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**OAK RIDGE  
NATIONAL  
LABORATORY**

**Expedient Emergency  
Sanitation Measures**

**MARTIN MARIETTA**

I. Gutmanis  
C. V. Chester

Interagency Agreement DOE 1457-1457-A1  
and FEMA EMW-84-E-1737, Work Unit 3441D

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MARTIN MARIETTA ENERGY SYSTEMS, INC.  
FOR THE UNITED STATES  
DEPARTMENT OF ENERGY

089 4 25 131

Printed in the United States of America. Available from  
National Technical Information Service  
U.S. Department of Commerce  
5285 Port Royal Road, Springfield, Virginia 22161  
NTIS price codes—Printed Copy: A05 Microfiche A01

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**EXPEDIENT EMERGENCY SANITATION MEASURES**

**FINAL REPORT**

**I. Gutmanis\***  
**C. V. Chester**

**March 1989**

**Report Prepared by**  
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**1250 24th Street, SW**  
**Washington, DC 20037**  
**under**  
**Subcontract No. 41X56553V**

**Date Published - April 1989**

**Research sponsored by the**  
**Federal Emergency Management Agency**

**Prepared for the**  
**ENERGY DIVISION**  
**OAK RIDGE NATIONAL LABORATORY**  
**Oak Ridge, Tennessee 37831-6285**  
**operated by**  
**MARTIN MARIETTA ENERGY SYSTEMS, INC.**  
**for the**  
**U.S. DEPARTMENT OF ENERGY**  
**under**  
**Contract No. DE-AC05-84OR21400**

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS None	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION / AVAILABILITY OF REPORT Unlimited	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A		4. PERFORMING ORGANIZATION REPORT NUMBER(S) ORNL/Sub/87-56553/1	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) ORNL/Sub/87-56553/1		5. MONITORING ORGANIZATION REPORT NUMBER(S) N/A	
6a. NAME OF PERFORMING ORGANIZATION Oak Ridge National Laboratory	6b. OFFICE SYMBOL (if applicable)	7a. NAME OF MONITORING ORGANIZATION Federal Emergency Management Agency	
6c. ADDRESS (City, State, and ZIP Code) POB 2008 Oak Ridge, TN 37831-6190		7b. ADDRESS (City, State, and ZIP Code) 500 C St., SW Washington, DC 20472	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION FEMA	8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER FEMA Interagency Agreement No. EMW-84-E-1737 Mod 4	
8c. ADDRESS (City, State, and ZIP Code) 500 C Street, SW Washington, DC 20472		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO.	PROJECT NO. 10
		TASK NO.	WORK UNIT ACCESSION NO. 3441D
11. TITLE (Include Security Classification) Expedient Emergency Sanitation Measures			
12. PERSONAL AUTHOR(S) I. Gutmanis, C. V. Chester			
13a. TYPE OF REPORT Final	13b. TIME COVERED FROM 10/86 TO 10/88	14. DATE OF REPORT (Year, Month, Day) March 1989	15. PAGE COUNT app. 90
16. SUPPLEMENTARY NOTATION None			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	
15	02	Civil Defense, Sanitation	
06	00		
19. ABSTRACT (Continue on reverse if necessary and identify by block number)			
<p>This guide is designed as an annotated checklist to aid local officials who are responsible for maintaining or restoring adequate sanitation in a widespread emergency. In the event of a major earthquake or nuclear attack, sewage collection and treatment systems, electric power and water treatment and distribution systems may be damaged or destroyed. Loss of sanitary sewage systems and water treatment capability sharply increases risk of the spread of disease among the survivors.</p> <p>The guide includes details of expedient methods of water disinfection, septic waste disposal, and disease vector control. Information on obtaining and using chemicals for these purposes is included. (FR)</p>			
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL		22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL

## CONTENTS

ACTIONS TO BE TAKEN TO ENSURE COMMUNITY HEALTH AND SANITATION IMMEDIATELY FOLLOWING A MAJOR NATIONAL EMERGENCY . . . . .	v
ABSTRACT . . . . .	vii
1. POSTEMERGENCY WATER SUPPLY MANAGEMENT . . . . .	1
1.1 ESTIMATION OF EMERGENCY WATER ALLOWANCES . . . . .	1
1.2 DETERMINATION OF WATER SUPPLY SOURCE(S) . . . . .	2
1.2.1 Precipitation . . . . .	3
1.2.2 Surface Water . . . . .	4
1.2.3 Ground Water . . . . .	5
1.3 DISINFECTION/TREATMENT OF WATER . . . . .	5
1.3.1 Filtration and Settling . . . . .	6
1.3.1.1 Ultrafiltration . . . . .	6
1.3.1.2 Earth filtration . . . . .	6
1.3.1.3 Settling . . . . .	9
1.3.2 Boiling . . . . .	10
1.3.3 Disinfection by Chemical Additives . . . . .	10
1.3.3.1 Chlorine . . . . .	10
1.3.3.1.1 Use of chlorine as a water disinfectant . . . . .	11
1.3.3.1.2 Use of chlorine in an emergency. . . . .	12
1.3.3.2 Sodium hypochlorite . . . . .	15
1.3.3.3 Calcium hypochlorite . . . . .	16
1.3.3.3.1 Use of calcium hypochlorite as a water disinfectant. . . . .	17
1.3.3.4 Iodine . . . . .	17
1.3.3.4.1 Use of iodine compounds as water disinfectants. . . . .	18
1.3.3.5 Bromine/bromine chloride . . . . .	18
1.3.3.5.1 Use of bromine and bromine compounds as water disinfectants	18
1.4 EMERGENCY TRANSPORT OF WATER FOR HOUSEHOLDS . . . . .	20
2. EMERGENCY BURIAL OF HUMAN REMAINS . . . . .	23
3. EMERGENCY WASTE DISPOSAL . . . . .	25
3.1 PONDS . . . . .	27
3.2 LAGOONS . . . . .	28
3.3 SANITARY LANDFILL . . . . .	29
3.4 TEMPORARY LATRINES . . . . .	29
3.5 TEMPORARY KITCHEN AND RELATED WASTE DISPOSAL SITES . . . . .	32
3.6 SOAKAGE PITS . . . . .	32
3.7 GREASE TRAPS . . . . .	32
3.8 USE OF SANITARY CHEMICALS IN WASTE DISPOSAL . . . . .	34

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A-1	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>



CONTENTS (contd)

	<u>Page</u>
4. PEST CONTROL . . . . .	35
4.1 EMERGENCY SANITATION MEASURES FOR RODENT CONTROL . . . . .	36
4.2 EMERGENCY SANITATION MEASURES FOR FLY CONTROL . . . . .	38
4.3 EMERGENCY SANITATION MEASURES FOR MOSQUITO CONTROL . . . . .	39
4.4 EMERGENCY SANITATION MEASURES FOR LOUSE CONTROL . . . . .	40
4.5 EMERGENCY SANITATION MEASURES FOR FLEA CONTROL . . . . .	41
4.6 USE OF INSECTICIDES FOR INSECT CONTROL . . . . .	42
4.6.1 Number of Pesticides Available . . . . .	42
4.6.2 Substitutability of Pesticides . . . . .	43
4.6.3 Form of Pesticides Available . . . . .	43
4.6.4 Equipment Used in Pesticide Application . . . . .	43
4.6.5 Dosages of Pesticides . . . . .	43
4.6.6 Location of Pesticides . . . . .	44
5. PUBLIC INFORMATION ACTIVITIES . . . . .	45
Appendix A. LOCATION OF DISINFECTION CHEMICALS MANUFACTURING PLANTS . . . . .	A-1
Appendix B. TRADE NAMES OF COMMERCIAL RODENTICIDES AND INSECTICIDES . . . . .	B-1

**ACTIONS TO BE TAKEN TO ENSURE COMMUNITY HEALTH  
AND SANITATION IMMEDIATELY FOLLOWING  
A MAJOR NATIONAL EMERGENCY**

1. Assess the problem: destruction, disruption, environmental hazards
2. Determine available sources of water
3. Identify possible sources of water contamination and take immediate action where possible
4. Establish and enforce water allowances
5. Locate supplies of critical water disinfection chemicals
  - 5.1 Locate bulk chlorine supplies in community water treatment facilities, paper and textile mills, industrial establishments, etc.
  - 5.2 Locate supplies of sodium hypochlorite in retail stores in the form of detergent powder or chlorine bleach (e.g., Clorox) in community water treatment facilities, milk processing plants, commercial laundries, etc.
  - 5.3 Locate supplies of calcium hypochlorite powder in establishments servicing swimming pools and in hardware and garden stores
  - 5.4 Locate supplies of iodine in pharmacies (as iodine tablets, or crystals, tincture of iodine) and in chemical laboratories
  - 5.5 Locate bromine chloride supply in community sewage treatment and municipal water facilities, industrial facilities in the form of compounds used in water boiler and cooling water treatment, and hardware and garden stores
6. Establish, disseminate, and enforce emergency water disinfection procedures
  - 6.1 Boiling procedures
  - 6.2 Filtration procedures
  - 6.3 Chemical additives for water disinfection procedures
7. Dispose of human remains

8. Establish and enforce waste disposal procedures
  - 8.1 Construct and operate ponds, lagoons
  - 8.2 Construct temporary latrines
  - 8.3 Construct and operate sanitary land fills
9. Locate supplies of pesticides
  - 9.1 Locate pesticides to be used as rodenticides
  - 9.2 Locate pesticides to be used against non-flying insects
  - 9.3 Locate pesticides to be used against flying insects.  
(Pesticides may be found in retail establishments  
and/or agricultural supply establishments.)
10. Apply pesticides
11. Provide appropriate public health information to population



## ABSTRACT

This guide is designed as an annotated checklist to aid local officials who are responsible for maintaining or restoring adequate sanitation in a widespread emergency. In the event of a major earthquake or nuclear attack, sewage collection and treatment systems, electric power and water treatment and distribution systems may be damaged or destroyed. Loss of sanitary sewage systems and water treatment capability sharply increases risk of the spread of disease among the survivors.

The guide includes details of expedient methods of water disinfection, septic waste disposal, and disease vector control. Information on obtaining and using chemicals for these purposes is included.

## 1. POSTEMERGENCY WATER SUPPLY MANAGEMENT

The management of water supply for the population in the postemergency period is the most critical emergency sanitation activity.<sup>1</sup>

### 1.1 ESTIMATION OF EMERGENCY WATER ALLOWANCES

If the water supply systems do not function or if the supply of water is limited, specific allowances of water must be established. Such allowances must be communicated to the population and enforced.

Estimation of emergency water allowance, in units of *gallons per capita per day*, is the initial activity in postemergency water supply management for the general public.

The established minimum water allowances for the immediate postemergency period are as follows:<sup>2</sup>

Households	2 L (0.5 gal)/capita/day
Hospitals	20 L (5 gal)/capita/day
Mass Care	12 L (3 gal)/capita/day

Minimum water allowances restrict water use to medical, drinking, and food preparation purposes only; all other activities which require water are prohibited under minimum allowances.

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<sup>1</sup>See: Salmon, R.J., Environmental Health Planning for Postattack Conditions: Some Problems, Programs, and Priorities, Research Triangle Institute, 1966, AD-632865.

<sup>2</sup>Leopold, L.B. and Langbein, W.B., A Primer on Water, U.S. Department of Interior, Geological Survey (1964), AD-673125.

If the water supply systems function and water is available, less stringent water allowances may be established.

Throughout the postemergency period, the specific water allowances and any changes in these allowances must be communicated to the population.

## 1.2 DETERMINATION OF WATER SUPPLY SOURCE(S)

Two types of water sources in the postemergency period are the conventional (preemergency) sources of water and temporary emergency sources of water.

The conventional source of water in most populated areas is the community water system. These conventional sources will be used in a postemergency period if these systems function or if damages to these systems may be repaired within 12 to 24 h.<sup>3</sup>

The sequence of activities to determine the use of a community water system as a source of emergency water supply in the postemergency period is as follows:

1. Determine the damage to the community water system (i.e., to the pipeline network and the pumping stations).

---

<sup>3</sup>A detailed discussion of this subject can be found in

A Prototype Manual on Civil Defense Aspects of Waterworks Operations, Prepared for OCD Contract No. OCD-OS-62-106. Arcadia, CA: Engineering Science, Inc., August 1964, AD-642118, and

Recovery and Restoration: Metropolitan Water Works Following Nuclear War Attack, Engineering Science, Inc., 1963, AD-405713.

2. Determine the damage to the community water treatment facilities (e.g., electrical supply, pumps, settling ponds and chlorination tanks).
3. Undamaged portions of the system should be used to treat and deliver water. Generators may be used to supplant inactive electric power sources. If treatment facilities are damaged, water should be disinfected manually at the community or household level.
4. If sufficient quantities of water cannot be supplied via the community water system, other temporary emergency sources must be found.
5. Work should begin as soon as possible to restore water disinfection treatment facilities.

In the event the community water system does not function and cannot be restored in 12 to 24 h, a temporary emergency source of water must be found,<sup>4</sup> such as (1) water collected from precipitation; (2) surface waters (lakes, rivers, ponds, canals); and (3) groundwater.

#### 1.2.1 Precipitation

Precipitation (as rain or snow) represents a preferable source of emergency water because of its limited biological contamination. However, this source of emergency water may be limited in quantity and duration, and collection of rain or snow water for large populations may be difficult. After nuclear attack, precipitation is likely to be contaminated with radioactivity for many days, and water filtration to remove radioactivity must be undertaken.

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<sup>4</sup>See: Hawkins, M.B., Procedures for the Assessment and Control of the Shorter Term Hazards of Nuclear Warfare Fallout in Water Supply Systems, Institute of Engineering Research, Civil Defense Research Project, University of California, Berkely, March 1, 1961, AD-414985.

### 1.2.2 Surface Water

Surface water sources include lakes, rivers, streams, ponds, and canals. These sources may be contaminated and should not be assumed to be potable. Therefore, appropriate disinfection and decontamination measures should be employed either at the household or community level in accordance with the procedures presented in Sect. 1.3.

Water from the surface water supply should be drawn as distant from known sources of contamination as possible. Sources of contamination include landfills, agricultural and livestock wastes, industrial and domestic sewerage discharges, fuel oil storage sites, and other detrimental land use areas.

