Bioenvironmental Engineering Environmental Field Manual

Volume 1 - Desktop Reference Guide

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Air Combat Command
Langley AFB, Virginia

BIOENVIRONMENTAL ENGINEERING **FIELD MANUAL 00-1**
AIR COMBAT COMMAND

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FOREWORD

Air Force worldwide contingency operations have highlighted a critical need for environmental and "combat" occupational health surveillance and testing programs in the field. Assuring the safety and occupational health of our people directly affects combat capability during contingency operations and can also impact on operational readiness following their return.

The responsibilities for Air Force environmental and combat occupational health contingency surveillance and testing programs fall directly on the Bioenvironmental Engineering community. We must train and equip our people to meet the demands of this critically important mission. This field manual is but one tool to assist our engineers and technicians in this endeavor. We developed this manual as a memory aid for use in the field by fully qualified Bioenvironmental Engineering Officers and Technicians. It synopsizes testing requirements, processes and procedures. It is not intended as a comprehensive detailed set of checklists that can guide an unqualified person through testing processes. We must assure our people are already trained and qualified before they deploy. This manual will simply serve to organize their thoughts and reinforce what they have already learned.

Two volumes comprise this manual. Volume 1 is the desktop reference guide that includes comprehensive information for use in the office or laboratory. Volume 2 is the pocket reference guide that includes abbreviated information for use in the field. This will be a living document. Based on experiences in the field, I encourage comments and/or recommendations that will improve its value to the community.

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Note: To reduce confusion, all tables and figures are numbered identically in both Volumes 1 and 2 of this field manual. Since fewer tables and figures are used in Volume 2, the numbers are not sequential in nature.

INTRODUCTION

With the requirement to go anywhere anytime, ACC forces can find themselves operating in a variety of locations ranging from bare base operations to fully functional main operating bases. Regardless of the conditions, Bioenvironmental Engineering Services (BES) Officers and Technicians will be required to establish surveillance and testing programs to meet the needs of the deployed forces. This field manual provides the information you will need to establish required surveillance and testing programs.

This manual includes sections on water, waste management, site selection, nuclear, biological, and chemical environmental surveillance, industrial health threat assessments, health risk baselines, and emergency response operations. At the time this manual was published, the Air Force was completing work on a number of deployment teams and equipment packages for the medical community. As the Unit Type Codes (UTCs) for the various teams and equipment packages are complete, they will be included in Appendix E to this field manual.

Section 1
Water

SECTION 1 -WATER

1.1 General. This section provides information and guidance on surveillance and testing of source water, potable water systems, bottled water, and tactical water disinfection and distribution equipment. The information is to be used during training exercises and actual deployments to provide the best possible water for human consumption.

1.2 Potable Water. Safe water is essential to every living organism. Insufficient quantity and quality of drinking water are not only debilitating to the individual, but could have a significant impact on operational readiness. Potable water cannot be taken for granted. It is one of the combat commander's precious resources.

1.2.1 Daily Water Requirements. Daily water requirements for personnel in the field vary. However, it is important to understand that dehydration can occur quickly in both extremely hot and cold climates. An individual subject to high heat stress can lose in excess of one quart (one liter) of water per hour. Sustained dehydration can result in heat stress and deterioration of performance, and if left untreated, ultimately death. Consuming sufficient quantities of water is absolutely necessary to keep personnel in good physical and mental condition. Table 1-1 shows drinking water intake and work/rest cycle requirements for various heat conditions. Table 3-1 provides Air Force planning factors for all water usage requirements. Keep in mind that the body must also replenish the electrolytes (Na, K), essential to proper muscle function, lost through perspiration.

Table 1-1 - Water Intake Requirements (AFOSH Std 48-7)

Heat Condition	Temperature °F (WBGT)	Water Intake (qts/hr)	Work/Rest Cycle (min)
1	78 - 81.9	1/2	Continuous
2	82 - 84.9	1/2	50/10
3	85 - 87.9	1	45/15
4	88 - 89.9	1 1/2	30/30
5	90 & above	2+	20/40

1.2.2 Health Concerns. Water that is not properly treated and disinfected can spread diseases such as cholera, shigellosis, typhoid, and paratyphoid fever. Untreated water can also transmit viral hepatitis, gastroenteritis, and parasitic diseases such as amoebic dysentery, giardiasis, cryptosporidosis, and schistosomiasis. Potable water is free from disease-producing levels of organisms, poisonous substances, chemical or biological agents, and radioactive contaminants. However potable water may not be palatable. Palatable water is pleasing in appearance and taste. It is free from color, turbidity, taste, and odor. Also, it is cool and aerated. **Palatable water may not be potable.**

1.2.3 Quality Standards. Quality standards for potable water vary depending on force structure and duration of use. The DoD Tri-Service standards for field water quality are shown in Table 1-2 and Table 1-3 . As a member nation of both NATO and the Quadripartite Armies (American, British, Canadian, Australian), the United States has agreed to accept and provide water meeting the standards of NATO STANAG 2136 and QSTAG 245 for short-term (1 - 7 days) and long-term (greater than 7 days) use. Table 1-2 shows the minimum acceptable potable water standards for short-term consumption. Table 1-3 shows the minimum acceptable potable water standards for long-term consumption. Table 1-4 shows U.S. drinking water standards that should be adopted as a goal for potable water in the field whenever possible.

1.2.4 Water Sources. Water may be obtained from a variety of sources in the field such as rivers, streams, ponds, lakes, wells, ice, snow, etc. However, all water sources should be considered unsafe until tested and approved for use. Additional factors to consider when selecting water sources are discussed in Section 3, Site Selection.

Table 1-2 - Short-Term Potable Water Standards (AFOSH Std 48-7)

	U.S. Tri-Service		QSTAG 245	STANAG 2136
CONSUMPTION RATE	**5L/Day**	**15 L/Day**	**5 L/Day**	**5 L/Day**
Physical Properties				
Color (Color Unit)	50	50		50
Odor (Threshold Number)	3	3		3
pH	5 - 9	5 - 9	5 - 9.2	5 - 9
Temperature (^{O}C)	4 - 35	4 - 35	4 - 35	4 - 35
TDS (mg/L)	1000	1000	1500	1000
Turbidity (NTU)1	1	5	1	
Chemical Properties				
Arsenic (mg/L)	0.3	0.1	2	0.3
Cyanide (mg/L)	6	2	20	6
Chloride (mg/L)	600	600		600
Lindane (mg/L)	0.6	0.2		
Magnesium (mg/L)	100	30		100
Sulfate (mg/L)	300	100		300
Microbiological				
Coliform (#/100 mL)	1	1	1	1
Virus (#/100 mL)			1	1
Spores/Cyst (#/100 mL)			1	1
Chemical Agents				
Hydrogen cyanide (ug/l)	6	2		
BZ (Incapacitants) (ug/l)	7	2.3		
Lewisite (arsenic fraction) (ug/l)	80	27		
Sulfur mustard (ug/l)	140	47	200	200
Nerve agents (ug/l)				2200
VX	15	5		
GD	12	4		
GB	28	9.3		
GA	140	46		
T-2 toxins (ug/l)	26	8.7		
Radiological				
Radiological	8 uCi/L	3 uCi/L		

Table 1-3 - Long-Term Potable Water Standards (AFOSH Std 48-7)

	U.S. Tri-Service		QSTAG 245	STANAG 2136
CONSUMPTION RATE	**5L/Day**	**15 L/Day**	**5 L/Day**	**5 L/Day**
Physical Properties				
Color (color unit)	15	15	15	15
Odor (threshold number)	3	3		3
pH	5 - 9	5 - 9	5 - 9.2	5 - 9
Temperature (^{O}C)	15 - 22	15 - 22	15 - 22	15 - 22
TDS (mg/L)	1000	1000	1500	1000
Turbidity (NTU)1	1	1	1	1
Chemical Properties				
Arsenic (mg/L)	0.06	0.02	0.05	0.06
Cyanide (mg/L)	6	2	0.5	6
Chloride (mg/L)	600	600	600	600
Lindane (mg/L)	0.6	0.2		
Magnesium (mg/L)	100	30	150	100
Sulfate (mg/L)	300	100	400	300
Microbiological				
Coliform (#/100 mL)	1	1	1	1
Virus (#/100 mL)			1	1
Spores/Cyst (#/100 mL)			1	1
Chemical Agents				
Hydrogen cyanide (ug/l)	6	2		
Mustard (ug/l)			50	50
Nerve agents (ug/l)			5	5
Radiological				
Radiological	.1 uCi/L	.05 uCi/L	.06 uCi/L	2.2 Bq/mL

1.2.5 Public Water Systems. Existing public water systems are the easiest and, in most cases, the safest sources because this water has been treated to some extent. However, this does not preclude the requirement to test the quality of the water. All water from public water systems will be considered unsafe until tested and approved.

1.2.6 Surface Water. Surface waters such as lakes, rivers, streams, and ponds are usually more accessible than other sources and capable of supplying adequate quantities of water. However, this does not preclude the requirement to test the quality of the water. All water from surface sources will be considered unsafe until tested and approved. Water intakes must be placed as far from the bank as possible to minimize the effects of contamination sources along the edge of the water. Also, to avoid picking up mud and other debris, intakes must not be positioned at the surface or bottom of the source.

1.2.7 Ground Water. Ground water such as wells and springs is usually less susceptible to contamination than surface water. However, it is sometimes difficult to determine the adequacy of supplies. All water from ground sources will be considered unsafe until tested and approved. Ground water sources must be at least 100 yards from potential sources of contamination such as latrines, septic tanks, industrial run off, etc

1.2.8 Source Water Testing. Regardless of the source, water quality tests must be performed to determine if the water is potable or can be made potable by purification. Under ideal situations, the nearest supporting lab shown in Table 1-5 should analyze water samples. If supporting labs cannot be used, Bioenvironmental Engineering personnel must test the source water for the properties listed in Table 1-6 using one or more of the water test kits shown. BES personnel must contact supporting labs and coordinate requirements prior to shipping any samples.

Table 1-4 - EPA Public Drinking Water Standards (AFOSH Std 48-7)

Parameter	MCL	MCLG	units	Parameter	MCL	MCLG	units
Organics				Inorganics			
Benzene	0.005	0	mg/L	Arsenic	0.05		mg/L
Carbon tetrachloride	0.005	0	mg/L	Fluoride	4	4	mg/L
o-Dichlorobenzene	0.6	0.6	mg/L	Asbestos	7	7	mfl
para-Dichloroethane	0.075	0.075	mg/L	Barium	2	2	mg/L
1,2-Dichloroethane	0.005	0	mg/L	Cadmium	0.005	0.005	mg/L
cis-1,2-Dichloroethylene	0.07	0.07	mg/L	Chromium	0.1	0.1	mg/L
trans-1,2-Dichloroethylene	0.1	0.1	mg/L	Mercury	0.002	2	mg/L
1,1-Dichloroethylene	0.007	0.007	mg/L	Nitrate (as N)	10	10	mg/L
Dichloromethane	0.005	0	mg/L	Nitrite (as N)	1	1	mg/L
1,2-Dichloropropane	0.005	0	mg/L	Selenium	0.05	0.05	mg/L
Ethylbenzene	0.7	0.7	mg/L	Antimony	0.006	0.006	mg/L
Monochlorobenzene	0.1	0.1	mg/L	Beryllium	0.004	0.004	mg/L
Styrene	0.1	0.1	mg/L	Cyanide	0.2	0.2	mg/L
Tetrachloroethylene	0.005	0	mg/L	Nickel	0.1	0.1	mg/L
Toluene	1	1	mg/L	Thallium	0.002	0.0005	mg/L
1,2,4-Trichlorobenzene	0.07	0.07	mg/L	Lead	0.015	0	mg/L
1,1,1-Trichloroethane	0.2	0.2	mg/L	Copper	1.3	1.3	mg/L
1,1,2-Trichloroethane	0.005	0.003	mg/L	**Radionuclides**			
Trichloroethylene	0.005	0	mg/L	Gross alpha activity	15		pCi/L
Total trihalomethanes	0.1		mg/L	Combined Radium 226/228	5		pCi/L
Vinyl chloride	0.002	0	mg/L	Beta activity, mrem	4		mrem
Xylenes (total)	10	10	mg/L	Strontium 90	8		pCi/L
Benzo(a)pyrene	0.0002	0	mg/L	Tritium	20000		pCi/L
Di(2-ethylhexyl)adipate	0.4	0.4	mg/L	**Secondary Standards**			
Di(2-ethylhexl)phthalate	0.006	0	mg/L	Aluminum	.05-.2		mg/L
Hexachlorobenzene	0.001	0	mg/L	Chloride	250		mg/L
Hexachlorocyclopentadiene	0.05	0.05	mg/L	Color	15		C.U.
2.3.7.8-TCDD (Dioxin)	3E(-8)	0	mg/L	Copper	1		mg/L
Alachlor	0.002	0	mg/L	Corrosivity	>0		LSI
Atrazine	0.003	0.003	mg/L	Fluoride	2		mg/L
Carbofuran	0.04	0.04	mg/L	Foaming Agents	0.5		mg/L
Chlordane	0.002	0	mg/L	Iron	0.3		mg/L
2,4-D	0.07	0.07	mg/L	Manganese	0.05		mg/L
Dalapon	0.2	0.2	mg/L	Odor	3		TON
DBCP	0.0002	0	mg/L	pH	6.5-8		
Dinoseb	0.007	0.007	mg/L	Silver	0.1		mg/L
Diquat	0.02	0.02	mg/L	Sulfate	250		mg/L
Endothall	0.1	0.1	mg/L	Total dissolved solids	500		mg/L
Endrin	0.002	0.002	mg/L	Zinc	5		mg/L
Ethylene dibromide (EDB)	0.00005	0	mg/L				
Glyphosate	0.7	0.7	mg/L				
Heptachlor epoxide	0.0002	0	mg/L				
Heptachlor	0.0004	0	mg/L				
Lindane	0.0002	0.0002	mg/L				
Methoxychlor	0.04	0.04	mg/L				
Oxamyl (Vydate)	0.2	0.2	mg/L				
PCBs	0.0005	0	mg/L				
Pentachlorophenol	0.001	0	mg/L				
Picloram	0.5	0.5	mg/L				
Simazine	0.004	0.004	mg/L				
2,4,5-TP (Silvex)	0.05	0.05	mg/L				
Toxaphene	0.003	0	mg/L				

MCL-Maximum Contaminant Level; MCLG-Maximum Contaminant Level goal

Table 1-5 - Support Labs (AFOSH Std 48-7)

Commander USACHPPM Direct Support Fort George Meade, ND 20755-5225 DSN 923-6205 (301) 677-6205	Armstrong Laboratory 2402 E Drive Brooks AFB, TX 78235-5114 DSN 240-3626/2061/3305 (210) 536-3626
Commander USACHPPM Direct Support Activity - South Fort McPherson, GA 30330-5000 DSN 588-3234 (404) 464-3332	Commander USACHPPM Aberdeen Proving Ground, MD 21010-5422 DSN 584-3919 (410) 671-2306
Commander USACHPPM Direct Support Activity - West Fitzsimons Army Medical Center Aurora, CO 80045-5001 DSN 943-8881 (303) 361-3726	Commander USACHPPM - Europe Attn: Preventive Medicine APO New York 09180 Ask overseas operator for: Gibbs Barracks in Landstuhl 2223-8203
Kadena Air Base Detachment 3 - Armstrong Lab Unit 5213 APO AP 96368-5213 DSN 3135-634-1769	Officer in Charge NAVENPVNTMEDU #2 1887 Powhatan St. Norfolk, VA 23511-3394 (757) 444-7671
Commander USACHPPM - Pacific APO San Francisco 96343 Ask overseas operator for: Camp Zama 228-4111	Officer in Charge NAVENPVNTMEDU #5 Box 368143 3035 Albacore Alley San Diego, CA 92136-5199 (619) 556-7070
Officer in Charge NAVENPVNTMEDU #6 Box 112, Bldg 1535 Pearl Harbor, HI 96860-5040 (808) 471-9505	Officer in Charge NAVENPVNTMEDU #7 PSC 825, Box 295 FPO AE 09627-2003 011-399-556-4099
Commanding Officer Navy Environmental Health Center 2510 Walmer Ave Norfolk, VA 23513-2617 (757) 363-5608	

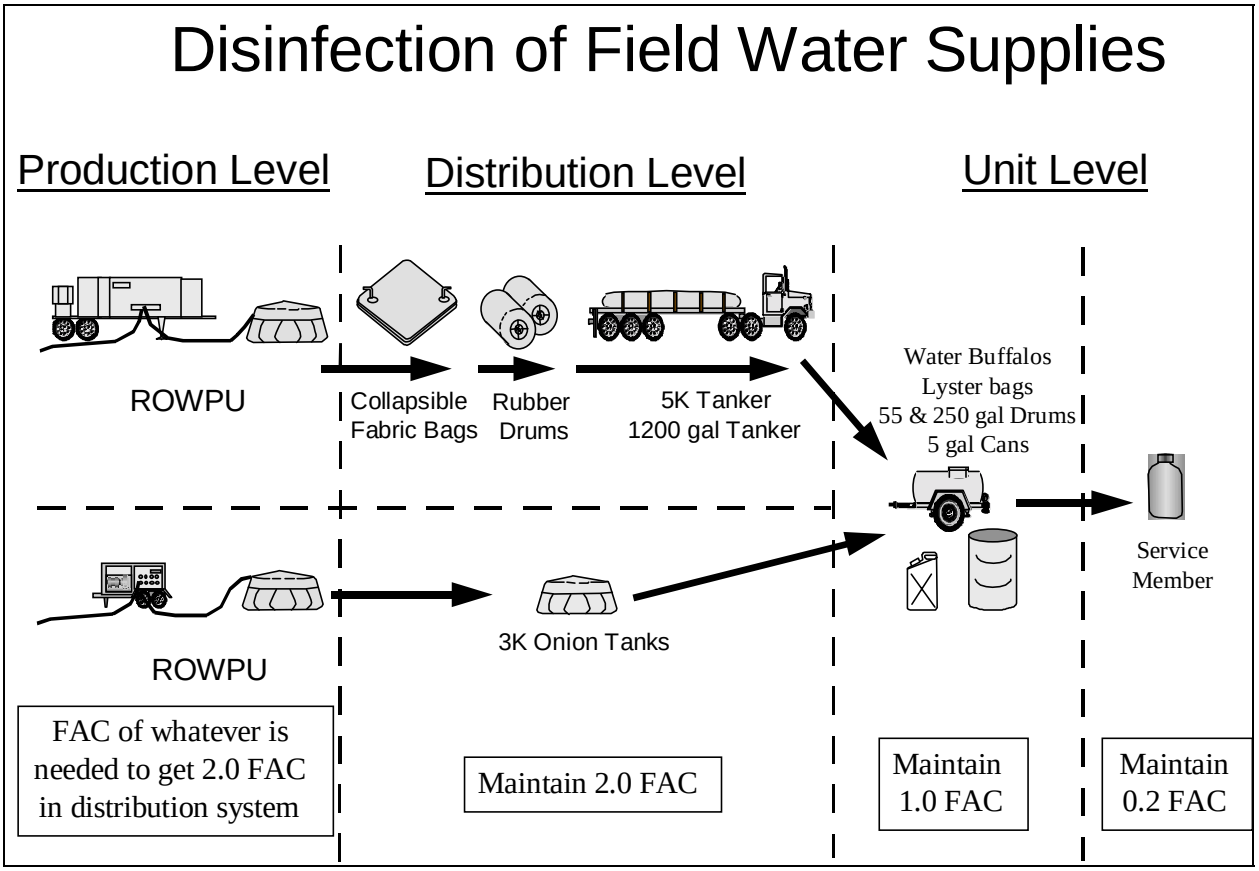
Table 1-6 - Water Test Kits (AFOSH Std 48-7, ACC PAM TOA)

Physical Properties	WQAS-PM	WQAS-ENG	WQAS-P	Test Strips	M272	DREL 2010
Acidity (mg/L)						10-4000
Alkalinity (mg/L)						10-4000
Color (color unit)		0-100 PCU				
pH	4- 0	3-10	2-12			0-14
Temperature (^{O}C)			0-48			
TDS (ppm)		0-50000	10-50000			
Turbidity (NTU)	0-500 FTU	5-200 JTU	0-150 NTU			
Other (mg/L)						
Arsenic				0.1-3.0		0-0.200
Bromine						0-4.5
Cadmium (ug/L)						0-80
Calcium						0-4
Carbon dioxide						10-1000
Chloride						10-8000
Chlorine						0-2
Chromium						0-0.6
Copper						0-5
Cyanide				1.0-30		0-0.200
Chloride	1000-20000	0-1,500		500-3000		
Dissolved oxygen						1-10+
Fluoride						0-2
Iodine						0-7
Iron, total						0-3
Lead (ug/L)						0-600
Manganese, HR						0-20
Magnesium				10-120		0-4
Nitrate	0-30					
Nitrogen, ammonia						0-2.5
Nitrogen, nitrate						0-30, 0-4.5
Nitrogen, nitrite						0-0.300
Phosphorus, reactive						0-2.5
Phosphorus, total						0-2.5
Residue, non-filterable						0-750
Selenium						0-1
Silver						0-0.60
Silica						0-1.600
Sodium chromate						0-1100
Sulfate	0-150	0-3000		400-1600		0-70
Sulfide						0-0.600
Zinc						0-2
Chem. Agents (ug/l)						
Hydrogen cyanide					20000	
Lewisite					2000	
Mustard					2000	

1.2.9 Water Purification. The Reverse Osmosis Water Purification Unit (ROWPU) is the preferred method for purifying water because it reliably provides high quality potable water, even from low quality, contaminated sources. Other treatment methods, such as diatomaceous earth (DE) filtration, can remove suspended materials and organisms. However, no method, other than ROWPU, effectively removes inorganic and organic contamination. **The reverse osmosis portion of the ROWPU shall not be bypassed for any reason**.

1.2.10 Potable Water Disinfection. While the ROWPU treats water for physical and chemical properties and chemical agents, it does not remove or destroy harmful microbiological organisms (pathogenic viruses, bacteria, and protozoans) or low molecular weight organic compounds. Accordingly, potable water must be disinfected to remove disease-producing organisms. Chlorine is the disinfectant agent specified for military use throughout the Tactical Water Distribution System (TWDS). In the Air Force the TWDS is referred to as the Harvest Eagle Water System.

It is the only widely accepted agent that destroys organisms in water and leaves an easily detectable residual that serves as a tracer element. Disappearance of chlorine in potable water signals potential contamination in the system. Figure 1-1 depicts potable water disinfection requirements throughout the TWDS. Sodium hypochlorite and calcium hypochlorite are the two chemicals used by the military to chlorinate water. Table 1-13 provides National Stock Numbers (NSN) and nomenclatures for both chemicals. Table 1-7 and Table 1-8 provide estimated dosage quantities for both chemicals.



FAC = Free-available chlorine

Figure 1-1 - Disinfection of Field Water Supplies (AFOSH Std 48-7)

Table 1-7 - Estimated Sodium Hypochlorite Dosage Quantities

Sodium Hypochlorite Dosage Calculator									
Desired Parts Per Million		**1**	**1**	**1**	**1**	**5**	**5**	**5**	**5**
Strength of Chlorine Solution		**5%**	**10%**	**15%**	**16%**	**5%**	**10%**	**15%**	**16%**
Gallons of Water to be Chlorinated	**50000**	1.0 gal 3785 cc	2.0 qt 1892 cc	42.7 oz 1262 cc	40.0 oz 1183 cc	5.0 gal 18925 cc	10.0 qt 9463 cc	213.3 oz 6308 cc	200.0 oz 946 cc
	25000	2.0 qt 1892 cc	1.00 qt 946 cc	21.33 oz 631 cc	20.00 oz 591 cc	10.0 qt 9463 cc	5.0 qt 4731 cc	106.7 oz 3154 cc	100.0 oz 2957 cc
	10000	25.6 oz 757.0 cc	12.80 oz 378.5 cc	8.53 oz 252.3 cc	8.00 oz 236.6 cc	128.0 oz 3785 cc	2.0 qt 1892 cc	42.67 oz 1262 cc	40.0 oz 1183 cc
	5000	12.8 oz 378.5 cc	6.40 oz 189.2 cc	4.27 oz 126.2 cc	4.00 oz 118.3 cc	2.0 qt 1892 cc	1.0 qt 946.0 cc	21.33 oz 630.8 cc	20.0 oz 591.4 cc
	2000	5.1 oz 151.4 cc	2.56 oz 75.7 cc	1.71 oz 50.5 cc	1.60 oz 47.3 cc	25.6 oz 757.0 cc	12.8 oz 378.5 cc	8.53 oz 252.3 cc	8.0 oz 236.6 cc
	1000	2.56 oz 75.70 cc	1.28 oz 37.85 cc	0.85 oz 25.23 cc	0.80 oz 23.66 cc	12.80 oz 378.5 cc	6.40 oz 189.2 cc	4.27 oz 126.2 cc	4.00 oz 118.3 cc
	500	1.28 oz 37.85 cc	0.64 oz 18.92 cc	0.43 oz 12.62 cc	0.40 oz 11.83 cc	6.40 oz 189.2 cc	3.20 oz 94.62 cc	2.13 oz 63.08 cc	2.00 oz 59.14 cc
	200	0.51 oz 15.14 cc	0.26 oz 7.57 cc	0.17 oz 5.05 cc	0.16 oz 4.73 cc	2.56 oz 75.70 cc	1.28 oz 37.85 cc	0.85 oz 25.23 cc	0.80 oz 23.66 cc
	100	0.26 oz 7.57 cc	0.13 oz 3.78 cc	0.09 oz 2.52 cc	0.08 oz 2.37 cc	1.28 oz 37.85 cc	0.64 oz 18.92 cc	0.43 oz 12.62 cc	0.40 oz 11.83 cc
	50	0.13 oz 3.78 cc	0.06 oz 1.89 cc	0.04 oz 1.26 cc	0.04 oz 1.18 cc	0.64 oz 18.92 cc	0.32 oz 9.46 cc	0.21 oz 6.31 cc	0.20 oz 5.91 cc
	25	0.06 oz 1.89 cc	0.03 oz 0.95 cc	0.02 oz 0.63 cc	0.02 oz 0.59 cc	0.32 oz 9.46 cc	0.16 oz 4.73 cc	0.11 oz 3.15 cc	0.10 oz 2.96 cc
	10	0.03 oz 0.76 cc	0.01 oz 0.38 cc	0.01 oz 0.25 cc	0.01 oz 0.24 cc	0.13 oz 3.78 cc	0.06 oz 1.89 cc	0.04 oz 1.26 cc	0.04 oz 1.18 cc

$$\textbf{Ounces of Sodium Hypochlorite for 1 ppm solution} = \frac{1}{1{,}000{,}000} \times \frac{\textbf{gallons of water to be chlorinated}}{\textbf{Strength of chlorine solution}} \times \frac{\textbf{128 fluid ounces}}{\textbf{gallon}}$$

Conversion Factors:

1 gallon (gal) = 4 quarts (qt)
1 gallon = 8 pints (pt)
1 gallon = 128 Fluid Ounces (oz)
1 gallon = 3785.41 Cubic Centimeters (cc)
1 quart = 946.35 Cubic Centimeters
1 pint = 473.18 Cubic Centimeters
1 Fluid Ounce = 29.57 Cubic Centimeters

Table 1-8 - Estimated Calcium Hypochlorite Dosage Quantities

Calcium Hypochlorite Dosage Calculator									
Desired Parts Per Million		**1**	**1**	**1**	**1**	**5**	**5**	**5**	**5**
Strength of Chlorine Solution		**55%**	**60%**	**65%**	**70%**	**55%**	**60%**	**65%**	**70%**
Gallons of Water to be Chlorinated	**50000**	12 oz	11.12 oz	10.26 oz	9.53 oz	60.7 oz	55.60 oz	51.32 oz	47.66 oz
		344 grams	315 grams	291 grams	270 grams	1720 grams	1576 grams	1455 grams	1351 grams
	25000	6.07 oz	5.56 oz	5.13 oz	4.77 oz	30.3 oz	27.80 oz	25.66 oz	23.83 oz
		172 grams	158 grams	146 grams	135 grams	860 grams	788 grams	728 grams	676 grams
	10000	2.43 oz	2.22 oz	2.05 oz	1.91 oz	12.1 oz	11.12 oz	10.26 oz	9.53 oz
		69 grams	63 grams	58 grams	54 grams	344 grams	315 grams	291 grams	270 grams
	5000	1.21 oz	1.11 oz	1.03 oz	0.95 oz	6.07 oz	5.56 oz	5.13 oz	4.77 oz
		34 grams	32 grams	29 grams	27 grams	172 grams	158 grams	146 grams	135 grams
	2000	0.49 oz	0.44 oz	0.41 oz	0.38 oz	2.43 oz	2.22 oz	2.05 oz	1.91 oz
		13.8 grams	12.61 grams	11.64 grams	10.81 grams	68.8 grams	63.05 grams	58.20 grams	54.04 grams
	1000	0.24 oz	0.22 oz	0.21 oz	0.19 oz	1.21 oz	1.11 oz	1.03 oz	0.95 oz
		6.88 grams	6.31 grams	5.82 grams	5.40 grams	34.4 grams	31.53 grams	29.10 grams	27.02 grams
	500	0.12 oz	0.11 oz	0.10 oz	0.10 oz	0.61 oz	0.56 oz	0.51 oz	0.48 oz
		3.44 grams	3.15 grams	2.91 grams	2.70 grams	17.2 grams	15.76 grams	14.55 grams	13.51 grams
	200	0.05 oz	0.04 oz	0.04 oz	0.04 oz	0.24 oz	0.22 oz	0.21 oz	0.19 oz
		1.38 grams	1.26 grams	1.16 grams	1.08 grams	6.88 grams	6.31 grams	5.82 grams	5.40 grams
	100	0.02 oz	0.02 oz	0.02 oz	0.02 oz	0.12 oz	0.11 oz	0.10 oz	0.10 oz
		0.69 grams	0.63 grams	0.58 grams	0.54 grams	3.44 grams	3.15 grams	2.91 grams	2.70 grams
	50	0.01 oz	0.01 oz	0.010 oz	0.010 oz	0.06 oz	0.06 oz	0.05 oz	0.05 oz
		0.34 grams	0.32 grams	0.29 grams	0.27 grams	1.72 grams	1.58 grams	1.46 grams	1.35 grams
	25	0.01 oz	0.006 oz	0.005 oz	0.005 oz	0.03 oz	0.03 oz	0.026 oz	0.024 oz
		0.17 grams	0.16 grams	0.15 grams	0.14 grams	0.86 grams	0.79 grams	0.73 grams	0.68 grams
	10	0.00 oz	0.002 oz	0.002 oz	0.002 oz	0.01 oz	0.01 oz	0.010 oz	0.010 oz
		0.07 grams	0.06 grams	0.06 grams	0.05 grams	0.34 grams	0.32 grams	0.29 grams	0.27 grams

Notes: Figures expressed in ounces are in dry ounces not fluid ounces. Where two figures are shown, use one or the other, not both.

$$\text{Ounces of Calcium Hypochlorite for 1 ppm solution} = \frac{1}{1{,}000{,}000} \times \frac{\text{gallons of water to be chlorinated}}{\text{Strength of chlorine solution}} \times \frac{16 \text{ ounces}}{\text{pound}} \times \frac{8.34 \text{ pounds}}{\text{gallon}}$$

Conversion Factors

1 ounce (oz) = 28.35 grams
1 pound (lb) = 453.59 grams
1 pound = 16 ounces
1 gallon of water weighs 8.34 pounds

1.2.10.1 Disinfection of water distribution system (WDS). The WDS consists of water production (600 gph and 3000 gph ROWPU), storage (800K gal, 300K gal, and 40K gal), and bulk transport (3K gal and 5K gal semitrailer-mounted fabric tanks) systems. Free-available chlorine (FAC) will be maintained at 2 ppm throughout the TWDS. The correct contact time prior to testing is 30 minutes at all points throughout the system.

1.2.10.2 Disinfection of diataminaceous earth (DE) filtered water. The FAC for DE filtered water depends on the temperature of the water. For water temperatures of less than 15 ^{O}C, DE filtered water will be disinfected by adding chlorine at the production site to maintain a 5 mg/L FAC after a 30-minute contact time. For water temperatures greater than 15 ^{O}C, DE filtered water will be disinfected by adding chlorine at the production site to maintain a 2 mg/L FAC after a 30-minute contact time

1.2.10.3 Disinfection of water treated by other means. Water purified by means other than ROWPU or DE filtration will be disinfected by adding chlorine at the production site to maintain a 5 mg/L FAC after a 30-minute contact time.

1.2.10.4 Disinfection at the unit level. FAC will be maintained at 1 ppm in unit-level containers (400 gal trailers, lyster bags, collapsible pillow tanks, and 55 gal and 250 gal drums).

1.2.10.5 Disinfection at the individual level. FAC will be maintained at 0.2 ppm at the individual service member level.

1.2.10.6 Emergency disinfection. When away from supply lines and treated water is not available, individual service members must select the clearest, cleanest water with the least odor and treat the water using individual water purification means. These means include.

- Iodine. Iodine tablets come in bottles of 50 tablets (NSN 6850-00-985-7166). The correct treatment is two tablets per quart of water. The treated water should be allowed to sit for 35 minutes before drinking.
- Boiling. To effectively kill most disease-producing organisms, water must be held at a rolling boil for 1 to 2 minutes. When cooled, it should be kept in a covered or capped uncontaminated container.
- Chlor-Floc. Chlor-Floc is an emergency disinfectant that also removes suspended particles from cloudy or discolored water. Individuals should follow the instructions printed on the Chlor-Floc kit.

1.2.11 Potable Water Test Standards. If the water point will be operational for less than seven days, Table 1-2 is used to determine the constituents to analyze and the applicable standards. If the water point will be operational for more than seven days, Table 1-3 is used. In temperate regions, the standards for 5 L/day consumption rate are applied. In arid regions and most arctic regions, the standards for 15 L/day consumption are used. When water is provided/produced by U.S. forces for United States, NATO, and/or Quadripartite forces, the most stringent standards will be applied. When water is obtained from NATO or Quadripartite forces, it must meet standardization agreement (STANAG) or Quadripartite Standardization Agreement (QSTAG) standards respectively.

1.2.12 Potable Water Test Frequencies. The responsibility and frequency for performing tests on potable water are as follows.

1.2.12.1 Operator tests. Water production/distribution personnel will check the water from purification equipment (ROWPU, DE filtration, etc.) for chlorine residual, pH, temperature, TDS, and turbidity every 30 minutes of the operating day; check storage and distribution points every hour; and check unit water trailers, fabric drums, lyster bags, and other containers daily. Source water will be tested for chlorine demand daily.

1.2.12.2 BES tests. BES personnel must sample and test municipal water, host nation water, and/or potable water from military purification equipment, storage tanks, distribution points, field kitchens, and latrines for FAC, pH, and coliforms shown in Table 1-2 or Table 1-3 on a weekly basis. Source water must be tested for chlorine demand weekly. Whenever potable water tests reveal no free available chlorine, you should obtain samples and have the water analyzed for heterotrophic plate count (HPC). Heterotrophs are microorganisms that require organic

compounds as an energy source. Heterotrophic plate count analysis measures or quantifies the amount of viable bacteria in the water. This analysis tells you about the overall quality of the drinking water and the efficiency of treatment processes.

1.2.12.3 All properties. BES personnel will sample and test source water, municipal water, host nation water, and/or water from military purification equipment, storage, distribution points, field kitchens, and latrines for all properties shown in Table 1-2 , Table 1-3 , or Table 1-4 every six months.

1.2.12.4 Chemical agents. Tests frequencies for chemical agents are based on mission oriented protection posture (MOPP) conditions. Water production/distribution personnel must test water from military purification equipment, storage, and distribution points for chemical agents as shown in Table 1-9 .

Table 1-9 - Minimum Frequency of Tests for Chemical Agents and Radioactivity (AFOSH Std 48-7)

Threat Level	MOPP	Minimum Test Frequency
No known threat	0	Monthly
Slight threat	1	Weekly
Medium threat	2	Daily
Severe threat	3	Twice daily
Imminent threat	4	Hourly

1.2.12.5 Radiological testing. In the event of nuclear attack, surviving water systems downstream from ROWPUs must be sampled for radiological contamination. Normally, field units will not have radiation detection equipment capable of measuring to the concentration standards shown in Table 1-2 , Table 1-3 , and Table 1-4 . Accordingly, you will have to send the samples to one of the laboratories listed in Table 1-5 for analysis.

1.2.13 Potable Water Sampling Requirements. Table 1-10 provides equipment, container, and chemical needs and special instructions for a variety of potable water sampling requirements. BES Officers and Technicians should use this table to plan their sampling tasks prior to going into the field.

1.2.14 Water Distribution System Inspection Criteria. The BES will perform periodic inspections of the water distribution system (including site conditions), kitchen(s), and latrines to ensure the potability of the water and maintenance of sanitary conditions. Inspection results will be documented. A water point inspection report form is included in Appendix C . A copy of the inspection report should be left with the inspected unit and a copy should be sent to the command surgeon and the headquarters of the unit that produces/provides the water.

1.2.14.1 General site conditions. No pollution sources shall exist nearer than 2 miles upstream or upgradient from the water source (river, lake, etc.) Drainage must be adequate to prevent ponding at distribution points. Dust control measures will be employed to prevent dustborne bacteria from contaminating water and equipment. Rodent and insect breeding areas must be controlled to prevent the spread of disease. Bivouac areas should be located at least 100 feet downgradient or downstream from the water source; latrines must be at least 100 yards downgradient or downstream. Well heads shall be closed and locked or within a secure area to prevent unauthorized entry. Garbage and trash must be properly stored and disposed to prevent contamination of the water source or system.

1.2.14.2 ROWPU treatment operations. The intake line of the ROWPU shall be affixed with a strainer. When the source is a body of water (lake, pond, river, stream, etc.), a float or anchor should hold the intake line at least 4 inches from the surface or bottom. The effluent line should be positioned so effluent is discharged at least 25 yards downstream from the intake line in the case of flowing surface sources. The ROWPU trailer/pallets must be level and grounded. The filter backwash tank must be filled with brine and there will be a separate storage tank for raw water, if raw water storage is used. Generator(s) should be grounded and ventilated to prevent carbon monoxide intoxication. A fire extinguisher should be in the immediate area and operators should wear ear protection within 50 feet of operating equipment. Where diseases such as schistosomiasis and leptospirosis are prevalent or chemical agents are likely, operators must wear rubber hip boots and long rubber gloves.

Table 1-10 - Potable Water Sampling Requirements (ECSAM)

Sample For	Sample Container	Sample Size	Reagent	Notes
Coliform	125 mL bottle or bag	90%	10 mg sodium thiosulfate	Take pH and FAC
pH	Test kit	10-20 mL	tablets	
Chlorine (FAC)	Test kit	10-20 mL	tablets	
Chlorine demand	Test kit & 1-qt amber bottle	10-20 mL	tablets	Test, hold residual water for 1 hr, test again
Fluoride	100 mL bottle or test instrument	90%		Follow mfr. instructions
Lead	250 mL glass or plastic	100%	5 mL 1:1 nitric acid:dist water	Do not flush system Take in early AM
Copper	250 mL glass or plastic	100%	5 mL 1:1 nitric acid:dist water	Do not flush system Take in early AM
Alkalinity	1-liter glass or plastic	90%		Take pH and temp
Calcium hardness	1-liter glass or plastic	90%		
Total dissolved solids	1-liter glass or plastic	90%		
Nitrate	1-liter glass or plastic	90%		Add 8 mL sulfuric acid if not tested in 48 hrs
Nitrite	1-liter glass or plastic	90%	Add 8 mL sulfuric acid if not tested in 48 hrs	
Ammonium	1-liter glass or plastic	90%	100 mg sodium thiosulfate	Add 8 mL sulfuric acid if not tested in 48 hrs
Metals	1-liter glass or plastic	90%	1:1 nitric acid distilled water	pH<2
Chloride, sulfate	1-liter glass or plastic	90%		
Cyanide	1-liter glass or plastic	90%	2 mL 10N sodium hydroxide; 100 mg sodium thiosulfate	pH>12
Phosphorus	1-liter glass or plastic	90%	1:1 sulfuric acid distilled water	pH<2
Trihalomethanes	2-40 mL amber glass vials	100%	2-3 mg sodium thiosulfate	Assure no air bubbles Teflon-lined cap
VOCs	2-40 mL amber glass vials	100%	25 mg ascorbic acid; 1:1 hydrochloric acid:dist water	pH<2; Teflon-lined cap; Assure no air bubbles
Pesticides	1-liter glass or plastic	90%	80 mg sodium thiosulfate	Teflon-lined cap
PCBs	1-liter glass or plastic	90%	80 mg sodium thiosulfate	Teflon-lined cap
Radionuclides	1-liter glass or plastic	90%		Teflon-lined cap
Ethylene dibromide	2-40 mL glass vials	100%	3 mg sodium thiosulfate	Assure no air bubbles Teflon-lined cap
Turbidity	Direct reading instrument			Follow mfr. instructions
Temperature	Direct reading instrument			
Color	1-liter glass or plastic	90%		

1.2.14.3 Water monitoring. The inspector must verify that purification/distribution personnel are testing treated water IAW paragraph 1.2.12.1 above. All water test kits should be checked for expired chemicals and the chemical agent test kit must have sufficient analysis materials for one day of testing at mission oriented protection posture (MOPP) 4 (see paragraph 1.2.12.4 above).

1.2.14.4 Water storage. Water storage tanks will be level. Manholes will be closed and locked and open top tanks will be covered. Interior surfaces should be clean and the words "POTABLE WATER" should be stenciled on the outside of the tank. Tanks must be of sufficient size to support requirements.

1.2.14.5 Water distribution. Standpipe hoses must be at least 4 feet above ground surfaces. Hose nozzles will be clean and kept off the ground. Operators will check water container interiors for cleanliness prior to filling. Tankers, trailers, drums, 5-gallon cans or other containers used for storage or distribution of petroleum products or other hazardous materials will not be used for storage or distribution of potable water.

1.2.14.6 Recordkeeping and supply. Water production personnel will keep records of equipment readings, water testing, and results, chemical usage and the name of units and the amount of water issued to each. Water production

and issue forms are included in Appendix B. Chemical containers will be properly labeled, capped tightly, and kept dry. Activated carbon and calcium hypochlorite will be stored separately to prevent mixing that could cause a violent reaction. Fuel and chemicals for operation of equipment should be sufficient for anticipated duration of operations or until resupply.

1.2.14.7 400-hundred gallon water trailer. Manhole covers on the 400-gallon water trailer will seal effectively to prevent contamination of the water. Rubber gaskets will be intact and not have cracks, missing pieces, excessive dry rot, or improper fit. The manhole cover locking mechanism will be functional. The manhole cover and tank interior will not be rusted. Spigots will be functional. The T handle for dispensing water from the tank will open and close freely. Locking devices for spigot covers will be functional. Drain plugs should be hand tight and easy to remove.

- Trailers with stainless steel and aluminum tanks. Interior seams will be free of rust. If interior surfaces are cracked to the point where the polyurethane foam insulation is exposed, the trailer should be put out of service and repaired. Trailer interiors will not be painted or covered with any material.
- Trailers with fiberglass tanks. Stains caused by natural water impurities, such as iron and manganese are permitted. However, stains resulting from rust, storage of unauthorized liquids, or improper painting are not permitted. Chips or cracks in the interior surface are ideal areas for biological growth and contamination. Trailers where more than 10 percent of the interior is chipped or cracked or where the fiberglass subsurface is exposed will be put out of service and repaired. Flaking of the interior surface paint may result from use of unauthorized paint or improper surface preparation. Trailers with excessive flaking of interior surfaces should be put out of service and repaired.

1.2.14.8 Tank trucks. Inspection criteria for manhole covers are the same as for 400-gallon trailers. Dispensing valves should operate freely and close tightly. Threads on hose couplings should be intact and undamaged. Dust caps must be attached to dispensing valves except when valves are in use. The mesh screen inside the filling port and the tank interior should be free of rust. Metal interiors will not be painted.

1.2.14.9 Fabric water tanks and drums. If the fabric material has been repaired, patches or temporary plugs must be secure. The check-valve adapter must be undamaged and open easily. Dust caps must be attached to couplers when not in use.

1.3 Bottled Water. Bottled water is sealed in bottles or other containers by a commercial or military source for human consumption. Testing of bottled or packaged water and bottling/packaging plants varies depending on the source of the water.

1.3.1 Military Bottled Water. Water that is produced and packaged by the military will conform to the standards shown in Table 1-11 . Preventive medicine (Public Health) personnel will also inspect military purification and packaging operations prior to the start of operations. All water destined for packaging by the military will be purified via ROWPU and chlorinated to 2 mg/L FAC after a 30-minute contact time. Packaged water should be stored in a clean, covered, well-ventilated area and maintained at temperatures between 35 ^{O}F and 84 ^{O}F. Water should be packaged and distributed within 7 days of production.

1.3.2 Commercial Bottled Water. When bottled water is obtained from military approved sources or the Defense Logistics Agency (DLA), the majority of testing is already performed. A list of military approved sources can be found in VETCOM Circular 40-1, Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement, USAREUR Circular 40-657, and , Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement in the Republic of Korea. Army or DLA quality assurance personnel inspect commercial bottling facilities to insure compliance with acceptable sanitation standards. The quality assurance personnel send representative bottles of finished product to appropriate labs for microbiological and chemical analyses.

Table 1-11 - Bottled Water Quality Standards (21 CFR 165.110)

Contaminant (CAS No.)	mg/L	Contaminant (CAS No.)	mg/L
Inorganics		**Synthetic Organic Chemicals**	
Antimony	.006	Alachlor (15972-60-8)	0.002
Barium	2	Atrazine (1912-24-9)	0.003
Beryllium	0.004	Benzo(a)pyrene (50-32-8)	0.0002
Cadmium	0.005	Carbofuran (1563-66-2)	0.04
Chromium	0.1	Chlordane (57-74-9)	0.002
Copper	1.0	Dalapon (75-99-0)	0.2
Cyanide	0.2	1,2-Dibromo-3-chloropropane (96-12-8)	0.0002
Lead	0.005	2,4-D (94-75-7)	0.07
Mercury	0.002	Di(2-ethylhexyl)adipate (103-23-1)	0.4
Nickel	0.1	Dinoseb (88-85-7)	0.007
Nitrate	10 (as nitrogen)	Diquat (85-00-7)	0.02
Nitrite	1 (as nitrogen)	Endothall (145-73-3)	0.1
Total Nitrate and Nitrite	10 (as nitrogen)	Endrin (72-20-8)	0.002
Selenium	0.05	Ethylene dibromide (106-93-4)	0.00005
Thallium	0.002	Glyphosate (1071-53-6)	0.7
Volatile Organic Compounds		Heptachlor (76-44-8)	0.0004
Benzene (71-43-2)	0.005	Heptachlor epoxide (1024-57-3)	0.0002
Carbon tetrachloride (56-23-5)	0.005	Hexachlorobenzene (118-74-4)	0.001
o- Dichlorobenzene (95-50-1)	0.6	Hexachlorocyclopentadiene (77-47-4)	0.05
p- Dichlorobenzene (106-46-7)	0.075	Lindane (58-89-9)	0.0002
1,2-Dichloroethane (107-06-2)	0.005	Methoxychlor (72-43-5)	0.04
1,1-Dichloroethylene (75-35-4)	0.007	Oxamyl (23135-22-0)	0.2
cis-1,2-Dichloroethylene (156-59-2)	0.07	Pentachlorophenol (87-86-5)	0.001
trans-1,2-Dichloroethylene (156-60-5)	0.1	PCB's (as decachlorobiphenyl) (1336-36-3)	0.0005
Dichloromethane (75-09-2)	0.005	Picloram (1918-02-1)	0.5
1,2-Dichloropropane (78-87-5)	0.005	Simazine (122-34-9)	0.004
Ethylbenzene (100-41-4)	0.7	2,3,7,8-TCDD (Dioxin) (1746-01-6)	3 x 10⁻⁸
Monochlorobenzene (108-90-7)	0.1	Toxaphene (8001-35-2)	0.003
Styrene (100-42-5)	0.1	2,4,5-TP (Silvex) (93-72-1)	0.05
Tetrachloroethylene (127-18-4)	0.005	**Other**	
Toluene (108-88-3)	1	Aluminum	0.2
1,2,4-Trichlorobenzene (120-82-1)	0.07	Silver	0.1
1,1,1-Trichloroethane (71-55-6)	0.20	Sulfate	250.0
1,1,2-Trichloroethane (79-00-5)	0.005		
Trichloroethylene (79-01-6)	0.005		
Vinyl chloride (75-01-4)	0.002		
Xylenes (1330-20-7)	10		

1.3.3 Bottled Water Testing. The BES will test all commercial or military bottled water for microbiological contamination after delivery/receipt. Additional test requirements are as follows.

1.3.3.1 Coliform testing. Total coliform testing will be performed using the membrane filter technique or by the defined substrate method, such as the commercially available "colilert" and "colisure" tests. Each lot shall be tested upon receipt at a central storage facility, warehouse, port of entry, or other theater area issue point. One percent of the total number of bottles, or up to 10 samples, whichever is less, will be tested for each lot. Samples shall be collected randomly throughout the lot. If any of the above tests is positive for coliform, suspend the use and/or issue of the entire lot of bottled water and resample to confirm the results. The resample should consist of 10 percent of the remainder of the lot or up to 10 samples. If the resample is positive for coliforms, the lot shall not be used for potable purposes. If water is in short supply, the contaminated lot can be used for personal hygiene, or other non-potable uses. The lot can also be used for drinking if first treated with chlorine or iodine tablets.

1.3.3.2 Heterotrophic plate count (HPC). Commercial bottled water normally has no free available chlorine. Whenever tests on commercial or military bottled water reveal no free available chlorine, you should obtain samples and have the water analyzed for heterotrophic plate count (HPC). Heterotrophs are microorganisms that require organic compounds as an energy source. Heterotrophic plate count analysis measures or quantifies the amount of viable bacteria in the water. This analysis tells you about the overall quality of the drinking water.

1.3.3.3 Visual inspection. Each lot will be visually inspected every 30 days at major storage sites and end user locations. The bottles will be inspected for cracked caps and cloudy appearance. Individual bottles with cracked caps or cloudy appearance shall not be used for potable purposes. If water is in short supply, the contaminated bottles can be used for personal hygiene, or other non-potable uses. They can also be used for drinking if first treated with chlorine or iodine tablets.

1.3.4 Storage of Bottled Water. Bottled and/or packaged water should not be stored in direct sunlight. It should be stored in shaded, well-ventilated areas, and in an upright position. Bottles/packages should be issued on a "first-in first-out" basis. If the bottles/packages are somehow subjected to direct sunlight for more than 5 days, they should be reinspected prior to issue IAW paragraph 1.2.3 above.

1.4 Non-Potable Water. All water that has not been tested by BES personnel and approved by the command surgeon as potable water will be considered non-potable. When a source has been approved, it should be labeled with a sign reading **"POTABLE WATER SOURCE."** Water sources that have not been tested or not approved for consumption should be labeled **"NON-POTABLE WATER. DO NOT DRINK."** Such sources include construction water points, untested faucets, cisterns, wash racks, etc. Typical authorized uses for non-consumptive water are shown in Table 1-12 .

1.5 Host Nation Water. Water provided by a host nation or treated by host nation field purification equipment must comply with NATO, Quadripartite, or other multinational agreements. NATO and Quadripartite standards are listed in Table 1-2 and Table 1-3 . Water obtained from host nation municipal drinking water systems will be considered unsafe until tested. These sources are considered fixed installations; therefore, field water standards are not applicable. In such cases, Final Governing Standards (FGS) should be the basis for water quality. Where FGSs do not exist, EPA public drinking water standards (Table 1-4) apply.

1.6 Planning/Assessments. The impact of crisis situations can be minimized or eliminated all together through effective advanced planning and realistic vulnerability assessments. The BES is responsible for developing a potable water sampling plan and assessing the vulnerability of the water system in terms of potential water shortfalls and human health effects. This section provides information to help you meet these responsibilities.

Table 1-12 - Water Quality Standards for Non-consumptive Uses (AFOSH Std 48-7)

Water Quality	Typical Uses
Disinfected non-potable fresh water	Decontamination of personnel
	Retrograde cargo washing
	Heat casualty body cooling
	Graves registration sanitation
	Well development
Non-potable fresh water	Vehicle coolant
	Aircraft washing
	Pest control
	Field laundry
	Concrete construction
	Well drilling
Sea water	Vehicle washing (may lead to corrosion)
	Electrical grounding
	Fire fighting
	NBC decontamination of material/equipment

1.6.1 Sampling Plan. Each BES must develop a sampling plan that insures the health and combat readiness of deployed personnel through a systematic approach to monitoring the source, treatment, and distribution of the potable water. This plan will be the basis for all activities associated with quality assurance and quality control of base drinking water. The following outline shows information and topics that should be covered in the plan.

DRINKING WATER SAMPLING PLAN

1. The Drinking Water Sampling Plan must be responsive to two critical requirements: 1) Protection of the maximum number of large water users (i.e., messing facilities, dormitories) and critical personnel (i.e., air crews, aircraft water distribution systems) and 2) Rapid identification and isolation of sources of contamination Some examples of what should be sampled include water sources, water purification/treatment facilities, storage tanks, distribution components (pumps, pipelines, hoses, etc.), tactical equipment (trucks, trailers, buffaloes, transportable fabric tanks/drums, etc.), mess halls, latrines, etc. The plan should provide enough information so that sample takers know where to draw the samples, e.g. from each spigot of each latrine, from one foot below the surface of the lake, from the sample connection on the downstream side of the main distribution pump, from the bottom drain of the water buffalo, etc. so that sources of contamination can be verified.

2. This section of the sampling plan provides specific information on what samples must be taken from each of the points identified in paragraph 1 above and “how often” they should be drawn. Tri-Service, Quadripartite, NATO, and U.S. EPA Potable water standards and test frequencies are shown in this field manual. However, your plan must also consider other sampling requirements and frequencies that may be mandated by, joint medical authorities, host nations, Final Governing Standards, etc. Depending on the complexity of your water system, this section of the plan could be covered by a table or series of tables such as shown below. Note: these tables are not all inclusive. They are for illustration purposes only. Your plan will most likely cover different sample points, requirements, and frequencies. This field manual does not consider population a factor when determining test frequencies for potable water. However, the population served should be documented in your plan because some regulatory requirements (i.e., FGSs) specify test frequencies based on population.

Example of Microbiological Sampling Requirements

Sample Point	Population Served	Sampling Frequency	Samples Per Year	QC Samples Per Year		OPR
				KN	FD	
Well 1	2000	1/week	52	12	6	BES
ROWPU	2000	1/week	52		6	BES
Tank 1	2000	1/week	52		6	BES
Field Mess	2000	1/week	52		6	BES
Latrine 1	1500	1/week	52		6	BES
Latrine 2	500	1/week	52		6	BES

Continue as required until all sample points are covered.
KN = Known Positives (para 3a)
FD = Field Duplicates (para 3b)

Example of Physical and Chemical Sampling Requirements
Sample Point - ROWPU

Parameter	Population Served	Sampling Frequency	Samples Per Year		OPR
			Regular	FD	
FAC	2000	every 30 min during operation	2920	292	CE
FAC	2000	weekly	52	6	BES
FAC	2000	2/year	2	1	BES
pH	2000	every 30 min during operation	2920	292	CE
pH	2000	weekly	52	6	BES
pH	2000	2/year	2	1	BES
TDS	2000	every 30 min during operation	2920	292	CE
TDS	2000	2/year	2	1	BES
Turbidity	2000	every 30 min during operation	2920	292	CE
Turbidity	2000	2/year	2	1	BES
Arsenic	2000	2/year	2	1	BES
Cyanide	2000	2/year	2	1	BES
Chloride	2000	2/year	2	1	BES
Hydrogen Cyanide	2000	1/week @ MOPP 0	52	6	CE
Hydrogen Cyanide	2000	2/year	2	1	BES
BZ	2000	1/week @ MOPP 0	52	6	CE
BZ	2000	2/year	2	1	BES
Lewisite	2000	1/week @ MOPP 0	52	6	CE
Lewisite	2000	2/year	2	1	BES
Sulfur Mustard	2000	1/week @ MOPP 0	52	6	CE
Sulfur Mustard	2000	2/year	2	1	BES

Continue as required until all chemical and nerve agents are covered.

3. QA/QC Guidelines. It is good professional practice to adopt a QA/QC program to validate analytical test data. A QA/QC program normally consists of trip blanks and known positive (KN) and field duplicate (FD) samples that are collected at the same time regular samples are collected.

a. Trip blanks are used to detect contamination of the environmental samples during shipping and handling. Trip blanks are prepared by the laboratory, transported to the field, kept with the environmental samples throughout the sampling effort, and returned to the laboratory for analysis with the volatile organic environmental samples. Trip blanks are volatile sample containers filled by the

laboratory with organic-free water and are not opened in the field. One trip blank should be included in every cooler that contains environmental samples to be analyzed for volatile organic compounds.

b. Known positives are used for QC of total coliform analyses. In addition to the known positives that are taken with every sample event, one sample per month should be collected from a source that is known to be biologically contaminated (polluted pond, toilet, etc.). This sample should be analyzed for total coliforms to confirm that your laboratory techniques work. This requirement follows the guidance issued in Quality Assurance Standard Method 9020.

c. Field duplicates (FD) are taken to verify the results of laboratory analysis. There are two types of field duplicates: coded field duplicates (CFD); and non-coded field duplicates (NCFD). When an off-site laboratory is contracted to perform analytical tests, CFDs should be collected. CFDs are duplicate samples collected in the field and given different sample identifiers so that the off-site contracted laboratory does not know that the two samples are duplicates. When Base personnel are responsible for sample collection and analysis, NCFDs should be taken. NCFDs are duplicate samples collected in the field and are given the recognized sample identifier. The appropriate use of coded field duplicates and non-coded field duplicates should be determined locally. The frequency of the field duplicates should be evenly distributed over the year. You should draw one FD for every 10 regular samples for each sampling point. This protocol is referred to as the 10 percent rule.

4. Sampling procedures. This section of your plan should include special instructions associated with collecting and analyzing samples, e.g., sample container requirements, sample quantities, reagent requirements and quantities, companion sample requirements, security access requirements, unit POCs, etc.

5. Sample handling requirements. This is where you address specific information on identification of samples, sample forms, sample numbering systems, sample custody requirements and procedures, shipping procedures, sample packaging and marking requirements, commercial/contract laboratory specialties, capabilities, etc.

6. Reporting requirements. This section of the plan addresses reporting, notification, and administrative procedures.

a. Reports. Identify all reporting requirements, formats/forms, and suspenses, as well as the names and addresses of activities requiring reports.

b. Non-compliance notification. Provide specific instructions on who is to be notified when any portion of the water system is contaminated or otherwise, out of compliance with standards. Notification requirements will most likely vary by location, command, and/or regulatory activity. Make sure you develop these procedures in conjunction with CE.

c. Administrative procedures. Include information on special operating logs, form requirements, and publications. Address records retention requirements, to include sample logs, reports, notification letters, sample results, etc. Monthly operating reports/logs should be marked for 3-years retention. Bacteriological test results should be marked for 5-years retention. Chemical, chemical agent, and radiological test results should be marked for 10-years retention.

7. Financial management. Include instructions on development and submission of program requirements. Document your current operating budget. List local and central contracts available to you for supplies, equipment, and/or laboratory services.

1.6.2 Water Contaminants and Effects. Certain water constituents could reduce performance of exposed personnel and thereby jeopardize mission accomplishment. The following information should help decision makers and medical personnel better understand the potential effects of various contaminants in water.

1.6.2.1 Waterborne diseases. Water is a carrier of many organisms that cause intestinal disease. An epidemic of one of these diseases among service members can be more devastating than enemy action. Raw water can contain bacteria that are native to the area as well as a variety of bacteria from external sources. The principal diseases contracted by humans from contaminated water are diarrheal in nature. However, a number of non-diarrheal infections are also possible. The most prevalent waterborne diseases are as follows.

- Diarrhea. Acute diarrhea can be caused by campylobacter, certain strains of Escherichia coli, and some non-cholera vibrios. Onset of diarrhea, abdominal pain, nausea, vomiting, and fever normally occurs after an incubation period of 2-3 days.
- Cholera. Cholera is caused by an enterotoxin produced by the bacillus Vibrio cholerae. This intestinal disease produces profuse watery stools. occasional vomiting, rapid dehydration, and circulatory collapse. Cholera occurs mainly in Asia, Africa, and parts of the Mediterranean. The incubation period is a few hours to 5 days (normally 2-3 days). Infectivity continues until a few days after recovery.
- Typhoid. Typhoid fever is a severe prolonged disease with a high rate of complications. It is characterized by sustained fever, headache, malaise, anorexia, enlargement of the spleen, a non-productive cough, constipation, and involvement of lymphoid tissues. Typhoid is caused by the bacillus Salmonella typhi. The period of incubation is 1-3 weeks. Infectivity continues through convalescence.
- Amebiasis. Amebiasis is caused by a protozoan, Entamoeba histolytica. This protozoan may be acquired via an infective cyst that is passed in feces. Although most cases are asymptomatic, acute cases exhibit fever, chills, and bloody diarrhea. The incubation period is commonly 2-4 weeks. Infectivity continues through the period of cyst passing, that may be several years.
- Giardiasis. Giardiasis, another protozoan infection, principally affecting the upper small intestine. Giardia cysts can be passed by wild animals (such as beavers). As with amebiasis, most cases are asymptomatic. After an incubation period of 7-21 days, acute cases may present abdominal cramps, flatulence, diarrhea, fatigue, and weight loss. If left untreated, passage of the cysts may continue for 3 months.
- Cryptosporidosis. Cryptosporidosis is an infection caused by the Cryptosporidium parvum oocyst, that is most often transmitted through the feces of cattle and other domestic animals, and humans. The incubation period is 1-12 days, with an average of 7 days. People with intact immune functions may have asymptomatic infections. However, people with impaired immunity generally have symptoms including, profuse and watery diarrhea, abdominal cramping, malaise, fever, nausea, and vomiting.
- Shigellosis. Known also as bacillary dysentery, shigellosis is an acute bacterial disease primarily involving the large intestine. It is characterized by diarrhea accompanied by fever, nausea, and sometimes vomiting. The severity of the illness is a function of the age of the patient, pre-existing state of nutrition, the size of the infecting dose, and the serotype of the organism. The incubation time is 1-7 days. Persons infected remain capable of spreading the disease until Shigella are no longer present in the feces, usually within 4 weeks of the illness.
- Viral Hepatitis A (infectious hepatitis). Caused by hepatitis A virus, infectious hepatitis ranges from mild illness lasting 1-2 weeks to a severe disabling disease lasting several months. The onset of the symptoms is abrupt with fever, malaise, anorexia, nausea, and abdominal discomfort, followed by jaundice. The incubation period is 15-50 days and most commonly from 28-30 days. Infectivity occurs during the later half of the incubation period until the first week of jaundice.
- Schistosomiasis. Schistosoma mansoni, S. japonicum, and S. haematobium are the major species that cause human disease. Each occurs in a specific geographic area. Schistosoma mansoni occurs in the Arabian Peninsula, Africa, South America, and the Caribbean; S. japonicum in Japan, China, and the Philippines; and S. haematobium in Africa and the Middle east. After maturation within the body, the adult flukes can cause intestinal or urinary tract complications. The incubation period is 4-6 weeks after infection. Infectivity can last as long as 10 years.

1.6.2.2 Chemical contamination. Chemical contamination and associated health risks are as follows.

- Chloride. High concentrations of chloride cause water to taste bad. The greatest health concern is that people become dehydrated when they reduce their water consumption due to the bad taste. Dehydration can result in significant performance degradation. At concentrations exceeding 600 mg/L, chloride can also cause laxative effects.
- Magnesium. Elevated levels of magnesium can cause acute laxative action that can result in dehydration. Dehydration can lead to discomfort, weariness, apathy, impaired coordination, delirium, and heat stroke.

- Sulfate. The cause and effects are the same as for magnesium.
- Arsenic and Lewisite. Human exposure to elevated levels of arsenic and lewisite can affect several different organ systems, including the circulatory, gastrointestinal, integumetary, nervous, hepatic, renal, and immune systems. Lewisite is an organic trivalent arsenic compound that could be lethal.
- Cyanide and hydrogen cyanide. Exposure to cyanide in drinking water can lead to a variety of performance-degrading health effects. Once a toxic level has accumulated in the blood, the cyanide exerts its effects rapidly, acting as a chemical asphyxiant. The nervous and respiratory systems are the first to be effected. Typical symptoms are headache, breathlessness, weakness, palpitations, nausea, giddiness, and tremors.
- Lindane. Lindane is a pesticide used throughout the world. Ingestion of lindane in drinking water can cause nausea, vomiting, frontal headache, restlessness, upper abdominal pain, diarrhea, tremors, ataxia, and reflex loss. At high doses, epileptiform seizures can occur, followed by systemic failure and even death.

