerson, D., ed. 1984. "Atmospheric Science and Power Production." DE84005177 (DOE/TIC-27601), National Technical Information Service, U.S. Department of Commerce, Springfield, VA, 22161.

=General  
+Transport & Diffusion-Models; Reaction Products; Air Pollution

S1218

Committee on the Atmosphere and the Biosphere. 1981. Atmosphere-Biosphere Interactions: Toward a Better Understanding of the Ecological Consequences of Fossil Fuel Combustion. National Academy Press, Washington, DC.

=General; Phosphorous Smokes  
+Transport & Diffusion-Models; Water Pollution

S1219

Johnston, W.G., and L.B. Sargent Jr. 1970. "The determination of vapor pressures of low viscosity lubricants from distillation data." ASLE (Am. Soc. Lubric. Eng.) Transactions, 25th Annual Meeting in Chicago, May 4-8, 1970. 13(4):304-1C.

=Diesel Fuel Smokes; Fog Oil Smokes  
+Physical Properties

S1220

Hansch, C., and A.J. Leo. 1979. Substituent Constants for Correlation Analysis in Chemistry and Biology. John Wiley & Sons, New York, NY.

=General  
+Physical Properties; Chemical Properties; Food Chain-Bioconcentration, Uptake

S1221

Grasselli, J.G., and W.M. Ritchey, eds. 1975. Atlas of Spectral Data and Physical Constants for Organic Compounds, 2nd Edition, Vols. I-VI. CRC Press, Inc., 18901 Cranwood Parkway, Cleveland, OH 44128.

=General  
+Physical Properties; Chemical Properties; Food Chain-Bioconcentration, Uptake

S1222

Karickhoff, S.W., and D.S. Brown. 1979. "Determination of Octanol/Water Distribution Coefficients, Water Solubilities, and Sediment/Water Partition Coefficients for Hydrophobic Organic Pollutants." Report EPA-600/4-79-032. U.S. Environmental Protection Agency, Athens, GA.

=General  
+Chemical Properties; Physical Properties; Food Chain-Bioconcentration; Water Pollution; Soil Contamination; Analytic Methods

**AUTHOR, TITLES, ACCESSION NUMBER, BY AUTHOR**

The following bibliographic list is organized alphabetically by the principle author's last name. It includes all of the information in the full citation except for the identifiers and descriptors. The accession number is provided at the end of the citation.

Albro, P.E., and L. Fishbein. 1970. "Absorption of aliphatic hydrocarbons by rats." Biochim. Biophys. Acta. 219:437-446 (S1136).

American Conference of Governmental and Industrial Hygienists (ACGIH). 1976. "TLV's Threshold Limit Values for Chemical Substances in Workroom Air." In N.I. Sax. Dangerous Properties of Industrial Materials, 4th Edition. Van Nostrand Reinhold, New York, NY (S1124).

Ballou, J.E. 1981. "Chemical Characterization and Toxicologic Evaluation of Airborne Mixtures." Project 3S162780A843. AD-A102678. Battelle Pacific Northwest Labs, Richland, WA. DAMD17-79-C-9160 (S1055).

Barker, E.A., E.A. Smuckler, and E.P. Benditt. 1963. "Effects of thioacetamide and yellow phosphorus poisoning on protein synthesis in vivo." Lab. Invest., 12:955-960 (S1152).

Barr, W.A. 1982. "Chemical Systems Laboratory Information Exchange Meetings, 30 September and 9 November, 1982." Report ARCSL-SP-83008, AD-C030723. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1077).

Berkowitz, J.B., A.J. Colella, R.G. Thomas, G.S. Young, W.J. Lyman, R.G. Vranka, R.C. Anderson, W.D. Steber, and A.L. Preston. 1981. "Research and Development for Health and Environmental Hazard Assessment. Task Order 5. Occupational and Environmental Hazards Associated with the Formulation and Use of White Phosphorus-Felt and Red Phosphorus-Butyl Rubber Screening Smokes" AD-A116956. Arthur D. Little, Inc., Acorn Park, Cambridge, MA. 02140. DAMD17-79-C-9139 (S1003).

Blackman, G.R. 1983. "Cloud Geometry Analysis of the Smoke Week VA Obscuration Trials." Final Report ASL-DR-83-0009. U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88002 (S1178).

Bock, W., R. Butler, S. Katz, N. Rajendran, and A. Snelson. 1981. "Physical and chemical characterization of smoke produced from white phosphorus/felt wedge." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 2:737 (S1026).

Born, G. (Inventor). 1983. "Screening Smoke with a Broad Absorption Band." Patent: Germany Offen DE 3147850 A1, Coden: GwXXBX 6pp. (in German). Messerschmitt-Boelkow-Blohm G.m.b.H. (Fed. Rep. Ger.) (S1015).

Brahmachari, H.D. 1958. "Toxicity of white oil." Current Sci. 27(11):440-441 (S1138).

Brakhnova, I.T. 1975. Environmental Hazards of Metals. Consultants Bureau, New York, NY. (S1191).

Brown, B.J., G.E. Affleck, E.G. Cummings, R.L. Farrand, and W.C. Starke. 1981. "The Subchronic Effects of Repeated Exposure to White Phosphorus/Felt Screening Smokes in Rats." Report ARCSL-TR-80068, AD-B058048L. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1069).

Brown, H.S., C.A. Rowan, and D.R. Bishop. 1984. "Development of an air toxics program in Massachusetts." Proc. of the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA June 24-29, 1984. 84(7.3):2-28 (S1128).

Buchanan, D.J., M.V. Sigal Jr., C.S. Robinson, K. Pope, J.E. Ferguson, and J.B. Thomison. 1954. "Studies of phosphorus intoxication. I. Changes in blood, urine, and tissues of dogs poisoned with phosphorus." Arch. Ind. Hyg. Occup. Med. 1(9):1-8 (S1150).

Buchanan, M.V., I.B. Rubin, and J.H. Moneyhun. 1983. "Compositional Changes in Red and Violet Smoke Mixes after Combustion." Report CONF-830459-1. Smoke/Obscurants Symp., Adelphi, MD, April 26, 1983. Oak Ridge National Laboratory, TN (S1007).

Bulger, J.P. 1982. "Obscurants: countermeasures to modern weapons." Military Review. 62(5):45-53 (S1109).

Burrows, D. et al. 1973. "Mammalian Toxicology and Toxicity to Aquatic Organisms of White Phosphorus and "Phossy Water", a Waterborne Munitions Manufacturing Waste Pollutant - A Literature Evaluation." Prepared for: U.S. Army Medical Research and Development Command. Associated Water and Air Resources Engineers Inc. (S1112).

Burrows, D. et al. 1975. "Toxicity to Aquatic Organisms and Chemistry of Nine Selected Waterborne Pollutants from Munitions Manufacture - A Literature Evaluation." Technical Report TR-7503, AD-A010660. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1118).

Callahan, J.F., C.L. Crouse, G.E. Affleck, R.L. Farrand, R.W. Dorsey, M.S. Ghuman, R.J. Pellerin, D.H. Heitkamp, C. Lilly, J.J. Feeney, and J.T. Weim. 1983. "The Acute Inhalation Toxicity of Diesel Fuels (DF2 and DF1) Used in Vehicle Engine Exhaust Smoke Systems (VEESS)." Technical Report ARCSL-TR-82064. Chemical Systems Laboratory, U.S. Army Armament Research and Development Command, Aberdeen Proving Ground, MD 21010 (S1050).

Campbell, D. 1960. "Expenditure Requirements for the Attack of Specified Target with Pot, Smoke, Floating, an-M7 Gb Filled." AD-316606/3. Chemical Warfare Labs., Army Chemical Center, MD (S1204).

Carlson, B.R., D.H. Anderson, M.E. Milham, T.L. Tarnove, and R.H. Frickel. 1976. "Infrared Extinction Spectra of Some Common Liquid Aerosols." Report ED-TR-77006, AD-A034669. Edgewood Arsenal Aberdeen Proving Ground, MD (S1034).

Chan, T.L., and M. Lippmann. 1980. "Experimental measurements and empirical modeling of the regional deposition of inhaled particles in humans." Am. Ind. Hyg. Assoc. 41:399-409 (S1157).

Chin, A., and L. Borer. 1981. "Studies of the Effluents from Burning Navy Green Smoke Devices." Report NWSC/CR/RDTR-156, AD-B061993L. Naval Weapons Support Center, Applied Sciences Dept, Crane, IN (S1070).

Christensen, H.E., T.T. Luginbyhl, and B.S. Carroll, eds. 1980. Registry of Toxic Effects of Chemical Substances. U.S. Dept of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health (S1125).

Cichowicz, J.J. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 4 of 5. HC Smoke." ARCSL-EA-83, AD-A141972/O. U.S. Army Armament, Munitions, and Chemical Command, Chemical Research and Development Center, Aberdeen Proving Ground, MD 21010 (S1040).

Cichowicz, J.J., and R.S. Wentzel. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 5 of 5. Dyes/Colored Smokes." AD-A141973. U.S. Army Armament, Munitions, and Chemical Command, Chemical Research and Development Center, Aberdeen Proving Ground, MD 21010 (S1042).

Cogley, D.R., L.E. Craker, C.D. Torgeson, and D.L. Sirois. 1979. "Biological Testing of Rocky Mountain Arsenal for Phytotoxic Substances. Final Report." AD A076565. Walden Division of Abcor, Inc., Wilmington, MA (S1159).

Cohn, S.L. 1981. "Transport and Diffusion Solutions for Obscuration Using the XM-825 Smoke Munition." Report ERADCOM/ASL-TR-0100, AD-A109739/3. U.S. Army Electronics Research and Development Command, Atmospheric Sciences Lab, White Sands Missile Range, NM (S1202).

Coleman, R.A., A.E. Sherr, and R.J. Tucker. 1979. "The Development of Infrared Region Smoke Agents. Final Report." American Cyanamid Company, Bound Brook, New Jersey. DAAA25-76-C-0443 (S1052).

Committee on Toxicology, National Research Council. 1979. "Criteria for Short-Term Exposures to Air Pollutants." Report NAS/ACT/P-885, AD A087853. National Research Council, 2101 Constitution Avenue, N.W., Washington, DC, 29418. N00014-79-C-0049 (S1175).

Committee on the Atmosphere and the Biosphere. 1981. Atmosphere-Biosphere Interactions: Toward a Better Understanding of the Ecological Consequences of Fossil Fuel Combustion. National Academy Press, Washington, DC (S1218).

Conway, P.E., ed. 1982. Environmental Risk Analysis for Chemicals. Van Nostrand Reinhold Co., New York, NY (S1190).

Cooper, A.E., and E.J. Owens. . "A Review of the Toxicology of Screening Smokes." Private document provided by U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1114).

Cragin, J.H. 1982. "Chemical Obscurant Tests During Winter. Environmental Fate." Report CRREL-SR-82-19, AD-B068594L. Cold Regions Research and Engineering Lab, Hanover, NH (S1071).

Craker, L.D., and J.C. Dacre. 1975. "Munitions-Related Substances of Potential Concern as Airborne Pollutants: A Phytotoxicological Evaluation." Final Technical Report 7511, AD A052168. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1160).

Crook, J.W., P. Hott, H.T. Weimer, R.L. Farrand, A.E. Cooper, J.H. Manthei, R. Nelson, and D.H. Heitcamp. 1981. "The Acute Toxicity of Polyethylene Glycol 200 in Laboratory Animals." Report ARCSL-TR-81058, AD-A106519. Chemical Systems Laboratory, ATTN: DRDAR-CLJ-R, Aberdeen Proving Ground, MD, 21010 (S1083).

D'Amico, W.P., W. H. Clay, and A. Mark. 1979. "Diagnostic Tests for Wick-Type Payloads and High Viscosity Liquids. Final Report." Final Report ARBRL-MR-02913, AD-E430270, AD-A072812/1. U.S. Army Armament Research and Development Command, Ballistics Research Lab, Aberdeen Proving Ground, MD (S1186).

Dacre, J.C., W.D. Burrows, A.F. Hegyeli, C.W.R. Wade, T.A. Miller, and D.R. Cogley. 1979. "Problem Definition Study on Potential Environmental Pollutants. V. Physical, Chemical, Toxicological, and Biological Properties of Seven Substances Used in Pyrotechnic Compositions." Technical Report 7704, AD-A090631. U.S. Army Medical Research and Development Command, ATTN: CCEU-UBG, Fort Detrick, Frederick, MD, 21701 (S1082).

Dalbey, W.E., S. Lock, S. Garfinkel, and F.J. Stenglein Jr. 1981. "Inhalation Toxicology." ORNL-5927. Biology Division Progress Report for Period of June 1, 1980 - July 31, 1982 pp. 148-150. Oak Ridge National Laboratory, Oak Ridge, TN 37830. W-7405-eng-26 (S1051).

Dalbey, W., S. Lock, B. Holmberg, J. Moneyhun, and M. Guerin. 1981. "Acute exposures of rats to an inhaled aerosol of diesel fuel." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD. 2:759-771 (S1115).

Dalbey, W., and S. Lock. 1983. "Inhalation Toxicology of Diesel-Fuel Obscurant Aerosol in Sprague-Dawley Rats. Chemical Characterization and Toxicological Evaluation of Airborne Mixtures. Final Report. Phase I. Acute Exposure." Report ORNL/TM-8867, AD-A132650. Oak Ridge National Laboratory, TN (S1004).

Daley, P.S. 1984. "Military marches toward new horizons in pollution control." Pollut. Eng. February 1984:31-42 (S1176).

Deiner, A., and C. Poiley. 1972. "Analysis of Smoke Dyes. Part 1. The Analysis of 1,4-Diamino-2,3-Dihydroanthraquinone (Leuco 1,4-Diaminoanthraquinone)." Report EA-TR-4603, AD-892281L. Edgewood Arsenal MD (S1030).

Diaz-Rivera, R.S., P.H. Collazo, E.R. Pons, and M.V. Torregrosa. 1950. "Acute phosphorus poisoning in man. A study of 56 cases." Medicine. 29:269-298 (S1153).

Dolce, T.J., and D.F. Metz. 1977. "An Analysis of the Smoke Cloud Data from the August 1975 Jefferson Proving Ground Smoke Test. Technical Report." Report AMSAA-TR-201, AD-A045874/5. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD (S1096).

Douda, B.E. 1973. "Pyrotechnic Exploratory Development and Pollution Abatement." AD-907284L. Naval Ammunition Depot Crane, IND. NAD-CR-RDTR-231 (S1032).

Drummond, J.D. 1981. "Analyses of Smoke Week I for HC, WP, and Foreign WP." Report ERADCOM/ASL-CR-81-0008-1, AD-E800272. AD-A098590/3. New Mexico State Univ., Physical Science Lab., Las Cruces, NM (S1086).

Dumbauld, R.K., S.F. Saterlie, and C.S. Cheney. 1982. "Analysis of Multiple Source Obscurants on the Realistic Battlefield (AMSORB). Vol. I. Mathematical Models and Computer Program Description." AD-A117663/5. Cramer (H.E.) Co. Inc., Salt Lake City, UT (S1205).

Durica, A. 1976. "Pyrotechnics." Translation of Tehnologija Eksplozivnih Materija (Yugoslavia). AD-B014883L. 8:325-326 (1972). Army Foreign Science and Technology Center, Charlottesville, VA (S1062).

Dvore, D.S., and R. Vaglio-Laurin. 1982. "Atmospheric diffusion of small instantaneous point releases near the ground." Atmos. Environ. 16(12):2791-2798 (S1053).

Edzwald, J.P. 1977. "Phosphorus in aquatic systems: The role of the sediments." In I.H. Suffet, ed. Fate of Pollutants in the Air and Water Environments, Part 1. pp. 183-214. John Wiley & Sons, New York, NY (S1144).

Elkins, R.E., and R.H. Kohl. 1981. "Proceedings of the Smoke/Obscurants Symposium V, held at Harry Diamond Laboratories, Adelphi, MD, April 28-30, 1981. Vol. 1." Report DRCPM-SMK-T-001-81-VOL-1, AD-A104760 (see also Vol 2, AD-A104761). Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1056).

Elkins, R.E., and R.H. Kohl - Editors. 1982. "Proceedings of the Smoke Obscurants Symposium VI, Held at HDL, 27-29 April, 1982. Vols. I, II (Unclassified Sections). Sponsored by PM Smoke/Obscurants." Technical Report DRCPM-SMK-T-001-82. Proc. of the Smoke/Obscurants Symp. VI, Harry Diamond Laboratories, Adelphi, MD. April 27-29, 1982. Unclassified sections (S1173).

Erickson, M.L., H.D. McKinney, and L. Davenport. 1980. "White Phosphorus Dry Fill Line." Report ARCSL-TR-80015, AD-A089981. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1036).