When a stream is used, the intake should be located upstream from any such source of contamination. In lakes and ponds, it is generally desirable to locate the intake as far from the shore as practicable, because the amount of contamination usually decreases with the increase in distance from the shore. The water quality of muddy streams can be improved by use of a water-filtering well--i.e., by digging a hole on the bank and permitting water to seep slowly into it through the bank (Fig. 1).

Another method is to dig a shallow trench so that water can flow into it from the stream and settle. After the dirt has settled, the clean water may be taken and disinfected by methods described in Sect. 1.3.

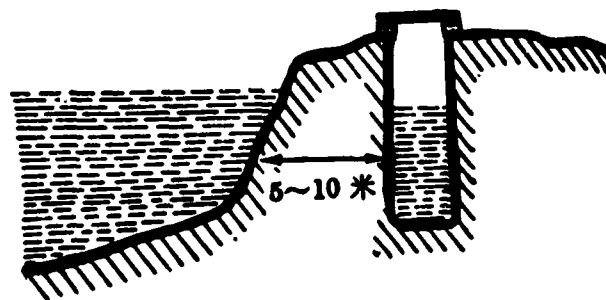


Fig. 1. A water-filtering well.

### 1.2.3 Groundwater

Groundwater is normally less contaminated than surface water and therefore more desirable as an emergency water source. It is generally free from chemical, radiological, or biological contamination. Harmful microorganisms are usually reduced to tolerable levels by natural filtration of the groundwater through the soil. Groundwater, however, may be inaccessible without pumps, which may require electricity or the digging of wells.

A groundwater source should be taken from a site selected to ensure that possible sources of contamination will not drain into it. It is recommended that a groundwater source should be at least 30 m (100 ft) from all possible sources for contamination and preferably much farther. To prevent surface contamination, a well that is selected as an emergency source of potable water should have a casing or lining, an impervious platform or apron, and a cover.

### 1.3 DISINFECTION/TREATMENT OF WATER

In a postemergency period, water from any source may be contaminated. Appropriate analysis for contamination must be undertaken as soon as possible. There are several methods of water treatment to kill disease-producing organisms. The population must be informed of these methods and provided instructions for appropriate disinfection/treatment of water.

There are three basic methods for treatment of water:<sup>5</sup>

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<sup>5</sup>Detailed discussions on this subject are provided in Brown, Stephen, L.; Lee, Hong; and Yu, Oliver S., Postattack Food Production and Food and Water Contamination, Menlo Park, CA: Stanford Research Institute, June 1968, AD-6761872/LL.

1. filtration with settling (combined with boiling and/or chemical additions),
2. boiling, and
3. addition of certain disinfection chemicals.

### 1.3.1 Filtration and Settling

Use of expedient raw water filtration methods removes many, but not all, disease-producing organisms. Filtration is also the most effective primitive method to remove radioactive material.<sup>6</sup>

#### 1.3.1.1 Ultrafiltration

In recent years filters capable of removing particles as small as bacteria have become available. These porous ceramic filters are now used to sterilize water and other fluids. Large capacity units may be found in industrial plants requiring large amounts of sterile water. Small units capable of treating enough (few hundred ml/min) water for a family are sold in sporting goods and camping and backpacking stores. These units do not remove dissolved radioactive or toxic materials. They are expensive, small units costing in the neighborhood of \$200 in 1988.

#### 1.3.1.2 Earth filtration

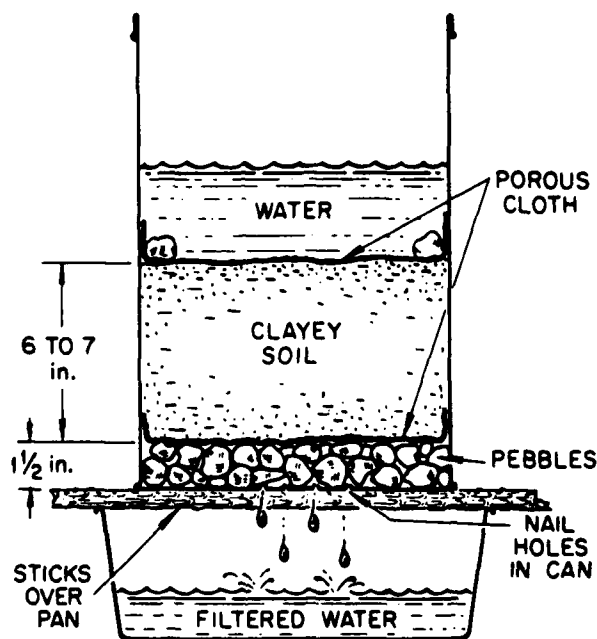
Filtering through earth removes essentially all the fallout particles and more of the dissolved radioactive material than does boiling-water distillation, a generally impractical purification method that does not eliminate dangerous radioactive iodines. Earth filters, if properly constructed, can be more effective in removing radioactive iodines than are ordinary ion-exchange water softeners or charcoal

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<sup>6</sup>Pressman, M., Household Methods of Removing Radioactive Materials From Water, U.S. Army Eng. Research and Development Lab., 1962, AD-265585/LL.

filters. In areas of heavy fallout, approximately 99% of the radioactivity in water could be removed by filtering it through ordinary earth.

A schematic design of effective filter is shown in Fig. 2. The procedure for constructing such a filter is described as follows:



**Fig. 2. Expedient filter to remove some of the impurities and radioactivity from water.**

(1) Perforate the bottom of a 5-gal can, large bucket, watertight wastebasket, or similar container with approximately a dozen nail holes. Punch the holes from the bottom upward, staying within about 2 in. of the center.

(2) Place a layer about 1 1/2 in. thick of washed pebbles or small stones on the bottom of the can. If pebbles are not available twisted coat-hanger wires or small sticks can be used.



(3) Cover the pebbles with one thickness of terrycloth towel, burlap sackcloth, or other porous cloth. Cut the cloth in a roughly circular shape about 3 in. larger than the diameter of the can.

(4) Take soil from at least 4 in. below the surface of the ground. Do not use pure clay (not porous enough) or sand (too porous). (Nearly all fallout particles remain near the surface except after deposition on sand or gravel.)

(5) Pulverize the soil, then gently press it in layers over the cloth that covers the pebbles so that the cloth is held snugly against the sides of the can. The soil in the can should be 150-175 mm (6-7 in. thick.

(6) Completely cover the surface of the soil layer with one thickness of fabric as porous as a bath towel in order to keep the soil from being eroded as water is poured into the filtering can. The cloth will also remove some of the particles from the water. A dozen small stones placed on the cloth near its edges will secure it adequately.

(7) Support the filter can on rods or sticks placed across the top of a container that is larger in diameter than the filter can (a dishpan will do).

The contaminated water should be poured into the filter can, preferably after allowing it to settle as described below. The filtered water should be disinfected by one of the methods described in Sect. 1.3.

If the 15 to 17 cm (6 or 7 in.) of filtering soil is a sandy clay loam, the filter initially will deliver about 6 L (6 quarts) of clear water per hour. (If the filtration rate is faster than about 1 L (1 quart) in 10 min, remove the upper fabric and recompress the soil). After several hours, the rate will be reduced to about 2 L (2 quarts) per hour.

When the filtering rate becomes too slow, it can be increased by removing about 1 cm (1/2 in.) of soil and then replacing the fabric. The life of a filter is extended and its efficiency increased if muddy water is first allowed to settle for several hours in a separate container, as described in Sect. 5.2. After about 50 L (50 quarts) have been filtered, rebuild the filter by replacing the used soil with fresh soil.

### 1.3.1.3 Settling

Settling is one of the easiest methods to remove certain impurities and/or most fallout particles from water; it should be used in combination with filtration and chemical disinfection. The procedure is as follows:

(1) Fill a bucket or other deep container three-quarters full of the water or rain.

(2) Dig pulverized clay or clayey soil from a depth of 10 or more cm (4 in.) below ground surface and stir it into the water. Use approximately a 2-cm (1-in.) depth of dry clay or dry clayey soil for every 10-cm (4-in.) depth of water. Stir until most clay particles are suspended in the water.

(3) Let the clay settle for at least 6 h. The settling clay particles will carry most of the suspended fallout particles to the bottom and cover them.

(4) Carefully dip out or siphon the clear water and disinfect it.

Note, however, that settling alone will not remove disease-bearing organisms from raw water.

### 1.3.2 Boiling

Boiling is an expedient means of disinfecting relatively small quantities of water. The water must be held at a rolling boil for 5 to 10 min to kill most disease-producing organisms. When a pressure cooker is used, the time may be reduced to 2 to 3 min. The practicability of boiling, however, is limited by the availability of fuel and appropriate equipment for large populations.

### 1.3.3 Disinfection by Chemical Additives

Disinfection of raw water (i.e., killing of disease-producing organisms) can be readily accomplished by addition of certain chemicals to the water. There are five such chemicals that are used as water disinfectants:

- (1) chlorine,
- (2) sodium hypochlorite,
- (3) calcium hypochlorite,
- (4) iodine, and
- (5) bromine.

#### 1.3.3.1 Chlorine

Chlorine, a greenish-yellow poisonous gas, is one of the best water disinfectants and is frequently used by community-wide water treatment plants. For large-scale uses, gaseous chlorine is shipped in bulk quantities and arrives at the point of use in railroad tank cars (in 16-ton, 30-ton, 55-ton, 85-ton, and 90-ton chlorine capacity). For smaller users, the chlorine gas is repackaged in cylinders. These are 240 x 75 cm (8 ft x 30 in.) pressure containers which have a capacity of 1 ton of liquid chlorine. For very small users of chlorine, smaller containers (pressure cylinders) with capacity of 70 kg (150 lb) of chlorine are used. Chlorine is a widely used chemical and is

manufactured in about 60 locations in the United States (see Appendix A for specific location of these facilities).

In many communities, chlorine can be found in community treatment facilities for both potable and waste water. Chlorine can also be found in paper mills, textile mills, and chemical plants.

#### 1.3.3.1.1 Use of chlorine as a water disinfectant

Use of chlorine in water disinfection should be undertaken only by trained personnel.<sup>7</sup>

Under normal operating conditions, sufficient chlorine is added to water to produce a free available chlorine (FAC) residual of at least 5.0 ppm after 10 min contact time at a pH between 6.5 and 7.5.

The effectiveness of chlorine disinfection is affected by the following variables:

- (1) a combination of (a) the form of chlorine present, (b) the pH of the water, and (c) the contact time. As the pH of the water increases from 5 to 9, the form of the chlorine residual changes from hypochlorous acid (HOCL), the most effective form, to hypochlorite ion (OCL<sup>-</sup>), which is less effective. The most effective disinfection occurs when the pH is between 5.5 and 6.5. If the pH of the water is high, more chlorine may need to be added. At the same pH, a longer contact time also results in increased disinfection.
- (2) the type and density of organisms present (virus, bacteria, protozoa, helminth, spores, or others) and their respectivity to

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<sup>7</sup>See: White, G.C., Handbook of Chlorination, Von Nostrand Reinhold, New York, 1972, and Appendix C.

chlorine disinfection. The cysts of the protozoa Entamoeba histolytica and Giardia lamblia are the most resistant.

- (3) the temperature of the water. At lower temperatures, bacterial kill tends to be slower and higher FAC residuals or longer contact times are needed.
- (4) the concentration of substances other than disease-producing organisms that exert a chlorine demand. During disinfection, chlorine demand can be exerted by chemical compounds such as those containing ammonia and organic material. In such cases additional chlorine must be added to achieve sufficient disinfection.
- (5) adequate mixing of chlorine and chlorine-demanding substances. The disinfecting agent must be well dispersed and thoroughly mixed to ensure that all of the disease-producing organisms come in contact with the chlorine for the required contact time.
- (6) the concentration of suspended solids. Suspended solids can surround and protect organisms from the disinfectant.

#### 1.3.3.1.2 Use of chlorine in an emergency

It may become necessary to use chlorine for water disinfection without the availability of an operating water treatment plant. This can occur if (1) the plant is damaged, (2) electric power for pumps is unavailable, (3) the water distribution system is damaged, or (4) supplies of chlorine are interrupted. In the last case, limited supplies of chlorine on hand must be conserved for potable water only, which in a severe emergency can be reduced to 4L (1 gal)/person/d.

In the U.S. under normal circumstances, approximately 400 L (100 gal) of treated water are supplied to each person each day. Restricting chlorine use to potable water only and restricting that to

4 L/d (1 gal/d) will extend the chlorine supply by a factor of 100. A single 1000-kg (2000-lb) chlorine cylinder used under these circumstances can treat 4 L/d (1 gal/d), at 5 ppm  $\text{Cl}_2$ , for 100,000 people for 500 d. Most water treatment plants using chlorine keep several days' to a few weeks' supply on hand. Extending the life of that supply by a factor of 100 should offer a sufficient time to reestablish supplies.

The procedure for emergency use of chlorine can be a two-stage process. Initially, chlorine gas might be used by technically trained personnel to produce a concentrated (1%) solution of chlorine. This solution could be distributed in small containers [~4-L (1-gal) plastic bottles supplied by the customers] to each neighborhood, where it could be distributed to each family in soft drink bottles. Families would use it at the rate of a scant teaspoon to 1 gal of drinking water.

Filling and distributing containers of chlorine solution would be a considerable logistic operation, requiring as much as 2 or 3 weeks to organize, after fallout had decayed to the point where people could move about for a few hours each day. Until that time people would have to get by on water treated with whatever supplies of household bleach (sodium hypochlorite solution) are available in the community (see Sect. 1.3.3.2).

Concentrated chlorine solution can be produced at an undamaged plant using the existing equipment if tools and fittings are available to divert and collect the chlorine solution before it is injected into the main water stream.

If diversion of the normal chlorine solution line is not feasible, if the plant is damaged, or if electric power is unavailable, equipment must be improvised to mix chlorine gas with water.

Every water plant using chlorine has at least two (and usually more) sets of fittings to connect the chlorine cylinders (or tank cars) to

flexible tubing. The fittings usually include a pressure regulator and a flow sensor (rotameter). This equipment can be used to connect the cylinders to improvised mixing equipment.