1.6.2.3 Chemical agent contamination. Chemical agent contamination and associated health risks are as follows.

- Hydrogen Cyanide. Hydrogen cyanide is used as a threat agent. It is also referred to as hydrocyanic acid or prussic acid. Its effects are the same as described for cyanide.
- Organophospate (OP) threat agents. OP threat agents in drinking water can cause abdominal cramps, vomiting, diarrhea, and headache. Sufficiently high levels consumed over the course of a 7-day period may lead to death.
- Trichothecene mycotoxin T-2. The performance-degrading effects of trichothecene mycotoxin T-2 show up as nausea and vomiting.

1.6.2.4 Radiological contamination. There are many possible effects that could result from exposure to radiation. Exposure to radiation could cause carcinogenic and mutagenic effects that would only become evident years after exposure. More severe exposure to radiation (not normally associated with drinking water) can result in anorexia, nausea, fatigue, vomiting, diarrhea, and eventually death. Nausea and vomiting would most likely occur at doses of 100 rad. Full recovery would be expected in 6-8 weeks. At doses of 1000-5000 rad, death would occur in a week or less. At doses exceeding 5000 rad, incapacitation is immediate.

1.6.2.5 Physical properties. Turbidity, color, odor, and total dissolved solids all relate to palatability of water and an aversion to its use leading to dehydration due to reduced water intake. Color, turbidity, and odor producing compounds interfere with the ability of chlorine to provide disinfection

1.6.3 Vulnerability Assessment. As discussed throughout this manual, the Air Force operational mission and the health and effectiveness of its personnel are critically dependent on sufficient quantities of uncontaminated water. Potable water systems present cheap, soft targets and an opportunity for an adversary to adversely impact a unit's mission. Likewise, mission degradation can occur as a result of damage to an installation's water system caused by natural disasters. Due to the potential negative impact to a unit's mission, it is critical that each wing/installation commander be provided a water vulnerability assessment. AFI 48-119 assigns the responsibility for preparing this vulnerability assessment to BES.

1.6.3.1 Crossfunctional team. While BES is officially responsible for developing the vulnerability assessment, bioenvironmental personnel do not possess sufficient expertise to complete the entire document. Accordingly, you may need representatives from the following activities to help develop the vulnerability assessment in the areas indicated.

- Airbase Operations - NBC defense, NBC planning, and base training
- Civil Engineer - maintenance/operation of the water system, emergency planning
- Security Police - counter-terrorism measures, security of facilities, and security planning and training
- Operations - threat assessments, probable enemy attack scenarios
- Weather - probable natural disasters

- Other service/host government - same as Civil Engineer

1.6.3.2 Assessment format. The following outline shows information and topics that should be covered in the vulnerability assessment.

WATER VULNERABILITY ASSESSMENT

1. Identify and describe the component parts of the potable water system
   a. Water system schematic. The schematic should show key sources of water such as wells, rivers, ponds, commercial pipelines, etc. It should show facilities such as, treatment plants, pumping stations, pipelines, and distribution grids. The schematic should also include tactical equipment such as, ROWPUs, fabric tanks, TWDS, etc., and organic vehicles used for distribution of water such as tractors, trailers, and 2 1/2 ton trucks. Potential sources where you can find pre-existing schematics include water production/purification personnel, CE, other services, Joint/Service headquarters, host nation, commercial water company, operating contractor, etc. If a pre-existing schematic is not available, you or someone on your team should sketch one.
   b. Identify capabilities of key components. This step is necessary so you can assess the potential impact of a loss to any portion of the system, identify backup equipment requirements, and/or identify critical security requirements.
      1) Water source(s) and capacity(ies) per day
         a) Traditional sources, e.g., commercial system, wells, surface water, bottled water, etc.
         b) Emergency sources, e.g., nourishing liquids from commissary, exchange, NAF, commercial stores, etc.
      2) Water purification/treatment capacity per day
         a) Infrastructure
         b) Tactical equipment
      3) All existing and potential storage - size, type
      4) Distribution components and capacity(ies) per day
         a) Facilities - pumps, pipelines, hoses, etc.
         b) Tactical equipment - trucks, trailers, buffaloes, transportable fabric tanks/drums, etc.

2. Identify probable contamination events and assign impact characteristics
   a. Typical natural disasters for your area, e.g., flood, tornado, hurricane, earthquake, blizzard, sand storm, etc.
      1) Potential impact characteristics, e.g., damage/destruction of facilities, pipelines, tanks, supplies, and power; personnel casualties; diversion of resources from warfighting. .....
   b. Conventional attack
      1) Potential impact characteristics: damage/destruction of facilities, pipelines, tanks, supplies, and power; personnel casualties; diversion of resources from warfighting. .....
   c. Sabotage - biological, chemical
      1) Potential impact characteristics: denial of water, personnel casualties, diversion of resources from warfighting.
   d. Nuclear - warfare/accident
      1) Potential impact characteristics: damage/destruction of facilities, pipelines, tanks, supplies, and power; denial of water; personnel casualties; diversion of resources from warfighting.

e. Industrial accidents, e.g., chemical/hazardous material spills into water source, etc.

1) Potential impact characteristics: denial of water, personnel casualties, diversion of resources from warfighting.

f. Cross connections, e.g., areas vulnerable to contamination due to lack of adequate back flow prevention, low pressure, back siphoning, etc. Conditions where contaminates can be drawn back into the lines through interruptions in pressure or low pressures caused by large demands for water, such as fire fighting.

1) Potential impact characteristics: denial of water, personnel casualties, diversion of resources from warfighting. .....

3. Estimate the effect of probable event(s) on system components. This is where you must estimate the effect of each probable contamination event (paragraph 2 above) on each of the system components you identified in paragraph 1b above. The effect should be expressed as none, partial, or total. The type and extent of probable damage and corrective measures should also be estimated for each event and component. This section lends itself to a metric format with the following headings.

a. Component, Effect (none, partial, total), Type & Extent of Damage, and Corrective Measures

4. Estimate water consumption requirements over time, prior to and following the event(s). This will serve to quantify potential impacts.

a. This section can be in the form of narrative, charts, tables, or graphs

5. Determine potential impacts. Express potential impacts in terms of water shortfall(s) and health effects.

6. Identify the facilities and/or resources (people, equipment, vehicles, supplies, etc.) that caused the shortfall(s)

7. Identify fixes/workarounds

1.7 Water Conservation. In situations where water supplies are scarce, installation commanders must establish water conservation management practices. Water conservation management has two functions. The first is to assure water usage is prioritized. The second is to assure the correct quality of water is being use for appropriate purposes.

1.7.1 Quantity Limitations. Where water quantity is limited, the commander must assure personnel consume no more than the correct amount of water for existing conditions (see Table 1-1). Water usage for other purposes must be limited to direct support of warfighting weapon systems and facilities.

1.7.2 Quality Limitations. Where sufficient quantities of raw water are available but potable water is limited, the commander must assure personnel consume no more than the correct amount of water. However, untreated, non-potable, or sea water can be used for a variety of direct and/or indirect mission support requirements. Table 1-12 provides typical uses for non-consumptive water.

1.7.3 No Limitations. Even in situations where there are no water quantity or quality limitations, water management is still important. Puddling or ponding of water should be avoided as this could become a breeding ground for insects and bacteria.

1.8 Equipment. The following equipment may be encountered in field operations.

1.8.1 600 GPH ROWPU. The 600 gph ROWPU is intended for the production of potable water from fresh, brackish, or saline sources. The unit is trailer-mounted. It can be air dropped and requires a 5-ton prime mover. The unit is designed to purify 600 gallons of water per hour from fresh water sources with a TDS of 1,500 ppm at a temperature of 77 ^{O}F. It can purify 400 gph of water from saline water sources of 35,000 ppm at 77 ^{O}F. Production is dependent on the temperature of the source water. At 50 ^{O}F, the ROWPU will purify 300 gph of water from fresh water and 200 gph of water from saline water. This unit is capable of effectively removing potentially hazardous concentrations of all know chemical and biological agents and radioactive by-products of nuclear origin.

1.8.2 3,000 GPH ROWPU. The 3,000 gph ROWPU is contained in a 8 X 8 X 20 foot ISO container, mounted on a standard 30-foot military trailer. It is air transportable and can remove the same contaminants as the 600 gph unit, except the production rate is higher. A 60-kW diesel generator that is mounted on the back of the trailer powers the unit. At 77 ^{O}F, it can produce 3,000 gph of water from fresh water and 2,000 gph of water from saline water. At 50 ^{O}F, the purification rates are 1,500 gph from fresh water and 1,000 gph for saline water.

1.8.3 3,000-Gallon Onion Tank. The 3,000-gallon onion tank is a highly mobile, easily transportable, manually inflatable, collapsible fabric water tank. Empty, each tank measures 23 X 28 X 42 inches and weighs 130 pounds. Full, each tank measures 56 X 148 X 94 inches and weighs 24,020 pounds.

1.8.4 Potable Water Storage and Distribution System (PWS/DS). The PWS/DS consists of fabric tanks and related equipment to store and distribute potable water to combat forces. It is intended for use in arid environments. The total capacity of the PWS/DS is dependent on the number of fabric tanks assigned. The PWS/DS can receive bulk water from hoselines or tank trucks and issue water to tank trucks, semitrailer-mounted fabric tanks, water buffaloes, forward area water point supply systems or small unit containers, such as 5-gallon cans.

1.8.5 Forward Area Water Point Supply Systems (FAWPSS). The FAWPSS is a portable, self-contained, gas or diesel operated unit that dispenses potable water to troop units. The FAWPSS comes equipped with a 150 gpm pump, six 500-gallon water storage and dispensing drums, and four distribution nozzles.

1.8.6 Semitrailer-Mounted Fabric Tank (SMFT). SMFTs are 3,000-gallon or 5,000-gallon collapsible fabric tanks that come equipped with all required gages, fittings, tie-down straps, and emergency repair items. The tanks are designed to be tied down on trailers or line-haul trucks. The SMFTs are used for resupply of forward units.

1.8.7 Storage Equipment. Units are equipped with a large variety of water storage containers including canteens, 5-gallon water cans, collapsible fabric drums, and 400-gallon water trailers. Water supply companies have collapsible tanks ranging in size up to 50,000 gallons.

1.8.8 Field Showers. Field shower equipment consists of pumps, heater unit, generator, portable eight-head shower unit, tents, and vehicles. Collapsible water storage tanks are used for storage of potable water or for storage and purification of fresh water. These field showers can also be used as personnel decontamination stations.

1.9 Water Container Cleaning/Sanitizing. Periodically, all potable water containers should be cleaned and sanitized to remove potential contaminants and improve the palatability of the water. This two-step process is normally performed by water production and distribution personnel or unit sanitation teams who are trained in the standards and techniques associated with the processes. Table 1-13 includes equipment cleaning and sanitizing supplies needed for these processes.

1.9.1 Confined Spaces. Some potable water storage equipment is large enough to accommodate a person working inside the tank or container. Under such situations the tanks/containers are considered confined spaces and appropriate precautions must be taken prior to allowing personnel to enter the equipment (AFOSH 91-25, see http://afpubs.hq.af.mil).

1.9.2 Cleaning. The first step in the cleaning process is to remove rust from interior surfaces by using scouring powder and a non-metallic scouring pad or brush. Following this step, thoroughly rinse the container and discard the contents. Prepare a soap solution by adding 1/3 of a canteen cup of dish washing liquid to 10 gallons of water. Thoroughly wash the interior surfaces of the equipment. For small containers, e.g., 5-gallon cans add 1 gallon of soap solution and shake vigorously for 1 minute and drain the contents. For larger containers, scrub the interior surface with a long-handled brush. Clean pumps, pipes, valves, and spigots by drawing soap solution through them. Rinse the container twice with warm water to remove the soap solution. After cleaning, all containers must be sanitized. WARNING. Containers previously used for storage of petroleum or other hazardous products will not be used for storage of potable water.

1.9.3 Sanitizing. All potable water containers must be sanitized with 100 ppm chlorine solution after cleaning. The first step in the process is to construct a seepage pit or sump to discharge the waste chlorine solution. The waste chlorine solution will never be discharged into bodies of water or the sanitary sewer system. Chlorine can kill aquatic organisms in the water and bacteria in the sewer system that are needed for waste degradation. Options for preparing the 100 ppm chlorine solution are as follows. 1) add 1 ampoule of calcium hypochlorite to 1 gallon of potable water; 2) add 5 level spoonfuls of calcium hypochlorite to 100 gallons of potable water; 3) add 1 spoonful of liquid bleach to 1 gallon of potable water; 4) add 1 quart of bleach to 100 gallons of potable water. For smaller containers, fill the freshly cleaned container with the chlorine solution, close the covers, ports, or caps, and allow the solution to remain in the container for 60 minutes. For larger containers, apply the sanitizing solution to the interior surfaces by spraying or brushing. The solution must remain in contact with the surface for 60 minutes. This may require reapplication of the solution every 10 minutes or so, to keep surfaces wet. Rinse the container twice with potable water.

1.10 Recreational Water Surveillance. Just as with contaminated potable water, unhealthy recreational water facilities can result in the temporary loss of combat forces. Installation commanders must establish a hygiene, testing and surveillance program that will assure maintenance of water quality in pools, spas, hot tubs, and natural bathing areas.

1.10.1 Responsibilities. The health and hygiene of recreational water facilities rest with Civil Engineers (CE), Services (SV), Public Health (PH), and BES. CE is responsible for construction and maintenance of pools, hot tubs, and spas and for assuring that the pool operator correctly maintains and operates equipment and keeps records. SV oversees the general day-to-day operation of public bathing facilities to assure sanitary and safe conditions for patrons and appoints bathing facility personnel. PH performs routine facility sanitation inspections. BES provides water quality surveillance, bacteriological monitoring, and industrial hygiene surveillance.

1.10.2 Swimming Pools. The following standards apply to swimming pools used by Air Force personnel.

1.10.2.1 Sanitation. The pool operator must drain and clean recirculation-type pools as recommended by the Medical Group Commander. The operator must clean the pool daily with a suction cleaner or other bottom cleaning device and maintain a clean and healthful environment around the pool.

Table 1-13 - Equipment and Supplies

NSN	ITEM
6810-01-358-4336	Calcium hypochlorite (HTH), 1 lb (65%)
6810-00-255-0472	Calcium hypochlorite (HTH), 100 lb (65%)
6810-01-225-2682	Calcium hypochlorite (HTH), 25 lb (55%)
6810-00-242-4770	Calcium hypochlorite (HTH), 45 lb (65%)
6810-00-238-8115	Calcium hypochlorite (HTH), 5 lb (65%)
6810-01-368-3566	Calcium hypochlorite (HTH), 50 lb (60%)
6810-00-255-0471	Calcium hypochlorite (HTH), 6 oz bottle (65%)
6810-00-200-2370	Calcium hypochlorite (HTH), 75 lb (70%)
6810-01-065-2410	Calcium hypochlorite (HTH), 90 lb (65%)
7930-00-899-9534	Dish washing compound, 5 gal bottle
6850-00753-4827	DS2 Decontaminating agent (1.3 qt)
6850-00-753-4870	DS2 Decontaminating agent (5 gal)
6850-00-985-7166	Iodine tablets (bottle of 50)
4230-01-101-3984	M258A1 - Skin decontamination kit
7920-00-061-0038	Plastic scrub brush
7920-00-753-5242	Scouring pad
7930-00-205-0442	Scouring powder, 14 oz can
6810-00-290-3835	Sodium hypochlorite, 1 gal bottle (10%)
6810-00-944-4129	Sodium hypochlorite, 1 gal bottle (5%)
6810-00-300-5702	Sodium hypochlorite, 1 pt bottle (5%)
6810-00-769-1870	Sodium hypochlorite, 1/2 gal bottle (15%)
6810-01-204-0689	Sodium hypochlorite, 15 gal bottle (10%)
6810-00-214-8743	Sodium hypochlorite, 5 gal bottle (10%)
6810-00-169-5163	Sodium hypochlorite, 5 gal bottle (15%)
6810-00-598-7316	Sodium hypochlorite, 5 gal bottle (5%)
6810-01-296-6999	Sodium hypochlorite, 55 gal drum (16%)
6810-01-355-8501	Sodium hypochlorite, 55 gal drum (16%)
6850-00-297-6653	Super tropical Bleach (STB)
6685-00-444-6500	Thermometer, self-indicating, bimetallic
6850-00-270-6225	Water purification chlorination kit
6665-00-159-2218	Wet-bulb Globe Temperature (WBGT) Kit

1.10.2.2 Water Quality. Pool water must come from approved drinking water sources and meet the guidelines shown in Table 1-14 and Table 1-15 . The operator should ensure pools equipped with overflow gutters are overflowed each day to remove scum and debris. Pools equipped with surface skimmers shall be maintained at a level such that the skimmer operates continuously. Pools shall be shocked as necessary to kill algae. For chlorine shock, total chlorine is raised to 10 ppm. For bromine and iodine, follow manufacturer's directions. If feces or vomit is found in the pool, the operator shall take the following action.

- Close the pool and notify patrons to exit
- Remove the physical debris
- Notify the BES
- Allow appropriate disinfectant time (Table 1-16) to elapse or shock the pool
- Pool can be reopened after completion of disinfectant time and when disinfectant levels can be maintained

1.10.2.3 Measurement. The operator shall measure the pH and disinfectant residual at all four corners of the pool in accordance with (IAW) the frequency in Table 1-14 . Enter the average of the values on an AF Form 708. If results are outside the acceptable range, the operator must notify the BES. Periodically, the BES determines the pH and

disinfectant residual levels, enters the results on an AF Form 708 and compares the results to the readings entered by the operator. If the readings differ significantly, the BES must determine the cause of the discrepancy and ensure the operator takes corrective action. The BES shall perform bacteriological sampling for Heterotrophic Plate Count (HPC) and Fecal Coliform (FC) within 72 hours prior to seasonal opening of the pool or when pool related illnesses occur.

Table 1-14 - Swimming Pool Water Quality Guidelines (AFOSH STD 48-14)

Testing By Bathing Facility Manager				
Parameter	**Frequency**	**Min**	**Max**	**Comments**
pH	Every 2 hours during operation	7.2	7.8	
Free chlorine residual	Every 2 hours during operation	Table 1-15	2.0 ppm	Min depends on pH
Combined chlorine	Every 2 hours during operation	None	0.2 ppm	
Cyanuric acid	Biweekly	30 ppm	100 ppm	Used to stabilize free chlorine
Bromine	Daily	2.0 ppm	4.0 ppm	
Iodine	Daily	0.5 ppm	1.2 ppm	Not for outdoor pools
Temperature	Daily	none	82 ^{O}F	
Total alkalinity	Weekly	60 ppm	180 ppm	
Testing By Civil Engineering Personnel				
Calcium hardness	Monthly	None	500 ppm	
Total dissolved solids	Bimonthly	None	3000 ppm	
Turbidity	When water is cloudy	6” black disk must be visible on bottom of deepest part of pool		

Table 1-15 - Minimum Free Available Chlorine (FAC) Residual Versus pH for pools (AFOSH STD 48-14)

pH	**Minimum FAC Stabilized with Cyanuric Acid (ppm)**	**Minimum FAC Residual not Stabilized (ppm)**
7.2	1.00	0.40
7.3	1.00	0.40
7.4	1.00	0.40
7.5	1.00	0.40
7.6	1.25	0.50
7.7	1.50	0.60
7.8	1.75	0.70

Table 1-16- Disinfection Times to Reach Acceptable Inactivation of Bacteria, Virus, and Giardia Lamblia Cysts (AFOSH STD 48-14)

	pH < or =		
Free Residual < or = (mg/l)	**7.0**	**7.5**	**8.0**
0.4	88 min	105 min	125 min
0.6	60 min	72 min	85 min
0.8	47 min	55 min	67 min
1.0	37 min	45 min	54 min
1.2	32 min	39 min	46 min
1.4	28 min	34 min	41 min
1.6	25 min	30 min	37 min
1.8	23 min	28 min	34 min
2.0	22 min	25 min	31 min
2.2	20 min	24 min	29 min
2.4	18 min	22 min	27 min
2.6	17 min	21 min	25 min
2.8	16 min	20 min	24 min
3.0	16 min	19 min	23 min

1.10.2.4 Inspections. For seasonally operated pools, a representative from CE, SV, BES, PH, and Safety shall conduct a joint inspection approximately 30 days prior to opening the pool. For continuously operated pools, the inspection should be performed about 30 days prior to heavy seasonal use. SV shall coordinate the inspection. Based on past performance history, the PH shall conduct periodic sanitary inspections of pool facilities. The BES shall ensure the pool operator is using proper testing procedures for pH, alkalinity, and disinfectant residual. During periods of operation, the CE shall perform a weekly inspection of the filtration, recirculation, and disinfectant equipment to assure proper operation. The following elements are provided as minimum inspection criteria. A negative response to any question indicates the need for corrective action.

- Date of inspection and name of inspector(s) and pool operator.
- Copy of pool rules prominently displayed?
- Lifeguards enforcing pool rules?
- Cleaning requirements being followed?
- AF Form 708 properly completed?
- Water on apron draining away from pool?
- Water quality parameters (pH, temp, disinfectant level, turbidity) being met?
- Pool surface water free of scum/debris?
- Pool bottom and sides clean? Vacuumed and scrubbed as needed?

- Proper first aid equipment present?
- Toilet/Shower facilities cleaned and disinfected as required?
- Phone readily available with emergency numbers clearly displayed?
- Is piping diagram of water and sewer lines posted near spa chemical equipment?

1.10.3 Spas and Hot Tubs. The following standards apply to spas and hot tubs used by Air Force personnel.

1.10.3.1 Sanitation. The operator shall maintain a clean and healthful environment in and around the spa/hot tub and assure the spa/hot tub is shocked daily. For spas/hot tubs disinfected with chlorine, shock consists of raising the total chlorine to 10 ppm. Follow manufacturer's directions for other disinfectants.

1.10.3.2 Water Quality. The operator shall obtain water from approved drinking water sources and ensure the spa/hot tub water quality meets the guidelines in Table 1-17 and Table 1-18. The operator shall also ensure spas/hot tubs are overflowed into overflow gutters (if so equipped) or skimmed daily to remove scum and surface debris.

Table 1-17 - Spa and Hot Tub Water Quality Guidelines (AFOSH STD 48-14)

Testing By Bathing Facility Manager				
Parameter	**Frequency**	**Min**	**Max**	**Comments**
pH	Every 1 hour during operation	7.2	7.8	
Free chlorine residual	Every 1 hour during operation	Table 1-18	5.0 ppm	Min depends on pH
Combined chlorine	Every 1 hour during operation	None	0.2 ppm	
Bromine	Daily	2.0 ppm	5.0 ppm	
Temperature	Daily	none	104 ^{O}F	
Total alkalinity	Weekly	60 ppm	180 ppm	
Testing By Civil Engineering Personnel				
Calcium hardness	Monthly	None	500 ppm	
Total dissolved solids	Bimonthly	None	3000 ppm	
Turbidity	When water is cloudy	shock or drain and refill spa/hot tub		

Table 1-18 - Minimum Free Available Chlorine (FAC) Residual Versus pH For Spas and Hot Tubs (AFOSH STD 48-14)

pH	**Minimum FAC Residual (ppm)**
7.2	2.00
7.3	2.00
7.4	2.00
7.5	2.00
7.6	2.50
7.7	3.00
7.8	3.50

1.10.3.3 Measurement. The bathing facility manager shall measure pH, temperature, and disinfectant residual level prior to daily opening and hourly thereafter, or use a continuous reading device. CE shall conduct water quality measurements at intervals specified in Table 1-17, and others as necessary, making corrective actions at water supply or informing facility manager of additional treatments recommended. BES shall periodically measure pH, temperature, and disinfectant residual level. BES shall determine the frequency of measurements based on past performance history. Measurements should be made at times of heavy use.

1.10.3.4 Inspection. Spa/Hot tub operators shall inspect the facilities, including disinfection equipment, once weekly and as necessary or recommended by the Medical Group Commander. BES shall periodically inspect public spas/hot tubs to ensure water quality parameters are being met. BE shall determine inspection frequency based on past performance history. PH shall periodically inspect public spas/hot tubs to ensure proper safe and sanitary conditions around the spas and hot tubs. PH shall determine inspection frequency based on past performance history. The following elements are provided as minimum inspection criteria. A negative response to any question indicates the need for corrective action.

- Copy of rules and warnings prominently displayed?
- At least 1 employee with documented first-aid training and CPR certification on duty?
- Operator enforcing rules?
- Cleaning requirements being followed?
- AF Form 708 properly completed?
- Water on apron draining away from spa/hot tub?
- Water quality parameters (pH, Temp, disinfectant level, turbidity) being met?
- Scum/debris removed from surface of water periodically?
- Bottom and sides clean?
- Proper first aid equipment present?
- Toilet/Shower facilities cleaned and disinfected as required?
- Phone readily available with emergency numbers clearly displayed?
- Is piping diagram of water and sewer lines posted near spa chemical equipment?

1.10.4 Natural Bathing Areas. The Medical Group Commander shall approve all areas proposed for natural bathing facilities. The decision should be based on the following considerations:

- Site Location. Ensure the bathing areas are free of the effects of point and non-point pollution sources. Sources of potentially dangerous contamination include waste discharges from communities, industries, marine craft, local animal populations, and water fowl. The water must meet the source water quality standards outlined in Table 1-19 .
- Type of Bottom. These areas should have bottoms which slope gently and uniformly toward deep water; have no holes or sudden step-offs; be free of hidden or submerged obstructions such as rocks, stumps, snags, and sunken logs; be composed of firm sand, small-sized gravel, or shale; and have no silt, quicksand, shell patches, sharp and broken rock, or debris in depths of 5 ft (1.5 m) or less.
- Physical Water Quality. Consider the depth and turbidity of the water, presence of currents, rip tides, and dangerous marine or aquatic life.
- Natural bodies of water located in areas where schistosomiasis (bilharziasis), leptospirosis, or primary amoebic meningoencephalitis are endemic shall not be approved for recreational purposes without the concurrence of the public health or preventive medicine officer. Special consideration must be given to the prevalence of disease in the immediate locale as well as the presence of disease-causative agents in the body of water.

Table 1-19 - Source Water Quality Guidelines

Parameter	Criteria, ppm
Ammonia	0.5 (as N)
Arsenic	0.1
Barium	1.0
Cadmium	0.01
Chromium	0.05
Copper	1.0
Iron (soluble)	0.3
Lead	0.05
Manganese (soluble)	0.05
Mercury	0.002
Selenium	0.01
Sulfate	250
Zinc	5.0
Pesticides (EPA method 608)	
Aldrin	0.001
Chlordane	0.003
DDT	0.05
Dieldrin	0.001
Endrin	0.0005
Heptachlor	0.0001
Heptachlor epoxide	0.0001
Lindane	0.005
Methoxychlor	1.0
Organic phosphates plus carbamates	0.1
Toxaphene	0.005
Herbicides	
2,4-D	0.02
2,4,5-T	0.002
2,4,5-TP (Silvex)	0.03
Phenols	0.001

1.10.4.1. Sanitation. The operator must keep the beach areas cleaned and raked at all times and ensure that facilities (toilets, showers, dressing rooms, etc.) are kept clean and sanitary.

1.10.4.2. Water Quality. Natural bathing areas present significantly more risks in terms of pathogenic organisms because the water is not treated chemically. Table 1-20 shows diseases of concern related to natural recreational waters. Fecal coliform (FC) will be used as the indicator organism for evaluating the microbiological suitability of the water. Use the multiple-tube fermentation or membrane filter technique and compare results of at least five samples taken over fewer than 30 days. The FC content should not exceed a log mean of 200/100 ml, nor should more than 10 percent of the total samples during any 30-day period exceed 400/100 ml.

1.10.4.3 Measurement. BES shall periodically take bacteriological samples for fecal coliform prior to season opening and for FC or other common pathogens based upon past history at the natural swimming area. If a local health department. Host nation, or other service routinely collects water quality samples, BES shall work with these agencies to share data to avoid duplication of sampling. BES shall collect samples and have them analyzed for the contaminants listed in Table 1-19 during the pre-season inspection. Periodically throughout the swimming season,

BE should sample specifically for any contaminant with the potential to exceed acceptable limits based upon environmental conditions. These guidelines should assist in approving a site for use.

Table 1-20 - Diseases of Concern Associated With Natural Bathing Areas

DISEASE	Sources	Characteristics	Symptoms
Leptospirosis	Leptospira interrogan; water contaminated with urine from infected animals such as rats, swine, and cattle	Generally found in fresh water	Fever, chills, and headache
Giardiasis	Giardia Lamblia; in the intestinal tracts of mammals such as beavers and foxes living near bathing areas	Gastrointestinal illness; generally found in fresh water	Diarrhea, cramps
Shistosome dermatitis, known as "swimmers itch" or "water rash"	Larvae of certain trematode worms of birds and mammals penetrate the skin	Common to freshwater lakes in the northcentral U.S.; can be prevented by limiting exposure to water to less than 30 minutes, followed by vigorous towel drying between fingers and toes	Dermatitis characterized by skin eruptions
Primary amoebic meningoence-phalitis (PAM)	Naegleria fowleri; a free-swimming amoeba associated with warm natural bodies of water	Common to southern U.S.; a parasitic disease untreatable with antiparasitic agents, antibiotics, and antimetabolites	Severe headache, fever, death
Schistosomiasis, also known as bilharziasis	Schistosoma mansoni (blood flukes); snails act as intermediate hosts for the cercariae, a larval form of the fluke; also found in parasite-infected drinking water, and other Schistosoma species	Serious public health disease found in fresh or mildly brackish water of tropical and semi-tropical areas such	Diarrhea, abdominal pain; liver and urinary disorders
Cryptosporidiosis	Cryptosporidium; a pathogenic intestinal protozoa found in man and animals that forms resistant oocysts; water contaminated through direct deposit of human and animal feces into receiving waters	Oocysts associated with turbid waters; ingestion causes gastrointestinal illness	Diarrhea

1.10.4.4 Inspections**.** Representatives from SV, BE, PH, and SEG shall conduct a pre-season survey of natural bathing areas. PH shall periodically conduct a general inspection of the area and operations, as necessary, to ensure safe and sanitary conditions are being maintained. The following elements are provided as minimum inspection criteria. A negative response to any question indicates the need for corrective action. Examine for potential sources of pollution such as agricultural drainage or waste water discharges.

- Evaluate the bacteriological and chemical effects of such discharges on the bathing area.
- Water depth and bottom slope safe?
- Free of dangerous reptiles, submerged objects, drop-offs, or other physical endangerments?

- General cleanliness satisfactory for safety?
- Proper first aid safety equipment present?
- Safety guidelines prominently displayed and being followed and enforced by lifeguards?

Section 2
Waste Management

SECTION 2 - WASTE MANAGEMENT

2.1 General. This section provides information and guidance on surveillance and testing requirements associated with wastewater, field waste disposal, solid waste, and mortuary operations. This information is used to assure that waste discharges from the installation have a minimum impact on the environment. The waste management requirements in this section consider infrastructure conditions ranging from bare base to well-established facilities and utility systems. The BES must tailor the waste management requirements in the section to align with infrastructure conditions. Where Final Governing Standards (FGS), additional Host Nation requirements, or United States codes are in effect, BES must establish a sampling and testing program that assures compliance with applicable documents. Check with your installation environmental activity to determine if FGS, additional Host Nation requirements, or US codes apply.

2.2 Planning. The impact of crisis situations can be minimized or eliminated all together through effective advanced planning. The BES should develop a Waste Management Sampling Plan similar in format to the Drinking Water Sampling Plan. Your plan should address the questions "what, where, and how often" to monitor wastewater, solid waste, and mortuary operations. This plan will be the basis for all activities associated with quality assurance and quality control of installation waste management. Specific sampling and testing requirements and information are provided in the various paragraphs covering each topic. However, the following outline shows general topics that should be addressed in the plan.

WASTE MANAGEMENT SAMPLING PLAN

1. This portion of the sampling plan should address the "what and where" questions - what must be sampled and from where should the samples be taken. Some examples of what should be sampled include direct, indirect, and industrial wastewater discharge points, uncharacterized accumulated waste, inert metal content of compost, etc. The "where" section of the plan should provide enough information so sample takers know where to draw the samples, e.g., from the point of final discharge prior to mixing with the receiving water, from the bottom one third, middle and top one third of a drum, etc.

2. This section of the sampling plan provides specific information on what samples must be taken from each of the points identified in paragraph 1 above and "how often" they should be drawn. This section of the plan could be covered by a series of tables similar to the ones in your potable water sampling plan.

3. QA/QC Guidelines. It is good professional practice to adopt a QA/QC program to validate analytical test data. A QA/QC program normally consists of known positive (KN) and field duplicate (FD) samples that are collected at the same time regular samples are collected.

a. Known positives are used for QC of total coliform analyses. KN samples will be collected at a frequency of one per sampling month for wastewater discharge points.

b. Field duplicates (FD) are taken to verify the results of laboratory analysis. There are two types of field duplicates: coded field duplicates (CFD); and non-coded field duplicates (NCFD). When an off-site laboratory is contracted to perform analytical tests, CFDs should be collected. CFDs are duplicate samples collected in the field and given different sample identifiers so that the off-site contracted laboratory does not know that the two samples are duplicates. When Base personnel are responsible for sample collection and analysis, NCFDs should be taken. NCFDs are duplicate samples collected in the field and are given the recognized sample identifier. The appropriate use of coded field duplicates and non-coded field duplicates should be determined locally. The frequency of the field duplicates should be evenly distributed over the year. You should draw one FD for every 10 regular samples for each sampling point. This protocol is referred to as the 10 percent rule.

4. Sampling procedures. This section of your plan should include special instructions associated with collecting and analyzing samples, e.g., sample container requirements, sample quantities, reagent requirements and quantities, companion sample requirements, security access requirements, unit POCs, etc.

5. Sample handling requirements. This is where you address specific information on identification of samples, sample forms, sample numbering systems, sample custody requirements and procedures, shipping procedures, sample packaging and marking requirements, commercial/contract laboratory specialties, capabilities, etc.

6. Reporting requirements. This section of the plan addresses reporting, notification, and administrative procedures.

a. Reports. Identify all reporting requirements, formats/forms, and suspenses, as well as the names and addresses of activities requiring reports.

b. Non-compliance notification. Provide specific instructions on who is to be notified when the installation is out of compliance with standards. Notification requirements will most likely vary by location, command, and/or regulatory activity. Make sure you develop these procedures in conjunction with CE.

c. Administrative procedures. Include information on special operating logs, form requirements, and publications. Address records retention requirements, to include sample logs, reports, notification letters, sample results, etc. Monthly operating reports/logs should be marked for 3-years retention. Bacteriological test results should be marked for 5-years retention. Chemical, chemical agent, and radiological test results should be marked for 10-years retention.

7. Financial management. Include instructions on development and submission of program requirements. Document your current operating budget. List local and central contracts available to you for supplies, equipment, and/or laboratory services.

2.3 Wastewater. When used in conjunction with FGSs and applicable permitting documents, if any, this section provides the information needed to establish a sampling and testing program for wastewater. The requirements contained in this subsection should be incorporated into your environmental sampling plan.

2.3.1 Definitions. Wastewater discharge falls into three categories - direct, indirect, and industrial. Direct discharge is the introduction of pollutants directly to surface waters or soil. Indirect discharge is any introduction of pollutants in process wastewater that flows to a domestic wastewater treatment plant (DWTP) or other collection systems such as retention ponds and stabilization lagoons. Process wastewater is any water which during manufacturing or processing, comes into direct contact with, or results from the production or use of, any raw material, intermediate product, finished product, by-product, or waste product. Industrial discharge is a wastewater leaving specific industrial operations (electroplating, anodizing, metal coating, chemical etching and milling, electroless plating, printed circuit board manufacturing) or an industrial wastewater treatment plant (IWTP). Wastewater standards apply to regulated facilities. Regulated facilities include DWTP, IWTP, and an industrial discharger. A DWTP is a DoD or host nation facility designed to treat wastewater (primarily domestic sewage) prior to discharge to a nation's waters. An IWTP is a DoD facility designed to treat process wastewater prior to discharge to a nation's waters. An industrial discharger is any installation that discharges wastewater from one of the previously mentioned industrial processes.

2.3.2 Non-BES Requirements. Operational and management activities, other than the BES, must assure the following general criteria are met concerning direct and indirect wastewater discharges. There are no general criteria for non-BES activities regarding industrial wastewater discharges.

2.3.2.1 Direct discharges. Non-BES requirements for direct discharges of wastewater are as follows:

- The pH of the effluent must not exceed the range of 6.0-9.0.
- DWTPs treating water generated from medical and dental treatment facilities must chemically disinfect the effluent prior to direct discharge.
- A system must be established to investigate water pollution complaints from individuals or local water pollution control authorities.

- Wastewater may be used for irrigation purposes or otherwise discharged onto the soil provided it has been screened for and conforms to the limits for non-conventional pollutants shown in Table 2-1 ; it has been disinfected; and the guidance below is followed.
    - ◊ The wastewater may not be used in areas frequented by children and for the irrigation of leaf and root crops.
    - ◊ The wastewater must be applied in a controlled manner (for example, no surface water runoff) such as to prevent erosion. The environmental impact of use of the wastewater must be periodically evaluated by controls of the soil, vegetation, groundwater, nearby surface waters as well as the presence of vapors or odors emanating from the soil.
    - ◊ Use of treated and disinfected water must ensure that the soil, subsoil, aquifers and vegetation will not be degraded. To that end, the site of application must be chosen on the basis of topographical, morphological, geological and hydrological characteristics. The depth of the soil may not be less than 1.50 meters and a baseline soil investigation must be carried out to determine soil pH, electrical conductivity, salinity, sodium adsorption ratio, and cat ion exchange capacity. Protection of the groundwater will require detailed study of the aquifer system in the area concerned.
    - ◊ Coordinate specific discharge requirements with the appropriate host nation authorities

2.3.2.2 Indirect discharges. Non-BES activities must comply with the following requirements prior to discharge of wastewater to all DWTPs and associated collection systems:

- The discharge of solid or viscous pollutants that would result in an obstruction to the domestic wastewater treatment plant flow is prohibited.
- Ignitability and explosivity:
    - ◊ The discharge of wastewater with a closed cup flash point of less than 60° C (140° F) is prohibited.
    - ◊ The discharge of wastes with any of the following characteristics is prohibited:
        - ∗ A liquid solution that contains more than 24 percent alcohol by volume and has a flash point less than 60° C (140° F)
        - ∗ A non-liquid which under standard temperature and pressure can cause a fire through friction
        - ∗ An ignitable compressed gas
        - ∗ An oxidizer, such as peroxide
- The discharge of any of the following wastes is prohibited:
    - ◊ Wastes that are normally unstable and readily undergo violent changes without detonating;
    - ◊ Wastes that react violently with water;
    - ◊ Wastes that form explosive mixtures with water or form toxic gases or fumes when mixed with water;
    - ◊ Cyanide or sulfide waste that can generate potentially harmful toxic fumes, gases, or vapors;
    - ◊ Waste capable of detonation or explosive decomposition or reaction at standard temperature and pressure;
    - ◊ Wastes that contain explosives regulated by Chapter 5; and
    - ◊ Wastes that produce any toxic fumes, vapors, or gases with the potential to cause safety problems or harm to workers.
- It is prohibited to discharge pollutants that have the potential to be structurally corrosive to the DWTP. In addition, no discharge of wastewater below a pH of 5.5 is allowed, unless the DWTP is specifically designed to handle this type of wastewater.
- The discharge of the following oils, which can pass through or cause interference to the DWTP, is prohibited: petroleum oil, non-biodegradable cutting oil, and products of mineral oil origin.

- Activities or installations that have a significant potential for spills or batch discharges will develop a slug prevention plan. Each plan must contain the following minimum requirements:
    - ◊ Description of discharge practices, including non-routine batch discharges;
    - ◊ Description of stored chemicals;
    - ◊ Plan for immediately notifying the DWTP of slug discharges and discharges that would violate prohibitions under this section, including procedures for subsequent written notification within five days;
    - ◊ Necessary practices to prevent accidental spills. This would include proper inspection and maintenance of storage areas, handling and transfer of materials, loading and unloading operations, control of plant site runoff, and worker training;
    - ◊ Proper procedures for building containment structures or equipment; Necessary measures to control toxic organic pollutants and solvents; and
    - ◊ Proper procedures and equipment for emergency response, and any subsequent plans necessary to limit damage suffered by the treatment plant or the environment.
- The discharge of trucked and hauled waste into the DWTP, except at locations specified by the DWTP, is prohibited.

2.3.3 BES Requirements. The BES must assure the following requirements are met concerning direct, indirect, and industrial wastewater discharges. Appropriate portions of this subsection should be incorporated into your Environmental Sampling Plan.

2.3.3.1 Direct discharges. Table 2-1 shows parameters and discharge limits for pollutants in wastewater that is discharged directly to surface waters or soil. Conventional pollutants (BOD, COD, TSS, and pH) are sampled at the frequency shown in Table 2-2. Non-conventional pollutants are sampled using a series of screening programs discussed below.

- Initial screening. Initial screening should be carried out at least once every two years or when operational changes occur which may alter wastewater characteristics. A single grab sample shall be taken at the point of final discharge. If a parameter exceeds the discharge limit given in Table 2-1, confirmation screening should be conducted. If the value of a parameter is below the discharge limit, then sampling and analysis for this parameter shall not be required until the next initial screening event.
- Confirmation screening. Each parameter that exceeds the discharge limits during initial screening should have its presence confirmed in this phase. For each parameter that exceeds the limits during the initial screening phase, a minimum of seven grab samples should be taken for analysis over a 14-day period. The sampling schedule should vary the sampling time over a 24-hour day and the day of the week. Each grab sample should be analyzed for the parameter of concern. If any parameter in one or more of the seven samples is confirmed as having an elevated value (above that defined in Table 2-1), then continued monitoring will be conducted.
- Continued monitoring. Elevated levels of any parameter that arise from the confirmation screening should be monitored in accordance with frequency given in Table 2-2. The monitoring frequency should vary according to the discharge flow through the treatment works; where direct discharges occur without treatment, the 30-day average of the actual flow should determine the monitoring frequency. Continued monitoring should be conducted until the value of the parameter is sustained below the limits given in Table 2-1. The parameter of concern should then be monitored at the next initial screening event.

Table 2-1 - Wastewater Pollutants

Parameter	Discharge Limits	
	Direct to Surface Water	**Indirect**
Conventional Pollutants		
Biochemical Oxygen Demand (BOD)	30 day avg not > 30 mg/L; 7 day avg not > 45 mg/L	
Chemical Oxygen Demand (COD)	30 day avg not > 25 mg/L; 7 day avg not > 40 mg/L	
Total Suspended Solids (TSS) (new source)	30 day avg not > 30 mg/L; 7 day avg not > 45 mg/L	
Total Suspended Solids (TSS) (existing source)	30 day avg not > 45 mg/L; 7 day avg not > 65 mg/L	
pH	6.0 - 9.0	
Non-Conventional Pollutants		
Active chlorine	0.2 mg/L	0.3 mg/L
Aldehydes as H-CHO	1 mg/L	2 mg/L
Aluminum	1 mg/L	2 mg/L
Ammonium nitrogen as NH4+	15 mg/L	30 mg/L
Aromatic Organic Solvents	0.2 mg/L	0.4 mg/L
Arsenic	0.5 mg/L	0.5 mg/L
Barium	20 mg/L	
Boron	2 mg/L.	4 mg/L
Cadmium	0.02 mg/L	0.02 mg/L
Chloride as chlorine	1,200 mg/L	1,200 mg/L
Chlorinated pesticides	0.05 mg/L	0.05 mg/L
Chlorinated solvents	1 mg/L	2 mg/L
Color	Not perceptible after 1:20 dilution through a 10 cm wedge	Not perceptible after 1:40 dilution through a 10 cm wedge
Copper	0.1 mg/L	0.4 mg/L
Cr III as chromium	2 mg/L	4 mg/L
Cr VI as chromium	0.2 mg/L	0.2 mg/L
Fecal coliform	12,000 /100 ml	
Fecal streptococci	2,000 /100 ml	
Fluoride as fluorine	6 mg/L	12 mg/L
Iron	2 mg/L	4 mg/L
Lead	0.2 mg/L	0.3 mg/L
Manganese	2 mg/L	4 mg/L
Mercury	0.005 mg/L	0.005 mg/L

Table 2-1 (Con't)

Parameter	Discharge Limits	
	Direct to Surface Water	**Indirect**
Mineral oil, (non-saponifiable)	5 mg/L	10 mg/L
Nickel	2 mg/L	4 mg/L
Nitrate nitrogen as N	20 mg/L	30 mg/L
Nitrated organic solvents	0.1 mg/L	0.2 mg/L
Odor	C	
Oil and grease	20 mg/L	40 mg/L
Organo phosphorus pesticides	0.1 mg/L	0.1 mg/L
Phenol as C_6H_5OH	0.5 mg/L	1 mg/L
Selenium	0.03 mg/L	0.03 mg/L
Settleable Solids	0.5 ml/l	2 ml/l
Sulfate as SO_4	1,000 mg/L	1,000 mg/L
Sulfide as H_2S	1 mg/L	2 mg/L
Sulfite as SO_3	1 mg/L	2 mg/L
Surfactants	2 mg/L	4 mg/L
Temperature °C	Will not cause a temperature difference of more than 3°C in receiving water	
Tin	10 mg/L	
Total coliform	20,000 /100 ml	
Total cyanide	0.5 mg/L	1 mg/L
Total particulate (>than 1 cm)	absent	absent
Total phosphorus	10 mg/L	10 mg/L
Toxicity test	1:1 dilution must permit 50 percent survival for 24 hours at temperature 15°C. Use species Salmo gairdnerii Rich. For saline waters, use marine organisms.	1:1 dilution must permit 50 percent survival for 24 hours at temperature 15°C. Use species Carassius auratus.
Zinc	0.5 mg/L	1 mg/L

Table 2-2 - Conventional Pollutant Monitoring Frequencies

Discharge Flow (Million Gallons per Day) (1) (2)	Monitoring Frequency
0.0 - 0.099	Quarterly
0.1 - 0.99	Monthly
1.0 - 4.99	Weekly
>5.0	Daily

(1) For direct discharges through a treatment works, monitoring frequency is based on the design flow capacity of the plant.
(2) For direct and indirect discharges without treatment, monitoring frequency is based on the 30-day average actual flow.

2.3.3.2 Indirect discharges. Indirect wastewater discharges into DoD DWTPs, IWTPs, or other collection systems (retention ponds, stabilization lagoons) need not be sampled. Indirect wastewater discharged into non-DoD DWTPs must be sampled for the non-conventional pollutants shown in Table 2-1. The frequency of sampling is based on the screening programs discussed in paragraph 2.3.3.1.

2.3.3.3 Industrial discharges. Wastewater that leaves a specific industry, shop or IWTP involved in electroplating, anodizing, metal coating, chemical etching and milling, electroless plating, or printed circuit board manufacturing should be monitored for compliance on a quarterly basis. The discharge standards vary according to the quantity of discharge per day. Specific pollutants and maximum limits for discharges of less than 10,000 gallons of effluent per day and 10,000 gallons per day and more are shown in Table 2-3 and Table 2-4 respectively. All samples should be collected at the point of discharge (after treatment, if applicable) prior to any mixing with the receiving water.

Table 2-3 - Discharge Standards - Less than 10,000 gallons of Effluent per day

Pollutant	Daily Maximum (mg/L)	4-day Average (mg/L)	30-day Average (mg/L)
Cyanide, amenable	5.0	2.7	
Lead	0.6	0.4	
Cadmium [4.2]	0.5	-	0.3 g of Cd discharged per kg of Cd handled
Total toxic organics (TTO)	4.57	-	

See Table 2-5 for TTO

Table 2-4 - Discharge Standards - 10,000 Gallons of Effluent per Day or More

Pollutant	Daily Maximum (mg/L)	4-day Average (mg/L)	30-day Average (mg/L)
Cyanide, total	1.9	1.0	
Copper	4.5	2.7	
Nickel	4.1	2.6	
Chrome	7.0	4.0	
Zinc	4.2	2.6	
Lead	0.6	0.4	
Cadmium [4.2]	0.5	-	0.3 g of Cd discharged per Kg of Cd handled
Total Metals	10.5	6.8	
Total toxic organics (TTO)	2.13	-	

See Table 2-5 for TTO

Table 2-5 - Components of Total Toxic Organics

Component	Component	Component
1,1,1-Trichloroethane	4-Nitrophenol	Fluoranthene
1,1,2,2-Tetrachloroethane	Acenaphthene	Fluorene
1,1,2-Trichloroethane	Acenaphthylene	Gamma-BHC
1,12-Benzoperylene (benzo (g,h,i) perylene)	Acrolein (propenyl)	Heptachlor
1,1-Dichloroethane	Acrylonitrile	Heptachlor epoxide (BHC-hexachlorocyclohexane)
1,1-Dichloroethene	Aldrin	Hexachlorobenzene
1,2,4-trichlorobenzene	Alpha-BHC	Hexachlorobutadiene
1,2,5,6-Dibenzanthracene(dibenzo (a,h) anthracene)	Alpha-endosulfan	Hexachlorocyclopentadiene
1,2-benzoanthracene (benzo (a) nthracene)	Anthracene	Hexachloroethane
1,2-Dichlorobenzene	Benzene	Indeno (1,2,3-cd) pyrene (2,3-o-phenylene pyrene)
1,2-Dichloroethane	Benzidine	Isophorone
1,2-Dichloropropane	Benzo (a) pyrene (3,4 benzopyrene)	Methyl bromide (bromomethane)
1,2-Diphenylthydrazine	Beta-endosulfan	Methyl chloride (chloromethane)
1,2-trans-dichloroethene	Bis (2-chloroethoxy) methane	Methylene chloride (9 dichloromethane)
1,3-Dichlorobenzene	bis (2-chloroethyl) ether	Naphthalene
1,3-Dichloropropylene (1,3-dichloropropene)	bis (2-chloroisopropyl)-ether	Nitrobenzene
1,4-Dichlorobenzene	bis (2-ethylhexyl) phthalate	N-nitrosodimethylamine
11,12-Benzofluoranthene (benzo (k) fluoranthene)	Bromodichloromethane	N-nitrosodi-n-propylamine
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	Bromoform (tribomomethane)	N-nitrosodiphenylamine
2,4,6-Trichlorophenol	Butyl benzyl phthalate	PCB-1016 (Arochlor 1016)
2,4-Dichlorophenol	Carbon Tetrachloride (tetrachloromethane)	PCB-1221 (Arochlor 1221)
2,4-Dimethylphenol	Chlordane (technical mixture and metabolites)	PCB-1232 (Arochlor 1232)
2,4-Dinitrophenol	Chlorobenzene	PCB-1242 (Arochlor 1242)
2,4-Dinitrotoluene	Chloroethane	PCB-1248 (Arochlor 1248)
2,6-Dinitrotoluene	Chloroform (trichloromethane)	PCB-1254 (Arochlor 1254)
2-Chloroethyl vinyl ether (mixed)	Chrysene	PCB-1260 (Arochlor 1260)
2-Chloronaphthalene	Delta-BHC	p-Chloro-m-cresol
2-Chlorophenol	Dibromochloromethane	Pentachlorophenol
2-Nitrophenol	Dieldrin	Phenanthrene
3,3-Dichlorobenzidine	Diethyl phthalate	Phenol
3,4-Benzofluoranthene (benzo (b) luoranthene)	Dimenthyl phthalate	Pyrene
4,4-DDD (p,p-TDE)	Di-n-butyl phthalate	Tetrachloroethene
4,4-DDE (p,p-DDX)	Di-n-octyl phthalate	Toluene
4,4-DDT	Endosulfan sulfate	Toxaphene
4,6-Dinitro-o-cresol	Endrin	Trichloroethene
4-Bromiphenyl phenyl ether	Endrin aldehyde	Vinyl chloride (chloroethylene
4-Chlorophenyl phenyl ether	Ethylbenzene	

2.3.3.4 QA/QC guidelines. It is good professional practice to adopt a QA/QC program to validate analytical test data. A QA/QC program normally consists of trip blanks and known positive (KN), field duplicate (FD), and matrix spike/matrix spike duplicate samples that are collected at the same time regular samples are collected.

a. Trip blanks are used to detect contamination of the environmental samples during shipping and handling. Trip blanks are prepared by the laboratory, transported to the field, kept with the environmental samples throughout the sampling effort, and returned to the laboratory for analysis with the volatile organic environmental samples. Trip blanks are volatile sample containers filled by the laboratory with organic-free water and are not opened in the field. One trip blank should be included in every cooler that contains environmental samples to be analyzed for volatile organic compounds.

b. Known positives are used for QC of total coliform analyses. KN samples will be collected at a frequency of one per sampling month for wastewater discharge points. This requirement follows the guidance issued in Quality Assurance Standard Method 9020.

c. Field duplicates (FD) are taken to verify the results of laboratory analysis. There are two types of field duplicates: coded field duplicates (CFD); and non-coded field duplicates (NCFD). When an off-site laboratory is contracted to perform analytical tests, CFDs should be collected. CFDs are duplicate samples collected in the field and given different sample identifiers so that the off-site contracted laboratory does not know that the two samples are duplicates. When Base personnel are responsible for sample collection and analysis, NCFDs should be taken. NCFDs are duplicate samples collected in the field and are given the recognized sample identifier. The appropriate use of coded field duplicates and non-coded field duplicates should be determined locally. The frequency of the field duplicates should be evenly distributed over the year. You should draw one FD for every 10 regular samples for each sampling point. This protocol is referred to as the 10 percent rule.

d. Matrix Spike/Matrix Spike Duplicates (MS/MSD). MS/MSD analyses are used to determine the effect, if any, a matrix or an interferent on the matrix has on the precision and accuracy of the sample results. The MS/MSD analyses are a pair of samples, the MS and the MSD, thus for each MS/MSD there will be two samples collected. MS/MSDs should be collected for: confirmation screening of direct and indirect discharges; continued screening of direct and indirect discharges; and industrial discharges (when applicable). The number of MS/MSD pairs to be collected comply with the 5 percent rule and the first MS/MSD pair should be taken at the beginning of each sampling year, so that the quality of the data received from the laboratory is established at an early stage. MS/MSD pairs should not be collected for the initial screening program for direct and indirect discharges. MS/MSD analyses should be performed on the parameters shown in Table 2-6 .

Table 2-6 - Parameters For Which MS/MSD Duplicates Should be Taken

Aldehydes as H-CHO	Pesticides/PCBs
Ammonium nitrogen	Phosphorus pesticides
Chloride	Sulfate
Chlorinated pesticides	Sulfite
Fluoride	Surfactants
Metals	Total cyanide
Nitrite	Total phosphorus
Organo	2,3,7,8 TCDD
Volatile organics (aromatic, chlorinated and nitrated solvents)	Semivolatile organics (phenol as C_6H_5OH, chlorinated and nitrated solvents)

2.3.3.5 Sampling procedures. The wastewater section of your environmental plan should include special instructions associated with collecting and analyzing samples, e.g., sample container requirements, sample quantities, reagent requirements and quantities, companion sample requirements, security access requirements, unit POCs, etc. Table 2-7 provides information on wastewater sampling requirements that should be included in your plan. The collection points for direct, indirect, and industrial discharges are as follows:

- Direct and indirect discharges: collect samples at the point of final discharge prior to any mixing with the receiving water
- Industrial discharges: collect samples at the point of discharge (after treatment) prior to any mixing with the receiving water

2.3.3.6 Sample identification. Sample containers should be identified with a separate identification label. Labeling should be done in indelible/waterproof ink. Errors should be crossed out with a single line, dated, and initialed. Each label should include project identification, a unique sample identification number (including date and time of collection), sampler's name or initials, preservatives added, and required analytical method numbers.

2.3.3.7 Sample custody. A chain-of-custody (COC) Record should accompany all samples. When transferring samples, the individuals relinquishing and receiving the sample should sign and date the record. Shipments should be sent by express carrier. Airbills should be retained as part of the permanent documentation. When samples are shipped to a laboratory, they must be placed in containers sealed with custody seals. Two seals should be placed on each shipped container - one at the front and one at the back. Clear tape should be placed over the seals to ensure that seals are not accidentally broken during shipment.

2.3.3.8 Sample shipment. After labeling and preservation, samples must be stored in refrigerators or ice-filled cooler chests, until shipment or delivery to a laboratory. Holding of samples is discouraged unless it is absolutely necessary. Sample should be shipped out daily. Laboratories should be notified by telephone of the shipment along with the estimated time of arrival. Procedures for packing samples for shipment/delivery are as follows:

- Individual sample bottles should be wrapped in bubble pack to prevent breakage during shipment
- The wrapped bottles should be placed in insulated shipping coolers lined with a large plastic garbage bag, along with plastic bags of crushed ice, blue ice packs, or dry ice. Extra bubble pack may be added around or between the wrapped bottles to provide additional protection
- A Change of Custody Record describing the contents of the cooler should be placed in a sealed plastic bag and taped to the upper lid of the cooler.
- The shipping coolers should be sealed to prevent leakage of melting ice and affixed with security labels taped over opposite ends of the lid.
- The coolers or shipping containers should be shipped via express delivery to the laboratory.

2.4 Field Waste Disposal. The requirement for waste disposal under field conditions is the same as for a permanent installation. Wastes must be disposed of in such a way as to preclude contamination of surface or subsurface waters, attraction of rodents and insects, creation of a nuisance, or violation of federal, state, or local (to include host nation) pollution abatement laws or regulations. The Air Force (AF) has bare base housekeeping equipment consisting of tents, kitchens, showers, latrines, etc. The nickname for this equipment is Harvest Eagle. However, there may be situations when the Harvest Eagle equipment will not be deployed or has not yet arrived. In such cases, your unit may have to rely on "expedient" field methods to handle waste disposal. The devices or types and methods of waste disposal discussed in this subsection have been devised by U.S. Forces to meet the criteria of simple construction and adequate sanitation.

2.4.1 Latrine Facilities. For temporary camps, 1-3 days, straddle trench latrines can be constructed. For longer encampments, deep pit latrines, bored hole latrines, pail latrines, etc., and urine soakage pits would be used. The various types of latrines and conditions under which they would be employed will be discussed in following subsections. However, first you need to understand some general rules that will help ensure an adequate level of sanitation and environmental protection.

2.4.1.1 Sizing. For planning purposes, one toilet will serve 17.5 personnel (AFPAM 10-219 v5). In the case of male personnel, urinals can substitute for 1/3rd of the required number of latrines. The full number of toilets must be provided for female personnel. Since about 16 percent of Air Force personnel are female, a corresponding percentage of field latrines must be provided. If your activity consisted of 1000 personnel, you would need 48 toilets for male personnel and 9 toilets for female personnel. Since 1/3rd of the toilets for males can be replaced with urinal facilities, the final numbers of latrine facilities are 32 toilets and 16 urinals for males and 9 toilets for females.

1000 personnel X 16 percent = 160 females	1000 - 160 = 840 males
160/17.5 = 9 toilets for females	840/17.5 X 1/3 = 16 urinals for males
	840/17.5 X 2/3 = 32 toilets for males

2.4.1.2 Location. To make sure that food and water are protected from contamination, latrines must be located at least 100 yards from the unit dining facilities and 100 feet from the nearest water source or supplies. Latrines must always be dug above the natural water table and on level ground. Waste must not be allowed to drain into any water source. Normally, latrines are located at least 30 yards from the end of the unit area and always downhill from the encampment

2.4.1.3 Screening. Canvas or brush screening should be placed around each facility, or the latrine can be enclosed within a tent. In cold climates, the shelter should be heated. A drainage ditch should be dug around the facility to prevent surface water from running off into the latrine. Shelters should be sprayed periodically with an approved insecticide to control flies.

2.4.1.4 Hand washing devices. A simple hand-washing device must be installed near the latrine enclosure. It must be easy to operate and constantly supplied with fresh water and soap. A soakage pit must be constructed to accept the rinseate. The BES and unit commanders must aggressively emphasize washing hands as a means of controlling transmission of diseases.

2.4.1.5 Policing. Commanders must assign personnel to clean and maintain the latrines on a daily basis. Improper sanitation could lead to dysentery and diarrhea that can render personnel ineffective for combat operations.

2.4.1.6 Closing. When a latrine pit becomes filled to within one foot of the surface or when it is to be abandoned, remove the latrine box (Figure 2-3) and close as follows.

- Fill the pit to the ground level with successive 3-inch layers of earth. Pack each layer to prevent fly pupa from hatching and getting out of the closed latrine.
- Place a sign on top of the covered pit that reads “Closed Latrine” and the date it was closed.

2.4.1.7 Latrines used in normal water table areas**.** The following latrines can be employed in conditions where ground water does not run into the pit, i.e., the water table is below the bottom of the pit.

- Cat hole. The simplest of all field latrines is the “cat hole” (Figure 2-1). This method is used when personnel are on the move. Simply dig a 12” wide by 6” to 12” deep hole that is filled in and compacted after use.
- Straddle trench. This is the most common type of latrine for situations when a unit will only be in place for a 1 to 3 days. The trench is dug 1 foot wide by 2 ½ feet deep by 4 feet long (Figure 2-2). Trenches should be at least 2 feet apart. No seats are provided but boards can be placed along both sides of the pit to provide better footing. Toilet paper must be provided and protected from the elements. Earth and a shovel must also be available so each person can cover their waste. When the unit leaves the area, abandons the latrine, or it is filled to within 1 foot of the surface, the trench must be closed as discussed in paragraph 2.4.1.6.

Table 2-7 - Wastewater Sampling Requirements

Sample For	Sample Container	Size	Reagent	Notes
Biochemical oxygen demand	1-liter glass or plastic	90%		Cool sample to 4°C
Chemical oxygen demand	1-liter glass or plastic Teflon-lined cap	90%	Sulfuric preservative to pH<2	Cool sample to 4°C
Total suspended solids	1-liter glass or plastic	90%		Cool sample to 4°C
pH	1-liter glass or plastic			Analyzed immediately using field instrument
Settleable solids	1-liter glass or plastic	90%		Cool sample to 4°C
Total particulate	1-liter glass or plastic	90%		Cool sample to 4°C
Oil, Grease, Mineral Oil	1-liter glass	90%	hydrochloric acid	Ensure pH of 2 Cool sample to 4°C
Microbiological	125-ml or plastic sample bag	>100 ml or 90%	10 mg sodium thiosulfate	Do not touch inside portion of lid; take pH and FAC
Metals	1-liter plastic Teflon-lined cap	90%	1:1 nitric acid: distilled water to pH <2	
Chloride	1-liter glass or plastic	90%		
Sulfates	1-liter glass or plastic	90%		
Fluoride	100 ml glass	90%		
Phosphorus	1-liter glass or plastic	90%	1:1 sulfuric acid: distilled water to pH <2	
Nitrite, nitrate	1-liter glass or plastic	90%	0.8 ml sulfuric acid if not tested in 48 hrs	pH of 2
Ammonium	1-liter glass or plastic	90%	100 mg sodium thiosulfate; 0.8 ml sulfuric acid if not tested in 48 hrs	pH of 2
TKN	1-liter glass or plastic	90%	0.8 ml sulfuric acid if not tested in 48 hrs	pH of 2
Cyanide, phenol, chlorinated and nitrated organic solvents, chlorinated pesticides, organo phosphorus pesticides, aldehydes as H-CHO	1-liter amber glass Teflon-lined cap		For total cyanide: sodium hydroxide to pH >12	Assure no air bubbles Cool sample to 4°C
Sulfite as SO_3	125 ml plastic	100%	1.25 ml EDTA	Assure no air bubbles Cool sample to 4°C
Aromatic, chlorinated, and nitrated organic solvents	40-ml glass vials Teflon-lined septum	100%	Hydrochloric acid to pH<2	Assure no air bubbles Cool sample to 4°C
Surfactants	500 ml plastic	100%		Assure no air bubbles Cool sample to 4°C

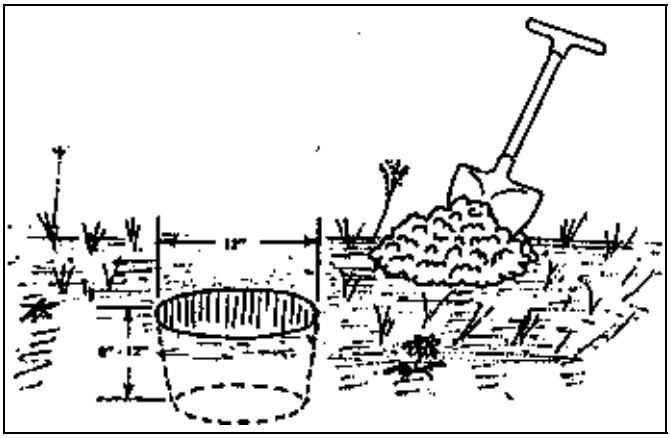


Figure 2-1 - Cat Hole Latrine

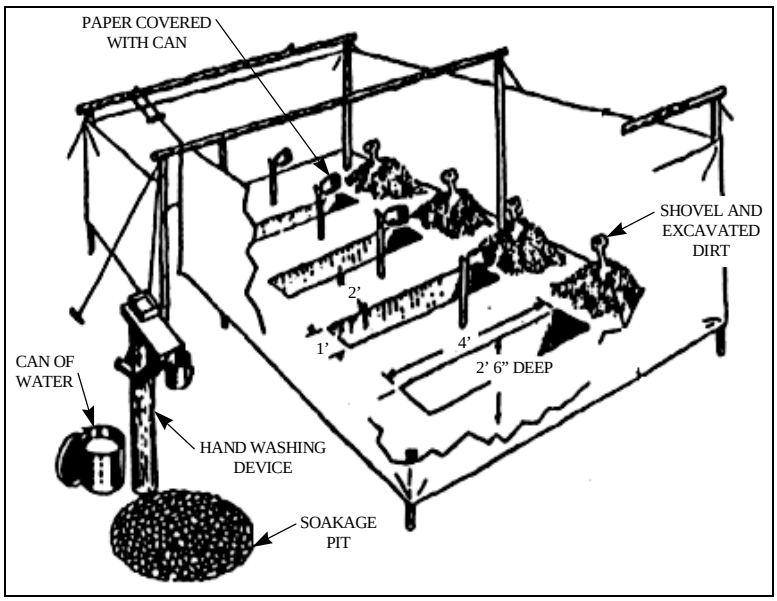


Figure 2-2 - Straddle Trench Latrine

- Deep pit latrines. Deep pit latrines are employed when a unit will be at a location for longer than three days. The standard deep pit latrine is equipped with a four position box, 8 feet long by 2 ½ feet at the base (Figure 2-3). The holes must be covered with fly-proof, self-closing lids. All cracks must be fly-proofed by covering them with wood or tin. A metal deflector must be placed inside the front of the box to prevent the wood from becoming saturated with urine. The pit portion of the latrine is 2 feet wide by 7 ½ feet long. The depth of the pit will depend on the estimated length of time you will be without Harvest Eagle equipment. A rule of thumb is one foot of depth for each week of use. Pits should not be deeper than six feet to avoid cave-ins. To assure sanitation, latrine boxes must be cleaned every day. As with other types of latrines, toilet paper must be available and hand-washing facilities must be installed. When the unit leaves the area, abandons the latrine, or it is filled to within 1 foot of the surface, the pit must be closed as discussed in paragraph 2.4.1.6 .