- Evans, E.H. 1945. "Casualties following exposure to zinc chloride smoke." The Lancet. 2:368-370 (S1164).
- Farmer, W.M. 1981. "The instrument cluster concept in obscurant field testing." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 1:127-145 (S1024).
- Farmer, W.M. 1982. "Relationships between battlefield obscurant parameters measured over large and small distance scales." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:53-60 (S1045).
- Farmer, W.M., F.A. Schwarts, R.D. Morris, J.O. Hornkohl, and M.A. Binkley. 1981. "Field characterization of phosphorus smokes using spectral transmittance and real-time concentration measurements." Proc. of the Soc. of Photo-Optical Instr. Eng. 277:48-57 (S1046).
- Fitzgerald, J.W. 1975. "Approximation formulas for the equilibrium size of an aerosol particle as a function of its dry size and composition and the ambient relative humidity." J. Appl. Meteorol. 14:1044-1049 (S1145).
- Fitzgerald, N.E., V.A. Cirillo, and F.J. Galbraith. 1962. "Mass spectrometric method for analysis of petroleum distillates in the furnace oil-kerosine boiling range." Analy. Chem. 34(10):1276-1280 (S1135).
- Fleming, R.S.L., J.W. Miller, and V.R. Swayne Jr. 1942. "Some recent observations on phosphorus toxicology." J. Ind. Hyg. Toxicol. 24:154-158 (S1155).
- Fossa, A.K., M.M. Riano, P.J. Lavin, and D.R. Vollmre. 1984. "New York State techniques and experience in regulation toxic air contaminants." Proc. of the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA June 24-29, 1984. 84(6.2):2-16 (S1130).
- Fowler, B.W., and T.B. Owens. 1979. "A Parametric Model for the Effect of White Phosphorus Smoke on Target Detection. I. Model Development." Technical Report O-82-2, AD-A083787. U.S. Army Missile Command, Redstone Arsenal, AL (S1163).
- Fry Jr., R.R. 1977. "Method for Preparing a Smoke Agent (Patent)." Report FAT-APPL-843 390, PATENT-4 151 233, AD-D006361/0. Department of the Army, Washington, DC (S1091).
- Garvey, D.M., G. Fernandez, C.W. Bruce, and R.G. Pinnick. 1981. "In Situ Measurements of Phosphorus Smokes During Smoke Week III." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, Maryland 20783. US Army Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico 88022. 1:183-213 (S1006).
- Gerber, M.N., and W.W. Reaves. 1973. "Plastic Bonded Smoke (Patent)." Report PAT-APPL-93 207, PATENT-3 726 225, AD-D001119/7. Department of the Army, Washington, DC (S1104).

Ghoshal, A.K., E.A. Porta, and W.S. Hartroft. 1971. "Isotopic studies on the absorption and tissue distribution of white phosphorus in rats." Exp. Mol. Pathol. 14(2):212-219 (S1139).

Giddings, J.C., G. Karaiskakis, K.D. Caldwell, and M.N. Myers. 1983. "Colloid characterization by sedimentation field-flow fractionation. I. Monodisperse populations." J. Colloid and Interface Sci. 92(1):66-88 (S1148).

Giglio, D.A., and J. Steedman. 1977. "Proceedings of the 1977 Smoke Symposium Held at Harry Diamond Laboratories on 25-26 January 1977." AD-C015516. Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1073).

Gilliam, C.W., G.S. Bradley, and C.A. Lipscomb Jr. 1973. "Smoke Design Criteria." Report EDTR-238, AD-761615. Naval Ammunition Depot, Research and Development Department, Crane, IN 47522 (S1132).

Gomez, R., and M.H. Van Atta. 1984. "Corps of Engineers airland battlefield environment thrust." Army Res., Dev. and Acquisition Magazine. May-June 1984:17-19 (S1180).

Gordon, M.G. 1975. "Smoke Seminar, 20 August 1974. Special Publication." Report ED-SP-75003, AD-A015987. Edgewood Arsenal, Aberdeen Proving Ground, MD (S1103).

Grasselli, J.G., and W.M. Ritchey, eds. 1975. Atlas of Spectral Data and Physical Constants for Organic Compounds, 2nd Edition, Vols. I-VI. CRC Press, Inc., 18901 Cranwood Parkway, Cleveland, OH 44128 (S1221).

Gremillion, A.F., and D.A. Lieblong. 1979. "Study and Evaluation of Several Smoke-Generating Materials for use in Hazard-Free Cartridges for 81-mm Mortar Inert Training Ammunition. Final Report." AD-A070824. BEI Electronics Inc, Little Rock, AR (S1092).

Handel, G. 1976. "The properties of atmospheric aerosol particles as functions of relative humidity at thermodynamic equilibrium with the surrounding moist air." Adv in Geophys, 19:73-188 (S1029).

Hanna, S.R., G.A. Briggs, and R.P. Hosker, Jr. 1982. "Handbook on Atmospheric Diffusion." Technical Information Center, U.S. Department of Energy. Atmospheric Turbulence and Diffusion Laboratory, National Oceanic and Atmospheric Administration (S1189).

Hansch, C., and A.J. Leo. 1979. Substituent Constants for Correlation Analysis in Chemistry and Biology. John Wiley & Sons, New York, NY (S1220).

Hansen, F.V., R. Pena, and R.K. Umstead. 1980. "Deliberate Air Pollution: The Art of Smoke Screening." AD-A090399. Army Electronics Research and Development Command, Atmospheric Sciences Lab., White Sands Missile Range, NM (S1088).

Hardy, C.R., A. Jarvis, and G.E. Fike. 1976. "The Development of a Screening Smoke Composition. Part 2. Thermal Analysis." Report CDE-TP-206, AD-B019770L. Chemical Defense Establishment Porton Down (England) (S1065).

Heimann, H. 1946. "Chronic phosphorus poisoning." J. Ind. Hyg. Toxicol. 24(4):142-150 (S1158).

Henry, M.C., C.D. Rowlett, and J.J. Barkley Jr. 1981. "Mammalian Toxicologic Evaluation of Hexachlorethane Smoke Mixture and Red Phosphorus." AD-A109593. Litton Bionetics Inc., 5516 Nicholson Lane, Kensington, MD 20795, DAMD17-78-C-8086 (S1084).

Hess, G.M. 1979. "Aerosol Laser Passive Countermeasures." Report D180-24922-1 (Distributed only to U.S. Govt. Agencies), AD-C018650L. Boeing Aerospace Co., Seattle, WA (S1074).

Hilado, C.J., and M.T. Lopez. 1977. "Relative toxicity of pyrolysis products of some elastomers." J. Combustion Toxicol 4(1):61-68 (S1116).

Hill, H.G., J.E. Villaume, and K. Wasti. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 5 of 8. Occupational Health and Safety and Environmental Aspects of Zinc Chloride." Final Report, AD-A056020. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103, DAMD-17-77-C-7020 (S1081).

Hodgman, M.S., R.C. Weast, and S.M. Selby, eds. 1959. Handbook of Chemistry and Physics, 41st Edition. Chemical Rubber Publishing Co., 2310 Superior Ave. N.E., Cleveland, OH (S1201).

Holmberg, R.W., and J.H. Moneyhun. 1980. "Symposium on Diesel Fuel Obscurants. Ft. Detrick, MD 13 Nov 1980." Report CONF-801156-2. Oak Ridge National Lab, TN (S1011).

Holmberg, R.W., J.H. Moneyhun, and T.M. Gayle. 1983. "Chemical Characterization and Toxicologic Evaluation of Airborne Mixtures: Generating, Monitoring, and Controlling Petroleum Aerosols for Inhalation-Chamber Studies. Task Summary Report." Report ORNL/TM-8903, AD-A134214. Oak Ridge National Lab, TN (S1002).

Holmberg, R.W., and J.H. Moneyhun. 1982. "System for the Continuous Generation of Phosphorus Aerosol from Red Phosphorus-Butyl Rubber." Report CONF-820468-1. Smoke/Obscurants Symp. VI, Adelphi, MD, April 27, 1982. Oak Ridge National Lab, TN (S1010).

Holst, G.C. 1984. "NATO smoke trials in France and Norway." Army Res., Dev. and Acquisition Magazine. September-October 1983:24-25 (S1177).

Holt, L.J. 1982. "The CBU-88/B Bomb Cluster Smoke Development Program." Report NWC-TP-6040, AD-C029375L. Naval Weapons Center, China Lake, CA (S1076).

Horse, H.R., N. Hotter, and H.J. Bielecki. 1977. "Abstracts of Chemical Systems Laboratory Technical Publications 1 July - 30 September 1977." Report ARCSL-SP-77012, AD-C012418L. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1072). Classified Report.

Howley, G.G. 1983. The Condensed Chemical Dictionary, 10th ed. Van Nostrand Reinhold Co., New York, NY (S1161).

Hunt, L., C. Lee, R. Summer, and D. Trapp. 1982. "The Employment of Smoke for Signature Reduction and Site Obscuration for Improving TNF Survivability and Security (U)." Report DNA-TR-81-141. SAI, P.O.Box 2351, La Jolla, CA 92038. DNA-001-81-C-0255 (S1039).

Jarvis, A. 1970. "The combustion reactions of a pyrotechnic white smoke composition." Combust. Flame 14:313-320 (S1117).

Jenkins, R.A., R.W. Holmberg, J.H. Moneyhun, and J.S. Wike. 1981. "Chemical and physical characterization of a diesel fuel obscurant for inhalation toxicology studies." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 2:739-758 (S1027).

Jenkins, R.A., T.M. Gayle, J.S. Wike, and D.L. Manning. 1982. "Sampling and chemical characterization of concentrated smokes." ASTM Spec. Tech. Publ. No. C4-786000-17. Toxic Materials in the Atmosphere: Sampling and Analysis. American Society for Testing and Materials, Philadelphia, PA. 786:153-66 (S1016).

Jenkins, R.A., and J.S. Wike. 1980. "Chemical Characterization of Diesel Fuel Obscurants." Report CONF-801156-1. Symp. on Diesel Fuel Obscurants. Ft. Detrick, MD, November 13, 1980. Oak Ridge National Lab, TN (S1013).

Johnson, D.M., and C.W. Gilliam. 1974. "Pollution Abatement: Reclamation of Red Phosphorus Smoke Composition." Report NAD-CR-RDTR-267, AD-778341. Naval Ammunition Depot, Crane, IN (S1022).

Johnson, F.A., and R.B. Stonehill. 1961. "Chemical pneumonitis from inhalation of zinc chloride." Diseases of the Chest. 40:619-624 (S1194).

Johnson, W.W., and H.O. Sanders. 1977. "Chemical Forest Fire Retardants: Acute Toxicity to Five Freshwater Fishes and Scud." Technical Paper 91. U.S. Fish Wildlife Service, Columbia, MO, 65201 (S1213).

Johnston, W.G., and L.B. Sargent Jr. 1970. "The determination of vapor pressures of low viscosity lubricants from distillation data." ASLE (Am. Soc. Lubric. Eng.) Transactions, 25th Annual Meeting in Chicago, May 4-8, 1970. 13(4):304-10 (S1219).

Jongen, W.M.F., G.M. Alink, and J.H. Koeman. 1978. "Mutagenic effect of dichloromethane on Salmonella typhimurium." Mutat. Res. 56:245-248 (S1140).

Karickhoff, S.W., and D.S. Brown. 1979. "Determination of Octanol/Water Distribution Coefficients, Water Solubilities, and Sediment/Water Partition Coefficients for Hydrophobic Organic Pollutants." Report EPA-600/4-79-032. U.S. Environmental Protection Agency, Athens, GA (S1222).

Katz, S., A. Snelson, R. Butler, R. Narayanan, W. Bock, and S. Relwani. 1979. "Physical and Chemical Characterization of Military Smokes. Part III. White Phosphorus-Felt Smokes." AD-A115657. IIT Research Institute, 10 West 35th Street, Chicago, Illinois 60616. DAMD17-78-C-8085 (S1058).

Katz, S., A. Snelson, R. Butler, R. Farlow, and R. Welker. 1980. "Physical and Chemical Characterization of Military Smokes. Part II. Fog Oils and Oil Fogs." AD-A093205. IIT Research Inst., Chicago, IL. DAMD17-78-C-8085. Project 3E162777A846 (S1038).

Katz, S., A. Snelson, R. Farlow, R. Welker, and S. Mainer. 1980. "Physical and Chemical Characterization of Fog Oil and Hexachloroethane Smokes. Part 1. Hexachloroethane Smokes." AD-A080936. IIT Research Institute, 10 West 35th Street, Chicago, IL 60616. DAMD17-78-C-8085 (S1041).

Kennedy, B.W. 1981. "Battlefield Induced Contamination Test. Project Summary." Internal Report. U.S. Army Electronics Research and Development Command, Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88002 (S1174).

Kennedy, G.L., and H.J. Trochimowicz. 1982. "Inhalation toxicology." In A. Wallace Hayes, ed. Principles and Methods of Toxicology. pp. 185-207. Raven Press, New York, NY (S1195).

Kinghorn, R.R.F. 1983. An Introduction to the Physics and Chemistry of Petroleum. John Wiley & Sons, New York, NY (S1211).

Kitchens, J.F., W.E. Harward III, D.M. Lauter, R.S. Wentzel, and R.S. Valentine. 1978. "Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Vol. III. Pyrotechnic Related Chemicals. Final Report. October 1977-April 1978." Report ARC-49-5730-03. AD-A066309. Atlantic Research Corp., Alexandria, VA (S1094).

Kohl, R.H. 1980. "Proceedings of the 1979 Chemical System Laboratory Scientific Conference on Obscuration and Aerosol Research. Contract Report." Report No.: ARCSL-CR-81023; AD-A113733/0. Kohl (Ronald H.) and Associates, Tullahoma, TN (S1105).

Krist, K.L., and W.M. Farmer. 1981. "Measurement of battlefield obscurant parameters with the point characterization instrumentation system." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:45-52 (S1047).

Krone, U. 1981. "Preparation and manufacture of a new batch of pyrotechnical screening smokes: NT screening smoke." Journal Article Int. Jahrestag. - Fraunhofer-Inst. Treib-Explosivst. (Chem. Mech. Technol.). Nico-Pyrotechnik Hanns-Juergen Diederichs K.-G., Trittau, Fed. Rep. Ger. 211-33pp. (in German) (S1018).

Lai, M. and D. Rosenblatt. 1977. "Identification of Transformation Products of White Phosphorus in Water." Report NSWC/WOL/TR-76-103, AD-A041068. U.S. Army Medical Research and Development Command, Fort Detrick, MD. DAMD17-77-C-7027 (S1169).

Laskowski, D.A., C.A.I. Goring, P.H. McCall, and R.L. Swann. 1982. "Terrestrial environment." In R.A. Conway, ed. Environmental Risk Analysis for Chemicals. Chapter 6. Van Nostrand Reinhold Co., New York, NY (S1197).

Lee, Cheng-Chun; J.V. Dilley, J. R. Hodgson, D.O. Helton, W.J. Wiegand, D.C. Roberts, B.C. Anderson, L.M. Halfpap, and L.D. Kurtz. 1975. "Mammalian Toxicity of Munition Compounds. Phase I. Acute Oral Toxicity, Primary Skin and Eye Irritation, Dermal Sensitization, and Disposition and Metabolism." Formal Report 1, Project MRI 3900-B, AD-B01150. Midwest Research Institute, 425 Volker Blvd., Kansas City, MO, 64110. DAMD-17-74-C-4073 (S1171).

Leong, K.J., and H.N. MacFarland. 1983. "Hazards from thermodecomposition of epoxy resins." Arch. Environ. Health. 7:675-681 (S1127).

Lewis Sr., Richard J., and R.L. Tatken, eds. 1982. Registry of Toxic Effects of Chemical Substances, 1980 Edition. Vols. 1 and 2. U.S. Dept of Health, and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health (S1199).

Lewis, J.W. 1965. "Human Factors Evaluation of the E24 CS Munition. Technical Memo." Report CRDL-TM-2-34, AD-474350/6. Chemical Research and Development Labs, Edgewood Arsenal, MD (S1101).

Lindauer, G.C., and A.W. Castleman Jr. 1971. "Initial size distributions of aerosols." Nucl. Sci. and Eng. 43:212-217 (S1151).

Liss-Suter, D. 1978. "A Literature Review - Problem Definition Studies on Selected Toxic Chemicals. Vol. 8. Environmental Aspects of Diesel Fuel and Fog Oils SGF No. 1 and SGF No. 2 and Smoke Screens Generated from Them." AD-A056021. Franklin Inst. Research Lab., Science Information Services Dept., Philadelphia, PA. DAMD17-77-C-7020 (S1035).