Chlorine is a dangerously toxic gas. Improvised operations with it should be carried out only by experienced technical personnel in a well-ventilated area using respiratory protection.

The situation at each chlorination plant will be different: different size and design, different damage, different tools, equipment, and materials available for improvisations. The following untested suggestions are offered to indicate possible approaches to the problem of improvising chlorination equipment in the field.

The simplest (and less than ideal) technique may be simply to inject the gas into the bottom of a tank of water through a plastic pipe which has a closed end and some small holes drilled near its closed end. The tank should be as deep as possible and the chlorine admitted slowly enough to minimize the chlorine escaping from the surface. This operation must be conducted in a very well ventilated area. The mixing tank should be vented in a way that prevents exposure of the operators and nearby personnel to dangerous concentrations of chlorine. The vent can be connected to an improvised blower-driven stack or another absorbing tank.

The rate at which chlorine can be admitted may be considerably improved by admitting it near the bottom of one leg of a long U-tube, both ends of which are connected to a slightly elevated tank. The U-tube, which can be made of 5-cm (2-in.) flexible plastic pipe need not be vertical but must slope continuously upward to the tank.

If a chlorine-resistant water pump and motive power are available, a better way to mix chlorine and water is to inject both the chlorine and the water on the suction side of the pump and to pump the mixture through

about 15 m (50 ft) of pipe connecting the pump discharge and a chlorine solution storage tank.

The strength of the solution can be controlled by chlorine flow rate and time for a known amount or flow rate of water. A chlorine flow rate of 100 lb/d (a common unit in water treatment plants) will produce about 200 L (50 gal) of 1% chlorine solution in 1 h.

#### 1.3.3.2 Sodium hypochlorite

Sodium hypochlorite, essentially liquid bleach, is used as a water disinfectant and a bleaching agent in swimming pools, laundries, milk processing plants, and textile and paper and pulp mills. It is sold in retail establishments under various brand names such as Clorox, Purex, and Dazzle.

Sodium hypochlorite is shipped in bulk, tank trucks and drums. It is sold in 3.8- and 7.6-L polyethylene bottles, 23- and 57-L carboys, and 200-L drums. Over 120 sodium hypochlorite manufacturing facilities are located in the United States (see Appendix A) for listing of these. Sodium hypochlorite can be found in:

- (1) Community water treatment facilities
- (2) Swimming pool supply establishments
- (3) Retail establishments (as common bleach under various trade names)
- (4) Supply establishments for milk processing plants
- (5) Commercial laundries
- (6) Textile Mills
- (7) Pulp and paper mills

##### 1.3.3.2.1 Use of sodium hypochlorite as water disinfectant

Sodium hypochlorite acts as water disinfectant essentially by releasing chlorine. The disinfection potency of 1 mg/L of chlorine from



sodium hypochlorite is just as effective as an equivalent amount derived from liquefied chlorine gas. The procedure for using sodium hypochlorite as an emergency water disinfectant for households is as follows:

Add 5 mL (1 scant teaspoonful) to each 40 L (10 gal) of clear water and stir. Add 2 scant teaspoonfuls if the water is muddy or colored. Wait at least 30 min before drinking, to allow enough time for the chlorine to kill all the microorganisms. Properly disinfected water should have a slight chlorine odor.

To disinfect small quantities of water, put 2 drops of household bleach containing 5.25% sodium hypochlorite in each quart of clear water. Use 4 drops if the water is muddy or colored. Because of its wide availability, ease of use, safety, and economy, household chlorine bleach is the preferred agent for the purification of drinking water in an emergency. Four liters (1 gal) of bleach can treat 40,000 L (10,000 gal) of drinking water. Community emergency plans should include a recommendation that each household keep 4 L (1 gal) of bleach on hand for water disinfection during an emergency.

#### 1.3.3.3 Calcium hypochlorite

Calcium hypochlorite is employed in water purification as a disinfectant and is an ingredient in the commercial brands such as HTH, Camporit, and Perchloron. Calcium hypochlorite, a crystalline solid, is usually sold as a hydrate.

Calcium hypochlorite is shipped as a granular product or as tablets in 1- to 16-kg polyethylene containers. It is also shipped in 23-, 34-, and 45-kg fiber drums with a polyethylene-coated aluminum lining and a galvanized steel cover. There are three firms which manufacture calcium hypochlorite in the United States (see Appendix A).

Calcium hypochlorite can be found in

- (1) establishments providing service for swimming pools where calcium hypochlorite is used as a disinfectant,
- (2) milk processing plants, and
- (3) food processing plants.

#### 1.3.3.3.1 Use of calcium hypochlorite as a water disinfectant

For household use of calcium hypochlorite as an emergency water disinfectant, dissolve 30 mL (2 tablespoons) of calcium hypochlorite in 4 L (1 gal) of water to make concentrate. Add 5 mL (1 scant teaspoonful) of concentrate to each 40 L (10 gal) of clear water and stir. Add 10 mL (2 scant teaspoonfuls) if the water is muddy or colored. Wait at least 30 min before drinking, to allow enough time for the concentrate to kill all the microorganisms. Properly disinfected water should have a slight chlorine odor.

To disinfect small quantities of water, put 2 drops of concentrate in each quart of clear water. Use 4 drops if the water is muddy or colored. If a dropper is not available, use a spoon and a square-ended strip of paper 6 mm (1/4 in.) wide by 50 mm (2 in.) long in the spoon with an end hanging down about 1 cm (1/2 in.) beyond the end of the spoon. Then when the concentrate is placed in the spoon and the spoon is carefully tipped, drops the size of those from a medicine dropper, will drop off the end of the strip.

#### 1.3.3.4 Iodine

Iodine is also employed as a disinfectant in water purification, usually in the form of water-soluble organic complexes. It is a gray to purplish-black crystalline element that rarely occurs in nature in the elemental state, but it can be produced from naturally occurring iodine compounds. *Iodine is highly toxic.* Over two-thirds of all iodine used

in the United States is imported; there are only three iodine manufacturing facilities in the United States (see Appendix A). Forms of iodine which are most useful for water disinfection are:

- (1) iodine tablets,
- (2) iodine crystals,
- (3) iodophor (specially formulated compound used as disinfectant),  
and
- (4) iodine tincture.

Various iodine compounds to be used for emergency water disinfection can be found in pharmacies and chemical plants.

#### 1.3.3.4.1 Use of iodine compounds as water disinfectants

The following is the procedure for use of iodine compounds as emergency water disinfectant:

Add 5 drops of tincture of iodine to each 1 L (1 quart) of water, and let stand 30 min. If the water is cloudy, add 10 drops to each quart. Commercial water purification tablets should be used as directed.<sup>8</sup>

#### 1.3.3.5 Bromine/bromine chloride

Elemental bromine is a very dark, reddish-brown liquid.

Because of the hazards of transporting elemental bromine, it is often manufactured in compounds (e.g., bromine salts) that are less hazardous to transport.

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<sup>8</sup>Black, A.P., et al., "Iodine for the Disinfection of Water", Journal of the American Waterworks Association, Vol. 60, No. 1, January 1968, pp. 69-83.

Bromine is transported and sold for the purposes of disinfection as bromine chloride in crystal form or as hypobromous acid (HOBr). The use of bromine requires special handling and transportation because of its corrosive and poisonous nature. Small quantities of bromine are shipped in cases of nine 6.5-lb glass bottles with lead caps packed in expanded mica or some other inert absorbent. Larger quantities are shipped in 40-L (10-gal) lead-lined drums or in special nickel-clad or lead-lined cars. The safest method of shipment is in pressurized containers, isotanks, that hold 14 tons of bromine.

There are a total of eight bromine manufacturing facilities in the United States, all located in Arkansas and Michigan (see Appendix A). Bromine or its compounds can be found in (1) community sewage treatment plants, (2) community water treatment facilities, and (3) many industrial facilities (bromine compounds are used for boiler and cooling water treatment).

#### **1.3.3.5.1 Use of bromine and bromine compounds as water disinfectants**

To use bromine and/or bromine compounds for emergency water disinfection, dissolve 30 mL (2 tablespoons) of bromine in 1 gal of water to make concentrate. Add 5 mL (1 scant teaspoonful) of concentrate to each 40 L (10 gal) of clear water and stir. Add 2 scant teaspoonfuls if the water is muddy or colored. Wait at least 30 min before drinking, to allow enough time for the concentrate to kill all the microorganisms. Properly disinfected water should have a slight chlorine odor.

To disinfect small quantities of water, put 2 drops of concentrate in each quart of clear water. Use 4 drops if the water is muddy or colored. If a dropper is not available, use a spoon and a square-ended strip of paper or thin cloth about 6 x 50 mm (1/4 x 2 in.). Put the strip in the spoon with an end hanging down about 1 cm (1/2 in.) beyond the end of the spoon. When the concentrate is placed in the spoon and

the spoon carefully tipped, drops the size of those from a medicine dropper will drip off the end of the strip.

#### 1.4 . EMERGENCY TRANSPORT OF WATER FOR HOUSEHOLDS

(Adopted from Nuclear War Survival Skills by C. H. Kearny)

In the event of a major emergency, water supply systems may be destroyed. Consequently, a community or a household must arrange for emergency transport of water.

At a community level, emergency water transport may be accomplished using such equipment as fire trucks and hoses, plastic irrigation pipe, appropriate tank trucks, or street cleaning trucks. At the household level, usually only a few large containers are available for carrying water to a shelter and storing it in adequate amounts for several weeks. Polyethylene trash bags make practical water containers when used as waterproof liners inside smaller fabric bags or pillowcases. To avoid possible pinhole leakage it is best to put one waterproof bag inside another.

To close a plastic bag of water so that hardly any will leak out, first spread the top of the bag until the two inner sides of the opening are together. Then fold in the center so that the folded opening is 4 thicknesses, and smooth. Continue smoothly folding in the middle until the whole folded-up opening is only about 4 cm (1-1/2 in.) wide. Then fold the top of the bag over on itself so the folded-up opening points down. With a strip of cloth or a soft cord, bind and tie the folded-over part with a bow knot.

For long hikes, it is best to tie the water-holding plastic bags so that the openings are higher than the water levels inside.

To transport this type of expedient water bag in a vehicle, tie a rope around the fabric outer bag near its opening, so that the rope also encircles and holds the plastic liner-bags just below their tied-shut openings. The other end of this rope should then be tied to some support, to keep the openings higher than the water level.

To use two fabric bags or pillowcases to carry a heavy load of water contained in larger plastic liner-bags, connect the two fabric bags.

A small pebble, a lump of earth, or a similar object should be tied inside the opening of each bag before the two are tied together, to hold them securely. The bag that is to be carried in front should have the pebble tied about four inches further down from the edge of its opening than the pebble tied in the bag to be carried in back. This keeps the pebbles from being pressed against the carrier's shoulder by a heavy load.

A pair of trousers with both legs tied shut at the bottoms can be used to carry a balanced load if pillowcases or other fabric bags are not at hand. Such a balanced load can be slung over the shoulder with the body erect and less strained than if the same weight were carried in a single bag-like pack on the back. However, trouser legs are quite narrow and do not provide room to carry more than a few gallons.

To prevent water from slowly leaking through the tied-shut openings of plastic bags, the water levels inside should be kept below the openings.

## 2. EMERGENCY BURIAL OF HUMAN REMAINS

Burial of the dead is a very sensitive and important issue. A nuclear strike or other catastrophe may result in mass casualties which, if left unattended, could pose a major health risk to the survivors. Furthermore, time and resources may make it difficult to follow conventional burial practices. The dead must be buried quickly and effectively to prevent the spread of disease.

The simplest and most effective method of burial may be to employ mass graves, using the appropriate disinfectants and insecticides as a hedge against the spread of disease. These graves should be located so as to avoid contamination of the water supply. As resources permit, health officials may also consider more amenable burial practices. All these activities need to be coordinated with local government officials and agencies such as the public health service, public works, offices of medical examiner and pathologist, and others, as necessary. Several publications provide detailed discussion of this sensitive issue.<sup>1</sup>

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<sup>1</sup>Polson, C.J., et al., The Disposal of the Dead, New York: Philosophical Library, Inc., 1963; and

Orth, G.L., "Disaster and Disposal of the Dead", Milit. Med., 124 (1959, 505).

### 3. EMERGENCY WASTE DISPOSAL

The principal objective of waste disposal is to prevent the transmission of the disease pathogens in organic matter to the population. Such transmission may occur through direct contact, contamination of the water supply, or contamination of food by vector-borne organisms (flies being the principal vector).<sup>1</sup> Contamination of the water supply is the usual mode of transmission. This may result from sewage effluents mixing with surface water sources or from seepage from lagoons or waste disposal sites into the water supply. Hence, special precautions must be taken to ensure that the disposal of wastes does not endanger the supply of drinking water. Proper treatment and disposal of wastes can essentially eliminate the number of disease organisms transmitted in these ways.

Normally treatment of septic sewage is adequately handled by community septic sewage collection systems (sewers) and treatment plants. Both usually depend on an operating water system, and electric power. If damaged in an attack, repair and restoration of the sewer system, treatment plant, and water system, and electric supply will be high-priority but usually major reconstruction activities. Damage assessment and estimation of reconstruction requirements should be done by experienced professional engineers. The local emergency manager may participate in the decision as to whether enough local resources exist to attempt early restoration of sewage service (and in what areas), but the details of repair should be left to the cognizant technical personnel. If repair of the sewage and treatment systems, water system or electric power will be delayed, protracted or unfeasible due to degree of damage and/or unavailability of repair material, then the provision of field expedient waste disposal facilities will become another of the responsibilities of the emergency manager. Several studies have been made of

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<sup>1</sup>See: Craun, G.F., et al., "Review of the Causes of Waterborne-Disease Outbreaks", Journal of American Waterworks Association, January 1973.



emergency sanitation.<sup>2</sup> This guide includes information adopted from those works for rapid application, and additional information on obtaining and using sanitation chemicals (Appendices A and B).

The wastes of primary concern to emergency sanitation workers are (1) dead animals; (2) human wastes (feces and urine); (3) liquid wastes (wash, bath, and liquid kitchen wastes); (4) garbage; and (5) rubbish.