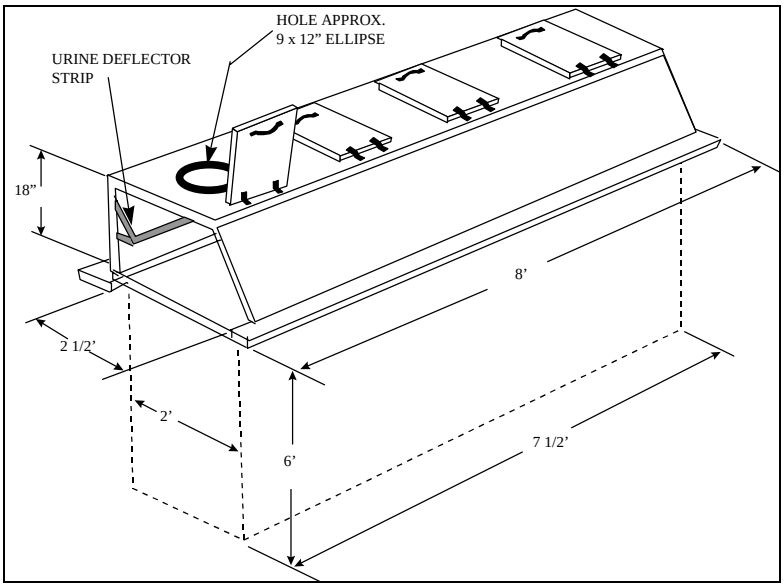


Figure 2-3 - Deep Pit Latrine With Latrine Box

- Bored-hole latrine. This type of latrine consists of a hole about 18 inches in diameter and 15 to 20 feet deep. A one-hole latrine box (Figure 2-4) covers the hole. A drum with a fly-proof seat cover can be placed in the hole. Sanitation and closure rules are the same as previously discussed.

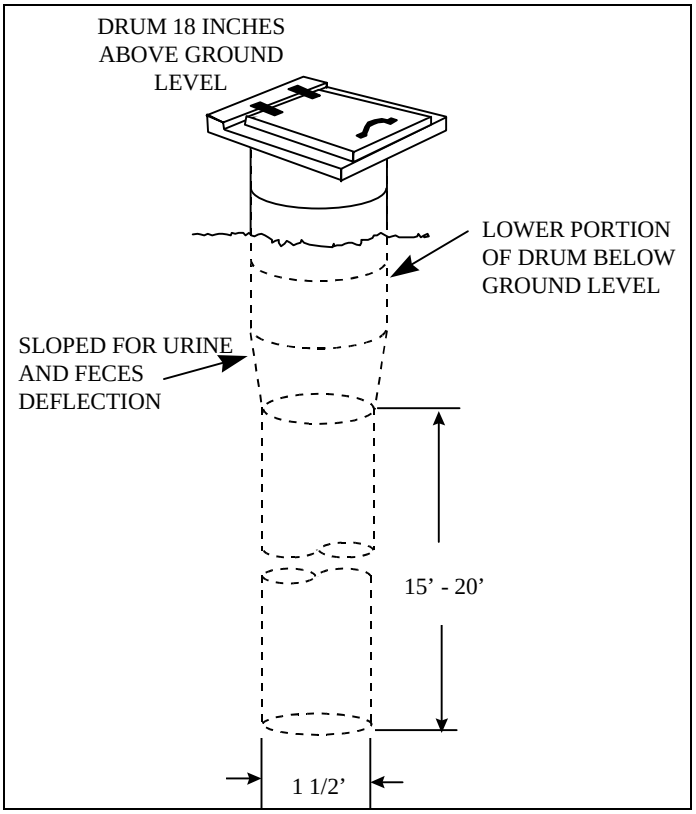


Figure 2-4 - Bored Hole Latrine

- Chemical latrines. Chemical latrines or toilets can be used in the field when government or local policy permits. These latrines come equipped with a holding tank containing chemical additives to aid in the decomposition of waste and control of odor. The toilets are normally rented from a contractor who also pumps out the waste on an as required basis. Sanitation rules are the same as previously discussed.

2.4.1.8 Latrines used in high water table areas**.** In situations where the presence of a high water table or rock formations near the surface of the ground prevents the digging of a waste pit of adequate depth, several alternate methods are available.

- Mound latrine. Mound latrines (Figure 2-5) are simply latrine boxes that are placed on top of a mound of dirt high enough to keep the waste from entering the water table. If timber or wood is available, a crib can be built to enclose the pit and help support the box. The mound is then built around the crib by compacting successive 1-foot layers of soil. If timber or wood is not available, the mound can be built and then the pit can be dug into the mound. Fly-proofing, sanitation, and closure are the same as previously discussed.

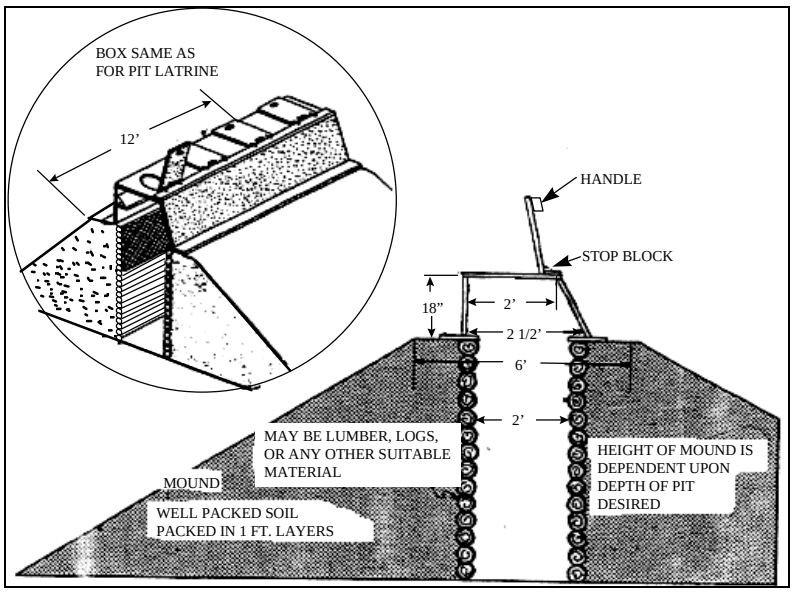


Figure 2-5 - Mound Latrine

- Burnout latrine. Burnout latrines (Figure 2-6) are particularly suitable for jungle areas with high water tables or when soil is rocky, hard, or frozen. These latrines were used extensively in certain parts of Vietnam. Since the waste is burned out, these latrines cannot be used where air pollution regulations prohibit open burning. A burn-out latrine consists of a 55-gallon drum with the top cut out. The drum is placed into the ground leaving enough exposed for comfortable seating. The drum is fitted with a fly-proof wood seat with a self-closing lid. Drums should be burned out daily using gasoline or jet fuel until the waste is rendered dry and odorless. Males should be encouraged to use urinal latrines so that liquid waste is minimized in the burnout drums. Sanitation requirements regarding cleaning the seat, and providing toilet paper, and hand washing devices are the same as previously discussed.

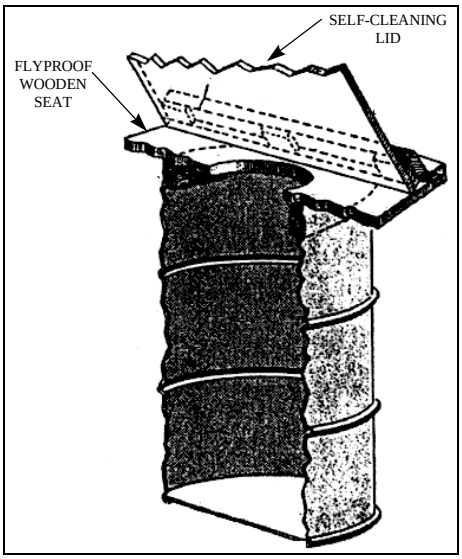


Figure 2-6 - Burn Out Latrine

- Pail or bucket latrine. A pail or bucket latrine (Figure 2-7) is a standard latrine box that has been modified to include an impervious floor and a hinged rear door. A bucket or pail is placed under each position. Pails should be emptied and cleaned daily. The waste can be burned (air pollution laws permitting) or it can be buried. Disposable plastic liners can be put into each pail to improve sanitation, reduce cleaning requirements, and make burial/burning easier. Fly proofing, sanitation, and closure are the same as previously discussed.

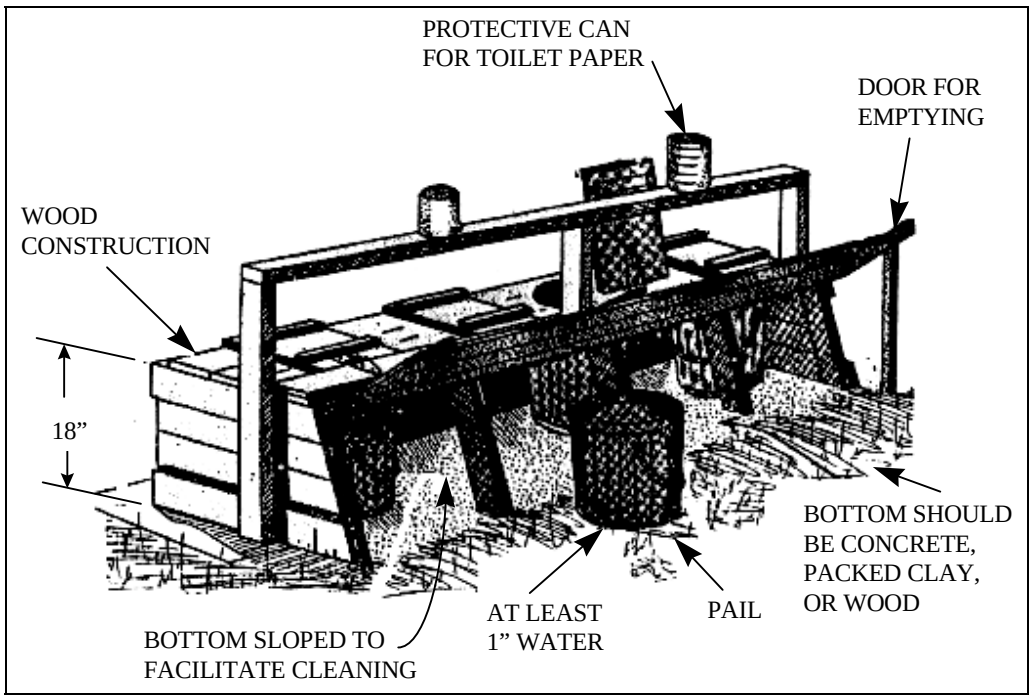


Figure 2-7 - Pail or Bucket Latrine

2.4.1.9 Urinal facilities**.** Construction of urinal facilities for male personnel will significantly reduce the amount of waste going into other latrine facilities. Accordingly, one of the following urinal facilities should be collocated with each male latrine.

- Urine soakage pit. Urine soakage pits (Figure 2-8) are 4 foot by 4 foot square holes filled with course material such as rocks, flattened tin cans, broken bottles, etc. A border of small stones is laid around the perimeter. Pipes with funnels or separate troughs can be used in conjunction with the soakage pit. An optional ventilating shaft can be installed to improve evaporation and extend the useful life of the pit. Funnels and troughs must be cleaned daily with soap and water. Oil and grease must not be allowed to enter the pit as they will hinder proper drainage and evaporation. If the pit becomes clogged, it can be sprayed with insecticide to improve its operation. When a pit is no longer needed, it should be sprayed with insecticide and covered with a 2-foot mound of dirt.

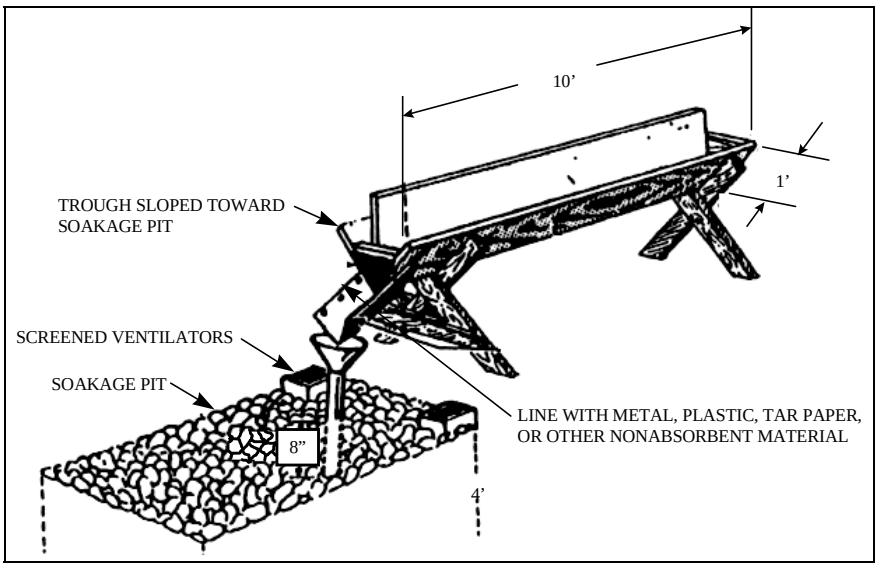


Figure 2-8 - Urine Soakage Pit

2.4.2 Other Wastewater Facilities. Every device or facility that is used for washing or drinking in the field must have some kind of soakage area under it to prevent pools and mud from forming. The area around hand washing devices, wash racks, lyster bags, water buffaloes, etc., should be excavated to a depth of a few inches and filled with stones to form a soakage pit. Wastewater from wash racks should be run through a grease trap before it flows into a soakage pit/trench. Water from field showers must also be drained into a soakage pit/trench. However, a grease trap is not required.

2.4.3 Solid Waste. Solid waste must be disposed of promptly and thoroughly or an encampment could soon become a smelly filthy dump. Flies, rats, and other vermin would be attracted and would add to the individual's discomfort as well as endanger the health of all personnel. This subsection deals with processes and facilities for disposal of solid waste.

2.4.3.1 Refuse. The Air Force planning factor for generation of refuse is 4 lbs/person/day (AFPAM 10-219 v5). This includes garbage (waste from preparation and serving of food), rubbish (paper, cartons, boxes, cans, etc.), ashes, and industrial wastes. There are two methods for disposing of refuse in the field - burning and burring.

- Burning. There are two types of incinerators typically used in the field. The first type, the barrel incinerator (Figure 2-9), can be constructed from a 55-gallon drum. The top is removed and scrap pipes are inserted through holes that are bored near the bottom of the drum to create an improvised grate. Holes are bored in the bottom of the drum. The drum is elevated on rocks, bricks, or cans to allow an updraft that will keep the fire supplied with oxygen. The second type, the inclined-plane incinerator (Figure 2-10) is suitable for burning combustible and liquid waste as well as wet garbage. Gasoline flows from the drum and is ignited at a vapor burner under the lower grate. Waste is placed into the incinerator at the top of the incline. Heat passes above and below the inclined plane. This dries and incinerates the waste as it flows down the incline.

- Burying. The typical sanitary landfill in the field is constructed using the trench method (Figure 2-11). Normally, a bulldozer digs a trench into which refuse is dumped. The bulldozer spreads and compacts the refuse and covers it with six inches of earth at the end of the day. When each trench is filled, it is covered with two feet of compacted soil and marked with a sign reading "Abandoned Land Fill". To minimize the possibility of pollution and disease the following rules must be followed when siting a landfill.
  - ◊ keep a minimum of 30 feet of clay between strata and refuse
  - ◊ site the landfill at least 500 feet from wells/water sources
  - ◊ do not use mines for disposal of refuse
  - ◊ locate the landfill in an area of stable soil
  - ◊ locate the landfill downwind from the installation/encampment

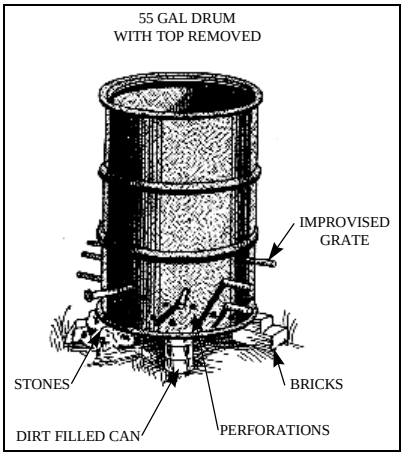


Figure 2-9 - Barrel Incinerator

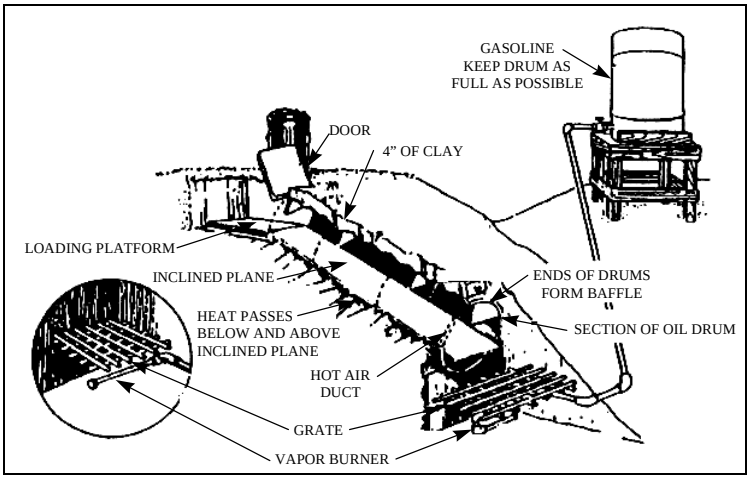


Figure 2-10 - Inclined-Plane Incinerator

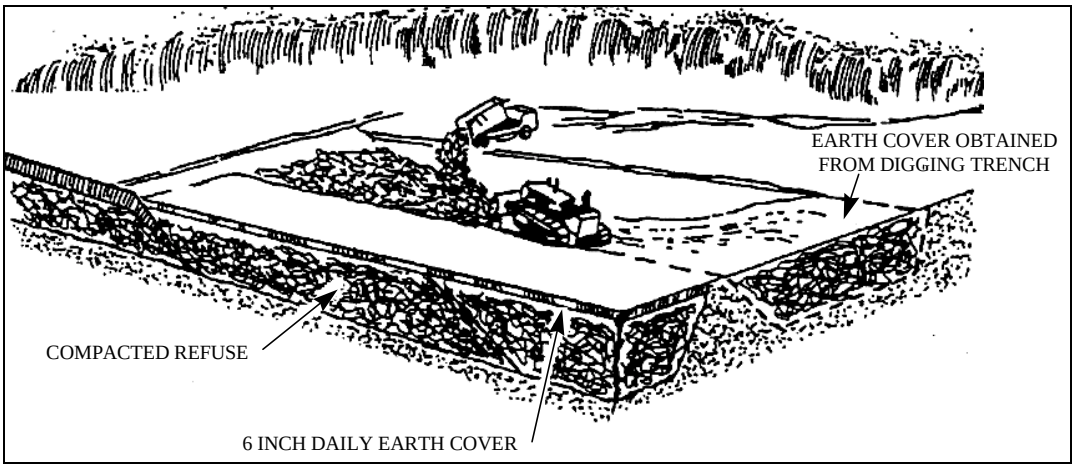


Figure 2-11 - Trench Method - Sanitary Landfill

2.4.3.2 Medical. Medical waste consists of sputum, surgical dressings, swabs, disposable diapers, culture media, pathological tissues, blood clots and blood, live vaccine containers, syringes, and other materials from infectious patients. The standard methods of disposing of infectious waste are burring and incineration. If waste is buried, it must be mounded with compacted soil and marked with a sign reading, "Medical Waste". However, controlled incineration is the preferred method for disposal of infectious waste. The inclined-plane incinerator (Figure 2-10) is an approved means for incineration of medical waste in the field. Medical waste will not be disposed of in a barrel incinerator or by open burning.

2.4.4 Kitchen Waste Facilities. Liquid waste from kitchen facilities contains particles of food, grease, and soap. Consequently, this liquid must be treated before it is disposed of.

2.4.4.1 Soakage pits. In temporary camps or before Harvest Eagle equipment arrives, a unit must construct soakage pits to treat liquid waste from kitchen operations. These soakage pits are constructed similar to urine pits (Figure 2-8), only a grease trap is substituted for the pipes, funnels, and troughs. A unit of approximately 200 people would need two soakage pits. Each pit would be used on alternate days. This allows for evaporation and reduces the possibility of the pits becoming clogged. Soakage pits should be close to the edge of the unit area but at least 30 yards away from the nearest water source. When a soakage pit becomes clogged, it will not accept additional liquid. In this case, the pit must be abandoned and a new one dug. When a kitchen liquid waste soakage pit is closed, it must be covered with one foot of compacted soil and marked with a sign that reads, "Closed Kitchen Waste Soakage Pit".

2.4.4.2 Soakage trench. Where the water table or rock formations will not allow construction of the standard four-foot deep soakage pit, a soakage trench can be employed (Figure 2-12). A soakage trench consists of a 2-foot square by 1-foot deep pit with trenches radiating out from the center. The trenches are six feet long and vary in depth from one foot at the center pit to 1-½ feet at the end of the trench. The pit and trenches are filled with material similar to that used in the urine pit. Two such trench systems should be built to handle 200 people. As with soakage pits, soakage trenches are also used on alternate days. A soakage trench is closed in a manner similar to a soakage pit.

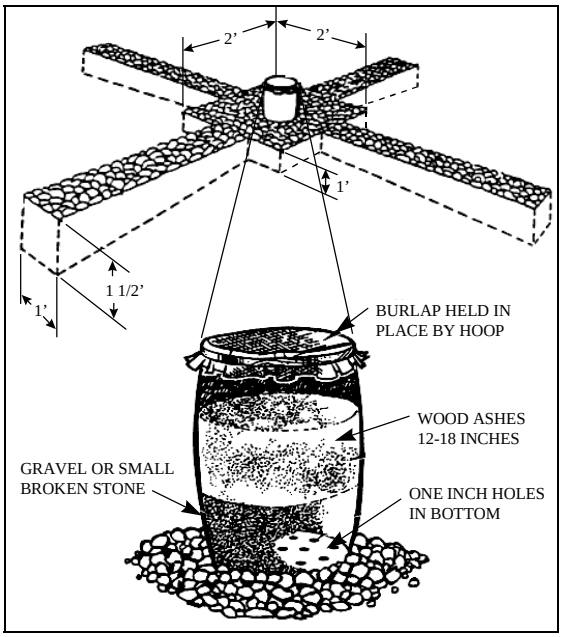


Figure 2-12 - Soakage Trench

2.4.4.3 Grease traps. A grease trap must be used with each kitchen liquid waste soakage pit or trench. The trap should be of sufficient capacity so that hot greasy water being added will not heat the cooled water already in the trap. Otherwise, the grease will remain uncongealed and pass through the trap. All kitchen liquid waste must pass through a grease trap to remove as much grease and food particles as possible to prevent clogging soakage pits and trenches.

2.4.4.4 Baffle grease trap. A baffle grease trap is the most effective way to remove grease from field kitchen liquid waste. There are two types of baffle traps - the barrel trap and the box trap (Figure 2-13) . Baffle traps consist of two chambers separated by a baffle that is approximately one inch above the floor of the trap. The first chamber is about twice the size of the second chamber. A two-inch drainpipe runs from the second chamber to the soakage pit. The trap is filled with cool water until the water comes out of the drain pipe. The trap is now ready to receive liquid waste. The liquid waste is poured through filter material such as grass or straw into the first chamber. When grease strikes the cool water, it congeals and floats to the top of the first chamber where it is trapped by the baffle. Being heavier than the grease, the water flows through the 1-inch opening below the baffle and then out the drain pipe. To remain effective, grease traps must be clean. The filter material (grass or straw) must be replaced daily and the grease must be skimmed from the surface of the water. The filter material and grease must be buried or burned. Periodically, the entire trap must be drained so sediment can be removed from the bottom. The one inch opening under the baffle cannot be allowed to become clogged or the trap will not work properly.

2.4.4.5 Filter grease trap. A filter grease trap can be made from 30 to 50 gallon drums. The top of the drum is removed and 1-inch holes are bored into the bottom (Figure 2-12). The drum is placed in the center of the soakage pit with the bottom of the drum two inches below the surface. The bottom 1/3rd of the barrel is filled with crushed rock or stone. The middle 1/3rd is filled with filter material such as sand, charcoal, ashes, or straw. A piece of burlap or other fabric is placed over the top to serve as a strainer. Kitchen liquid waste is poured into the barrel. The burlap traps food particles, grease is trapped in the filter material, and the water drains out the bottom into the soakage pit. The burlap must be replaced and burned daily. Once a week the filter material must be removed, buried, and replaced.

2.4.4.6 Evaporation beds**.** In places where clay soil or rock formations preclude using standard soakage pits or trenches, evaporation beds (Figure 2-14) can be employed to handle liquid waste from field kitchens. These beds work best in hot dry climates. Beds are normally 8 by 10 feet. Sufficient beds must be constructed to allow three

square feet of surface area per person per day. The beds are constructed by scraping of the top soil and forming 12 inch high dikes. The soil in the basin of the dike is then spaded or loosened to a depth of 12 inches and raked to form six inch high ridges. Each day, liquid waste is poured (or piped) into a bed to a depth of three inches above the ridges. The waste is then allowed to evaporate and percolate. After 3 or 4 days, the bed is normally dry enough to allow it to be spaded and reformed. Other beds are flooded on successive days and allowed to dry out as the first bed. As with soakage pits, grease should be removed from the liquid waste before it is allowed to enter the beds.

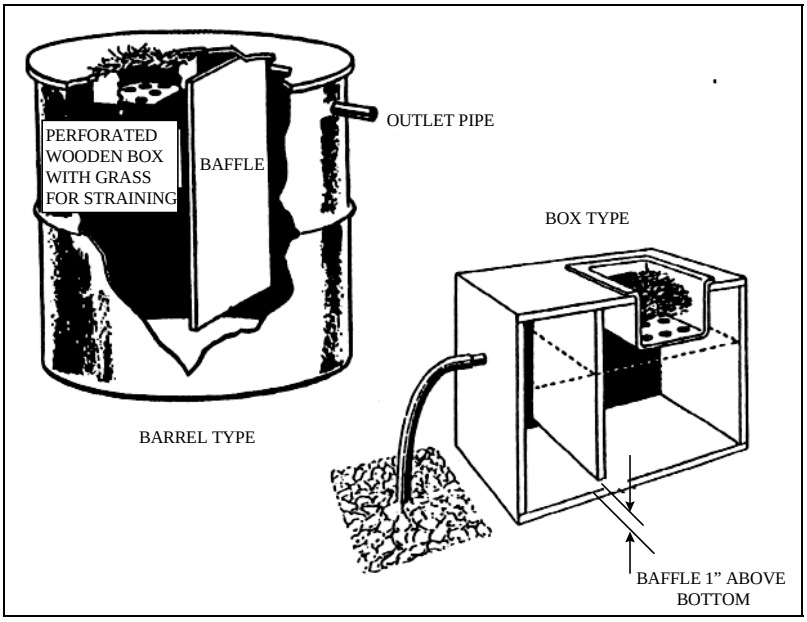


Figure 2-13 - Baffle Grease Traps

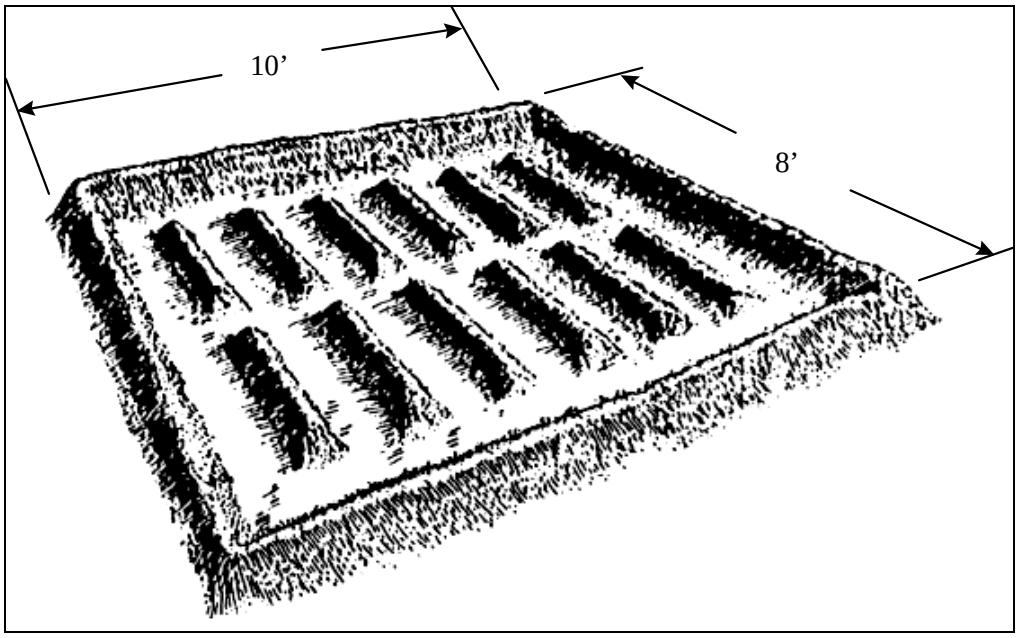


Figure 2-14 - Evaporation Bed

2.4.5 Hazardous Waste. HW management under field conditions can be influenced by a variety of regulations/activities, such as, the U.S. EPA, individual states, Final Governing Standards (FGS), host nation requirements, etc. The information contained in this subsection follows general principles associated with HW management under the rules promulgated by the U.S. EPA. The BES should coordinate with the installation environmental activity to determine specific HW requirements that may be in effect at the deployed location.

2.4.5.1 HW management requirements. As a generator of solid waste, the base is required to determine which solid wastes are considered to be hazardous wastes. Development of a sampling and testing program that will enable the identification and management of HW is the responsibility of the BES. IAW 40 CFR (264.13, 265.13, 268.7, and 270.14), each installation must have a Hazardous Waste Management Plan (HWMP). A Hazardous Waste Analysis Management Action Plan (herein referred to as the MAP), developed by the BES, is an important portion of the HWMP. The overall purpose of the MAP is to assure that adequate information is developed to characterize the hazardous waste so that it can be properly managed. To accomplish this purpose, the BES must understand how HW is identified.

2.4.5.2 HW identification. By most definitions, hazardous waste (HW) is considered a category of solid waste. To be considered a hazardous waste, a material must first meet the definition of a solid waste. Solid waste includes:

- Solids, liquids, and containerized gases;
- Discarded materials, which include materials that are abandoned, recycled, or inherently waste-like;
- Materials or substances that have served their original purpose

If the material is determined to be a solid waste, then it must be evaluated to determine if it is excluded or exempted from regulation. Under the Resource Conservation and Recovery Act (RCRA) the following wastes are excluded or exempted from HW regulation.

- Household waste.
- Mixtures of wastewater and certain hazardous wastes covered by a Clean Water Act permit.
- Non terne-plated oil filters that have been gravity hot drained. Notes: Terne plated oil filters are composed of an alloy of tin and lead. If the filter is not marked, you can call the Filter manufacturing Council at (201) 263-0544 to determine if it is non-terne-plated. Gravity hot draining consists of draining the filter at room temperature or higher for 12 hours.
- Recyclables, such as batteries, scrap metal, freon, fuels.
- Other excluded waste as listed in 40 CFR 261.4.
- Exempted wastes such as “environmental” samples being sent to a laboratory. Environmental samples are typically samples such as: drinking water, groundwater, surface water, background and control soils, sediments, treated waste water effluent, biological specimens, and any sample not expected to be contaminated with high levels of hazardous materials. Samples collected from process waste streams, bulk, storage tanks, industrial process streams, or soil, sediment, or water samples collected from areas suspected of being highly contaminated need to be shipped as a hazardous material.

If the material is a solid waste and it is not excluded or exempt then it must be determined if the waste is hazardous. A solid waste is considered hazardous if it possesses a hazardous characteristic or if it is listed by the U.S. EPA or other environmental regulatory activity (State, FGS, Host Nation, etc.) as a hazardous waste. Characteristic HWs are those that are ignitable, corrosive, reactive, or toxic.

- Ignitability is determined from the flash point of the waste. Flash point is determined through a test procedure that identifies whether a waste is ignitable. Ignitable hazardous waste and liquids have flash points less than 140° F.
- Corrosive wastes are those having a pH less than or equal to 2, or greater than or equal to 12.5. These wastes may degrade unit structures or systems and may require pretreatment.

- Reactive wastes have the potential to be unstable and may undergo a violent change without detonation. They may react violently with water, form potentially explosive mixtures with watering, generate quantities of toxic gases, vapors or fumes when mixed with water, and may be cyanide or sulfide-bearing that can generate toxic gases, vapors, or fumes when exposed to pH conditions between 2 and 12.5. Reactive wastes may also be capable of detonation or explosive reaction if exposed to a strong initiating source or if heated under confinement, and may be readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
- Wastes that contain any of the toxic contaminants at concentration levels equal to or greater than the regulatory level listed in Table 2-8 are considered hazardous wastes.

2.4.5.3 Hazardous waste streams. Now that you know what materials are considered as HW by the regulators, you must work with the installation environmental activity and hazardous waste generators to identify the hazardous waste streams on your installation. The key to this process is completion of a DRMS Form 1930, hazardous waste profile sheet (HWPS). A blank HWSP can be found at Appendix C. The initial identification of hazardous waste streams can be accomplished in two ways - generator knowledge and laboratory analysis. In some cases, generators may be fully knowledgeable of waste stream characteristics and with the help of Satellite Accumulation Point Managers and the HW Site Manager, they can complete the HWPS. Some generators may have even brought a copy of the HWPS from their home installation. In other cases, the BES will have to provide sampling and analysis so that the HW can be characterized. In all cases a HWPS must accompany HW that is turned in to the Defense Reutilization and Marketing Service (DRMS) or any other disposal activity/agent. The last step in the process of identifying HW is to determine if it is listed as a HW by any of the regulatory activities. Table 2-9 provides a list of most of those chemicals.

Table 2-8 - Toxic Contaminants

EPA Hazardous Waste Number	Contaminant	Regulatory Level (mg/L)
D004	Arsenic	5.0
D005	Barium	100.0
D018	Benzene	0.5
D006	Cadmium	1.0
D019	Carbon Tetrachloride	0.5
D020	Chlordane	0.03
D021	Chlorobenzene	100.0
D022	Chloroform	6.0
D007	Chromium	5.0
D023	o-Cresol	200.0[2]
D024	m-Cresol	200.0[2]
D025	p-Cresol	200.0[2]
D026	Cresol	200.0
D016	2,4-D	10.0
D027	1,4-Dichlorobenzene	7.5
D028	1,2-Dichloroethane	0.5
D029	1,1-Dichloroethylene	0.7
D030	2,4-Dinitrotoluene	0.13[1]
D012	Endrin	0.02
D031	Heptachlor (and its epoxide)	0.008
D032	Hexachlorobenzene	0.13[1]
D033	Hexachlorobutadiene	0.5
D034	Hexachloroethane	3.0
D008	Lead	5.0
D013	Lindane	0.4
D009	Mercury	0.2
D014	Methoxychlor	10.0
D035	Methyl Ethyl Ketone	200.0
D036	Nitrobenzene	2.0
D037	Pentachlorophenol	100.0
D038	Pyridine	5.0[1]
D010	Selenium	1.0
D011	Silver	5.0
D039	tetrachloroethylene	0.7
D015	Toxaphene	0.5
D040	Trichloroethylene	0.5
D041	2,4,5-Trichlorophenol	400.0
D042	2,4,6-Trichlorophenol	2.0
D017	2,4,5-TP (Silvex)	1.0
D043	Vinyl Chloride	0.2

1. Quantitation limit is greater than the regulatory level. The quantitation limit therefore becomes the regulatory level.
2. If the 0-, m-, and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/L.

Table 2-9 - Chemical Constituents and Analytical Test methods (EPA Publication SW-846)

Chemical Constituent	CAS No.	Preferred Method	Alternate Method	Alternate Method
0,0,0-Triethyl phosphorothioate	126681	8270		
1,1,1-Trichloroethane	71556	8260	8240	8021
1,1,1,2-Tetrachloroethane	630206	8260	8240	8021
1,1,2,2-Tetrachloroethane	79345	8260	8240	8021
1,1,2-Trichloroethane	79005	8260	8240	8021
1,1-Dichloroethane	75343	8260	8240	8021
1,1-Dichloroethene	75354	8260	8240	8021
1,1,-Dichloropropene	563586	8260	8240	8021
1,1-Dimethylhydrazine	57147	8250		
1,2,3,4-Tetrachlorobenzene	634662	8270	8250	8120
1,2,3,5-Tetrachlorobenzene	634902	8270	8250	8120
1,2,3-Trichlorobenzene	87616	8260	8270	
1,2,3-Trichloropropane	96184	8260	8240	8021
1,2,4,5-Tetrachlorobenzene	95943	8270	8250	8120
1,2,4-Trichlorobenzene	120821	8270	8021	8120
1,2,4-Trimethylbenzene	95636	8260	8021	
1,2-Dibromo-3-chloropropane	96128	8260	8021	
1,2-Dibromomethane	106934	8260	8021	
1,2-Dichlorobenzene	95501	8260	8270	8120
1,2-Dichloroethane	107062	8260	8240	
1,2-Dichloroethene (total)	540590	8260	8240	
1,2-Dichloropropane	78875	8260	8240	8021
1,2-Dichloropropylene	542756	8260	8240	
1,2-Diepoxybutane	1464535	8240		
1,2-Dimethylhydrazine	540738	8250		
1,2-Dinitrobenzene	99650	8270	8250	
1,2-Diphenylhydrazine	122667	8270	8250	
1,2-Trans-Dichloroethylene	156605	8260		
1,3,5-Trimethylbenzene	108678	8260	8021	
1,3,5-Trinitrobenzene	99354	8270		
1,3-Dichlorobenzene	541731	8260	8021	8120
1,3-Dinitrobenzene	528290	8270	8250	
1,3-Dichloropropane	142289	8260	8021	
1,4-Dichlorobenzene	106467	8260	8270	8021
1,4-Dichlorobutene	31423924	8240		
1,4-Dinitrobenzene	100254	8270	8250	
1,4-Naphthoquinone	130154	8270		
1,4-Phenylenediamine	106503	8270		
1-Acetyl-2-thiourea	591082	8270		
1-Chloronaphthalene	90131	8270	8250	
1-Naphthylamine	134327	8270	8250	
2,3,4,6-Tetrachlorophenol	58902	8270	8250	
2,2-Dichloropropane	590207	8260	8021	
2,4,5-T	93765	8150	8151	
2,4,5-TP	93721	8150	8151	
2,4,5-Trichlorophenol	95954	8270	8040	
2,4,5-Trimethylaniline	137177	8270		
2,4,6-Tribromophenyl	118796	8270		
2,4,6-Trichlorophenol	88062	8270	8040	
2,4,-D	94757	8150	8151	
2,4-DB		8150		
2,4-Diaminotoluene	95807	8270		
2,4-Dichlorophenol	120832	8270	8250	8040
2,4-Dimethylphenol	105679	8270	8040	
2,4-Dinitrophenol	51285	8270	8040	

Table 2-9 (Cont)

Chemical Constituent	CAS No.	Preferred Method	Alternate Method	Alternate Method
2,4-Dinitrotoluene	121142	8270	8250	
2,4-Toluene diisocyanate	584849	8250	8270	
2,6-Dichlorophenol	87650	8270	8250	8040
2,6-Dinitrophenol	573568	8270	8040	
2,6-Dinitrotoluene	606202	8270	8250	
2-Acetylaminofluorene	53963	8270		
2-Aminoanthraquinone	117793	8270		
2-Butanone (MEK)	78933	8260	8240	8015
2-Chloroethanol	107073	8240		
2-Chloroethylvinyl ether	110758	8240	8010	
2-Chloronaphthalene	91587	8270	8250	8120
2-Chlorophenol	95578	8270	8250	8040
2-Chlorotoluene	95498	8260	8021	
2-Cyclohexyl-4,6-dinitrophenol	131895	8270		
2-Ethoxyethanol	110805	8240	8030	
2-Flurobiphenyl	321608	8270	8250	
2-Fluorophenol	367124	8270	8250	
2-Hexanone	591786	8240	8260	8015
2-Methylnaphthalene	91576	8270	8250	
2-Methylphenol	95487	8270	8250	
2-Napthylamine	91598	8270	8250	
2-Nitroaniline	88744	8270	8250	8040
2-Nitrophenol	88755	8270	8250	
2-Nitropropane	79469	8240	8030	
2-Picoline	109068	8240	8250	
3,3-Dichlorobenzidine	91941	8270	8250	
3,3-Dimethoxybenzidine	119904	8270		
3,3-Dimethylbenzidine	119937	8270		
3-(Chl.meth)pyridine hydrochloride	6959484	8270		
3-Chloropropionitrile	562767	8240		
3-Methylcholanthrene	56495	8270		
3-Methylphenol	108394	8270		
3-Nitroaniline	99092	8270	8250	
4,4'-DDD	72548	8080	8270	
4,4'-DDE	72559	8080	8270	
4,4'-DDT	50293	8080	8270	
4,4-Oxydianiline	101804	8270		
4,6-Dinitro-2-methylphenol	534521	8270	8250	
4-Aminobiphenyl	92671	8270	8250	
4-Bromofluorobenzene	460004	8240		
4-Bromphenyl phenyl ether	101553	8270	8110	
4-Chloro-3-methylphenol	59507	8270	8250	8040
4-Chloraniline	106478	8270	8250	
4-Chlorophenyl phenyl ether	7005723	8270	8250	8110
4-Chlorotoluene	106434	8260	8021	
4-Methyl-2-pentanone (MIBK)	108101	8240		
4-Methylphenol	106445	8270	8250	
4-Nitroaniline	100016	8270	8250	
4-Nitrobiphenyl	92933	8270		
4-Nitrophenol	100027	8270	8040	8250
5,5-Diphenylhydantoin	57410	8270		
5-Chloro-2-methylaniline	95794	8270		
5-Nitroacenaphthene	602879	8270		
5-Nitro-o-anisidine	99592	8270		
5-Nitro-o-toluidine	99558	8270		

Table 2-9 (Cont)

Chemical Constituent	CAS No.	Preferred Method	Alternate Method	Alternate Method
Acenaphthene	83329	8270	8100	8310
Acenaphthylene	208968	8270	8100	8310
Acetone	67641	8240		
Acetonitrile	75058	8240	8030	
Acetophenone	98862	8270	8250	
Acrolein	107028	8240	8030	
Acrylamide	79061	8015	8240	
Acrylonitrile	107131	8240	8030	
Aldrin	309002	8270	8080	
Allyl alcohol	107186	8240		
Allyl chloride	107051	8240		
Aluminum (Al)	7429905	6010	7021	7020
Aminoazobenzene	60093	8270		
Anilazine	101053	8270		
Aniline	62533	8270	8250	
o-Anisidine	90040	8270		
Anthracene	120127	8270	8100	8310
Antimony (Sb)	7440360	6010	7041	7040
Aroclor-1016 (PCB)	12674112	8080	8270	8250
Aroclor-1221 (PCB)	11104282	8080	8270	8250
Aroclor-1232 (PCB)	11141165	8080	8270	8250
Aroclor-1242 (PCB)	53469219	8080	8270	8250
Aroclor-1248 (PCB)	12672296	8080	8270	8250
Aroclor-1254 (PCB)	11097691	8080	8270	8250
Aroclor-1260 (PCB)	11096825	8080	8270	8250
Arsenic (As)	7440382	6010	7061	7060
Azinphos-methyl	86500	8270		
Barium (Ba)	7440393	6010	7081	7080
Benzene	71432	8260	8240	8021
Benzidine	92875	8270	8250	
Benzo[a]anthracene	56553	8270	8100	8310
Benzo[a]pyrene	50328	8270	8100	8310
Benzo[b]fluoranthene	205992	8270	8100	8310
Benzo[g,h,i]perylene	191424	8270	8100	8310
Benzo[k]fluoranthene	207089	8270	8100	8310
Benzoic acid	65850	8270		
Benzyl alcohol	100516	8270		
Benzyl chloride	100447	8250		
Beryllium (Be)	7440417	6010	7091	7090
BETX		8020		
Alpha-BHC	319846	8080	8270	8250
Beta-BHC	319857	8080	8270	8250
Delta-BHC	319868	8080	8270	8250
Gamma-BHC (Lindane)	58899	8080	8270	8250
Bis (chloromethyl) ether	542881	8270	8110	
Bis (2-Chloroethoxy) methane	111911	8270	8110	
Bis (2-Chloroethyl) ether	111444	8270	8110	
Bis (2-Chloroisopropyl) ether	39638329	8270	8110	
Bis (2-Ethylhexyl) phthalate	117817	8270	8060	
Bromobenzene	108861	8260		
Bromochloromethane	74975	8260	8240	8021
Bromodichloromethane	75274	8260	8240	8021
Bromoform	75252	8260	8240	8021
Bromomethane	74839	8260	8240	8021
Bromoxynil	1689845	8270		
n-Butyl benzene	104518	8260	8021	

Table 2-9 (Cont)

Chemical Constituent	CAS No.	Preferred Method	Alternate Method	Alternate Method
sec-Butyl benzene	135988	8260	8021	
tert-Butyl benzene	98066	8260	8021	
Butyl benzyl phthalate	85687	8270		
Cadmium (Cd)	7440439	6010	7131	7130
Captafol	2425061	8270		
Captan	133062	8270		
Carbaryl	63252	8270		
Carbofuran	1563662	8270		
Carbon disulfide	75150	8240		
Carbon tetrachloride	56235	8260	8240	8010
Carbophenothion	786196	8270		
Alpha-Chlordane	5103719	8080		
Gamma-Chlordane	5103742	8080		
Chlordane	57749	8080	8270	8250
Chlorfenvinphoe	470906	8270		
Chlorine (Cl)	7782505	9252		
Chloroacetaidehyde	107200	8240	8010	
Chlorobenzene	108907	8260	8240	8021
Chlorobenzilate	510156	8270		
Chlorodibromomethane	124481	8240		
Chloroethane	75003	8260	8240	8021
Chloroform	67663	8260	8240	8021
Chloromethane	74873	8260	8240	8021
Chloroprene	126998	8240		
Chromium (Cr)	7440473	6010	7191	7190
Chromium (VI)	18540299	7198	7197	7196
Chrysene	218019	8270	8100	8310
Cis-1,2-Dichloroethene	156594	8260	8021	
Cis-1,3-Dichloropropene	10061015	8240		8240
Cobalt	7440484	6010	7201	7200
Copper (Cu)	7440508	6010	7211	7210
Coumaphoe	56724	8270		
Cresols	1319773	8270	8250	
p-Cresidine	120718	8270		
Crotoxyphoe	7700176	8270		
Cyanides	57125	9010	9012	
Dalapon		8150		
Demeton-o	298033	8270		
Demeton-s	126750	8270		
Diallate (cis or trans)	2303164	8270		
Dibenz[a,h]anthracene	53703	8270	8100	8310
Dibenz[a,j]acridine	224420	8270	8100	
Dibenzofuran	132649	8270		
Dibromochloromethane	124481	8260	8240	8021
Dibromomethane	74953	8260	8240	8021
Dibutyl chlorendate	1770805	8080		
Dicambia		8150		
Dichlone	117806	8270		
Dichlorodifluoromethane	75718	8260	8240	8021
Dichlorovos	62737	8270		
Dicrotophos	141662	8270		
Dieldrin	60571	8080	8270	
Diethyl ether		8015		
Diethyl phthalate	84662	8270	8060	
Dimethoate	60515	8270		
Dimethyl phthalate	131113	8270	8060	

Table 2-9 (Cont)

Chemical Constituent	CAS No.	Preferred Method	Alternate Method	Alternate Method
Dimethylaminoazobenzene	29387926	8270		
a,a-Dimethylphenethylamine	122098	8270	8250	
Di-n-butylphthalate	84742	8270	8060	
Di-n-octylphthalate	117840	8270	8060	8270
Dinoseb	88857	8270	8150	
Diphenylamine	122394	8270		
Disulfoton	298044	8270		
Endosulfan I(alpha-endosulfan)	959988	8080	8270	
Endosulfan II(beta-endosulfan)	33213659	8080	8270	
Endosulfan sulfate	1031078	8080	8270	
Endrin	72208	8080	8270	8250
Endrin aldehyde	7421934	8080	8270	
Endrin ketone	53494705	8080	8270	
Epichlorohydrin	106898	8240		
EPN	2104645	8270		
Ethion	563122	8270		
Ethanol	64175	8015		
Ethyl carbarnate	51796	8270		
Ethyl ether	60297	8015	8240	
Ethyl methacrylate	97632	8240		
Ethyl methanesulfonate	62500	8270		
Ethylbenzene	100414	8260	8240	8021
Ethylene dibromide	106934	8240	8010	
Famphur	52857	8270		
Fensulfothion	115902	8270		
Fenthion	55389	8270		
Fluchloralin	33245395	8270		
Fluorene	86737	8270		
Fluoranthene	206440	8270	8100	8310
Fluorene	86737	8270	8100	8310
Formaldehyde	50000	8015	8240	
Formic acid	64186	8250		
Heptachlor	76448	8080	8270	8250
Heptachlor epoxide	1024573	8080	8270	
Hexachlorobenzene	118741	8270	8120	
Hexachlorobutadiene	87683	8270	8120	8260
Hexachlorocyclopentadiene	77474	8270	8120	
Hexachloroethane	67721	8260	8120	8270
Hexachloropropene	1888717	8270		
Hexamethyl phosphoramide	680319	8270		
Hydroquinone	123319	8270		
Indeno(1,2,3-cd)pyrene	193395	8270	8100	8310
Iodomethane	74884	8240		
Iron (Fe)	7439896	6010	7381	7380
Isodrin	465736	8270		
Isophorone	78591	8270	8090	
Isopropylbenzene	98828	8260	8021	
p-isopropyltoluene	99876	8260	8021	
Isosafrole	120581	8270		
Kepone	143500	8270		
Lead (Pb)	7439921	6010	7421	7420
Leptophos	21609905	8270		
Malathion	121755	8270		
Maleic anhydride	108316	8270	8250	
Manganese (Mg)	7439965	6010	7461	7460
MCPA		8150		

Table 2-9 (Cont)

Chemical Constituent	CAS No.	Preferred Method	Alternate Method	Alternate Method
MCPP		8150		
Mercury (Hg)	7439976	7471	7470	
Mestranol	72333	8270		
Methapyrilene	91805	8270		
Methoxychlor	72435	8080	8270	
Methylene Chloride	75092	8260	8240	8021
Methyl Iodide	74884	8240		
Methyl methacrylate	80626	8240		
Methyl methanesulfonate	66273	8270	8250	
Methyl parathion	298000	8270		
Mexacarbate	315184	8270		
Mirex	2385855	8270		
Monocrotophos	6923224	8270		
Naled	300765	8270		
Naphthalene	91203	8260	8270	8021
Nickel (Ni)	7440020	6010	7521	7520
Nitrobenzene	98953	8270	8250	8090
Nitrobenzene-d5	4165600	8270	8250	8090
Nitrofen	1836755	8270		
Nitroquinoline-1-oxide	56575	8270		
N-Nitrosodibutylamine	924163	8270	8250	
N-Nitrosodiethylamine	55185	8270		
N-Nitrosodimethylamine	62759	8270	8070	
N-Nitrosodi-n-propylamine	621647	8270	8070	
N-Nitrosodiphenylamine	86306	8270	8070	
N-Nitrosomethylethylamine	10595956	8270		
N-Nitrosomorpholine	59892	8270		
N-Nitrosopyrrolidine	930552	8270		
N-Nitrosopiperidine	100754	8270	8250	
Octamethyl pyrophosphoramide	152169	8270		
Oil and Grease		9070	9071	
Parthion	56382	8270		
Pentachlorobenzene	608935	8270	8250	
Pentachloronitrobenzene	82688	8270	8250	
Pentachlorophenol	87865	8270	8250	8040
Phenacetin	62442	8270	8250	
Phenanthrene	85018	8270	8250	8100
Phenobarbital	50066	8270		
Phenol	108952	8270	8250	8040
Phenol-d5	4165622	8270		
Phorate	298022	8270	8140	
Phosalone	2310170	8270		
Phosmet	732116	8270		
Phosphamidon	13171216	8270		
Phthalic anhydride	85449	8270		
Piperonyl sulfoxide	120627	8270		
Pronamide	23950585	8270	8250	
n-propylamine	107108	8240	8021	
n-propylbenzene	103651	8260		
Pyrene	129000	8270	8100	8310
Pyridine	110861	8270	8240	
Safrole	94597	8270		
Selenium (Se)	7782492	6010	7741	7740
Silver (Ag)	7440224	6010	7761	7760
Strychnine	57249	8270		
Styrene	100425	8260	8240	8021

Table 2-9 (Cont)

Chemical Constituent	CAS No.	Preferred Method	Alternate Method	Alternate Method
Sulfides	18496258	9030	9031	
Sylfallate	95067	8270		
Terbufos	13071799	8270		
Terphenyl-dl4	1718510	8270		
Tetrachloroethene (PCE)	127184	8260	8240	8021
Tetrachlorophenol	58902	8270	8040	
Tetrachlorvinphos	961115	8270		
Tetraethyl pyrophosphate	107493	8270		
Thallium (Tl)	7440280	6010	7841	7840
Thionazine	297972	8270		
Thiophenol (Benzenethiol)	108985	8270		
Toluene	108883	8260	8240	8021
Toluene-d8	2037265	8260	8240	
Toluenediamine	25376458	8250		
Toluene diisocyanate	584849	8270		
o- Toluidine	95534	8270		
Total Organic Carbon (TOC)		9060		
Total Organic Halide (TOX)		9020	9022	
Total Petroleum Hydrocarbons (TPH)		8015		
Total Pheonols		9065		
Toxaphene	8001352	8080	8270	8250
Trans-1,2-Dichloroethene	156605	8260	8240	8021
Trans-1,3-Dichloropropene	10061026	8240	8010	
Trichloroethene (TCE)	79016	8260	8240	8021
Trichlorofluoromethane	75694	8260	8240	8021
Trichloropropane	25735299	8010	8240	
Trifluralin	1582098	8270		
Trimethyl phosphate	512561	8270		
Tri-p-toyl phosphate	78320	8270		
Tris(2,3-dibromopropyl) phosphate	126727	8270		
Vanadium	7440622	6010	7911	7910
Vinyl Acetate	108054	8240		
Vinyl chloride (VCL)	75014	8260	8240	8021
m-Xylene	108383	8260		
Xylenes (total)	1330207	8260	8240	8021
Zinc (Zn)	7440666	6010	7951	7950
Ignitibility		1010	1020	
Corrosivity		9040		
pH		9040	9045	
Reactivity		9010	9030	
TCLP		1311		

2.4.5.4 HW sampling schedule. The hazardous waste sampling schedule is, perhaps, the most important part of your MAP. The frequency of waste stream sampling is based on the volume of waste generated. High volume waste streams are defined as those that generate more than three 55-gallon drums of waste per year. Each of the high volume waste streams will be reviewed against characterization data or sampled and analyzed by the BES once each six months. Low-volume waste streams are those which generate three 55-gallon drums or less per year. Low-volume waste streams will be reviewed against characterization data or sampled and analyzed by the BES once a year after the initial characterization unless there is a process change that would dictate a more frequent review. Results of all analyses will be provided to the installation environmental activity to updated hazardous waste profile sheets. An example of a simple HW sampling schedule is shown below.

Example of HW Sampling Schedule

Action	Year 1				Year 2				Year 3				Year 4			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Review Characterization and/or Analyze Sample From High Volume Waste Streams																
1	x		x		x		x		x		x		x		x	
2		x		x		x		x		x		x		x		x
3	x		x		x		x		x		x		x		x	
4		x		x		x		x		x		x		x		x
5	x		x		x		x		x		x		x		x	
6		x		x		x		x		x		x		x		x
7	x		x		x		x		x		x		x		x	
8		x		x		x		x		x		x		x		x
Review Characterization and/or Analyze Sample From Low Volume Waste Streams																
9	x												x			
11		x												x		
12			x												x	
13				x												x
Analyze Sample From New Waste Streams	Analyze prior to turn-in to DRMO or off-site disposal.															
Analyze Waste Oil	Analyze each batch four weeks prior to pick up by waste hauler.															
Review MAP	x				x				x				x			

2.4.5.5 Test parameters. In the next section of the MAP, the BES must determine and document the specific parameters that should be analyzed for each waste stream. All new, unknown, and non-recurring hazardous waste streams must be tested in accordance with the toxic characteristic leaching procedure (TCLP) to determine if they exhibit the toxicity characteristic. When process knowledge is sufficient to certify that none of the TCLP contaminants could be present, the major components of each hazardous waste stream must be defined on the hazardous waste profile sheet. If process knowledge is insufficient, these wastes will be tested to determine their major components. Test methods for major components are shown in Table 2-9 . As test parameters become known for each waste stream, the BES must document the information in the form of a waste analysis parameter work sheet. An example of a waste analysis parameter worksheet is shown below.

Example of Waste Analysis Parameter Worksheet

Waste Stream Number	Waste Name	Waste Stream Type	Generating Unit	Location	High or Low Volume Waste Stream	Physical State	Waste Parameters (1)							
							Ignit-ability	Reac-tivity	Corro-sivity	TCLP				Other
										Metals	VOC	SVOC	Full	
1	Solvent Tank Sludge	Sludge	1st FS	Bldg 1000	High	Semi-solid	X			X	X			
2	Spent Chromic Acid Bath	Corrosive Liquid	1st FS	Bldg 1000	Low	Liquid	X		(2)	X				

(1) Test parameters requested are based on available knowledge for each waste stream. As more information is supplied, e.g., by generator's knowledge or MSDS information, some test parameters may be deleted. In cases where the material is not altered by the process, characterization of the waste is provided by the MSDS, and no waste samples are collected.

(2) Analyses will not be requested in instances where the results can be assumed by generator knowledge of the process.

2.4.5.6 Sampling equipment. Determination of the appropriate sampling equipment and sampling procedure depends upon the chemical constituents and physical state of the waste. Examples of appropriate sampling equipment are listed in Table 2-10 . Although there are multiple physical states and different waste sampling procedures for each physical state, only those procedures most appropriate for typical wastes generated are discussed. Selection of the sampling method and equipment is based on the following criteria:

- Disposability or ease of decontamination;
- Ease of operation;
- Compatibility with waste;
- Safety; and
- Prevention of dilution, escape, or cross-contamination.

Both sampling equipment and sample bottles must be clean in order to prevent contamination of the sample. Personnel collecting hazardous waste samples must wear personal protective equipment including impervious gloves, chemical safety goggles, coveralls, and suitable boots when sampling hazardous waste. A minimum of Level B protection (e.g., chemical splash suit, impervious gloves, impervious outer boots, and a positive pressure self-contained breathing apparatus) must be worn when sampling unknown waste streams.

2.4.5.7 Sample request procedures. A sample analysis request form (Appendix C) should accompany the sample to the laboratory. The field portion of the form is completed by the person collecting the sample and should include pertinent information such as the sample number, the requested analysis, and the name and phone number of the person collecting the sample. The laboratory conducting the analysis will typically provide the sample analysis request form with a chain-of-custody. The laboratory portion of the form is then completed by laboratory personnel and includes the name of the person receiving the sample, laboratory sample number, date and time of sample receipt, sample allocation, and analysis to be performed.

Table 2-10 - Sampling Equipment and Waste Streams

	Waste Location or Container								
Waste Type	**Drum**	**Sacks and Bags**	**Open-Bed Truck**	**Closed-Bed Truck**	**Storage Tanks or Bins**	**Waste Piles**	**Ponds, Lagoons, and Pits**	**Convey or Belt**	**Pipe**
Free-Flowing liquids and slurries	Coliwasa	N/A	N/A	Coliwasa	Weighted bottle [a]	N/A	Dipper	N/A	Dipper
Sludges	Trier	N/A	Trier	Trier	b	b	b	b	b
Moist powders or granules	Trier	Trier	Trier	Trier	Trier	Trier	Trier	Shovel	Dipper
Dry powders or granules	Thief	Thief	Thief	Thief	b	Trier	Thief	Shovel	Dipper
Sand or packed powders and cranules	Auger	Auger	Auger	Auger	Thief	Thief	b	Dipper	Dipper
Large-Grained solids	Lg trier	Lg trier	Lg trier	Lg trier	Lg trier	Lg trier	Lg trier	Trier	Dipper

a. When the tank is adequately agitated or a recirculation line is accessible, samples can be collected through a side tap.

b. This type of sampling situation can present significant logistical sampling problems, and sampling equipment must be specifically selected or designed based on site and waste conditions. No general statement about appropriate sampling equipment can be made.

2.4.5.8 Sampling protocols. All samples will be collected using standard collection methods as specified in Table 2-11. Sample containers, preservation, and holding times are listed in Table 2-12.

Table 2-11 - Sampling Protocols

Physical State of Waste	Protocols
Extremely viscous liquids and solids	ASTM Standard D140-70
Crushed or powdered material	ASTM Standard D346-75
Soil or rock-like material	ASTM D1452-65
Fly ash-like material	ASTM Standard D2234-76
Containerized liquid waste	US EPA SW-846-COLIWASA Procedure
Liquid wastes in pits, ponds, lagoons, and similar reservoirs	US EPA SW-846-Pond Sampler

2.4.5.9 Sample types. If the waste is contained in five or fewer containers, every container should be sampled. However, if there are a large number of containers, choose a subset of containers to be sampled randomly by using a random number table. Prior to analysis, the laboratory may make up homogeneous samples of the same waste stream into a composite sample. Main sample types include grab and composite.

- A sample taken from a particular location at a distinct point in time is called a grab sample. This type of sample is useful in determining waste stream variability when multiple or frequent samples are taken. However, this type of sampling may require a large number of samples.
- A composite sample is a set of individually collected samples that are combined into a single sample for analysis. This is the most common type of sample for obtaining average concentration estimates of a waste stream.