Liss-Suter, D., J.E. Villaume, and P.N. Craig. 1984. "A Literature Review - Problem Definition Studies on Selected Toxic Chemicals. Vol. No. 4 of 8. Occupational Health and Safety Aspects of Diesel Fuel and Fog Oils SGF No. 1 and SGF No. 2 and Smoke Screens Generated from Them." Final Report, AD-A055903. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. DAMD17-77-C-7020 (S1085).

Liss-Suter, D., R. Mason, and P.N. Craig. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 1 of 8. Occupational Health and Safety Aspects of Diesel Fuel and White Smoke Generated from It." Final Report, AD-A056018. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. DAMD-17-77-C-7020 (S1079).

- Lushbaugh, C.C., J.W. Green, and C.E. Redemann. 1950. "Effects of prolonged inhalation of oil fogs on experimental animals." Arch. Ind. Hyg. Occup. Med. 1:237-247 (S1142).
- Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt. 1982. Handbook of Chemical Property Estimation Methods, Environmental Behavior of Organic Compounds. McGraw-Hill Book Company, New York, NY (S1193).
- Malins, D.C., W.T. Rouball, and S.I. Stranahan. 1978. "The accumulation of low molecular weight aromatic hydrocarbons of crude oil by coho salmon (*Oncorhynchus kisutch*) and starry flounder (*Platichthys stellatus*)." Arch. of Environ. Contamination and Toxicol. 7(2):237-244 (S1215).
- Manthei, J.H., F.K. Lee, M. Donnelly, and J.T. Weimer. 1980. "Preliminary Toxicity Screening Studies of 11 Smoke Candidate Compounds." Report ARCSL-TR-79056, AD-C021764L (S1113).
- Marchetti, R.M. 1979. "A Transport and Diffusion Model for Smoke Munitions." Report AMSAA-TR-272, AD-A079489. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD (S1090).
- Martonen, T. 1983. "Deposition of inhaled particulate matter in the upper respiratory tract, larynx, and bronchial airways: a mathematical description." J. Toxicol. and Environ. Health. 12:787-800 (S1023).
- McGriffin, J. 1962. "Chemical Analysis of Yellow Smoke Mixture Visibility. Investigation of Smokes and Flares." Report RDTR 30, AD-283297. Naval Ammunition Depot Crane, IN (S1014).
- McGriffin, J. 1962. "Chemical Analysis of Red Smoke Mixture for Visibility. Investigation of Smokes and Flares." Report RDTR 26, AD-288745. Naval Ammunition Depot, Crane, IN (S1019).
- McIntyre, F.L. 1975. "Explosive Classification Testing for Pyrotechnic Bulk Composition and End Items. Technical Report. 24 September 1973-June 74." Report EA-4D51, EM-CR-74054, AD-B004013/9. General Electric Co., Engineering and Science Services Lab, Bay Saint Louis, MS (S1095).
- McIntyre, F.L., and G.L. McKown. 1976. "Explosive Classification Testing of Experimental Colored Smoke Compositions and End Items." Report EA-2400, Project DA-5761313, AMC-4932, AD-B014090. General Electric Co., Engineering and Sciences Lab, Bay Saint Louis, MO. NAS8-27750 (S1061).
- McKenney Jr, R.L. 1971. "Development of Experimental Intermetallic-Forming Starter System for the M1 Smoke (HC) Canister. Final Report. May-Aug 1971." Report AFATL-TR-71-136, AD-892269/2. Air Force Armament Lab., Eglin AFB, FL (S1087).

- McKivrigan, J.L. 1981. "Life Cycle Environmental Assessment 155 mm, Improved Smoke Projectile, XM825." U.S. Army Armament Research and Development Command, Chemical Systems Laboratory, Aberdeen Proving Ground, MD 21010 (S1054).
- McLain, W.H., and R.W. Evans. 1965. "A New Smoke Screening Chemical for Use in Aerial Smoke Tanks. Summary Progress Report No. 6 (Final)." Final Report DRI-2304 448-6512-F, AD-479680. University of Denver, Mechanics Division, Denver Research Institute, CO. DA 18-035-AMC-127(A) (S1102).
- Melzian, B.D. 1982. "Acute toxicity, histopathology, and bioconcentration-retention studies with no. 2 fuel oil and the blue crab, *Callinectes sapidus* Rathbun." (Abstract). Dissertation Abstr. Int. 43(11):3448-B. Univ. Microfilms Int., Order No. DA8306410 (S1210).
- Miller, R.D., R.S. Ryczak, and A. Ostrofsky. 1979. "Phosphorus Removal in a Pilot Scale Trickling Filter System by Low-Level Lime Addition to Raw Wastewater." Technical Report 7901, AD A065041. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1028).
- Muhly, R.L. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 1 of 5. Fog Oil, Diesel Fuels, and Polyethylene Glycol (PEG 200)." Report ARCSL-EA-83001-Vol-1, AD-A134846. Chemical Research and Development Center, Aberdeen Proving Ground, MD (S1059).
- National Institutes of Health; Environmental Protection Agency. 1984. "Chemical Information System. On-Line Search." NIH-EPA/Chemical Information System, CIS, Inc.--Fein Marquait Associates, 7215 York Road, Baltimore, Maryland 21209 (S1172).
- Nau, C.A., J. Neal, and M. Thornton. 1966. "C9 - C12 fractions obtained from petroleum distillates. An evaluation of their potential toxicity." Arch. Environ. Health. 12:382-393 (S1208).
- Needels, C.J. 1977. "The Simulation of Tactical Smoke on the Modern Battlefield. Final Report." Master's thesis, AD-A043839/O. Army Command and General Staff Coll., Fort Leavenworth, KS (S1097).
- Nelson, J.G. 1981. "Applications overview of battlefield obscurant parameters measured in U.S. Army tests." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:34-38 (S1048).
- Nelson, J.G. 1982. "A Critique of Transport and Diffusion Models for Man-Made Obscurants." Workshop on the Parameterization of Mixed Layer Diffusion, Los Alamos National Laboratories, October 20-23, 1981. U.S. Army Research Office, U.S. Army Atmospheric Sciences Laboratory, Aberdeen Proving Ground, Maryland 21005 (S1044).
- Newell, R.S., H.L. Lamuth, C.V. Levere, E.E. Westbrook, and L.R. Lowe. 1981. "Requirements for Smoke Screens to Defeat Sensors in the Infrared Spectrum." (Distributed only to US Govt Agencies), AD-C026933L. Prepared in cooperation with Battelle Columbus Labs, OH. AAI Corp., Baltimore, MD. DAAK11-79-C-0123 (S1075).

Newell, R.S., and J.T. Brown. 1976. "Analysis of Large-Area Screening Systems. Vol. 1. Executive Summary." Executive Summary, AD-B07342. Battelle Columbus Laboratories, 505 King Avenue, Columbus, OH, 43201. DAAA15-77-C-0030 (S1192).

Novak, E.W., L.B. Lave, J.J. Stukel, and S. Miller. 1983. "A Health Risk Assessment of the Use of Hexachloroethane Smoke on an Army Training Area." U.S. Army Corps of Engineers, Construction Engineering Research Laboratory, Technical Report N-164. U.S. Army Medical Bioengineering Research and Development Laboratory, Attn:SGRD-UBG-M (S1043).

Ohmstede, W.D., and E.B. Stenmark. 1979. "A model for characterizing transport and diffusion of air pollution in the battlefield environment." AD-A128458. Proc. of the Joint Conference on Applications of Air Pollution Meteorology (2nd), 24- 29 Mar 80, New Orleans, LA. American Meteorological Society, Boston, MA. pp. 416-423 (S1131).

Pani, P., E. Gravela, and C. Mazzarino. 1972. "On the mechanism of fatty liver in white phosphorus poisoned rats." Exptl. Mol. Pathol. 16:201-209 (S1141).

Pankow, J.F., and G.L. McKown. 1975. "Effects of Environmental and Processing Conditions on Composition and Sensitivity of HC White Smoke Mix." Report EM-CR-74053, AD-B004012/1. General Electric Co., Engineering and Science Services Lab, Bay Saint Louis, MO. NAS8-27750 (S1206).

Patrick, D.R. 1984. "EPA's process of assessing and managing risks posed by exposure to toxic air pollutants." Proc. of the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA June 24-29, 1984. 84(103.2):2-7 (S1129).

Patterson, E.M., and D.A. Gillette. 1977. "Commonalities in measured size distributions for aerosols having a soil-derived component." J. Geophys. Res. 82:2074-2082 (S1147).

Pennsyle, R.O. 1979. "Methodology for Estimating Smoke/Obscurant Munition Expenditure Requirements. Technical Report. May-Dec 1978." Report ARCSL-TR-79022, AD-A069157. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1093).

Pennsyle, R.O., and R. Winkler. 1982. "Computer Program For Smoke/Obscurant Hazard Prediction (HAZRD2)." U.S. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD. DAAK11-80-C-0091 (S1133).

Petrovic, K., and D. Vitorovic. 1976. "Recognition and qualitative characterization of commercial petroleum fuels and synthetic fuels by a gas chromatographic fingerprinting technique." J. Chromatogr. 119:413-422 (S1134).

Pinnick, R.G., and S.G. Jennings. 1980. "Relationship Between Radiative Properties and Mass Content of Phosphoric Acid, HC, Petroleum Oil, Sulfuric Acid Military Smokes." Technical Report ASL-TR-0052, AD-A084941. U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM (S1165).

- Randerson, D., ed. 1984. "Atmospheric Science and Power Production." DE84005177 (DOE/TIC-27601), National Technical Information Service, U.S. Department of Commerce, Springfield, VA, 22161 (S1217).
- Ratney, R.S., D.H. Wegman, and H.B. Elkins. 1974. "In vivo conversion of methylene chloride to carbon monoxide." Arch. Environ. Health. 18:223-26 (S1185).
- Rinehart, W.E., and T. Hatch. 1964. "Concentration product (CT) as an expression of dose in sublethal exposures to phosgene." Am. Ind. Hyg. Assoc. J. 25:524-553 (S1209).
- Ripley, W. 1963. "Investigation of MK 25 Mod 2 Smoke-Flare Composition." Report NAD-CR-RDTR-33, AD-411548. Naval Ammunition Depot, Crane, IN (S1020).
- Ripley, W., and C. Armour. 1960 "Chemical Analysis of a Typical Phosphorus Smoke and Flare Composition." Report RDTR-16, AD-632684. Naval Ammunition Depot, Crane, IN (S1021).
- Ripley, W., and V. Need. 1961. "Quantitative Analysis of a Green Smoke Composition." Report RDTR 22, AD-267653. Naval Ammunition Depot (S1008).
- Rohrs, L.C. 1957. "Metal-fume fever from inhaling zinc oxide." A.M.A. Arch. Indust. Hyg. 16:42 (S1207).
- Rosenblatt, D.H. 1981. "Environmental Risk Assessment for Four Munitions-Related Contaminants at Savanna Army Depot Activity." Technical Report 8110, AD-A116650. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1121).
- Rosenblatt, D.H., J.C. Dacre, and D.R. Cogley. 1982. "An environmental fate model leading to preliminary pollutant limit value for human health effects." In R.A. Conway, ed. Environmental Risk Analysis for Chemicals. pp. 474-505. Van Nostrand Reinhold, New York, NY (S1120).
- Rosenblatt, D.H., and M.J. Small. 1981. "Preliminary Pollutant Limit Values for Alabama Army Ammunition Plant." Technical Report 8105, AD-A104203. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1122).
- Rosenblatt, D.H., and R.J. Kainz. 1982. "Options and Recommendations for a Polybromobiphenyl Control Strategy at the Gratiot County, Michigan Landfill." Technical Report 8204, AD-A121243. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1123).
- Rosenblatt, D.H., and W.R. Hartley. 1984. "The Preliminary Pollutant Limit Value Concept." Private document provided by U.S. Army Medical Bioengineering Research and Development Laboratory, Health Effects Research Division, Fort Detrick, MD (S1119).
- Rosenblatt, D.H. 1984. "Guest editorial: The name of the game." Environ. Sci. and Technol. 18(2):39A (S1183).

Rubel, G.O. 1978. "Predicting the Droplet Size and Yield Factors of a Phosphorus Smoke as a Function of Droplet Composition and Ambient Relative Humidity under Tactical Conditions." Report ARCSL-TR-78057, AD-A064076. Chemical Systems Laboratory, Aberdeen Proving Ground, MD (S1167).

Ryczak, R.S., and R.D. Miller. 1979. "A Review of Phosphorus Removal Technology." Technical Report 7706, AD A040802. U.S. Army Medical Bioengineering Research & Development Laboratory, Fort Detrick, MD 21701 (S1156).

Sax, N.I. 1975. Dangerous Properties of Industrial Materials, 4th Edition. Van Nostrand Reinhold Co., New York, NY (S1126).

Sax, N.I. 1979. Dangerous Properties of Industrial Materials, 5th Edition. Van Nostrand Reinhold Co., New York, NY (S1196).

Sax, N.I. 1984. Dangerous Properties of Industrial Materials, 6th Edition. Van Nostrand Reinhold Co. New York, NY (S1187).

Scheunemann, W. 1981. "IR optical properties of screening smoke particles." Journal Article Int. Jahrestag. - Fraunhofer-Inst. Treib-Explosivst. (Chem. Mech. Technol.). Bundesinst. Chem. Tech. Untersuch., Swisttal-Heimerzheim, Fed. Rep. Ger. 235-51pp. (in German) (S1017).

Sedat, G. 1976. "Fiche de Resultats d'Etudes sur les Compositions Fumigenes Coulables et Jour/Nuit Coulables pour l'Annee 75-76 (Three Papers Containing the Results of a Study of Castable Smoke Compositions and Day/Night Castable Compositions)." (Text in French). AD-B015235L. Direction des Constructions et Armes Navales Toulon (France) (S1053).

Shaffer, R.E. (Inventor). 1978. "Composition for Screening Infra-Red Radiation." US Patent No. 4100102, July 11, 1978. Application No. 35380, June 10, 1960. Coden: USXXAM. Class: 252305000. C09K-003/30. US Dept of the Army (S1009).

Shaw, G.C., and P.S. Shadlesky. 1973. "Smoke/Flame Pyrotechnic Marker Compositions." Report TWR-7776, AD-919460. Thiokol Corp, Wasatch Div., Brigham City, Utah (S1033).

Shidlovsky, A.A. 1965. "Fundamentals of Pyrotechnics. Technical Memo." Report PA-TM-1615, AD-462474. Feltman Research Labs. Picatinny Arsenal, Dover, NJ (S1099).

Shinn, J.H. 1979. "Problems in the assessment of air pollution effects on vegetation." In J.R. Pfafflin and E.N. Ziegler, eds. Advances in Environmental Science and Engineering, Vol. 2. pp. 88-105. Gordon and Breach Publishers, New York, NY (S1182).

Shirkey, R.C. 1981. "Effect of atmospheric and man-made obscurants on visual contrast." Proc. of the Soc. of Photo-Optical Instr. Eng. 305:37-44 (S1049).

Shoshkes, M., W.G. Sanfield Jr., S.J. Rosenbaum, and A.J. Fisk. 1950. "Distribution, effect and fate of oil aerosol particles retained in the lungs of mice." Arch. Ind. Hyg. Occup. Med. 1:20-35 (S1143).

Slack, A.V. 1968. Phosphoric Acid. Vol. 1., Parts I and II. Fertilizer Science and Technology Series, Marcel Dekker, Inc., New York (S1012).

Smalley, H.M. 1983. "Dugway Proving Ground smoke and obscurant field measurement technology." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:39-44 (S1025).

Smith, M.D., and C.S. Ferrett Jr. 1977. "Advanced Technology for Pyrotechnic Mixtures and Munitions. Technical Report. September 1972-August 1976." Report ARCSL-TR-77043, EM-TR-77030, AD-A042790. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1098).

Smith, M.D., and F.M. Stewart. 1982. "Environmentally acceptable smoke munitions." Proc. Int. Pyrotech. Semin. 8:623-35. U.S. Army Armament Research and Development Command, Chemical Systems Laboratory, Aberdeen Proving Ground, MD, 21010 (S1111).

Smith, M.P. 1981. "Substitution of nontoxic dye in M18 colored smoke grenades." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 2:773-781 (S1031).

Spangord, R.J., R.T. Podoll, R.T. Rewick, T.S. Chou, R.B. Wilson, J. Backovsky, and D.L. Roberts. 1983. "Environmental Fate of WP/F and RP/BR Military Screening Smokes. Phase I. Literature Review. Final Report (DRAFT)." Phase I. Final Report. SRI international, Menlo Park, CA. DAMD17-83-C-2320 (S1166).

Stocum, W.E., and R.G. Hamilton. 1976. "Risk Analysis of Exposure to High Concentrations of Zinc Chloride Smoke." Report SAND-76-0386. Sandia Labs., Albuquerque, NM. Available from National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, VA, 22161 (S1198).