Depending on the type of waste, the expedient construction and management of the following emergency waste disposal facilities may be required:

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<sup>2</sup>Backmann, F., "Emergency Treatment of Army Camp Sewage," Eng. News Record, 129, 1942, p. 107.

Blohn, C. L., Human Waste Sanitation Studies, Truesdail Laboratories, Inc., Philadelphia, 1965, AD-706931.

Fischer, R., Dickinson L., Meyer, J., Wagner, T. P., Emergency Sewage Procedures During CRP, Scientific Services Inc., Redwood City, CA 1978, AD-A063713.

Hermon, J. A., Leach, J. M., and Adams, L. W., Postattack Sanitation, Waste Disposal, Pest and Vector Control, and Civil Defense Aspects of Waterworks, Arcadia, CA, Engineering-Science, Inc., June 1968.

Hermon, J. A., and Leach, J. M., Postattack Sanitation: Waste Disposal, Pest and Vector Control Requirements and Procedures, Menlo Park, Engineering-Science, Inc., 1965, AD-611769.

Hermon, J. A., and Leach, J. M., Postattack Sanitation: Waste Disposal, Pest and Vector Control and the Effects of Fallout in Waste Water and Sewer Systems, Engineering-Science, Inc., 1967, AD-645599.

International Civil Defense Organization, "Sanitation in Natural Disasters," Bulletin of the ICDO, No. 204, Geneva, Switzerland, June 1972.

- (1) ponds,
- (2) lagoons,
- (3) temporary latrines,
- (4) sanitary landfill,
- (5) incinerators, and
- (6) temporary kitchen and related waste disposal sites.

Operation of these emergency waste disposal systems may require certain construction activities, principally consisting of earth moving and excavation.<sup>3</sup>

### 3.1 PONDS

Liquid wastes may be disposed of in specially constructed ponds. Ponds use natural aeration, primarily algae photosynthesis, to provide oxygen. Heavily loaded ponds sometimes require supplemental aeration equipment to help maintain dissolved oxygen concentration and to mix the wastewater periodically. The usual design criteria for ponds are population per acre loading or areal biological oxygen demand (BOD) loading.

The shallow depth of ponds allows algae to provide oxygen for bacteria throughout the volume of the pond. Being shallow, these ponds are very land-intensive so that the majority of ponds used in waste treatment are facultative ponds.

Ideally, facultative ponds maintain three biological zones: an aerobic surface zone where bacteria and algae exist in a symbiotic relationship, a layer containing anaerobic bacteria, and an intermediate zone containing both aerobic and anaerobic bacteria. To maintain the

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<sup>3</sup>See: Harmon et al, op. cit.  
Fischer, et al, op. cit.

aerobic zone, organic loadings are generally in the range of 25 to 60 kg BOD/ha./d (20 to 50 lb acre/d). This corresponds to a population loading of approximately 250 to 750 persons/ha. (100 to 300 persons/acre) of surface area for ponds without primary treatment and 150 to 450 persons/acre with primary treatment.

Because anaerobic ponds do not require aerobic conditions, they have the highest organic loadings, typically in the range of 250 to 1200 kg/ha./d (200 to 1000 lb BOD/acre/d). The high organic loadings are necessary to maintain anaerobic conditions throughout the ponds, and warm temperatures 25°C (75°F) minimum are required to maintain a population of methane bacteria. Anaerobic ponds have been used extensively to treat high-temperature, high-strength industrial wastes such as those from the meat packing industry. Because of the relatively low BOD concentration and cool temperature of domestic wastewater, anaerobic ponds are seldom used to treat municipal waste.

All ponds exhibit certain general operating characteristics, such as the fact that treatment efficiency is affected most notably by the organic loading, hydraulic detention time, temperature of the wastewater, and sunlight intensity. Because of these interrelated factors, effluent quality cannot always be related simply to the organic loading; and in some cases, as loadings are increased, effluent quality may not change significantly.

### 3.2 LAGOONS

Lagoons are similar to ponds but usually have shorter retention duration times and higher BOD loadings because artificial aeration is used to supply greater amounts of oxygen for bacterial growth. Algae are sometimes present, but they are not the main source of oxygen.

A lagoon is a stable system exhibiting slowly decreasing treatment with increased loading. Insufficient aeration capacity affects lagoon

performance. If aerobic conditions cannot be maintained, biological rates are somewhat reduced and odors can develop. The efficiency of aeration equipment varies, but a general rule of thumb is 0.6 kg oxygen/KWh (1 lb. of oxygen/hp.h); to remove 1 kg of BOD requires approximately 1.5 kg of oxygen. Using these values the capacity of the aeration equipment can be estimated and then compared with the organic load imposed on the system.

### 3.3 SANITARY LANDFILL

Using a sanitary landfill is a practical method for the emergency disposal of organic waste and garbage. For a conventional-size landfill a hole 6 x 36 m (20 x 60 ft) and at least 1.2 m (4 ft) deep should be dug, and waste should be laid in layers. Each layer can be treated with an appropriate disinfectant if available to kill disease pathogens, then promptly covered with earth to prevent access of insects and rodents.

Care must be taken that the landfill does not contaminate the water supply. The landfill should not be located near surface water sources, and the direction of drainage should be away from all community water sources. In areas where the water table is high, special care must be taken to ensure that groundwater is not contaminated.

Landfills should be removed from population centers to reduce the risk of disease transmission by insects and rodents.

### 3.4 TEMPORARY LATRINES

Temporary latrines used as an emergency sanitation measure for the disposal of human wastes are an adequate temporary means to control disease vectors after an emergency.

To protect food and water from contamination, all latrines should be

located at least 90 m (100 yd) from food preparation areas and at least 30 m (100 ft) from all sources of water. Accessibility to users is a secondary consideration.

Latrines should be scrubbed with soap and water daily, and the area should be sprayed with insecticides weekly. If fly problems develop, the latrine pits should be sprayed. Hand washing facilities should be available at each latrine.

Several types of temporary latrines may be constructed and are described in detail in the following paragraphs.

(a) Deep Pit Latrine. If conditions permit (i.e., low water table, enough soil to dig pit), the pit latrine is a good way to dispose of human waste in the absence of a piped sewer system.

A pit is dug 60 cm (2 ft) wide and 225 cm (7 1/2 ft) long, allowing 7.5 cm (3 in.) of earth surface on each side of the pit to support the latrine box. The depth of the pit depends upon the estimated length of time the latrine is to be used. As a guide, a depth of 30 cm (1 ft) is allowed for each week of estimated use, plus a minimum of 1 ft of depth for dirt cover when the pit is closed. It is not generally desirable to dig the pit more than 180 cm (6 ft) deep because of the danger of the walls caving in. Rock or a high groundwater level may also limit the depth of the pit. In some soils, supports of planking or other material may be necessary to prevent the walls from caving in. Earth should be packed tightly around the bottom edges of the box to seal any openings through which flies could enter.

A standard four-seat latrine box is 240 cm (8 ft) long and 75 cm (2 1/2 ft) wide at the base. The number of seats should be sufficient to accommodate at least 8% of the population at any one time. The holes should be covered with flyproof, self-closing lids. Any cracks should be

flyproofed by nailing strips of wood or tin over them. A metal deflector (which can be made from flattened cans) should be placed inside the front of the box to prevent urine from soaking into the wood.

It is sometimes desirable to install a vent stack in the more permanent pit latrines to release moisture-laden gases of decomposition, thus preventing condensation from forming inside the self-closing lids. The vent stack should extend from the upper part of the pit to approximately 2 m (7 ft) above ground level. The outside opening of the vent stack must be screened to prevent flies from entering.

(b) Mound Latrine. A mound latrine may be indicated when a high groundwater level or a rock formation near the ground surface prevents digging a deep pit. Forming a dirt mound makes it possible to build a deep pit that does not extend into groundwater or rock.

A four-seat, flyproof latrine box is placed on top of a mound of earth with a top at least 180 cm (6 ft) wide and 3.6 m and 12 (ft) long. The mound is made high enough to meet the depth requirement of the pit, allowing 30 cm (1 ft) from the base of the pit to the water or the rock level. Before the mound is built, the area where it is to be placed should be broken up or plowed in order to aid seepage of liquids from the pit. The mound is formed in approximately 30-cm (1-ft) layers, with each layer roughened before the next is added. When the desired mound height has been reached, the pit is dug into the mound. It may be necessary to brace the walls with wood, sandbags, or other suitable material to prevent cave-ins. The exact size of the base of the mound depends upon the type of soil; it should be made large enough to avoid a steep slope. It may be necessary to provide steps up the slope.

An alternate method for constructing the mound latrine is to build the pit first on top of the ground, using lumber, logs, corrugated sheet metal, or other available material. The dirt is then piled around the pit and up to its brim, thus creating the mound.

(c) Pail Latrine. A pail latrine can be built in populated areas or in rocky soil and marshes. A standard latrine box (described under deep pit latrines) can be converted for use as a pail latrine by placing a hinged door on the rear of the box, adding a floor, and placing a pail under each seat. If the box is located in a building, it should, if possible, be fitted into an opening made in the outer wall so that the rear of the box can be opened from outside the building. The seats and rear door should be self-closing, and the entire box should be made fly-proof. The floor of the box is made of an impervious material (concrete, if possible) and should slope enough toward the rear to facilitate rapid drainage of water used in cleaning the box. A urinal may be installed in the latrine enclosure with a drainpipe leading to a pail outside, which should also be enclosed in a flyproof box. The waste in pails may be disposed of by burning or by burial in a suitable area. Emptying and hauling containers of waste must be closely supervised to prevent careless spillage.

### 3.5 TEMPORARY KITCHEN AND RELATED WASTE DISPOSAL SITES

Liquid wastes may be disposed of in the soil by means of soakage pits if a piped sewer system is not available. In order for the soil to absorb liquids, grease and soap, as well as any solid particles, must first be removed; thus, a grease trap is a necessary part of each soakage pit.

### 3.6 SOAKAGE PITS

A soakage pit 120 cm (4 ft) square and 120 cm (4 ft) deep is normally adequate to dispose of liquid kitchen waste for 200 persons. Several pits should be constructed, each pit used on alternate days to lessen the possibility of clogging. Care must be taken to locate soakage pits so that they do not contaminate the water supply. The 120 cm (4-ft) square, 120 cm (4-ft) deep soakage pit should be filled to ground level

with rocks, bricks, broken bottles, or similar rubble, with stones piled on top. Should a soakage pit become clogged, it is closed by covering it with 30 cm (1 ft) of compacted earth, then marked, and a new pit is constructed.

### 3.7 GREASE TRAPS

(a) Baffle Grease Trap. A baffle grease trap may be made from a drum or a water-tight box that is divided vertically into entrance and exit chambers by attaching a wooden baffle. The baffle, placed so that the entrance chamber is approximately twice the size of the exit chamber, should hang to a point within 25 mm (1 in.) of the bottom. A strainer made from a small, perforated box filled with straw, hay, or burlap is inserted into the lid above the entrance chamber. A pipe is inserted into the exit chamber ~75-150 mm (3-6 in.) below the top as an outlet to the soakage pit. This baffle grease trap is usually placed on the ground at the side of the soakage pit with the outlet pipe extending 30 cm (1 ft) beneath the surface at the center of the pit. If a grease trap is not watertight, it must be placed partially under the ground.

Before the grease trap is used, the chambers are filled with cool water. The waste liquid is poured through the strainer, which retains any solids. As the warm liquid strikes the cool water, the grease rises to the surface of the entrance chamber and the liquid runs under the baffle, filling the exit chamber. When the liquid reaches the outlet pipe near the top of the exit chamber, it runs through the pipe into the soakage pit. Unless the grease trap is of sufficient capacity, the warm, greasy liquid poured into the trap heats the cool water in the trap; thus, the grease remains uncongealed and passes through the trap. Grease trap efficiency can be increased by constructing it with multiple baffles or by using a series of traps.

The baffle grease trap must be properly maintained to prevent clogging of the soakage pit. The grease retained in the trap should be



skimmed from the surface of the water as often as required and either buried or burned. The entire trap should be emptied and thoroughly scrubbed with hot, soapy water as often as necessary.

(b) Barrel Filter Grease Trap. The barrel filter grease trap may be made from a 120-400l (30- to 50-gal) barrel or drum with the top removed and a number of large holes bored into the bottom. Gravel or small stones are placed in the bottom to a depth of 20 cm (8 in.) and are covered with 30-45 cm (12-18 in.) of ashes or sand. A piece of burlap is fastened to the top of the barrel to serve as a coarse filter. The trap may be placed directly on the soakage pit on a platform with a trough leading to the pit.

Every two days the grease trap should be emptied, washed, and refilled, and the material removed should be buried. The burlap filter should be either washed or replaced every day.

### 3.8 USE OF SANITARY CHEMICALS IN WASTE DISPOSAL

Because waste disposal sites attract rodents and insects, sites must be monitored for the presence of vermin, and appropriate sanitation chemicals must be used. The appropriate chemicals and their uses are presented in Sect. 4.6, and trade names of commercial rodenticides and insecticides are given in Appendix B.

#### 4. PEST CONTROL

In the postemergency environment lapses in sanitation can lead to the growth of insect and rodent populations and associated vector-borne diseases.<sup>1</sup> The most effective measures for the control of vector-borne diseases involve reducing the environment's capacity to support insects and rodents. Of paramount importance here is proper sanitation and protection of the food supply are important disease preventatives.

Measures to reduce rodent population include structural repairs to keep rodents out of homes, protection of food supplies, and garbage and refuse disposal. The most effective method to control mosquitos is to drain stagnant water. The housefly transmits enteric infections through access to infected human feces and to human food and food facilities.

Early postemergency measures in regard to vector-borne disease control should be geared toward current disease incidence and known vector involvement at the time of the emergency. Not enough people in the United States are already infected for many vector-borne diseases to pose an immediate threat even if populations of insects and rodents rise rapidly.