Table 2-12 - Sample Containers, Preservation, and Holding Times (EPA Publication SW-846)

Matrix/Parameters to be Analyzed	Sample Type	Analytical Method	Sample Container Type and Materials	Preservation Method	Maximum Holding Time
LIQUIDS:					
Volatile organics	Grab	SW-8240	3-40 ml VOA with Teflon-lined Septum	Cool to 4°C, pH<2 HCl; $Na_2S_20_3$	14 days
Semivolatile organics	Grab	SW-8270	2-1 liter amber glass with Teflon-lined cap	Cool to 4°C $Na_2S_20_3$	7 days for extraction 40 days for analysis
Pesticides/herbicides	Grab	SW-8080/8150	2-1 liter amber glass with Teflon-lined cap	Cool to 4°C	7 days for extraction 40 days for analysis
Insecticides	Grab	SW-8000s	2-1 liter amber glass with Teflon-lined cap	Cool to 4°C	7 days for extraction 40 days for analysis
Polychlorinated biphenyls (PCBs)	Grab	SW-8080	2-1 liter amber glass with Teflon-lined cap	Cool to 4°C	7 days for extraction 40 days for analysis
Dioxins and furans	Grab	SW-8280	2-1 liter amber glass with Teflon-lined cap	Cool to 4°C	30 days for extraction 45 days for analysis
Metals (total)	Grab	SW-6010/7000	1-1 liter polyethylene bottle	Cool to 40°C pH<2 HNO_3	6 months for analysis
Mercury (total)	Grab	SW-7470	1-1 liter polyethylene bottle	Cool to 4°C pH<2 HNO_3	13 days (plastic) 38 days (glass)
Chromium (VI)	Grab	SW-7196	500 ml amber glass	Cool to 4°C	24 hours
pH	Grab	SW-9040	1-250 ml polyethylene bottle	None	Analyze immediately
Total organic halogens	Grab	SW-9020	1-1 liter amber glass with Teflon-lined cap	Cool to 4°C; pH<2 H_2S0_4	7 days
Total organic carbon (TOC)	Grab	SW-9060	1-1 liter amber glass with Teflon-lined cap	Cool to 4°C; pH<2 HCl or H_2S0_4	28 days
BTU value	Grab	ASTM D240-85	100-ml glass	Cool to 4°C	None specified
Ash content	Grab	ASTM D482-80	100-ml glass	Cool to 4°C	None specified
CONCENTRATED LIQUID WASTE:					
Flashpoint	Grab	SW-1010	8-oz widemouth glass with Teflon lined cap	None	30 days
Cyanide	Grab	SW-9020	1-l liter glass	Cool to 4°C NaOH to pH >12	14 days
Sulfide	Grab	SW-9030	1-1 liter glass	Cool to 4°C NaOH to pH >12	7 days
Explosivity[b]	Grab	NA	NA	NA	NA

Table 2-12 (Cont)

Matrix/Parameters to be Analyzed	Sample Type	Analytical Method	Sample Container Type and Materials	Preservation Method	Maximum Holding Time
SOLIDS:					
Volatile organics	Composite	SW-8240	4-oz widemouth glass with Teflon liner	Cool to 4°C	14 days
Semivolatile organics	Composite	SW-8270	4-oz widemouth glass with Teflon liner	Cool to 4°C	14 days for extraction 40 days for analysis
Pesticides/herbicides	Composite	SW-8080/8150	4-oz widemouth glass with Teflon liner	Cool to 4°C	14 days for extraction 40 days for analysis
Insecticides	Composite	SW-8000s	4-oz widemouth glass with Teflon liner	Cool to 4°C	14 days for extraction 40 days for analysis
Polychlorinated Biphenyls (PCBs)	Composite	SW-8080	4-oz widemouth glass with Teflon liner	Cool to 4°C	14 days for extraction 40 days for analysis
Dioxins and furans	Composite	SW-8280	4-oz widemouth glass with Teflon liner	Cool to 4°C	30 days for extraction 45 days for analysis
Mercury	Composite	SW-7471	4-oz widemouth glass with Teflon liner	Cool to 4°C	28 days for extraction 28 days for analysis
Chromium (VI)	Composite	SW-7196	4-oz widemouth glass with Teflon liner	Cool to 4°C	24 hours
Metals	Composite	SW-6010/7000	4-oz widemouth glass with Teflon liner	None	6 months for extraction 6 months for analysis
pH	Composite	SW-9045	4-oz widemouth glass with Teflon liner	None	Analyze immediately
Total organic halogens	Composite	SW-9020	4-oz widemouth glass with Teflon liner	Cool to 4°C	7 days
Total organic carbon (TOC)	Composite	SW-9060	4-oz widemouth glass with Teflon liner	Cool to 4°C	28 days
TCLP volatiles	Composite	SW-1311/8240	4-oz widemouth glass with Teflon liner	Cool to 4°C	14 days for TCLP extraction 14 days for analysis

Table 2-12 (Cont)

Matrix/Parameters to be Analyzed	Sample Type	Analytical Method	Sample Container Type and Materials	Preservation Method	Maximum Holding Time
TCLP semivolatiles	Composite	SW-1311/8270	8-oz widemouth glass with Teflon liner	Cool to 4°C	14 days for TCLP extraction 7 days for extraction 40 days for analysis
TCLP pesticides/ herbicides	Composite	SW-1311/ 8080/8150	8-oz widemouth glass with Teflon liner	Cool to 4°C	14 days for TCLP extraction 7 days for extraction 40 days for analysis
Metals (TCLP)	Composite	SW-1311/ 6010/7000	4-oz widemouth glass with Teflon liner	Cool to 4°C	6 months for TCLP extraction 6 months for analysis
Mercury (TCLP)	Composite	SW-1311/7470	8-oz widemouth glass with Teflon liner	Cool to 4°C	28 days for TCLP extraction 28 days for analysis
BTU value	Composite	ASTM D2015-85	4-oz widemouth glass with Teflon liner	Cool to 4°C	None specified
Ash Content	Composite	ASTM D1553-83	4-oz widemouth glass with Teflon liner	Cool to 4°C	None specified
CONCENTRATED SOLID WASTE:					
Flashpoint	Composite	SW-1010	8-oz widemouth glass with Teflon liner	Cool to 4°C	30 days
Reactive cyanide	Composite	SW-846 Chapter 7/9020	8-oz widemouth glass with Teflon liner	Cool to 4°C	14 days/14 days
Reactive sulfide	Composite	SW-846 Chapter 7/9030	8-oz widemouth glass with Teflon liner	Cool to 4°C	14 days/7 days
Explosivity	Composite	NA	8-oz widemouth glass with Teflon liner	Cool to 4°C	NA
Paint Filter Test	Composite	SW-9095	8-oz widemouth glass with Teflon liner	Cool to 4°C	NA
Corrosivity	Composite	SW-846 Chapter 7	8-oz widemouth glass with Teflon liner	Cool to 4°C	14 days/14 days

a. Highly concentrated samples generally do not require preservation. When chemical preservation is required, care must be taken to ensure that incompatible preservations are not added. For example, an aqueous sample that is to be analyzed for metals should not have acid added to it if the sample also contains cyanides.

b. Explosivity will be determined using analytical data from specific tests.

2.4.5.10 Waste sampling plan. A waste sampling plan is another key element of your MAP. This plan describes the sampling procedures and safety equipment associated with each type of waste stream found on your installation. The waste sampling plan is very important because, at any time, someone unfamiliar with your base may have to assist you in taking samples. The plan will provide the information needed to allow them to take the samples in a timely manner. In addition, since considerable time may elapse between sample collection, the plan will serve as a quick refresher for you. Table 2-13 shows an example of a waste sampling plan.

Table 2-13 - Example of a Waste Sampling Plan

Waste Stream	Physical State	Sample Procedures	Safety Equipment
Waste oil/ fuel	Liquid	If the waste is contained in a drum, use a COLIWASA to collect a composite sample. If more than one drum is present, combine a COLIWASA from each drum to make one sample. If the waste is contained in a storage tank, use a weighted bottle to collect a composite sample.	Impervious gloves, chemical safety goggles, coveralls, and suitable boots. Sample in a well-ventilated area.
Used solvent	Liquid	Use a COLIWASA to collect a composite sample. If more than one drum is present, combine a COLIWASA from each drum to make one sample.	Impervious gloves, chemical safety goggles, coveralls, and suitable boots. Sample in a well-ventilated area. If respiratory protection is required when handling the material during the process, then the same level of protection should be worn when sampling the waste.
Paint waste	Liquid	Use a COLIWASA to collect a composite sample. If more than one drum is present, combine a COLIWASA from each drum to make one sample.	Impervious gloves, chemical safety goggles, coveralls, and suitable boots. Sample in a well-ventilated area. If respiratory protection is required when handling the material during the process, then the same level of protection should be worn when sampling the waste.
Wastewater	Liquid	Use a COLIWASA to collect a composite sample. If more than one drum is present, combine a COLIWASA from each drum to make one sample.	Impervious gloves, chemical safety goggles, coveralls, and suitable boots. Sample in a well-ventilated area.
Sludge	Semi-solid	Use a sampling trier to collect a composite sample. If more than one drum is present, combine a trier from each drum to make one sample.	Impervious gloves, chemical safety goggles, coveralls, and suitable boots. Sample in a well-ventilated area.
Corrosive liquid	Liquid	Use a COLIWASA to collect a composite sample. If more than one drum is present, combine a COLIWASA from each drum to make one sample.	Impervious gloves, chemical safety goggles, coveralls, and suitable boots. Sample in a well-ventilated area.
Unknown	Solid	Use a thief sampler to collect a composite sample.	Chemical splash suit, impervious gloves, impervious outer boots, and a positive pressure self-contained breathing apparatus
Unknown	Liquid	Use a COLIWASA to collect a composite sample.	Chemical splash suit, impervious gloves, impervious outer boots, and a positive pressure self-contained breathing apparatus
Unknown	Semi-solid	Use a sampling trier to collect a composite sample.	Chemical splash suit, impervious gloves, impervious outer boots, and a positive pressure self-contained breathing apparatus

2.4.5.11 Samples from rag containers. Ideally, several samples should be taken from locations dispersed both horizontally and vertically through the open containers. General guidance for obtaining a representative sample based on the container's volume is as follows:

- 55-gallon drum. Collect one rag from each of ten depth intervals and section into quarters. Composite sample by placing one section from each depth into sample container.
- 30-gallon drum. Collect one rag from each of six depth intervals and section into quarters. Composite sample by placing one section from each depth into sample container.
- 5-gallon drum. Collect one rag from each of three depth intervals and section into quarters. Composite sample by placing one section from each depth into sample container.

A vertical profile of the container is obtained by inserting forceps into the waste at the appropriate sample depth, opening the forceps jaws, closing the jaws on a rag, and retracting the forceps sampler from the container. The removed waste rags are then laid out flat on a clean working surface. Each rag is cut into quarters (1/4) and the lower right quarter of each rag will be placed in the sample container. The sample jar(s), is preserved, if required, sealed, labeled, and placed in an appropriate shipping container(s) for transportation to the laboratory.

2.4.5.12 Samples from unknown wastes. The first phase of obtaining samples of unknown waste is to eliminate any immediate hazard. This includes isolating the area, restricting personnel access, and containing any leaks or spills. Required protective clothing should be identified as well as any equipment specifications such as the use of non-sparking tools. A bulging drum indicates that it is under pressure and should not be sampled until pressure is relieved. Record conditions, markings and observations of containers. Include any background information on the waste that has been obtained through a record search or personnel interview. The following information describing the physical characteristics of the waste should be recorded:

- Color - Describe the color of the waste (e.g., blue, clear, varies).
- Physical State (e.g., solid, liquid, powder, gas, semi-solid, or sludge).
- Layers - note whether the waste is multi-layered (e.g., oil/water/sludge), bi-layered (e.g., oil/water), or homogeneous.
- Percentage Liquid - estimate the percentage of liquid volume (The Paint Filter Test, SW846 Method 9095, must be conducted to confirm that there are no free liquids).
- **2.4.5.13** Decontamination of sampling equipment. Equipment decontamination consists of physically removing contaminants from the sampling equipment by washing with a decontamination solution and rinsing with clean water. The procedure used is determined by evaluating the specific contaminant and reviewing the manufacturer's recommendations. In all cases, methods to minimize decontamination solution waste and decontamination rinse water generated during this process will be implemented. Decontamination equipment/materials include:
- Soft-bristle scrub brushes and long-handle scrub brushes used to remove contaminants;
- Buckets of water or garden sprayers used for rinsing;
- Large, galvanized wash tubs, stock tanks, or children's wading pools used as containers for wash and rinse solutions;
- Large plastic bags for the storage of contaminated clothing and supplies;
- Metal or plastic cans or drums used for the storage of contaminated rinseate liquids; and
- Paper or cloth towels used for drying equipment, if necessary.

A general decontamination procedure is provided below. Modification to this method and use of differing decontamination solutions are determined by the BES prior to sampling.

1. Disassemble sampling apparatus, if necessary;
2. Clean each part with a scrub brush and the appropriate decontamination solution;
3. Triple rinse with potable water;
4. Rinse with distilled water;
5. Air dry; and
6. Inspect sampling apparatus for thoroughness of cleaning.
7. Decontamination rinseate is collected in a drum and disposed as hazardous waste. An inventory of the chemicals that are present in the decontamination rinseate is maintained during accumulation of the waste. The decontamination is disposed after a sufficient volume has accumulated.

2.4.5.14 Sample documentation. Sample labels, analysis request forms, and chain-of-custody forms (Appendix C) are used for all waste sample shipments to ensure the integrity of samples from collection to data reporting. The possession and handling of samples must be traceable from collection through analysis and final disposition. The documentation of the sample history is called chain-of-custody. The parts of the chain-of-custody process include the use of sample labels that are placed on containers prior to sampling and filled out by the BES or accumulation site manager at sample collection. Necessary information on the sample label includes number, name of collector, date and time of collection, and place of collection. A chain-of-custody record should also be filled out and accompany every sample. This record should contain the sample number, signature of collector, date and time of collection, place and address of collection, waste type, signature of persons involved in the chain of custody, and inclusive dates of possession. The BES will provide the chain-of-custody form.

2.4.5.15 Categorizing samples for shipment. Prior to determining the proper shipping requirements, the generator must determine if the waste stream is hazardous. Samples are broadly categorized as environmental or hazardous depending on whether they are collected off the site or on, whether they contain low or high concentrations of contaminants, whether or not they pose a threat to the safety of the worker or professional carrier or shipper, and whether or not the samples must be shipped according to the Department of Transportation (DOT) regulations. Environmental samples are typically samples such as: drinking water, groundwater, surface water, background and control soils, sediments, treated waste water effluent, biological specimens, and any sample not expected to be contaminated with high levels of hazardous materials. Samples collected from process waste streams, bulk, storage tanks, industrial process streams, or soil, sediment, or water samples collected from areas suspected of being highly contaminated need to be shipped as a hazardous material in accordance with DOT regulations. The appropriate regulations governing the shipment of hazardous samples are located in the 49 CFR 171 through 177. It is also important to note that most professional carriers use the International Air Transport Association (IATA) rules for regulating the transport of dangerous goods. Samples collected and determined to be hazardous by the generator should be shipped in accordance with DOT or IATA regulations. Professional shippers such as Federal Express and UPS follow the IATA rules for regulating the shipment of dangerous goods. Special DOT training is required for any persons packaging, labeling, or shipping hazardous materials or wastes.

2.4.5.16 Shipment of unknown samples. If a sample is collected that is of a known substance that is listed in the Hazardous Materials Table, 49 CFR 172.101, then that sample must be identified, packaged, marked, labeled, and shipped according to the specified instructions for that material. However, if the composition of the sample is unknown, the generator must select the appropriate transportation category in accordance with the DOT Hazardous Material Classification. The generator should use process knowledge and Material Safety Data Sheet (MSDS) to determine the waste's properties. Generally, samples of unknown waste should be classified in the following hazard classes: Flammable Liquid, Flammable Solid, Corrosive Material, Poisonous Material or Infectious Substance, Explosive, Gas, Oxidizing Substance or Organic Peroxides, Radioactive Material, or Miscellaneous Hazardous Material. For all shipments of hazardous wastes, it is prudent to review the shipping requirements with AF transportation personnel or a professional shipper prior to sample shipment.

2.4.5.17 Packaging samples for shipment. All outer and inner packaging of hazardous samples must meet the DOT or IATA prescribed requirements. When United Nations (UN) approved specification packaging is not required,

packages must be constructed such that when properly sealed for shipment they will not leak due to changes in temperature, humidity, pressure, or from vibration. Absorbent material or cushioning must be capable of absorbing the contents of the largest inner package or the entire outer package contents as specified. Absorbent material must not react dangerously with the sample.

2.4.5.18 Shipping papers**.** All hazardous shipments must be shipped with a hazardous material shipping paper. The carrier-provided Bill of Lading is acceptable as a hazardous material shipping paper. If a professional shipper is not used (i.e., Air Force personnel are driving the sample to a the laboratory), a shipping form should be used with the following basic entries in the sequence shown below:

- The proper shipping name;
- Hazard Class or division number;
- Identification number (UN number);
- Packaging Group;
- Total net quantity; and
- Emergency response information.

2.4.5.19 Shipping labels. All markings and labels should be affixed to any other surface than the bottom. Markings and labels must be on the same side as the proper shipping name if the package size allows. Labels should be displayed next to each other (not more than 5.9 inches apart) but not overlapping. Markings or labels should be displayed on a background of a contrasting color, or have a solid or dotted line outer border. All outer packaging must be marked with the following information:

- Proper shipping name
- UN identification number
- The name and address of the generator
- The total net quantity of the sample
- An orientation label (i.e., THIS END UP) for liquids and over packs
- The statement, "INNER PACKAGES COMPLY WITH PRESCRIBED PACKAGING SPECIFICATIONS," for overpacks

2.4.5.20 Laboratories. Under ideal situations, hazardous waste samples should be shipped to the nearest laboratory listed in Table 1-5. BES personnel must contact supporting labs and coordinate requirements prior to shipping samples.

2.4.5.21 Quality assurance/control goals. Quality Assurance (QA) is a method used to assure that all information, data, and conclusions/recommendations for all hazardous waste analysis tasks are technically sound, statistically valid, and properly documented. Quality Control (QC) is the process through which QA satisfies its goals. The QA/QC program must be followed for all steps of the waste analysis process and should be evaluated to determine its efficiency by a knowledgeable person who is not directly involved with analysis of the waste. Analytical method precision and accuracy are dependent on the waste stream and the intended use of the information. The primary uses of the information are:

- Emergency response hazardous material identification if a spill occurs.
- Ensure compliance/consistency with hazardous waste management procedures, and appropriate federal, state, and local regulations.

Because of the variety of waste streams generated, chemical and physical testing must be comprehensive and dynamic. The quantity of data will be dependent upon the waste streams and associated variables. All QA/QC procedures will comply with the most recent edition of SW-846 or other EPA-approved procedures and methods

2.4.5.22 Sample collection QA/QC. Sampling equipment will be visually inspected by the sample technician prior to sampling and immediately following decontamination. If contamination is observed on sampling equipment, modifications to decontamination procedures will be made, documented, and the equipment will be fully decontaminated. If the equipment cannot be decontaminated or is damaged, the equipment will be replaced.

2.4.5.23 Equipment blanks. An equipment blank is used to verify that the sampling device has been properly decontaminated. An equipment blank is a deionized water sample collected from a non-dedicated decontaminated sampling device. The sampling device is filled with water that is then transferred to the sample container using the same procedures as those used to collect actual waste samples. The sample is then transported and analyzed at the laboratory. An equipment blank is recommended for each sampling day. At a minimum, equipment blanks will be collected and analyzed on a semiannual basis and will be linked to the sample technician's performance evaluation. The BES will determine if equipment blanks are required more frequently based on visual inspections of decontaminated equipment and previous laboratory results. If cross-contamination is suspected, these QA/QC procedures will be implemented to define the problems, and corrective action will be taken. All information will be documented and no sample data will be corrected using trip or equipment blank results.

2.4.6 Depleted Uranium. Depleted Uranium (DU) is a byproduct of the uranium enrichment process that is used to produce fuel for reactors. DU is a highly dense metal (19.1 g/cm^3), has a relatively high melting point (1132 ^{O}C), and has a low fabrication cost. Accordingly, DU is extensively used in industrial and military applications. U.S. Forces primarily use DU as aircraft counterbalances and for Armor Piercing/Incendiary (API) munitions.

2.4.6.1 Hazards. The hazards associated with DU depend on its physical form (solid versus particulate) and its chemical form (oxidized versus elemental). For the applications normally found on the battle field, the primary hazards are radiological and toxicological.

- Radiological hazards associated with DU occur from both external and internal exposures. DU decay products emit alpha, beta and gamma/x-ray radiation that can result in external radiation for personnel. Contact doses from bare DU can be on the order of 15 mrem/hr for gamma radiation and 238 mrem/hr for beta radiation. However, DU counterbalances and API munitions are normally clad (covered) to prevent corrosion. This cladding essentially eliminates the alpha and beta radiation exposure and reduces the gamma/x-ray exposure. In its clad form, DU typically exhibits whole body gamma levels of 1 mR/hr. Adequate training on DU hazards is provided to munitions handlers and aircraft maintenance personnel, who are normally exposed to clad DU. Therefore, external radiation from contact is not a significant threat. However, those personnel engaged in decontamination of DU contaminated equipment, facilities, and environmental media are of primary concern for internal exposure resulting from inhalation of DU.
- Toxicological hazards associated with DU occur from ingestion or inhalation of particulate matter. Insoluble particulates that reach the lungs are primarily a radiological concern. However, the most significant health threat posed by DU is from the soluble DU fraction that is inhaled or ingested. Again, those personnel engaged in decontamination of DU contaminated equipment, facilities, and environmental media are of primary concern for internal exposure resulting from inhalation of DU.

2.4.6.2 Potential contaminated media. Typical contaminated media found on the battle field are intact DU components, vehicle surfaces, and environmental media (air, water, and soil).

- Intact DU components such as aircraft counterbalances and API munitions will corrode or oxidize if exposed to air. This surface oxidation can become a minor source of contamination of personnel, equipment, vehicles, and the environment.
- Vehicle surfaces may become contaminated with DU as a result of direct API munitions strikes, traveling through DU contaminated environment. API munitions that hit an armored target essentially burn their way through the metal. As a result, DU oxide particles are deposited in or on the vehicle and as far as 100 yards down wind. The metal surrounding the penetration hole is generally the area of highest contamination. Resuspension of DU particulates inside vehicles is also a concern.

- Environmental media can be contaminated from weathering of intact DU components and release of DU oxides from API munition strikes or fires. However, environmental media contamination is generally minor compared to vehicle surface contamination.
- The surfaces of equipment, vehicles, and facilities can be contaminated as a result of ground handling and/or storage accidents/fires.
- The gun on the A-10 can become contaminated as a result of DU ammunition misfiring or jamming.

2.4.6.3 Precautions. As discussed previously, ingestion/inhalation of DU particles from any form of contamination is the primary hazard of concern. The following commonsense rules apply when dealing with DU contaminated material.

- Insure protective equipment (instrumentation, respirators, gloves, etc.) is operational and use it.
- Establish appropriate controls (contamination control station, radiological monitors, air sampling, etc.) to minimize the spread of contamination.
- Do not eat, drink, or smoke in potentially contaminated areas.
- Minimize time, maximize distance, and maximize shielding in order to keep doses received as low as possible.
- Minimize/eliminate unnecessary contact/entry into vehicles that have been impacted by DU munitions.

2.4.6.4 Exposure standards. The limit for radiation exposure is expressed in terms of annual dose equivalent that combines internal and external sources. The annual dose equivalent limits are:

5 rem to the whole body or major part of the body
- 50 rem to any one organ, including the skin
- 50 rem to any extremity
- 15 rem to the lens of the eye

Compliance with these standards for external radiation sources is typically measured by use of personal dosimetry. Dose equivalents for internal radionuclides are based on the Annual Limit of Intake (ALI). The ALI is the amount of a radionuclide that will result in a committed effective dose of 5 rem per year for the whole body or 50 rem to any one organ. The ALI for insoluble DU is 4×10^{-2} Curies per year (Ci/yr). Since inhalation is the primary concern, compliance with established ALI is also defined in terms of meeting Derived Air Concentration (DAC) values. The DAC assumes exposure of 2000 work hours per year and breathing 1.2 cubic meters of air per hour. The DAC for insoluble DU (oxide) is 2×10^{-11} Ci/ml.

2.4.6.5 Contamination limits. The Nuclear Regulatory Commission (NRC) has established limits for DU contamination in terms of average fixed contamination (one square meter average area), maximum fixed contamination (over any 100 cm^2 area) and removable contamination (that which can be removed by wiping with dry filter paper). All three criteria must be satisfied to comply with contamination limits. Limits for vehicles/equipment and persons and clothing are as follows

- Vehicles/equipment. Alpha = 5,000 dpm/100 cm^2 average fixed; 15,000 dpm/100 cm^2 maximum fixed; and, 1,000 dpm/100 cm^2 removable. Beta = 0.05 mrad/hr fixed at 2.5 cm and 500 dpm/100 cm^2 removable. Note dpm = disintegrations per minute.
- Persons and clothing. Alpha = as low as possible. Attempt to decontaminate to background, but in no circumstances above 200 dpm/100 cm^2 over any 100 cm^2 averaging area. Respirators should be decontaminated to 100 dpm/100 cm^2 or less. Beta = 0.05 mrad/hr fixed at 2.5 cm, to background for removal.

2.4.6.6 Protective clothing/equipment. The purpose of protective clothing is to minimize the spread of contamination, minimize personnel contamination and decontamination requirements, and to minimize the risk of ingesting/inhaling radioactive material. The type of protective clothing depends on the circumstances. However, the primary risk is ingestion/inhalation of DU oxide from contaminated vehicles/equipment that have been hit by API

munitions. It has also been determined that DU oxide concentrations are highest in the enclosed spaces of destroyed armor/vehicles. Based on experience, the following protective clothing/equipment is required for the conditions cited.

- Interior of vehicles/equipment: Cotton work gloves, disposable coveralls with hood, and full face respirator. Shoe covers are preferred but regular combat boots may be worn if all openings are sealed with tape. An appropriate breathing zone sampler is recommended to assess the extent of DU contamination and for use in approving the downgrade of respiratory protection.
- Exterior of vehicles/equipment: Cotton gloves and disposable coveralls. Shoe covers are preferred but regular combat boots may be worn if all openings are sealed with tape.
- Handling intact exposed DU components: Cotton gloves and disposable coveralls.

2.4.6.7 Radiation detection equipment and surveys. The type of equipment/surveys depends on the conditions. The following equipment/surveys are required for the scenarios indicated.

- Personnel monitoring. The most likely sources of personnel contamination will be from direct contact with contaminated media. Contamination on personnel should be monitored using the ADM-300 with AP-100 alpha probe. Use the ADM-300 BP-100 beta probe for beta detection. Probes should be held close to, but not in contact with, the surface to be surveyed.
- large area soil and gross vehicle monitoring. Weathering and subsequent attenuation of alpha/beta radiation, coupled with the need to screen large areas or pieces of equipment require monitoring for gamma radiation from decay of DU daughter products. A calcium fluoride or sodium iodide solid gamma scintillator type probe is required. A micro R or microrem-type instrument must be used to assess external exposure rates.
- Vehicle/equipment surveys. A suitable alpha survey meter is required for monitoring vehicle/equipment contamination where the surface is relatively free of oils, grease, or other debris that might reduce the alpha particles. For vehicles/equipment coated with oil, grease, or other debris a thin window pancake GM probe is appropriate.
- On-site air sample analysis. Use the ADM-300 meter for screening of collected sir samples. The intent of this screen is primarily to validate the continued need for respiratory equipment.

2.4.7 Mortuary Operations. Comprehensive mortuary affairs procedures and requirements are contained in Joint Publication 4-06, Joint Tactics, Techniques, and Procedures for Mortuary Affairs in Joint Operations. That document designates the Army component commander as the executive agent for theater mortuary affairs support. However, each service component is responsible for providing its own mortuary affairs support, collecting and maintaining information on the deceased, and performing mortuary affairs support functions for other Service components when required. Temporary interment of remains in overseas theaters is permitted as a last resort. However, every effort will be made to return remains to CONUS as soon as possible. Based on joint organizational structure and responsibilities, Air Force activities in the theater of operations could be involved in mortuary affairs programs ranging from search and recovery to operation of a Mortuary Affairs Collection Point (MACP), a Mortuary Affairs Decontamination Collection Point (MADCP), and/or a Theater Mortuary Evacuation Point (TMEP). Personnel involved in these activities must follow special health, and sanitation procedures. The BES should periodically assess compliance with these procedures to assure the health and safety of all personnel.

2.4.7.1 The threat. Personal health and sanitation practices are important in the daily operation of any mortuary affairs facility. Handling remains in various stages of decomposition can result in medical hazards. Infectious organisms may be associated with human remains and the areas where remains are held or processed. The handling of remains during receiving, processing, and evacuation operations may cause these organisms to spread from body openings. Therefore, each mortuary affairs activity needs to ensure that strict personal health, personal hygiene, and sanitation procedures are constantly followed. The successful implementation of personal health and sanitation procedures will prevent:

- the spreading of diseases from the human remains to personnel working in or located at a mortuary affairs facility

- the contracting of diseases from the mortuary affairs facility's environment (i.e., walls and floors, protective clothing, equipment and supplies) to individuals who work in, visit, or are located at a mortuary affairs facility
- the spread of a disease from an individual who has contracted or is a carrier of a disease to other susceptible individuals with whom the infected individual comes in contact

2.4.7.2 Mortuary affairs procedures and facilities. Joint Publication 4-06 provides detailed guidance on the various mortuary affairs procedures and facilities. This manual will deal with the minimum health and hygiene requirements associated with the various phases of mortuary affairs operations.

2.4.7.3 General health, sanitation, and medical guidelines. To reduce the chance of becoming infected, personnel conducting mortuary affairs functions should adhere to the following health, sanitation, and medical guidelines when dealing with remains.

- Always wear disposable surgical or rubber gloves when handling human remains. Discard the gloves after each use, especially when the remains is known to have an infectious disease.
- Always wear an outer protective garment, preferably one that prevents the penetration of liquids (i.e., a rubber or plastic wrap-around apron or gown).
- Wear a protective oral-nasal mask designed to prevent inhalation of infections or hazardous particles.
- Wear protective head and shoe coverings, especially in handling known infectious disease cases.
- Rinse gloved hands in appropriate disinfectant between actual uses during preparation of remains.
- Scrub hands and forearms with a suitable medicated soap or disinfectant after handling the last remains.
- Shower or cleanse the entire body surface, including shampooing of the hair at the end of the day.
- Incinerate all disposable protective clothing, bandages, dressings, sheets, towels, and other items coming into direct contact with the remains or body fluids.
- Take necessary steps to circulate the air in the entire facility, especially when working in an enclosed facility.
- Clean and disinfect all supplies, equipment and facility surfaces that came in contact with the remains or body fluids.
- Receive a thorough routine physical examination, including chest x-rays every six months.
- Adhere to a strict program of routine immunizations to include those immunizations required for all contagious and/or infectious diseases common to the area of operations. All mortuary affairs personnel should also be vaccinated for hepatitis B.
- Have periodic blood tests to check for the human immunodeficiency virus and other blood-related diseases.
- Contact a physician for proper preventive treatment prior to handling remains with a known infectious disease.

2.4.7.4 Unit recovery operations. When performing recovery operations, use any means available to cover all remains and portions of remains recovered. Units that do not have human remains pouches can use ponchos, blankets, large plastic bags, or other suitable items. Safety and sanitation factors should be considered. Diseases can easily be transmitted through the body fluids from the remains to individuals handling the remains. Personnel who conduct recovery operations should be provided gloves and protective clothing for the mission and adequate washing facilities after the mission. When personnel conducting a recovery mission encounter a remains, they must first check to ensure that the remains is safe to evacuate. Remains must be free of the risk of spreading harmful contamination and must have all unexploded ordnance, explosives, booby-traps, and other hazardous items removed. Coordination should be made with nuclear, biological, or chemical (NBC) or explosive ordnance disposal (EOD) specialists for assistance or guidance when biological or chemical agents or hazardous items are suspected. Once the remains is determined safe to handle, proceed with the recovery.

2.4.7.5 Mortuary Affairs Collection Point (MACP) operations. The MACP is the basic building block for modern day mortuary affairs support. MACPs are operated by the Services throughout the operational area. Site selection requirements for the MACP are included in Section 3 of this manual. The basic functions of the MACP are to receive and prepare remains for movement to the Theater Mortuary Evacuation Point (TMEP). Personnel working in the MACP follow the basic health, sanitation, and medical guidelines in paragraph 2.4.7.3 above. Remains awaiting movement to the TMEP must be kept refrigerated. The temperature of the refrigeration container must be maintained between 34 and 37 degrees Fahrenheit.

2.4.7.6 Mortuary Affairs Decontamination Collection Point (MADCP). In accordance with joint doctrine, a MADCP is established whenever there is a threat of NBC warfare. The basic functions of a MADCP are to receive, decontaminate, and prepare remains for movement to the TMEP. Site selection requirements for the MADCP are included in Section 3 of this manual. Personnel working in the MADCP follow the basic health, sanitation, and medical guidelines in paragraph 2.4.7.3 above. However, because of the potential for NBC contaminated remains, MADCP personnel must wear mission-oriented protective posture (MOPP) ensemble at all stations except the release station. Standard MADCP facilities require installation of a sump that receives the soap and water and decontaminating solution used in the process. The sump is located next to the wash and rinse station and should be large enough to accommodate approximately 1000 gallons of liquid. When decontamination operations are finished, a sufficient amount of decontaminating solution is added to the sump to neutralize the contamination. Table 2-14 and Table 2-15 provide mixing ratios for 1-2 percent strength decontaminating solution made from super tropical bleach (STB), calcium hypochlorite (HTH) or 5 percent strength sodium hypochlorite (see Table 1-13 for NSNs). BES or Readiness personnel determine the amount of solution to add to the sump. The decontaminating solution is allowed to sit in the sump for 1 hour and then the sump is back filled with dirt. In the case of nuclear contamination, the site must be marked and reported in accordance with NBC doctrine.

Table 2-14 - Water To STB or HTH Mix (Joint Publication 4-06)

Amount of Agent	Amount of Chemical	
1 Gallon	.24 pounds	These mixtures will provide a 1-2 percent (by weight) agent
5 Gallons	1.2 pounds	
25 Gallons	6 pounds	
50 Gallons	12 pounds	
100 Gallons	24 pounds	

Table 2-15 - Water to Sodium Hypochlorite (5 Percent Strength) Mix (Joint Publication 4-06)

Amount of Agent	Amount of Chemical	
1 Gallon	.50 pounds	These mixtures will provide a 1-2 percent (by weight) agent
5 Gallons	2.25 pounds	
25 Gallons	12.5 pounds	
50 Gallons	25 pounds	
100 Gallons	50 pounds	

2.4.7.6.1 Hazardous waste disposal of contaminated waste is a major concern for the MADCP. All uniforms, equipment, overgarments, and bandages should be considered contaminated. The MADCP must dispose of this waste properly. All clothing should be placed in the same sump into which the water from the wash and rinse station was drained. MADCP personnel should also have an alternate means of disposal when the sump cannot be used. Burning waste is not preferred, as burning causes downwind vapor hazards. However, if burning is the only alternate method available, the following procedures must be followed.

- An NBC-3 report must be prepared prior to burning waste, and all units downwind must be notified.
- The fire must be started before the contaminated materials are added.

- After burning is completed, three parts decontaminating solution are mixed with two parts ashes, and the mixture is buried.

Regardless of the method of destruction, the area must be marked with standard NBC warning triangles. Clothing or protective gear worn by MADCP personnel must be disposed of in the same way as those of the remains, to include gloves and aprons.

2.4.7.6.2 During the handling of remains, care must be taken to avoid exposure to blood or body fluids. Rubber gloves, aprons, surgical masks, and eye protection must be worn when working with remains. If contact is made, the area is washed immediately with disinfectant and/or soap solution.

2.4.7.6.3 The use of biological agents may not be known prior to the recovery and decontamination operations. If it is suspected that biological agents have been employed, all remains recovered in the contaminated area must be decontaminated. All personnel must follow strict guidance for the wearing of personal protective equipment when handling remains when a biological hazard is suspected. With some modification, (mostly lowering or raising the pH balance of the decontaminating solution) the same procedures that are effective for the decontamination of chemical agents are effective for the removal and surface decontamination of biological agent contamination. Once the biological agent is known, the pH of the decontaminating solution will be changed to a level required by the Theater Command Surgeon. However, additional precautions are necessary because active biological agents may persist internally in the remains. Remains contaminated with cholera or suspected cholera, infectious tuberculosis, plague, suspected smallpox, yellow fever, or suspected viral hemorrhagic fevers will require embalming, shipment in a hermetically sealed case, and/or a Centers for Disease Control and Prevention (CDC) Biosafety Branch, Office of Health and Safety permit prior to the shipment of remains. In such a case, decontamination procedures must be modified to include the required additions. Procedures are developed based on the type of biological agent. If a theater mortuary is necessary for the embalming of remains, it should be set up outside the contaminated area. Remains leaving the MADCP have no surface contamination. Normal procedures now used by civilian morgue and funeral workers for the processing of “biologically infected” remains are safe and adequate in protecting the workers and the public. Remains suspected of biological contamination must be placed in two human remains pouches and marked "BIOLOGICAL (BIO)" prior to evacuation to a MADCP. These remains must be kept separate from other remains during the processing and while awaiting transportation. The top of all case file forms must be marked "BIO." Non-durable personal effects (PE) considered to be contaminated with biological agents must be entered on a certificate of destruction and placed in separate contaminated waste barrels marked "BIO." Durable PE are treated the same as those for chemical agent contamination. The theater senior medical advisor should, based on the type of contamination, establish specific procedures for further handling of remains.

2.4.7.6.4 When the potential for the use of nuclear weapons exists, MADCP personnel must be prepared to process mass fatalities. Deaths can occur from the immediate effects of the nuclear explosion (blast and shock, initial nuclear radiation, and thermal radiation) or from exposure to the residual nuclear radiation (primarily fallout). The MADCP must take special precautions in the recovery and decontamination processes. Radiation surveys must be added to all MADCP operations. These include routes of travel, MADCP sites, and all remains brought to the MADCP. Unit commanders are responsible for recovery and evacuation of remains to a MADCP. Unit personnel may be assisted by mortuary affairs personnel if the situation allows. Recovered remains must be placed in a human remains pouch and marked with a tag displaying the letters NUCLEAR. Remains should be moved to the decontamination site in a covered vehicle. Before entering a nuclear-contaminated area to recover remains, personnel must monitor the area to determine the parameters under which recovery personnel may work. It is not intended that commanders needlessly subject their personnel to extreme hazards to recover the dead. Nuclear-contaminated remains are cleaned with soap and water and brushing. Water is used to rinse the body. Shielding is used to minimize exposure to MADCP personnel. Normal MOPP gear, such as personal protection ensemble, rubber aprons, gloves, and masks should be used for shielding. Wastewater is directed into the sump, where it is contained to minimize the spread of contamination and protect MADCP personnel. Before leaving the area, personnel fill the sump and mark it with standard nuclear contamination markers. Any clothing on the remains is removed and placed in metal drums. The drums are placed at least 50 feet outside the work area. The metal lids are kept on the drums except when depositing clothing. If after three attempts at decontamination, the remains still register contamination, they are segregated from other remains and technical experts are consulted. If no resolution is reached, remains will be interred in-theater

with the geographic combatant commander's concurrence. Remains that register no contamination are placed in a remains pouch and moved to the TMEP. These remains are considered free of any radiation hazard and are handled the same as any other remains.

2.4.7.7 Theater mortuary evacuation point (TMEP. The primary mission of a TMEP is to evacuate all remains and accompanying personal effects to a military mortuary. TMEPs are normally located at aerial ports of embarkation. More than one TMEP may be established based on the geographic size, population, and location of units within the theater. Additional siting considerations are included in Section 3 of this manual. If MACPs and MADCPs have correctly prepared remains for shipment, the primary tasks of the TMEP are quality control, administration, and temporary storage in refrigerated containers. Accordingly, the general health, sanitation, and medical guidelines included in paragraph 2.4.7.3 are normally all that are required for TMEP operations. Joint guidelines (Joint Pub 4-06) call for evacuation of remains to a military mortuary within 24 hours. Temperature standards for refrigerated storage containers are the same as for MACP and MADCP facilities (between 34 and 37 degrees Fahrenheit).

Section 3
Site Selection

SECTION 3 - SITE SELECTION

3.1 General. BES personnel assigned to the Preventive Aerospace Maintenance (PAM) team collect and interpret data to assess adverse effects on the health of deployed personnel and the environment and recommend engineering or procedural controls, or personal protective equipment. One of your key activities will be to assist the Civil Engineers and others in various reconnaissance activities. Your participation on reconnaissance teams will help in the selection of beddown sites and facility configurations that will best meet health, hygiene, and sanitation requirements of deployed forces and minimize environmental impact. In addition, you will find that data collected during reconnaissance activities will be useful in preparation of the Water Vulnerability Assessment discussed in section 1 and the environmental health risk baseline discussed in Section 6.

3.2 Environmental Reconnaissance. Environmental reconnaissance will help deploying forces collect the data necessary to develop an environmental plan (IAW JCS Publication 4-04 and AFI 32-7006), assess environmental and health risks, and collect information for use in developing beddown facility plans and operations. Key elements of environmental reconnaissance of interest/concern to the BES are as follows.

3.2.1 Sources of Pollution. It is important to identify and avoid existing or potential sources of pollution that could impact the health and safety of deployed forces. Sources of pollution, such as, landfills, agricultural and livestock waste, industrial discharge points, sewage discharge points, petroleum sites, and past spill events are all possible areas of concern with respect to protection of ground and surface water. Warehouses, garages, storage facilities, and industrial plants located in the immediate vicinity of the proposed beddown site can increase the potential for preexisting or future pollution and should be cause for more in depth reconnaissance of the area. See Section 5 and Section 6 of this FM for information on industrial health threats and environmental baseline sampling.

3.2.2 Drainage. Proper drainage is important from a health and sanitation perspective as well as a facility construction perspective. Avoid low points or valleys that could be a focal point for water collection. Avoid flood-plains and areas with high water tables. As discussed in previous sections of this manual, many expedient, tactical, or "harvest" facilities require good drainage and/or soakage pits to assure proper operation and healthy and sanitary conditions. Select sites where the soil supports good percolation.

3.2.3 Field Contamination. The reconnaissance team should avoid selecting sites where there is evidence of field contamination. Field contamination consists of dead animals, fish or vegetation, excessive algae growth, oil slicks or sheens, sludge deposits, etc. Existing field contamination can increase the potential for disease-carrying vermin and insects as well as toxic pollutants in soil, vegetation, and ground water.

3.2.4 Potential Industrial Health Threats. The reconnaissance team should avoid selecting beddown sites in close proximity to industrial facilities and activities that produce toxic/hazardous substances or use large quantities of these substances in manufacturing processes. Such facilities could release toxic/hazardous substances as a result of damage from bombing, sabotage or industrial accidents. Typical industrial facilities/activities of concern are fertilizer plants, petroleum refineries, petroleum storage terminals, chemical plants, nuclear power plants, metals processing plants, etc. See Section 5 of this FM for more information on assessing industrial health threats.

3.2.5 Habitat for Pests and Rodents. Beddown sites should be located away from habitat that attracts pests and rodents. Tall grass and thick underbrush can be a breeding ground for ticks, fleas, and lice. Mosquitoes and gnats thrive in marshy areas and bread in standing water. Flies are attracted to and breed in areas where food and other organic matter are disposed, such as dumps, landfills, stock yards, etc.

3.2.6 Soil Characteristics and Geology. The soil characteristics and geology of potential beddown sites must also be taken into consideration. Wherever possible the team should avoid sites where the soil is extremely sandy or contains a high percentage of clay. Well-composed top soil and compacted sub-soil will improve the operation of expedient, tactical, or "harvest" facilities that should improve health and sanitation. The team should also study the geology of the area. Large quantities of rock will make it more difficult to dig latrines, sumps, drainage pits, graves, etc. Rock outcroppings are more common in hilly terrain than in flat or rolling country. The team should take enough boring samples to determine the geology of the potential beddown site.

3.2.7 Noise Pollution. Combat forces need adequate rest to maintain peak performance. Wherever possible, the team should look for potential beddown sites that will allow for some form of separation (distance or terrain or foliage buffers) between cantonment areas and flightline activities.

3.3 Source Water Selection. Selection of a water source (water reconnaissance) is one of the most important elements of the site selection process. Water source reconnaissance must be accomplished by a team that includes CE (water production and environmental) and BES personnel. CE is the POC. Appendix C includes a water reconnaissance report form that the team can use as a checklist to assure all important selection criteria are considered.

3.3.1 Factors to Consider. When choosing a raw water source, you should consider the following factors.

3.3.1.1 Quantity. Will the source provide an adequate supply of potable and non-potable water for all personnel for the expected duration of operations? Table 3-1 provides water use planning factors for determining potable as well as non-potable water consumption.

Table 3-1 - Water Use Planning Factors (AFPAM 10-219 vol. 5)

FUNCTION	WATER USAGE FACTOR (gal/person/day)
Potable Water	
Drinking	4.0
Personal hygiene	2.7
Shower	1.3
Food preparation	3.0
Hospital	1.0
Heat treatment	1.0
Non-potable Water	
Laundry	2.0
Construction	1.0
Graves registration	0.2
Vehicle operations	0.3
Aircraft operations	2.0
10 percent Loss factor	(1.5)
TOTAL	20.0

3.3.1.2 Quality.

- Is the water free of contamination such as sewage, toxic elements or compounds, or NBC warfare agents?
- Can the source be made secure against contamination by sabotage?
- Is the water objectionable due to turbidity, color, odor, or taste?
- Is the water source protected from possible organic contamination by sewage or run off from latrines, showers, industrial activities, etc.?
- Can the water be treated adequately with the resources available?

3.3.1.3 Accessibility. Is the source accessible to water purification and transport equipment?

3.3.2 Site Examination. The proposed source water site and an area within 2 miles of the site must be examined for sources of pollution and evidence of contamination. Water purification units should not be sited near areas where there is evidence of pollution or contamination.

3.3.3 Water Testing. In addition to the test requirements shown in Table 1-6, BES personnel must consider other factors when determining the suitability of each site. Factors that have the greatest short-term (acute) impact, such as microbiological quality, are of greatest importance. However, other factors such as odor, chlorine demand, watershed vegetation, organic debris in the water, the type of source, etc., must be included in the determination of suitability. BES personnel should combine good judgment with any available testing resource to determine the water quality of each site.

3.4 Site Selection for Mortuary Facilities. Section 2 of this field manual provides health and sanitation requirements for three types of mortuary facilities - the mortuary affairs collection point (MACP), the mortuary affairs decontamination collection point (MADCP), and the theater mortuary evacuation point TMEP). This subsection provides site selection criteria for the three types of facilities as well as for theater internment sites should they be needed. The reconnaissance team for siting mortuary facilities should consist of Services, CE Environmental, and BES personnel. Services is the POC.

3.4.1 MACP. Sites for MACPs, structured to provide support to a given area or major command, or to serve as an intermediate or transit point, should be chosen based on the following features: (1) Close to a main supply route; (2) ability to build a road network on site or to use an existing road network; (3) ability to build a helipad on site or to use an existing helipad; (4) close to engineer support for construction and/or maintenance of a road network and helipad; (5) close to a field landing strip or fixed airport; (6) close to transportation or aviation support; (7) accessible to fixed or mobile refrigeration containers; (8) close to source of life support and/or personnel services; (9) Close to tactical communication support; (10) ability to screen area using natural screening or screening material; and (11) terrain potential for a nearby temporary interment site.

3.4.2 MADCP. A MADCP may be prepositioned to support an operational sector in anticipation of the need to process contaminated remains or deployed to support a known contaminated area. Proximity to the contaminated area or the sector to be supported is the primary factor for site location, followed by environmental and terrain considerations. The MADCP site should be located upwind of the contaminated area. NBC staff should be consulted in picking a MADCP location, as they can advise on expected flow of contamination.

3.4.2.1 Environmental Considerations. Factors to be considered are the runoff of contaminated water and the proximity to a populated area (civilian or military). There must be enough land area to construct a sufficient number of 1000 gallon sumps and drainage systems to decontaminate the anticipated number of remains. To prevent decontamination from runoff water, the MADCP should be located at an elevation equal to or lower than surrounding populated areas and away from rivers, streams, and natural drainage.

3.4.2.2 Terrain Considerations. Natural concealment and shading, such as small hills, sand dunes, buildings, and trees, are ideal factors when planning to locate the MADCP. Proximity to a good road network and availability of landing zones and airfields is also important.

3.4.3 TMEP. Location of the TMEP is key to the overall success of its mission. Choose a site based on the following factors: (1) flight lines and helipads; (2) quick, easy access to AMC operations, transportation, and cargo and/or special handling areas; (3) ability to use existing refrigeration facilities and/or to build or install temporary fixed vans, and cold storage units; (4) ability to use an existing and/or build a road network to handle and regulate large traffic flow; and (5) ability to use existing and/or to install cooling system, ventilation system, electrical lines, phone lines, and water lines. Personnel from the site assessment team must coordinate with the area commander prior to selecting a proposed site. This is done to ensure that the proposed site will not interfere with any ongoing flight line or base operations.

3.4.4 Internment sites. The burial site should be on high ground with good drainage. Avoid areas that have high water tables or that can flood easily. The survey team should dig pilot holes to check for underlying rock formations and ease in digging.

Section 4
Nuclear, Biological, and Chemical Environmental Surveillance

SECTION 4 - NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) ENVIRONMENTAL SURVEILLANCE

4.1 General. Nuclear, biological, and chemical (NBC)-capable nations, including developing nations, may use NBC weapons to achieve political or military objectives. Weapons of mass destruction (WMD) may be used alone or in conjunction with conventional combat power. The number of nations capable of developing and possessing WMD is steadily increasing and the potential for their use can range from blackmail or acts of terrorism to conflict or war. Nuclear threats occur within a given theater of war and could proceed without the exchange of strategic nuclear weapons. Biological threats can cause lethal, disabling, contagious, or non-contagious type casualties. Chemical warfare achieves surprise and causes mass casualties that hinder the momentum of an opposing force, disrupt command, control, communications, computers, and intelligence (C4I), and degrade combat potential. This section covers the threats that may be encountered, the injuries that may be sustained, and the detection and measurement processes that must be undertaken by the BES under NBC operations.

4.2 Organization and Responsibilities. At the installation level, the CE readiness flight oversees the disaster preparedness (DP) program. The disaster response force (DRF) is the primary response organization. The DRF is made up of the disaster control group (DCG), the base command post, unit control centers, and specialized teams. The DCG coordinates and directs operations and support requirements with the command post, unit control centers, specialized teams, and coordinates with other authorities. The command post directs actions in support of the installation's assigned mission. As the focal point for base wide notification and operation, it receives and sends orders, information, and requests pertinent to the assigned task. The Disaster Preparedness Support Team (DPST) augments the CE readiness flight. DPST members work under readiness flight supervision and perform selected and critical operational tasks. The Contamination Control Teams (CCT) control contamination for mission essential functions. BES personnel may perform duties throughout the organizational structure. However, in most cases the BES:

- Detects and evaluates NBC hazards
- Determines personnel protective measures and equipment
- Advises the On Scene Commander (OSC) on evacuation requirements
- With readiness flight, determines the need for monitoring personnel, CCT procedures, and contamination control requirements
- Coordinates with the medical treatment representative regarding monitoring and decontaminating medical casualties
- Coordinates with mortuary affairs officer to determine procedures for decontaminating remains (Section 2 of this manual)

4.3 Nuclear Operations. Total nuclear war with utilization of all available nuclear weapons could result in complete devastation of the involved nations' military combat and logistic systems as well as their supporting civilian social structures and economies. However, situations short of total nuclear war are possible in which nuclear weapons could be employed in limited numbers or for a limited time, along with conventional weapons. Under such circumstances, the BES must understand the characteristics of nuclear weapons, the effects and casualties that could occur, and the detection and measurement procedures that must be employed.

4.3.1 Characteristics of Nuclear Weapons. An explosion of any type results from the very sudden release of a large amount of energy within a limited space. The rapid release of energy causes a great increase in temperature and pressure. Nuclear weapons are similar to conventional weapons because their destructive power is due primarily to blast or shock. However, nuclear detonations can be thousands of times more powerful than the largest conventional explosions. In addition, nuclear detonations release ionizing radiation and much more intense thermal radiation. The total energy released from a nuclear explosion is distributed as shown in Figure 4-1 .

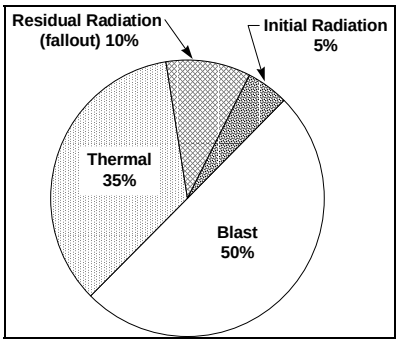


Figure 4-1 - Energy Distribution

4.3.1.1 Blast wave**.** As a result of the very high temperatures and pressures at the point of detonation, hot gaseous residues move outwardly from the center of the explosion with very high velocities. The strength of the blast wave steadily decreases as it moves through the air away from the blast center. A large part of the destruction caused by a nuclear explosion is due to blast effects. Objects within the path of the blast wave are subjected to severe, sharp increases in atmospheric pressure and to extraordinarily severe winds. After the shock front has traveled a certain distance, the pressure behind the front drops below atmospheric pressure. At this point the air is sucked in toward the fireball of the explosion. So the blast associated with a nuclear explosion first travels outwardly from the blast center and then inwardly back to the center. Blast overpressure of five psi over normal atmospheric pressure (14.7 psi at sea level) will destroy buildings and even damage concrete and steel reinforced structures.

4.3.1.2 Thermal radiation**.** Large amounts of electromagnetic radiation in the visible, infrared, and ultraviolet regions of the electromagnetic spectrum are emitted from the surface of the fireball within the first minute or less after detonation. This thermal radiation travels outward from the fireball at the speed of light, 300,000 km/sec. The chief hazard of thermal radiation is the production of burns and eye injuries in exposed personnel. Such thermal injuries may occur even at distances where blast and initial nuclear radiation effects are minimal. Absorption of thermal radiation will also cause the ignition of combustible materials and may lead to fires that then spread rapidly among the debris left by the blast. The range of thermal effects increases markedly with weapon yield.

4.3.1.3 Initial radiation**.** As indicated in Figure 4-1 , about 5 percent of the energy released in a nuclear air burst is transmitted as initial neutron and gamma radiation. The neutrons result almost exclusively from the energy producing fission and fusion reactions, while the initial gamma radiation includes that arising from these reactions as well as that resulting from the decay of short-lived fission products. The intensity of initial nuclear radiation decreases rapidly with distance from the point of burst due to the spread of radiation over a larger area as it travels away from the explosion, and to absorption, scattering, and capture by the atmosphere. The character of the radiation received at a given location also varies with distance from the explosion. Near the point of the explosion, the neutron intensity is greater than the gamma intensity, but with increasing distance the neutron-gamma ratio decreases. Ultimately, the neutron component of initial radiation becomes negligible in comparison with the gamma component. The range for significant levels of initial radiation does not increase markedly with weapon yield.

4.3.1.4 Residual radiation**.** Residual radiation hazard from a nuclear explosion is in the form of radioactive fallout and neutron-induced activity. Residual ionizing radiation arises from:

- Fission products. These are intermediate weight isotopes that are formed when a heavy uranium or plutonium nucleus is split in a fission reaction. There are over 300 different fission products that may result from a fission reaction. Many of these are radioactive with widely differing half-lives. Some are very short, i.e., fractions of a second, while a few are long enough that the materials can be a hazard for months or years. Their principal mode of decay is by the emission of beta and gamma radiation.
- Unfissioned nuclear material. Nuclear weapons are relatively inefficient in their use of fissionable material, and the explosion without undergoing fission disperses much of the uranium and plutonium. Such unfissioned nuclear material decays by the emission of alpha particles and is of relatively minor importance.

- Neutron-induced material. Induced radioactive material is created when soil and debris are drawn up into the mushroom cloud. Intense irradiation causes the material to become radioactive and emit beta and gamma radiation. As the vaporized materials in the mushroom cloud cool, the materials solidify and fall to the earth as radioactive fallout particles.

4.3.2 Fallout. The characteristics and intensity of fallout will vary depending on atmospheric conditions and the type of blast. Atmospheric conditions such as precipitation and wind speed and direction at different altitudes will influence fallout. Fallout particles of visual size should descend for about 24 hours after the blast. This is referred to as early or local fallout. The remaining very small particles will descend very slowly over large areas. This is called delayed or worldwide fallout. The amount of fallout depends greatly on the height of the blast above the earth's surface. The closer the blast to the surface the greater the fallout.

4.3.3 Types of Bursts. The blast, thermal radiation, nuclear radiation, and fallout of a nuclear weapon detonation vary with the location of the detonation in relation to the surface of the earth. Selection of the type of burst is determined by the desired effects, the type of target, the method of delivery, and many other variables. Nuclear detonations generally are classified as air bursts, surface bursts, subsurface bursts, and high-altitude bursts.

4.3.3.1 Air bursts. An air burst is defined as a nuclear detonation in which no part of the fireball touches the earth's surfaces. Nearly all of the energy of an air burst is emitted as blast and thermal energy that travel great distances. Characteristics of an air burst are:

- Maximum initial radiation
- Maximum blast effect over a large area
- Maximum thermal effect over a large area
- Reduced fallout

4.3.3.2 Surface bursts. A surface burst is a detonation in which the fireball comes in contact with the earth's surface, causing severe cratering at ground zero. Soil, buildings, terrain features, and denser air absorb much of the blast, thermal energy, and initial radiation. The greatest effect is in the form of residual radiation caused by the surface material that is sucked into the fireball, irradiated and then returned to earth as fallout. Characteristics of a surface burst are:

- Maximum fallout over a large area
- Reduced initial nuclear radiation
- Reduced thermal radiation
- Reduced blast effect
- Cratering effect at ground zero
- **4.3.3.3** Subsurface bursts. With a subsurface burst, the detonation takes place beneath the surface of the earth or the water. Most of the energy from a subsurface burst is released as shock. Depending on the depth of the detonation, the blast wave may push rock and debris through the earth surface. This is referred to as venting. Venting normally results in extremely heavy but localized residual radiation. Characteristics of a surface burst are:
- Short range surface shock
- Severe subsurface shock
- Negligible thermal radiation
- Negligible initial nuclear radiation
- Extremely heavy local residual radiation

4.3.3.4 High-altitude burst. A high-altitude burst is one that occurs over 100,000 feet above the earth's surface. Blast energy, thermal and initial radiation as well as fallout that reaches the earth's surface are all minimal. All nuclear detonations produce significant electromagnetic energy in the form of electromagnetic pulse (EMP). However, high-altitude bursts produce the most EMP. EMP is very destructive to electrical systems. A high-altitude burst could cause EMP damage over millions of square kilometers.

4.3.4 Biological Effects of Nuclear Explosions. In order to effectively detect and monitor the effects of nuclear detonations and advise the command staff on exposure limits and decontamination requirements, the BES must understand the biological effects of nuclear explosions. The previous subsections described the physical characteristics of nuclear explosions. The following subsections consider the biological effects.

4.3.4.1 Blast wave. There are two basic types of blast forces - overpressure and wind drag.

4.2.4.1.1 Overpressure. When overpressures act directly upon a resilient target such as the human body, rapid compression and decompression result in transmission of pressure waves through the tissues. These waves can be quite severe and will result in damage primarily at junctions between tissues of different densities (bone and muscle) or at the interface between tissue and air spaces. Lung tissue and the gastrointestinal system, both of which contain air, are particularly susceptible to injury. The resulting tissue disruptions can lead to severe hemorrhage or to air embolism, either of which can be rapidly fatal. The range of overpressures associated with lethality can be quite variable. It has been estimated that overpressures as low as 1.9 atmospheres (atm) can be lethal, but that survival is possible with overpressures as high as 2.5 atm. The probabilities of death from various overpressures are summarized in Table 4-1. The significant thing shown by the data in Table 4-1 is that the human body is remarkably resistant to static overpressure, particularly when compared with rigid structures such as buildings. Shattering of an unreinforced cinder block panel, for example, will occur at 0.1-0.2 atm.

Table 4-1 - Probability of Death Vs Peak Overpressure (Army FM 8-9)

Probability of Death (approximate %)	Peak Overpressure (atm)
1	1.6 - 2.2
50	2.2 - 3.9
100	3.9+

4.3.4.1.2 Wind drag. The drag forces of the blast winds are proportional to the velocities and duration times of those winds, that in turn vary with distance from the point of detonation, yield of the weapon, and altitude of the burst. These winds are relatively short in duration but are extremely severe. They can be much greater in velocity than the strongest hurricane winds and may reach several hundred miles per hour. Considerable injury can result, from objects (missiles) that are propelled by the wind or from human bodies being blown against objects and structures in the environment. Table 4-2 shows the distances from the center of nuclear blasts at which you can expect serious injuries to occur from objects that are being propelled by the wind as missiles. Table 4-3 shows the probability of translational injuries at various wind velocities. Translational injuries are injuries resulting from a human body being propelled into non-yielding surfaces. Table 4-4 shows the distances from ground zero at which a 154 pound human body can be blown at various velocities by various weapon yields. Table 4-3 and Table 4-4 can be used together to estimate the probability of serious injuries to the human body resulting from wind drag.

4.3.4.1.3 Blast wave injuries. Missile injuries will predominate. About half of the patients seen will have wounds of their extremities. The thorax, abdomen, and head will be involved about equally. Missile injuries of the thorax, neck, and the head will be responsible for a large percentage of deaths because these types of injuries have a high probability of immediate fatality. Generally, missile injuries caused by nuclear weapons will be of the low velocity type. Severe injuries may be survived since extensive soft tissue cavitation would not be a factor. These injuries can occur with or without perforating wounds of the abdomen or the chest.

4.3.4.2 Thermal radiation. The thermal radiation emitted by a nuclear detonation causes burns in two ways, by direct absorption of thermal energy through exposed surfaces (flash burns) or by the indirect action of fires caused in the

environment (flame burns). If a nuclear weapon detonation occurs in easily flammable surroundings, indirect flame burns could outnumber all other types of injury.

Table 4-2 - Range From Ground Zero and Probability of Injuries (Army FM 8-9)

Yield (Kt)	Range for 1 Percent Probability of Serious Injury (miles)	Range for 50 Percent Probability of Serious Injury (miles)	Range for 99 Percent Probability of Serious Injury (miles)
1	0.17	0.14	0.11
10	0.45	0.35	0.27
20	0.61	0.47	0.36
50	0.87	0.68	0.52
100	1.18	0.93	0.68
200	1.55	1.18	0.93
500	2.24	1.68	1.30
1000	2.98	2.24	1.68

Table 4-3 - Percent Probability of Translational Injuries (Army FM 8-9)

Velocity of Body (miles/hr)	Probability of Blunt Injuries & Fractures	Probability of Death
5.8	>1%	-
14.8	50%	>1%
38	99%	50%
99.5	-	99%

Table 4-4 - Wind Drag Effects on a 154-Pound Human Body (Army FM 8-9)

	Velocity of Body		
Yield (Kt)	**5.8 (miles/hr)**	**14.8 (miles/hr)**	**38 (miles/hr)**
1	0.24	0.17	0.12
10	0.62	0.47	0.33
20	0.81	0.62	0.44
50	1.18	0.87	0.62
100	1.55	1.18	0.87
200	1.99	1.55	1.18
500	2.86	2.24	1.68
1000	3.67	2.98	2.24

4.3.4.2.1 Flash burns. Thermal radiation travels in a straight line from the fireball. The amount of thermal energy decreases rapidly with distance. Close to the fireball the thermal output will be so great that all objects will be incinerated. The actual range out to which overall lethality would be 100 percent will vary with yield, position of burst, weather, the environment and how soon those burned can receive medical care. The dose of thermal radiation to exposed skin required to cause a flash second-degree burn will vary depending on the yield of the weapon and the distance from ground zero (Table 4-5). While most thermal injury predictions are based on exposed skin, it is important to understand that clothing can provide added protection from thermal radiation. The BDU provides approximately twice the protection of bare skin. The chemical ensemble provides approximately four times the protection of bare skin.

Table 4-5 - Distance From Ground Zero vs Burns to Bare Skin (Army FM 8-9)

Yield	Distance for Production of Second Degree Burns (miles)
1 Kt	.48
10 Kt	1.3
100 Kt	2.9
1 Mt	5.7
10 Mt	9

4.3.4.2.2 Flame burns. Indirect or flame burns result from exposure to fires caused by the thermal effects upon the environment. The probability of flame burns cannot be quantified as well as can flash burns. The variables of environmental flammability are too great to allow prediction of either incidence or severity. The burns themselves will be far less uniform in degree and will not be limited to exposed surfaces. For example, the respiratory system may be exposed to the effects of hot gases produced whenever extensive fires occur. Respiratory system burns are associated with severe morbidity and high mortality rates.

4.3.4.2.3 Thermal injuries. Expect first, second, and third degree burns to the whole body and critical organs; i.e., head and neck, respiratory tract, genitalia, hands, and feet.

4.3.4.2.4 Eye injuries. The effects of thermal/visual radiation on the eyes fall into two main categories, temporary flash blindness and permanent retinal scarring. The initial brilliant flash of light produced by the nuclear detonation causes flash blindness. More light energy is received on the retina than can be tolerated, but less than is required for irreversible injury. During the daylight hours, flash blindness does not persist for more than about 2 minutes, but generally is of the order of seconds. At night, when the pupil is dilated for dark adaptation, flashblindness will affect personnel at greater ranges and will last for longer periods of time. Figure 4-2 illustrates separation distances and the potential for flashblindness and retinal burns as a function of explosion yield.

4.3.4.3 Ionizing radiation. Blast and thermal injuries in many cases will far outnumber radiation injuries. However, radiation effects are considerably more complex and varied than are blast or thermal effects and are subject to considerable misunderstanding. A wide variety of ionizing radiation can interact with the body. However, there are only four types of radiation associated with atmospheric and underground nuclear detonations that are of significance. In order of importance, they are gamma, neutron, beta, and alpha.

4.3.4.3.1 Gamma radiation. Gamma radiation, emitted during the nuclear detonation or later in fallout, is highly energetic. About 75 percent of the photons will interact with target tissue. If the gamma photon flux is high and the whole body is exposed, a fairly homogeneous deposition of energy will occur. This is in marked contrast to the highly localized energy deposition pattern of alpha and beta radiations.