Stoyanov, L., E. Stoichkova, and G. Suykov. 1976. "Smoke Camouflage: Present and Future." Translation of Voenna Tekhnika (Bulgaria), Report AST-16201-001-76, FSTC-0024-76, AD-B015571L. 2:12-13 (1975). Army Foreign Science and Technology Center, Charlottesville, VA (S1064).

Stuebing, E.W., R.H. Frickel, and G.O. Rubel. 1980. "Recent Research on Phosphorus Smoke." AD-A090442. Document Location NTIS. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1037).

Sullivan Jr., J.H., H.D. Putnam, M. A. Keirn, B.C. Pruitt, Jr. and J.C. Nichols. 04/7. "A Summary and Evaluation of Aquatic Environmental Data in Relation to Establishing Water Quality Criteria for Munition-Unique Compounds. Part 3. White Phosphorus." Final Report, AD-A083625. Water and Air Research Inc., P.O. Box 1121, Gainesville, FL, 32601. DAMD-17-77-C-7027 (S1168).

Sullivan, J.D., and R.G. Reitz. 1980. "Fuel-Air Explosions in a Fog Oil Smoke Environment. Final Report." Report ARBRL-MR-02985, AD-E430393. AD-A083294/9. Army Armament Research and Development Command, Ballistics Research Lab., Aberdeen Proving Ground, MD (S1089).

Sutton, C., and J.A. Calder. 1974. "Solubility of higher molecular weight n-paraffins in distilled water and seawater." Environ. Sci. Technol., 8(7):645-7 (S1216).

- Swiller, A.I., and H.E. Swiller. 1957. "Metal-fume fever." Am. J. Med., 22:173 (S1212).
- Talley, R.C., J.W. Linhart, A.J. Trevino, L. Moore, and A.M. Beller. 1972. "Acute elemental phosphorus poisoning in man: Cardiovascular toxicity." Amer. Heart J., 84:139-140 (S1154).
- Tarnove, T.L. 1980. "Studies of the Chemistry of the Formulation of Phosphorus-Derived Smokes and Their Implications for Phosphorus Smoke Munitions." Report ARCSL-TR-80049, AD-B053301L. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1068).
- Turner, D., H.G. Baxter, G.M. Davies, A.R. Eyres, G.L. Lees, J. Mitchell, J.T. Sanderson, J. Steel, and J.P. Moore. 1975. "Methods for the determination of the atmospheric concentration of oil mist." Ann. Occup. Hyg. 18(4):293-297 (S1146).
- Turner, R.E., P.G. Eitner, C.D. Leonard, and D.G.S. Snyder. 1980. "Battlefield Environment Obscuration Handbook. Vol. I. Final Report. December 1979 - December 1980." Report No.: SAI-80-009-AA-VOL-1; AD-A102822/4. Science Applications, Inc., Ann Arbor, MI (S1106).
- U.S. Army Atmospheric Sciences Laboratory and The U.S. Army Project Manager-Smoke Obscurants. 1983. "Atmospheric aerosol and optics data library." Atmos. Aerosol and Optics Data Library Bulletin. 1(2):9-16 (S1184).
- U.S. Army Test & Evaluation Command. 1978. "Inventory Smoke Munition Test. Phase IIa. Vol. I." 607pp. Final Report DPG-FR-77-314-Vol-1, AD-B031191. Aberdeen Proving Ground, MD 21005. Attn: DRCPM-SMK-T (S1067).
- U.S. Army Test and Evaluation Command. 1978. "Basic Smoke Characterization Test." Report DPG-FR-77-311, AD-B031190L. U.S. Army Dugway Proving Ground, Dugway, UT (S1203).
- U.S. Department of the Army. 1983. "Obscuring smoke munition." Army Research, Development, & Acquisition, August, 1983, Vol. 24, Issue 4, p.26 (S1108)
- U.S. Department of the Army. 1982. "Smoke and Obscurants Program. 'Keep on Smokin'." Army Research, Development, & Acquisition. 23(3):1-3 (S1110).
- U.S. Dept of the Army, U.S. Chemical School. 1984. Commander's Manual. Series FM 3-54 C/CM, LCCN gp 800C2235. U.S. Government Printing Office, Washington, DC (S1001).
- Van Wazar, J.R. 1961. Phosphorus and Its Compounds, Vol. II. Technology, Biological Functions and Applications. Interservice Publishers Inc., New York, NY (S1200).
- Verschuren, K. 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co., New York, NY (S1162).

Vigus, E.S., and A. Deiner. 1981. "Evaluation of Replacement Red Smoke Dyes for 1-N Methylaminoanthraquinone." Technical Report ARCSL-TR-81054, AD-A107286. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1057).

Wagner, W.O., O.J. Dobrogorski, and H.E. Stokinger. 1961. "Antagonistic action of oil mists on air pollutants." Arch. Environ. Health. 2(5):523-534 (S1137).

Wasti, K., K.J.R. Abaidoo, and J.E. Villaume. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 2 of 8. Occupational Health and Safety Aspects of Phosphorus Smoke Compounds." Final Report, AD-A056019. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. DAMD-17-77-C-7020 (S1080).

Webster III, H.A., and D.S. Haas. 1978. "Test of Smoke/Flame Compositions in MK 99 Marine Smoke and Illumination Signal." Report NWSC/CR/RDTR-82, AD-B029040L. Naval Weapons Support Center, Crane, IN (S1066).

Weeks, M.H. 1960. "The Toxicity of Combustion Products of Pyrotechnics. Technical Memo. 7 August - 26 October 1959." Report CWL-TM-26-12, AD-474403/3. Army Chemical Warfare Labs, Army Chemical Center, MD (S1100).

Weimer, J.T., G.E. Affleck, R.L. Rarrand, F.K. Lee, and R.J. Pelerin. 1980. "The Acute and Chronic Effects of Repeated Exposures to United Kingdom Red Phosphorus Screening Smokes in Rats, Mice, Guinea Pigs, and Rabbits." Report ARSCL-TR-79053, AD-B051834L. Chemical Systems Laboratory, Attn: DRADAR-CLJ-R, Aberdeen Proving Ground, Maryland 21010 (S1005).

Wentsel, R. 1983. "Environmental Effect Studies on EA5763." Chemical Research and Development Center, ATTN: DRSMC-CLT-I (A)/Dr. Wentsel, Aberdeen Proving Ground, Maryland 21010 (S1181).

Wenz, D.J., and R.S. Wentsel. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 3 of 5. Infrared." Report ARCSL-EA-83005, AD-C033575. Chemical Research and Development Center, Aberdeen Proving Ground, MD (S1078).

Whitacre, C.G., P.E. Robinson, W.L. Kneas, and A.L. Freeman. 1977. "Computer Program For Chemical Hazard Prediction." Report ARCSL-TR-77049. Chemical Systems Laboratory, Attn: DRDAR-CLY-A, Aberdeen Proving Ground, MD 21010 (S1179).

Windholz, M., S. Budavari, R.F. Blumetti, and E.S. Otterbein, eds. 1983. The Merck Index, 10th Edition. Merck & Co. Inc., Rahway, NJ (S1170).

Windholz, M., S. Budavari, L.Y. Stroumstos, and M.N. Fertig, eds. 1976. The Merck Index, 9th Edition. Merck & Co. Inc., Rahway, NJ (S1188).

Yang F-S, K.D. Caldwell, and J.C. Giddings. 1983. "Colloid characterization by sedimentation field-flow fractionation. II. Particle-size distribution." J. Colloid and Interface Sci. 92(1):81-91 (S1149).

Yon, R.L., R.S. Wentzel, and J.M. Bane. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants, Vol. No. 2 of 5. Red, White, and Plasticized White Phosphorus." Report ARCSL-EA-83004-Vol-2, AD-A135910. Chemical Research and Development Center, Aberdeen Proving Ground, MD (S1060).

Young, R.N., and A.J. Sethi. 1975. "Compositional changes of a fuel oil from an oil spill due to natural exposure." Water, Air, and Soil Pollut. 5(1975):195-205 (S1214).

Zirkind, R. 1979. "A Battlefield Obscuration Model (Smoke & Dust). Final Report. July 1977 - October 1979." AD-A080459/1. General Research Corp., McLean, VA. Operations Analysis Group (S1107).

**AUTHOR, TITLES, ACCESSION NUMBER, BY OBSCURANT TYPE**

The following five bibliographic lists are provided in order of accession. They include bibliographies of Colored Smokes, Diesel Fuel and Fog Oil Obscurants, General References, HC and Zinc Chloride Obscurants, Infrared Obscurants, and Phosphorous Obscurants. They include all of the information in the full citation except for the identifiers and descriptors. The accession number is provided at the end of each citation.

Bibliography of Colored Smokes

- Buchanan, M.V., I.B. Rubin, and J.H. Moneyhun. 1983. "Compositional Changes in Red and Violet Smoke Mixes after Combustion." Report CONF-830459-1. Smoke/Obscurants Symp., Adelphi, MD, April 26, 1983. Oak Ridge National Laboratory, Oak Ridge, TN (S1007).
- Ripley, W., and V. Need. 1961. "Quantitative Analysis of a Green Smoke Composition." Report RDTR 22, AD-267653. Naval Ammunition Depot (S1008).
- McGriffin, J. 1962. "Chemical Analysis of Yellow Smoke Mixture Visibility. Investigation of Smokes and Flares." Report RDTR 30, AD-283297. Naval Ammunition Depot, Crane, IN (S1014).
- McGriffin, J. 1962. "Chemical Analysis of Red Smoke Mixture for Visibility. Investigation of Smokes and Flares." Report RDTR 26, AD-288749. Naval Ammunition Depot, Crane, IN (S1019).
- Ripley, W. 1963. "Investigation of MK 25 Mod 2 Smoke-Flare Composition." Report NAD-CR-RDTR-33, AD-411548. Naval Ammunition Depot, Crane, IN (S1020).
- Ripley, W., and C. Armour. 1960 "Chemical Analysis of a Typical Phosphorus Smoke and Flare Composition." Report RDTR-16, AD-632684. Naval Ammunition Depot, Crane, IN (S1021).
- Deiner, A., and C. Polley. 1972. "Analysis of Smoke Dyes. Part 1. The Analysis of 1,4-Diamino-2,3-Dihydroanthraquinone (Leuco 1,4-Diaminoanthraquinone)." Report EA-TR-4603, AD-892281L. Edgewood Arsenal, MD (S1030).
- Smith, M.P. 1981. "Substitution of nontoxic dye in M18 colored smoke grenades." Proc. of the Smoke/Obscurants Symp. V. Harry Diamond Laboratories, Adelphi, MD 20783. 2:773-781 (S1031).
- Douda, B.E. 1973. "Pyrotechnic Exploratory Development and Pollution Abatement." AD-907284L. Naval Ammunition Depot Crane, IN. NAD-CR-RDTR-231 (S1032).
- Shaw, G.C., and P.S. Shadlesky. 1973. "Smoke/Flame Pyrotechnic Marker Compositions." Report TWK-7776, AD-919460. Thiokol Corp, Wasatch Div., Brigham City, UT (S1033).

Cichowicz, J.J., and R.S. Wentzel. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 5 of 5. Dyes/Colored Smokes." AD-A141973. U.S. Army Armament, Munitions, and Chemical Command, Chemical Research and Development Center, Aberdeen Proving Ground, MD 21010 (S1042).

Vigus, E.S., and A. Deiner. 1981. "Evaluation of Replacement Red Smoke Dyes for 1-N Methylaminoanthraquinone." Technical Report ARCSL-TR-81054, AD-A107286. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1057).

McIntyre, F.L., and G.L. McKown. 1976. "Explosive Classification Testing of Experimental Colored Smoke Compositions and End Items." Report EA-2400, Project DA-5761313, AMC-4932, AD-B014090. General Electric Co., Engineering and Sciences Lab, Bay Saint Louis, MO. NAS8-27750 (S1061).

Durica, A. 1976. "Pyrotechnics." Translation of Technolgija Eksplozivnih Materija (Yugoslavia). AD-B014883L. 8:325-326 (1972). Army Foreign Science and Technology Center, Charlottesville, VA (S1062).

Sedat, G. 1976. "Fiche de Resultats d'Etudes sur les Compositions Fumigenes Coulables et Jour/Nuit Coulables pour l'Annee 75-76 (Three Papers Containing the Results of a Study of Castable Smoke Compositions and Day/Night Castable Compositions)." (Text in French). AD-B015235L. Direction des Constructions et Armes Navales Toulon (France) (S1063).

Webster III, H.A., and D.R. Neas. 1979. "Test of Smoke/Flame Compositions in MK 99 Marine Smoke and Illumination Signal." Report NWSC/CR/RDTR-82, AD-B029040L. Naval Weapons Support Center, Crane, IN (S1066).

Chin, A., and L. Eorer. 1981. "Studies of the Effluents from Burning Navy Green Smoke Devices." Report NWSC/CR/RDTR-156, AD-B061993L. Naval Weapons Support Center, Applied Sciences Dept, Crane. IN (S1070).

Daera, J.C., W.D. Burrows, A.F. Hegyeli, C.W.R. Wade, T.A. Miller, and D.B. Cogley. 1979. "Problem Definition Study on Potential Environmental Pollutants. V. Physical, Chemical, Toxicological, and Biological Properties of Seven Substances Used in Pyrotechnic Compositions." Technical Report 7704, AD-A090631. U.S. Army Medical Research and Development Command, ATTN: SGRU-UBG, Fort Detrick, Frederick, MD, 21701 (S1082).

Gremillion, A.F., and D.A. Lieblong. 1979. "Study and Evaluation of Several Smoke-Generating Materials for Use in Hazard-Free Cartridges for 81-mm Mortar Inert Training Ammunition. Final Report." AD-A070824. BEI Electronics Inc, Little Rock, AR (S1092).

Kitchens, J.F., W.E. Harvard III, D.M. Lauter, R.S. Wentzel, and R.S. Valentine. 1978. "Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Vol. III. Pyrotechnic Related Chemicals. Final Report. October 1977-April 1978." Report ARC-49-5730-03. AD-A066309. Atlantic Research Corp., Alexandria, VA (S1094).

Smith, M.D., and C.S. Ferrett Jr. 1977. "Advanced Technology for Pyrotechnic Mixtures and Munitions. Technical Report. September 1972-August 1976." Report ARCSL-TR-77043, EM-TR-77030, AD-A042790. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1098).

Weeks, M.H. 1960. "The Toxicity of Combustion Products of Pyrotechnics. Technical Memo. 7 August - 26 October 1959." Report CWL-TM-26-12, AD-474403/3. Army Chemical Warfare Labs, Army Chemical Center, MD (S1100).

Smith, M.D., and F.M. Stewart. 1982. "Environmentally acceptable smoke munitions." Proc. Int. Pyrotech. Semin. 8:623-35. U.S. Army Armament Research and Development Command, Chemical Systems Laboratory, Aberdeen Proving Ground, MD 21010 (S1111).

Rosenblatt, D.H., and M.J. Small. 1981. "Preliminary Pollutant Limit Values for Alabama Army Ammunition Plant." Technical Report 8105, AD-A104203. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1122).

Gilliam, G.W., C.S. Bradley, and C.A. Lipscomb Jr. 1973. "Smoke Design Criteria." Report REPR-238, AD-761615. Naval Ammunition Depot, Research and Development Department, Crane, IN 47522 (S1132).

#### Bibliography of Diesel Fuel and Fog Oil Obscurants

Boimberg, R.W., J.H. Moneyhun, and T.M. Gayle. 1983. "Chemical Characterization and Toxicologic Evaluation of Airborne Mixtures: Generating, Monitoring, and Controlling Petroleum Aerosols for Inhalation-Chamber Studies. Task Summary Report." Report ORNL/TM-8903, AD-A134214. Oak Ridge National Laboratory, Oak Ridge, TN (S1002).

Dalbey, W., and S. Lock. 1983. "Inhalation Toxicology of Diesel-Fuel Obscurant Aerosol in Sprague-Dawley Rats. Chemical Characterization and Toxicological Evaluation of Airborne Mixtures. Final Report. Phase I. Acute Exposure." Report ORNL/TM-8867, AD-A132650. Oak Ridge National Laboratory, Oak Ridge, TN (S1004).

Nolmberg, R.W., and J.H. Moneyhun. 1980. "Symposium on Diesel Fuel Obscurants. Ft. Detrick, MD 13 Nov 1980." Report CONF-801156-2. Oak Ridge National Laboratory, Oak Ridge, TN (S1011).

Jenkins, R.A., and J.S. Wike. 1980. "Chemical Characterization of Diesel Fuel Obscurants." Report CONF-801156-1. Symp. on Diesel Fuel Obscurants. Ft. Detrick, MD, November 13, 1980. Oak Ridge National Laboratory, Oak Ridge, TN (S1013).