Furthermore, it takes time for pests to reproduce and reach populations that would constitute a hazard. Delay in undertaking the proper measures when the pests are present may allow for the rapid growth of pest populations. However, initiation of control measures while pest populations are still at harmless levels may be a waste of scarce

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<sup>1</sup>See: Johnston, D.R.; Laney, M.N.; Hill, E.L., Postattack Health and Medical Care Contingency Plans and Procedures, Research Triangle Institute, 1974, AD-4011360/LL; and

Salmon, R.J., An Assessment of Selected Community Environmental Health Problems and Requirements under Postattack Conditions, Research Triangle Institute, 1965, AD-600131.

resources. In the case of insects, control measures should be initiated five to seven days after the initiation of other emergency sanitation measures. In the case of rodents, there is a two- to three-month time lag before the population grows enough to constitute a hazard and make control measures necessary. Of course, preventive measures such as rat-proofing, and drainage of stagnant waters may be begun earlier as resources permit.

Third, efforts to control pests must consider the change of seasons and time emergency activities accordingly. During seasons when the ambient temperature reaches freezing, the reproduction cycle of most insects is drastically curtailed; therefore, activities designed to control these insects may also be curtailed. Rodent, louse and flea life cycles are not affected by ambient temperature and must be controlled year round.<sup>2</sup>

#### 4.1 EMERGENCY SANITATION MEASURES FOR RODENT CONTROL

The most effective methods of rodent control are to eliminate hiding places and to prevent access to food and waste. The following measures should be implemented:

- Food and harborage should be made inaccessible by rat-proofing all buildings as well as the food storage areas inside buildings.
- Structural measures should be taken to keep rodents out of homes and food storage areas.
- Food should be stored in tightly covered metal, glass, or plastic containers if possible.

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<sup>2</sup>For discussion of these issues, see: Bissell, R.A., "Delayed-Impact Infectious Disease after a Natural Disaster", The Journal of Emergency Medicine 1, 1983, 59-66.

- All garbage and rubbish should be disposed of promptly and properly.
- Surveys for signs of rodents should be made regularly by sanitation workers.

Certain signs indicate not only the presence of rodents but also the type of rodents, the approximate number, and their location. Overhead scurrying noises are a reasonably sure sign of rats, as are holes gnawed into food containers and through walls, and smudges along beams, pipes, or floors close to walls. The presence of burrows is a sign of Norway rats. Like most animals, rats create paths or runs in which they travel. A run has a smudgy, greasy appearance.

In any area where food is handled or stored, traps should be used in order to avoid the potential hazards associated with using rodenticides around food. A large number of traps should be used, as a 10% catch is considered good. The following procedures should be followed in setting up traps:

- a. Bait traps with the food that has attracted the rodents. Normally, good baits are oily foods such as bacon and peanut butter; cereals such as oatmeal and cream of wheat; and fresh fruits and vegetables such as apples, bananas, lettuce and carrots. Citrus fruits and acid vegetables such as tomatoes do not make good bait.
- b. Place traps along rows and burrows. Position so rodents can approach from both directions. If possible, sprinkle a light dusting of 2% diazinon powder around each trap to kill parasites as they leave the dead rodent. Otherwise, the parasites, which transmit diseases, will leave the dead rodent and find a new host.

In areas where food is not handled or stored, poisonous bait stations may be used to control rodents. Again, a residual insecticide should be sprinkled around the bait trap to kill parasites as they leave the dead rodent.

All traps and bait stations must be checked early each morning for dead rodents.

- a. Apply insect repellent to the hands, sleeves, and front of clothing to repel any parasites that may attempt to leave the rodents as they are removed from the traps or stations. Do not assume that all parasites have already left the rodents or have been killed in the insecticide dust.
- b. Using long-handled tongs or a shovel, pick up the rodents and place them in a plastic bag or a metal container with a tightly fitted lid.
- c. Burn the dead rodents or bury them in sanitary landfill.

#### **4.2 EMERGENCY SANITATION MEASURES FOR FLY CONTROL**

Fly-borne diseases include dysentery, cholera, and typhoid. Flies transmit disease organisms on the tiny hairs of their bodies and feet and in their feces and vomitus. They may carry disease germs directly from manure, garbage, and human feces to food and water.

Breeding grounds should be eliminated through proper sanitation; all human and organic wastes must be covered and disposed of or treated promptly and effectively.

To prevent food and water contamination from fly-borne disease, wastes should be disposed of at least 100m (100 yd) from food preparation areas and 30m (100 ft) from sources of water. All food handling places should be properly screened to protect food against infestation by flies. Food-handling places should also be equipped with self-closing doors that fit snugly and open outward.

Insecticides may be used to control adult flies or larva. Waste disposal sites should be sprayed to prevent fly breeding.

### 4.3 EMERGENCY SANITATION MEASURES FOR MOSQUITO CONTROL

Mosquito-borne diseases include malaria, yellow fever, dengue fever, and encephalitis (sleeping sickness).

Mosquitoes go through four stages during their life cycle: egg, larva, pupa, and adult. The time required for mosquitoes to complete their life cycle varies greatly, depending upon their species and the weather conditions. Most species of medical importance require approximately one to three weeks to complete the life cycle from the egg to the adult. The larval and pupal stages of all mosquitoes are passed in water where the larvae, sometimes called wigglers, can be easily detected.

In their adult or flying stage, certain mosquitoes such as Anopheles -- vectors of malaria -- can fly at least one mile; Aedes aegypti -- vectors of yellow fever -- can travel a few hundred yards; other species have been known to travel 100 miles or more when the wind is favorable.

Mosquitoes will breed in practically any collection of water which stands longer than five to seven days.

Since all mosquitoes require water for breeding, the control of standing water is the most effective means of eliminating mosquitoes. This may be accomplished by (1) ensuring the proper disposal of discarded containers and filling in any holes, ruts, or other low areas in which water can collect and stand; and (2) applying an insecticide to water holes that cannot be eliminated at sufficient intervals to kill the mosquito larvae. Insecticides for the control of larvae may be applied in various formulations. Only a small quantity of the actual chemical ingredient is necessary to attain control.

Adult mosquitoes, as well as other insects, may be controlled by clearing away such mosquito resting places as tall grass, bushes, and

vines; by space spraying with an insecticide; and by applying a residual insecticide to human shelters, food preparation areas, and latrines. In addition, any living area may be mosquito-proofed with nets and screens.

Loose clothing that covers the body may afford a large measure of protection (mosquitoes can bite through most clothing when worn tightly). If available, insect repellents may also provide individual protection.

#### 4.4 EMERGENCY SANITATION MEASURES FOR LOUSE CONTROL

Louse-borne diseases include typhus fever, relapsing fever, and trench fever.

Lice are particularly associated with cold weather. Although they are present in the higher altitudes of the tropics, they are found more commonly in temperate and subarctic areas where people wear heavy clothing in several layers.

Lice thrive during famines and wars and among people suffering economic hardship. Whenever large groups of people are deprived of homes, clothing, and bathing facilities, lice usually appear. If they are unable to feed, they die in a relatively short time. In the higher temperatures, lice require more food and die even more quickly if they are deprived of it.

Lice are spread by contact with infested persons or with things onto which adult lice or eggs have dropped, such as straw, debris, blankets, clothing, or latrine seats. Lice are controlled by dusting hair, clothing, and bedding and living quarters with a low toxicity (for humans) insecticide such as Sevin (trademark Union Carbide Corporation).

#### 4.5 EMERGENCY SANITATION MEASURES FOR FLEA CONTROL

The female flea lays her eggs in nests of rodents or in places where dogs and cats sleep. Certain insecticides may be used to control fleas on animals except for cats, rabbits, and other animals that clean themselves by licking. Merely dusting the animals with an appropriate insecticide, however, will not control the fleas, as flea eggs and larvae are in the debris about the areas where the animals rest. Unless these areas are properly treated, reinfestation will take place.

Should a plague epidemic occur, dusting with insecticides to kill fleas must always be accomplished before rat-poisoning operations are started; otherwise the fleas will leave the dead rodents and attack man.

When rats or other flea-infested animals enter buildings, the fleas may infest the cracks and crevices in the floors. These fleas may deposit eggs which hatch into larvae which continue to live and develop. Good cleaning practices will do much to eliminate or prevent such infestations.

Individuals should employ protective measures in flea-infested areas. This is especially important for persons who perform flea and rodent control work where plague and typhus fever (murine) are present. Clothing, particularly the trouser legs, should be impregnated with insect repellent. Insect repellent should also be applied to the hands and other exposed portions of the body.

#### 4.6 USE OF INSECTICIDES FOR INSECT CONTROL

Many insecticides are available for the control of various insects; over 50,000 separate preparations are registered as insecticides in the United States. A large proportion of these are agricultural insecticides used for specific crops and specific insects.



Appendix C presents currently available pesticides for the control of:

- (a) Rodents
- (b) Flying insects, and
- (c) Non-flying insects

#### **4.6.1 Number of Pesticides Available**

Appendix B presents the commercial names of 25 rodenticides, about 100 pesticides to be used against flying insects, and more than 180 pesticides to be used against non-flying insects. Not all of these pesticides are available in all areas of the United States. Rather the large number of pesticides reflects the trend by pesticide manufacturers to formulate pesticide with a very narrow range of effectiveness designed to kill specific pests at a specific period in a pest's life cycle. In any one area of the United States only a portion of pesticides manufactured may be available. It is important to note that changes occur in the pesticides available at any one time. Further, new pesticides are added and others removed from the market.

#### **4.6.2 Substitutability of Pesticides**

To a significant degree, the pesticides formulated to a specific purpose (i.e., pesticides to be used against flying insects and non-flying insects) may be substituted for each other. The feasibility of such substitution depends on specific pesticides.

#### **4.6.3 Form of Pesticides Available**

Essentially all of these pesticides may be available in any area in a number of different forms:

- (1) concentrates of active ingredients,
- (2) dose format (diluted) ingredients,

- (3) emulsifiable concentrates,
- (4) wettable powders,
- (5) bait doses,
- (6) dusts,
- (7) granules,
- (8) pressurized sprays, and
- (9) smokes.

#### **4.6.4 Equipment Used in Pesticide Application**

Complex, specially designed equipment such as crop duster airplanes can be used for pesticide application, but essentially all pesticides may be applied using conventional equipment found in most households such as hand sprayers, water propelled sprayers, and garden pesticides applicators and fertilizer spreaders.

#### **4.6.5 Dosages of Pesticides**

It is not possible to prescribe appropriate dosages of pesticides without information as to the specific form of the pesticide. Appropriate dosages for all pesticides are clearly shown on retail containers.

#### **4.6.6 Location of Pesticides**

Typical locations of pesticides are as follows:

- (1) Retail stores (for household size pesticide formulas)
- (2) Garden supply establishments
- (3) Agricultural supply establishments
- (4) Pesticide formulators

## 5. PUBLIC INFORMATION ACTIVITIES

There is a critical need in a postemergency period to inform the public of specific sanitation and public health issues.

At the minimum public information needs to be provided on the following:

1. the safety of the available water in the postemergency period and the need to disinfect the water at the household level of consumption;
2. water allowances;
3. sources of water, and water transport and supply information;
4. waste disposal procedures; and
5. availability of chemicals to be used at the household level for water disinfection

The following sections of this guide should be copied and distributed to the public in an emergency:

- 1.3 Disinfection/treatment of water.
- 1.4 Emergency transport of water for households.
- 3.4 Temporary latrines.
- 3.5 Temporary kitchen and related waste disposal sites.
- 3.6 Soakage pits.
- 3.7 Grease traps.

**APPENDIX A**

**Location of Disinfection Chemicals Manufacturing Plants**

## A-1

Table A-1

Company, Plant, Location and Annual Capacity of  
Chlorine Manufacturers, U.S. 1984

<u>State</u>	<u>County</u>	<u>Metropolitan Area</u>	<u>Company</u>	<u>Annual Capacity of Chlorine in Thousands of Metric Tons</u>
Alabama	Colbert	Muscle Shoals	Diamond Shamrock Corporation	136
Alabama	Mobile	Mobile	Diamond Shamrock Corporation	40
Alabama	Washington	McIntosh	Olin Corporation	350
Alabama	Mobile	LeMoyne	Stauffer Chemical Company	70
California	Contra Costa	Pittsburg	Dow Chemical	180
Delaware	New Castle	Delaware City	Diamond Shamrock Corporation	130
Georgia	Glynn	Brunswick	Brunswick Pulp & Paper Co.	30
Georgia	Glynn	Brunswick	LCP Chemicals and Plastics	50
Georgia	Richmond	Augusta	Olin Corporation	100
Illinois	St. Clair	Sauget	Monsanto Company	40
Indiana	Posey	Mount Vernon	General Electric	50
Kansas	Sedgwick	Wichita	Vulcan Materials	240
Kentucky	Marshall	Calvert City	B.F. Goodrich Company	116
Louisiana	Ascension	Geismar	Vulcan Materials Company	220
Louisiana	Calcasieu	Lake Charles	PPG Industries, Inc.	1050

Table A-1 (Continued)

Louisiana	East Baton Rouge	Rouge	Ethyl Corporation	65
Louisiana	East Baton Rouge	Baton Rouge	Formosa Plastics Company	180
Louisiana	Iberville	Plaquemine	Dow Chemical	1050
Louisiana	Iberville	Plaquemine	Georgian Chemical Corporation	410
Louisiana	Iberville	St. Gabriel	Stouffer Chemical Corporation	160
Louisiana	St. James	Gramercy	Kaiser Aluminum & Chemical	180
Louisiana	St. James	Convent	B.F. Goodrich Company	260
Louisiana	St. Charles	Taft	Occidental Petroleum	250
Maine	Penobscot	Orrington	LCP Chemicals & Plastics	75
Michigan	Muskegon	Montague	Occidental Petroleum	75
Michigan	Wayne	Wyandotte	Peruwalt Corporation	90
Mississippi	Warren	Vicksburg	Vertac Chemical Corporation	30
Nevada	Clark	Henderson	Stouffer Chemical Corporation	104
New Jersey	Union	Linden	LCP Chemicals Corporation	150
New York	Niagara	Niagara Falls	E.I. DuPont	80
New York	Niagara	Niagara Falls	Occidental Petroleum	320
New York	Niagara	Niagara Falls	Olin Corporation	84
New York	Onondaga	Syracuse	LCP Chemicals & Plastics	80

Table A-1 (Continued)

North Carolina	Columbus	Acme	LCP Chemicals Corporation	50
Ohio	Ashtabula	Ashtabula	RMI Company	64
Ohio	Ashtabula	Ashtabula	LCP Chemicals & Plastics	50
Oklahoma	Muskogee	Muskogee	Fort Howard Paper Company	4
Oregon	Linn	Albany	Oregon Metallurgical Corporation	1
Oregon	Multnomah	Portland	Pennwalt Corporation	136
Tennessee	Bradley	Charleston	Olin Corporation	230
Texas	Brazoria	Freeport	Dow Chemical	2400
Texas	Brazoria	Oyster Creek	Dow Chemical	320
Texas	Harris	La Porta	Diamond Shamrock Corporation	465
Texas	Harris	Deer Park	Diamond Shamrock Corporation	360
Texas	Nueces	Corpus Christi	E.I. DuPont	500
Texas	Harris	Cedar Bayou	Mobay Chemical Corporation	80
Utah	Tooele	Rowley	AMAX, Inc.	20
Virginia	Hopewell Prince Georges	Hopewell	Hercules, Inc.	20
Washington	Cowlitz	Longview	Weyerhaeuser	135
Washington	Pierce	Tacoma	Occidental Petroleum	180
Washington	Pierce	Tacoma	Pennwalt Corporation	80
Washington	Whatcom	Bellingham	Georgia-Pacific Corporation	80
West Virginia	Kanawha	So. Charleston	FMC Corporation	263
West Virginia	Marshall	Moundsville	LCP Chemicals & Plastics	80
West Virginia	Wetzel	Natrium	PPG Industries, Inc.	255
Wisconsin	Brown	Green Bay	Fort Howard Paper Company	5
Wisconsin	Wood	Port Edwards	Vulcan Materials Company	65

Sources: Completion based on information available from CIE, Chemical Week, industrial directories of various states, and industry interviews.