4.3.4.3.2 Neutron radiation. Neutrons are uncharged particles and can react only with the nuclei of target atoms. The probability of neutron radiation from a fission explosion is roughly comparable to that of low-energy gamma photons. Therefore, neutron radiation can result in whole-body irradiation. The energy deposition will not be uniform, and the side of the body that faces the detonation will absorb more energy than the opposite side. Assuming an equal dose, neutron radiation has been found to be less incapacitating than gamma radiation.

4.3.4.3.3 Beta radiation. High speed electrons in the form of beta radiation lose most of their energy after penetrating only a few millimeters of tissue. If the beta emitting material is on the surface of the skin, the resulting beta irradiation causes damage to the basal stratum of the skin. The lesion is similar to a superficial thermal burn. However, if the beta material is incorporated internally, the beta radiation can cause much more significant damage. The damage will be in spheres of tissue around each fragment or source of radioactive material. The total damage is a function of the number of sources and their distribution in the body.

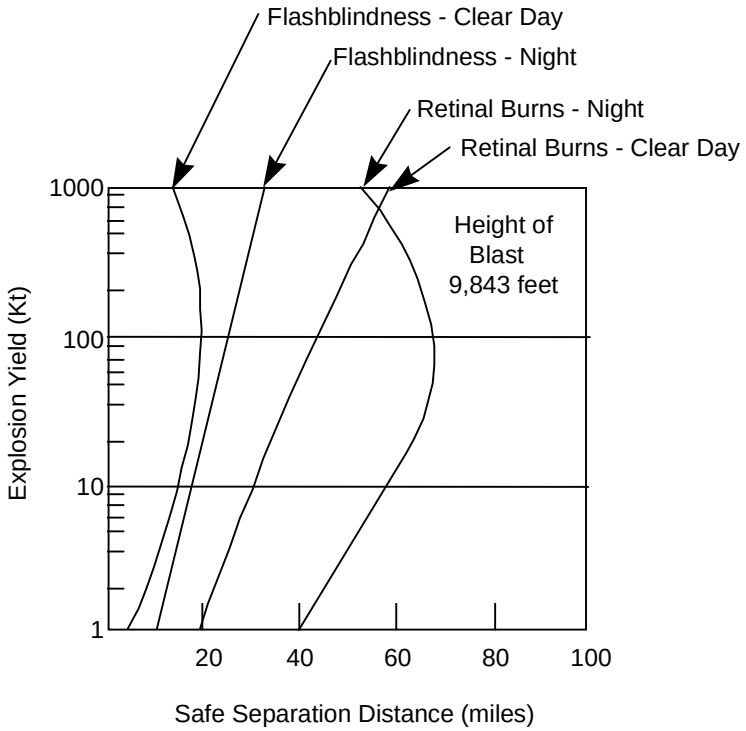


Figure 4-2 - Safe Separation Distance and Potential for Flashblindness or Retinal Burns (Army FM 8-9)

4.3.4.3.4 Alpha radiation. The energy of these relatively heavy positively charged particles is fully absorbed within the first 20 micrometers of exposed tissue. Because of this, alpha radiation is not an external hazard. If alpha-emitting material is internally deposited, all the radiation energy will be absorbed in a very small volume of tissue immediately surrounding each particle. The cells immediately adjacent to the source are killed. However, most tissues with a reasonable reserve can tolerate the loss of a few cells quite readily. Therefore, although internal alpha radiation can be lethal to individual cells, the overall acute hazard is small.

4.3.4.4 Radiation injuries. Radiation injury can result from a single exposure at the time of nuclear detonation, from exposure to high levels of fallout, or from repeated exposures to both. Whole-body irradiation, where absorbed doses are high and acquired over short periods of time, will result in acute radiation sickness. There are three characteristic syndromes that make up the typical clinical pattern of acute radiation sickness. These are the hematopoietic, gastrointestinal, and neurovascular syndromes that occur with increasing dose respectively.

4.3.4.4.1 Hematopoietic syndrome. Hematopoietic syndrome, or syndrome of bone-marrow depression, occurs at lower doses than the others and would be the most common form of radiation sickness seen in nuclear combat. Manifestations of bone-marrow depression are seen following doses of radiation in the low through midlethal range.

4.3.4.4.2 Gastrointestina syndrome. As the probability of lethality becomes 100 percent with higher doses, the gastrointestinal syndrome will predominate. This syndrome, which will also be common, develops from combined severe damage to bone marrow and the gastrointestinal tract.

4.3.4.4.3 Neurovascular syndrome. The neurovascular syndrome is associated with absorbed doses in the supralethal range and would be seen quite rarely since heat and blast effects would cause immediate lethality in most situations where the required very high radiation doses would be sustained. Exceptions could occur in aircrews exposed to prompt nuclear radiation from high altitude detonations and personnel protected against heat and blast in hardened sites below the surface or personnel in vehicles or shelters in the proximity of enhanced weapons' detonations. In these circumstances, an increase in the numbers of casualties receiving radiation doses in the supralethal range can be expected.

4.3.4.5 Signs and symptoms. Table 4-6 shows expected symptoms and prognoses resulting from various doses of radiation.

Table 4-6 - Radiation Doses and Symptoms/Prognoses (Army FM 8-9 and 90750 CDC)

Dose (rads)	Symptoms/Prognoses
50	No visible effects.
75-100	Brief periods of nausea and vomiting on day of exposure in 10 percent of exposed personnel.
200-300	50 percent of exposed personnel may experience some symptoms of radiation sickness (anorexia, fatigue, weakness, fever, infection). 5 percent to 10 percent may require medical attention. No deaths expected.
450-550	Serious radiation sickness in most exposed personnel (previous symptoms plus bleeding and ulceration). Expect 50 percent to die in two to four weeks.
600+	Serious radiation sickness in all exposed personnel (previous symptoms plus dizziness, disorientation, fluid loss, electrolyte imbalance, headache, fainting, prostration). Expect all to die in one to three weeks.

4.3.5 Detection and Measurement. The pocket dosimeter, ADM-300 multifunction survey meter with accessories, and Staplex air sampler are the three primary pieces of radiation detection, measurement, and computation (RADIAC) equipment used by the US Air Force.

4.3.5.1 Pocket dosimeters. Ionization chambers measure dose and dose rate from gamma and x-radiations. A typical ionization chamber that measures total dose is the pocket dosimeter. It is the size of a large fountain pen (See Figure 4-3). It has a chamber containing two electrodes, one of, which is a quartz fiber loop free to move with respect to its mounting. Radiation entering the chamber causes ionization within the sensitive volume. The distance the fiber moves is proportional to the dose received in the chamber. Instruments of this type are sensitive to severe shock and humidity and small enough to be worn comfortably. The great advantage of this type of instrument is that it can be read at any time without the aid of a supplementary charger-reader by simply holding it up to a source of light and looking into it. Personnel wear pocket dosimeters to determine the radiation dose that is received when they are required to work in the presence of ionizing radiation. Dosimeters can also be used to monitor dose rates either inside or outside fallout shelters.

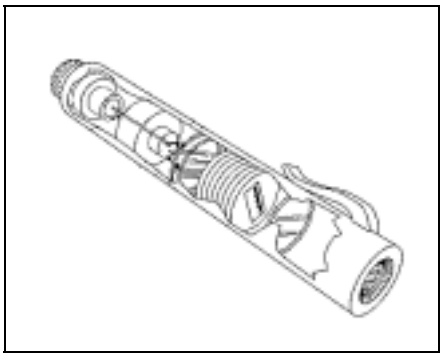


Figure 4-3 - Pocket Dosimeter

4.3.5.2 Geiger-Mueller counters. There are a number of radiation measurement devices employed within the DoD. Most are categorized as Geiger-Mueller (G-M) counters. G-M counters are normally used for detecting single ionizing events that take place within the sensitive volume of the counter. They are very rugged and sensitive to low levels of radiation. They usually emit audible “clicks” when radiation is detected. The Air Force has standardized on the ADM-300 Multifunction Survey Meter (Figure 4-4). The ADM-300 uses G-M technology. The unit is microprocessor-based. The processor controls all functions including detection, calculation, compensation, and display. The ADM-300 employs a low-range G-M tube that spans a range of 10 uR/hr to 5 R/hr. The high-range

tube spans a range of 5 R/hr to 10,000 R/hr. The unit can be equipped with five probes - alpha, beta, gamma, neutron, and x-ray (Figure 4-5). Since you may operate in a joint environment, it is important that you at least be aware of some of the other RADIAC equipment used within the DoD. The AN/PDR-77 is a suitcase sized unit similar to the ADM-300. It detects and measures alpha, beta, gamma, and x-ray radiation. The AN/VDR-2 is designed to perform ground radiological surveys. It can be used in a vehicle or in the dismounted mode as a hand held instrument. It detects, measures, and displays beta and gamma radiation. The CP-696/PDR-75 is a portable rugged monitor designed to record the exposure of individual personnel to gamma and neutron radiation. It is used in conjunction with the DT-236/PDR-75 dosimeter. This device is worn like a wrist watch. When personnel return from a mission where exposure to radiation was likely, they simply insert the dosimeter into the CP-696 reader that displays the cumulative radiation dose. The AN/UDR-13 is a compact hand held or pocket carried tactical device. It is capable of measuring gamma/neutron dose from a nuclear event plus gamma dose and dose-rate from fallout in a tactical battlefield situation. It has digital display and can detect neutron/gamma radiation and fallout in the 0.1 to 999 cGy range.

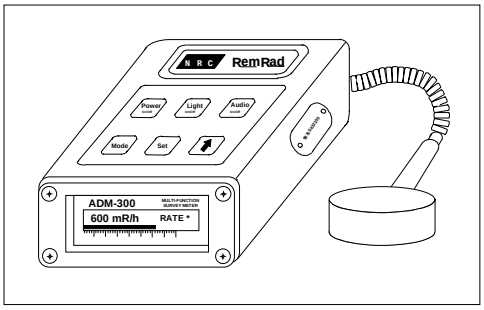


Figure 4-4 - ADM-300 Multifunction Survey Meter

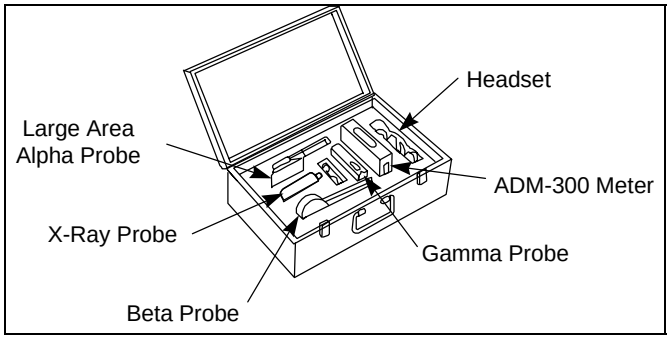


Figure 4-5 - ADM-300 and Accessories

4.3.5.3 Staplex air sampler. The Staplex air sampler (Figure 4-6) is used in conjunction with the ADM-300 to measure airborne alpha radiation. The Staplex sampler can be used to measure background radiation as well as elevated radiation within contaminated areas. It is normally used to determine the need for respiratory protection for personnel who must work within contaminated areas. The Staplex can use two different sizes of filter paper - 8” x 10” or 4” round. However, since in this case, bigger is better, most BES offices stock the 8” x 10” filter paper. The measurement process is the same whether taking a background reading or an actual reading. The Staplex is normally mounted on a tripod at the 5-foot level facing into the wind. Note: in the case of a nuclear accident (e.g., crashed aircraft), primary air samples are taken every 90 degrees around the accident site. Secondary air samples are taken 82 feet (25 meters) downwind from the site, and further downwind depending on the wind speed (Table 4-7).

Table 4-7 - Secondary Air Sampling Distances Based on Wind Speed (90750 CDC)

Wind Speed	Distance From Site
6-10 MPH (4-9 knots)	3,500 feet (1,000 meters)
11-15 MPH (10-13 knots)	5,100 feet (1,500 meters)
16-20 MPH (14-17 knots)	6,700 feet (2,000 meters)
Above 20 MPH (above 17 knots)	8,400 feet (2,500 meters)

The Staplex is run for about 20 minutes or until 1000 cubic feet of air has been pulled through the sampler. The ADM-300 meter with alpha probe is used to measure the amount of contamination that has been absorbed by the filter paper. The reading is taken in counts per minute (cpm). The alpha probe is run diagonally across the filter paper two times. The value for cpm is the average of the two readings. After you determine the cpm for each sample, you must calculate the disintegrations per minute per cubic meter (dpm/m^3). The following formula is used:

$$\mathbf{dpm/m^3} = \frac{\mathbf{cpm \times 35.3 \times Af}}{\mathbf{0.5 \times Ef \times F \times Ec \times Ac \times V}}$$

Where:

cpm = counts per minute
35.3 = conversion factor for feet^3 per meter^3
Af = collection area of Staplex filter paper in cm^2
Ef = collection efficiency of filter paper
F = self absorption factor of filter paper
Ec = counting efficiency of ADM-300
Ac = active detection area in cm^2 of alpha probe
V = total volume of air that passed through Staplex (ft^3)
[V = flow rate in cfm (Fr) x sampling time in min (T)]

Notes: The Staplex filter holder reduces the collection area of 8" x 10" filter paper from 516 cm^2 to 406 cm^2 . The self absorption factor of the filter paper is 50 percent (0.5). The collection efficiency varies according to the size of the particles being collected (approximately 0.5 for one micron particles). The counting efficiency of the ADM-300 alpha probe is 30 percent (0.3). The active area of the ADM-300 alpha probe is 92 cm^2.

Example: An air sample was taken using a Staplex sampler equipped with 8" x 10" filter paper. A reading of 800 cpm was obtained using an ADM-300 alpha probe. The Staplex maintained a flow rate of 50 cfm over a 30 minute sample time.

$$\mathbf{dpm/m^3} = \frac{\mathbf{cpm \times 35.3 \times Af}}{\mathbf{0.5 \times Ef \times F \times Ec \times Ac \times Fr \times T}}$$

$$\text{dpm/m}^3 = \frac{800 \times 35.3 \times 406}{0.5 \times 0.5 \times 0.5 \times 0.3 \times 92 \times 50 \times 30} = 2216 \text{ dpm/m}^3$$

Since the Air Force has standardized on the Staplex sampler and ADM-300, you can combine the constants and simplify the formula. If you use 8" x 10" filter paper a good round number is 4200. The formula then becomes:

$$\mathbf{dpm/m^3} = \frac{\mathbf{cpm \times 4200}}{\mathbf{Fr \times T\ (min)}}$$

Remember to subtract the background radiation from your results. Table 4-8 provides respiratory protection requirements for various ranges of airborne alpha concentrations. Table 4-9 shows permissible exposures to airborne Plutonium-239.

Table 4-8 - Respiratory Protection Based on Airborne Alpha Contamination (90750 CDC)

Airborne Alpha Concentration	Respiratory Protection
Below 100 dpm/m^2	None
100 - 10,000 dpm/m^2	Full-face with high efficiency particulate air filter (HEPA) such as M-17
Above 10,000 dpm/ m^2	Self-contained breathing apparatus

Table 4-9 - Permissible Exposures to Airborne Plutonium-239 (90750 CDC)

Individual Exposed	Exposure Hours per Week	Concentration dpm/m^2
Radiation workers (cleanup crew, monitors)	168 (continuous)	22
	40	66
	20	133
	10	266
	5	533
	2	1066
	1	2220
General public	168 (continuous)	2
	12	22
	6	44

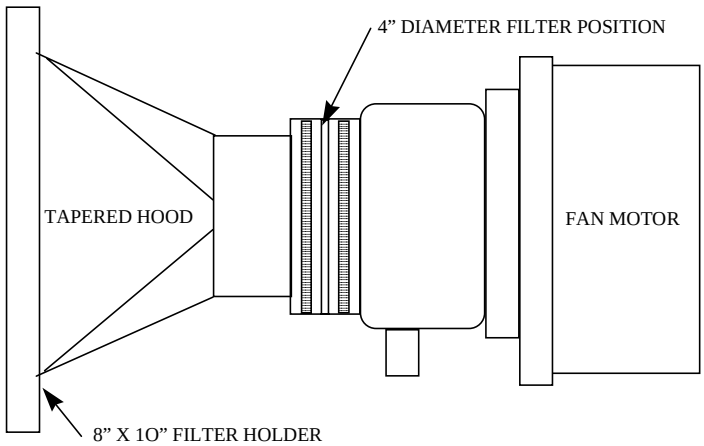


Figure 4-6 - Staplex Air Sampler (90750 CDC)

4.3.6 Exposure Control. Shielding is the best way to protect personnel from exposure to radiation. Material is available on the battlefield to construct/prepare expedient fallout shelters that offer substantial shielding against gamma radiation (see Table 4-10). Generally, the denser or heavier the material, the better shielding it offers. The degree of protection afforded by a fallout shelter is expressed as a "protection factor," or a "transmission factor." The protection factor is simply the fraction of the available radiation dose that penetrates the shelter and reaches those inside compared to the radiation received by an unprotected person. Thus, a protection factor of 2 indicates that an individual in the shelter receives one-half of the radiation dose he would receive if unprotected. A protection factor of 100 (associated with about six half-value thicknesses) indicates that only 1/100 or 1 percent of the radiation dose reaches those inside. Transmission factors, expressed in percentages or in decimals, refer to that fraction of the ambient unshielded dose that is received by personnel within the shelter. Fallout gamma transmission factors for some common shelters are shown in Table 4-11. Even with the most effective shielding possible, exposure control management is a major responsibility of the BES. Commanders must be given a means for monitoring and controlling the amount of radiation exposure personnel receive. This is done by exposing personnel only when necessary, ensuring exposures are kept within established minimums, and evenly distributing exposures among workers. There are five factors influencing the injuries caused by nuclear radiation.

- The total dose accumulated from previous exposures
- Periods over which doses are received
- Periods of recuperation between periods of exposure

- Physical condition, sex, and age of the individual
- The presence of other injuries

Table 4-10 - Shielding Potential of Common Material (Army FM 8-10-7)

Material	½ Value Layer Thickness*
Steel	0.7” (1.8 cm)
Concrete	2.2” (5.6 cm)
Earth	3.3” (8.4 cm)
Water	4.8” (12.2 cm)
Wood	8.8” (22.4 cm)

* ½ Value Layer Thickness: The thickness of a given material that reduces the dose or dose rate by approximately one-half

Table 4-11 - Transmission Factors for Nuclear Radiation (Army FM 8-10-7)

Shield	Neutrons	Initial Gamma	Residual
Built up city area (in open)	1.0	0.5	0.7
Foxhole	0.3	0.2	0.1
Frame house			
First floor	1.0	0.9	0.5
Basement	0.5	0.3	0.1
Multistory buildings			
Top floor	1.0	0.9	0.1
Intermediate floors	0.9	0.9	0.02
Lower floor	0.9	0.9	0.1
Basement	0.5	0.5	0,01
Earth covered shelter	0.05	0.02	0.005
Wooded forest	1.0	1.0	0.8

For planning purposes, 200 rads of accumulated dosage are used as the acceptable upper limit for personnel. This limit could be received during a one-time exposure, but it is much better to spread out the exposure over time. Following a nuclear explosion, all personnel will report to assigned shelters. After fallout arrives, radiation intensities must be plotted constantly. The information derived from the plots is used by command to determine exposure levels to personnel and to judge the impact on war fighting capabilities. Radiation intensity is measured by personal dosimeters, radiation, detection, and computation (RADIAC) equipment, or air samplers. Dose rates are calculated manually or by computer and exposure control personnel document doses received by individuals on exposure history forms.

4.3.6.1 Fallout radiation levels. Before doses and stay times can be determined, accurate assessments of fallout radiation levels must be made. To effectively control exposures, you must know the current levels and be able to estimate previous and future levels. The following formulas are used.

Fallout decay formula

$$I_1 t_2^{-1.2} = I_2 t_1^{-1.2}$$

Where:

I_1 = radiation intensity at time one in roentgens per hour (R/hr)
t_2 = time two in hours after the burst
I_2 = radiation intensity at time two in R/hr
t_1 = time one in hours after the burst

Example: A burst occurred at 0700. The measured fallout level at 1000 (3 hours after the burst [H+3]) was 268 R/hr. Estimate the fallout at 1400 (7 hours after the burst [H+7]).

$\mathbf{I_1}$ = 268 R/hr
$\mathbf{t_2}$ = 7 hr
$\mathbf{I_2}$ = unknown
$\mathbf{t_1}$ = 3 hr

$$\mathbf{I_1 t_2^{-1.2} = I_2 t_1^{-1.2}}$$

$$268 \times 7^{-1.2} = I_2 \times 3^{-1.2}$$

$$I_2 = \frac{268 \times 7^{-1.2}}{3^{-1.2}} = \frac{268 \times 0.097}{0.268} = 97 \text{ R/hr}$$

In many cases it is important to know the *standard dose rate* (R_1) which is the fallout intensity at 1 hour after the burst (H+1). Since fallout will not have completed falling in 1 hour, R_1 is a theoretical value.

$$\mathbf{R_1 = R_t / t^{-1.2}}$$

Where:

$\mathbf{R_1}$ = dose rate at 1 hour after the blast
$\mathbf{R_t}$ = a measured dose rate in R/hr
t = time in hours after the burst when the dose rate ($\mathbf{R_t}$) was measured

Example: Find the fallout at H+1 if the actual measured fallout at H+3 was 268 R/hr.

$\mathbf{R_t}$ = 268 R/hr at 3 hours after the blast
t = 3 hrs
$\mathbf{R_1}$= unknown

$\mathbf{R_1 = R_t / t^{-1.2}}$ = $268/3^{-1.2}$ = 1000 R/hr (at 1 hour after the burst)

Once you have the fallout rate at H+1, you can calculate the fallout rate at any other time using the same formula.

Example: If the fallout intensity was 1000 R/hr at H+1, what will the fallout intensity be at H+7?

$\mathbf{R_1}$ = 1000 R/hr at 1 hour after the blast
$\mathbf{R_t}$ = unknown
t = 7 hrs

$$\mathbf{R_1 = R_t / t^{-1.2}}$$

$\mathbf{R_t = R_1 \times t^{-1.2}}$ = $1000 \times 7^{-1.2}$ = 97 R/hr (at 7 hours after the burst)

Once you have determined the fallout intensity at two different times, you can estimate intensities at other times using a logarithmic fallout plot (Figure 4-7). Simply plot the two known intensities, draw a line between the points and extend the line in both directions. Now you can find the estimated intensity at any time after the burst. Figure 4-8 shows a fallout decay nomogram that provides another way to estimate fallout intensities. Lay a ruler across the nomogram so that it lines up with the example 268 R/hr point on the line at the left marked DOSE RATE AT H+t (R_t). Hold the ruler steady on this point and rotate the right end of the ruler so it lines up with the three-hour point on the middle line marked TIME AFTER BURST. The value where the ruler crosses the line at the right

should be 1000 R/hr, the dose rate at H+1. Once you have the fallout rate at H+1, you can find the fallout rate at any other time by placing the ruler on the value at H+1 on the right line and rotating the left end of the ruler until it lines up with the time of interest on the middle line. Where the ruler crosses the line at the left read the fallout rate for the time of interest.

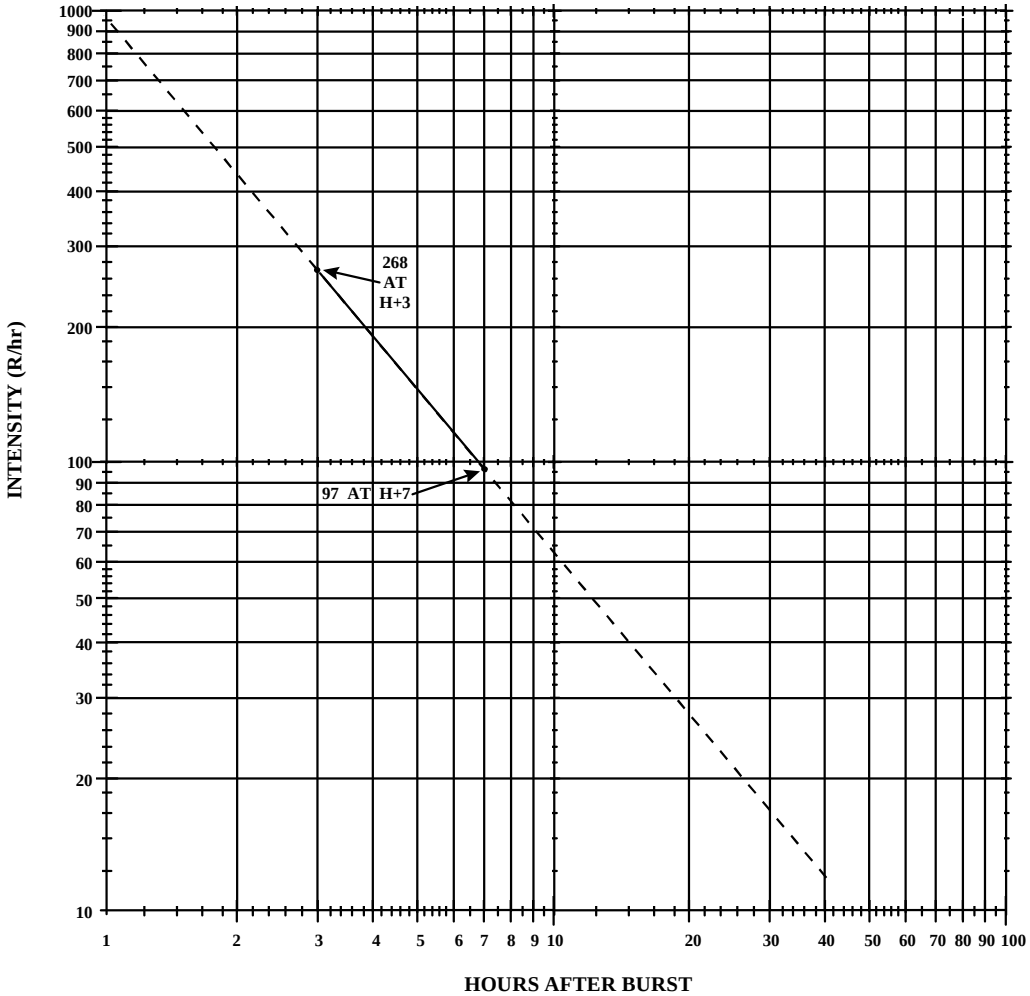


Figure 4-7 - Logarithmic Fallout Plot (90750 CDC)

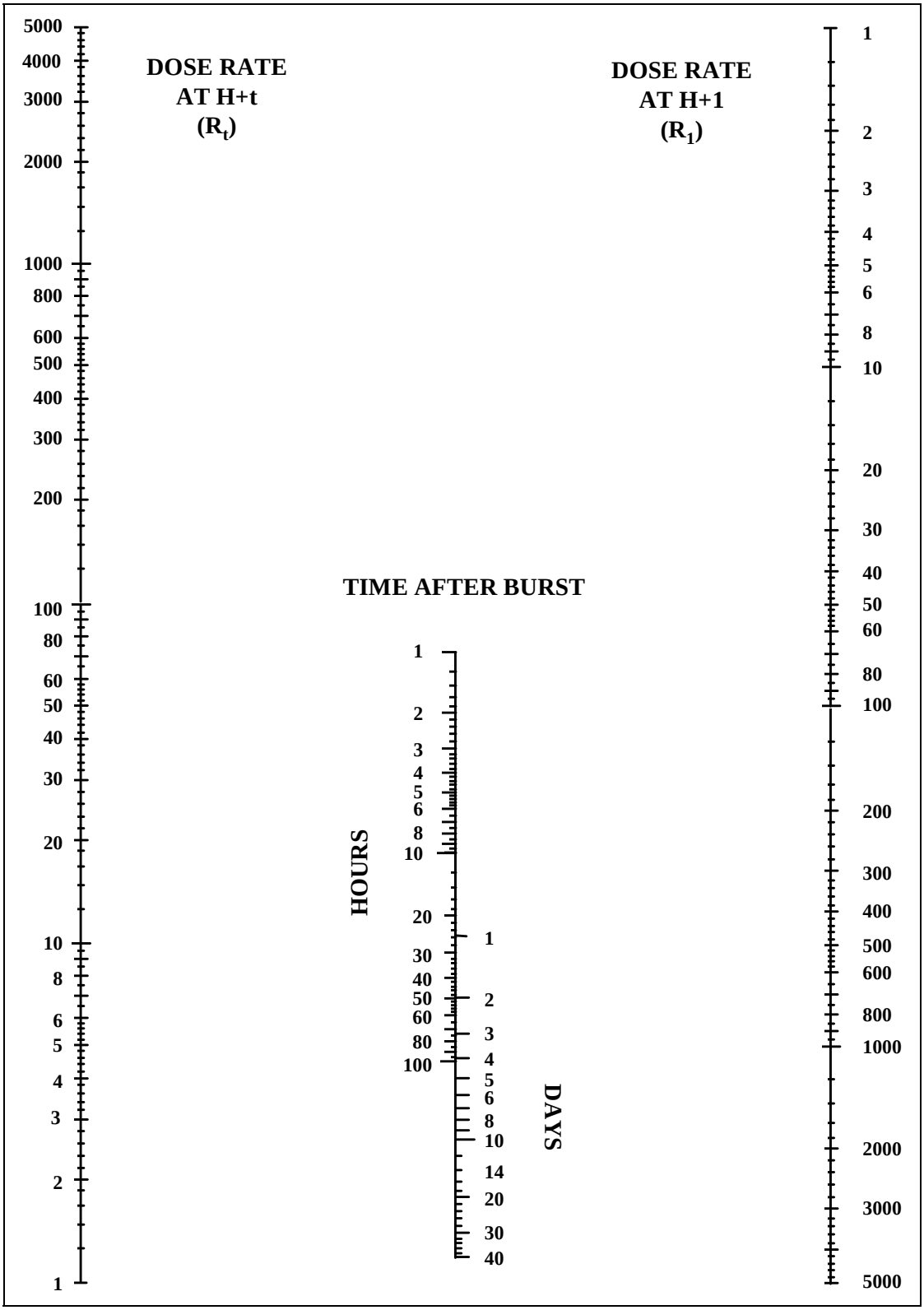


Figure 4-8 - Fallout Decay Nomogram (90750 CDC)

4.3.6.2 Dose calculations. The best way to determine actual dose is through the use of pocket dosimeters (Figure 4-3). Select a person who has to leave the shelter to perform a mission and have he/she wear a dosimeter. When this is not possible, the following formula can be used to calculate doses.

$$\mathbf{D} = \frac{(\mathbf{R_1} + \mathbf{R_2}) \times \mathbf{t}}{\mathbf{2}}$$

Where:

D = dose in rads
R_1 and R_2 = fallout intensities in R/hr at the beginning and end of exposure
t = time of exposure in hours

Example: find the dose in rads that a person received who went out of the shelter for 1 hour starting at H+3 to refuel an airplane.

D = unknown
R_1 = 268 R/hr (fallout intensity at H+3)
R_2 = 189 R/hr (fallout intensity at H+4)
t = 1 hr (duration of exposure)

$$\mathbf{D} = \frac{(\mathbf{R_1} + \mathbf{R_2}) \times \mathbf{t}}{\mathbf{2}}$$

$$D = \frac{(268 + 189) \times 1}{2} = 39.5 \text{ rads}$$

Warning: During the first 10-12 hours after the burst, when the radiation is decaying most rapidly, the above formula is only accurate if the time increment from R_1 to R_2 is 1 hour or less. After 12 hours the increment should not exceed one-half the time from detonation to the beginning of the time increment. The dose will be greatly overestimated, unless you follow these restrictions. If, during the first 12 hours, the period of exposure exceeds 1 hour, simply calculate the dose in 1-hour increments.

Example: A Red Horse crew went out of the shelter at H+3 to repair one of the parallel taxiways. How much radiation dose did they receive?

D = unknown
R_3 = 268 R/hr (fallout intensity at H+3)
R_4 = 189 R/hr (fallout intensity at H+4)
R_5 = 145 R/hr (fallout intensity at H+5)
R_6 = 116 R/hr (fallout intensity at H+6)
R_7 = 97 R/hr (fallout intensity at H+7)
t = 1 hr (duration of exposure)

$$\mathbf{D} = \frac{(\mathbf{R_3} + \mathbf{R_4}) \times \mathbf{t}}{\mathbf{2}} + \frac{(\mathbf{R_4} + \mathbf{R_5}) \times \mathbf{t}}{\mathbf{2}} + \frac{(\mathbf{R_5} + \mathbf{R_6}) \times \mathbf{t}}{\mathbf{2}} + \frac{(\mathbf{R_6} + \mathbf{R_7}) \times \mathbf{t}}{\mathbf{2}}$$

$$D = \frac{(268 + 189) \times 1}{2} + \frac{(189 + 145) \times 1}{2} + \frac{(145 + 116) \times 1}{2} + \frac{(116 + 97) \times 1}{2}$$

D = 228.5 + 167 + 130.5 + 106.5 = 632.5 rads (which means the entire Red Horse crew will probably die)

The preceding formula cannot be used to estimate previous doses or predict future doses. Accordingly, the following formula, derived from the decay equation can be used.

$$\mathbf{D = 5R_1 (t_1^{-0.2} - t_2^{-0.2})}$$

Where:

D = dose in rads
R_1 = fallout rate at H+1
t_1 and t_2 = times in hours after the burst for beginning and end of exposure

Example: it is H+3 and the Commander must send a Red Horse crew out of the shelter to repair one of the parallel taxiways. The Commander has asked you to estimate how much radiation dose the crew will receive.

D = unknown
R_1 = 1000 (fallout rate at H+1)
t_1 = 3
t_2 = 7

$$\mathbf{D = 5R_1 (t_1^{-0.2} - t_2^{-0.2})}$$

$D = 5 \times 1000 \times (3^{-0.2} - 7^{-0.2}) = 5 \times 1000 \times (0.8027 - 0.6776) = 626$ rads (you can tell the Commander that the entire crew will receive a lethal dose of radiation)

Another way to estimate dose is to use the nomogram show in Figure 4-9 . The centerline labeled (D/R_1) is the pivot point for finding out information.

Example: After you tell the commander that the Red Horse crew will receive a lethal dose of radiation, he decides he can make due with one taxiway until H+14, which is 4 hours before the wing sortie rate will require the use of both taxiways. He asks how much radiation dose will the crew receive.

Using the nomogram (Figure 4-9), place your ruler on 14 hrs on the line at the far right, labeled ENTRY TIME. Move the left end of the ruler until it is aligned with 4 hrs on the line labeled, STAY TIME (HOURS). The ruler crosses the centerline (D/R_1) at a value of 0.15. Hold the ruler at 0.15 and rotate the left end downward so that it aligns with 1000 on the line labeled, DOSE RATE AT 1 HOUR R_1. Now read the value where the ruler crosses the line labeled, TOTAL DOSE (D). The value is 150. This means the Red Horse crew would receive an estimated dose of 150 rads. From Table 4-6, you can estimate that approximately 30 percent of the crew may experience some symptoms of radiation sickness. A small percentage (less than 5 percent) may require medical attention. However, none of the crew should die.

4.3.6.3 Radiological logs/records. To assure effective exposure control, two types of documentation must be maintained - shelter radiological log (Figure 4-10) and individual radiological dose record (Figure 4-11). Locally developed forms or general-purpose forms can be used.

4.3.7 Radiological Surveys. In addition to air sampling and exposure control duties, the BES may also perform other radiological surveys, such as, *area surveys* to determine fallout patterns; *personnel surveys* to detect the presence of contaminated material on the body's surface, in body openings, or in wounds; *equipment surveys* are conducted primarily to determine requirements for decontamination.

4.3.7.1 Area surveys. The principle objective in an area survey is to establish the location and radiation levels associated with one or more isodose rate lines. An isodose rate line is a plotted contour line that depicts the location of some uniform level of radiation or radioactive contamination. Two methods of plotting isodose rate lines are illustrated in Figure 4-12 and Figure 4-13. The radial plot is the simpler of the two and can be done quickly with minimum personnel. The grid system is more accurate, but it is time consuming and requires a large number of personnel to cover a large area. In practice, both methods might be employed using the best features of each system.

The radial plot is used to establish the isodose rate line boundaries and the grid system is used to plot heavily contaminated areas in detail. Care must be used in selecting a focal point for a radial plot as the entire contamination area may be missed. Whatever system is used, the following rules must be observed:

- Isodose rate lines must always close
- Isodose rate lines cannot cross each other
- Isodose rate lines can cross a survey line only at a data point

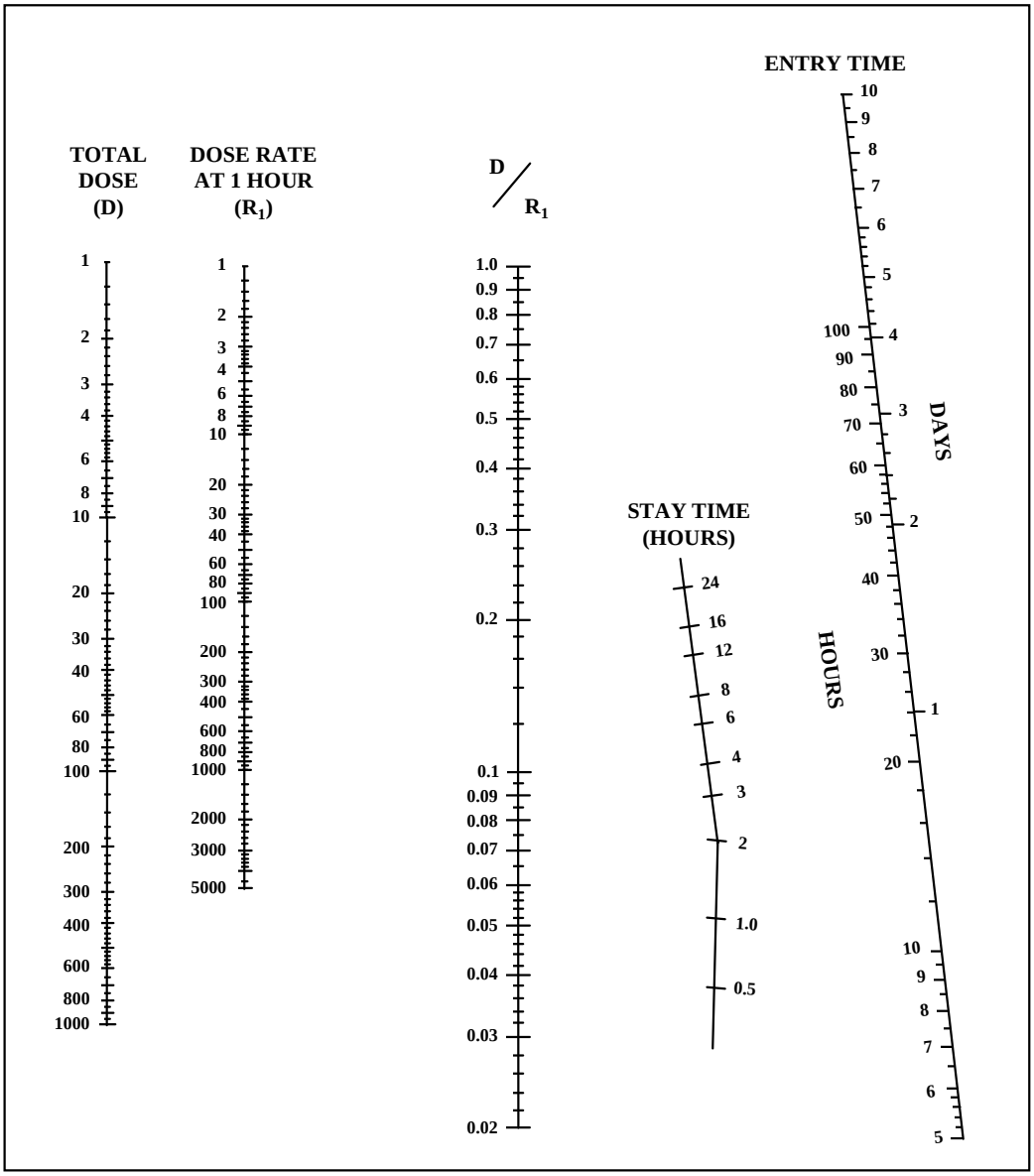


Figure 4-9 - Fallout Dose Nomogram (90750 CDC)

SHELTER RADIOLOGICAL LOG									BUILDING NUMBER				PROTECTION FACTOR				DETONATION TIME				FALLOUT ARRIVAL TIME			
DATE:																								
TIME:	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
DOSIMETER READING:																								
RATE METER READING																								
DOSE FOR PERIOD:																								
ACCUMULATED DOSE:																								
REMARKS/EVENTS:																								
DATE:																								
TIME:	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
DOSIMETER READING:																								
RATE METER READING																								
DOSE FOR PERIOD:																								
ACCUMULATED DOSE:																								
REMARKS/EVENTS:																								

Figure 4-10 - Shelter Radiological Log (90750 CDC)

INDIVIDUAL RADIOLOGICAL DOSE RECORD									NAME				ASSIGNED SHELTER BLDG			
DATE:																
TIME:	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
LOCATION:																
DOSE FOR PERIOD:																
ACCUMULATED DOSE:																
RETURN BEFORE DOSE:																
REMARKS/EVENTS:																
DATE:																
TIME:	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
LOCATION:																
DOSE FOR PERIOD:																
ACCUMULATED DOSE:																
RETURN BEFORE DOSE:																
REMARKS/EVENTS:																

Figure 4-11 - Individual Radiological Dose Record (90750 CDC)

To perform an area survey, personnel move into an area until the radiation level established as a guide in the preparatory phase is reached. That point is then designated on a map. Following the readout from the radiation instrument, the isodose rate line for that radiation level is followed to the left or right as terrain dictates until the isodose rate line closes. An isodose rate line closes when a survey team having moved to its right eventually returns to the location in which the first reading was taken and plotted. Having completed this isodose rate line, higher or lower levels of activity are selected and other isodose rate lines are established. The report of an area survey should include the following information: the name of survey team members, the date and time that the survey was performed, the type of radiation detection equipment used in the survey, and other remarks that may be helpful in evaluating the attached survey plot.

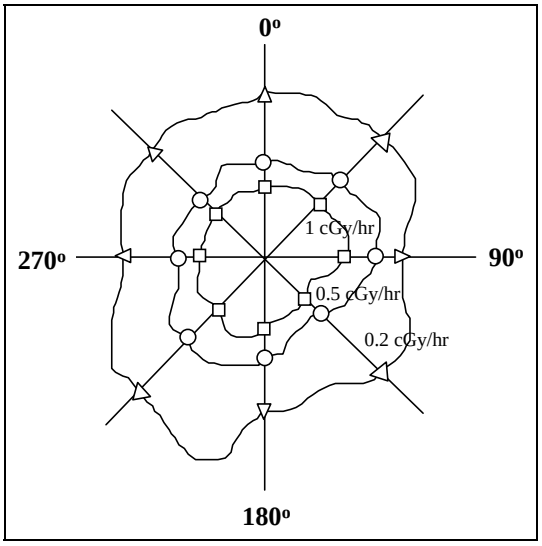


Figure 4-12 - Radial Plot Area Survey (Army FM 8-9)

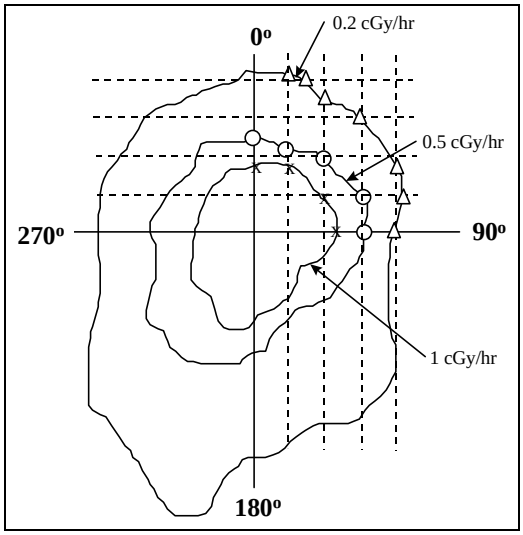


Figure 4-13 - Grid Plot Area Survey (Army FM 8-9)

4.3.7.2 Personnel surveys. Area surveys are generally considered as passive surveys, i.e., actions taken based on survey results may be deferred for hours or days. However, personnel surveys are active, in that actions taken to remove contaminated materials from body surfaces are usually taken immediately. Because they are active surveys, the locations of the contamination on body surfaces are not usually plotted as is the case in area surveys. Instead, contaminated areas are identified with tapes, dyes, magic markers, etc., on the body surface itself. In performing a personnel survey, the individual to be monitored stands, with legs spread and arms extended. The radiation monitor begins the survey at the head, subsequently surveying the upper trunk, arms, lower trunk and legs. The individual being surveyed then turns around and the procedure is repeated. As in area surveys, care must be taken not to permit the detector probe to touch any potentially contaminated surfaces. When a contaminated area is identified, it is marked. If it is suspected that contamination may have entered a body opening or wound, swabs may be used to collect surface material. These swabs may then be checked with a radiation detector. Personnel survey records should indicate the name of the individual surveyed, the sites and levels of any activity detected, and the nature of any instructions given to the contaminated individual concerning decontamination procedures.

4.3.7.3 Equipment/material surveys. Equipment/material surveys are performed in a manner similar to that used for area surveys. Hand sketches of the object to be surveyed are prepared. Surveying begins at the lower and outer surface of the object to be surveyed and progresses in an upward direction until the object is completely surveyed. Areas of contamination and levels of activity identified are noted on the sketch. Survey records developed from equipment/material monitoring are similar in their information content to those prepared for area surveys.

4.3.8 Radiation Decontamination Operations. Radiologically contaminated personnel are those whose outer body surfaces have been contaminated with fallout from a nuclear detonation. These fallout residues such as dust, ashes, dirt, or mud, will be loosely adhered to the clothing and skin of the person; and, once these residues have been removed, he/she does not present a radiation hazard. Ninety to ninety-five percent of decontamination can be accomplished by simply removing the individual's outer clothing and shoes. Once removed, contaminated clothing can be placed in bags, tagged, and removed to a remote section of the shelter or medical facility to avoid creating a hazard due to concentration of such contamination. The clothing can be decontaminated or disposed of as time permits. The second phase of decontamination consists of washing or wiping the individual's face and hands. This should result in 98 percent decontamination. The third phase of decontamination consists of washing the hair, or clipping the hair and washing the scalp. The third phase need only be accomplished if the individual arrives without headgear and/or monitoring indicates that the hair is contaminated.

4.4 Biological Agents. Throughout history, infectious diseases contracted naturally have had a significant impact on military operations. The intentional dissemination of disease adds a new dimension to threats that are posed by infectious and toxic agents traditionally transmitted only by natural routes. Biological weapons are unique in their ability to inflict large numbers of casualties over a wide area with minimal logistics requirements and by means which can be virtually untraceable. The ease and low cost of producing an agent, the difficulty in detecting its presence and protecting (and treating) it's intended victims, and the potential to selectively target humans, animals, or plants conspire to make defense against this class of weapon particularly difficult. As the military and economic gaps between nations grow and as some less advantaged nations seek a balance of power, there maybe a tendency by these nations to overcome their disadvantage by choosing weapons of mass destruction that can be produced easily and cheaply.

4.4.1 Characteristics of Biological Agents. Biological agents can be used to injure or kill humans, domestic animals, or plants (food crops, rubber, lumber, cotton, etc.). The identification of biological agents is difficult and slow because their presence cannot always be detected by the unaided senses. As living organisms, biological agents can reproduce rapidly in a victim and spread to other individuals. Biological agents make good clandestine weapons because a very small amount of material can incapacitate or kill many personnel. Intrinsic features of biological agents that influence their potential for use as weapons include: Infectivity; virulence; toxicity; pathogenicity; incubation period; transmissibility; lethality; and stability. Unique to many of these agents, and distinctive from their chemical counterparts, is the ability to multiply in the body over time and actually increase their effect.

4.4.1.1 Infectivity. The infectivity of an agent reflects the relative ease with which microorganisms establish themselves in a host species. Pathogens with high infectivity cause disease with relatively few organisms, while those with low infectivity require a larger number. High infectivity does not necessarily mean that the symptoms and signs of disease appear more quickly, nor that the illness is more severe.

4.4.1.2 Virulence. The virulence of an agent reflects the relative severity of disease produced by that agent. Different microorganisms and different strains of the same microorganism may cause diseases of different severity.

4.4.1.3 Toxicity. The toxicity of an agent reflects the relative severity of illness or incapacitation produced by a toxin.

4.4.1.4 Pathogenicity. This reflects the capability of an infectious agent to cause disease in a susceptible host.

4.4.1.5 Incubation period. A sufficient number of microorganisms or quantity of toxin must penetrate the body to initiate infection (the infective dose), or intoxication (the intoxicating dose). Infectious agents must then multiply (replicate) to produce disease. The time between exposure and the appearance of symptoms is known as the incubation period. This is dose; virulence; route of entry; governed by many variables, including: the initial rate of replication; and host immunological factors.

4.4.1.6 Transmissibility. Some biological agents can be transmitted from person-to-person directly. Indirect transmission (for example, via arthropod vectors) may be a significant means of spread as well. In the context of biological warfare (BW) casualty management, the relative ease with which an agent is passed from person-to-person (that is, its transmissibility) constitutes the principal concern.

4.4.1.7 Lethality. Lethality reflects the relative ease with which an agent causes death in a susceptible population.

4.4.1.8 Stability. The viability of an agent is affected by various environmental factors, including temperature, relative humidity, atmospheric pollution, and sunlight. A quantitative measure of stability is an agent's decay rate (for example, *aerosol decay rate*).

4.4.1.9 Additional factors. Additional factors that may influence the suitability of a microorganism or toxin as a biological weapon include ease of production; stability when stored or transported; and ease of dissemination.

4.4.2 Types of biological agents. Biological agents can be living organisms, excretions from organisms, or man-made chemical compounds. Table 4-12 shows the diseases that can be caused in humans by various living organisms.

Table 4-12 - Possible Antipersonnel Agents (90750 CDC)

Organism	Disease
Bacteria	Anthrax, bacillary dysentery, brucellosis, cholera, diphtheria, glanders, melioidosis, plague, tuberculosis, tularemia, typhoid fever, paratyphoid fever
Rickettsiae	Q fever, Rocky Mountain spotted fever, epidemic and murine typhus, scrub typhus
Virus	Dengue fever, encephalitis, infectious hepatitis, smallpox, yellow fever
Fungus	Coccidioidomycosis, histoplasmosis, nocardiosis, blastomycosis
Protozoa	Malaria, amoebic dysentery

4.4.2.1 Bacteria. Bacteria are small free-living organisms, most of which may be grown on solid or liquid culture media. The organisms have a structure consisting of nuclear material, cytoplasm, and cell membrane. They reproduce by simple division. The diseases they produce often respond to specific therapy with antibiotics.

4.4.2.2 Viruses. Viruses are organisms that require living cells in which to replicate. They are therefore intimately dependent upon the cells of the host that they infect. They produce diseases that generally do not respond to

antibiotics but which may be responsive to antiviral compounds, of which there are few available, and those that are available are of limited use.

4.4.2.3 Rickettsiae. Rickettsiae are microorganisms that have characteristics common to both bacteria and viruses. Like bacteria, they possess metabolic enzymes and cell membranes, utilize oxygen, and are susceptible to broad-spectrum antibiotics. They resemble viruses in that they grow only within living cells.

4.4.2.4 Chlamydia. Chlamydia are obligatory intracellular parasites incapable of generating their own energy source. Like bacteria, they are responsive to broad-spectrum antibiotics. Like viruses, they require living cells for multiplication.

4.4.2.5 Fungi. Fungi are primitive plants that do not utilize photosynthesis, are capable of anaerobic growth, and draw nutrition from decaying vegetable matter. Most fungi form spores, and free-living forms are found in soil. The spore forms of fungi are operationally significant. Fungal diseases may respond to various antimicrobial.

4.4.2.6 Toxins. Toxins are poisonous substances produced and derived from living plants, animals, or microorganisms; some toxins may also be produced or altered by chemical means. Toxins may be countered by specific antisera and selected pharmacological agents. A natural toxin causes a type of food poisoning known as botulism. One well-known synthesized toxin is a poison known as yellow rain.

4.4.2.7 Disease characteristics. Table 4-13 provides more comprehensive information about the various diseases that can be caused by the five categories of BW agents discussed above.

4.4.3 Dissemination of Biological Agent. Dissemination is the process by which infectious diseases or toxins are dispersed to cause disease or intoxication. The same routes of entry pertinent to natural spread of diseases (that is, through inhalation, ingestion, or skin exposure) are also relevant to biological agents that are delivered intentionally by weapons. Biological agent attacks can be overt (open) or covert (hidden). An overt attack is readily apparent, whereas, a covert attack may not be detected until the biological agent actually effects the force. A person or animal might be used as a saboteur to spread disease. Agents can also be introduced into water and food supplies. It is very difficult to defend against biological attack. However, if all personnel are made aware of this type of weapon, and stay alert to suspicious acts, the threat can be reduced. Biological agents are most likely to be delivered covertly and by aerosol.

4.4.3.1 Respiratory exposure. Inhalation of agent aerosols, with resultant deposition of infectious or toxic particles within alveoli, provides a direct pathway to the systemic circulation. The natural process of breathing causes a continuing influx of biological agent to exposed individuals. The major risk is pulmonary retention of inhaled particles. Droplets as large as 20 microns can infect the upper respiratory tract. However, these relatively large particles generally are filtered by natural anatomic and physiological processes, and only much smaller particles (ranging from 0.5-5 microns) reach the alveoli efficiently (Figure 4-14). Still smaller droplets are inhaled, but they are not efficiently retained in humans. Aerosol delivery systems aim to generate invisible clouds with particles or droplets between 0.5 and 10 microns in diameter that can remain suspended for long periods. Infection by the respiratory route may induce disease at doses lower than those generally associated with naturally acquired infections by the oral route. The subsequent illness may differ from the natural pattern, and the incubation period may be much shorter.

4.4.3.2 Ingestion. Food and water supplies may be contaminated during an aerosol BW attack. Unwary consumption of such contaminated materials could result in disease.

4.4.3.3 Dermal exposure. Intact skin provides an excellent barrier for most, but not all, biological agents. However, mucous membranes and damaged skin constitute breaches in this normal barrier through which agents may readily pass.

Table 4-13 - Biological Agent Data Chart (Army FM 8-9)

Disease	Likely Method of Dissemination	Transmissibility Person to Person	Infectivity	Incubation Time	Duration of Illness	Lethality	Persistence	Vaccination
BACTERIA								
Anthrax	Spores in aerosol	No	Moderate	1-6 days	3-5 days	High	Spores are highly stable	Yes
Brucellosis	Aerosol; sabotage (food supply)	No	High	Days to months	Weeks to years	Low	Long persistence in wet soil & food	Yes
Cholera	Aerosol; sabotage (food/water supply)	Negligible	Low	1-5 days	1 or more weeks	Moderate to high	Unstable in aerosols & pure water	Yes
Melioidosis	Aerosol	Negligible	High	Days to months	4-20 days	Variable	Stable	None
Plague	Aerosol, infected vectors	High	High	2-3 days	1-2 days	Very high	Less important because of high transmissibility	Yes
Tularemia	Aerosol	No	High	2-10 days	2 or more weeks	Moderate	Not very stable	Yes
Typhoid fever	Aerosol; sabotage (food/water supply)	Negligible	Moderate	7-21 days	Several days	Moderate		Yes
RICKETTSIAE								
Epidemic typhus	Aerosol, infected vectors	No	High	6-16 days	Weeks to months	High	Not very stable	No
Q-fever	Aerosol; sabotage (food supply)	No	High	10-20 days	2 days to 2 weeks	Very low	Stable	Yes
Rocky Mt spotted fever	Aerosol, infected vectors	No	High	3-10 days	2 weeks to months	High	Not very stable	No
Scrub typhus	Aerosol, infected vectors	No	High	4-15 days	up to 16 days	Low	Not very stable	No
CHLAMYDIA								
Psittacosis	Aerosol	Negligible	Moderate	4-15 days	Weeks to months	Very low	Stable	No
Coccidioido-mycosis	Aerosol	No	High	1-2 weeks	Weeks to months	Low	Stable	No
Histoplasmosis	Aerosol	No	High	1-2 weeks	Weeks to months	Low	Long persistence in soil	No
TOXINS								
Botulinum	Aerosol; sabotage (food/water supply)	No		Hours to days	24-72 hours	High	Stable	Yes
Clostridium perfringens	Aerosol; sabotage	No		8-12 hours	24 hours	Low	Stable	No
Trichothecene mycotoxins	Aerosol; sabotage	No		Hours to days	Hours	High	Stable	No
Palytoxin	Aerosol; sabotage	No		Minutes	Minutes	High	Stable	No
Ricin	Aerosol	No		Days	Days	High	Stable	Under development
Saxitoxin	Aerosol; sabotage	No		Minutes to days	Minutes to days	High	Stable	No
Staphylococcal enterotoxin B	Aerosol; sabotage	No		Days to weeks	Days to weeks	Low	Stable	Under development
Tetrodotoxin	Aerosol; Sabotage	No		Minutes to days	Minutes to days	High	Stable	No
VIRUSES								
Chikun-Gunya Fever	Aerosol	None	High	2-6 days	2 weeks to months	Very low	Relatively stable	Experimental

Disease	Likely Method of Dissemination	Transmissibility Person to Person	Infectivity	Incubation Time	Duration of Illness	Lethality	Persistence	Vaccination
Crimean-Congo hemorrhagic fever	Aerosol	Moderate	High	3-12 days	Days to weeks	High	Relatively stable	Experimental
Dengus fever	Aerosol	None	High	3-6 days	Days to weeks	Low	Relatively unstable	Experimental
Eastern equine encephalitis	Aerosol	None	High	5-15 days	1-3 days	High	Relatively unstable	Yes
Ebola fever	Aerosol	Moderate	High	7-9 days	5-16 days	High	Relatively unstable	No
Korean hemorrhagic fever	Aerosol	None	High	4-42 days	Days to weeks	Moderate	Relatively stable	Experimental
Lassa fever	Aerosol	Low to moderate	High	10-14 days	1-4 weeks	Unknown	Relatively stable	No
Omsk hemorrhagic fever	Aerosol; water	Negligible	High	3-7 days	7-10 days	Low	Relatively unstable	Experimental
Rift valley fever	Aerosol, infected vectors	Low	High	2-5 days	Days to weeks	Low	Relatively stable	Yes
Russian Spring-Summer encephalitis	Aerosol; milk	None	High	8-14 days	Days to months	Moderate	Relatively unstable	Yes
Smallpox	Aerosol	High	High	10-17 days	1-2 weeks	High	Stable	Yes
Wester equine encephalitis	Aerosol	No	High	1-20 days	1-3 weeks	Low	Relatively unstable	Yes
Venezuelan equine encephalitis	Aerosol, infected vectors	Low	High	1-5 days	Days to weeks	Low	Relatively unstable	Yes
Yellow fever	Aerosol	None	High	3-5 days	1-2 weeks	High	Relatively unstable	Yes

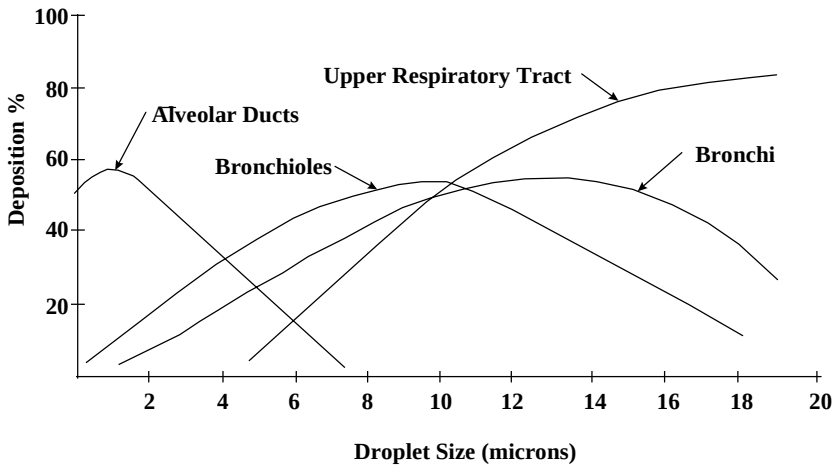


Figure 4-14 - Droplet Size and Penetration of Respiratory Passages (Army FM 8-8)

4.4.3.4 Contaminated food and water. Direct contamination of consumables, such as drinking water, foodstuffs, or medications, could be used as a means to disseminate infectious agents or toxins. This method of attack would be most suitable for sabotage activities and might be used against limited targets such as water supplies or food supplies of a military unit or base. Filtration and adequate chlorination significantly reduce this hazard as it pertains to water.

4.4.3.5 Arthropods. Attempts might be made to spread typical vector-borne diseases by releasing infected natural (or unnatural) arthropod hosts such as mosquitoes, ticks or fleas. These live vectors can be produced in large number and infected by allowing them to feed on infected animals, infected blood reservoirs, or artificially produced sources of a biological agent.

4.4.3.6 Peak threat conditions. Atmospheric conditions are critical to the effective use of biological agents. The optimal time for use of BW weapons is during the late night and early morning. It is during these hours that biological aerosols are least affected by ultra-violet radiation. In addition, neutral or inversion conditions are most likely to be present at these times. The phenomenon of atmospheric inversion best allows an agent cloud to travel along the land surface.

4.4.4 Attack Indicators. Following a BW attack, the disease pattern is likely to have characteristics that differ from those of a naturally occurring epidemic. In contrast to naturally occurring epidemics, in which disease incidence increases over a period of weeks or months, the epidemic curve for most artificially induced outbreaks is compressed, peaking within a few hours or days. Rather than peaks and troughs, a steady and increasing stream of patients will be seen. The simultaneous appearance of outbreaks in different geographical locations should also alert commanders to the possibility of a biological agent attack. Other BW attack indicators are:

- A large number of casualties within minutes to hours suggesting an attack with a toxin.
- An illness type highly unusual for the geographic area, e.g., Venezuelan equine encephalitis in Europe.
- An illness occurring in an unnatural epidemiological setting, where environmental parameters are not conducive to natural transmission, e.g., human Venezuelan equine encephalitis in the absence of antecedent disease in horses or in the absence of vector mosquitoes.
- An unusually high prevalence of respiratory involvement in diseases that, when acquired in nature, generally cause a non-pulmonary syndrome: the signature of aerosol exposure, e.g., inhalation versus cutaneous anthrax; pneumonic versus bubonic plague; or, a primarily pneumonic versus enteric illness with staphylococcal enterotoxin (SEB).
- Casualty distribution aligned with wind direction.

- Lower attack rates among those working indoors, especially in areas with filtered air or closed ventilation systems, than in those exposed outdoors.
- Increased numbers of sick or dead animals, often of different species (most BW agents are capable of infecting/intoxicating a wide range of hosts).
- Witness to an attack, or discovery of an appropriate delivery system (such as finding a contaminated bomblet or rocket from which an infectious agent is subsequently isolated and identified).
- Large numbers of rapidly fatal cases, with few recognizable signs and symptoms, resulting from exposure to multiple lethal doses near the dissemination source.

4.4.5 Detection and Identification. Detection and identification of biological agents require collection of diagnostic information and specimens from patients as well as environmental sampling. Medical (non-BES) personnel are responsible for patient diagnosis and collection of specimens. Environmental sampling is the responsibility of the BES. However, there are no quick and easy methods for rapidly identifying known BW agents in the field. New technology and equipment such as the Army's Biological Integrated Detection System (BIDS), and the Navy's Interim Biological Agent Detection System (IBADS) are very close to being fielded. The Air Force is watching both development programs for possible adoption. Until new BW technology is readily available, the BES must stress to all personnel the importance of defensive measures to prevent or reduce the effects of BW agents. The BES must also employ manual techniques for collection of environmental samples.

4.4.5.1 Defensive measures. During an attack where BW agents are suspected of use, your initial protective measure is to don your gas mask (Figure 4-15) and ground crew ensemble (Figure 4-16). The ground crew ensemble will cover all exposed skin and the filters in the gas mask are very effective against BW agents. Even BDUs offer protection against bites from insects that could be infected with biological organisms. The best way to keep your natural defense against infection is by keeping yourself in good physical condition and practicing good personal hygiene. The following measures should help protect personnel from BW agents following an actual or suspected attack.

- Keep immunizations up to date and take all prescribed medication.
- Report illnesses promptly.
- Isolate active cases.
- Practice good personal hygiene. Keep yourself and your living area clean. Unsanitary conditions can produce breeding grounds for insects and rodents that can carry infectious BW agents.
- Keep your nose, mouth, and skin covered when BW agents are suspected.
- Where possible, maintain good natural or mechanical ventilation which is a means for diluting bacteria.
- Control dust to reduce airborne spread of disease.
- Protect your food and water. Bottled, canned, or shrink wrapped foods are safe after a BW attack if the seals have not been broken.
- Maintain sanitary conditions in messing facilities.
- All personnel must be alert to signs of BW attack. Watch for low-flying aircraft and bombing attacks where low-order detonations are employed or where parachutes are used to slow their descent.