Jenkins, R.A., T.M. Gayle, J.S. Wike, and D.L. Manning. 1982. "Sampling and chemical characterization of concentrated smokes." ASTM Spec. Tech. Publ. No. 04-786000-17. Toxic Materials in the Atmosphere: Sampling and Analysis. American Society for Testing and Materials, Philadelphia, PA. 786:153-66 (S1016).

Jenkins, R.A., R.W. Holmberg, J.H. Moneyhun, and J.S. Wike. 1981. "Chemical and physical characterization of a diesel fuel obscurant for inhalation toxicology studies." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 2:739-758 (S1027).

Carlson, H.R., D.H. Anderson, M.E. Milham, T.L. Tarnove, and R.H. Frickel. 1976. "Infrared Extinction Spectra of Some Common Liquid Aerosols." Report ED-TR-77006, AD-A034669. Edgewood Arsenal Aberdeen Proving Ground, MD (S1034).

Liss-Suter, D. 1978. "A Literature Review - Problem Definition Studies on Selected Toxic Chemicals. Vol. 8. Environmental Aspects of Diesel Fuel and Fog Oils SCF No. 1 and SCF No. 2 and Smoke Screens Generated from Them." AD-A056021. Franklin Inst. Research Lab., Science Information Services Dept., Philadelphia, PA. DAMD17-77-C-7020 (S1035).

Katz, S., A. Snelson, R. Butler, R. Farlow, and R. Welker. 1980. "Physical and Chemical Characterization of Military Smokes. Part II. Fog Oils and Oil Fogs." AD-A093205. IIT Research Inst., Chicago, IL. DAMD17-78-C-8085. Project 3E162777A846 (S1038).

Hunt, L., C. Lee, R. Summer, and D. Trapp. 1982. "The Employment of Smoke for Signature Reduction and Site Obscuration for Improving TNF Survivability and Security (U)." Report DNA-TR-81-141. SAI, P.O.Box 2351, La Jolla, CA 92038. DNA-001-81-C-0255 (S1039).

Nelson, J.G. 1982. "A Critique of Transport and Diffusion Models for Man-Made Obscurants." Workshop on the Parameterization of Mixed Layer Diffusion, Los Alamos National Laboratories, October 20-23, 1981. U.S. Army Research Office, U.S. Army Atmospheric Sciences Laboratory, Aberdeen Proving Ground, MD 21005 (S1044).

Callahan, J.F., C.L. Crouse, G.E. Affleck, R.L. Farrand, R.W. Dorsey, M.S. Ghussman, R.J. Pellarin, D.Y. Heitkamp, C. Lilly, J.J. Feehey, and J.T. Weim. 1983. "The Acute Inhalation Toxicity of Diesel Fuels (DF2 and DF1) Used in Vehicle Engine Exhaust Smoke Systems (VESS)." Technical Report ARCSL-TR-82064. Chemical Systems Laboratory, U.S. Army Armament Research and Development Command, Aberdeen Proving Ground, MD 21010 (S1050).

Dalbey, W.E., S. Lock, S. Garfinkel, and F.J. Stenglein Jr. 1981. "Inhalation Toxicology." ORNL-5927. Biology Division Progress Report for Period of June 1, 1980 - July 31, 1982 pp. 148-150. Oak Ridge National Laboratory, Oak Ridge, TN 37830. W-7405-eng-26 (S1051).

Baltes, J.E. 1981. "Chemical Characterization and Toxicologic Evaluation of Airborne Mixtures." Project 3S162780A843. AD-A102678. Battelle Pacific Northwest Labs, Richland, WA. DAMD17-79-C-9160 (S1055).

Elkins, R.E., and R.H. Kohl. 1981. "Proceedings of the Smoke/Obscurants Symposium V, held at Harry Diamond Laboratories, Adelphi, MD, April 28-30, 1981. Vol. 1." Report DRCPM-SMK-T-001-81-VOL-1, AD-A104760 (see also Vol 2, AD-A104761). Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1056).

Muhly, R.L. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/ Obscurants. Vol. No. 1 of 5. Fog Oil, Diesel Fuels, and Polyethylene Glycol (PEG 200)." Report ARCSL-EA-83001-Vol-1, AD-A134846. Chemical Research and Development Center, Aberdeen Proving Ground, MD (S1059).

Giglio, D.A., and J. Steedman. 1977. "Proceedings of the 1977 Smoke Symposium Held at Harry Diamond Laboratories on 25-26 January 1977." AD-C015516. Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1073).

Liss-Suter, D., R. Mason, and P.N. Craig. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 1 of 8. Occupational Health and Safety Aspects of Diesel Fuel and White Smoke Generated from It." Final Report, AD-A056018. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA 19103. DAMD-17-77-C-7020 (S1079).

Liss-Suter, D., J.E. Villiams, and P.N. Craig. 1984. "A Literature Review - Problem Definition Studies on Selected Toxic Chemicals. Vol. No. 4 of 8. Occupational Health and Safety Aspects of Diesel Fuel and Fog Oils SGF No. 1 and SGF No. 2 and Smoke Screens Generated from Them." Final Report, AD-A055903. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA 19103. DAMD17-77-C-7020 (S1085).

Hansen, F.V., R. Pena, and R.K. Umstead. 1980. "Deliberate Air Pollution: The Art of Smoke Screening." AD-A090399. Army Electronics Research and Development Command, Atmospheric Sciences Lab., White Sands Missile Range, NM (S1088).

Sullivan, J.D., and R.G. Reitz. 1980. "Fuel-Air Explosions in a Fog Oil Smoke Environment. Final Report." Report ARBRL-MR-02985, AD-E430393. AD-A083294/9. Army Armament Research and Development Command, Ballistics Research Lab., Aberdeen Proving Ground, MD (S1089).

McLain, W.H., and R.W. Evans. 1965. "A New Smoke Screening Chemical for Use in Aerial Smoke Tanks. Summary Progress Report No. 6 (Final)." Final Report DRI-2304 448-6512-F, AD-479680. University of Denver, Mechanics Division, Denver Research Institute, CO. DA 18-035-AMC-127(A) (S1102).

Kohl, R.H. 1980. "Proceedings of the 1979 Chemical System Laboratory Scientific Conference on Obscuration and Aerosol Research. Contract Report." Report No.: ARCSL-CR-81023; AD-A113733/0. Kohl (Ronald H.) and Associates, Tullahoma, TN (S1105).

Turner, R.E., P.G. Eitner, C.D. Leonard, and D.G.S. Snyder. 1980. "Battlefield Environment Obscuration Handbook. Vol. I. Final Report. December 1979 - December 1980." Report No.: SAI-80-009-AA-VOL-1; AD-A102822/4. Science Applications, Inc., Ann Arbor, MI (S1106).

Dalbey, W., S. Lock, B. Holmberg, J. Moneyhun, and M. Guerin. 1981. "Acute exposures of rats to an inhaled aerosol of diesel fuel." Proc. of the Smoke/ Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD. 2:759-771 (S1115).

Petrovic, K., and D. Vitorovic. 1976. "Recognition and qualitative characterization of commercial petroleum fuels and synthetic fuels by a gas chromatographic fingerprinting technique." J. Chromatogr. 119:413-422 (S1134).

Fitzgerald, M.E., V.A. Cirillo, and F.J. Galbraith. 1962. "Mass spectrometric method for analysis of petroleum distillates in the furnace oil-kerosine boiling range." Analy. Chem. 34(10):1276-1280 (S1135).

Albro, P.E., and L. Fishbein. 1970. "Absorption of aliphatic hydrocarbons by rats." Biochim. Biophys. Acta. 219:437-446 (S1136).

Wagner, W.O., O.J. Dobrogorski, and H.E. Stokinger. 1961. "Antagonistic action of oil mists on air pollutants." Arch. Environ. Health. 2(5):523-534 (S1137).

Brahmachari, H.D. 1958. "Toxicity of white oil." Current Sci. 27(11):440-441 (S1138).

Lushbaugh, C.C., J.W. Green, and C.E. Redemann. 1950. "Effects of prolonged inhalation of oil fogs on experimental animals." Arch. Ind. Hyg. Occup. Med. 1:237-247 (S1142).

Shoshkes, M., W.G. Banfield Jr., S.J. Rosenbaum, and A.J. Fisk. 1950. "Distribution, effect and fate of oil aerosol particles retained in the lungs of mice." Arch. Ind. Hyg. Occup. Med. 1:20-35 (S1143).

Turner, D., H.G. Baxter, G.M. Davies, A.R. Eyres, G.L. Loes, J. Mitchell, J.T. Sanderson, J. Steel, and J. P. Moore. 1975. "Methods for the determination of the atmospheric concentration of oil mist." Ann. Occup. Hyg. 18(4):293-297 (S1146).

Pinnick, R.G., and S.G. Jennings. 1980. "Relationship Between Radiative Properties and Mass Content of Phosphoric Acid, HC, Petroleum Oil, Sulfuric Acid Military Smokes." Technical Report ASL-TR-0052, AD-A084941. U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM (S1165).

Committee on Toxicology, National Research Council. 1979. "Criteria for Short-Term Exposures to Air Pollutants." Report NAS/ACT/P-885, AD A087853. National Research Council, 2101 Constitution Avenue, N.W., Washington, DC 29418. NG0014-79-C-0049 (S1175).

Newell, R.S., and J.T. Brown. 1976. "Analysis of Large-Area Screening Systems. Vol. 1. Executive Summary." Executive Summary, AD-B07342. Battelle Columbus Laboratories, 505 King Avenue, Columbus, OH 43201. DAAA15-77-C-0030 (S1192).

Nau, C.A., J. Neal, and M. Thornton. 1966. "C9 - C12 fractions obtained from petroleum distillates. An evaluation of their potential toxicity." Arch. Environ. Health 12:382-393 (S1208).

Melzian, B.D. 1982. "Acute toxicity, histopathology, and bioconcentration-retention studies with no. 2 fuel oil and the blue crab, *Callinectes sapidus* Rathbun." (Abstract). Dissertation Abstr. Int. 43(11):3448-B. Univ. Microfilms Int., Order No. DAS306410 (S1210).

Kinghorn, R.R.F. 1983. An Introduction to the Physics and Chemistry of Petroleum. John Wiley & Sons, New York, NY (S1211).

Young, R.N., and A.J. Sethi. 1975. "Compositional changes of a fuel oil from an oil spill due to natural exposure." Water, Air, and Soil Pollut. 5(1975):195-205 (S1214).

Malins, D.C., W.T. Roubail, and S.I. Stranahan. 1978. "The accumulation of low molecular weight aromatic hydrocarbons of crude oil by coho salmon (*Oncorhynchus kisutch*) and starry flounder (*Platichthys stellatus*)." Arch. of Environ. Contamination and Toxicol. 7(2):237-244 (S1215).

Sutton, C., and J.A. Calder. 1974. "Solubility of higher molecular weight n-paraffins in distilled water and seawater." Environ. Sci. Technol. 8(7):545-7 (S1216).

Johnston, W.G., and L.B. Sargent Jr. 1970. "The determination of vapor pressures of low viscosity lubricants from distillation data." ASLE (Am. Soc. Lubric. Eng.) Transactions, 25th Annual Meeting in Chicago, May 4-8, 1970. 13(4):304-10 (S1219).

#### Bibliography of HC and Zinc Chloride Obscurants

Hunt, L., C. Lee, R. Summer, and D. Trapp. 1982. "The Employment of Smoke for Signature Reduction and Site Obscuration for Improving INF Survivability and Security." Report DNA-TR-81-14). SAI, P.O.Box 2351, La Jolla, CA 92038. DNA-001-81-C-0255 (S1039).

Cichowicz, J.J. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 4 of 5. HC Smoke." ARCSL-EA-83, AD-A141972/O. U.S. Army Armament, Munitions, and Chemical Command, Chemical Research and Development Center, Aberdeen Proving Ground, MD 21010 (S1040).

Katz, S., A. Snelson, R. Farlow, R. Welker, and S. Mainer. 1980. "Physical and Chemical Characterization of Fog Oil and Hexachloroethane Smokes. Part 1. Hexachloroethane Smokes." AD-A080936. IIT Research Institute, 10 West 35th Street, Chicago, IL 60616. DAMD17-78-C-8085 (S1041).

Novak, E.W., L.B. Lave, J.J. Stukel, and S. Miller. 1983. "A Health Risk Assessment of the Use of Hexachloroethane Smoke on an Army Training Area." U.S. Army Corps of Engineers, Construction Engineering Research Laboratory, Technical Report N-164. U.S. Army Medical Bioengineering Research and Development Laboratory, Attn:SGRD-UBG-M (S1043).

Nelson, J.G. 1982. "A Critique of Transport and Diffusion Models for Man-Made Obscurants." Workshop on the Parameterization of Mixed Layer Diffusion, Los Alamos National Laboratories, October 20-23, 1981. U.S. Army Research Office, U.S. Army Atmospheric Sciences Laboratory, Aberdeen Proving Ground, MD 21005 (S1044).

Elkins, R.E., and R.H. Kohl. 1981. "Proceedings of the Smoke/Obscurants Symposium V, held at Harry Diamond Laboratories, Adelphi, MD, April 28-30, 1981. Vol. 1." Report DRCPM-SMK-T-001-81-VOL-1, AD-A104760 (see also Vol 2, AD-A104761). Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1056).

U.S. Army Test & Evaluation Command. 1978. "Inventory Smoke Munition Test. Phase IIa. Vol. I." 607pp. Final Report DPG-FR-77-314-Vol-1, AD-B031191. Aberdeen Proving Ground, MD 21005. Attn: DRCPM-SMK-T (S1067).

Giglio, D.A., and J. Steedman. 1977. "Proceedings of the 1977 Smoke Symposium Held at Harry Diamond Laboratories on 25-26 January 1977." AD-C015516. Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1073).

Hill, H.G., J.E. Villaume, and K. Wasti. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 5 of 8. Occupational Health and Safety and Environmental Aspects of Zinc Chloride." Final Report, AD-A056020. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA 19103. DAMD-17-77-C-7020 (S1081).

Henry, M.C., C.D. Rowlett, and J.J. Barkley Jr. 1981. "Mammalian Toxicologic Evaluation of Hexachloroethane Smoke Mixture and Red Phosphorus." AD-A109593. Litton Bionetics Inc., 5516 Nicholson Lane, Kensington, MD 20795. DAMD17-78-C-8086 (S1084).

Drummond, J.D. 1981. "Analyses of Smoke Week I for HC, WP, and Foreign WP." Report ERADCOM/ASL-CR-81-0008-1, AD-E800272. AD-A098590/3. New Mexico State Univ., Physical Science Lab., Las Cruces, NM (S1086).

McKenney Jr, R.L. 1971. "Development of Experimental Intermetallic-Forming Starter System for the M1 Smoke (HC) Canister. Final Report. May-Aug 1971." Report AFATL-TR-71-136, AD-892269/2. Air Force Armament Lab., Eglin AFB, FL (S1087).

Hansen, F.V., R. Pena, and R.K. Umstead. 1980. "Deliberate Air Pollution: The Art of Smoke Screening." AD-A090399. Army Electronics Research and Development Command, Atmospheric Sciences Lab., White Sands Missile Range, NM (S1098).

Marchetti, R.M. 1979. "A Transport and Diffusion Model for Smoke Munitions." Report AMSAA-TR-272, AD-A079489. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD (S1090).

Gremillion, A.F., and D.A. Lieblong. 1979. "Study and Evaluation of Several Smoke-Generating Materials for Use in Hazard-Free Cartridges for 81-mm Mortar Inert Training Ammunition. Final Report." AD-A070824. BEI Electronics Inc, Little Rock, AR (S1092).

Kitchens, J.F., W.E. Harward III, D.M. Lauter, R.S. Wentzel, and R.S. Valentine. 1978. "Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Vol. III. Pyrotechnic Related Chemicals. Final Report. October 1977-April 1978." Report ARC-49-5730-03. AD-A066309. Atlantic Research Corp., Alexandria, VA (S1094).

Dolce, T.J., and D.F. Metz. 1977. "An Analysis of the Smoke Cloud Data from the August 1975 Jefferson Proving Ground Smoke Test. Technical Report." Report AMSAA-TR-201, AD-AC45874/5. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD (S1096).

Kohl, R.H. 1980. "Proceedings of the 1979 Chemical System Laboratory Scientific Conference on Obscuration and Aerosol Research. Contract Report." Report No.: ARCSL-CR-81023; AD-A113733/0. Kohl (Ronald H.) and Associates, Tullahoma, TN (S1105).

Turner, R.E., P.G. Eitner, C.D. Leonard, and D.G.S. Snyder. 1980. "Battlefield Environment Obscuration Handbook. Vol. I. Final Report. December 1979 - December 1980." Report No.: SAI-80-009-AA-VOL-1; AD-A102822/4. Science Applications, Inc., Ann Arbor, MI (S1106).