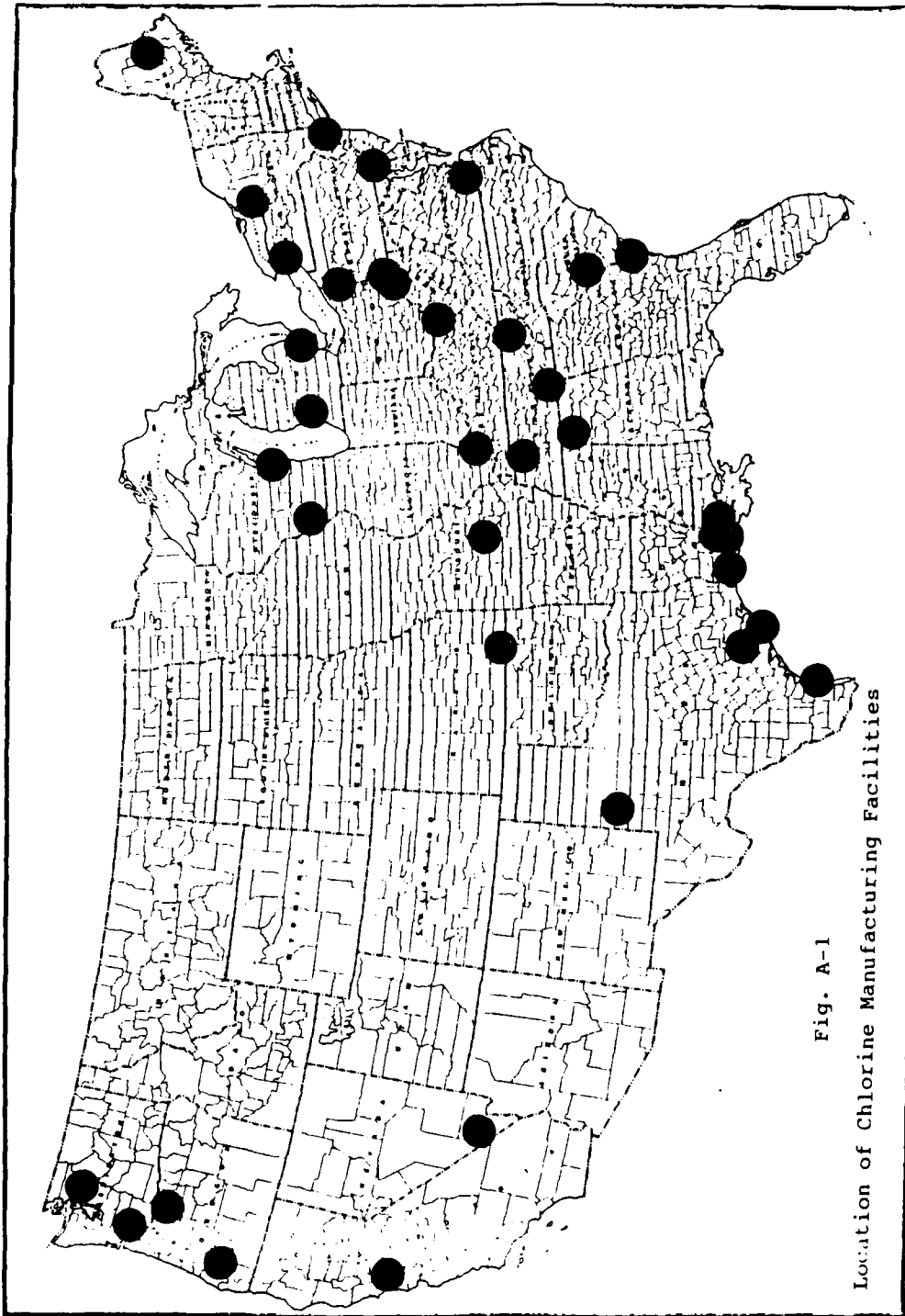


Fig. A-1

Location of Chlorine Manufacturing Facilities



Table A-2

Company, Plant, Location and Annual Capacity of  
Sodium Hypochlorite Manufacturers, U.S. 1984

<u>State</u>	<u>County</u>	<u>Metropolitan Area</u>	<u>Company</u>
Alabama	Colbert	Muscle Shoals	Thompson Hayward Chemical Co.
Alabama	Mobile	Evans City	Thompson Hayward Chemical Co.
Alabama	Mobile	Mobile	Scott Paper Co.
Arizona	Pinal	Eloy	Hasa Chemical Inc.
Arizona	Maricopa	Phoenix	Georgia-Pacific Corp.
Arizona	Maricopa	Phoenix	Hill Brothers Chemical Corp.
Arkansas	Crittenden	West Memphis	Nuway Products Inc.
California	Contra Costa	Antioch	Imperial West Chemical Co.
California	Los Angeles	City of Commerce	Georgia-Pacific Corp.
California	Los Angeles	Los Angeles	Clorox Company
California	Los Angeles	South Gate	Purex Corp.
California	Orange	Anaheim	Continental Chemical Company
California	Sacramento	Sacramento	Continental Chemical Company
California	San Diego	San Diego	Baron Blakeslee Inc.
California	San Joaquin	Tracy	All-Pure
California	San Joaquin	Tracy	Georgia-Pacific Corp.

Table A-2 (Continued)

California	Soleno	Fairfield	Clorox Company
Colorado	Adams	Commerce City	Dixie Petro Chem.
Colorado	Boulder	Rocky Flats	Thoro Products Co.
Colorado	Denver	Denver	Purex Corporation
Connecticut	New Haven	New Haven	H. Krevit & Co. Inc.
Delaware	New Castle	Delaware City	Chloramone Corp. Florida
Florida	Dade	Miami	U.S. Chlorine Inc.
Florida	Dade	Opa Locka	Kleen-Brite Laboratories, Inc.
Florida	Dade	Medley	Allied Universal Chlorine
Florida	Duval	Jacksonville	Jones Chemical, Inc.
Florida	Hillsborough	Tampa	Thompson Hayward Chemical Co.
Florida	Pinellas	Clearwater	Clearwater Chemical Corp.
Florida	Pinellas	St. Petersburg	Jones Chemical Co.
Florida	Polk	Auburndale	Purex Corp.
Georgia	Clayton	Forrest Park	Chlorox Company
Georgia	Cobb	Powder Springs	Thompson Hayward Chemical Co.
Georgia	Fulton	Atlanta	Purex Corp.
Georgia	Spalding	Griffin	Lowell Bleachery South
Georgia	Witfield	Dalton	Farm & Industrial Chemical Co.

Table A-2 (Continued)

Illinois	Cook	Chicago	Chlorox Company
Illinois	Cook	Chicago	Purex Corp.
Illinois	Cook	Lemont	K.A. Steel Chemicals, Inc.
Illinois	Macon	Decatur	A.E. Staley Mfg.
Illinois	St. Clair	Dupo	Vertex Chemical Co.
Illinois	Winnebago	Rockton	Beloit Corp.
Indiana	Lake	Hammond	American Maize Producers Co.
Indiana	Marion	Indianapolis	Erbrich Products Co., Inc.
Iowa	Clinton	DeWitt	Vertex Chemical Co.
Kansas	Allen	Iola	Treat-Rite Water Lab, Inc.
Louisiana	Iberville	St. Gabriel	Thompson Hayward Chemical Co.
Louisiana	Orleans	New Orleans	Purex Corp.
Louisiana	West Feliciana	St. Francisville	Crown Zellerbach
Maine	Cumberland	Westbrook	Scott Paper Company
Maine	Penobscot	Orrington	LCP Chemicals & Plastics, Inc.
Maryland	Baltimore City	Baltimore	Delta Chemical Corp.
Maryland	Frederick	Frederick	Chlorox Company
Massachusetts	Bristol	Attleboro	Montrose-Haeuser Company
Michigan	Wayne	Riverview	Jones Chemical Inc.

---

Table A-2 (Continued)

Michigan	Wayne	Romulus	High-Po-Chlor
Minnesota	Ramsey	St. Paul	Dixie Petro Chem.
Minnesota	Ramsey	St. Paul	Hawkins Chemical Inc.
Minnesota	Ramsey	St. Paul	Purex Corp.
Mississippi	Clay	West Point	Artex Int'l Inc.
Missouri	Jackson	Kansas City	Chlorox Company
Missouri	St. Louis City	St. Louis	Purex Corp.
New Hampshire	Hillsborough	Merrimack	Jones Chemical Inc.
New Jersey	Hudson	Jersey City	Chlorox Company
New Jersey	Hudson	Kerney	Kuehne Chemical Company Inc.
New Jersey	Hudson	South Kerney	Arden Chemical Co.
New York	Niagara	Niagara Falls	Occidental Petroleum Corp.
New York	Onondaga	Syracuse	LCP Chemicals & Plastics, Inc.
North Carolina	Columbus	Acme	LCP Chemicals & Plastics, Inc.
North Carolina	Craver	New Bern	Weyerhauser Co.
North Carolina	Guilford	High Point	High Point Chemical Corp.
North Carolina	Mechlenburg	Charlotte	Burriss Chemical Inc.
North Carolina	Mecklenburg	Charlotte	Chlorox Company
North Carolina	Mecklenburg	Charlotte	Jones Chemical Inc.

Table A-2 (Continued)

North Carolina	Washington	Plymouth	Weyerhaeuser Co.
Ohio	Cuyahoga	Cleveland	Chlorox Company
Ohio	Lucas	Toledo	Purex Corp.
Ohio	Montgomery	Dayton	Miami Products & Chemical Co.
Ohio	Tuscarawas	Dover	ICI Industries
Oklahoma	McCurtain	Valiant	Weyerhaeuser Co.
Oregon	Lane	Springfield	Weyerhaeuser Co.
Oregon	Linn	Albany	Oregon Metallurgical Corp.
Pennsylvania	Bucks	Bristol	Purex Corp.
Pennsylvania	Bucks	Shoemakersville	Wolfe Dye & Bleach Works, Inc.
Pennsylvania	Butler	Mars	James Austin Co.
Pennsylvania	Greene	Morrisville	Wonder Chemical Co.
Pennsylvania	Lancaster	Downieville	James Austin Co.
Pennsylvania	Lancaster	Euphrata	Walter W. Moyer Co.
Pennsylvania	Lawrence	West Pittsburgh	Reactive Metals & Alloy Company
Pennsylvania	Schuylkill	Port Carbon	Pittsville Bleach & Dye Company
Rhode Island	Providence	Fields Point	George Mann & Co. Inc.
South Carolina	Greenville	Mauldin	Morton Thiokol Inc.
Tennessee	McMinn	Niota	Dycho Company

Table A-2 (Continued)

Tennessee	Shelby	Memphis	Thompson Hayward Chemical Co.
Tennessee	Shelby	Memphis	Vertex Chemical Co.
Texas	Cameron	San Benito	South Texas Chlorine Inc.
Texas	Harris	Bayport	Dixie Petro Chemical
Texas	Harris	Dallas	Purex Corp.
Texas	Harris	Dallas	Thompson Hayward Chemical Co.
Texas	Harris	Houston	Chlorox Company
Texas	Tarrant	Ft. Worth	Dixie Petro Chem.
Texas	Tarrant	Ft. Worth	Georgia Pacific Corp.
Texas	Tarrant	Ft. Worth	Wright Inc.
Texas	Travis	Austin	Southwestern Analytical Chemical
Utah	Salt Lake	Salt Lake City	Thatcher Chemical Co.
Virginia	Salem	Salem	Purex Corp.
Washington	King	Auburn	Georgia-Pacific Corp.
Washington	Grays Harbor	Cosmopolis	Weyerhaeuser Co.
Washington	Cowlitz	Longview	Weyerhaeuser Co.
Washington	Pierce	Tacoma	Jones Chemical Inc.
Washington	Pierce	Tacoma	Occidental Petroleum Corp.
Washington	Pierce	Tacoma	Purex Corp.
Wisconsin	Milwaukee	Milwaukee	Hydrite Chemical Co.