Figure 4-15 - M-17 Gas Mask (90750 CDC)

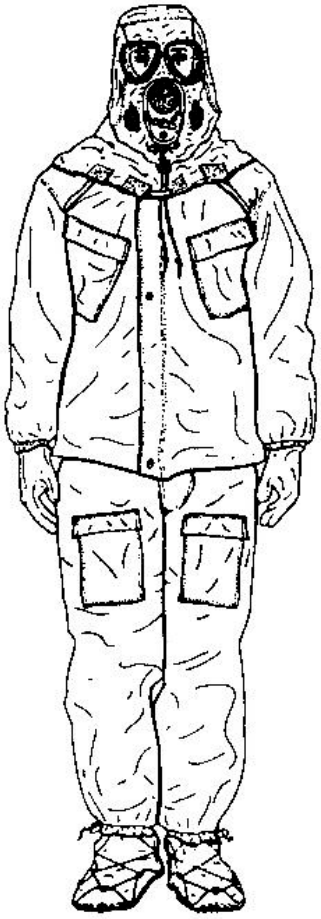


Figure 4-16 - Ground Crew Ensemble (90750 CDC)

4.4.5.2 Manual sample techniques. There are several methods of collecting suspected biological agent samples, such as collecting samples of earth and vegetation, taking wet or dry swab samples, and collecting aerosol samples using an impinger. During a sampling survey, you should note the condition of the soil in the vicinity of bomb bursts. Liquid, damp soil, or oddly colored dust around a bomb crater could be an indication of BW agents. Any unusual circumstances, objects, or other details should be documented so that an accurate appraisal can be made after samples are analyzed. You must keep detailed data about each sample, such as the time and place of the sample, weather conditions, elapsed time since the last enemy attack, and a general description of the appearance of the area. You should also be alert for the possibility of duds. You might be able to obtain a sample of pure agent from an unexploded or undamaged delivery vehicle. Remember to contact EOD personnel should you find any unexploded ordnance.

4.4.5.3 Sample analysis. Most well equipped medical laboratories are capable of detecting common BW agents. However, should you need special techniques and/or sampling requirements, the United States Army Medical Research Institute of Infectious Diseases (USAMRIID at Fort Detrick, Maryland is the DoD agency for BW defense. USAMRIID personnel can advise on sampling methods and are capable of analyzing samples for a wide variety of BW agents. Contact information is as follows:

Commander USAMRIID
Attn: SGRD-UIZ-R
Fort Detrick, Maryland 21702-5011
(301) 619-2285

4.4.6 Decontamination of Biological Agents. Most chemical decontaminating solutions and procedures are also effective for BW agents. Because most pathogenic organisms require favorable environmental conditions to thrive, natural decontamination methods can often be very effective in killing them. You should always take advantage of weathering when time permits since weathering requires so little expenditure of resources. Other simple techniques such as washing, boiling, or introduction of dry heat can also effectively neutralize BW agents.

4.4.6.1 Personnel decontamination. For personnel in the field, remove potentially contaminated clothing as soon as possible. Then wash the entire body with soap and water or a 0.5 percent chlorine solution (Table 4-24).

4.4.6.2 Facility and equipment decontamination. Heated Paraformaldehyde powder is an effective decontaminating solution for small enclosed spaces, equipment, and aircraft interiors that are contaminated with organisms and bacterial spores. The powder is placed in shallow pans and heated to 450°. Electric fry pans or regular fry pans on electric hot plats are ideal for this process. Use three grams of powder per cubic foot of space to be decontaminated. Allow a contact time of 2 hours, then ventilate for 12 hours. Formaldehyde gas is flammable in concentrations from 7 percent to 73 percent so do not exceed the strength of three grams per cubic foot. Formaldehyde solution (formalin) is an effective decontaminant for large interior spaces and cargo aircraft. Spray full strength at a rate of one quart per 1000 cubic feet of space. Vapors should be allowed to remain for
16 hours and then ventilated for 24 hours. Carboxide (ETO) is a mixture of ethylene oxide and carbon dioxide that is also good for decontaminating interiors. Seams and joints should be sealed or taped where possible and the ETO introduced at a rate of 60 pounds per 1000 cubic feet of space. Contact time is 6 to 8 hours. ETO vapors are toxic so you must wear masks and gloves when employing this process. Methyl bromide is commonly used against fungi. Benzalkonium chloride is available under trade names such as Zepheran Chloride, Zephirol, Roccal Benirol, Germitrol, Drapolene, Cequartyl, Germinal, Rodalon, and Osyan. For use against salmonella, brucella, and pasteurella, a 1 percent solution with a contact time of 5 minutes is effective. For Rocky Mountain spotted fever, typhus, and Q fever, use a 2 percent solution with a contact time of 5 minutes. For Venezuelan equine encephalitis, use a 1 percent solution with a contact time of 30 minutes.

4.4.6.3 Decontamination of other materials. Supertropical bleach (STB) is a mixture of chlorinated lime (30 percent available chlorine) and calcium oxide. It normally comes as a white powder. However, STB can be mixed with water to produce a slurry that can be used to decontaminate wood, terrain, concrete, and other porous material that are not damaged by chlorine. To be effective, STB must be in direct contact with the material. Sodium hypochlorite

solution can also be used to decontaminate these types of materials. **Warning.** STB is corrosive to most fabrics and metals, therefore it should never be used to decontaminate aircraft surfaces.

4.5 Chemical Agents. A chemical agent is a chemical substance that is intended for use in military operations to kill, seriously injure or incapacitate people because of its physiological effects. Chemical agents were first used in World War I, when chlorine gas was released, from large cylinders, in favorable wind conditions. This surprise operation caused massive casualties, demoralization of the forces attacked and demonstrated the need for protection from this kind of warfare. Chemical agents were not used in World War II, but at the end of the war stockpiles of newer agents, called "nerve gases," were discovered. These were found to be effective in much lower concentrations than those agents known up to that time. Since World War II, there have been several confirmed reports that chemical agents have been used in armed conflicts including the Iran-Iraq conflict. Riot control agents such as CS (tear agent) have been used repeatedly, for example, in South-East Asia to support tactical operations: in particular to flush out guerrillas from hiding and to render places of concealment untenable. These compounds and other tear agents are frequently used as riot control agents by police forces. The fact that chemical agents were not used in World War II did not prevent their use in recent conflicts and do not exclude the possibility of their use in a future war. The effectiveness of chemical agents as tactical weapons was clearly demonstrated in World War I and in the Iran-Iraq conflict. They can equally affect both forward and rear areas.

4.5.1 Characteristics of Chemical Weapons. Known agents cover the whole range of physical properties. Under ambient conditions their physical state may be gaseous, liquid, or solid. Their vapor pressures vary from high to negligible. Their vapor densities vary from slightly lighter to considerably heavier than air. The range of odors varies from none to highly pungent or characteristic. They may be soluble or insoluble in water. Agents with a low boiling point and high vapor pressure tend to be non-persistent. Agents with a high boiling point and low volatility tend to be more persistent. Agents are sufficiently stable to survive dissemination and transport to the site of use. Their inherent reactivity and stability can vary widely. Some chemically reactive agents denature rapidly, whereas other less reactive agents require, for example, bleach solutions to inactivate them. It should be realized that not all individuals of a species react in the same way to a given amount of agent, some being more or less sensitive as a result of many factors, of which genetic background, race and age are examples.

4.5.1.1 Persistency. Chemical agents may be divided into two main categories as follows: non-persistent and persistent agents. Non-persistent agents disperse rapidly after release and present an immediate, short duration hazard. They are released as airborne particles, liquids and gases, and intoxication usually results from inhalation. Persistent agents continue to present a hazard for considerable periods after delivery by remaining as contact hazard or by vaporizing over a period to produce a hazard by inhalation. Non-persistent agents may be made persistent by thickening.

4.5.1.2 Effectiveness. Effectiveness is the capacity of an agent to produce the maximum number of casualties or amount of disruption of operations with the least amount of agent. "Effectiveness" is a general term that takes in such criteria as suitability, toxicity, irritancy, etc. For instance, of two similar volatile toxic agents, the one that is toxic at a lower dose can be said to be more effective. Similarly, of two irritant compounds, the one that is irritant at a lower dose can be said to be the more effective. Effectiveness is also dependent on the ability of the population attacked to neutralize or counter the effects of agents once they have been delivered. The duration of effectiveness depends on the physical characteristics of the agent, the amount of agent delivered, the weapon system used, the terrain and the weather in the target area at the time the agent is delivered.

4.5.1.3 Meteorological factors. Meteorological conditions greatly influence the use and effectiveness of chemical weapons. To understand the impact of chemical agents, you should be aware of how the following meteorological factors influence their use.

- The effect of wind is to disperse agents rapidly in open country. However, dangerous concentrations may remain longer in woods, trenches, dug-outs and built-up areas.
- High temperatures decrease the persistency of agents and cause higher vapor concentrations. Low temperatures increase the persistency of agents. Some agents may freeze thus reducing the immediate contact hazard. There

is a danger of carrying such frozen agents on clothing and equipment into a warm building with the subsequent risk of toxic vapor being given off.

- Rain disposes, dilutes and promotes hydrolysis of agents. This reduces their effectiveness but does not make them impossible to use.
- When the air temperature is higher than that at ground level (a state of inversion), agents in the vapor state will persist for longer periods than when the air temperature is lower than that at ground level (a state of lapse).

4.5.1.4 Routes of absorption. Chemical agents may enter the body by several routes and the nature and onset of signs and symptoms may vary accordingly. Gases, vapors and aerosols, when inhaled, may be absorbed through any part of the respiratory tract, from the mucosa of the nose and mouth to the alveoli of the lungs. They may also be directly absorbed by the eye. Aerosol particles larger than 5 µm tend to be retained in the upper respiratory tract, while those smaller than 1 µm tend to be breathed in and out again, although some of these smaller particles may be retained. Droplets of liquid and, less commonly, solid particles may be absorbed through the surface of the skin and mucous membranes. Toxic compounds with a characteristic action on the skin can produce their effects when deposited on the skin as solid or liquid particles. Agents that penetrate the skin may form temporary reservoirs so that delayed absorption may occur. Even the vapor of some volatile agents can penetrate the intact skin and intoxication may follow. Wounds or abrasions (even minor injuries caused by shaving or by chemical depilation) present areas that are more permeable than intact skin. Chemical agents may contaminate food and drink and be absorbed by the gastrointestinal tract. Irritation or damage to the surfaces concerned may not accompany the penetration of agents by these various routes.

4.5.2 Types of Chemical Agents. Table 4-14 lists the various known chemical agents and the signs and symptoms associated with their use.

4.5.3 Nerve Agents. Nerve agents (NA) are a group of particularly toxic chemical warfare agents. They were developed just before and during World War II and are related chemically to the organophosphorus insecticides. The principle agents in this group are: GA (Tabun), GB (Sarin), GD (Soman), GF and VX (methylphosphonothioic acid). These agents are commonly referred to by their abbreviations. Nerve agents are organophosphorus esters. The “G” agents tend to be non-persistent whereas the “V” agents are persistent. Some “G’ agents may be thickened with various substances in order to increase their persistence, and therefore the total amount penetrating intact skin. Nerve agents can be colorless, or yellowish to brown liquids. Some nerve agents have a faint fruity odor. The LCt_{50} of nerve agents range from 100 to 400 mg-min/m^3, which is a very tiny amount to cause death. Nerve agents inhibit an enzyme called cholinesterase. The body uses cholinesterase to allow the muscles to relax after being energized by a nerve ending. The nerve agents prevent the cholinesterase from doing its job so your muscles become continually stimulated in an uncontrollable manner. The physical properties of nerve agents are given in Table 4-15.

Table 4-14 - Signs and Symptoms of Chemical Agents

Chemical/Agent	Signs and Symptoms
Nerve Agents	
Tabun (GA) ; Sarin (GB) ; Soman (GD) Methylphosphonothioic acid (VX)	Constricted/unequal pupils, headache, eye pain, blurred vision, tightness in chest, cough, nausea, vomiting, increased sweating, hypersalivation, involuntary urination, fatigue, cramps, muscular twitching, convulsions, loss of consciousness, coma
Blister Agents	
Sulfur Mustard Gas (HD) Nitrogen Mustard gas (HN)	Eyes: mild conjunctivitis to temporary blindness; Skin: high temperature, wet skin, blisters, deep burns; Respiratory tract: pain, hoarseness, cough, loss of voice; Gastrointestinal tract: nausea, vomiting, pain, diarrhea
Lewisite (L)	Eyes: conjunctivitis, temporary or permanent blindness; Skin: similar to mustard gas but more severe & painful; Respiratory tract: similar to mustard gas but more severe
Halogenated Oxime - Phosgene oxime (CX)	Eyes: severe irritation, corneal lesions, blindness; Skin: severe irritation & pain, affected area turns white; Respiratory tract: pulmonary oedema
Choking Agents	
Phosgene (CG); Diphosgene (DP)	Coughing, choking, tightness in the chest, nausea, vomiting, headache, tearing
Blood Agents	
Hydrogen Cyanide (AC)	Weakness of the legs, vertigo, nausea, headache, increase respiration, violent convulsions, coma, cardiac failure
Cyanogen Chloride (CK)	Intense irritation of nose, throat, and eyes, coughing, tightness in the chest, tearing
Incapacitants	
CNS Depressants (BZ)	Sleepiness, diminished alertness, vomiting, dry mouth, blurred vision, confusion, stupor
CNS Stimulants (LSD)	Nausea, confused state, delusions, hallucinations, rapid heart rate, sweating palms, cold extremities, trembling, anxiety
Riot Control Agents	
Lachrymators (tear gas) Orthochlorobenzylidene- malononitrile (CS) Chloracetophenone (CN) Dibenzoxazepine (CR)	Burning sensation in the eyes, tearing, inflammation of the eyelids, temporary blindness, irritation of respiratory tract
Vomiting Agents Diphenylchlorarsine (DA) Diphenylaminearsine chloride (Adamsite (DM)) Diphenylcyanarsine (DC).	Burning sensation in nose and throat, hypersalivation, coughing, sneezing, nausea, vomiting, itching of the skin

Table 4-14 (Con't)

Chemical/Agent	Signs and Symptoms
Smokes, Fuels & Incendiary Materials	
Zinc chloride smoke (HC)	Labored breathing, hoarseness, harsh respiratory sounds, tearing, coughing, expelling of fluid from the throat
Chlorosulphonic acid fog (CSA)	Irritation of the eyes, nose, or skin, prickling sensation of the skin, coughing, soreness of the chest
Titanium tetrachloride cloud (FM)	Acid burns of the eyes or skin
Hydrocarbon fumes	Drowsiness, dizziness, headache, vomiting, unconsciousness
White phosphorus (WP) Red phosphorus (RP); Thermite (TH)	Thermal burns of skin or respiratory tract, suffocation
Herbicides	
2,4-D & 2,4,5-T	Gastroenteric distress, diarrhea, neuropathy, pain, paralysis
Cacodylic	Burning in the mouth and throat, gastroenteric pain, vomiting, diarrhea, dehydration, jaundice, collapse
Picloram	Same as 2,4-D, mild inflammation of the skin, eye irritation

Table 4-15 - Physical Properties of Nerve Agent (Army FM 8-9)

Property	Tabun (GA)	Sarin (GB)	Soman (GD)	VX
Appearance	Colorless to brown liquid giving off colorless vapor	Colorless liquid giving off colorless vapor	Colorless liquid giving off colorless vapor	Amber colored liquid
Molecular weight	162.12	140.1	182.2	267.4
Density g/cm^{-3} at 25°C	1.07	1.09	1.02	1.01
Melting point (^{o}C)	-50	-57	-42	-51
Boiling point (^{o}C)	240	147	198	298
Vapor density	5.63	4.86	6.33	9.2
Vapor pressure (mmHg at 25°C)	0.07	2.9	0.4	0.007
Volatility (mg/m^{-3})	90 (0 ^{o}C) 610 (25 ^{o}C) 858 (30 ^{o}C)	4,100 (0 ^{o}C) 22,000 (25 ^{o}C) 29,800 (30 ^{o}C)	531 (0 ^{o}C) 3,900 (25 ^{o}C) 5,570 (30 ^{o}C)	10.5 (25 ^{o}C)

4.5.4 Blister Agents. Blister or vesicant agents are likely to be used both to produce casualties and to force opposing troops to wear full protective equipment thus degrading fighting efficiency. Blister agents can be thickened in order to contaminate terrain, ships, aircraft, vehicles or equipment with a persistent hazard. The vesicant agents include sulfur mustard (HD), nitrogen mustard (HN), the arsenical vesicants such as lewisite (L), and the halogenated oximes (CX) whose properties and effects are very different from those of the other vesicants. Vesicants burn and blister the skin or any other part of the body they contact. They act on the eyes, mucous membranes, lungs, skin and blood-forming organs. They damage the respiratory tract when inhaled and cause vomiting and diarrhea when ingested. The physical properties of blister agents are given in Table 4-16 .

Table 4-16 - Physical Properties of Blister Agents (Army FM 8-9)

Property	Sulfur Mustard (HD)	Nitrogen Mustard (HN)	Lewisite (L)	Phosgene Oxime (CX)
Appearance	Colorless to light yellow liquid giving off colorless vapor	Dark colored liquid giving off colorless vapor	Dark oily liquid giving off colorless vapor	White solid or yellow-brown liquid
Molecular weight	159.1	204.5	207.35	113.9
Density g/cm^{-3}	1.27 (25°C)	1.24 (25°C)	1.89(20°C)	
Melting point (^{o}C)	14.5	-3.7	-8 to 0.1	39 to 43
Boiling point (^{o}C)	217	256	190	129
Vapor density	5.4	7.1	7.1	3.94
Vapor pressure (mmHg)	0.072 (20°C)	0.011	0.087 (0°C) 0.304 (20°C)	3.6 (20°C)
Volatility (mg/m^{-3})	75 (0 ^{o}C) 610 (20 ^{o}C) 2,860 (40 ^{o}C)	13 (0 ^{o}C) 121 (25 ^{o}C) 390 (40 ^{o}C)	1,060 (0 ^{o}C) 4,480 (20 ^{o}C) 8,260 (30 ^{o}C)	20,000 (20 ^{o}C) 60,000 (35 ^{o}C)

4.5.4.1 Mustard agents. Mustard agents are persistent liquids that may be in the form of sulfur compounds such as distilled mustard (HD) and mustard-T (HTH), or nitrogen compounds such as HN-1, HN-2, and HN-3. Both liquid and vapor forms are readily absorbed by internal and external parts of the body. Generally, there is no pain on initial contact, except when exposed to the eyes. Initial symptoms may mot appear for 4 to 8 hours, at which time the affected area begins to redden. At 8 to 12 hours after contact, blistering begins. The blisters are very susceptible to infection which is the leading cause of death from these agents. Damage to the eyes can be even worse, sometimes resulting in permanent damage. If inhaled, these agents inflame the throat and windpipe and produce a harsh cough. Recovery from mustard agents can take many weeks.

4.5.4.2 Lewisite. Lewisite is an arsenical blister agent. Related compounds can be found in herbicides, pesticides, and pharmaceuticals. Direct contact causes an immediate stinging sensation followed by reddening of the skin in about 30 minutes. Blisters begin to form in about 13 hours. The blisters are similar to those of mustard agents. However, the burns are much deeper. Inhalation of large amounts may be fatal in as little as 10 minutes. Exposure to the eyes can cause permanent damage. Because of its irritant properties and its arsenic content, lewisite can act as a blister agent and choking agent as well a systemic poison.

4.5.4.3 Phosgene oxime. Phosgene oxime (CX) is solid urticant (nettle gas) that produces an immediate sensation of pain, ranging from a mild prickling to a severe bee sting. The skin will redden and develop rings and welt-type blisters in about 30 minutes. Within 24-hours the affected skin will turn yellow or brown. Some days later the dead skin will scale followed by crust formation and a purulent discharge. Any exposure to phosgene that causes pain will kill tissue cells at the point(s) of contact. Very few compounds are as painful and destructive to the tissues. Phosgene oxime also affects the eyes, causing corneal lesions and blindness and may affect the respiratory tract causing pulmonary oedema.

4.5.5 Choking Agents. Chemical agents that attack lung tissue, primarily causing pulmonary oedema, are classed as lung damaging agents. To this group belong phosgene (CG), diphosgene (DP), chlorine (Cl) and chloropicrin (PS). Phosgene is the most dangerous member of this group and the only one considered likely to be used in the future. Phosgene is a colorless gas with an odor of new mown hay, grass, or green corn. It was used for the first time in 1915, and it accounted for 80 percent of all chemical fatalities during World War I. Phosgene exerts its effects solely on the lungs. It damages the capillaries, scars the lungs, and causes a seepage of watery fluid into the air sacs. In lethal amounts, phosgene causes the air sacs to become flooded and the patient virtually drowns. Phosgene's boiling point is 8.2°C, making it an extremely volatile and non-persistent agent. Its vapor density is 3.4 times that of air. It may therefore remain for long periods of time in trenches and other low lying areas. It is readily soluble in organic solvents and fatty oils. In water, phosgene rapidly hydrolyses with the formation of hydrochloric acid and carbon dioxide. Its physical properties are shown in Table 4-17.

Table 4-17 - Physical Properties of Choking Agents (Army FM 8-9)

Property	Phosgene (CG)	Diphosgene (DP)
Appearance	Colorless gas	Colorless gas
Molecular weight	98.2	197.9
Density g/cm^{-3}	1.38 (20°C)	1.65 (20°C)
Melting point (°C)	-128	-57
Boiling point (°C)	7.6	127
Vapor density	3.4	6.8
Vapor pressure (mmHg)	365 (-10°C) 555 (0 °C) 1173 (20 °C)	1.0 (0 °C) 4.2 (20 °C)
Volatility (mg/m^{-3})	528,000 (-40 °C) 2,200,000 (-10 °C) 4,300,000 (7.6 °C)	12,000 (0 °C) 45,000 (20 °C) 270,000 (52 °C)

4.5.6 Blood Agents. Cyanogen agents produce their effects by interfering with oxygen utilization at the cellular level. Inhalation is the usual route of entry. The most likely blood agents to be used on the battlefield are hydrogen cyanide (AC) and cyanogen chloride (CK). These chemicals have very high volatilities that make them excellent for quick knockdown, non-persistent gas attack. The gas quickly disperses, leaving buildings and equipment in fully usable condition. Cyanides also cause gas mask filters to break down more rapidly. Tissues affected by blood agents are unable to extract oxygen from the blood that causes the victim to die from asphyxiation. The physical properties of blood agents are shown in Table 4-18 .

Table 4-18 - Physical Properties of Blood Agents (Army FM 8-9)

Property	Hydrogen Cyanide (AC)	Cyanogen Chloride (CK)
Appearance	Colorless liquid giving off colorless vapor	Strongly irritating colorless gas
Molecular weight	27.02	61.48
Density g/cm^{-3}	0.687 (10°C)	1.18 (20°C)
Melting point (^{o}C)	-13.3	-6.9
Boiling point (^{o}C)	25.7	12.8
Vapor density	0.93	2.1
Vapor pressure (mmHg)	165 (-10°C) 256 (0 ^{o}C) 600 (20 ^{o}C) 742 (25 ^{o}C)	1,010 (20 ^{o}C)
Volatility (mg/m^{-3})	37,000 (-40 ^{o}C) 1,080,000 (25 ^{o}C)	6,132,000 (25 ^{o}C)

4.5.6.1 Hydrogen cyanide. Hydrogen cyanide is a colorless, highly volatile liquid and represents a non-persistent hazard. The vapor is less dense than air and has a faint odor, somewhat like bitter almonds, although about 25 percent of people are unable to smell this. The more rapidly cyanide levels build up in tissue, the more acute are the signs and symptoms of poisoning and the smaller is the total absorbed dose required to produce a given effect. In high concentrations there is an increase in the depth of respiration within a few seconds. This stimulation may be so powerful that a casualty cannot voluntarily hold his or her breath. Violent convulsions occur after 20 to 30 seconds with cessation of respiration within 1 minute. Cardiac failure follows within a few minutes. With lower concentrations, the early symptoms are weakness of the legs, vertigo, nausea and headache. These may be followed by convulsions and coma that may last for hours or days depending on the duration of exposure to the agent. If coma is prolonged, recovery may disclose residual damage to the central nervous system manifested by irrationality, altered reflexes and unsteady gait that may last for several weeks or longer; temporary or permanent nerve deafness has also been described. In mild cases there may be headache, vertigo and nausea for several hours before complete recovery.

4.5.6.2 Cyanogen chloride. Cyanogen chloride, after absorption, reacts in such a way that hydrogen cyanide is eventually released. The effects on the body are essentially similar to those of hydrogen cyanide, but, in addition, cyanogen chloride also has local irritant effects. Cyanogen chloride is a colorless, highly volatile liquid. Its vapor, heavier than air, is very irritating to the eyes and mucus membranes. Cyanogen chloride's pungent, biting odor is marked by its irritating lachrymatory properties. Normally cyanogen chloride is non-persistent. Cyanogen chloride acts in two ways. Its systemic effects are similar to those of hydrogen cyanide but it also has local irritant effects on the eyes, upper respiratory tract and lungs. Cyanogen chloride injures the respiratory tract, resulting in severe inflammatory changes in the bronchioles and congestion and oedema in the lungs. Initially, cyanogen chloride stimulates the respiratory center and then rapidly paralyses it. In high concentrations, however, its local irritant action may be so great that labored breathing is produced. Exposure is followed by an immediate intense irritation of the nose, throat and eyes, with coughing, tightness in the chest and lachrymation. Afterwards the exposed person may become dizzy and with increasingly labored breathing. Unconsciousness is followed by failing respiration and death within a few minutes. Convulsions, retching and involuntary defecation may occur. If these effects are not fatal, the signs and symptoms of pulmonary oedema may develop. There may be persistent cough with much frothy sputum, rales in the chest, severe labored breathing, and marked cyanosis.

4.5.7 Incapacitating Agents. Incapacitating chemical agents are capable of producing physiological or mental effects that prevent exposed personnel from performing their duties for a significant period of time. Medical treatment while not essential may in some cases facilitate more rapid recovery. In the narrower sense the term has come to mean those agents that are:

- Highly potent (an extremely low dose is effective) and logistically feasible.
- Able to produce their effects by altering the higher regulatory activity of the central nervous system.
- Of a duration of action lasting hours or days, rather than of a momentary or fleeting action.
- Not seriously dangerous to life except at doses many times the effective dose.

- Not likely to produce permanent injury in concentrations that are militarily effective.

These criteria eliminate many drugs that might otherwise be considered as incapacitants. Opiates and strong sedatives are too dangerous on account of their low margin of safety and milder tranquilizers cause little actual loss of performance capability. Many compounds have been considered as incapacitants and medical staffs must be on the alert to detect and report any unusual clinical appearances. All lethal agents in low doses may produce incapacitating effects and it is possible that new agents for incapacitation may be developed. Agents that produce unconsciousness or induce vomiting may be developed in the future. The two best known incapacitants are CNS depressants (anticholinergics) and CNS stimulants (LSD).

4.5.7.1 CNS depressants. CNS depressants produce their effects by interfering with transmission of information across central synapses. An example of this type of agent is 3-quinuclidinyl benzilate (BZ). Relatively high doses produce toxic delirium that destroys the ability to perform any military task. In many respects BZ resembles atropine and scopolamine, except that it is more potent and its effects last longer. No permanent adverse effects have been reported from clinical studies. BZ is effective by all routes of administration.. It readily crosses the blood-brain barrier and is distributed to all areas of the brain and spinal cord. After administration of an effective dose by inhalation, by mouth, or by injection, mild peripheral effects of BZ occur within 1 hour. Maximal central effects occur after about 4 hours and last 24 to 48 hours. Small doses of BZ cause sleepiness and diminished alertness. Diagnosis can be made by noting increased heart rate, dry skin and lips, and drowsiness. The exposed person becomes progressively intoxicated. In 1-4 hours, dizziness, ataxia, vomiting, dry mouth, blurred vision, confusion, sedation progressing to stupor will occur. From 4-12 hours after exposure, the individual will display an inability to respond to the environment effectively or to move about. In 12-96 hours, the individual will experience increasing activity, random unpredictable behavior with delusions and hallucination. Gradual return to normal behavior should occur 48 to 96 hours after exposure.

4.5.7.2 CNS stimulants. CNS stimulants cause excessive nervous activity by facilitating transmission of impulses. The effect is to flood the cortex and other higher regulatory centers with too much information, making concentration difficult and causing indecisiveness and inability to act in a sustained purposeful manner. A well-known drug that acts in this way is D-lysergic acid diethylamide (LSD). LSD is solid at normal temperatures and is soluble in water. It is a very difficult agent to disseminate and consequently is likely to be used by an enemy only in a clandestine manner. Very small doses (for example 50 micrograms per person) are capable of inducing a psychotic state in people, but the precise mechanism of action is not yet known. LSD has been shown to facilitate neural activity in the reticular activating system of the brain stem. It appears to interfere with the normal filtering action of this system, permitting sensory input to reach higher integrative centers without regard to its importance or relevance. The result is a decrease in the ability of the brain to process information selectively and in logical sequence. LSD may be inhaled or ingested. Initial effects appear within a few minutes of inhalation or within 30 to 60 minutes of ingestion. Maximum effects are reached within 2 to 3 hours and gradually subside over the next 4 to 8 hours. The clinical manifestations of LSD intoxication often include an early stage of nausea followed 45-60 minutes after dosage by a confused state in which delusions and hallucinations are common but not always experienced. There is some evidence that the effects may be held off, at least for a time, by determination to continue duty and that the presence of non-intoxicated comrades enables affected subjects to maintain contact with reality. Subjects intoxicated with LSD show evidence of sympathetic stimulation (rapid heart rate, sweating palms, pupillary enlargement, cold extremities) and mental excitation (nervousness, trembling or spasms, anxiety, euphoria and inability to relax or sleep). Feelings of tension, heightened awareness, exhilaration, kaleidoscopic imagery, emotions of every type, hilarity and exultation are characteristic. Paranoid ideas and more profound states of terror and ecstasy may also occur, especially in highly suggestible individuals.

4.5.8 Riot Control Agents. Riot control agents are irritants characterized by a very low toxicity (chronic or acute) and a short duration of action. Little or no latent period occurs after exposure. Riot control agents fall into two categories Lachrymators (tearing agents) and vomiting agents.

4.5.8.1 Tearing agents. There are three kinds of tearing agents that may be encountered. Orthochlorobenzylidene malononitrile (CS) is the most commonly used. Chloracetophenone (CN) is also used in some countries in spite of its higher toxicity. A newer agent is dibenzoxazepine (CR). All three agents impact the exposed individual in a

similar manner. Lachrymators act on the nerve endings, the cornea, mucous membranes and the skin. The reaction is very rapid. Exposure to tearing agents causes the following symptoms:

- Eyes: Symptoms include a violent burning sensation, conjunctivitis (lasting up to 30 minutes), inflammation of the eyelids (lasting about an hour), violent tearing (over 10-15 minutes) and an intolerance to light.
- Respiratory Tract: The first symptom is a burning sensation in the throat, developing into pain and extending to the trachea and bronchi. At a later stage a sensation of suffocation may occur, often accompanied by fear. In addition a burning sensation in the nose, inflammation of the nasal mucous membranes, and sometimes mild nose bleeding occurs. The sense of taste is often distorted for some hours after exposure. Nausea, diarrhea and headache have been observed. Sneezing occurs after mild exposure and may be persistent. Many exposed people have reported fatigue for some hours afterwards. Coughing, choking, retching and (rarely) vomiting occur after exposure.
- Skin: A burning sensation occurs especially in moist areas, but soon disappears. This burning sensation may recur some hours later, often while washing the area. Prolonged exposure to large amounts can cause inflammation and formation of cysts. Prolonged exposure, continuous or intermittent, to high concentrations, combined with high temperatures and humidity in the field may result in a cumulative effect.

4.5.8.2 Vomiting Agents. Vomiting agents produce strong pepper-like irritation in the upper respiratory tract with irritation of the eyes and profuse tearing. They cause violent uncontrollable sneezing, cough, nausea, vomiting and a general feeling of bodily discomfort. The principal agents in this group are diphenylchlorarsine (DA), diphenylaminearsine chloride (Adamsite (DM)), and diphenylcyanarsine (DC). DA, DM, and DC are dispersed as aerosols and produce their effects by inhalation or by direct action on the eyes. They are non-persistent agents. The particles fall to the ground after dispersion and are virtually ineffective unless resuspended. Di-phenyl-cyanoarsine (DC) is the most irritating of the group. The principal characteristics of these agents are summarized in Table 4-19. The onset of symptoms may be delayed for several minutes after initial exposure (especially with DM); effective exposure may, therefore, occur before the presence of the smoke is suspected. If the mask is put on then, symptoms will increase for several minutes despite adequate protection. As a consequence, the casualties may believe their mask is ineffective and by removing it, expose themselves further. Inhalation is followed by a burning sensation in the nose and throat, hypersalivation, coughing, sneezing, nausea and vomiting. Mental depression may occur during the progression of symptoms. The paranasal sinuses are irritated and fill with secretions and severe frontal headache can result. Symptoms reach their climax after 5 to 10 minutes and disappear 1 to 2 hours after cessation of exposure. Effects on the eyes are slight and are restricted to a burning sensation and tearing. Ingestion of food and water contaminated by vomiting agents may cause nausea, vomiting, diarrhea (sometimes bloodstained) and weakness and dizziness have been reported.

4.5.9 Smoke, Flame, Hydrocarbon Fumes, and Incendiaries. Smoke, flame, hydrocarbon fumes, and incendiaries are not normally associated with chemical weapons. However, these materials can incapacitate, and even kill personnel. It is important to understand some facts about these materials so that you can distinguish between them and other chemical weapons.

Table 4-19 - Properties of Vomiting Agents (Army FM 8-9)

Property	DM	DA	DC
Appearance	Yellow or green solid	Colorless, crystalline	Colorless solid
Specific gravity	1.86	1.4	
Melting point (^oC)	195	38	38
Boiling point (^oC)	410	330	337-346
Volatility (mg/m^{-3})	0.02 (-20 ^oC)	0.68 (20 ^oC)	1.5 (20 ^oC)
Solubility in water	Poor	Poor	Poor
Solubility in solvents	Poor	Good	Good
Smoke odor	Coal fire	Shoe polish	Garlic
Smoke color	Yellow	White or grey	White
Minimum irritant concentration (mg/m^{-3})	0.1	0.1	0.25

4.5.9.1 Smokes. Smokes are used to hide troops, equipment and areas from detection by obscuring vision. The smokes consist of small solid or liquid particles that become hydrated in contact with air and intercept or diffuse the light. Most smokes are not hazardous in concentrations that are useful for obscuring purposes. However, exposure to heavy smoke concentrations for extended periods, particularly if near the source of emission, may cause illness or even death. There are three chemicals that are routinely used for generation of smoke - zinc chloride (HC), chlorosulphonic acid (CSA), and titanium tetrachloride (FM).

4.5.9.1.1 Zinc chloride smoke mixture (HC) contains hexachloroethane, grained aluminum and zinc oxide. Upon burning, the mixture produces zinc chloride, zinc oxychlorides and HCl vapor that rapidly absorb moisture from the air to form a greyish white smoke. HC mixtures can be dispersed by several methods, including grenades, candles, smoke pots, cartridges, and air bombs. The toxicity of zinc chloride is mainly due to the formation of the strongly acidic HCl, but is also to a lesser extent due to thermal lesions. These are caused by the exothermic reaction of zinc chloride with water. The acidic HCl vapor causes lesions of the mucous membranes of the upper airways. The damage and clinical symptoms following zinc chloride exposure therefore appear immediately after the start of the exposure. However, damage to the lower airways, attributed to the presence of fine zinc chloride particles and phosgene, may result in delayed effects.

4.5.9.1.2 Chlorosulphonic acid (CSA) is a heavy, strongly acidic liquid that, when dispersed in air, absorbs moisture to form a dense white fog consisting of small droplets of hydrochloric and sulfuric acids. In moderate concentrations it is highly irritating to the eyes, nose and skin. The symptoms are usually limited to a prickling sensation of the skin, but exposure to high concentrations or long exposures to lower concentrations as found in the field, may result in severe irritation of the eyes, skin and respiratory tract. Eye irritation and oedema, tearing, and mild sensitivity to light may occur. Mild cough and soreness in the chest and moderate chemical dermatitis of the exposed skin are occasionally seen. Splashes of liquid in the eye are extremely painful and cause mineral acid burns with corneal erosions. Liquid chlorosulphonic acid solution on the skin may cause painful acid burns.

4.5.9.1.3 Titanium Tetrachloride (FM) is a yellow non-inflammable and corrosive fluid that on contact with damp air gives off a heavy dense white cloud. It is disseminated by aircraft for the production of vertical smoke curtains extending down to ground and sea level. The smoke consists of fine particles of free hydrochloric acid and titanium oxychloride. Liquid FM produces acid burns of the skin or eyes.

4.5.9.2 Flame materials. Incendiary agents are used to burn supplies, equipment and structures. The main agents in this group are white and red phosphorus (WP and RP), thermite (TH), and magnesium.

4.5.9.2.1 At ordinary temperatures, white phosphorus (WP) is a solid that can be handled safely under water. When dry, it burns fiercely in air, producing a dense white smoke. Fragments of melted particles of the burning substance may become embedded in the skin that produce multiple, deep, and variable size burns. The fragments continue to burn unless oxygen is excluded by flooding or smothering. Field concentrations of the smoke are usually harmless although they may cause temporary irritation to the eyes, nose or throat. In an artillery projectile white phosphorus is

contained in felt wedges that ignite immediately upon exposure to air and fall to the ground. Up to 15 percent of the white phosphorus remains within the charred wedge and can re-ignite if the felt is crushed and the unburned white phosphorus exposed to the atmosphere. Red phosphorus (RP) is not nearly as reactive as white phosphorus. It reacts slowly with atmospheric moisture and the smoke does not produce thermal injury, hence the smoke is less toxic.

4.5.9.2.2 Thermite incendiaries are a mixture of powdered aluminum metal and ferric oxide. TH is used in bombs for attacks on armored fighting vehicles. Thermite burns at about 2000°C and scatters molten metal, which may lodge in the skin producing small multiple deep burns.

4.5.9.2.3 Magnesium (Mg) burns at about 2000ºC with a scattering effect similar to that of thermite. Its particles produce deep burns. When explosive charges have been added to a magnesium bomb, the fragments may be embedded deep in the tissues, causing the localized formation of hydrogen gas and tissue necrosis.

4.5.9.3 Hydrocarbon fumes. Fuels consist largely of hydrocarbons that may have a narcotic effect. In this respect, because of their lower volatility, diesel and kerosene fuels are less dangerous than petrol gasoline. Fumes from the combustion of these fuels in internal combustion or jet engines contain a proportion of carbon monoxide, nitrous fumes, etc., that varies with the characteristics of the engine and the rate at which it is being run. The overheating of lubricating oils may result in the production of acrolein that is an aldehyde with intense irritant properties. A concentration of 5 mg/m is immediately detectable by odor but a concentration of 50 mg/m causes death in a short time from pulmonary oedema. Gasoline, diesel, and jet fuel vapors are heavier than air and as a result of this may be encountered in fuel tanks, in vehicles or in spaces where fuels have been stored. As far as their chemical properties are concerned, the hydrocarbons are inert, except when in an oxidizing atmosphere, that is capable of supporting combustion. Hydrocarbon fumes are preferentially absorbed into lipid rich tissue, for instance, the central nervous system. Their action is narcotic and they produce unconsciousness and death in concentrations over 1 percent (10,000 ppm) in the case of gasoline fumes. The exact dangerous concentrations depend on the volatility of the hydrocarbons in question, and on their aromatic content. Drowsiness and unconsciousness proceeding to death are encountered in severe poisoning. Less severe exposures may cause dizziness, headache, nausea, vomiting and muscular incoordination.

4.5.9.4 Incendiary devices. Flame-throwers, oil incendiary bombs that may also contain phosphorus and sodium, and fire bombs containing thickened gasoline are all considered incendiary devices. Lung damage from heat and irritating gases may be a complication added to the injuries from incendiaries, especially in confined spaces. As flames from these devices fill an enclosed fortification, the oxygen content of the air is reduced and a hot toxic atmosphere containing large amounts of carbon monoxide, unburned hydrocarbons and smoke is produced. The coolest and least contaminated air is found at floor level. Deaths may occur during or shortly after an attack due to the heat, the toxic atmosphere or suffocation caused by laryngeal or glottic oedema. Survivors may have thermal burns of the skin and upper respiratory tract, as well as pulmonary damage from the hot gases.

4.5.10 Herbicides. A herbicide is any preparation used to kill or inhibit the growth of plants. The term includes defoliants, desiccants, plant growth regulators and soil sterilants. Militarily, herbicides have been used against forest croplands and brush along roads and rivers and around military establishments. b. A wide variety of chemical substances have been used as herbicides. The four primary herbicides are 2,4-D, 2,4,5-T, cacodylic acid, and picloram.

4.5.10.1 2,4-D AND 2,4,5-T. Ingestion of a toxic dose of 2,4-D causes gastroenteric distress, diarrhea, mild CNS depression, difficulty in swallowing, and possibly transient liver and kidney damage. Some people have developed neuropathy as a result of skin contact with the compound. Some hours after exposure to 2,4-D, pain, a loss of feeling, and paralysis may develop. The disability may be protracted and recovery incomplete. However, the number of people who have developed neuropathy after exposure to 2,4-D is extremely small compared to the number of exposures that have occurred. The signs and symptoms of 2,4,5-T poisoning are similar to those of 2,4-D poisoning.

4.5.10.2 Cacodylic. The toxicity of cacodylic acid in humans is not known. However, the experience of workers in a chemical company who have had repeated exposures over long periods of time confirms the observation on rats that the toxicity of these compounds is relatively low. Ingestion of a toxic dose of cacodylic acid by humans may

cause slight burning of the mouth and throat, gastroenteric pain, vomiting, diarrhea, dehydration, jaundice, and collapse. CNS symptoms (headache, dizziness, and hyperexcitability) may be present, obscuring gastroenteric complaints. Shock may develop as a consequence of paralysis and increased permeability of the capillaries.

4.5.10.3 Picloram. As picloram contains 2,4-D isopropyl amine salt, ingestion of a toxic dose would probably produce the same signs and symptoms as are produced by 2,4-D herbicide. Prolonged contact of picloram with human skin will cause mild to moderate inflammation. Contact with the eyes can also be irritating.

4.5.11 Detection/Recognition of Chemical Attacks. It is essential that all personnel are familiar with the signs and symptoms of chemical agent poisoning. Medical and tactical intelligence channels should communicate with each other as early as possible. Threat information on potential use of CW weapons by enemy forces is important for the planning and execution of defensive operations. Once CW weapons have been used, identification of agents will be important to operational commanders. Detection and recognition of chemical attack will rely on information not only from detectors and intelligence sources but also from the casualties themselves. Casualty assessment and physical detection must work together to give the Commander the critical information necessary to maintain a warfighting capability.

4.5.12 Casualty Assessment. There are a number of CW agents for which there are no satisfactory detectors, such as incapacitating agents. In these cases and in cases where readiness and/or chemical warfare units failed to detect the use of agents, medical personnel must be able to recognize the signs and symptoms of chemical attack. In the case of nerve agents, signs and symptoms may range from mild meiosis, headache, and tightness of the chest to signs and symptoms associated with severe poisoning such as convulsions and respiratory failure. The nature and timing of symptoms will vary with the route of exposure. Although choking agents are less likely to be employed, the possibility of their use should not be forgotten. Here the danger is that the inactive period that follows the initial poisoning might be mistaken for recovery, and men or women might be sent back to duty even after a lethal dose. When chemical agents have been used by the enemy, it is important that the fullest and earliest information be given to medical units to facilitate the diagnosis of individual cases and to permit the arrangements for the reception of casualties. Operational units can play a critical role in the identification of chemical attack. Any individual who suddenly becomes a casualty without being wounded or who is suffering a greater degree of incapacitation than is compatible with his or her wound should be considered a possible chemical casualty. It is unlikely that chemical agents would produce single casualties under field conditions and a chemical attack should be suspected with any sudden increase in numbers of unexplained casualties. If chemical operations are unlikely, and if only a few people are affected, another toxic hazard may be more probable (for example, carbon monoxide). Operational units should be alert to the potential effects of chemical weapons and help medical personnel find answers to the following questions.

- Was the casualty wearing full protective equipment at the time of the attack?
- Were there any aircraft or artillery bombardments in the area at the time of the attack?
- Was there any evidence of spray, liquid droplets or smoke?
- Was anybody else affected and if so, how was he or she affected?
- Did the casualty or other personnel in the unit notice any unusual smell? (This is not a very reliable symptom under battle conditions, but it should be considered.)
- Did the available detection equipment respond positively?
- Was there any delay between exposure or contamination and the onset of effects, and if so, for how long?
- Did the effects persist after adjustment of the respirator?
- Has the casualty used any self-injection device? If so, did the symptoms improve or deteriorate?
- Is the casualty's behavior normal?
- Was the casualty exercising or at rest?
- Was the casualty in the open or under cover?

- For how long was the agent inhaled?
- How long was the interval between suspected contamination and decontamination?
- Does any of the following symptoms exist?
    - ◊ An unexplained sudden runny nose.
    - ◊ A feeling of choking or tightness in the chest or throat.
    - ◊ Blurring of vision and difficulty in focusing the eyes on close objects.
    - ◊ Irritation of the eyes.
    - ◊ Unexplained difficulty in breathing or increased rate of breathing.
    - ◊ Sudden feeling of depression.
    - ◊ Anxiety or restlessness.
    - ◊ Dizziness or light-headedness.
    - ◊ Slurred speech.
    - ◊ Nausea.
    - ◊ Muscular weakness.

Medical personnel will have to take the investigation from here and attempt to identify the chemical agent or agents based on clinical monitoring and assessments.

4.5.13 Physical Detection. The Air Force is working with the other services on new and sophisticated chemical agent detection and warning devices. The automatic chemical agent alarm system (XM22) will provide automatic detection of blister and nerve agents. The Joint Chemical Agent Detector (JCAD) is a detector or network of detectors capable of automatically identifying and quantifying chemical agent inside aircraft interiors. The Joint Service Lightweight Standoff Chemical Agent Detector (LSCAD) mounts on any type of vehicle and will detect nerve and blister agents at a distance of five kilometers. The Light NBC Reconnaissance System (LNBCRS) is a light vehicle base equipped with hand-held, portable, and mounted NBC identification and detection equipment. The other services are also working independently on chemical agent detection equipment such as the Chemical Agent Monitor (CAM), the Improved Chemical Agent Monitor (ICAM), the M21 remote sensing chemical agent alarm, and the Fox NBC reconnaissance system. All of this equipment is being fielded now or in the near future. However, this manual will only discuss detection equipment that is currently available for use.

4.5.13.1 CW agent alarms. The Air Force currently uses the M8A1, M90, and the AN/PSR-2 automatic chemical agent alarms to warn operational forces of CW attacks.

- The purpose of the M8A1 automatic chemical agent alarm (Figure 4-17) is to detect the presence of nerve agent vapors and sound an alarm. The M43A1 detector automatically detects nerve agent vapors. It will alarm and send a signal to a connected M42 alarm. The M42 alarm unit provides a warning light and horn at a remote location (up to 400 meters away) when the M43A1 detects nerve agent vapors. The unit comes equipped with a 36 volt non-rechargeable battery. An optional M10A1 power supply is available to convert power from an AC source to DC power for the M43A1. The battery or the he M10A1 attaches directly to the bottom of the M43A1 Detector.

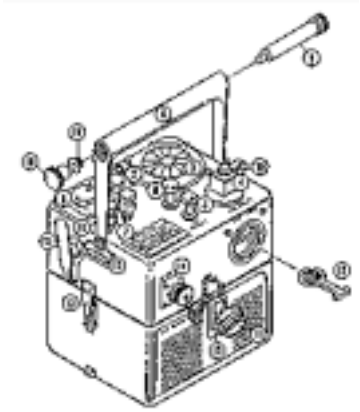


Figure 4-17 - M43A1 Automatic Chemical Agent Alarm (Block F Readiness Training)

- The M90 Chemical Agent Detector (CAD) (Figure 4-18) is designed to quickly detect and measure the presence of nerve and blister agent vapors and give a visual and audible alarm. The detector unit consists of nerve and blister agent alarm lights that illuminate when agent is detected. The detector also has a concentration indicator light that illuminates (LOW, MED, HIGH) to indicate approximate agent concentration. An M90 RH-1 remote alarm unit can be connected to the detector to provide an audible alarm separated from the detector unit. The M90 also has a blood agent detector but the Air Force warns its units not to rely on this capability. Units are instructed to use the M256A1 kit to detect blood agent.

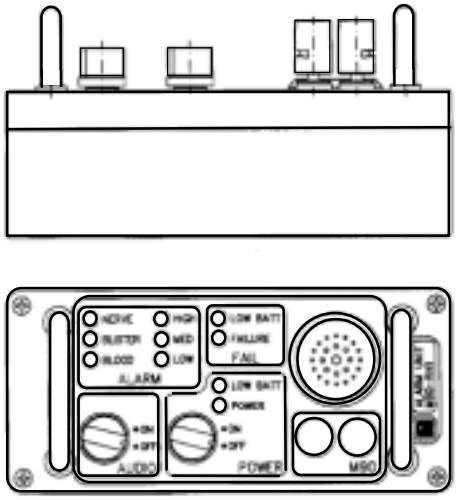
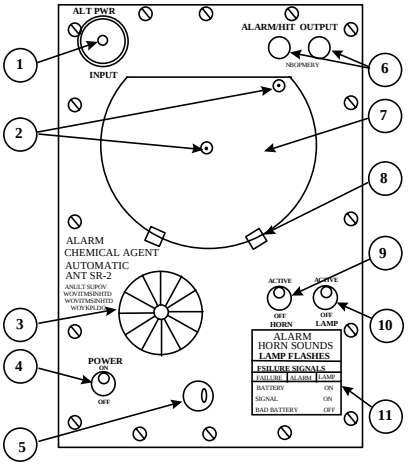


Figure 4-18 - M90 Chemical Agent Detector (CAD) (Block F Readiness Training)

- The automatic liquid agent detector (ALAD) (Figure 4-19), is a self-contained, battery-powered, portable unit that will detect the presence of liquid nerve and/or blister agents and provide a sound and light warning. The ALAD will not identify which chemical agent is detected. The system has an internal horn and lamp alarm. The horn sounds either, when chemicals are present, or when signal faults occur in the system. The lamp alarm provides continuous flashing light when an alarm signal is received from the ALAD. External alarms may be connected with field wire up to a distance of 1000 feet from the detector unit assembly.



1. A/C line power receptacle
2. Sensor pins
3. Horn
4. Power switch
5. Lamp
6. Signal post
7. Sensor mounting plate (with heater)
8. Sensor holder clamp
9. Horn enable/off switch
10. Lamp enable/off switch
11. Alarm/bit instructions

Figure 4-19 - Automatic Liquid Agent Detector (ALAD) (Block F Readiness Training)

4.5.13.2 CW reconnaissance. Immediately following an actual or suspected chemical agent attack, it will be necessary to perform a reconnaissance of the area to determine the type of agent employed and to assess the effect of the agent on the unit's ability to perform its mission. The commander needs to know if the agent is persistent or if the hazard to personnel will pass quickly. In addition, as mentioned earlier the medical community must know what type of chemical was employed in order to properly treat the casualties. The BES is responsible for monitoring in and around medical facilities, sampling water supplies, and possibly assisting readiness monitoring teams. In performing a CW reconnaissance, you should ask questions, make observations, and perform tests using CW detection kits. Your primary objective should be to determine the location of the agent, the type of agent, and the extent of general contamination. **Prior to entering any area suspected of chemical agent contamination, don your ground crew ensemble (GCE) shown in** Figure 4-16**.**

4.5.13.3 Questions and observations. In many cases the actual point or points of contamination will not be known. You will have to question personnel in the field and rely on your powers of observation to narrow down the reconnaissance area. In addition to the questions listed above, the following things may help you determine if and where chemical agents were used.

- Did anyone see anything released from low-flying aircraft?
- Did anyone see or hear bombs, artillery rounds, or missiles that appeared to be duds or blow up with only a small explosion?
- Were there any heavy concentrations of fog or smoke and, if so, where?
- Look for unusual spots on vegetation, rocks, buildings, etc.
- Look for evidence of unusual behavior in people or animals.

4.5.13.4 Where to look. Based on the characteristics of chemical weapons, you should look for contamination in shell craters; low lying areas such as ravines, drainage ditches, and streambeds, and in wooded areas or areas covered with high grass or underbrush. You should perform an initial check of the medical facility for areas of contamination. If contamination is found, establish decontamination requirements and priorities and recheck the area after decontamination is complete. If the hospital or base establishes a personnel or casualty decontamination point,

you should assist with monitoring both the clean area and contaminated area for chemical agent concentrations and advise on decontamination requirements. You must also check all installation water sources and food supplies for evidence of chemical contamination.

4.5.13.5 M256 test kit. The M256 test kit (Figure 4-20) is designed for detection and identification of airborne concentrations of nerve, blood, and blister agents within 15 minutes. It is a portable, expendable item consisting of a carrying case, 12 samplers, one book (25 sheets) of M8 detector paper, and a set of operating instructions. The primary components of the kit include a card that contains test spots, reagent ampoules, a heater assembly, and a rubbing tab. There are three phases to the sample process - preparation of the test spots, exposure of the test spots, and reading the test spots. The components of the kit are numbered to indicate the sequence for running the tests. After preparing the sampler in accordance with the kit directions, expose the sampler to the suspected atmosphere for 10 minutes. NOTES: In temperatures between 32° F and 50° F, wait an additional 5 minutes; in freezing temperatures (below 32° F), you must bring the sampler into a warm area after the 10-minute expose time to allow the reagents to thaw; in hot, dry climates, 5 minutes after exposure, rewet the nerve agent spot with the remaining liquid in ampoule three. The preferred method for testing vapors above suspected liquid agents is to concentrate the vapors in a container and expose the sampler within the container. Always hold the sampler up-wind from yourself so you do not expose it to vapors that may be emanating from your GCE. Once the final steps have been completed in accordance with the kit directions, determine the sample results based on the color of each test spot.

- Lewisite (L): positive result if marking pad is olive green; negative if it is tan
- NOTE: in hot, humid conditions, a positive lewisite result may be very faint. If this occurs, always perform a second test to confirm results.
- Mustard agents (H): positive if square test spot is blue or purple; negative if it is colorless
- Phosgene oxime (CX): positive if square test spot turns red or purple; negative if it is colorless
- Blood agent (AC): positive if round test spot is pink or blue; negative if it is colorless or tan
- Nerve agents (GA, GB, GD, VX): positive if star test spot is colorless or peach; negative if it is blue

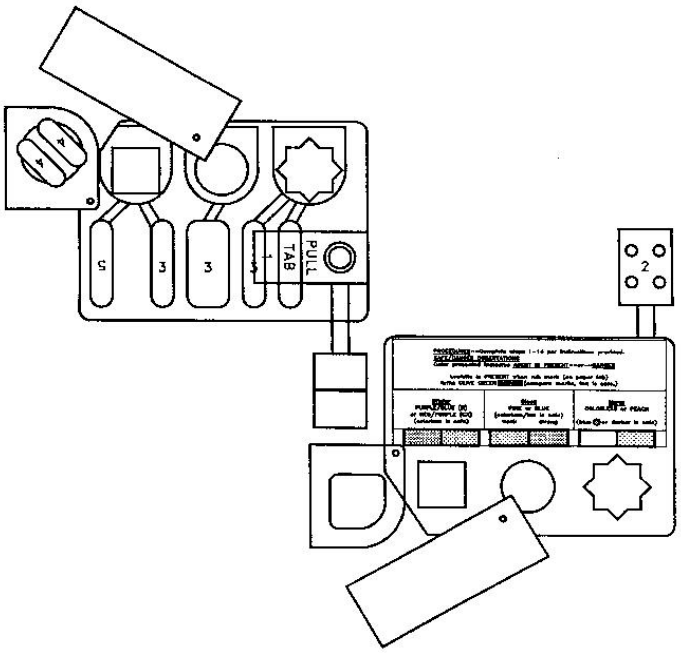


Figure 4-20 - M256 Chemical Agent Detection Kit (90750 CDC)

4.5.13.6 M8 detector paper. M8 detector paper, included in the M256 kit, can be used to quickly test suspected liquid nerve or blister agent. The paper booklet has a color chart and instructions for use. Touch a sheet of detector paper to the suspected liquid agent and observe the color change.

- Mustard agents (H): positive if paper turns magenta
- Nerve agents (GA, GB, GD): positive if paper turns yellow
- Nerve agent (VX): positive if paper turns olive green
- NOTE: Some decontaminants and other substances can indicate a false positive. Any positive result indicated by M8 detector paper must be confirmed by performing a test using the M256 kit.

4.5.13.7 M9 detector tape. M9 chemical agent detector tape is not part of the M256 kit. It must be ordered separately. The M9 tape is a roll of detection paper two inches wide by 30 feet long. It comes in a tear-off dispenser in a resealable moisture and vapor barrier bag. M9 paper changes color in the presence of liquid chemical agents but does not indicate which agent is present. The tape has a gummed back that will allow you to wrap it around the arms and ankles of the GCE to alert the wearer of exposure to liquid CW agents. The tape can also be used to mark equipment and vehicles that have been exposed to CW agents. The light green M9 tape will show pink or red spots when contaminated with agent. The M256 kit can then be used to determine the specific type of agent.

4.5.13.8 M272 CW detection kit. The M272 kit (Figure 4-21) is designed to detect harmful levels of cyanide (AC), mustard (HD), lewisite (L), and nerve agents (GA, GB, GD, VX) in raw or treated water. The kit can detect concentration levels down to 20 mg/L of cyanide, 2 mg/L of mustard and lewisite, and 0.02 mg/L of nerve agent. As long as the concentration of an agent is less than these detectable levels, the water is safe for short term and minimum consumption (up to seven days; five quarts per day). The kit provides enough material to perform 25 tests for each agent. A full block of tests for the four agents will take about 20 minutes. For best results, try to perform the tests where ambient temperatures are from 50° F to 105° F. You may need to perform the tests in a fully protected shelter during periods of heavy rain and low temperatures. In addition to the contents of the kit, you will need the following items:

- Protective gloves that come with the GCE
- Eye protection (use the standard gas mask)
- One full canteen of uncontaminated water for rinsing purposes
- A watch capable of measuring seconds for timing certain tests
- A thermometer that can measure water and ambient air temperature (NSN 6685-00-444-6500, self-indicating, bimetallic thermometer)
- A ¾ to one quart glass or metal container (a lab beaker will suffice)
- A glass or plastic stirrer for mixing simulant agents

The M272 kit contains a number of hazardous materials that are shown below. Therefore, unusable kits must be disposed of as hazardous waste.

- Alkaline solution: 7 percent sodium hydroxide
- Carbaryl (pesticide): 22.5 mg in the blue and white band tubes
- Potassium cyanide: 10 mg in the blue and red band tubes
- Tartaric acid: one gm yellow tablet in the green-labeled packet

Detailed test procedures are included with the M272 kit. However, some principles of operation are as follows:

- Nerve agent: the nerve agent test uses what are called *test tickets*. Test tickets are two chemically treated paper patches that are kept separate until the test is performed. The white patch, wetted with uncontaminated water,

will turn blue when the pink patch is pressed against it. When a nerve agent is present, it will prevent the patch from turning blue. The patch will stay white, which is an indication that the water is not safe to drink.

- Cyanide: A zinc mix is added to test water which forms gas bubbles. The bubbles carry agent products through the white beads in the blue band detector tube. If the beads turn yellow or brown, the water is not safe to drink.
- Lewisite and mustard gas: Both tests are performed on the same test water. When the test water is collected, add a salt mix to it. Testing must start quickly because mustard agent may break down or be lost after 30 minutes. Two tablets are added to the test water to start gas bubbling. The gas picks up lewisite or mustard agent and carries it through the beads in the detector tubes. Always make sure the stopper is tight in the test bottle. If water droplets wet the beads, they will not detect agents and the test will have to be repeated with new water and detector tubes. Lewisite is present when the white beads in the upper red band detector tube turn blue. Hence, the water is not safe to drink. If mustard is picked up by the lower blue band tube, the beads will not change color immediately. The tube must first be heated and then treated with a few drops of alkaline solution. If mustard is present, the beads will turn purple and the water is not safe to drink.

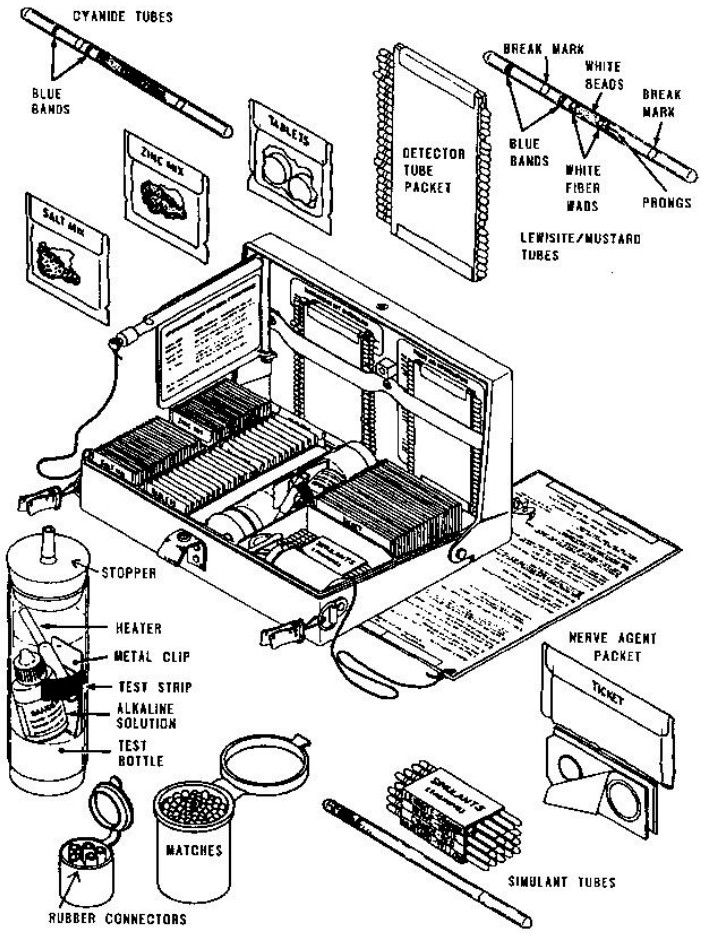


Figure 4-21 - M272 Chemical Agent Detection Kit (90750 CDC)

4.5.13.9 Monitoring of food. All food exposed to chemical attack that has not been protected by agent-proof containers or in fully protected stores must be considered contaminated. Monitoring for volatile agents only may be undertaken by putting the food into a clean plastic bag and sampling the air in the bag with the M256 kit. Where Lewisite contamination is suspected, the food may be suspended in water and the water tested with a water testing

kit. Liquid contamination on the surface of containers may be tested for using M8 detector paper, but this method will only be reliable while liquid agent remains.

4.5.13.10 Marking contamination. The purpose of the NBC Contamination Marking Set (Figure 4-22) is to mark areas or objects that are suspected or confirmed contaminated with NBC agents. The set consists of a carrying container that holds all individual parts of the marking set. There are three flag containers, each containing 20 marking flags. White flags are for marking nuclear contamination. Blue flags for marking biological contamination. Yellow flags for marking chemical contamination. The set also includes a ribbon container that holds 13 rolls of yellow marking ribbon. Each roll is 66 feet long. The ribbon is used to rope off contaminated areas and to hang flags between poles or other objects (Figure 4-23). There are also 48 marking stakes for hanging flags and attaching ribbon.

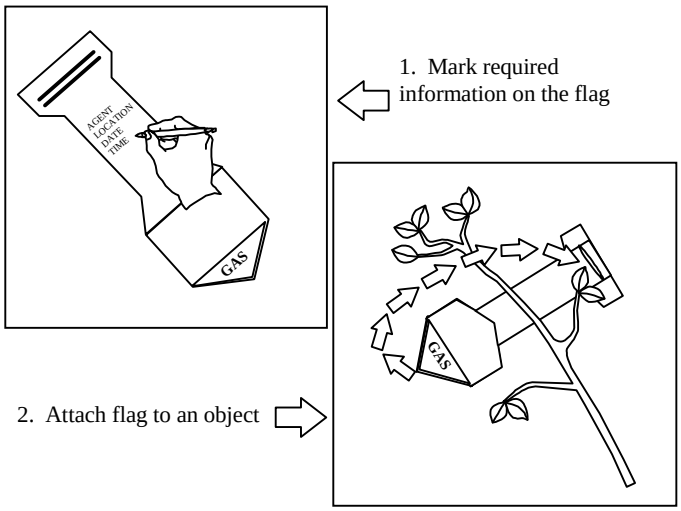


Figure 4-22 - NBC Contamination Marking Set (Block F Readiness Training)

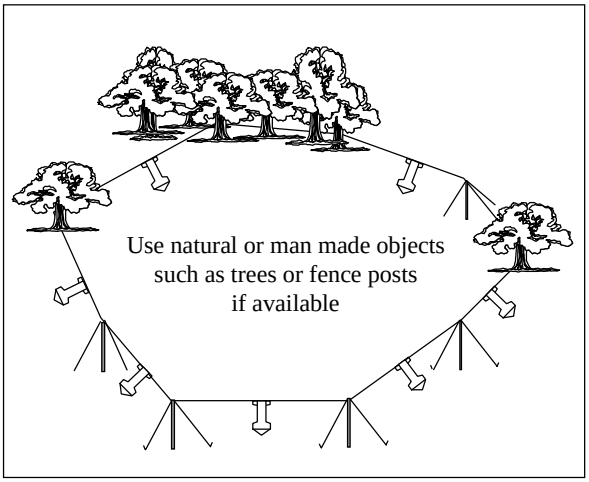


Figure 4-23 - Marking NBC Contaminated Areas (Block F Readiness Training)

4.5.14 Protection of Personnel. Standard issue chemical agent protective clothing and equipment are shown in Table 4-20 . NSNs for this equipment are included in Table 1-13 . Two types of protective masks are currently fielded - the older M-17 mask (Figure 4-15) and the newer MCU-2/P mask (Figure 4-24). Both masks provide adequate protection from NBC threats. However, the MCU-2/P has a larger face piece that allows a much better

field of vision, the screw-on filter canister allows for quicker filter change, and the canister mounts on either side of the mask. Neither of these masks are approved for use in oxygen deficient atmospheres nor are they approved for use in the presence of industrial-type hazardous chemicals in peacetime. The other services are also fielding new personal protective clothing that you may see during joint operations. A new chemical protection suit, the Joint Service Lightweight Integrated Suit Technology (JS-LIST) Ensemble is also under development. The JS-LIST is supposed to provide protection equal to the GCE with much less thermal burden. All four services are scheduled to begin fielding this suit in 1998.