Jarvis, A. 1970. "The combustion reactions of a pyrotechnic white smoke composition." Combust. Flame 14:313-320 (S1117).

Evans, E.H. 1945. "Casualties following exposure to zinc chloride smoke." The Lancet. 2:368-370 (S1164).

Pinnick, R.G., and S.G. Jennings. 1980. "Relationship Between Radiative Properties and Mass Content of Phosphoric Acid, HC, Petroleum Oil, Sulfuric Acid Military Smokes." Technical Report ASL-TR-0052, AD-A084941. U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM (S1165).

Kennedy, B.W. 1981. "Battlefield Induced Contamination Test. Project Summary." Internal Report. U.S. Army Electronics Research and Development Command, Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88002 (S1174).

Johnson, F.A., and R.B. Stonehill. 1961. "Chemical pneumonitis from inhalation of zinc chloride." Diseases of the Chest 40:619-624 (S1194).

Stocum, W.E., and R. G. Hamilton. 1976. "Risk Analysis of Exposure to High Concentrations of Zinc Chloride Smoke." Report SAND-76-0386. Sandia Labs., Albuquerque, NM. Available from National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, VA 22161 (S1198).

U.S. Army Test and Evaluation Command. 1978. "Basic Smoke Characterization Test." Report DPG-FR-77-311, AD-B031190L. U.S. Army Dugway Proving Ground, Dugway, UT (S1203).

Dumbauld, R.K., S.F. Saterlie, and C.S. Cheney. 1982. "Analysis of Multiple Source Obscurants on the Realistic Battlefield (AMSORB). Vol. I. Mathematical Models and Computer Program Description." AD-A117663/5. Cramer (H.E.) Co. Inc., Salt Lake City, UT (S1205).

Pankow, J.F., and G.L. McKown. 1975. "Effects of Environmental and Processing Conditions on Composition and Sensitivity of HC White Smoke Mix." Report EM-CR-74053, AD-B004012/1. General Electric Co., Engineering and Science Services Lab, Bay Saint Louis, MO. NAS8-27750 (S1206).

Rohrs, L.C. 1957. "Metal-fume fever from inhaling zinc oxide." A.M.A. Arch. Indust. Hyg. 16:42 (S1207).

Swiller, A.I., and H.E. Swiller. 1957. "Metal-fume fever." Am. J. Med., 22:173 (S1212).

#### Bibliography of Infrared (IR) Obscurants

Snaffer, R.E. (Inventor). 1978. "Composition for Screening Infra-Red Radiation." US Patent No. 4100102, July 11, 1978. Application No. 35380, June 10, 1960. Coden: USXXAM. Class: 252305000. C09K-003/30. US Dept of the Army (S1009).

Born, G. (Inventor). 1983. "Screening Smoke with a Broad Absorption Band." Patent: Germany Offen DE 3147850 A1, Coden: GWXXBX 6pp. (in German). Messerschmitt-Boelkow-Blohm G.m.b.H. (Fed. Rep. Ger.) (S1015).

Scheunemann, W. 1981. "IR optical properties of screening smoke particles." Journal Article Int. Jahrestag. - Fraunhofer-Inst. Treib-Explosivst. (Chem. Mech. Technol.). Bundesinst. Chem. Tech. Untersuch., Swisttal-Heimerzheim, Fed. Rep. Ger. 235-51pp. (in German) (S1017).

Krone, U. 1981. "Preparation and manufacture of a new batch of pyrotechnical screening smokes: NT screening smoke." Journal Article Int. Jahrestag. - Fraunhofer-Inst. Treib-Explosivst. (Chem. Mech. Technol.). Nico-Pyrotechnik Hanns-Juerge Diederichs K.-G., Trittau, Fed. Rep. Ger. 211-33pp. (in German) (S1018).

Carlson, H.R., D.H. Anderson, M.E. Milham, T.L. Tarnove, and R.H. Frickel. 1976. "Infrared Extinction Spectra of Some Common Liquid Aerosols." Report ED-TR-77006, AD-A034669. Edgewood Arsenal Aberdeen Proving Ground, MD (S1034).

Nelson, J.G. 1982. "A Critique of Transport and Diffusion Models for Man-Made Obscurants." Workshop on the Parameterization of Mixed Layer Diffusion, Los Alamos National Laboratories, October 20-23, 1981. U.S. Army Research Office, U.S. Army Atmospheric Sciences Laboratory, Aberdeen Proving Ground, MD 21005 (S1044).

Coleman, R.A., A.E. Sherr, and R.J. Tucker. 1979. "The Development of Infrared Region Smoke Agents. Final Report." American Cyanamid Company, Bound Brook, NJ. DAAA25-76-C-0443 (S1052).

Hardy, C.R., A. Jarvis, and G.E. Pike. 1976. "The Development of a Screening Smoke Composition. Part 2. Thermal Analysis." Report CDE-TP-206, AD-B019770L. Chemical Defense Establishment Porton Down (England) (S1065).

Cragin, J.H. 1982. "Chemical Obscurant Tests During Winter. Environmental Fate." Report CRREL-SR-82-19, AD-B068594L. Cold Regions Research and Engineering Lab, Hanover, NH (S1071).

Hess, G.M. 1979. "Aerosol Laser Passive Countermeasures." Report D180-24922-1 (Distributed only to U.S. Govt. Agencies), AD-C018650L. Boeing Aerospace Co., Seattle, WA (S1074).

Newell, R.S., H.L. Lamuth, C.V. Levere, E.E. Westbrook, and L.R. Lowe. 1981. "Requirements for Smoke Screens to Defeat Sensors in the Infrared Spectrum." (Distributed only to US Govt Agencies), AD-C026933L. Prepared in cooperation with Battelle Columbus Labs, OH. AAI Corp., Baltimore, MD. DAAK11-79-C-0123 (S1075).

Holt, L.J. 1982. "The CBU-88/B Bomb Cluster Smoke Development Program." Report NWC-TP-6040, AD-C029375L. Naval Weapons Center, China Lake, CA (S1076).

Wenz, D.J., and R.S. Wentsel. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. Vol. No. 3 of 5. Infrared." Report ARCSL-EA-83005, AD-C033575. Chemical Research and Development Center, Aberdeen Proving Ground, MD (S1078).

Gordon, M.G. 1975. "Smoke Seminar, 20 August 1974. Special Publication." Report ED-SP-75003, AD-A015987. Edgewood Arsenal, Aberdeen Proving Ground, MD (S1103).

Kohl, R.H. 1980. "Proceedings of the 1979 Chemical System Laboratory Scientific Conference on Obscuration and Aerosol Research. Contact Report." Report No.: ARCSL-CR-81023; AD-A113733/0. Kohl (Ronald H.) and Associates, Tullahoma, TN (S1105).

Turner, R.E., P.G. Eitner, C.D. Leonard, and D. G. S. Snyder. 1980. "Battlefield Environment Obscuration Handbook. Vol. I. Final Report. December 1979 - December 1980." Report No.: SAI-80-009-AA-VOL-1; AD-A102822/4. Science Applications, Inc., Ann Arbor, MI (S1106).

Manthei, J.H., F.K. Lee, M. Donnelly, and J.T. Weimer. 1980. "Preliminary Toxicity Screening Studies of 11 Smoke Candidate Compounds." Report ARCSL-TR-79056, AD-C021764L (S1113).

Giddings, J.C., G. Karaiskakis, K.D. Caldwell, and M.N. Myers. 1983. "Colloid characterization by sedimentation field-flow fractionation. I. Monodisperse populations." J. Colloid and Interface Sci. 92(1):66-88 (S1148).

Yang F-S, K.D. Caldwell, and J.C. Giddings. 1983. "Colloid characterization by sedimentation field-flow fractionation. II. Particle-size distribution." J. Colloid and Interface Sci. 92(1):81-91 (S1149).

Newell, R.S., and J.T. Brown. 1976. "Analysis of Large-Area Screening Systems. Vol. 1. Executive Summary." Executive Summary, AD-B07342. Battelle Columbus Laboratories, 505 King Avenue, Columbus, OH 43201. DAAA15-77-C-0030 (S1192).

## Bibliography of Phosphorous Obscurants

Berkowitz, J.B., A.J. Colella, R.G. Thomas, G.S. Young, W.J. Lyman, R.G. Vranka, R.C. Anderson, W.D. Steber, and A.L. Presron. 1981. "Research and Development for Health and Environmental Hazard Assessment. Task Order 5. Occupational and Environmental Hazards Associated with the Formulation and Use of White Phosphorus-Felt and Red Phosphorus-Butyl Rubber Screening Smokes" AD-A116956. Arthur D. Little, Inc., Acorn Park, Cambridge, MA 02140. DAMD17-79-C-9139 (S1005).

Weimer, J.T., G.E. Affleck, R.L. Rarrand, F.K. Lee, and R.J. Pelerin. 1980. "The Acute and Chronic Effects of Repeated Exposures to United Kingdom Red Phosphorus Screening Smokes in Rats, Mice, Guinea Pigs, and Rabbits." Report ARSCL-TR-79053, AD-B051834L. Chemical Systems Laboratory, Attn: DRADAR-CLJ-R, Aberdeen Proving Ground, MD 21010 (S1005).

Garvey, D.M., G. Fernandez, C.W. Bruce, and R.G. Pinnick. 1981. "In Situ Measurements of Phosphorus Smokes During Smoke Week III." Proc. of the Smoke/ Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, Maryland 20783. US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88022. 1:183-213 (S1006).

Holmberg, R.W., and J.H. Moneyhun. 1982. "System for the Continuous Generation of Phosphorus Aerosol from Red Phosphorus-Butyl Rubber." Report CONF-820468-1. Smoke/Obscurants Symp. VI, Adelphi, Md., April 27, 1982. Oak Ridge National Lab, TN (S1010).

Slack, A.V. 1968. Phosphoric Acid. Vol. 1., Parts I and II. Fertilizer Science and Technology Series, Marcel Dekker, Inc., New York (S1012).

Ripley, W., and C. Armour. 1960 "Chemical Analysis of a Typical Phosphorus Smoke and Flare Composition." Report RDTR-16, AD-632684. Naval Ammunition Depot, Crane, IN (S1021).

Johnson, D.M., and C.W. Gilliam. 1974. "Pollution Abatement: Reclamation of Red Phosphorus Smoke Composition." Report NAD-CR-RDTR-267, AD-778341. Naval Ammunition Depot, Crane, IN (S1022).

Bock, W., R. Butler, S. Katz, N. Rajendran, and A. Snelson. 1981. "Physical and chemical characterization of smoke produced from white phosphorus/felt wedge." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 2:737 (S1026).

Miller, R.D., R.S. Ryczak, and A. Ostrofsky. 1979. "Phosphorus Removal in a Pilot Scale Trickling Filter System by Low-Level Lime Addition to Raw Wastewater." Technical Report 7901, AD A065041. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1028).

Carlson, H.R., D.H. Anderson, M.E. Milham, T.L. Tarnove, and R.H. Frickel. 1976. "Infrared Extinction Spectra of Some Common Liquid Aerosols." Report ED-TR-77006, AD-A034669. Edgewood Arsenal Aberdeen Proving Ground, MD (S1034).

Erickson, M.L., H.D. McKinney, and L. Davenport. 1980. "White Phosphorus Dry Fill Line." Report ARCSL-TR-80015, AD-A089981. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1036).

Stuebing, E.W., R.H. Frickel, and G.O. Rubel. 1980. "Recent Research on Phosphorus Smoke." AD-A090442. Document Location NTIS. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1037).

Hunt, L., C. Lee, R. Summer, and D. Trapp. 1982. "The Employment of Smoke for Signature Reduction and Site Obscuration for Improving TNF Survivability and Security (U)." Report DNA-TR-81-141. SAI, P.O.Box 2351, La Jolla, CA 92038. DNA-001-81-C-0255 (S1039).

Nelson, J.G. 1982. "A Critique of Transport and Diffusion Models for Man-Made Obscurants." Workshop on the Parameterization of Mixed Layer Diffusion, Los Alamos National Laboratories, October 20-23, 1981. U.S. Army Research Office, U.S. Army Atmospheric Sciences Laboratory, Aberdeen Proving Ground, Maryland 21005 (S1044).

Farmer, W.M., F.A. Schwartz, R.D. Morris, J.O. Hornkohl, and M.A. Binkley. 1981. "Field characterization of phosphorus smokes using spectral transmittance and real-time concentration measurements." Proc. of the Soc. of Photo-Optical Instr. Eng. 277:48-57 (S1046).

McKivrigan, J.L. 1981. "Life Cycle Environmental Assessment 155 mm, Improved Smoke Projectile, XM825." U.S. Army Armament Research and Development Command, Chemical Systems Laboratory, Aberdeen Proving Ground, MD 21010 (S1054).

Ballou, J.E. 1981. "Chemical Characterization and Toxicologic Evaluation of Airborne Mixtures." Project 3S162780A843. AD-A102678. Battelle Pacific Northwest Labs, Richland, WA. DAMD17-79-C-9160 (S1055).

Elkins, R.E., and R.H. Kohl. 1981. "Proceedings of the Smoke/Obscurants Symposium V, held at Harry Diamond Laboratories, Adelphi, MD, April 28-30, 1981. Vol. 1." Report DRCPM-SMK-T-001-81-VOL-1, AD-A104760 (see also Vol 2, AD-A104761). Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1056).

Katz, S., A. Snelson, R. Butler, R. Narayanan, W. Bock, and S. Relwani. 1979. "Physical and Chemical Characterization of Military Smokes. Part III. White Phosphorus-Felt Smokes." AD-A115657. IIT Research Institute, 10 West 35th Street, Chicago, IL 60616. DAMD17-78-C-8085 (S1058).

Yon, R.L., R.S. Wentzel, and J.M. Bane. 1983. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants, Vol. No. 2 of 5. Red, White, and Elasticized White Phosphorus." Report ARCSL-EA-83004-Vol-2, AD-A135910. Chemical Research and Development Center, Aberdeen Proving Ground, MD (S1060).

U.S. Army Test & Evaluation Command. 1978. "Inventory Smoke Munition Test. Phase Ila. Vol. I." 607pp. Final Report DPG-FR-77-314-Vol-1, AD-8031191. Aberdeen Proving Ground, MD 21005. Attn: DRCPM-SMK-T (S1067)

Tarnove, T.L. 1980. "Studies of the Chemistry of the Formulation of Phosphorus-Derived Smokes and Their Implications for Phosphorus Smoke Munitions." Report ARCSL-TR-80049, AD-B053301L. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1068).

Brown, B.J., G.E. Affleck, E.G. Cummings, R.L. Farrand, and W.C. Starke. 1981. "The Subchronic Effects of Repeated Exposure to White Phosphorus/Felt Screening Smokes in Rats." Report ARCSL-TR-80068, AD-B058048L. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1069).

Cragin, J.H. 1982. "Chemical Obscurant Tests During Winter. Environmental Fate." Report CRREL-SR-82-19, AD-B068594L. Cold Regions Research and Engineering Lab, Hanover, NH (S1071).

Giglio, D.A., and J. Steedman. 1977. "Proceedings of the 1977 Smoke Symposium Held at Harry Diamond Laboratories on 25-26 January 1977." AD-C015516. Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1073).

Holt, L.J. 1982. "The CBU-88/B Bomb Cluster Smoke Development Program." Report NWC-TP-6040, AD-C029375L. Naval Weapons Center, China Lake, CA (S1076).

Wenz, D.J., and R.S. Wentzel. 1982. "Programmatic Life Cycle Environmental Assessment for Smoke/Obscurants. No. 3 of 5. Infrared." Report ARCSL-EA-83005, AD-C033575. Chemical Research and Development Center, Aberdeen Proving Ground, MD (S1078).

Wasti, K., K.J.R. Abaidoo, and J.E. Villaume. 1978. "A Literature Review - Problem Definition Study on Selected Toxic Chemicals. Vol. No. 2 of 8. Occupational Health and Safety Aspects of Phosphorus Smoke Compounds." Final Report, AD-A056019. The Franklin Institute Research Laboratories, Science Information Services Department, Benjamin Franklin Parkway, Philadelphia, PA, 19103. DAMD-17-77-C-7020 (S1080).

Henry, M.C., C.D. Rowlett, and J.J. Barkley Jr. 1981. "Mammalian Toxicologic Evaluation of Hexacholoroethane Smoke Mixture and Red Phosphorus." AD-A109593. Litton Bionetics Inc., 5516 Nicholson Lane, Kensington, MD 20795, DAMD17-78-C-8086 (S1084).

Drummond, J.D. 1981. "Analyses of Smoke Week I for HC, WP, and Foreign WP." Report ERADCOM/ASL-CR-81-0008-1, AD-E800272. AD-A098590/3. New Mexico State Univ., Physical Science Lab., Las Cruces, NM (S1086).