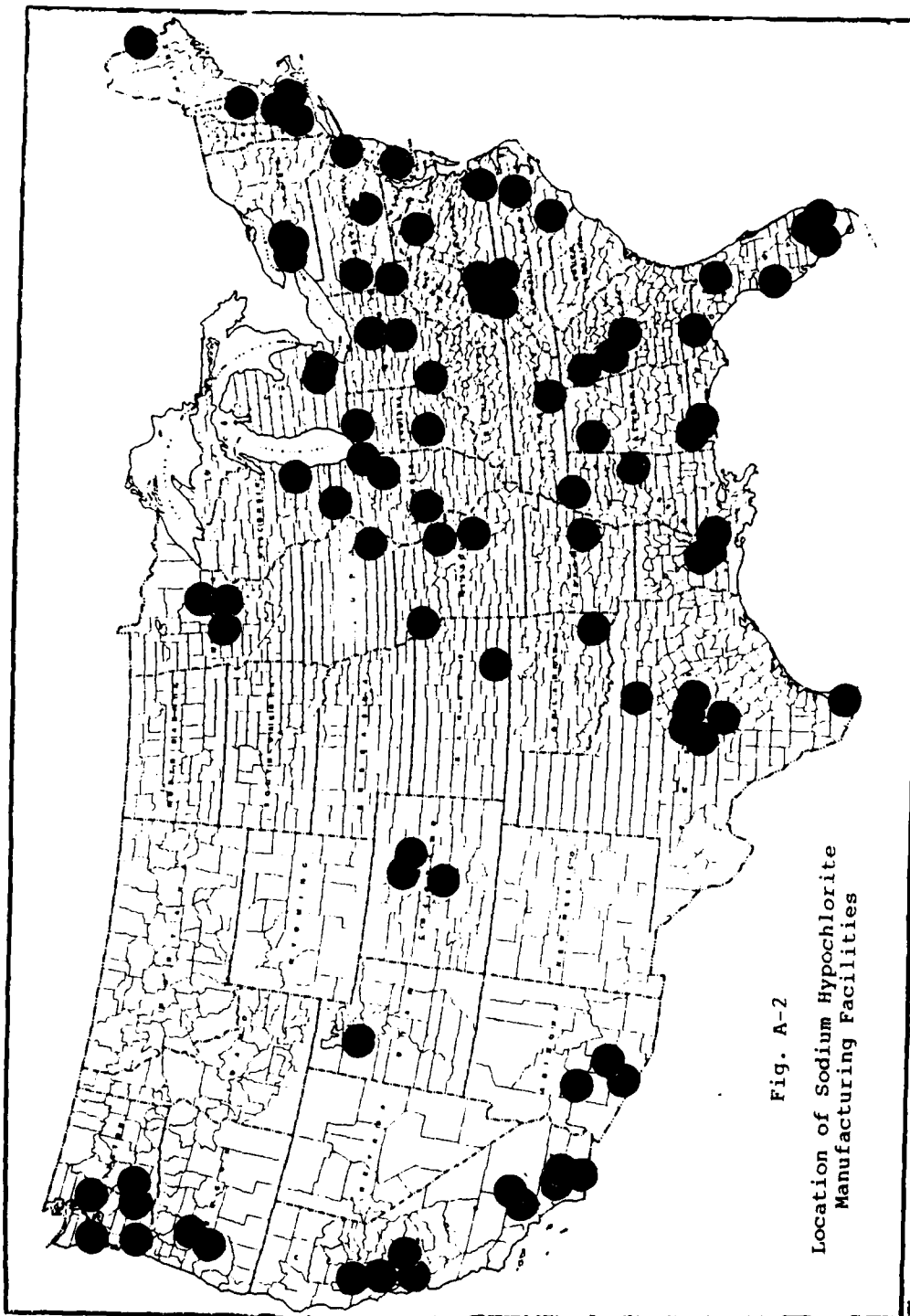


Fig. A-2  
Location of Sodium Hypochlorite  
Manufacturing Facilities

Table A-3

Company, Plant, Location and Annual Capacity of  
Calcium Hypochlorite Manufacturers, U.S., 1984

<u>State</u>	<u>County</u>	<u>Metropolitan Area</u>	<u>Company</u>	<u>Annual Capacity of Calcium Hydrochlorite in Tons</u>
Alabama	Marengo	Demopolis	Weslev Chemical	5,000
Tennessee	Bradley	Charleston	Olin Corp.	70,000
West Virginia	Wetzel	Natrium	PPG	38,000

Source: Interviews with Olin and Wesley Chemical Marketing Reporter, January 1986.



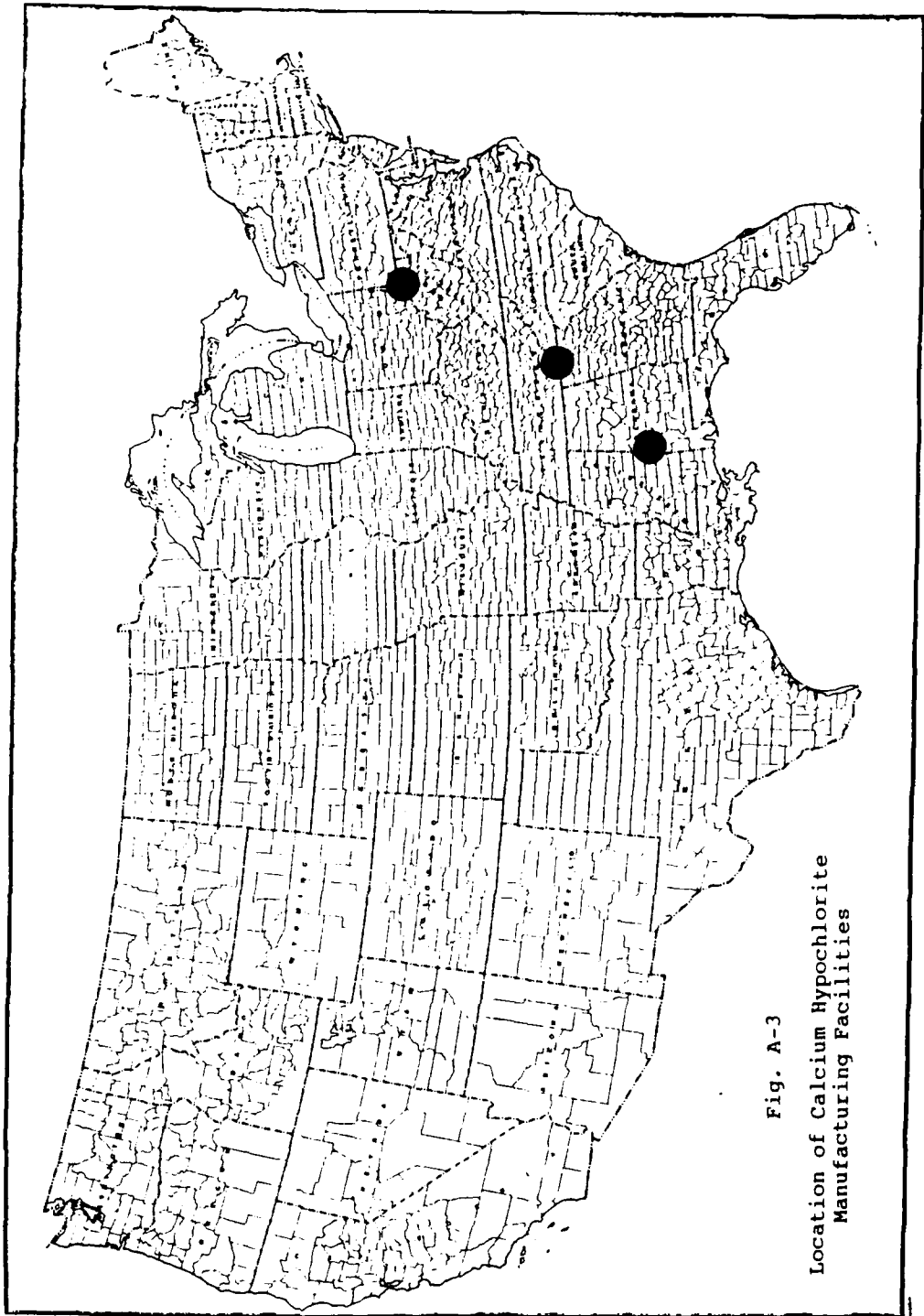


Fig. A-3  
Location of Calcium Hypochlorite  
Manufacturing Facilities

Table A-4

Company, Plant, Location and Annual Capacity  
of Bromine Manufacturers, U.S. 1984

<u>State</u>	<u>County</u>	<u>Metropolitan Area</u>	<u>Company</u>	<u>Annual Capacity of Bromine in MM Lbs</u>
Arkansas	Columbia	Magnolia	Dow Chemical USA	120
Arkansas	Columbia	Magnolis	Ethyl Corp.	160
Arkansas	Union	El Dorado	Arkansas Chemicals, Inc.	40
Arkansas	Union	El Dorado	Great Lakes Chemical	125
Arkansas	Union	Marysville	Great Lakes Chemical	53
Michigan	Bay	Midland	Dow Chemical USA	120
Michigan	Mason	Luddington	Dow Chemical USA	15
Michigan	Mason	Manistee	Norton-Thiokol	25

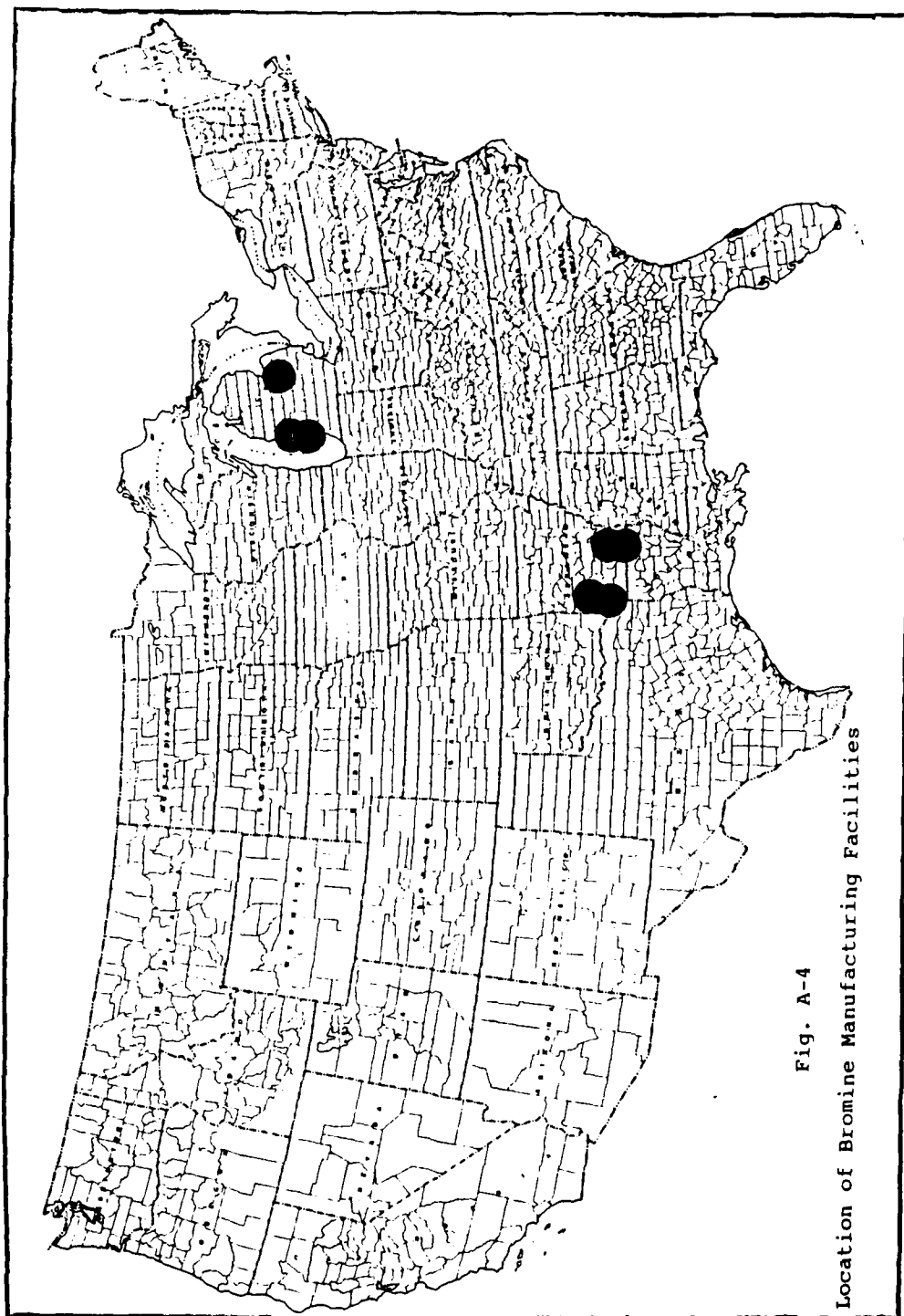


Fig. A-4

Location of Bromine Manufacturing Facilities

Table A-5

Company, Plant, Location and Annual Capacity  
of Iodine Manufacturers, U.S. 1985

<u>State</u>	<u>County</u>	<u>Metropolitan Area</u>	<u>Company</u>	<u>Annual Capacity of Iodine in Metric Tons</u>
Michigan	Bay	Midland	Dow Chemical USA	500
Oklahoma	Woodward	Woodward	Woodward Iodine Corp.	2,000
Oklahoma	Kingfisher	Dover	North American Brine Resources	350