Table 4-20 - Chemical Agent Protective Clothing and Equipment (AFI 32-4001)

ITEM	OPERATIONAL	TRAINING[1]
Groundcrew ensemble[2]	4	1
Protective mask[3]	1	
Overgarment	4	1
Black footwear covers or	8	1
green vinyl overboots (GVO)	4	1
Glove set	8	1
Hood	8	1
Filter set/Canister	8	1
M4 winterization[3, 4]	1	
M8 detector paper[3]	1	
M9 detector tape[3]	1	
M258A1 or M291 decon kit	4	
M58 training decon kit	0	1
Web belt	1	
Canteen[3]	1	
M1 canteen cap	1	
Helmet[3]	1	

Notes:

1. Units may use training equipment pools if shortage of operational equipment exists. However, the unit must maintain enough training equipment to support training and exercise objectives. Revert to the standard training equipment requirements stated above when operational equipment requirements are met.

2. An operational set consists of a protective mask, two filter sets/canisters, an overgarment, two pairs of footwear covers or one pair of GVOs, two pairs of glove sets, and two hoods. Each individual is issued one operational set and the other three operational sets are stored in squadron/unit shelters or bulk storage areas. An individual protective equipment set consists of a groundcrew ensemble, winterization kit (if required), M8 detector paper booklet, M9 detector paper roll, M258A1 or M291 decontamination kit, web belt, canteen, M1 canteen cap, and helmet.

3. Use these items for operations and training, no matter how many ensembles are issued.

4. Only required when chemical defense operations are expected in temperatures below zero degrees Fahrenheit.

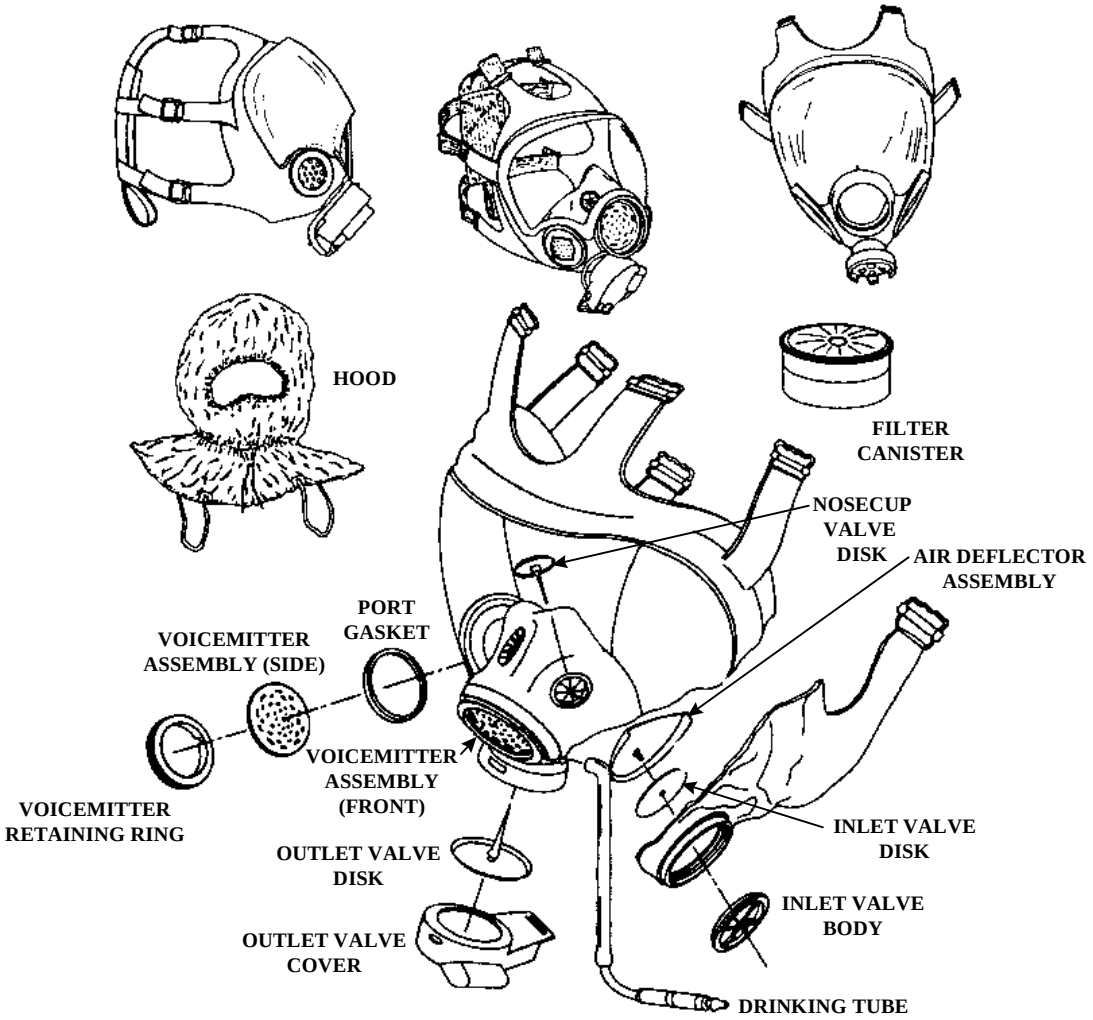


Figure 4-24 - MCU-2/P Mask (90750 CDC

4.5.15 Protection of food and water. Although it is expected that chemical agents will be used mainly against personnel, food and water supplies may easily become contaminated and may be contaminated deliberately. This may occur from contact with chemical agents in the form of vapor, aerosol, drops or splashes of liquid or particulate smokes. This may render food both unpalatable and toxic. Decontamination of food is difficult and often impossible, so that all food not packed in agent proof containers must be stored under protection. When decontamination of food is possible, the decision to undertake decontamination must depend on local factors, for example, the availability of new food. Generally, foods not packed in protective packages constitute the major difficulty. The type and extent of contamination, the availability of replacement supplies, and the available means of decontamination will dictate whether or not reclamation of contaminated items is worthwhile. Water is liable to contamination and may be contaminated deliberately. There are several methods of decontamination. Water is likely to be in short supply, and is more immediately important to the body than food, so methods of protection, control and decontamination of water must be considered.

4.5.15.1 Types of protection for food. In determining the disposition of packaged and stored supplies that have been contaminated, consideration must be given to the nature of the contaminant, as well as to the type of foodstuffs and the security afforded by the packaging material. Some of these factors are listed below:

- Airtight glass bottles, sealed aluminum laminated packages, and sealed metal cans give complete protection against vapor and liquid

- Wooden boxes not sealed for the exclusion of air give almost no protection against vapor and liquid
- Waxed paper boxes sealed for the exclusion of air give good protection against vapor and fair protection against liquid
- Untreated wrapping papers give poor protection against vapor and very little against liquid
- Ordinary textiles in a single layer packaging give almost no protection against vapor and liquid
- Coverings of sod and earth give good protection against vapor and liquid
- Overhead shelters give protection against liquid sprays and splashes. Closed buildings give protection against liquids but often not against vapors, unless the buildings are overpressured with filtered air
- Generally, double layers greatly increase the protective efficiency of packaging materials
- Field rations are packaged to protect the enclosed foods for hours even when the outside of the package is heavily contaminated with a liquid agent

4.5.15.2 Effects of agents on food. The effects of chemical agents on food depend on the properties of both the agent and the food. Contamination of water may lead to a toxic hazard when it is used for food preparation. Nerve and mustard agents readily penetrate fatty foods and will also penetrate granular foods (e.g., grain and sugar). Lewisite penetrates proteins less readily owing to their coagulating action. Fruit may be penetrated by nerve agents. Three groups of foods may be considered on the basis of their composition.

- Food Group 1: Foods with high fat and low water content (butter, fat, oil, ham, fat meat, cheese, milk, eggs and fish). These absorb nerve agents and mustard so readily that decontamination is impossible.
- Food Group 2: Foods with high water content, but low fat and a crystalline structure (e.g., fresh vegetables, fruit, sugar and salt). These absorb mustard and nerve agents in vapor and in liquid form.
- Food Group 3: Foods with low fat content and amorphous structure (flour, bread, grain, rice cereals, dried fruit and vegetables, tea, coffee, peas and beans). These absorb liquid nerve and mustard agents; some absorption of vapor may occur.

Food may become highly toxic without any change in its appearance. The expected effects of some chemical agents on the appearance of food are summarized in Table 4-21. The absence of these signs must not be relied upon in deciding that exposed food is fit for consumption. Table 4-22 shows the recommended disposition of food that has been contaminated with chemical agents.

Table 4-21 - Effects of Agents on Properties of Food (Army FM 8-9)

Agent	Taste	Smell	Color
Mustard	Affected	Garlic	Meat discolored
N-Mustards	Affected	Fishy	No discoloration
Lewisite	Acid	Unpleasant	Meat & vegetables discolored
Nerve agents	None	None	No effect
White phosphorus	Acid	Garlic	Glows in the dark

4.5.15.3 Protection of water. The appearance of water does not indicate contamination, and any water exposed to high concentrations of vapor, or any liquid contamination must be regarded as toxic until tests have been made. Open water sources subjected to chemical attack should be considered contaminated until tested. Water from deep wells will be safe provided that the well mouth is covered. Water in closed metal tanks will be safe provided that the tap and air inlet are decontaminated.

Table 4-22 - Disposition of Chemical Agent Contaminated Food (Army FM 8-9)

Type of Agent	Food Group 1	Food Group 2	Food Group 3
Nerve agents (liquid	Condemn	Condemn	Condemn
Nerve agents (vapor)	Condemn	Expose dry food to air for 48 hours. Wash other food with 2 percent sodium bicarbonate solution. Peel where applicable and cook by boiling	Expose dry food to air for 48 hours. Wash other food with 2 percent sodium bicarbonate solution. Peel where applicable and cook by boiling
Blister agents (liquid)	Condemn	Condemn	Condemn
Blister agents (vapor)	Condemn	Expose dry food to air for 48 hours. Wash other food with 2 percent sodium bicarbonate solution. Peel where applicable and cook by boiling	Expose dry food to air for 48 hours. Wash other food with 2 percent sodium bicarbonate solution. Peel where applicable and cook by boiling
Choking agents	Wash food with water. Expose to air for 24 hours. Food may still be unpalatable due to acid taste	Wash food with water. Expose to air for 24 hours. Food may still be unpalatable due to acid taste	Wash food with water. Expose to air for 24 hours. Food may still be unpalatable due to acid taste
Cyanide agents	Unlikely to dangerously contaminate food	Unlikely to dangerously contaminate food	Unlikely to dangerously contaminate food
Riot control agents	Food may be unpalatable	Food may be unpalatable	Food may be unpalatable

4.5.16 Decontamination. In wartime, manpower and time are critical resources that cannot be wasted on non-essential tasks. Decontamination of areas, facilities, and equipment must be limited to only what is essential to protect personnel and resume operations. The commander determines the need for decontamination operations based on the tactical situation, the nature and extent of contamination, resources available, and potential results of the operation. Decontamination beyond the individual level is accomplished by organizational personnel under the supervision of contamination control teams. Always give first priority to personnel decontamination to prevent casualties and reduce losses. The second priority is mission-essential aircraft and related equipment and material/facilities. The commander establishes mission requirements. There are four levels of decontamination - immediate, operational, thorough, and reconstitution. To select the best level to use, consider the amount of time, materials required, and what level of decontamination is acceptable for mission activities.

- Immediate decontamination is aimed at minimizing casualties, saving lives, and limiting the spread of contamination. It is conducted by the individual when they suspect they have been contaminated. It involves decontaminating the skin, personal clothing, and equipment.
- Operational decontamination is aimed at minimizing contact and transfer of contamination. It is conducted by individuals, crews, teams, or units when required by operations. It involves decontaminating specific parts of operationally essential equipment, material, work areas, and exchange of individual protective equipment.
- Thorough decontamination is aimed at reducing contamination to the lowest possible levels, to permit partial or total removal of IPE, and to maintain operations with minimum degradation. It is conducted by units or wings, with or without external support, when permitted by operations, manning, and resources. It involves decontaminating personnel, equipment, material, or work areas and may include some terrain beyond the scope of operational decontamination.
- Reconstitution decontamination is complete decontamination of all essential resources.

4.5.16.1 Types of decontaminants. There are three general types of decontaminants used to reduce or neutralize the hazards from chemical warfare agents. They are natural, standard, and miscellaneous. Table 4-23 summarizes the various decontaminants that can be used on chemical agents.

Table 4-23 - Chemical Agents and Effective Decontaminants (Block F Readiness Training)

Agent		Decontaminant
CHOKING AGENTS	Phosgene and diphosgene	None needed in field, aeration in closed spaces
NERVE AGENTS	TABUN - GA	Bleach slurry; dilute alkali, or DS2; steam and ammonia in confined area; M258A1, M291, M295 kits
	SARIN - GB	In confined area steam and ammonia; hot soapy water; M258A1, M291, M295 kits
	SOMAN - GD	Bleach slurry; dilute alkali, or DS2; steam and ammonia in confined area; M258A1, M291, M295 kits
	VX	STB, slurry or DS2 solution; hot soapy water, M258A1, M291, M295 kits
BLOOD AGENTS	AC and CK	None needed in the field
BLISTER AGENTS	Distilled mustard - HD	Bleach, fire, DS2, M258A1, M291, M295 kits
	Nitrogen mustard - HN-1, HN-2, HN-3	Bleach, fire, DS2, M258A1, M291, M295 kits
	Lewisite	Bleach, fire, DS2, caustic soda, M258A1, M291, M295 kits
VOMITING AGENTS	Adamsite - DM	None needed in the field; bleach or DS2 in confined spaces
TEAR AGENTS	CN	Aeration in the open; soda ash solution or alcoholic caustic soda in closed spaces
	CS	Water, 5 percent sodium bisulfite, and water rinse
INCAPACITATING AGENTS	BZ	Wash with soap and water; shake or brush; hypochlorite or caustic alcoholic solutions; detergent wetting solutions

4.5.16.1.1 Natural decontamination is divided into four basic groups: weathering, earth, fire, and water

- Weathering gradually decomposes chemical agents by aeration, evaporation, or hydrolysis. The time necessary for decontamination by weathering depends on the persistency of the agents, the chemical make-up, climatic conditions, and type of surface. Although weathering is the easiest method of decontamination to accomplish, prediction of agent persistency is difficult because of the many variables.
- Earth is used to seal or absorb contamination. Covering an area with approximately four inches of earth gives protection as long as the earth is not disturbed or the chemical agent exposed. An area treated in this manner will require periodic monitoring. In the absence of a better absorbent, you may use earth to remove liquid contamination from material by absorption.
- Fire vaporizes and destroys chemical agents. The ideal conditions for using fire are during falling temperatures with moderate winds blowing away from friendly forces. When using fire as a decontaminant remember to consider the possible downwind hazards.
- Flowing water will flush agents from surfaces and will hydrolyze some agents. Hot water is more effective than cold water and adding soap or detergent produces an even more effective decontaminant. High pressure application produces a better cleansing action than low pressure.

4.5.16.1.2 The next types of decontaminants are called standard decontaminants. There are four basic types of standard decontaminants - super tropical bleach (STB), decontaminating standard number 2 (DS2), high-test hypochlorite (HTH), and skin irritant decontaminant (SID).

- STB decontaminates most chemical agents and biological agents. STB is a mixture of chlorinated lime and calcium oxide in a white powder form. If needed, substitute household bleach for diluted STB. STB will decontaminate mustard, Lewisite, and nerve agents. STB is a strong oxidizing agent. It is very caustic and reacts with water to produce heat and toxic or corrosive vapors. Its solutions are very irritating to the skin, eyes, and respiratory system. Do not store STB with or near flammable chemicals such as DS2, solvents, paint removers, or petroleum products. When handling STB you should wear your individual protective equipment. STB is mixed with water to form a wet mixture called *slurry* or dry earth to form a *dry mix*. Slurry is used where agents have been absorbed into the ground or other porous materials. There are two types of slurry: one for manual application, the other for application by a power-driven decontamination apparatus. For manual application with swabs, brushes, or brooms, the most effective slurry is approximately equal parts (by weight) of STB and water. The recommended load for a 500-gallon power-driven decontaminating apparatus is 1,300 pounds of STB and 225 gallons, approximately 1,800 pounds, of water. The dry mix consists of STB thoroughly mixed with dry earth. The portions by weight are two parts of STB to three parts of earth or other dry material. You can use dry mix in shuffle boxes or place it under equipment to decontaminate agents flushed from it.

- DS2 is a general-purpose decontaminant available in ready-to-use solutions that effectively decontaminate all known toxic chemical agents. DS2 can be used to decontaminate equipment and material. When using DS2, apply to the contaminated surface and leave for 30 minutes before rinsing with water. The solution is effective at temperatures from minus 15° to 125° Fahrenheit. DS2 is very irritating to the skin and eyes; therefore, wear individual protective equipment when using it. Because of its low flash point, DS2 presents a fire hazard if used on heat-producing devices or running engines.

- HTH is a bleach in granular or tablet form. It has a higher percentage of chlorine than STB; therefore, it is more corrosive. HTH is used for decontamination of individuals and personal protective equipment. HTH is effective against Lewisite and V-nerve agents. Dissolve 6 ounces of HTH and 6 ounces of detergent in 12 gallons of water to make a decontamination solution. This solution must be changed daily.

- Skin irritant decontaminant (SID) is effective in neutralizing the skin irritating properties of riot control agents CS and CN. SID can be locally manufactured using isopropyl alcohol, glycerin, and sodium bisulfate. Mix 2½ cups of 70 percent isopropyl alcohol with 1 cup water, ½ cup of glycerin, and 2 level tablespoons of sodium bisulfate. SID should be sprayed or poured directly on the contaminated skin and rubbed in with the hand.

4.5.16.1.3 Miscellaneous decontaminants consist of a wide variety of items found on most Air Force bases. They include soap or detergent, caustic soda, washing soda, ammonia, household bleach, common solvents, degreasing solvent similar to GUNK, and absorbents.

- Soap or general-purpose liquid detergent provides a good cleaning medium for removing chemical contamination from individuals, equipment, and material. Soap solutions may be used in power-driven decontamination apparatuses or applied manually. General detergent is the only decontaminant for use in the M17 decontamination apparatus. Ten pounds of soap in 11 gallons of water is recommended for G-agents.

- Caustic soda or sodium hydroxide, which is more commonly known as lye, is a white solid that dissolves easily in water or alcohol. Caustic soda will destroy G-nerve agents on contact. Caustic soda hastens hydrolysis of Lewisite. However, mustard agent is destroyed only after prolonged contact. For a G-nerve and blister agents, a 5 percent water solution is prepared by dissolving 5 pounds of caustic soda in 12 gallons of water. For VX agents, a 5 percent alcohol solution is prepared by dissolving 5 pounds caustic soda in 6 gallons of water and 6 gallons of alcohol. As the name implies, this decontaminant is very caustic or corrosive and can easily burn skin and eat away clothing on contact. Wear protective equipment when using it.

- Washing soda is a white alkaline powder. Common names include soda ash and laundry soda. A hot or cold solution of washing soda and water is very effective and recommended for decontaminating G-nerve agents.

- Monothanolamine (MEA) is the most effective decontaminant for CS, CS-1, CS-2, and CN training and riot control agents.
- Ammonia or ammonia hydroxide which is an ammonia water solution is another decontaminant for chemical agents. It is effective against G-nerve agents.
- You can use common solvents such as de-icing fluids, kerosene, and alcohol for many chemical agents. Solvents remove agents from the contaminated surfaces; they don't destroy the agents.
- A degreasing solvent, such as GUNK*, is a non-corrosive, water-soluble liquid commonly used to clean aircraft and automobile engines. After applying, allow it to remain 15 minutes or more. Use water, preferably under pressure, to remove the solvent and to flush the dirt, grease, oil, and chemical agents from the equipment. Dispose of the contaminated waste properly.
- Absorbents are materials used to soak up and then physically remove, but not destroy the agents. You could use charcoal, coal dust, clay, dirt, manufactured absorbent, sawdust, etc., as absorbents. Absorbents are contaminated after use and must be handled as contaminated waste.
- Adsorbent is a material used to adhere, become attached mechanically or chemically to a chemical agent, but which does not destroy the agent, i.e., FULLER'S EARTH. The adsorbent is contaminated after use and is treated as contaminated waste.

4.5.16.2 Decontamination of people. As mentioned earlier, personnel decontamination receives a high priority in order to minimize casualties, save lives, and limit the spread of contamination. There are two basic types of personnel decontamination - individual decontamination that is performed by individual personnel on themselves or their buddies and personnel decontamination that is performed by contamination control or medical activities.

4.5.16.2.1 Individual decontamination. Individual personnel are issued nerve agent antidote auto-injectors for immediate treatment of nerve agent poisoning. Other kits are provided for decontamination of skin and personal protective equipment.

- Nerve agent. The current self-aid/buddy care for nerve agent poisoning includes pretreatment with nerve agent pyridostigmine pretreatment (NAPP) tablets followed by administration of the nerve agent antidote kit. The NAPP tablets are a pretreatment that makes the antidote kit more effective. The antidote kit contains atropine and pralidoxime chloride (2-PAM Cl) auto-injectors. Upon recognition of the onset of the symptoms of nerve agent poisoning (Table 4-14), inject yourself in the thigh or buttoxs (Figure 4-25) with one atropine and one 2-PAM Cl auto-injector. Attach the used auto-injectors to your pocket flap by jabbing the needle through the flap and bending the needle over. This will let medical personnel know how many injections were administered. If after 10 minutes the symptoms persist, inject yourself with another set of auto-injectors. If symptoms persist inject yourself again after 10 minutes. If a person is unable to perform self-aid, a "buddy" should administer the antidote. If the symptoms are very severe, inject all three antidote sets in rapid succession and pin the used auto-injectors to the victim's pocket flap.
- M258A1 skin decontamination kit. The M258A1 decontamination kit (Figure 4-26) is used for spot decontamination of the skin. If the kit is not available, use soap and water, or any other decontaminant shown in Table 4-23. The M258A1 kit contains six packets - three with a number one and three with a number two. Follow the instructions on the kit. Blot the chemical agent with the number one pad and then sponge the area with the number two pad. Number one neutralizes V and H agents and number two neutralizes G agents and also neutralizes the caustic substances left from the number one pad. This kit cannot be used in the eyes. If you get CW agent in your eyes, thoroughly flush them with water from your canteen.
- M291 skin decontamination kit. The M291 skin decontamination kit is for external use only. Contents of the kit may be slightly irritating to the skin or eyes. Keep the decontaminating powder out of the eyes, cuts, and wounds. Use water to flush your eyes, cuts, or wounds. Each M291 kit consists of a wallet-like carrying pouch containing six individual decontamination packets. Each packet contains an applicator pad filled with black decontamination powder. Unlike the M258A1 kit, the M291 pad does not need to be neutralized by application of a second pad. However, each skin decontamination procedure normally takes two M291 pads.

- M295 equipment decontamination kit. The M295 kit is for external use on equipment. It may be slightly irritating to skin or eyes. Keep the decontaminating powder out of eyes, cuts, and wounds. Avoid inhalation of the powder. The M295 kit is used to remove liquid chemical agents. Decontaminated items may still present a vapor hazard. Don't unmask until it's been determined safe to do so. The M295 kit allows you to decontaminate your individual equipment through physical removal and absorption of liquid chemical agents. Possible uses of the kit include immediate decontamination for equipment other than individual protective gear as well as for contamination control area (CCA) operations. For example, you should use the kit on your chemical ground crew ensemble at the entrance of a CCA. Currently, the M295 kit is not a part of an individual's basis of issue. AF guidance suggests that contamination control teams include this in their equipment inventory. Each M295 kit consists of a carrying pouch containing four individual decontamination packets. There are enough packets to do two complete individual equipment decontamination operations.

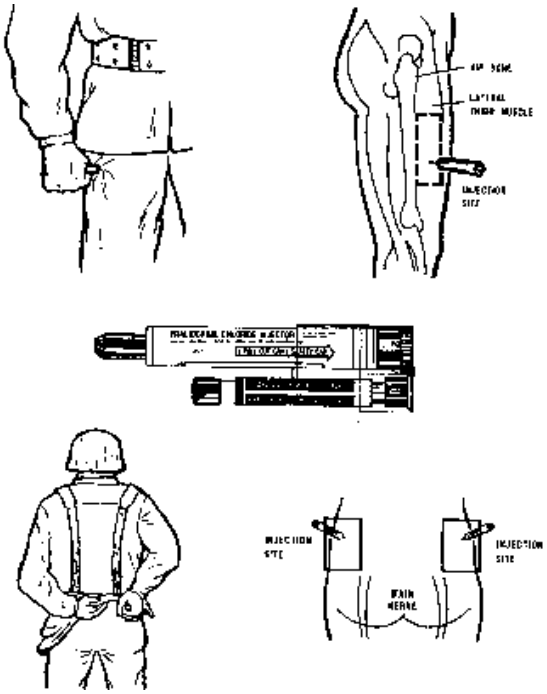


Figure 4-25 - Administration of The Nerve Agent Antidote Kit (90750 CDC)

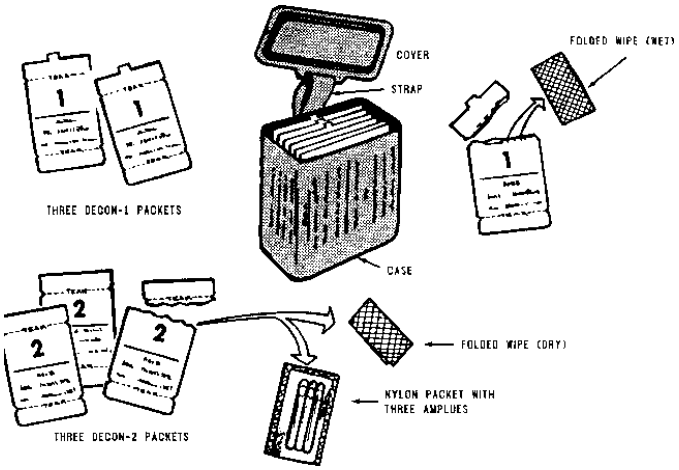


Figure 4-26 - M258A1 Skin Decontamination Kit (90750 CDC

4.5.16.2.2 Personnel decontamination. Specially trained contamination control teams (CCTs) use the M17 decontaminating apparatus to perform general personnel decontamination. The M17 is a 500-gallon water trailer with a pump and a heater. Soapy water can be pumped through a shower assembly for decontaminating people or through a spray wand for decontaminating anything else. When CCTs are available, the BES normally assists medical activities with decontamination of casualties. Accordingly, this subsection will address patient decontamination. Decontamination begins at the individual level as discussed in the previous paragraph. However, when conditions prevent individual decontamination or when contamination occurs en route to the medical facility, patient decontamination will have to be performed at the medical facility. The first requirement is to establish a patient decontamination area where all arriving patients can be checked for contamination and then decontaminated if required.

4.5.16.2.3 Patient decontamination area. The patient decontamination area should have two sides - a contaminated side and a clean side separated by a hot line (Figure 4-27). The area should be covered and sited so prevailing winds will blow contamination away from the facility. Shuffle pits containing STB or HTH should be provided at the entrance to the decontamination area and at the hot line. During operations, periodic checks are made of the atmosphere within the area. These checks are made using chemical agent detection equipment such as the chemical agent alarms discussed previously. Should chemical agent penetration occur, all personnel must don masks until the agent has been purged from the area. Normally, the medical facility will not be located in a contaminated environment. However, if liquid agent contamination is present, the immediate area around the entrance must be decontaminated. To decontaminate the area around the entrance use one or more of the following methods:

- Turn over about 4 inches (10 cm) of soil
- Remove the top layer of soil containing any liquid agent. Check the area with a detector or alarm after top soil removal to ensure complete removal of the agent
- Add several inches of clean soil or sand
- Mix STB into the soil to make a shuffle pit
- Use DS2 decontaminant on contaminated ground that is hard-surfaced or frozen

All personnel (staff and patients) must be decontaminated before they are permitted to cross the hot line into the clean side of the medical facility. Use chemical detection equipment to check for the presence of contamination on individuals and their equipment. If a chemical agent is detected, decontaminate the patient.

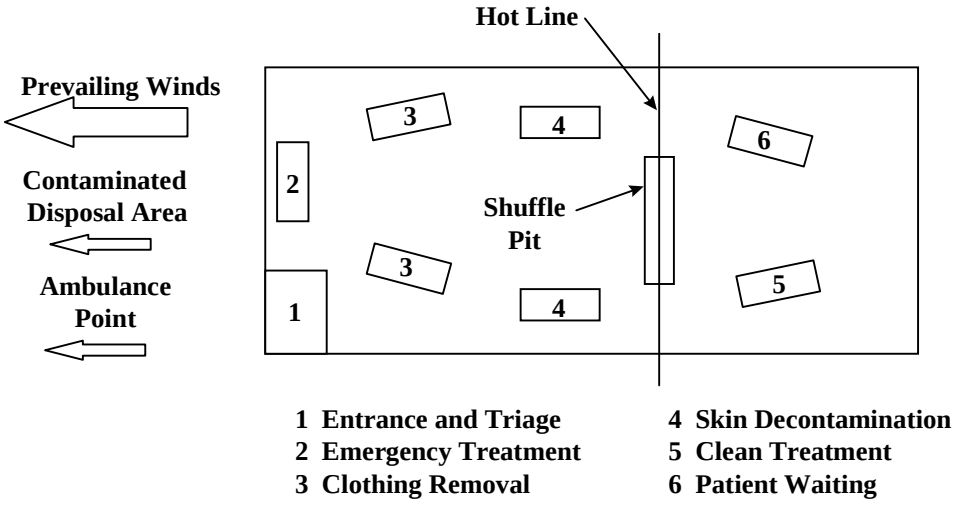


Figure 4-27 - Patient Decontamination Area (Army FM 8-10-7)

4.5.16.2.4 Patient decontamination. Patient decontamination is the systematic removal of clothing and contaminants from patients who are unable to decontaminate themselves. All patients arriving at the hospital from suspected contaminated areas will be considered as being contaminated. They must be decontaminated before being admitted into the clean areas of the hospital. The standard M258A1 or M291 skin decontaminating kits can be used for this purpose. An alternative patient decontamination agent is a chlorine solution. Two concentrations of the chlorine solution are required. Use a five percent chlorine solution to decontaminate gloves, aprons, litters, cutting device, the patient's mask hood, and other non-skin contact areas. Use a 0.5 (½) percent chlorine solution to decontaminate the patient's mask, skin, splints, and to irrigate wounds. To prepare the solutions, bulk calcium hypochlorite (HTH) or sodium hypochlorite (household bleach) may be used. Table 4-24 shows the amount of HTH (65 percent strength) and household bleach (5 percent strength) that must be added to water to produce 0.5 percent and 5 percent chlorine solutions.

Process a litter patient as follows. After the patient has been triaged and stabilized (if necessary) by the senior medic in the patient decontamination area, move him/her to the litter stands at the clothing removal station. The patient is decontaminated and undressed as follows:

1) Decontaminate the mask and hood. Use the M291 kit, or sponge down the front, sides, and top of the mask hood with a 5 percent chlorine solution or household bleach.
2) Remover the hood. Remove the hood by cutting it off or loosening it from the mask attachment points. Before cutting the hood, dip the cutting device in a 5 percent chlorine solution
3) Decontaminate the protective mask and exposed skin. Use the M291 kit or a 0.5 percent chlorine solution. Wipe the external parts of the mask. Cover the mask air inlets with gauze or your hand to keep the mask filter dry. Continue by wiping the exposed areas of the patients face, to include the neck and behind the ears
4) Remove gross contamination from the patient's overgarment. Remove all visible gross contamination by scraping with a stick or other scraping device. Decontaminate spots with the M295 kit or the 5 percent chlorine solution.
5) Remove the patient's personal effects and protective overgarment. Remove the patient's personal effects from his protective overgarment and BDU pockets. Place the articles in a plastic bag, label with the patient's identification, and seal the bag. If the articles are not contaminated, they are returned to the patient. If the articles are contaminated, place them in the contaminated holding area until they can be decontaminated, then return them to the patient.
6) Cut the patient's overgarment. The overgarment jacket and trousers may be cut simultaneously. Two persons may be cutting clothing at the same time. Cut around bandages, tourniquets, and splints, leaving them in place.
7) Remove overgarment jacket. Make two cuts, one up each sleeve from the wrist up to the shoulder, and then through the collar. Dip the cutting device in the 5 percent chlorine solution before making each cut to prevent contamination of the patient's uniform or underclothing. Keep the cuts close to the inside of the arms so that most of the sleeve material can be folded outward. Unzip the jacket; roll the chest sections to the respective sides, with the inner surface outward. Continue by tucking the clothing between the arm and chest. Roll the cut sleeves away from the arms, exposing the black liner.
8) Remove overgarment trousers. Cut both trouser legs starting at the ankle. Keep the cuts near the inseams to the crotch. With the left leg, continue cutting to the waist, avoiding the pockets. With the right leg, cut across at the crotch to the left leg cut. Place the cutting device in the 5 percent chlorine solution. Fold the cut trouser halves away from the patient and allow the halves to drop to the litter with contaminated (green) side down. Roll the inner leg portion under and between the legs.
9) Remove outer gloves. This procedure can be done with one person on each side of the patient working simultaneously. The decontamination team will decontaminate their gloves in 5 percent chlorine solution. Next, lift the patient's arms up and out of the cutaway sleeves unless detrimental to the patient's condition. Grasp the fingers of the glove, roll the cuff over the fingers, turning the glove inside out. Do not remove the inner cotton glove liners at this time. Carefully lower the arms across the chest after the outer gloves have been removed. Do not allow the patient's arms to come into contact with the exterior of his overgarment. Drop his gloves into the contaminated waste bag. Dip your gloves in the 5 percent chlorine solution.
10) Remove overboots. Cut the overboot laces and fold the lacing eyelets flat outwards. If the GVO is worn, first try to remove the overboot without cutting; if necessary, cut the boot along the front. While standing at the foot

of the litter, hold the heel with one hand, pull the overboot downwards, then pull towards you to remove the overboot over the combat boot heel. Remove the two overboots simultaneously. This reduces the likelihood of contaminating one of the combat boots. While holding the heels off the litter, have a decontamination team member wipe the end of the litter with the 5 percent chlorine solution to neutralize any liquid contamination that was transferred to the litter from the overboots. Lower the patient's heels onto the decontaminated litter. Place the overboots in the contaminated waste bag. Decontamination personnel dip their gloves in the 5 percent chlorine solution.

11) Remove battledress uniform. Cut the BDU jacket and trousers as described above for the protective overgarment. Roll the jacket and trousers as described for the protective overgarment.

12) Remove combat boots. Cut the boot laces along the tongue. Remove the boots by pulling them towards you. Place the boots in the contaminated waste bag. Do not touch the patient's skin with contaminated gloves when removing his boots.

13) Remove undergarments. Follow the procedures for cutting away the protective overgarment and rolling it away from the patient. If the patient is wearing a brassiere, cut it between the cups. Cut both shoulder straps where they attach to the cups and lay them back off of the shoulders. Remove the socks and cotton glove liners. Do not remove the patient's identification tags.

14) Transfer the patient to a decontamination litter. After the patient's clothing has been cut away, he/she is transferred to a decontamination litter or a canvas litter with a plastic sheeting cover. Decontamination team members decontaminate their gloves and aprons with the 5 percent chlorine solution. One member places his hands under the patient's legs at the thighs and Achilles tendons, a second member places his arms under the patient's back and buttocks, and a third member places his arms under the patient's shoulders and supports the head and neck. They carefully lift the patient using their knees (not their backs) to minimize back strain. While the patient is elevated, another decontamination team member removes the litter from the litter stands and replaces it with a decontaminated (clean) litter. The patient is carefully lowered onto the clean litter. The contaminated clothing and overgarments are placed in bags and moved to the contaminated waste disposal area. The dirty litter is rinsed with the 5 percent chlorine solution and placed in the litter storage area.

15) Decontaminate skin. With the patient lying on his/her back, spot decontaminate the skin using the M291 kit or a 0.5 percent chlorine solution. Decontaminate areas of potential contamination. Include areas around the neck, wrists, and lower parts of the face. Decontaminate the patient's identification tags and chain, if necessary. NOTE: complete body wash is not appropriate and may be injurious to the patient. During complete body wash the patient would have to be rolled over to reach all areas of the skin. This is not necessary for adequate decontamination. WARNINGS: DO NOT APPLY THE M291 KIT OR IRRIGATE WOUNDS IN THE ABDOMINAL AND THORACIC CAVITIES OR INTRACRANIAL HEAD INJURIES. DO NOT USE THE WIPES FROM THE M258A1 KIT AROUND ANY WOUNDS. DO NOT REMOVE SPLINTS.

16) Check patient for completeness of decontamination. The patient is checked with a monitor or with M8 detector paper for completeness of decontamination.

17) Dispose of contaminated waste. Dispose of contaminated bandages and coverings by placing them in a contaminated waste bag. Seal the bag and place it in the contaminated waste disposal area

18) Transfer the patient across the shuffle pit. The patient's clothing has been cut away and his skin, bandages, and splints have been decontaminated. Now the litter is transferred to the shuffle pit and placed on litter stands. The shuffle pit is wide enough to prevent the patient decontamination team members from straddling it while carrying the litter. Four decontamination team members transfer the patient to a clean treatment litter in the shuffle pit. Decontamination personnel rinse or wipe down their aprons and gloves with the 5 percent chlorine solution. Team members lift the patient off the litter and another decontamination team member removes the litter from the stands and returns it to the decontamination area. A medic from the clean side of the shuffle pit replaces the litter with a clean one. The patient is lowered onto the clean litter. Two medics from the clean side of the shuffle pit move the patient to the clean treatment area. The patient is treated in this area or awaits processing into the medical facility.

19) The litter removed by the decontamination team member is wiped down with the 5 percent chlorine solution in preparation for reuse.

Table 4-24 - Chlorine Solution for Patient Decontamination

	0.5 percent Strength Decon Solution		5 percent Strength Decon Solution	
Gallons of Decon Solution	**Amount of HTH**	**Amount of Household Bleach**	**Amount of HTH**	**Amount of Household Bleach**
5	5 oz	2 qts	3 lbs 2 oz	Note 1
10	10 oz	1 gal	6 lbs 4 oz	Note 1
25	1 lb 9 oz	2.5 gal	15 lbs 10 oz	Note 1
50	3 lbs 2 oz	5 gal	31 lbs 4 oz	Note 1

Note 1: Household bleach is approximately 5 percent chlorine solution so it can be used full strength

$$\text{ounces of HTH} = \text{\% strength of decon solution} \times \frac{\text{gallons of water to be chlorinated}}{\text{\% strength of HTH}} \times \frac{16 \text{ ounces}}{\text{pound}} \times \frac{8.34 \text{ pounds}}{\text{gallon of water}}$$

$$\text{gallons of household bleach (HHB)} = \text{\% strength of decon solution} \times \frac{\text{gallons of water to be chlorinated}}{\text{\% strength of HHB}}$$

4.5.16.3 Decontamination of equipment. DS2 neutralizes all known chemical agents and is the decontaminant of choice for most equipment. DS2 is available in 1.3 quart and 5 gallon containers (Table 1-13). The solution can be used in the M11 decontaminating apparatus (which resembles and operates like a fire extinguisher) and sprayed on contaminated equipment. DS2 can also be applied with brooms and swabs. After it has been applied, scrub the contaminated surface. Pay special attention to all nooks, recesses, and other hard-to-reach areas. To effectively neutralize a chemical agent, DS2 must remain in contact with the agent for 30 minutes. After 30 minutes, flush the surface with clean water. DS2 is irritating to the eyes and skin; therefore, you must wear a protective mask when applying it. If it comes in contact with your skin, wash the area with water. DS2 is flammable, so take care to keep it away from sources of ignition. DS2 is not corrosive to most metals, but it does corrode aluminum, cadmium, tin, and zinc after prolonged contact. Remember to flush all surfaces after the 30-minute contact time.

4.5.16.4 Decontamination of food. Before any decontamination is done, a careful survey should be made to determine the extent of the contamination. From information gained in this survey, the exposed items should be divided into three groups for separate treatment as described below.

- Group I will consist of canned and unopened packaged items that have been exposed only to the vapors of a chemical agent. Generally, the items in this group will be safe to issue to personnel after a brief period of outdoor airing to remove clinging vapors.
- Group II will consist of canned and unopened packaged items, the outsides of which have been contaminated with a liquid chemical agent. The best procedure is to allow self-decontamination of the packaging material by aging and airing. If a shortage of food does not permit the necessary time for self-decontamination, then a decontamination procedure is to strip off the outer contaminated coverings and examine the inner layer to see if agent penetration has occurred. If it has, continue stripping off layers until an uncontaminated layer is reached.
- Group III will consist of unpackaged or poorly packaged items that have been exposed to an agent in either vapor or liquid form. Decontamination of food itself will be attempted only in emergency situations when there is no alternative supply of food. The general decontamination procedure to be followed in sequence is:
    - Trimming of surface fat and/or grossly contaminated areas
    - Washing with water of 2 percent sodium bicarbonate solution or 1 percent chlorine solution
    - Boiling in water. Frying, roasting or boiling will not remove traces of nerve or blister agents from meats. Salvage of foods contaminated with droplets of the blister agents, especially the arsenical blister agents, is not practical.

4.5.16.5 Decontamination of water. Simple boiling is not a reliable method of decontamination. The following methods are available for decontaminating water and may be used in combination.

- Reverse Osmosis. The Reverse Osmosis Water Purification Unit (ROWPU) effectively removes chemical agent contamination.
- Filtration. In a small scale emergency, water may be decontaminated by running it through a spare unused respirator canister, provided that the flow rate is such that the water emerges drop by drop; any water coming through at first faster than this should be discarded. No more than 5 liters should be filtered with one canister.
- Superchlorination. Small amounts of water, in units of one liter, may be superchlorinated. Superchlorination consists of adding 10 times the normal amounts of chlorine to the water (see paragraph 1.2.10 and Table 1-7 and Table 1-8). Simple chlorination, as is used to disinfect water from naturally occurring bacterial contaminants, is not sufficient to decontaminate water suspected of being contaminated with chemical agents.
- Flocculation. Larger quantities of water may be treated by flocculation with metal salts, after which the water is treated with chlorine.

4.5.16.6 Disposal of contaminated waste. Following a chemical attack, a considerable amount of contaminated waste such as clothing, swabs, dressings, material, liquid effluent, etc. can be generated by decontamination operations. The process for disposal of decontamination waste in the field is not much different from disposal of hazardous waste in peacetime. The first step is to control or contain the waste. Non-liquid waste should be double-bagged in plastic trash bags and set aside in accumulation points to await disposal. Combustible material should be segregated from non-combustible material. Liquid waste from decontamination operations should be diverted to sumps or collected in holding tanks. If field expedient decontamination areas (areas where liquid effluent was allowed to soak into the ground) are employed, the areas should be cordoned off and marked for later treatment. The second phase of the disposal process is to actually dispose of or neutralize the waste. Disposal methods include incineration or burial. Combustible waste can be sent to commercial incineration facilities that are capable of incinerating medical waste, if such facilities are in or near the war zone. Field incineration of combustible decontamination waste can be handled similar to medical waste (Figure 2-10). Combustible and non-combustible decontamination waste can also be buried. However, before contaminated waste is buried, the disposal area must be evaluated for potential groundwater contamination. Usually, it is possible and desirable, to select disposal areas where the water table is low and to neutralize chemical agent contaminated waste prior to burial. This can be accomplished by pouring or spraying a 5 percent solution of HTH or STB over the material prior to covering it with earth. Contaminated effluent (wash water, decontaminating agent solutions, etc.) must be neutralized prior to disposal. If the effluent is in a holding sump or tank, neutralize it by adding sufficient HTH or STB to bring the effluent to a 5 percent chlorine concentration. At field expedient decontamination sites, you can do a certain degree of neutralization by sprinkling the ground with HTH or STB during and after decontamination operations.

Section 5
Industrial Health Threat Vulnerability Assessment

SECTION 5 - INDUSTRIAL HEALTH THREATS VULNERABILITY ASSESSMENT

5.1 General. The ability of the Air Force to conduct effective and sustained combat operations depends largely on the physical health of its personnel. Air Force policy is aimed at identifying and preventing illness and injury and maintaining a healthy work environment. The Air Force ensures the occupational health of its people by focusing on the identification and reduction of health threats in and around the workplace. In peacetime, the BES assesses health risks on the base. However, federal, state, and local agencies regulate, oversee, and assess industrial activities off the installation. In contingency situations, external agencies may not exist or if they exist, the Commander may not be able to trust their effectiveness. Accordingly, the BES must perform industrial health threat assessments and advise commanders of potential hazards that could impact combat operations.

5.2 Objectives of the Assessment. Section 1 of this manual discussed the importance of conducting a water vulnerability assessment. Performing an industrial health threats vulnerability assessment is a logical expansion of the water assessment. The objective of conducting such an assessment is to identify to the Commander, potential threats to the health of personnel resulting from industrial activities in or around the operations area. The assessment must identify industrial facilities, operations, and/or commodities that, if destroyed, damaged, released, or held hostage by the enemy, could result in a health threat to friendly combat and civilian personnel. You must also be concerned with industrial activities that could impact the health of friendly personnel as a result of non-combat related accidents, media contamination, friendly fire, or the crash of friendly aircraft. Industrial health threat vulnerability assessments could also be of value after hostilities end. Well-documented assessments may become very useful to health professionals who are tasked with investigating afflictions such as *Gulf War Illnesses.*

5.3 Cross-functional Team. While BES is responsible for developing the vulnerability assessment, bioenvironmental personnel do not possess sufficient expertise to complete the entire document. Accordingly, specialists from other activities must help complete the vulnerability assessment. In addition to other members of the Aerospace Medical Team (Public Health, Medical Readiness), the BES should enlist assistance from the following organizations to complete the assessment.

- Airbase Operations - NBC defense, NBC planning, and base training
- Civil Engineer - maintenance/operation of the utility systems, and emergency planning
- Security Police - counter-terrorism measures, security of facilities, and security planning and training
- Operations - threat assessments, probable enemy attack scenarios
- Safety - safety hazards, accident potential, risk assessment
- Weather - probable natural disasters
- Public Affairs - public affairs matters
- Other Service/host government - utility infrastructure, emergency planning, access to facilities, public affairs

5.4 Things To Consider. The assessment team reviews available information and performs reconnaissance to determine the existence of hazardous substances in the area, determines potential health hazards associated with the substances, and assesses the vulnerability to cause harm to friendly personnel and/or combat capability. The assessment team should conduct a reconnaissance of the area around the beddown site to identify industrial or agricultural activities that might have a negative health impact. Industrial complexes and agricultural acreage upwind and upgradient from the beddown site will probably present the greatest potential threat. The reconnaissance must be extensive enough to consider all potential sources of contamination that might impact the beddown site. For instance, a commercial nuclear power plant two miles downwind from the beddown site may not present as much risk as one that is 10 miles upwind. Significant pesticide contamination in a field 200 yards down gradient from the site may not be as threatening as pesticide contamination in fields that surround the base water supply five miles away. To assure the team has adequately assessed the threat, they must consider the following factors.

- what levels or concentrations of hazardous substances are present.

- is it possible that friendly personnel will be exposed to contamination and if so, how (exposure pathways).
- what harm might the substances cause to friendly personnel.
- will the health of people working at the nearby beddown site be affected.
- are there dangers, such as, unsafe buildings or operations, abandoned mine shafts, etc.

5.4.1 Levels Present. The first step of the process is to identify the hazardous substances that are present. This is accomplished through a combination of inquiry and physical reconnaissance. The objective is to identify industrial and/or agricultural activities near the beddown site and then conduct inquiries or on-site reconnaissance to determine the presence of hazardous substances or contamination. Table 5-1 provides a list of industries and the processes and hazardous substances that are typically associated with those industries. You can use this table to single out industrial and agricultural activities in your area that might possess a threat. The team should question sources such as host nation officials, permanently assigned DoD forces, locally hired workers, plant managers, farmers, etc., to confirm the presence, concentrations, or quantities of substances or contamination. The team can also perform physical reconnaissance to confirm the presence of hazardous substances. Look for tank shapes, ocean tankers, barges, tank cars, tank trucks that could indicate the presence of bulk liquid substances such as petroleum, solvents, feed stocks, pesticides, etc. Look for vent pipes coming out of the ground that could indicate the presence of underground storage tanks. Look for large numbers of drums, pails, cans, etc. that could indicate liquid hazardous substances. Look for pipeline markers, cleared right-of-ways, valve pits, river crossings, etc., that could confirm the presence of underground pipelines. Investigate smoke stacks, discharge pipes, surface run off, discolored soil, dead grass, dump sites, etc., for signs of contamination. In rural locations, look for grain elevators, silos, and large warehouses to confirm significant agricultural activity. Such activity could be a first indication of soil that is contaminated with pesticides, herbicides, etc. Look for stockyards, feedlots, or herds of animals that could be sources of microbiological contamination.

5.4.1.1 Environmental samples. Where there is evidence of potential contamination, BES personnel may need to collect environmental samples. Quantifying contamination levels could be a necessary step in assessing the potential health threat. Various procedures for obtaining environmental samples are covered in Sections 6 and 7 of this manual.

5.4.2 Exposure Pathways. Once you have identified potential or existing sources of contamination, you must determine the possibility of exposure. If there is no way for personnel to become exposed, then there is no threat regardless of the severity of actual or potential contamination. Determining the possibility of exposure is accomplished by evaluating exposure pathways. Exposure pathways are characterized by five elements:

1. Source, e.g., underground tank, landfill, surface run off, etc.
2. Transport media, e.g., groundwater, air, dust, etc.
3. Exposure point, e.g., drinking water well, food supply, hygiene facilities, etc.
4. Route of exposure, e.g., ingestion, inhalation, etc.
5. Receptor population, e.g., medical workers, shop workers, services personnel, air crew, etc.

Table 5-1 - Processes and Hazardous Substances Associated With Various Industries

Industry	Processes	Hazardous Substances Typically Found
Agriculture	Agriculture run off	1,2-Dichloropropane, 2,4,5-T, 2,4-D, alacalor, atrazine, carbofuran, chlorodane, dalapon, dibromochloropropane, dinoseb, dioxin, diquat, endothall, endrin, glyphosate, heptachlor, lindane, methoxychlor, oxamyl, picloram, simazine, toxaphene,
Animal/Human Waste	Fertilizers; natural run off,	Coliform, giardia lamblia, nitrate, nitrite, viruses
Chemical manufacturing	Agricultural chemical formulation; paint and coating formulation; pesticide chemical formulation; pharmaceutical formulation; printing ink formulation	2-Methoxyethylmercuric, acetone, ammonium hydroxide, arsenic pentoxide, arsenic trioxide, benzene, cacodylic acid, carbon tetrachloride, cekumethion, chlorobenzene, chloroform, chromic acid, cresol, dimethoate, dinitrocresol, dinoseb, disodium, disulfolon, ethyl acetate, ethyl alcohol, fmphur, glycol ethers, heavy metal solutions, heptane, heptane, hexane, hydrochloric acid, hydrofluoric acid, hypochlorites, ink sludge, isopropanol, isopropyl acetate, isopropyl alcohol, methane arsonate, methyl ethyl ketone, methyl parathion, methylene chloride,n-butyl acetate, naphtha, nicotine, nitric acid, organic peroxides, parathion, perchlorates, permanganates, phenol, phenylmercuric acetate, phosphoric acid, potassium hydroxide, propyl alcohol, sodium hydroxide, strychnine salt, solid, sulfides, sulfuric acid, temik, thallium sulfate, solid toluene, trichloroethylene, xylene
Chemical manufacturing	Pesticide, pigment, rubber, and synthetic fiber manufacturing; other chemical manufacturing	1,1,1-trichloroethane, acetone, benzene, carbon tetrachloride, chlorobenzene, chloroform, chromic acid, cresols, ethanol, ethyl benzene, ethylene dichloride, hexachloroethane, hydrochloric acid, hydrofluoric acid, hypochlorite, isopropanol, kerosene, methyl ethyl ketone, methylene chloride, nitric acid, phenol, phosphoric acid, potassium hydroxide, potassium permanganate, potassium sulfide, sodium hydroxide, sodium perchlorates, sodium permanganate, sodium sulfide, sulfuric acid, tetrachloroethylene, tetrahydroform, toluene, trichloroethylene, white spirits, xylene
Cleaning agents and cosmetics	Cleaning agent manufacturing; cosmetics manufacturing	1,1,1-trichloroethane, ammonium hydroxide, aromatic hydrocarbons, benzene, chlorobenzene, chromic acid, ethyl alcohol, ethyl benzene, ethylene dichloride, hydrobromic acid, hydrochloric acid, hydrofluoric acid, ignitable alcohol, isopropyl alcohol, methyl alcohol, nitric acid, petroleum distillates, phosphoric acid, potassium hydroxide, sodium hydroxide, sulfuric acid, toluene, white spirits, xylene
Cold storage	Refrigeration	Anhydrous ammonia
Drinking water	Treatment and sanitation	Chlorine, sulfur dioxide
Electronics	Electronics manufacturing	Antimony, arsenic, beryllium, lead, mercury, thallium
Equipment repairing	Paint Preparation and removal; painting; rust removal; spray booth, spray gun, and brush cleaning; degreasing parts and equipment	1,1,1-trichloroethane, ammonium hydroxide, benzene, carbon tetrachloride, chlorobenzene, chloroform, chromic acid, chromium, cresols, ethyl benzene, ethylene dichloride, hexachloroethane, hydrobromic acid, hydrochloric acid, hydrofluoric acid, methyl ethyl ketone, nickel, nitric acid, paints with lead, nickel, and chromium, petroleum distillates, phosphoric acid, potassium hydroxide, sodium hydroxide, sulfuric acid, toluene, trichloroethylene, used oil, white spirits
Furniture/Wood manufacturing and refinishing	brush cleaning; finishing; painting; staining; refinishing and stripping; spray gun cleaning; wax removal;	Acetone, alcohols, denatured alcohols, epoxy-ester resins, glycol ether, halogenated hydrocarbons, isopropanol, ketones, methanol, methylene chloride, mineral spirits, oxygenated solvents, paint, petroleum distillates, resins, shellac, titanium dioxide, toluene, turpentine, vinyl-acetate
Laboratories	Sample Analysis	1,4-dioxane, acetic acid, ammonium hydroxide, benzene, carbon tetrachloride, chloroform, ethanol, ethyl ether, formalin, fuming sulfuric acid, hexane, hydrochloric acid, isopropanol, methanol, methyl ethyl ketone, methylene chloride, nitric acid, oleum, pentane, perchloric acid, petroleum ether, potassium hydroxide, sodium hydroxide, sulfuric acid, tetrahydrofuran, toluene, xylene, acetone

Table 5-1 (Cont)

Industry	Processes	Hazardous Substances Typically Found
Leather processing	Finishing/Trimming	Benzene, carbon tetrachloride, chlorobenzene, ethyl benzene, hexachloroethane, kerosene, methyl ethyl ketone, naphtha, toluene, trichloroethylene, trichloroethylene, white spirits
Metal manufacturing	Electroplating; facility clean up; heat treating; metal finishing, and painting; pickling; metal cutting/machining	1,1,1-trichloroethane, acetic acid, acetone, acetyl, chloride, ammonium hydroxide, benzene, butyl, alcohol, carbon tetrachloride, chloroform, chromic, acid, cyanide waste, heavy metal wastewater, hydrobromic acid, hydrochloric acid, hydrofluoric acid, hypochlorites, kerosene, methyl ethyl ketone, methylene chloride, nitrates, nitric acid, o-dichlorobenzene, organic peroxides, p-dichlorobenzene, perchlorates, perchloric acid, permanganates, phosphoric acid, potassium hydroxide, sodium hydroxide, sulfides, sulfuric acid, tetrachloroethylene, toluene, trichloroethylene, trichlorotrifluoroethane, trichlorotrifluoromethane, white spirits, xylene
Nuclear power	Electricity production	Radiation and numerous hazardous material
Oil	Drilling, refining, storage, transport	Benzene, benzo(a)pyrene, selenium, toluene, xylene, petroleum products
Paper/Pulp	Bleaching; pulping; cleaning and degreasing; coating, coloring, and dyeing; sizing, and starching	Acids/alkalies, carbon tetrachloride, chlorine bleaches, chloroform, dyes, glues, hydrocarbons, inks, lime, ethylene chloride, paints, pigments, sodium hydroxide, sodium sulfide, solvents, sulfate bleaches, sulfurous acid, synthetic resins, tetrachloroethylene, trichloroethane, trichloroethylene
Pesticides	Manufacturing; application; cleanup	2,4,5 T, 2,4-D-, aldnn, amitrole, benzene, carbon, tetrachloride, chloroform, ddt, dieldrin, dimethoate, dinoseb, disulfoton, endosulfan, ethyl alcohol, heptachlor, isopropyl alcohol, kepone, lindane, methoxychlor, methyl, methyl alcohol, parathion, parathion, pentachlorophenol, strychnine, tetrachloroethylene, thiram, toluene, toxaphene, xylene
Photographic	Photo processing	Silver
Plastics	Plastics manufacturing	1,1 dichloroethylene, adipate, benzene, cyanide, ethylene glycol, ethylene thiourea, pcb, phthalate, phthalic anhydride, styrene
Textiles	Bleaching; disinfecting; dying; fabric finishing; wastewater treatment	Mineral spirits, 1,1,1-trichloroethane, benzene, chlorobenzene, combustible liquid nos, dichloromethane, methylene chloride, ethylene dichloride, flammable liquid nos, flammable solid nos, hazardous liquid or solid, nos, naphtha, tetrachloroethylene, perchloroethylene, toluene, trichloroethylene, xylene
Truck/Rail operations and maintenance	Cleaning tank trucks and tank cars; changing lead-acid batteries; degreasing parts and equipment; paint preparation and removal; painting; rust removal; spray booth, spray gun, and brush cleaning	1,1,1-trichloroethane, ammonium hydroxide, benzene, carbon tetrachloride, chlorobenzene, chloroform, chromic acid, ethyl benzene, ethylene dichloride, hexachloroethane, hydrobromic acid, hydrochloric acid, hydrofluoric acid, lead-acid batteries, methyl ethyl ketone, nitric acid, paints with lead, nickel, and chromium, petroleum distillates, phosphoric acid, potassium hydroxide, sodium hydroxide, sulfuric acid, toluene, white spirits
Vehicle maintenance	Installing lead-acid batteries; paint preparation and removal; painting; rust removal; spray booth, spray gun, and brush cleaning; tank cleanout; degreasing	Acetone, alcohols, aromatic hydrocarbons, benzene, chloride, distillates, epoxy ester resins, hydrocarbons, hydrochloric acid, hydrofluoric acid, isopropyl alcohol, ketones, lead dross, methanol, methyl isobutyl, methylene chloride, mineral spirits, oxygenated solvents, petroleum, petroleum distillates, petroleum naphtha, petroleum products in tanks, phosphoric acid, sodium hydroxide, solvents, toluene, vm&p naphtha, xylene,
Waste water	Treatment	Acrylamide, chlorine, epichlorohydrin, sulfur dioxide
Wood preserving	Boulton preconditioning; inorganic salt treatment, non-pressure treatment preservation; wastewater treatment; steam preconditioning	Ammonium, arsenate (cca), arsenic, chromated copper, chromium, creosote, inorganic preservatives, organic solvents, pentachlorophenol, stoddard solvent

5.4.2.1 Source of contamination. You will need specific detailed information to support your assessment. Remember, someone later on may also use your data so make sure you collect and document all information about the source in a logical and systematic manner. Examples of useful source information follow.

1. Site identifiers
   a) Site name and alias
   b) Address or location
   c) Type (e.g., landfill, spill, storage tank, smoke stack, etc.)
   d) Description of potential or existing contamination
   e) Name of responsible person (plant manager, farmer, landfill operator, etc.)
2. Site conditions
   a) Description of artificial or natural barriers (e.g., liners, walls, fences, ditches, etc.)
   b) Condition of structure or components (e.g., extreme corrosion on tank wall, leaking valves, etc.)
3. Geographic and demographic data
   a) Plot site on area map or sketch relationship to U.S. beddown/operating site
   b) Distance from U.S. beddown/operating site
   c) Sensitive land uses within one mile of site (e.g., reservoirs, aquifer recharge zones, etc.)
   d) Photographs showing site conditions
4. Substances identified
   a) Chemical names, CAS numbers (if known)
   b) Estimate of quantity on hand
   c) Estimate of range or extent of potential contamination should system fail
   d) Estimate of existing contamination in each medium (soil, air, surface water, and ground water)
   e) Concentration, range, or extent of existing contamination
   f) Identify potential waste materials and quantities
   g) Document chemical, mechanical, physical, meteorological, or other phenomena that might change the current state of the substance or contamination (e.g., earthquake zone, flood plain, etc.)
5. Analytical information (if samples were taken)
   a) Analytical results of samples taken
   b) Description of QA/QC employed
   c) Description of decontamination procedures for tools, instruments, and sampling equipment
   d) Sample storage protocol and holding times
   e) Identify which form of chemical is present, if important (e.g., chromium III vs chromium IV and elemental mercury vs methylated mercury, etc.)

5.4.2.2 Soil exposure pathway. Contaminated soil may expose personnel to multiple contaminants at levels of health concern. Ingestion of contaminated surface soil is a primary concern. Inhalation of contaminated dusts and direct dermal contact with contaminated soils also can lead to adverse health effects. Generally, people are exposed to only the top few inches of soil; therefore, surface soil is defined as the top three inches.

5.4.2.3 Surface water exposure pathway. Potential or existing contamination can be carried away from industrial and agricultural activities by surface water. In the case of existing contamination, all surface water bodies on or impacted by the industrial or agricultural site should be sampled, including ditches, gullies, arroyos, and perennial and intermittent streams that could transport contaminants away from the site. Samples should be taken in areas where there is potential for human exposure. In the case of potential contamination, you should identify all surface water bodies that might be carriers of contamination should industrial and agricultural substances be spilled or be dumped into the water.

5.4.2.4 Sediment exposure pathway. Personnel may be exposed to contaminated sediment either through direct dermal contact, ingestion, and inhalation or through a secondary pathway: ingestion of contaminated biota. Sediment sampling is needed at possible human exposure points where contaminated sediment may enter the food chain, such as fishing and hunting areas, where wildlife, fish, or shellfish may be caught and eaten. Sediments may also be disturbed and transported to possible human exposure points by bombing or movement of mechanized forces. Therefore, sampling and analysis of disturbed sediments, as well as the stream channels and impoundment areas, may be needed at some sites. For best evaluation of the potential exposure to personnel, sediment samples, like soil samples, should be shallow (0-3 inches).

5.4.2.5 Groundwater exposure pathway. Human exposure to contaminated groundwater from water supply wells is a common problem. To prevent or mitigate such exposure, the location and use of potentially contaminated wells or springs should be identified. Information needed for proper documentation and evaluation of the groundwater exposure pathway is explained in the section on water vulnerability assessments, paragraph 1.6.3.

5.4.2.6 Air exposure pathway. Adverse health effects (acute and chronic) associated with inhalation of air contaminants by personnel working near polluted sites can be cause for concern. Air emissions from past or current production processes, as well as volatilization of organic compounds, airborne particulates, and acid gases from polluted areas, may expose personnel to contaminants at levels of health concern. Hazardous substance areas from which air releases may be significant are: surface impoundments, where there may be leaking drums or tanks containing volatile organic compounds; landfills that produce methane gas, that can migrate; waste piles of materials that may be easily entrained by winds or that contain volatile organic contaminants; and contaminated soils that may become entrained in the air by winds or vehicular traffic. Air emissions may be generated by displacement of contaminated soil by hostile fire or mechanized movements. Emissions may also be generated by normal day-to-day activities such as commercial excavation, land farming, pond aeration, and stack emissions.