Hansen, F.V., R. Pena, and R.K. Umstead. 1980. "Deliberate Air Pollution: The Art of Smoke Screening." AD-A090399. Army Electronics Research and Development Command, Atmospheric Sciences Lab., White Sands Missile Range, NM (S1088).

Marchetti, R.M. 1979. "A Transport and Diffusion Model for Smoke Munitions." Report ANSAA-TR-272, AD-A079489. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD (S1090).

Kitchens, J.F., W.E. Farward III, D.M. Lauter, R.S. Wentzel, and R.S. Valentine. 1978. "Preliminary Problem Definition Study of 48 Munitions-Related Chemicals. Vol. III. Pyrotechnic Related Chemicals. Final Report. October 1977-April 1978." Report ARC-49-5730-03. AD-A066309. Atlantic Research Corp., Alexandria, VA (S1094).

Dolce, T.J., and D.F. Metz. 1977. "An Analysis of the Smoke Cloud Data from the August 1975 Jefferson Proving Ground Smoke Test. Technical Report." Report ANSAA-TR-201, AD-A045874/5. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD (S1096).

Weeks, M.H. 1960. "The Toxicity of Combustion Products of Pyrotechnics. Technical Memo. 7 August - 26 October 1959." Report CWL-TM-26-12, AD-474403/3. Army Chemical Warfare Labs, Army Chemical Center, MD (S1100).

McLain, W.H., and R.W. Evans. 1965. "A New Smoke Screening Chemical for Use in Aerial Smoke Tanks. Summary Progress Report No. 6 (Final)." Final Report DRI-2304 448-6512-F, AD-479680. University of Denver, Mechanics Division, Denver Research Institute, CO. DA 18-035-AMC-127(A) (S1102).

Gerber, M.N., and W.W. Reeves. 1973. "Plastic Bonded Smoke (Patent)." Report PAT-APPL-93 207, PATENT-3 726 225, AD-D001119/7. Department of the Army, Washington, DC (S1104).

Kohl, R.H. 1980. "Proceedings of the 1979 Chemical System Laboratory Scientific Conference on Obscuration and Aerosol Research. Contract Report." Report No.: ARCSL-CR-81023; AD-A13733/0. Kohl (Ronald H.) and Associates, Tullahoma, TN (S1105).

Turner, R.E., P.G. Eitner, C.D. Leonard, and D.G.S. Snyder. 1980. "Battlefield Environment Obscuration Handbook. Vol. I. Final Report. December 1979 - December 1980." Report No.: SAI-80-009-AA-VOL-1; AD-A102822/4. Science Applications, Inc., Ann Arbor, MI (S1106).

Smith, M.D., and F.M. Stewart. 1982. "Environmentally acceptable smoke munitions." Proc. Int. Pyrotech. Semin. 8:623-35. U.S. Army Armament Research and Development Command, Chemical Systems Laboratory, Aberdeen Proving Ground, MD 21010 (S1111).

Burrows, D. et al. 1973. "Mammalian Toxicology and Toxicity to Aquatic Organisms of White Phosphorus and "Phossy Water", a Waterborne Munitions Manufacturing Waste Pollutant - A Literature Evaluation." Prepared for: U.S. Army Medical Research and Development Command. Associated Water and Air Resources Engineers Inc (S1112).

Hilado, C.J., and M.T. Lopez. 1977. "Relative toxicity of pyrolysis products of some elastomers." J. Combustion Toxicol 4(1):61-68 (S1116).

Burrows, D. et al. 1975. "Toxicity to Aquatic Organisms and Chemistry of Nine Selected Waterborne Pollutants from Munitions Manufacture - A Literature Evaluation." Technical Report TR-7503, AD-A010660. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1118).

Leung, K.J., and H.K. MacFarland. 1983. "Hazards from thermodecomposition of epoxy resins." Arch. Environ. Health. 7:675-681 (S1127).

Ghoshal, A.K., E.A. Porca, and W.S. Hartroft. 1971. "Isotopic studies on the absorption and tissue distribution of white phosphorus in rats." Exp. Mol. Pathol. 14(2):212-219 (S1139).

Jongen, W.M.F., G.M. Alink, and J.H. Koeman. 1978. "Mutagenic effect of dichloromethane on *Salmonella typhimurium*." Mutat. Res. 56:245-248 (S1140).

Peri, P., E. Gravela, and C. Mezzarino. 1972. "On the mechanism of fatty liver in white phosphorus poisoned rats." Exptl. Mol. Pathol. 16:201-209 (S1141).

Edswald, J.P. 1977. "Phosphorus in aquatic systems: The role of the sediments." In I.H. Suffet, ed. Fate of Pollutants in the Air and Water Environment, Part 1. pp. 183-214. John Wiley & Sons, New York, NY (S1144).

Buchanan, D.J., M.V. Sigal Jr., C.S. Robinson, K. Pope, J.E. Ferguson, and J.B. Thomison. 1954. "Studies of phosphorus intoxication. I. Changes in blood, urine, and tissues of dogs poisoned with phosphorus." Arch. Ind. Hyg. Occup. Med. 1(9):1-8 (S1150).

Barker, E.A., E.A. Snuckler, and E.P. Benditt. 1963. "Effects of thioacetamide and yellow phosphorus poisoning on protein synthesis in vivo." Lab. Invest., 12:955-960 (S1152).

Diaz-Rivera, R.S., P.H. Collazo, E.R. Pons, and M.V. Lorregrosa. 1950. "Acute phosphorus poisoning in man. A study of 56 cases." Medicine 29:269-298 (S1153).

Talley, R.C., J.W. Linhart, A.J. Trevino, L. Moore, and J.M. Beller. 1972. "Acute elemental phosphorus poisoning in man: Cardiovascular toxicity." Amer. Heart J., 84:139-140 (S1154).

Fleming, R.B. L., J.W. Miller, and V.R. Swayne Jr. 1942. "Some recent observations on phosphorus toxicology." J. Ind. Hyg. Toxicol. 24:154-158 (S1155).

Ryczak, R.S., and R.D. Miller. 1979. "A Review of Phosphorus Removal Technology." Technical Report 7706, AD A040802. U.S. Army Medical Bioengineering Research & Development Laboratory, Fort Detrick, MD 217C1 (S1156).

Heimann, H. 1946. "Chronic phosphorus poisoning." J. Ind. Hyg. Toxicol. 24(4):142-150 (S1158).

Fowler, B.W., and T.B. Owens. 1979. "A Parametric Model for the Effect of White Phosphorus Smoke on Target Detection. I. Model Development." Technical Report O-82-2, AD-A083787. U.S. Army Missile Command, Redstone Arsenal, AL (S1163).

Pinnick, R.G., and S.G. Jennings. 1980. "Relationship Between Radiative Properties and Mass Content of Phosphoric Acid, HC, Petroleum Oil, Sulfuric Acid Military Smokes." Technical Report ASL-TR-0052, AD-A084941. U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM (S1165).

Spangford, R.J., R.T. Podoll, R.T. Rewick, T.S. Chou, R.B. Wilson, J. Backovsky, and D.L. Roberts. 1983. "Environmental Fate of WP/F and RP/BR Military Screening Smokes. Phase I. Literature Review. Final Report (DRAFT)." Phase I. Final Report. SRI international, Menlo Park, CA. DAMD17-83-C-2320 (S1166).

Rubel, G.O. 1978. "Predicting the Droplet Size and Yield Factors of a Phosphorus Smoke as a Function of Droplet Composition and Ambient Relative Humidity under Tactical Conditions." Report ARCSL-TR-78057, AD-A064076. Chemical Systems Laboratory, Aberdeen Proving Ground, MD (S1167).

Sullivan Jr., J.H., H.D. Putnam, M. A. Keirn, B.C. Pruitt, Jr. and J.C. Nichols. 04/7. "A Summary and Evaluation of Aquatic Environmental Data in Relation to Establishing Water Quality Criteria for Munition-Unique Compounds. Part 3. White Phosphorus." Final Report, AD-A083625. Water and Air Research Inc., P.O. Box 1121, Gainesville, FL 32601. DAMD-17-77-C-7027 (S1168).

Lai, M. and D. Rosenblatt. 1977. "Identification of Transformation Products of White Phosphorus in Water." Report NSWC/WOL/TR-76-103, AD-A041068. U.S. Army Medical Research and Development Command, Fort Detrick, MD. DAMD17-77-C-7027 (S1169).

Lee, Cheng-Chun; J.V. Dilley, J. R. Hodgson, D.G. Helton, W.J. Wiegand, D.C. Roberts, B.C. Anderson, L.M. Halfpap, and L.D. Kurtz. 1975. "Mammalian Toxicity of Munition Compounds. Phase I. Acute Oral Toxicity, Primary Skin and Eye Irritation, Dermal Sensitization, and Disposition and Metabolism." Formal Report 1, Project MRI 390Q-B, AD-B011150. Midwest Research Institute, 425 Volker Blvd., Kansas City, MO 64110. DAMD-17-74-C-4073 (S1171).

Kennedy, B.W. 1981. "Battlefield Induced Contamination Test. Project Summary." Internal Report. U.S. Army Electronics Research and Development Command, Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88002 (S1174).

Ratney, R.S., D.H. Wegman, and H.B. Elkins. 1974. "In vivo conversion of methylene chloride to carbon monoxide." Arch. Environ. Health. 18:223-26 (S1185).

D'Amico, W.P., W.H. Clay, and A. Mark. 1979. "Diagnostic Tests for Wick-Type Payloads and High Viscosity Liquids. Final Report." Final Report ARBRL-MR-02913, AD-E430270, AD-A072812/1. U.S. Army Armament Research and Development Command, Ballistics Research Lab, Aberdeen Proving Ground, MD (S1186).

Van Wazer, J.R. 1961. Phosphorus and Its Compounds, Vol. II. Technology, Biological Functions and Applications. Interservice Publishers Inc., New York, NY (S1200).

U.S. Army Test and Evaluation Command. 1978. "Basic Smoke Characterization Test." Report DPG-FR-77-311, AD-B031190L. U.S. Army Dugway Proving Ground, Dugway, UT (S1203).

Dumbauld, R.K., S.F. Saterlie, and C.S. Cheney. 1982. "Analysis of Multiple Source Obscurants on the Realistic Battlefield (AMSORB). Vol. I. Mathematical Models and Computer Program Description." AD-A117663/5. Cramer (H.E.) Co. Inc., Salt Lake City, UT (S1205).

Johnson, W.W, and H.O. Sanders. 1977. "Chemical Forest Fire Retardants: Acute Toxicity to Five Freshwater Fishes and Scud." Technical Paper 91. U.S. Fish Wildlife Service, Columbia, MO 65201 (S1213).

Committee on the Atmosphere and the Biosphere. 1981. Atmosphere-Biosphere Interactions: Toward a Better Understanding of the Ecological Consequences of Fossil Fuel Combustion. National Academy Press, Washington, DC. (S1218).

#### Bibliography of General References

U.S. Dept of the Army, U.S. Chemical School. 1984. Commander's Manual. Series FM 3-54 C/CN, LCCN gp 80002235. U.S. Government Printing Office, Washington, DC (S1001).

Krone, U. 1981. "Preparation and manufacture of a new batch of pyrotechnical screening smokes: NT screening smoke." Journal Article Int. Jahrestag. - Fraunhofer-Inst. Treib-Explosivst. (Chem. Mech. Technol.). Nico-Pyrotechnik Hanns-Juergen Diederichs K.-G., Trittau, Fed. Rep. Ger. 211-33pp. (in German) (S1018).

Martonen, T. 1983. "Deposition of inhaled particulate matter in the upper respiratory tract, larynx, and bronchial airways: a mathematical description." J. Toxicol. and Environ. Health. 12:787-800 (S1023).

Farmer, W.M. 1981. "The instrument cluster concept in obscurant field testing." Proc. of the Smoke/Obscurants Symp. V, Harry Diamond Laboratories, Adelphi, MD 20783. 1:127-145 (S1024).

Smalley, H.M. 1983. "Dugway Proving Ground smoke and obscurant field measurement technology." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:39-44 (S1025).

Handel, G. 1976. "The properties of atmospheric aerosol particles as functions of relative humidity at thermodynamic equilibrium with the surrounding moist air." Adv. in Geophys., 19:73-188 (S1029).

Hunt, L., C. Lee, R. Sumner, and D. Trapp. 1982. "The Employment of Smoke for Signature Reduction and Site Obscuration for Improving TNF Survivability and Security (U)." Report DNA-TR-81-141. SAI, P.O.Box 2351, La Jolla, CA 92038. DNA-001-81-C-0255 (S1039).

- Farmer, W.M. 1982. "Relationships between battlefield obscurant parameters measured over large and small distance scales." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:53-60 (S1045).
- Farmer, W.M., F.A. Schwartz, R.D. Morris, J.O. Hornkohl, and M.A. Binkley. 1981. "Field characterization of phosphorus smokes using spectral transmittance and real-time concentration measurements." Proc. of the Soc. of Photo-Optical Instr. Eng. 277:48-57 (S1046).
- Krist, K.L., and W.M. Farmer. 1981. "Measurement of battlefield obscurant parameters with the point characterization instrumentation system." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:45-52 (S1047).
- Nelson, J.G. 1981. "Applications overview of battlefield obscurant parameters measured in U.S. Army tests." Proc. of the Soc. of Photo-Optical Instr. Eng. 356:34-38 (S1048).
- Shirkey, R.C. 1981. "Effect of atmospheric and man-made obscurants on visual contrast." Proc. of the Soc. of Photo-Optical Instr. Eng. 305:37-44 (S1049).
- Dvornik, D.S., and R. Vaglio-Laurin. 1982. "Atmospheric diffusion of small instantaneous point releases near the ground." Atmos. Environ. 16(12):2791-2798 (S1053).
- Elkins, R.E., and R.H. Kohl. 1981. "Proceedings of the Smoke/Obscurants Symposium V, held at Harry Diamond Laboratories, Adelphi, MD, April 28-30, 1981. Vol. 1." Report DRCPM-SMK-T-001-81-VOL-1, AD-A104760 (see also Vol 2, AD-A104761). Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1056).
- Durica, A. 1976. "Pyrotechnics." Translation of Tehnologija Eksplozivnih Materija (Yugoslavia). AD-B014883L. 8:325-326 (1972). Army Foreign Science and Technology Center, Charlottesville, VA (S1062).
- Stoyanov, L., E. Stoichkova, and G. Suykov. 1976. "Smoke Camouflage: Present and Future." Translation of Voenna Tekhnika (Bulgaria), Report AST-16201-001-76, FSTC-0024-76, AD-B015571L. 2:12-13 (1975). Army Foreign Science and Technology Center, Charlottesville, VA (S1064).
- Hardy, C.R., A. Jarvis, and G.E. Pike. 1976. "The Development of a Screening Smoke Composition. Part 2. Thermal Analysis." Report CDE-TP-206, AD-B019770L. Chemical Defense Establishment Porton Down (England) (S1065).
- Norsey, H.R., N. Hotter, and H.J. Bielecki. 1977. "Abstracts of Chemical Systems Laboratory Technical Publications 1 July - 30 September 1977." Report ARCSL-SP-77012, AD-C012418L. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1072).
- Giglio, D.A., and J. Steedman. 1977. "Proceedings of the 1977 Smoke Symposium Held at Harry Diamond Laboratories on 25-26 January 1977." AD-C015516. Office of the Project Manager Smoke/Obscurants, Aberdeen Proving Ground, MD (S1073).

Barr, W.A. 1982. "Chemical Systems Laboratory Information Exchange Meetings, 30 September and 9 November, 1982." Report ARCSL-SP-83008, AD-C030723. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD (S1077).

Fry Jr., R.R. 1977. "Method for Preparing a Smoke Agent (Patent)." Report PAT-APPL-843 390, PATENT-4 151 233, AD-D006361/0. Department of the Army, Washington, DC (S1091).

Pennsyle, R.O. 1979. "Methodology for Estimating Smoke/Obscurant Munition Expenditure Requirements. Technical Report. May-Dec 1978." Report ARCSL-TR-79022, AD-A069157. Army Armament Research and Development Command, Chemical Systems Lab. Aberdeen Proving Ground, MD (S1093).

McIntyre, F.L. 1975. "Explosive Classification Testing for Pyrotechnic Bulk Composition and End Items. Technical Report. 24 September 1973-June 74." Report EA-4D51, EM-CR-74054, AD-B004013/9. General Electric Co., Engineering and Science Services Lab, Bay Saint Louis, MS (S1095).

Needels, G.J. 1977. "The Simulation of Tactical Smoke on the Modern Battlefield. Final Report." Master's thesis, AD-A043839/0. Army Command and General Staff Coll., Fort Leavenworth, KS (S1097).