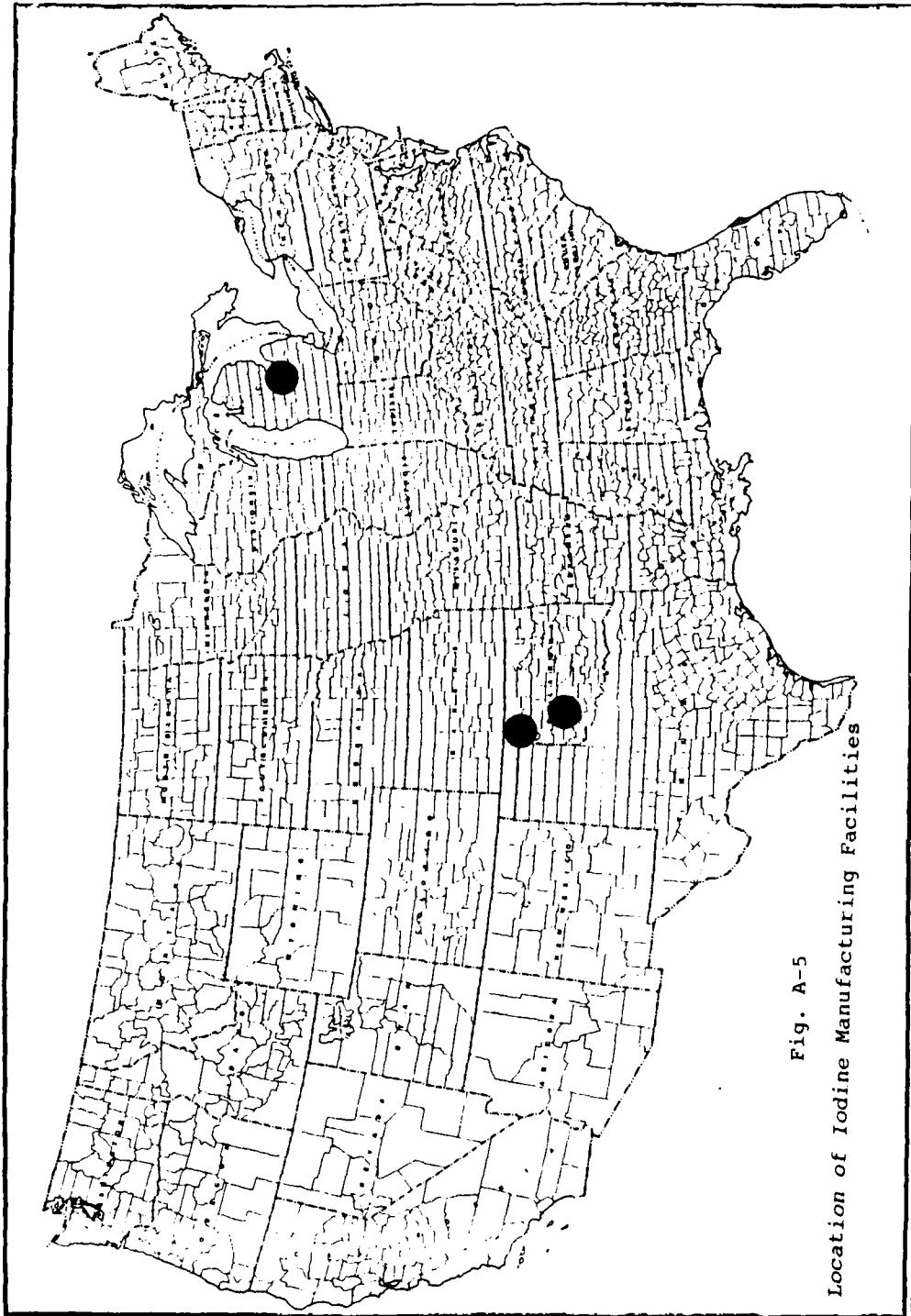


Fig. A-5

Location of Iodine Manufacturing Facilities

APPENDIX B

Trade Names for Rodenticides

Appendix B-1

Trade Names for Rodenticides

1) ANTU

Chemical Name

alpha-Naphthylthiourea

Trade Names:

a. Krysid

2) FLUOROACETAMIDE

Trade Names:

a. Compound 1081  
b. Fluorakid 100  
c. Fussol

3) TALON (Brodifacoum)

Chemical Name

3-[3-4'-bromo[1-1'-biphenyl]-4yl]-1,2,3,4-tetrahydro-1-naphthaleny]-4-hydroxy-2H-1-benzopyran-2-one

Trade Names:

a. Havoc	e. Talon
b. Klerat	f. Valid
c. PP581	g. WBA8119
d. Ratak Plus	h. Weather-Bloc Bait

4) WARFARIN

Chemical Name

4-hydroxy-3-(3-oxo-1-phenylbutyl)-2H-1-benzopyran-2-one

Trade Names:

a. CoRax	g. Panwarfin	m. Zoocoumarin
b. Coumafene	h. RAX	
c. Cov-R-Tox	i. Rodex	
d. Dethmor	j. Rodex Blox	
e. Kypfarin	k. Tox-Hid	
f. Liqua-Tox	l. Warfarin	

B-2  
Appendix B-2

Trade Names for Insecticides for Flying Insects

1) ABATE (Temphos)

Chemical Name

O'-O-(thiodi-4,1-phyethylene) bis(O'-O-dimethyl phosphorothioate)

Trade Names:

- |             |            |
|-------------|------------|
| a. Abathion | e. Abate   |
| b. Ecopro   | f. Lypor   |
| c. Swebate  | g. Nimitex |
| d. Biothion |            |

2) DIAZINON

Chemical Name

O,O-diethyl O-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl]  
phosphorothioate

Trade Names:

- |              |                |
|--------------|----------------|
| a. Agrox     | p. Diagran     |
| b. Basudin   | q. Diaterr-Fox |
| c. Dazzel    | r. Diazatol    |
| d. Dianon    | s. Diazol      |
| e. Diazajet  | t. Dyzol       |
| f. Diazide   | u. Fezudin     |
| g. Dizinon   | v. Garden-tox  |
| h. D.z.n.    | w. Kayazol     |
| i. G-24480   | x. Neocidol    |
| j. Kayazinon | y. Nipsan      |
| k. Knox Out  | z. Spectracide |
| l. Nucidol   |                |
| m. Sarolex   |                |
| n. Alfa-tox  |                |
| o. D-264     |                |

3) DIBROM

Chemical Name

1,2-dibromo-2,2-dichloroethyl dimethyl phosphate.



Trade Names: (Dibrom contd.)

- a. Bromex
- b. Dibrom
- c. Naled
- d. RE-4355

4) FENTHIONChemical Name

O,O-dimethyl O-[3-methyl-4-(methylthio)phenyl]-phosphorothioate.

Trade Names:

- |                 |                 |             |            |
|-----------------|-----------------|-------------|------------|
| a. Baycid       | e. Mercaptophos | i. Baytex   | m. Talodex |
| b. Bayer S-1752 | f. Spotton      | j. Entex    |            |
| c. ENT 25540    | g. Tiguvon      | k. Lebaycid |            |
| d. Figuron      | h. Bay 29493    | l. Queleto  |            |

5) MALATHIONChemical Name

Diethyl (dimethoxyphosphinothioyl) thiobutanedioate.

Trade Names:

- |                  |                     |
|------------------|---------------------|
| a. Calmathion    | m. Kop-Thion        |
| b. Celthion      | n. Kypfos           |
| c. Chemathion    | o. Malaspray        |
| d. Cythion       | p. Malamar          |
| e. E14049        | q. Malapele         |
| f. Emmatos       | r. Malathion        |
| g. Emmatos Extra | s. Malathiozoo      |
| h. Emmaton       | t. Malatol          |
| i. For-Mal       | u. Maltox           |
| j. Fyfanon       | v. Sumitox          |
| k. Hilthion      | w. Vegfru Malathion |
| l. Karbofos      | x. Zithiol          |

6) METHOXYCHLORChemical Name

1,1'-(2,2,2-trichloroethylidene)bis(4-methoxybenzene).

Trade Names:

- |             |                 |
|-------------|-----------------|
| a. Chemform | d. Moxie        |
| b. DMDT     | e. Methoxychlor |
| c. Marylate |                 |

7) PROPOXUR

Chemical Name:

2-(1-methylethoxy)phenyl methylcarbamate.

Trade Names:

- |                       |              |
|-----------------------|--------------|
| a. 58 12,315          | g. Bay 39007 |
| b. Baygen             | h. Blattanex |
| c. Propogon           | i. Sendran   |
| d. Sunicide           | j. Tendex    |
| e. Tugon Fliegenkugel | k. Uden      |
| f. Undene             |              |

8) RABON (Tetrachlorvinphos)

Chemical Name

2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate.

Trade Names:

- a. Gardona
- b. Rabon

B-5  
Appendix B-3

Insecticides Used Against Non-Flying Insects

1) DURSBAN (Chlorpyrifos)

Chemical Names

O,O-diethyl O-3,5,6-trichloro-2-pyridyl phosphorothioate.  
phosphorothioate.

Trade Names:

- a. Dursban
- b. Lorsban
- c. Chlorpyrifos
- d. Reldan

2) DIAZINON

Chemical Name

O,O-diethyl O-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl]

- |              |                |                |
|--------------|----------------|----------------|
| a. Ayrox     | k. Knox Out    | u. Fezudin     |
| b. Basudin   | l. Nucidol     | v. Garden-tox  |
| c. Dazzel    | m. Sarolex     | w. Kayazol     |
| d. Dianon    | n. Alfa-tox    | x. Neocidol    |
| e. Diazajet  | o. D-264       | y. Nipsan      |
| f. Diazide   | p. Diagan      | z. Spectracide |
| g. Dizinon   | q. Diaterr-Fos |                |
| h. D.z.n.    | r. Diazatol    |                |
| i. G-24480   | s. Diazol      |                |
| j. Kayazinon | t. Dyzol       |                |

3) DIMETHOATE

Chemical Name

O,O-dimethyl-S-[2-(methylamino)-2-oxoethyl] phosphorodithioate.

Trade Names:

- |               |               |
|---------------|---------------|
| a. Cygon      | f. Fostion MM |
| b. De-Fend    | g. L395       |
| c. Dimetate   | h. Pefekthion |
| d. EI 12,880  | i. Rogor      |
| e. Ferkethion | j. Roxion     |

4) FICAMChemical Name

2,2-dimethyl-benzo-1,3-dioxol-4-yl-N-methyl carbamate.

Trade Names:

- |            |                 |
|------------|-----------------|
| a. Dycarb  | h. Ficam        |
| b. Ficam D | i. Ficam Plus   |
| c. Ficam W | j. Ficam ULV    |
| d. Garvox  | k. Multamat     |
| e. NC 6897 | l. Nihil        |
| f. Seedox  | m. Tatoon (FBC) |
| g. Turcam  |                 |

5) HEPTACHLORChemical Name

1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methano-1H indene.

Trade Names:

- |                    |                 |
|--------------------|-----------------|
| a. Drinox          | e. E-3314       |
| b. Gold Crest H-60 | f. Heptagran    |
| c. Heptalube       | g. Heptamul     |
| d. Heptox          | h. Velsicol 104 |

6) LANNATE (Methomyl)Chemical Name

Methyl-N-[[ (methylamino) carbonyl]oxy]-ethanimidothioate.

Trade Names:

- a. DuPont 1179
- b. Lannate
- c. Nudrin

7) LINDANEChemical Name

1,2,3,4,5,6-hexachloro-cyclohexane.

Trade Names: (Lindane contd.)

a. Agronexit	k. Inexit	u. Lindapoudre
b. Agrox 3-way	l. Isotox	v. Lindaterra
c. Exagama	m. Kwell	w. Lindex
d. Forlin	n. Lacco Hi Lin	x. Lindust
e. Gallogama	o. Lacco Lin-0-Mulsion	y. Lin-0-Sol
f. Gamaphex	p. Lindafor	z. Lintox
g. Gammex	q. Lindagram	y. Lin-0-Sol
h. Gammexane	r. Lindagronox	z. Lintox
i. Gammopaz	s. Lindalo	aa. Nexit
j. Gexane	t. Lindamul	bb. Novigam
		cc. Lilvano1

8) MALATHIONChemical Name

Diethyl (dimethoxyphosphinothioyl)thiobutanedioate.

Trade Names

a. Calmathion	i. For-Mal	q. Malapele
b. Celthion	j. Fyfanon	r. Malathion
c. Chemathion	k. Hilthion	s. Malathiozoo
d. Cythioin	l. Karbofos	t. Malato1
e. E14049	m. Kop-Thion	u. Maltox
f. Emmatos	n. Kypfos	v. Sumitox
g. Emmatos Extra	o. Malaspray	w. Vegfru Malathion
h. Emmaton	p. Malamar	x. Zithiol

9) METHYL PARATHIONChemical Name

O,O-dimethyl-O-4-nitrophenyl phosphorothioate.

Trade Names:

a. Cekumethion	j. Devithion
b. Dimethyl Parathio	k. Drexel Methyl Parathion 4E
c. E 601	l. Folido M
d. Fosferno M50	m. Gearphox
e. Metacide	n. Metaphox
f. Methyl Parathion	o. Parataf
g. Paratox	p. Partron M
h. Penncap-M	q. Tekwaisa
i. Wofatox	

10) PARATHIONChemical Name

0.0-diethyl 0-4-nitrophenyl phosphorothioate.

Trade Names:

- |                  |                    |
|------------------|--------------------|
| a. AC 3422       | m. Alkron          |
| b. Alleron       | n. Aphonite        |
| c. Bladan        | o. Corothion       |
| d. Danthion      | p. E-605           |
| e. Ent 15108     | q. Ethyl Parathion |
| f. Etilon        | r. Folidol E-605   |
| g. Fosferno 50   | s. Niran           |
| h. Nitrostigmine | t. Orthophos       |
| i. Panthion      | u. Paramar         |
| j. Parawet       | v. Parathene       |
| k. Rhodiatosx    | w. Phoskil         |
| l. Stathion      | x. Soprathion      |
|                  | y. Thiophos        |

11) PROPOXURChemical Name

2-(1-methylethoxy)phenyl methylcarbamate.

Trade Names:

- |                       |              |
|-----------------------|--------------|
| a. 58 12.315          | g. Bay 39007 |
| b. Baygon             | h. Blattanex |
| c. Propogon           | i. Sendran   |
| d. Sunicide           | j. Tendex    |
| e. Tugon Fliegenkugel | k. Unden     |
| f. Undene             |              |

12) SEVIN (Carbaryl)Chemical Name

1-Naphthyl N-methylcarbamate.

Trade Names:

- |              |               |
|--------------|---------------|
| a. Carbamine | i. Carbaryl   |
| b. Cekubaryl | j. Denapon    |
| c. Devicarb  | k. Divcarbam  |
| d. Hexavin   | l. Karbaspray |
| e. Nac       | m. Ravyon     |
| f. Septene   | n. Sevin      |
| g. Tercyl    | o. Tricarnam  |
| h. UC 7744   |               |

13) RABON (Tetrachlorvinphos)

Chemical Name

2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate.

Trade Names:

- a. Gardona
- b. Rabon

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**EXPEDIENT EMERGENCY SANITATION MEASURES**    Unclassified  
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Oak Ridge National Laboratory, Oak Ridge, TN 37831  
Interagency Agreement: FEMA No. EMW-84-E-1737

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