Shidlovsky, A.A. 1965. "Fundamentals of Pyrotechnics. Technical Memo." Report PA-TM-1615, AD-462474. Feltman Research Labs. Picatinny Arsenal, Dover, NJ (S1099).

Lewis, J.W. 1965. "Human Factors Evaluation of the E24 CS Munition. Technical Memo." Report CRDL-TM-2-34, AD-474350/6. Chemical Research and Development Labs, Edgewood Arsenal, MD (S1101).

Kohl, R.H. 1980. "Proceedings of the 1979 Chemical System Laboratory Scientific Conference on Obscuration and Aerosol Research. Contract Report." Report No.: ARCSL-CR-81023; AD-A113733/0. Kohl (Ronald H.) and Associates, Tullahoma, TN (S1105).

Turner, R.E., P.G. Eitner, C.D. Leonard, and D.G.S. Snyder. 1980. "Battlefield Environment Obscuration Handbook. Vol. I. Final Report. December 1971-December 1980." Report No.: SAI-20-009-AA-VOL-1; AD-A102822/4. Science Applications, Inc., Ann Arbor, MI (S1106).

Zirkind, R. 1979. "A Battlefield Obscuration Model (Smoke & Dust). Final Report. July 1977 - October 1979." AD-A080459/1. General Research Corp., McLean, VA. Operations Analysis Group (S1107).

U.S. Department of the Army. 1983. "Obscuring smoke munition." Army Research, Development, & Acquisition, August, 1983, Vol. 24, Issue 4, p.26 (S1108).

Bulger, J.P. 1982. "Obscurants: countermeasures to modern weapons." Military Review, 62(5):45-53 (S1109).

U.S. Department of the Army. 1982. "Smoke and Obscurants Program. 'Keep on Smokin'." Army Research, Development, & Acquisition, 23(3):1-3 (S1110).

Cooper, A.E., and E.J. Owens. . "A Review of the Toxicology of Screening Smokes." Private document provided by U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1114).

Rosenblatt, D.H., and W.R. Hartley. 1984. "The Preliminary Pollutant Limit Value Concept." Private document provided by U.S. Army Medical Bioengineering Research and Development Laboratory, Health Effects Research Division, Fort Detrick, MD (S1119).

Rosenblatt, D.H., J.C. Dacre, and D.R. Cogley. 1982. "An environmental fate model leading to preliminary pollutant limit value for human health effects." In R.A. Conway, ed. Environmental Risk Analysis for Chemicals. pp. 474-505. Van Nostrand Reinhold, New York, NY (S1120).

Rosenblatt, D.H. 1981. "Environmental Risk Assessment for Four Munitions-Related Contaminants at Savanna Army Depot Activity." Technical Report 8110, AD-A116650. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1121).

Rosenblatt, D.H., and M.J. Small. 1981. "Preliminary Pollutant Limit Values for Alabama Army Ammunition Plant." Technical Report 8105, AD-A104203. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1122).

Rosenblatt, D.H., and R.J. Kainz. 1982. "Options and Recommendations for a Polybromobiphenyl Control Strategy at the Gratiot County, Michigan Landfill." Technical Report 8204, AD-A121243. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1123).

American Conference of Governmental and Industrial Hygienists (ACGIH). 1976. "TLV's Threshold Limit Values for Chemical Substances in Workroom Air." In N.I. Sax. Dangerous Properties of Industrial Materials, 4th Edition. Van Nostrand Reinhold, New York, NY (S1124).

Christensen, H.E., T.T. Luginbyhl, and B.S. Carroll, eds. 1980. Registry of Toxic Effects of Chemical Substances. U.S. Dept of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health (S1125).

Sax, N.I. 1975. Dangerous Properties of Industrial Materials, 4th Edition. Van Nostrand Reinhold Co., New York, NY (S1126).

Brown, H.S., C.A. Rowan, and D.R. Bishop. 1984. "Development of an air toxics program in Massachusetts." Proc. of the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA, June 24-29, 1984. 84(7.3):2-28 (S1128).

Patrick, D.R. 1984. "EPA's process of assessing and managing risks posed by exposure to toxic air pollutants." Proc. of the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA June 24-29, 1984. 84(103.2):2-7 (S1129).

Fossa, A.K., M.M. Riano, P.J. Lavin, and D.R. Vollmre. 1984. "New York State techniques and experience in regulation toxic air contaminants." Proc. of the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA, June 24-29, 1984. 84(6.2):2-16 (S1130).

Ohmstede, W.D., and E.B. Stenmark. 1979. "A model for characterizing transport and diffusion of air pollution in the battlefield environment." AD-A128458. Proc. of the Joint Conference on Applications of Air Pollution Meteorology (2nd), 24-29 Mar 80, New Orleans, LA. American Meteorological Society, Boston, MA. pp. 416-423 (S1131).

Pennsyle, R.O., and R. Winkler. 1982. "Computer Program For Smoke/Obscurant Hazard Prediction (HAZRD2)." U.S. Army Armament Research and Development Command, Chemical Systems Lab, Aberdeen Proving Ground, MD. DAAK11-80-C-0091 (S1133).

Shoshkes, M., W.G. Banfield Jr., S.J. Rosenbaum, and A.J. Fisk. 1950. "Distribution, effect and fate of oil aerosol particles retained in the lungs of mice." Arch. Ind. Hyg. Occup. Med. 1:20-35 (S1143).

Fitzgerald, J.W. 1975. "Approximation formulas for the equilibrium size of an aerosol particle as a function of its dry size and composition and the ambient relative humidity." J. Appl. Meteorol. 14:1044-1049 (S1145).

Patterson, E.M., and D.A. Gillette. 1977. "Commonalities in measured size distributions for aerosols having a soil-derived component." J. Geophys. Res. 82:2074-2082 (S1147).

Giddings, J.C., G. Karaiskakis, K.D. Caldwell, and M.N. Myers. 1983. "Colloid characterization by sedimentation field-flow fractionation. I. Monodisperse populations." J. Colloid and Interface Sci. 92(1):66-88 (S1148).

Yang F-S, K.D. Caldwell, and J.C. Giddings. 1983. "Colloid characterization by sedimentation field-flow fractionation. II. Particle-size distribution." J. Colloid and Interface Sci. 92(1):81-91 (S1149).

Lindauer, G.C., and A.W. Castleman Jr. 1971. "Initial size distributions of aerosols." Nucl. Sci. and Eng. 43:212-217 (S1151).

Chan, T.L., and M. Lippmann. 1980. "Experimental measurements and empirical modeling of the regional deposition of inhaled particles in humans." Am. Ind. Hyg. Assoc. 41:399-409 (S1157).

Cogley, D.R., L.E. Craker, C.D. Torgeson, and D.L. Sirois. 1979. "Biological Testing of Rocky Mountain Arsenal for Phytotoxic Substances. Final Report." AD A076565. Walden Division of Abcor, Inc., Wilmington, MA (S1159).

Craker, L.J., and J.C. Dacre. 1975. "Munitions-Related Substances of Potential Concern as Airborne Pollutants: A Phytotoxicological Evaluation." Final Technical Report 7511, AD A052168. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD (S1160).

Howley, G.G. 1983. The Condensed Chemical Dictionary, 10th ed. Van Nostrand Reinhold Co., New York, NY (S1161).

Verschuren, K. 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co., New York, NY (S1162).

Finnick, R.G., and S.G. Jennings. 1980. "Relationship Between Radiative Properties and Mass Content of Phosphoric Acid, HC, Petroleum Oil, Sulfuric Acid Military Smokes." Technical Report ASL-TR-0052, AD-A084941. U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM (S1165).

Windholz, M., S. Budavari, R.F. Blumetti, and E.S. Otterbein, eds. 1983. The Merck Index, 10th Edition. Merck & Co. Inc., Rahway, NJ (S1170).

National Institutes of Health; Environmental Protection Agency. 1984. "Chemical Information System. On-Line Search." NIH-EPA/Chemical Information System, CIS, Inc.--Fein Marquait Associates, 7215 York Road, Baltimore, MD 21209 (S1172).

Elkins, R.E., and R.H. Kohl - Editors. 1982. "Proceedings of the Smoke Obscurants Symposium VI, Held at HDL, 27-29 April, 1982. Vols. I, II (Unclassified Sections). Sponsored by FM Smoke/Obscurants." Technical Report DRCPM-SMK-T-001-82. Proc. of the Smoke/Obscurants Symp. VI, Harry Diamond Laboratories, Adelphi, MD, April 27-29, 1982. Unclassified sections (S1173).

Kennedy, B.W. 1981. "Battlefield Induced Contamination Test. Project Summary." Internal Report. U.S. Army Electronics Research and Development Command, Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88002 (S1174).

Committee on Toxicology, National Research Council. 1979. "Criteria for Short-Term Exposures to Air Pollutants." Report NAS/ACT/P-885, AD A087853. National Research Council, 2101 Constitution Avenue, N.W., Washington, DC 29418. N00014-79-C-0049 (S1175).

Valey, P.S. 1984. "Military marches toward new horizons in pollution control." Pollut. Eng. February 1984:31-42 (S1176).

Holst, G.C. 1984. "NATO smoke trials in France and Norway." Army Res., Dev. and Acquisition Magazine. September-October 1983:24-25 (S1177).

Blackman, G.R. 1983. "Cloud Geometry Analysis of the Smoke Week VA Obscurant Trials." Final Report ASL-DR-83-0009. U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88002 (S1178).

Whitacre, C.G., P.E. Robinson, W.L. Kneas, and A.L. Freeman. 1977. "Computer Program For Chemical Hazard Prediction." Report ARCSL-TR-77049. Chemical Systems Laboratory, Attn: DRDAR-CLY-A, Aberdeen Proving Ground, MD 21010 (S1179).

Gomez, R., and M.H. Van Atta. 1984. "Corps of Engineers airland battlefield environment thrust." Army Res., Dev. and Acquisition Magazine. May-June 1984:17-19 (S1180).

Shinn, J.H. 1979. "Problems in the assessment of air pollution effects on vegetation." In J.R. Pfafflin and E.N. Ziegler, eds. Advances in Environmental Science and Engineering, Vol. 2. pp. 88-105. Gordon and Breach Publishers, New York, NY (S1182).

Rosenblatt, D.H. 1984. "Guest editorial: The name of the game." Environ. Sci. and Technol. 18(2):39A (S1183).

U.S. Army Atmospheric Sciences Laboratory and The U.S. Army Project Manager-Smoke Obscurants. 1983. "Atmospheric aerosol and optics data library." Atmos. Aerosol and Optics Data Library Bulletin. 1(2):9-16 (S1184).

Sax, N.I. 1984. Dangerous Properties of Industrial Materials, 6th Edition. Van Nostrand Reinhold Co. New York, NY (S1187).

Windholz, M., S. Budavari, L.Y. Stroumstos, and M.N. Fertig, eds. 1976. The Merck Index, 9th Edition. Merck & Co. Inc., Rahway, NJ. (S1188).

Hanna, S.R., G.A. Briggs, and R.P. Hosker, Jr. 1982. "Handbook on Atmospheric Diffusion." Technical Information Center, U.S. Department of Energy. Atmospheric Turbulence and Diffusion Laboratory, National Oceanic and Atmospheric Administration (S1189).

Conway, P.E., ed. 1982. Environmental Risk Analysis for Chemicals. Van Nostrand Reinhold Co., New York, NY (S1190).

Brakhnova, I.T. 1975. Environmental Hazards of Metals. Consultants Bureau, New York, NY (S1191).

Newell, R.S., and J.T. Brown. 1976. "Analysis of Large-Area Screening Systems. Vol. 1. Executive Summary." Executive Summary, AD-B07342. Battelle Columbus Laboratories, 505 King Avenue, Columbus, OH 43201. DAAA15-77-C-0030 (S1192).

Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt. 1982. Handbook of Chemical Property Estimation Methods, Environmental Behavior of Organic Compounds. McGraw-Hill Book Company, New York, NY (S1193).

Kennedy, G.L., and H.J. Trochimowicz. 1982. "Inhalation toxicology." In A. Wallace Hayes, ed. Principles and Methods of Toxicology. pp. 185-207. Raven Press, New York, NY (S1195).

Sax, N.I. 1979. Dangerous Properties of Industrial Materials, 5th Edition. Van Nostrand Reinhold Co., New York, NY (S1196).

Laskowski, D.A., C.A.I. Goring, P.H. McCall, and R.L. Swann. 1982. "Terrestrial environment." In R.A. Conway, ed. Environmental Risk Analysis for Chemicals. Chapter 6. Van Nostrand Reinhold Co., New York, NY (S1197).

Lewis Sr., Richard J., and R.L. Tatken, eds. 1982. Registry of Toxic Effects of Chemical Substances, 1980 Edition. Vols. 1 and 2. U.S. Dept of Health, and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health (S1199).

Hodgman, M.S., R.C. Weast, and S.M. Selby, eds. 1959. Handbook of Chemistry and Physics, 41st Edition. Chemical Rubber Publishing Co., 2310 Superior Ave. N.E., Cleveland, OH (S1201).

Cohn, S.L. 1981. "Transport and Diffusion Solutions for Obscuration Using the XM-825 Smoke Munition." Report ERADCOM/ASL-TR-0100, AD-A109739/3. U.S. Army Electronics Research and Development Command, Atmospheric Sciences Lab, White Sands Missile Range, NM (S1202).

Campbell, D. 1960. "Expenditure Requirements for the Attack of Specified Target with Pot, Smoke, Floating, an-M7 Gb Filled." AD-316606/3. Chemical Warfare Labs., Army Chemical Center, MD (S1204).

Rinehart, W.E., and T. Hatch. 1964. "Concentration product (CT) as an expression of dose in sublethal exposures to phosgene." Am. Ind. Hyg. Assoc. J. 25:524-553 (S1209).

Randerson, D., ed. 1984. "Atmospheric Science and Power Production." DES4005177 (DOE/TIC-27601), National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161 (S1217).

Committee on the Atmosphere and the Biosphere. 1981. Atmosphere-Biosphere Interactions: Toward a Better Understanding of the Ecological Consequences of Fossil Fuel Combustion. National Academy Press, Washington, DC (S1218).

Hansch, C., and A.J. Leo. 1979. Substituent Constants for Correlation Analysis in Chemistry and Biology. John Wiley & Sons, New York, NY (S1220).

Grasselli, J.G., and W.M. Ritchey, eds. 1975. Atlas of Spectral Data and Physical Constants for Organic Compounds, 2nd Edition, Vols. I-VI. CRC Press, Inc., 18901 Cranwood Parkway, Cleveland, OH 44128 (S1221).

Karickhoff, S.W., and D.S. Brown. 1979. "Determination of Octanol/Water Distribution Coefficients, Water Solubilities, and Sediment/Water Partition Coefficients for Hydrophobic Organic Pollutants." Report EPA-600/4-79-032. U.S. Environmental Protection Agency, Athens, GA (S1222).

## GUIDE TO DATA BASE

### INTRODUCTION

Early in the data acquisition phase of this project, it became clear that an automated method for the storage and retrieval of information was needed. This need was filled with the purchase of an IBM personal computer equipped with an external 20 megabyte hard disk drive and various software packages. The software included: Lotus 123, Lotus Development Corporation, 161 First Street, Cambridge, MA 02142; IBM Personal Editor, International Business Machines Corporation; Microsoft Word, Microsoft Corporation; KnowledgeMan: The Knowledge Manager, Micro Data Base Systems, Inc., P.O. Box 248, Lafayette IN 47902.

Most of the collected data was entered and stored in tables created under KnowledgeMan. This data base manager allows Boolean searches of all types of data in all KnowledgeMan files. Microsoft Word and IBM Personal Editor were used in many word processing applications and Lotus 123 was used whenever a spreadsheet was required. The following Data Base Description Table is provided for the convenience of those interested in obtaining and using our Smokes and Obscurant Data Base.

### DATA BASE DESCRIPTIONS

Nine major tables were created under KnowledgeMan to fill specific needs. The names of these tables are listed in the Base Description Table along with their structure and purpose. They are available from LLNL on 5.25 inch DSDD diskettes in IBM Dos 2.0 format as either ASCII text files or as KnowledgeMan files. These files are also available on Sysgen Image cassette tape, Sysgen Incorporated, 47853 Warm Springs Blvd., Fremont, California 94539, or on Q-PAK 5.5 megabyte hard disk removable media, SyQuest Technology, 47923 Warm Springs Blvd., Fremont, CA 94538.

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Commander U.S. Army Medical Bioengineering Research and Development Laboratory ATTN: SGRD-UBD-A/Librarian Fort Detrick Frederick, MD 21701-5010	1
Commander U.S. Army Material Command ATTN: AMCEN-A 5011 Eisenhower Avenue Alexandria, VA 22333	1