5.4.2.7 Food-chain exposure pathway. People may be exposed to contaminants by eating plants or animals that have incorporated the contaminants into their bodies. Hunting, fishing, foraging, and farming activities may bring people into contact with contaminants. Some substances, particularly fat-soluble substances and heavy metals, may reach concentrations in animal tissues that are thousands of times higher than those found in water, soil, and sediment. When planning and designing an investigation of food-chain contamination, it is important to have a well-designed biota sampling protocol, with sample size large enough to be statistically significant (more than 20 samples per location per sampling episode are recommended). In particular, organisms of different species, ages, or reproductive status should not be sampled without strong justification. For example, when assessing the impact of contaminated sediment upon the edible fish populations in a stream, results of analyses of tissues from bottom feeding fish should not be combined with those from water-column feeders; because of their different feeding habits, very different effects may be expected. Special handling of biologic samples must be considered. Some analytical procedures require that live or fresh-frozen fish be transported to the lab immediately for analysis; the accuracy of other procedures may not be affected if formalin-preserved specimens or those held frozen for weeks or months are used.

5.4.3 Physical Hazards. Actual or potential environmental medium contamination is not the only threat to the health of personnel. Industrial and agricultural activities can also present significant physical hazards that should be included in the vulnerability assessment. A few examples of physical hazards include, high pressure piping, enclosed spaces capable of collecting flammable or toxic substances, explosive concentrations of dust (such as in grain elevators), unfenced holding ponds or lagoons, electrical transformers and exposed wiring, etc. Identification of such industrial hazards is the primary responsibility of the Safety representative on the team.

5.5 Determining The Threat. When the team has completed its reconnaissance, they must assess the threats associated with the various industrial and agricultural activities in the area. The threat can be grouped into three categories:

1. Physical threats caused by catastrophic event (e.g., flood, fire, explosion, bombing, etc.)
2. Emergency exposure threats caused by failure/destruction of a facility or system (e.g., bombed nuclear power plant releasing radiation, sabotaged cold storage facility releasing anhydrous ammonia, etc.)
3. Threats caused by routine exposure to contamination over some period of time (e.g., continual release of solvents into water supplies, heavy metals buildup in dusty soil, etc.)

5.5.1 Catastrophic Event. Assessing the impact of this category of threat requires some subjectivity. However, the results are fairly straightforward - personnel die, personnel are injured, or personnel are unharmed. For instance the team must assess the number of people who might drown if a large dam upgradient from the beddown site was to be destroyed by the enemy. How many people would suffer from debilitating burns if a petroleum refinery situated next to the beddown site were to catch on fire. As mentioned earlier assessing the impact, in terms of lost combat personnel resulting from these types of threats, is best performed by the safety personnel on the team.

5.5.2 Emergency Exposure. Emergency exposure situations (e.g., release of anhydrous ammonia from a nearby commercial cold storage facility) might require total or partial evacuation of the base because of an accumulation of toxic vapors. As you can imagine, the Commander would certainly want to know, in advance, if the base might have to be evacuated. This is the type of potential situation that must be addressed in your vulnerability assessment. To help you determine potential evacuation requirements, you should use the latest Threshold Limit Values (TLVs) handbook published by the American Conference of Governmental Industrial Hygienists (ACGIH) [every BEE is supposed to have the latest version]. This handbook lists time weighted average (TWA) exposure limits, short-term exposure limits (STELs) and ceiling limits (C) for toxic chemicals. Where more than one limit is listed for a chemical, you must comply with the most stringent limit. In situations where the catastrophic release of contamination from industrial facilities could result in concentration levels that exceed the limits shown in the ACGIH handbook, operating forces would have to be evacuated or be required to don PPE. Procedures and formulas for determining evacuation distances (toxic corridor lengths) are included in Section 7 of this manual.

5.5.3 Routine Exposure. The third category of health threat involves exposure to potential or existing contamination over an extended period of time. As an example, let's take a case where the host country has offered a large empty chemical storage warehouse just outside the base for storage of USAF equipment and material. You must assess if there are any threats to US forces. During your reconnaissance of the facility, you detected an odor similar to bleach. Subsequently, you obtained a number of air samples and determined there was a slight airborne concentration of Bromine. The best way to assess this type of industrial health threat is to use occupational exposure limits (OELs) for the substances involved. AF policy is that workers will not be exposed to concentrations of toxic substances greater than the OEL. The term OEL includes a number of occupational exposure limits. However, the BES shall determine the OEL using the most stringent limits from three sources: OSHA Permissible Exposure Limits (PELs), the American Conference of Government Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and other OSHA Standards. If none of these references provide a limit to use, BES must request guidance through command channels. OELs are established for short-term exposure limits of 15 minutes during the workday (OEL-STEL) or time-weighted average exposure limits for the entire 8-hour workday (OEL-TWA). The OSHA PELs and ACGIH TWAs are 8-hour limits. The ACGIH STELs are 15-minute limits. The AF has also established OELs for jet fuel (Table 5-2). Table 5-3 lists OSHA standards that mandate exposure limits that are not shown in the ACGIH TLV booklet.

Table 5-2 - Established OELs (AFOSH Standard 48-8)

	OEL-TWA		OEL-STEL	
Substance	**mg/m^3**	**ppm**	**mg/m^3**	**ppm**
JP-4	700	200	1050	300
JP-8	350	52	1800	267

Table 5-3 - References for Exposure Limits on Specific Substances (AFOSH Standard 48-8)

Substance	Reference	Substance	Reference
1,2-Dibromo-3-chloropropane	29 CFR 1910.1044	Acrylonitrile	29 CFR 1910.1045
2-Acetylaminofluorene	29 CFR 1910.1014	Aminodiphenyl	29 CFR 1910.1011
3,3'-Dichlorobenzidine	29 CFR 1910.1007	Benzene	29 CFR 1910.1028
4-Nitrobiphenyl	29 CFR 1910.1003	Benzidine	29 CFR 1910.1010
4-Dimethylaminoazobenzene	29 CFR 1910.1015	Cadmium	29 CFR 1910.1027
Alpha-naphthylamine	29 CFR 1910.1004	Coke oven emissions	29 CFR 1910.1029
Beta-naphthylamine 29	29 CFR 1910.1009	Cotton dust	29 CFR 1910.1043
Beta-propiolactone	29 CFR 1910.1013	Ethylene oxide	29 CFR 1910.1047
Bis-chloromethyl ether	29 CFR 1910.1008	Formaldehyde	29 CFR 1910.1048
Ethyleneimine	29 CFR 1910.1012	Inorganic arsenic	29 CFR 1910.1018
Methyl chloromethyl ether	29 CFR 1910.1006	Methylene dianiline	29 CFR 1910.1050
N-nitrosodimethylamine	29 CFR 1910.1016	Vinyl chloride	29 CFR 1910.1017

Once you have determined the actual or possible concentration level of any particular substance, you can calculate the cumulative exposure for an 8-hour shift using the following formula:

E =[C(a)T(a) + C(b)T(b) + . . . C(n)T(n)] ÷8

Where:

E is the equivalent exposure for the working shift in ppm
C is the concentration in ppm, during any period of time T where the concentration remains constant
T is the duration in hours, of the exposure at the concentration C.

The value of E must not exceed the 8-hour time weighted average specified in the ACGIH TLV handbook for the substance involved.

Example: Based on your reconnaissance, you determine the bromine concentrations in the host nation warehouse vary depending on where you are in the building. Bromine concentrations are 0.3 ppm at the north end of the building, 0.2 ppm at the center of the building, and 0.05 ppm at the south end of the building. After discussing the anticipated work flow and schedule with the Supply Superintendent, you determine Supply people will spend about 2 hours a day at the north end of the warehouse, 2 hours a day at the center of the warehouse and 4 hours a day at the south end of the building. Substituting this information in the formula, you have:

(0.3 x 2 + 0.2 x 2 + 0.05 x 4) ÷ 8 = 0.15 ppm

Since 0.15 ppm is greater than the 0.1 ppm limit for Bromine, the exposure is unacceptable. The Supply people will have to adjust their work schedule to reduce exposure time, use PPE while in the North end of the building, or not use the North end of the building at all.

There may also be potential or actual situations where workers will be exposed to more than one toxic substance at a time. In cases where substances affect the <u>same</u> organs of the body, you can compute the equivalent exposure using the following formula:

E(m) = [C(1) ÷L(1) + C(2) ÷L(2)) + ….. (C(n) ÷L(n)]

Where:

E(m) is the equivalent exposure for the mixture in ppm
C is the concentration in ppm, of a particular contaminant.
L is the exposure limit, in ppm for that substance specified in the ACGIH TLV handbook.

In order for the exposure to be within acceptable limits, the value of E(m) cannot exceed unity (1).

Example: A worker will be exposed to varying concentrations of three substances as shown below.

Substance	8-hour Exposure Concentration (ppm)	TWA from ACGIH TLV Handbook (ppm)
B	500	1,000
C	45	200
D	40	200

Substituting in the formula, you have:

$E(m) = 500 \div 1{,}000 + 45 \div 200 + 40 \div 200$
$E(m) = 0.500 + 0.225 + 0.200$
$E(m) = 0.925$

Since E(m) is less than unity (1), the exposure combination is within acceptable limits.

For mixtures where the substances affect <u>different</u> organs of the body, you can compute the equivalent exposure using the following formula:

C(1) ÷L(1) ; C(2) ÷L(2)); (C(3) ÷L(3); etc.

Where:

C is the concentration in ppm, of a particular contaminant.
L is the exposure limit, in ppm for that substance specified in the ACGIH TLV handbook.

In this case the threshold limit is exceeded when one or more of the individual values exceeds unity.

5.5.4 Other Routine Exposures. As discussed previously, personnel can also be exposed to contamination via water and food chain pathways. Section 1 of this manual provides guidance on water quality, sampling, purification, and disinfection. In the case of potential or actual contamination of the food chain, your assessment must identify the contaminated food stuffs or collection points. Services personnel must avoid the tainted sources when obtaining food supplies for chow halls, cafeterias, or field kitchens. Personnel must be told to eat food from approved on-base facilities and/or meals ready to eat (MREs).

5.6 Identifying Workarounds. It is very important to identify fixes or workarounds for each of the potential or actual contaminations. In most cases, beddown sites will have already been selected based on other tactical and/or strategic factors. Unless you actually participate on a site selection team, or you uncover critically unsafe situations around an existing site, it is unlikely that you will be able to influence the location of a beddown site. However, there are probably many perfectly acceptable fixes or workarounds for most situations. The team has not done its job unless it provides recommended solutions to the Commander. Some solutions include marking areas of contamination with off-limits signs; remediate critically important areas; purify contaminated water; add control technology; restrict exposure times; or require the wearing of PPE.

5.7 Assessment Format. The following outline provides recommended subject matter for inclusion in an industrial health vulnerability assessment. This is not an all inclusive list of topics. In order to present an accurate assessment of the situation, some assessments may require less information and some may require more.

1. Identify actual or potential contamination event
   - natural disaster
   - conventional attack

- sabotage
- nuclear warfare
- industrial accident/inefficiencies

2. Identify the site
   - Site name and alias
   - Address or location
   - Type (e.g., landfill, spill, storage tank, smoke stack, etc.)
   - Name of responsible person (plant manager, farmer, landfill operator, etc.)
3. Site conditions
   - Description of artificial or natural barriers (e.g., liners, walls, fences, ditches, etc.)
   - Condition of structure or components (e.g., extreme corrosion on tank wall, leaking valves, etc.)
4. Geographic and demographic data
   - Plot site on area map or sketch relationship to U.S. beddown/operating site
   - Distance from U.S. beddown/operating site
   - Sensitive land uses within one mile of site (e.g., reservoirs, aquifer recharge zones, etc.)
   - Photographs showing site conditions
5. Substances identified
   - Chemical names, CAS numbers (if known)
   - Estimate of quantity on hand
   - Estimate of range or extent of potential contamination should system fail
   - Estimate of existing contamination in each medium (soil, air, surface water, and ground water)
   - Concentration, range, or extent of existing contamination
   - Identify potential waste materials and quantities
   - Document chemical, mechanical, physical, meteorological, or other phenomena that might change the current state of the substance or contamination (e.g., earthquake zone, flood plain, etc.)
6. Analytical information (if samples were taken)
   - Analytical results of samples taken
   - Description of QA/QC employed
   - Description of decontamination procedures for tools, instruments, and sampling equipment
   - Sample storage protocol and holding times
   - Identify which form of chemical is present, if important (e.g., chromium III vs Chromium IV and elemental mercury vs methylated mercury. Etc.)
7. Exposure pathway(s)
   - soil
   - surface water
   - sediment
   - groundwater
   - air
   - food-chain
8. Estimate of effect
   - Immediate injury
   - Death
   - Long-term health

9. Potential impact
    - Shortage of war fighters
    - Saturation of medical facilities
    - Evacuation
    - Inconvenience
    - Loss of productivity
10. Fixes/workarounds
    - Marking areas of contamination with off limits signs
    - Remediate critically important areas
    - Purify contaminated water
    - Add control technology
    - Restrict exposure times
    - Require the wearing of PPE

Section 6
Environmental Health Risk Assessment Baseline

SECTION 6 - ENVIRONMENTAL HEALTH RISK ASSESSMENT BASELINE

6.1 General. The ability of the Air Force to conduct effective and sustained combat operations depends largely on the physical health of its personnel. Air Force policy is aimed at identifying and preventing illness and injury and maintaining a healthy work environment. The Air Force protects the physical health of its people by undertaking activities that assess impact, analyze risks, and advise commanders of actions to protect Air Force personnel from environmental hazards. In part, identifying assessing, and reducing health risks resulting from contaminated or polluted environmental media supports this. In addition to initial site selection activities, BES engineers and technicians must collect samples of the soil, air, water, and vegetation in and around beddown sites to support the development of health risk baseline information. Subsequently, health and preventive medicine specialists, use relative risk prioritization and risk assessment modeling techniques to identify requirements for periodic monitoring of beddown sites and assess the impact of media contamination on the health of deployed forces. This section deals with the requirements, equipment, and general procedures used to collect soil, air, water, and vegetation samples to support preparation of the environmental health risk assessment baseline. It is important to understand that Air Force BES personnel have been used in the past and may be used in the future to support the beddown of joint and/or combined forces. While the scope of sampling activities may differ as a result of joint/combined requirements, the basic principles remain unchanged.

6.2 Objectives. During peacetime, compliance with law and improving environmental quality are the primary objectives of the environmental sampling program. However, in preparation for contingency force beddowns, the primary objective of the environmental sampling program is to protect the health of warfighting forces. This objective is accomplished by thorough and orderly sampling of environmental media, analysis of the samples and assessment of the results. Establishing a baseline and maintaining a database of environmental sample results will most likely enhance the restoration of environmental quality and compliance following the cessation of hostilities. However, <u>the primary objectives of the environmental sampling program are force protection and maintenance of combat capability during and after hostilities</u>.

6.3 Preparation. Adequate advanced planning can certainly impact on the success or failure of your sampling program. While there are hundreds of details to address, some of the more important considerations are as follows. It is very important to determine the physical scope of your efforts. Make sure you know, up front, the physical area you are expected to cover. The resources and equipment needed to collect media samples that may impact a single Air Force beddown site are certainly different from those that are required for the beddown of an Army infantry division. You should also determine physical characteristics of the region or site (climate, soil conditions, topography, vegetation, rainfall, etc.). This will help you prepare for the type and number of samples that will have to be collected. You should also ascertain the anticipated use of the site. Planning for the type and number of samples could be different based on whether the site will be used for weapon system support facilities, personnel cantonment, office work, material storage, regional medical operations, etc. You should also determine how the samples will be distributed for analysis. Do you need just enough samples for one lab, say, Armstrong Lab or will samples have to be sent to more than one lab for analysis. Another important piece of information is whether you will have to be totally self sufficient - must you bring everything you need with you or can you obtain supplies and equipment at the site. Because of the tremendous number of details that must be addressed, you may want to use a standardized environmental sample planning process such as the EPA's Data Quality Objectives (DQOs). DQOs are a series of qualitative and quantitative statements that will help you clarify the objectives of sampling, define appropriate data to collect, and determine appropriate conditions to collect data. The DQO process consists of standardized planning steps that should ensure the type, quantity, and quality of environmental data are appropriate for your project. The goal of DQOs is to minimize expenditures by eliminating unnecessary data, while collecting sufficient data to support decision making. The DQO process consists of the following seven steps.

Step1: State the problem. During this step, you develop a brief description of the task (e.g., collect sufficient air, water, soil, and vegetation samples to determine if there is any environmental health hazards in or around a potential beddown site. This is the step in which you should also define available resources, list known or suspected contamination, and determine if there is any existing historical data (e.g., has any other USAF, DoD, allied, etc., personnel visited the site).

Step2: Identify the decision. This is where you identify the ultimate use for the data that will be determined from your sampling efforts. For instance, the data you collect will influence the decision to beddown at a

particular site, it will be used to determine the amount of contaminated media, or it will be used to monitor for trends, etc.

Step3: Identify inputs to the decision. Here you should identify the type and quantity of data needed, what sampling techniques and analytical methods are appropriate, and what are the physical and chemical characteristics of the site (e.g., soil permeability, soil chemistry, depth of water, hydrological factors, etc.). Typical outputs from this step could be potential contaminants, toxicity data, exposure pathways, receptors, physical and chemical characteristics, and fate and transport of contaminants.

Step4: Define boundaries of the study. During this step, you should define the geographical area you must cover and specific characteristics of the samples to be taken (e.g., top 3 inches of soil, ground water, ambient air, etc.) You should also determine if there are seasonal variations (winter, summer, dry, wet, etc.) when samples should be collected. Also, are there other constraints on collecting the samples (e.g., political, social, site access, transportation, etc.).

Step5: Develop decision rules. Here is where you should develop any rules that will be used to collect the samples. For instance, sample all potential sources of water or don't bother sampling rivers and lakes because the host government base already has a potable drinking water system. Another rule might be, soil samples are not required unless soil gas field screening indicates a predetermined level of contamination.

Step6: Specify limits on decision errors. At this step in the process, you need to define acceptable or unacceptable results. For instance must all measurable contamination be identified or is it permissible to overlook a few hot spots. Must all probability of error be eliminated by collecting large numbers of samples and analyzing each sample several times or is it permissible to collect a few representative samples and run one field test on each.

Step7: Optimizing the design. This is where you will identify the most resource-effective sampling plan that will generate the data needed to prepare an accurate health risk assessment.

6.4 Reconnaissance. As discussed in Section 5, you should review available information and perform reconnaissance to determine the existence of pollution or contamination in the area. Attempt to identify potential sources of contamination around the beddown site that might have a negative health impact. Industrial complexes, hazardous and solid waste disposal facilities/dumps, and agricultural activities upwind and upgradient from the beddown site will probably present the greatest potential sources of contamination. Your reconnaissance must be extensive enough to consider all sources of contamination that might impact the forces. For instance, active or inactive land fills in the area could be leaching pollutants. This would indicate a need for more extensive groundwater sampling. Significant farming operations up wind from the site would indicate a need to sample the air/dust for pesticides at the beddown site. Dense industrial activity along a river that might become a source of water for the beddown site would indicate a need for extensive and repeated sampling of the river water. The primary objectives of reconnaissance are to narrow the scope of your sampling, limit the resources necessary, and target suspected contamination.

6.5 Field Screening. There are two types of analytical data that are used to assess environmental health risks - laboratory analytical data and field analytical screening data. Laboratory analytical data are the results obtained from analysis of media samples you collect on site and send to a laboratory. Field screening data are the results you document on-site using direct reading methods (e.g., X-ray Fluorescence, soil gas, enzyme immunoassay, etc.). These screening methods can narrow the possible number of contaminants for laboratory analysis and are effective and economical for gathering large amounts of site data. Once an area is identified using field screening techniques, a smaller set of samples can be collected for laboratory analysis to substantiate the screening results. In situations where resources are constrained (time, money, manpower, etc.), field screening (with laboratory confirmation) will generally result in more analytical data from a site than will sampling for off-site laboratory analysis alone. A brief synopsis of various field screening equipment follows.

6.5.1 Photoionization Detectors (PID). A PID meter is a specialized gas chromatograph with a PID, that is sensitive to aromatic hydrocarbons and compounds with carbon-carbon double bonds. A PID detects total concentrations of VOCs and some non-volatile organics and inorganics in soils. Most PID meters do not contain columns, and are therefore, not capable of separating the various compounds of interest. PIDs only detect total concentrations of organic vapors. Some identification of compounds is possible if more than one probe is used.

6.5.2 Flame Ionization Detector (FID). An FID meter is a specialized gas chromatograph with an FID. The FID provides semi-quantitative detection of VOCs. The FID is not appropriate for heavy halogenated organic compounds that contain few carbon-hydrogen bonds. When operated in the "survey" mode, the instrument detects the total concentration of many organic vapors. When operated in the "GC" mode, the instrument is capable of identifying and measuring specific organic compounds. This instrument is very good when petroleum products are the environmental problem.

6.5.3 X-ray Fluorescence (XRF) Analyzers. XRF analyzers are used for the semiquantitative analysis of heavy metals in soils. Detection limits are in the low-ppm to a few hundred-ppm range depending on element and matrix. XRF is an analytical technique that uses high-energy electromagnetic radiation (X rays) for sample excitation. During a measurement, the X-ray tube exposes a sample to X radiation. Fluoresced photons are released by the sample, captured by the detector, and counted. This information is then analyzed quantitatively to give the concentration of each element present in the sample.

6.5.4 Enzyme Immunoassay (EI). EI can be used for a relatively wide range of organic compounds, including pentachlorophenol, polynuclear aromatic hydrocarbons, pesticides, PCBs, herbicides, explosives, dioxins, and fuel hydrocarbons (benzene, kerosene, diesel, gasoline, etc.). An immunoassay method has also been developed for mercury. Detection limits are generally in the ppm range with some ppb ranges, depending on the compounds of interest. Concentration measurements are semiquantitative and are recorded as either greater than or less than the calibration standard. It is used as a qualitative tool to determine if a contaminant is present above or below an action level. Immunoassay is appropriate for characterization and field screening. Immunoassay is a rapid analytical method that can be used instead of traditional testing methods to map rapidly the extent of contamination. This technology delivers rapid, accurate indications of contamination in soil, water, surface areas, and waste organic liquids. Immunoassay systems come in kits that are completely portable with a sample throughput up to 30 samples/hour.

6.5.5 Inorganic Test Kits. Inorganic test kits use spectrophotometer technology to detect and measure inorganic compounds in water. The DREL 2010 Portable Water Quality Laboratory included in the BES table of allowance employs such technology.

6.5.6 Portable Gas Chromatographs (GC). Portable gas chromatagraphs provide on-site field analysis of VOCs in air, water and soil with laboratory GC quality. Sampling is achieved either automatically through an internal pump or manually through injection into a heated injection port. Results are normally displayed digitally.

6.5.7 Radiation Detectors. See Section 4, paragraph 4.3.5.2, Geiger-Mueller counters.

6.6 Documenting Samples and Locations. It is extremely important to thoroughly document the locations where samples are collected. You should use global positioning systems (GPS), maps, aerial photographs, photographs taken from the ground and/or sketches to document where you obtained samples. In addition, all pertinent sampling data must be entered into a permanently bound logbook. This documentation is critical when assessing the risks associated with any contamination that was uncovered (e.g., exposure pathway analysis). Your documentation will also be critical in the development of follow up sampling plans and programs. A number of sample analysis request forms are included in Appendix C.

6.7 Sampling Equipment Decontamination. It is very important to minimize cross-contamination of sample media and samples. Proper equipment decontamination is a key process in preventing cross-contamination. Removing or neutralizing contaminants that have accumulated on sampling equipment ensures protection of personnel from permeating substances, reduces or eliminates transfer of contaminants to clean areas, prevents mixing of incompatible substances, and minimizes the likelihood of sample cross-contamination.

6.7.1 Decontamination Equipment and Materials. The following equipment and material are used in the decontamination of sampling equipment.

- appropriate personal protective equipment (e.g., impervious gloves, eye goggles or face shield, apron, boots, eyewash bottle, etc.)

- non-phosphate detergent
- selected solvents
- long-handled brushes
- drop cloths/plastic sheeting
- trash containers/bags
- paper towels
- galvanized tubs or buckets
- tap water
- distilled/deionized water
- metal/plastic containers for storage of rinsate
- pressurized sprayers for water and solvent
- aluminum foil
- 10 percent nitric acid
- acetone
- hexane
- methanol

6.7.2 Decontamination Methods. Contaminants can be physically removed from equipment, or deactivated by sterilization or disinfection. Gross contamination of equipment requires physical decontamination, including abrasive and non-abrasive methods. These include the use of wire brushes, air, and wet blasting, and high-pressure water cleaning, followed by a wash/rinse process using appropriate cleaning solutions. When organic contamination is present, use a solvent rinse.

6.7.2.1 Abrasive cleaning methods. Abrasive cleaning methods work by rubbing and wearing away the contaminant. Typical methods include mechanical cleaning using metal or nylon brushes, air blasting using equipment that forces abrasive material through a nozzle at high pressure, and wet blasting using equipment that sprays water and abrasive material through a nozzle at high pressure. Selection of the proper method depends on the amount of contamination to be removed and the size of the sampling equipment. High pressure and wet blasting methods produce large amounts of waste.

6.7.2.2 Non-abrasive methods. Non-abrasive cleaning involves forcing contaminants off sample equipment using high-pressure or ultra-high-pressure water.

6.7.2.3 Disinfection/rinse methods. Sampling equipment can also be decontaminated using disinfectants, sterilization by heating, and rinsing through dilution, physical attraction, and solubilization.

6.7.3 Cleaning Procedures. Use the following nine-step process for decontaminating sampling equipment. Table 6-1 shows appropriate solvent rinses for a variety of contaminants.

1. Use appropriate abrasive or non-abrasive procedures discussed above.
2. Wash with non-phosphate detergent solution.
3. Rinse with tap water.
4. Rinse with distilled/deionized water.
5. Rinse with 10 percent nitric acid (if sample will be analyzed for inorganics).
6. Rinse with distilled/deionized water.

7. Use solvent rinse (if sample will be analyzed for organics).
8. Air dry equipment completely.
9. Rinse again with distilled/deionized water.

Table 6-1 -Solvent Rinses for Various Soluble Contaminants (BEE EQS Course Handout #48)

Solvent	Soluble Contaminant
Water	Low-chain hydrocarbons; inorganic compounds; salts; some organic acids and other polar compounds
Dilute acids	Basic (caustic) compounds; amines; hydrazines
Dilute bases, e.g., detergent and soap	Metals; acidic compounds; phenol, thiols; some nitro and sulfonic compounds
Organic solvents, e/g/, alcohols, ethers, ketones, aromatics, straight-chain alkanes (hexane), and common petroleum products	Non-polar compounds (organic compounds)

6.7.4 Decontamination QA/QC. Collection of rinsate blanks is a quality assurance/quality control (QA/QC) procedure that is used to monitor the effectiveness of decontamination. Rinsate blanks are samples obtained by running analyte-free water over contaminated sampling equipment to test for residual contamination. A rinsate blank is used to assess cross-contamination brought about by improper decontamination procedures. Where dedicated or throw-away sampling equipment is not used, collect one rinsate blank per type of sampling device per day.

6.8 Media Sampling. The media of concern in assessing environmental health risks are soil, water, air, and vegetation. BEEs and BE technicians are very familiar with the peacetime sampling requirements associated with these media. However, for the purpose of developing an environmental health risk assessment baseline, you will not be concerned with some of the sampling that is driven by compliance and environmental quality concerns. For instance, unless the beddown requires major permanent facility construction, there is no need to worry about deep soil samples. In the case of air, you will not have to collect samples associated with peacetime permitting programs nor will you have to sample control technology equipment. Stack testing and air emissions inventories will not be required. In the case of water, you will not be concerned with sampling requirements associated with storm water and waste water permitting. Finally, sampling associated with the environmental restoration, hazardous material, hazardous waste, or pollution prevention programs will not normally be required for the health risk baseline. Media sampling requirements that are left after compliance and environmental quality samples are eliminated are those that allow you to assess health risks in terms of exposure pathways.

6.9 Soil Medium. Contaminated soil may expose personnel to multiple contaminants at levels of health concern. Ingestion of contaminated surface soil is a primary concern. Inhalation of contaminated dusts and direct dermal contact with contaminated soils also can lead to adverse health effects. Generally, people are exposed to only the top few inches of soil; therefore, surface soil is defined as the top 3 inches. Normally, for risk assessment purposes, you need only sample surface soil. Just in case you have to collect subsurface samples, equipment and procedures for subsurface sampling also are included in this manual.

6.9.1 Historical Data Review. Every effort should be made to review information about the site. For the kind of sites you will be sampling, your best approach is to ask local officials or residents about the history of the area. Attempt to determine past and present uses, disposal practices, and known site contamination. Collect information that describes chemical processes that may have been used on the site, as well as descriptions of raw materials used, products and wastes, and waste storage and disposal practices. Whenever possible, obtain site maps, facility blueprints, and aerial photographs that may detail past and present storage, process, and waste disposal locations.

6.9.2 Site Reconnaissance. A site reconnaissance is invaluable in assessing site conditions, evaluating areas of possible contamination, evaluating potential hazards, and developing a sampling plan. During the reconnaissance, fill data gaps left from the historical review by observing and documenting process and waste disposal areas, landfills, lagoons, and effluent pipes. Look for ponds, streams, and irrigation ditches that could carry contaminants

to the site. Note topographical and structural features, dead animals and dead or stressed vegetation, potential safety hazards, tank shapes, and visible label information from drums, tanks, or other containers found on the site.

6.9.3 Field Screening. If the historical data review and site reconnaissance yield little information about the site, use appropriate field screening equipment to narrow the parameters for analysis by ruling out the presence of high potential contamination such as acids, volatile organic compounds, pesticides, and PCBs.

6.9.4 Sampling Approaches. There are a number of approaches for selecting sampling locations. You should determine if your client or technical center (MAJCOM, HQ USAF, Theater CINC, Armstrong Lab, AFCEE, etc.) prefers one approach to the other. If the client does not specify an approach, you must select one based on your best judgment, historical data and/or the site reconnaissance. Representative soil sampling approaches include *judgmental, random, systematic grid, systematic random, and transect sampling.* Whatever approach or combinations of approaches you employ make sure to document it so the risk assessors can make appropriate judgments. Table 6-2 summarizes the acceptability of various sampling approaches based on three sampling objectives.

Table 6-2 - Sampling Approach Comparison (BEE EQS Course Handout #52)

	Sampling Approach				
Sampling Objective	**Judgment**	**Random**	**Systematic Grid**	**Systematic Random**	**Transect**
Establish threat	1	4	2 + A	3	2
Identify sources	1	4	2 + A	3	3
Determine extent of contamination	4	3	1 + B	1	1

1: Preferred approach
2: Acceptable approach
3: Moderately acceptable approach
4: Least acceptable approach
A: Should be used with field screening
B: Preferred only where known trends are present

6.9.4.1 Judgmental sampling. Judgmental sampling is the subjective selection of sampling locations at a site, based on historical information, visual inspection, and/or your best professional judgment. Since judgmental sampling has no randomization associated with the approach, statistical interpretation of results cannot be made. Use judgmental sampling to identify contaminants present at areas having the highest concentrations.

6.9.4.2 Random sampling. Random sampling is the arbitrary collection of samples within defined boundaries of the area of concern (Figure 6-1). Random sampling locations are chosen using a random selection procedure such as a random number table (Table 6-3). Randomization is necessary in order to make probability or confidence statements about sampling results. Random sampling is normally used where contamination is homogeneous throughout the site.

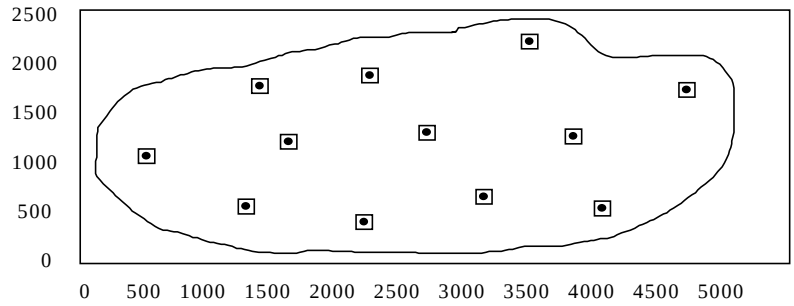


Figure 6-1 - Random Sampling (BEE EQS Course Handout #52)

6.9.4.3 Systematic grid sampling. Systematic grid sampling involves subdividing the area of concern by using a square or triangular grid and collecting samples from the node points (Figure 6-2). Systematic grid sampling is often used to delineate the extent of contamination and define concentration gradients.

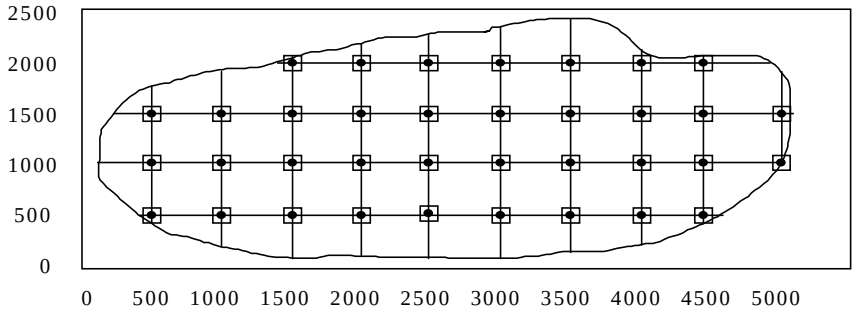


Figure 6-2 - Systematic Grid Sampling (BEE EQS Course Handout #52)

6.9.4.4 Systematic random sampling. Systematic random sampling is a useful and flexible design for estimating the average pollutant concentration within grid cells. Subdivide the area of concern by using a square or triangular grid as discussed above. Then collect samples from within each cell using random selection procedures (Figure 6-3).

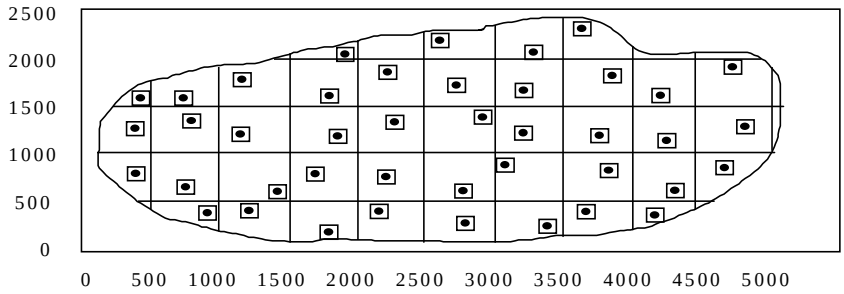


Figure 6-3 - Systematic Random Sampling (BEE EQS Course Handout #52)

Table 6-3 - Random Number Table (AU Sampling and Surveying Handbook)

	1	2	3	4	5	6	7	8	9	10
1	96268	11860	83699	38631	90045	69696	48572	0591l7	51905	10052
2	03550	59144	59468	37984	77892	89766	86489	466I9	50236	91136
3	22188	81205	99699	84260	19693	36701	43233	627I9	53117	71153
4	63759	61429	14043	44095	84746	22018	19014	76781	61086	902I6
5	55006	17765	15013	77707	54317	48862	53823	52905	70754	68212
6	81972	45644	12600	01951	72166	52682	37598	11955	73018	23528
7	06344	50136	33122	31794	86723	58037	36065	32190	31367	96007
8	92363	99784	94169	03652	80824	33407	40837	97749	1836l	72666
9	96083	16943	89916	55159	62184	86206	09764	20244	88388	98675
10	92993	10747	08985	44999	35785	65036	05933	77378	92339	96151
11	95083	70292	50394	61947	65591	09774	16216	63561	59751	78771
12	77308	60721	96057	86031	83148	34970	30892	53489	44999	18021
13	11913	49624	28519	27311	61586	28576	43092	69971	44220	80410
14	70648	47484	05095	92335	55299	27161	64486	71307	85883	69610
15	92771	99203	37786	81142	44271	36433	31726	74879	89384	76886
16	78816	20975	13043	55921	82774	62745	48338	88348	61211	88074
17	79934	35392	56097	87613	94627	63622	08110	16611	88599	02890
18	64698	83376	87527	36897	17215	74339	69856	43622	22567	11518
19	44212	12995	3581	37618	94851	63020	65348	55857	91742	79508
20	89292	00204	00579	70630	37136	50922	83387	15014	51838	81760
21	08692	87237	87879	01629	72184	33853	95144	67943	19345	03469
22	67927	76855	50702	78555	97442	78809	40575	79714	06201	34576
23	62167	94213	52971	85794	68067	78814	40103	70759	92129	46716
24	45828	45441	74220	84157	23241	49332	23646	09390	13031	51569
25	01164	35307	26526	80335	58090	85871	07205	31749	40571	51755
26	29283	31581	04359	45538	41435	61103	32428	94042	3997l	63678
27	19868	49978	81699	84904	50163	22652	07845	71308	00859	87984
28	14292	93587	55960	23159	07370	65065	06580	46285	07884	83928
29	77410	52135	29495	23032	83242	89938	40516	27252	55565	64714
30	36580	6921	35675	81645	60479	71035	99380	59759	42161	93440
31	07780	18093	31258	78156	07871	20369	53977	08534	39433	57216
32	07548	08454	36674	46255	80541	42903	37366	21164	975l6	66181
33	22023	60448	69344	44260	90570	01632	21002	24413	04671	05665
34	20827	37210	57797	34660	32510	71558	78228	42304	77197	79168
35	47802	79270	48805	59480	88092	11441	96016	76091	51823	94442
36	76730	86591	18978	25479	77684	88439	34112	26052	57112	91653
37	23439	02903	20935	76297	15290	84688	74002	09467	41111	19194
38	32927	83426	07848	59372	44422	53372	27823	25417	27150	21750
39	51484	05286	77103	47284	00578	88774	15293	50740	07932	87633
40	45142	96804	92834	26886	70002	96641	36008	02239	91563	66423

6.9.4.5 Transect sampling. Transect sampling involves establishing one or more transect lines across the surface of the site. Collect samples at regular intervals along the transect lines. Transect lines may be parallel or non-parallel (Figure 6-4). A primary benefit of transect sampling over systematic grid sampling is the ease of establishing and relocating individual lines versus entire grids. Transect sampling is often used to delineate the extent of contamination and to define contamination gradients. This sampling approach is also useful if you want to characterize a linear feature such as a drainage ditch. In this case, a transact line is run down the center of the ditch. Samples are collected along the line and then composited.

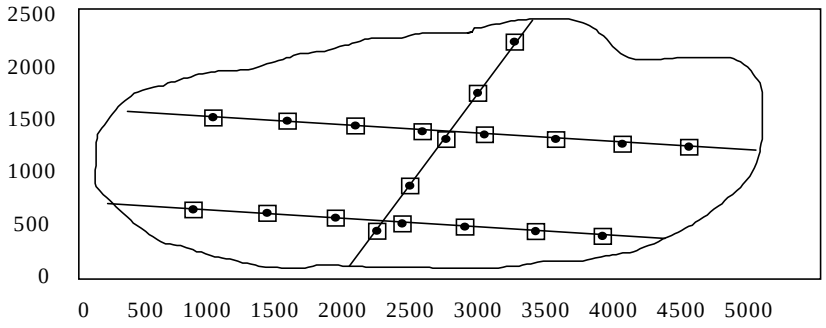


Figure 6-4 - Transect Sampling (BEE EQS Course Handout #52)

6.9.5 Sampling Locations. Once you have selected a sampling approach, the next step is to select sampling locations. Sampling pints may be located using a variety of methods. A simple method for locating random points consists of using a compass and a measuring tape, or pacing, to locate sampling points with respect to a permanent landmark. Then plot the point on a map or sketch for future reference.

6.9.6 Field Screening. Field screening generally provides analytical data of suitable quality for site characterization of soil and on-site health and safety decisions. When selecting one field screening method over another, consider cost, sample analysis time, potential interference, instrument limitations, detection limits, QA/QC requirements, operator training, and equipment availability. Also, you must consider which elements, compounds, or classes of compounds the field screening instrument is designed to analyze (e.g., VOCs, heavy metals, radiation, etc.). When using field screening instruments, you should send a minimum of 10 percent of the samples for laboratory analysis to validate the acceptability of screening results.

6.9.7 Selecting Soil Sampling Equipment. All sampling devices should be of sufficient quality not to contribute contamination to samples (e.g., painted surfaces that could chip off into the sample). The equipment must be easily decontaminated or inexpensive enough to throw away. Sample volume should also be considered when selecting equipment. Table 6-4 provides advantages and disadvantages of various soil sampling equipment.

6.9.8 Sample Collection and Preparation. Proper sample collection and preparation help to maintain sample integrity. Improper handling can result in a sample becoming unsuitable for the type of analysis required. A number of important sample preparation techniques follow.

6.9.8.1 Sample number. The number of samples needed will vary according to the sampling approach. In grid sampling, one sample is collected from each grid node regardless of the grid size. If a contaminated grid is found, you can sample more thoroughly to define the contamination. Normally, four samples are collected at equal distances from each other and the sides of the contaminated cell.

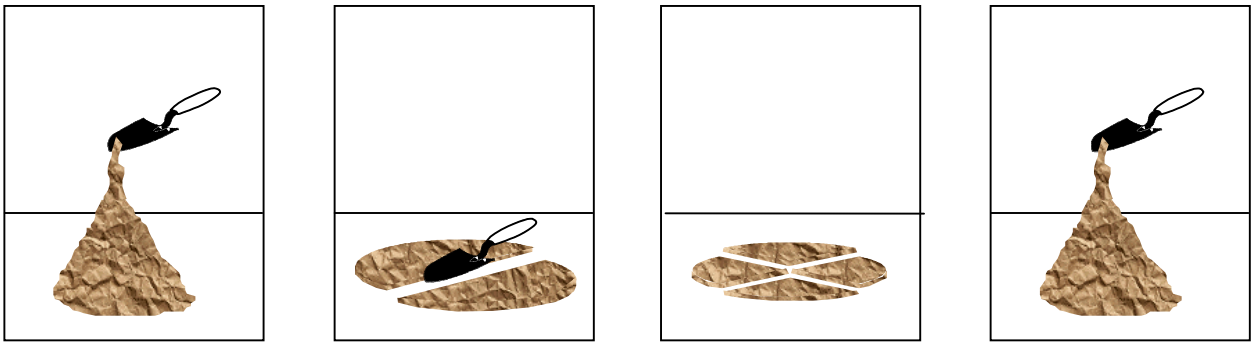
Table 6-4 - Soil Sampling Equipment (BEE EQS Course Handout #52)

Equipment	Applicability	Advantages and Disadvantages
Trier	Soft surface soil	Inexpensive; easy to use and decontaminate; difficult to use in rocky, dry, or sandy soil
Scoop or trowel	Soft surface soil	Inexpensive; easy to use and decontaminate; trowels with painted surfaces should be avoided
Tulip bulb planter	Soft soil, 0-6 in.	Easy to use and decontaminate; uniform diameter and sample volume; preserves soil core; limited depth capability; not useful for hard soils
Soil coring device	Soft soil, 0-24 in.	Relatively easy to use; preserves soil core; limited depth capability; can be difficult to decontaminate
Thin-walled tube sampler	Soft soil, 0-10 ft	Easy to use; preserves soil core; may be used in conjunction with bucket auger; acetate sleeve may be used to help maintain integrity of samples; easy to decontaminate; can be difficult to remove core samples
Split spoon sampler	Soil, 0 in. - bedrock	Excellent depth range; preserves soil core; acetate sleeve may be used to help maintain integrity of samples; useful for hard soils; often used in conjunction with drill rig for opening deep cores
Shelby tube sampler	Soft soil, 0 in. - bedrock	Excellent depth range; preserves soil core; tube may be used to ship sample; may be used in conjunction with drill rig for opening deep cores and for permeability testing; not durable in rocky soils
Bucket auger	Soft soil, 3 in. - 10 ft	Easy to use; good depth range; uniform diameter and sample volume; acetate sleeve may be useful to help maintain integrity of samples; may disrupt and mix soil horizons greater than 6 inches in thickness
Hand-operated power auger	Soil, 6 in. - 15 ft	Good depth range; generally used in conjunction with bucket auger for sample collection; destroys soil core; requires 2 or more operators; can be difficult to decontaminate; requires gasoline-powered engine (potential for cross-contamination)

6.9.8.2 Sample volume. Normally samples are taken at the surface (0-3 in.), extended surface (0-6 in.), and/or at one-foot depths. Non-water soluble contaminants such as dioxins and PCBs are often found within the first 6 inches of soil. Water-soluble contaminants such as metals, acids, and ketones will be found at deeper depths. For surface samples, collect soil over a surface area of one square foot per sample. For subsurface samples, one of the several coring devices should be used.

6.9.8.3 Extraneous material. Identify and discard materials in a field sample that are not relevant for characterizing the sample. Examples of extraneous material in soil samples include, grass, twigs or leaves.

6.9.8.4 Homogenizing samples. Homogenization is the mixing or blending of a soil sample in an attempt to provide uniform distribution of contaminants. Ideally, proper homogenization ensures that portions of the containerized samples are equal or identical in composition and are representative of the total soil sample collected. The correct procedure for homogenizing a sample is as follows. Place the entire sample in a stainless steel bucket and mix with a stainless steel spoon or scoop (disposable scoop and pan can also be used). Quarter the sample as shown in Figure 6-5, repeating the process five times until the sample is homogenized. Note: Do not homogenize samples of volatile compounds because the sample will lose volatile constituents.



Step 1: Cone sample on hard, clean surface then mix by forming new cone

Step 2: Flatten cone and divide in half

Step 3: Divide sample into quarters

Step 4: Remix opposite corners and reform cone. Repeat 5 times

Figure 6-5 - Quartering to Homogenize a Sample (BEE EQS Course Handout #52)

6.9.8.5 Splitting samples. Splitting samples after collection into two or more equivalent parts is performed when two or more portions of the same sample need to be analyzed separately. Follow the homogenization techniques above then split by filling two (or more) sample containers simultaneously with alternate scoops of the homogenized sample. Note: Do not split samples of volatile compounds because the sample will lose volatile constituents.

6.9.8.6 Composting samples. Composting is the process of physically combining several individual samples. This provides an average concentration of contaminants over a certain number of sampling points, that reduces the number of required lab analyses and the sample variability. Composting requires that each individual sample be the same in terms of volume and weight and that each sample be thoroughly homogenized. Note: Do not compost samples of volatile compounds because the sample will lose volatile constituents.

6.9.9 QA/QC. The goal of QA/QC is to identify and implement correct methodologies that limit the introduction of error into sampling and analytical procedures. In addition, to correct methodologies, there are a number of QA/QC samples that can be collected to evaluate the degree of site variation; determine whether samples were cross-contaminated during sampling and handling; or determine if a discrepancy in sample results is due to laboratory handling and analysis procedures. QA/QC sample results are used to assess the quality of the analytical results of environmental samples collected from a site.

6.9.9.1 Potential methodology errors. Identifying and quantifying error or variation in sampling and laboratory analysis can be difficult. However, it is important to limit their effect whenever possible. You must take care to eliminate the following four potential sources of error.

1. Sample design. Site variation includes differences in the type and concentration of contaminants throughout a site. Representative sampling should accurately identify and define this variation. Accordingly, you must be careful that your sample design does not result in "missed" site variations (e.g., grid or judgmental sampling points that fail to identify the source and extent of contamination as shown in Figure 6-6). Where historical or field screening data is incomplete, it may be appropriate to reduce the size of your grid and/or collect more judgment samples to assure you do not miss some contamination.
2. Sampling procedures. Errors can be introduced by improper sampling procedures, such as cross-contamination from the inappropriate use of sample collection equipment, unclean sample containers, improper equipment decontamination, and incorrect shipping techniques. The development and use of standard operating procedures will help ensure that all sampling tasks are accomplished the same way, regardless of the individual sampling team, date, or location of sampling activity.
3. Sample heterogeneity. Unlike water, soil is rarely homogeneous and it exhibits variable properties with lateral distance and depth. It is critical to homogenize your samples because the laboratory normally only uses a very small portion of the sample. If it is not correctly mixed, the analysis may not be representative of the sample.

4. Analytical procedures. Error that may originate in analytical procedures includes cross-contamination, inefficient extraction, and improper methodology. Various QA/QC samples and evaluation of recovery, precision, and bias, can be used to distinguish analytical error from error introduced during sampling activities.

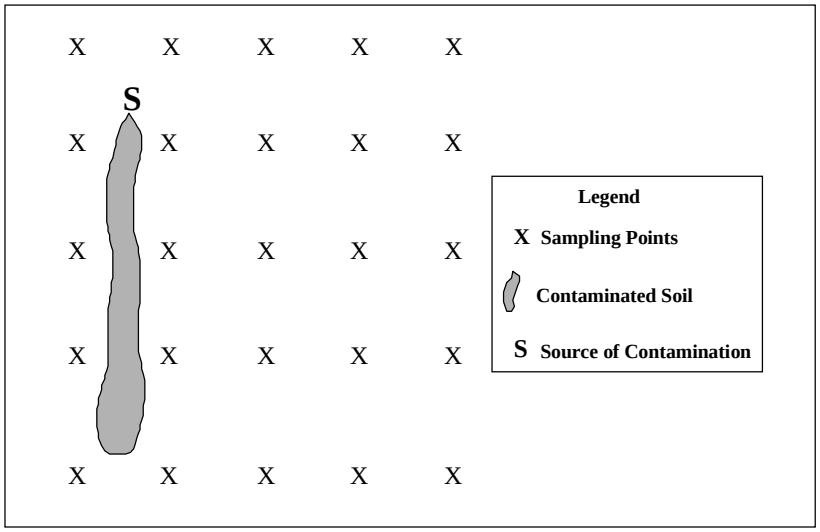


Figure 6-6 - Sampling Error Due to Sampling Design (BEE EQS Course Handout #52)

6.9.9.2 QA/QC samples. There are a number of QA/QC samples that are collected in the field or prepared by the laboratory. QA/QC samples are analyzed in addition to field samples and provide information on the variability and usability of environmental sample results. There are eight kinds of QA/QC samples.

1. Field replicates. Field replicates are field samples obtained from one location, homogenized, divided into separate containers, and treated as separate samples throughout the remaining handling and analytical processes. These samples are used to assess sample heterogeneity, sample methodology, and analytical procedures. For statistical analysis to be valid, a minimum of eight replicate samples would be required per site.
2. Collocated samples. Co-located samples are collected adjacent to routine field samples to determine local variability of the soil and contamination at the site. Typically, collocated samples are collected about 6 inches to 3 feet from the actual sample location. Collecting collocated samples at the rate of about 50 samples per acre is sufficient to demonstrate site variation.
3. Background samples. Background samples are collected upgradient from the area of suspected contamination where there is little chance of migration of the contaminants of concern. Background samples determine the natural composition of the soil and are considered “clean” samples. At least one background sample should be collected per site.
4. Rinsate blanks. See paragraph 6.7.4 above.
5. Performance evaluation samples (PE). PE samples evaluate the overall bias of the analytical laboratory and detect any error in the analytical method used. A third party using the same material as in the field sample normally prepares PE samples. The number and identity of PE samples are known to the preparer but unknown to the laboratory.
6. Matrix spike samples. Matrix spike and matrix spike duplicate samples (MS/MSDs) are environmental samples that are spiked in the laboratory with a known concentration of a target analyte to verify percent recoveries. MS/MSDs are primarily used to check sample matrix interference. They can also be used to monitor laboratory performance.
7. Field blanks. Field blanks are samples prepared in the field using certified clean sand or soil. The blank samples are sent with other samples, to the laboratory for analysis. Field blanks are used to evaluate contamination error associated with sampling methodology and laboratory procedure. Prepare field blanks at a rate of one per day when soil samples are being collected.

8. Trip blanks. Trip blanks are samples prepared prior to going into the field. Trip blanks are certified clean sand or soil and are handled, transported, and analyzed in the same manner as other volatile organic samples collected each day. Trip blanks are used to determine if any contamination is introduced into sampling, sample handling and shipment, and/or laboratory handling and analysis.

6.10 Air Medium. Adverse health effects (acute and chronic) associated with inhalation of air contaminants by personnel working near polluted sites can be cause for concern. Air emissions from past or current production processes, as well as volatilization of organic compounds, airborne particulates, and acid gases from polluted areas, may expose personnel to contaminants at levels of health concern. Hazardous substance areas from which air releases may be significant are as follows:

- surface impoundments, where there may be leaking drums or tanks containing volatile organic compounds
- landfills that produce methane gas, that can migrate
- waste piles of materials that may be easily entrained by winds or that contain volatile organic contaminants
- contaminated soils that may become entrained in the air by winds or vehicular traffic

6.10.1 Historical Data Review. Every effort should be made to review information about the site. For the kind of sites you will be sampling, your best approach is to ask local officials or residents about the history of the area. Determine the prevailing wind direction, and speed. Attempt to determine past and present industrial and agricultural activities located in the area, especially those located up-wind from the site. Collect information that describes raw materials used, products produced, emissions released, and/or wastes generated. Ask about military operations, construction, natural events, or meteorological factors that may impact air quality. Identify potential hazardous material/waste storage or manufacturing operations that could be deliberately targeted to produce chaos and maximize exposure potential. Whenever possible, obtain site maps, facility blueprints, and aerial photographs that may detail past and present storage, process, and waste disposal locations.

6.10.2 Site Reconnaissance. A site reconnaissance is invaluable in assessing site conditions, evaluating areas of possible contamination, evaluating potential hazards, and developing a sampling plan. During the reconnaissance, fill data gaps left from the historical review by observing and documenting manufacturing processes, waste disposal areas, landfills, lagoons, smoke stacks, and vet pipes. Note topographical features, such as hills, mountains, trees, flat expanses, etc. that could influence (increase or decrease) the amount of respirable particulates in the air.

6.10.3 Ambient Monitoring. For the most part, ambient air monitoring/sampling will be the only air sampling you will have to perform during health risk assessments. The primary concerns are volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polynuclear aromatic hydrocarbons (PAHs), pesticides, metals, radiation, total and respirable particulate matter, and criteria pollutants. In most cases, you will be collecting ambient air samples using SUMMA canisters and polyurethane foam (PUF) cartridges with high-volume air samplers. Screening methods should be used to quickly identify local conditions that require more quantitative analyses. Field screening is normally performed using portable Fourier Transform Infrared (FTIR) spectroscopy, and flame ionization detectors.

6.11 Water Medium. Human exposure to contaminated surface water and groundwater is a common problem. To prevent or mitigate such exposure, the location and use of potentially contaminated sources of water must be identified. Detailed information on water sources, standards, cleanliness, and surveillance is provided in Section 1 of the manual. This section will deal primarily with sampling equipment and techniques for surface water and groundwater. Since you will have the DREL 2010 lab, you can perform most of the water analyses in the field and document the results in your logbook. However, if time or circumstances do not permit, you will have to collect, package, and ship the samples to the laboratory(ies) for analysis. If you perform all water analyses in the field, you should periodically collect a sample and ship it to a laboratory for correlation testing.

6.11.1 Surface Water Sampling. Surface water samples are collected from all streams, rivers, lakes, ponds, lagoons, and surface impoundments within two miles of potential beddown sites. Sampling is generally accomplished through the use of one of the following samplers or techniques.

- Kemmerer bottle
- bacon bomb sampler
- dip sampler
- direct method

6.11.1.1 Kemmerer bottle. A Kemmerer bottle (Figure 6-7) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. Sampling procedures are as follows.

1. Using a properly decontaminated Kemmerer bottle, set the device so that the end pieces are pulled away from the sampling tube. This will allow the substance to be sampled to pass through the tube.
2. Lower the device to a predetermined depth. Avoid disturbing the bottom of the water source.
3. When the sampler is at the required depth, send down the messenger, that will close the device.
4. Retrieve the device and discharge the first 10 to 20 mL to clear any potential contamination on the valve. Transfer the sample to a sample container.
5. Package samples and complete necessary paperwork for transportation to the laboratory or analyze the sample using your DREL 2010 laboratory and document results in the logbook.

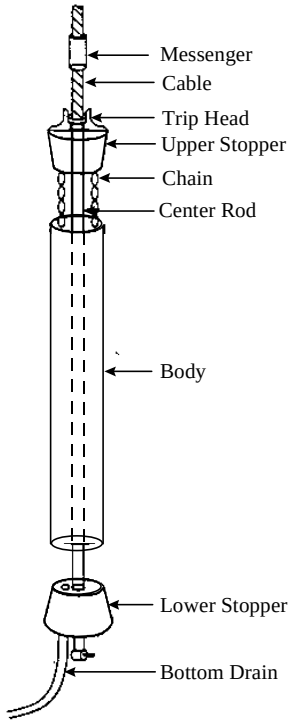


Figure 6-7 - Kemmerer Bottle (BEE EQS Course Handout #48)

6.11.1.2 Bacon bomb. A bacon bomb sampler (Figure 6-8) is used in similar situations to those outlined for the Kemmerer bottle. Sampling procedures are as follows.

1. Using a properly decontaminated bacon bomb sampler, slowly lower the sampler to the desired depth, allow the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut.
2. Release the trigger line and retrieve the sampler.
3. Transfer the sample to a sample container.
4. Package samples and complete necessary paperwork for transportation to the laboratory or analyze the sample using your DREL 2010 laboratory and document results in the logbook.

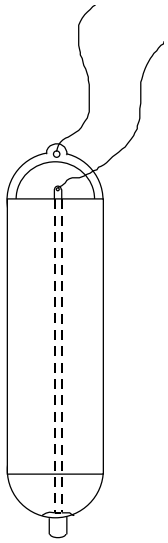


Figure 6-8 - Bacon Bomb Sampler (BEE EQS Course Handout #48)

6.11.1.3 Dip Sampler. A dip sampler (Figure 6-9) is useful for situations where a sample is to be recovered from a water source where direct access is limited. The long handle allows access from a discrete location. Sampling procedures are as follows.

1. Assemble the device IAW manufacturer's instructions. Assure the sampler is properly decontaminated.
2. Extend the device to the sample location and collect the sample.
3. Retrieve the sampler and transfer the sample to a sample container.
4. Package samples and complete necessary paperwork for transportation to the laboratory or analyze the sample using your DREL 2010 laboratory and document results in the logbook.

6.11.1.4 Direct method. The direct method for sampling surface water sources consists of using the DREL 2010 Water Quality Laboratory included in the BEE Table of Allowance. The DREL 2010 includes a spectrophotometer, conductivity/TDS meter, pH meter, reagent, and apparatus for performing all the tests shown in Table 1-6. Always collect samples under the surface of the water and avoid disturbing the bottom substrate. Follow the manufacturer's instructions and wear appropriate PPE when using the various instruments and performing tests.

6.11.2 Groundwater Sampling. Groundwater sampling is concerned with collection of water samples from the saturated zone of the subsurface. Every effort must be made to ensure that the sample is representative of the particular zone of water being sampled. Typical ground water contaminants include volatile and semi-volatile organic compounds, pesticides, metals, and biological organisms. Groundwater sampling normally falls into two categories – well sampling and soil gas sampling.

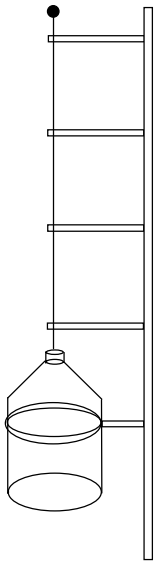


Figure 6-9 - Dip Sampler (BEE EQS Course Handout #48)

6.11.2.1 Well sampling summary. Groundwater wells must be purged prior to sampling. This is normally done with a number of devices. The most common purging devices are the bailer, submersible pump, non-gas contact bladder pump and inertia pump. All sampling and purging equipment must be decontaminated prior to use and between wells. Samples can be collected with any of the devices that are used for purging. Samples are placed into laboratory-cleaned containers, labeled, and logged. Containers, reagents, holding times, and preservatives for various samples are shown in Table 1-10.

6.11.2.2 Well sampling equipment/materials. Table 6-5 and Table 6-6 show equipment and materials that are required for well sampling.

Table 6-5 Well Sampling Equipment and Materials (BEE EQS Course Handout #48)

5-gallon pail	Logbook
Aluminum foil	Non-phosphate soap
Appropriate PPE	Packing materials
Bolt cutters	Pails or tubs
Calculator	Plastic sheathing
Chain of custody forms	Pump/bailer (bailer, submersible pump, non-gas contact bladder pump, suction pump, or inertial pump)
Containers for rinsate	Reagents and preservatives
Depth sounder	Sample containers
Distilled or deionized water	Several brushes
Engineer's rule	Sharp knife
Field data sheets	Shipping containers
Field screening instrument (FID or PID)	Steel brush
Forms and seals	Tap water
Garden sprayer	Tool box (screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench)
Keys for well cap, if appropriate	Water level indicator (steel tape)
Leather work gloves	Ziplock plastic bags

Table 6-6 - Bailers, Pumps, and Related Equipment (BEE EQS Course Handout #48)

Bailer	Enough nylon line to dedicate to each well; Teflon coated bailer wire
Submersible Pump	Electric generator; enough 1-inch black PVC coil pipe to dedicate to each well; hose clamps; safety cable; winch or pulley; gasoline; flow meter; gate valve; 1-inch nipples; tools (pipe wrenches, wire strippers, electrical tape, heat shrink, hose connectors, Teflon tape)
Non-gas Contact Bladder Pump	Compressor or nitrogen tank; batteries and charger; enough Teflon tubing to dedicate to each well; Swagelock fitting; tools (same as for submersible pump)
Suction Pump	Enough 1-inch black PVC coil pipe to dedicate to each well; gasoline; plumbing fittings; flow meter; gate valve; tools (same as for submersible pump)
Inertia Pump	5-gallon bucket

6.11.2.3 Purging. In a non-pumping well, there will be little or no vertical mixing of the water, therefore, the water becomes stagnant and not representative of the groundwater. To avoid collecting non-representative samples, follow the following guidelines.

- Generally, wells should be pumped or bailed prior to sampling. Purge a minimum of one volume of water in the well casing, and preferably, three volumes is recommended. In high-yielding ground water formations and where there is no stagnant water in the well casing, purging is not critical.
- For wells that can be pumped or bailed to dryness, the well should be evacuated and allowed to recover prior to sampling. If the recovery rate is fairly rapid and you can afford to wait, you should purge the well casing a second time before sampling. If you can't wait, it is permissible to sample after purging one volume of water.
- A non-representative sample can result from over purging of the well. Leachate concentrations may stratify and heavier contaminants may sink to the bottom of the aquifer if excessive pumping is performed. Do not purge more than three volumes of water from the well casing.

6.11.2.4 Calculating well casing volumes. Table 6-7 shows the volume of water per linear foot for various standard well casing diameters. To obtain the well volume, simply multiply the volume per linear foot times the height of water in the casing. If the casing diameter is not listed in the table, use the formula shown below to calculate the volume of water in the well casing.

Table 6-7 - Volume of Water per Linear Foot of Well Casing (BEE EQS Course handout #48)

Well Casing Diameter (inches)	v (volume in gal/ft)
2	0.1632
3	0.3672
4	0.6528
6	1.4688

Formula for volume of water in a well casing:

$$\mathbf{v = nr^2\ h\ (cf)}$$

Where:

v = volume of water in the well casing in gallons
n = pi = 3.14
r = radius of the well casing in feet
h = height of the water column in feet (this is determined by subtracting the depth to the water in the casing from the total depth of the well)
cf = conversion factor for gallons of water per cubic foot = 7.48

6.11.2.5 Preparation for purging/sampling. Prepare for purging and sampling as follows.

1. Start at the least contaminated well, if known.
2. Lay plastic sheathing around the well to minimize the likelihood of contamination of equipment from surrounding soil.
3. Remove locking well cap, note location, time, and date in logbook.
4. Remove well casing cap.
5. Monitor headspace with FID or PID for the presence of VOCs and record in logbook.
6. Lower water level measuring device into well until water surface is encountered.
7. Measure distance from water surface to reference point on well casing and record in logbook. If there is no reference point on the well casing, choose some other permanent point and annotate the location in the logbook.
8. Measure total depth of well two times and record in logbook.
9. Calculate the volume of water in the well casing.
10. Select the appropriate purging and sampling equipment.

6.11.2.6 Purging equipment and procedures. If, possible, purge three volumes of water from the well casing. During purging, you should take water level measurements periodically to determine the capacity of the aquifer to transmit water (transmissivity). The following purging devices and procedures are most commonly used. Table 6-8 summarizes the advantages and disadvantages of the various kinds of purging/sampling devices.

- Bailer. Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube, usually with a ball check-valve at the bottom. A line is used to lower the bailer into the well and retrieve a volume of water. Bailers are normally made of PVC, Teflon, or stainless steel. Bailers are good for purging small volume well casings. The following procedures are used to purge a well casing using a bailer.
    1. Start with a decontaminated bailer.
    2. Determine the volume of water to be purged.
    3. Lay plastic sheathing around the well to prevent contamination of the bailer line.
    4. Attach the line to the bailer and lower until it is completely submerged.
    5. Pull bailer out ensuring that the line falls on to the clean plastic sheathing.
    6. Pour the water into a 5-gallon pail until full to determine the number of bails necessary to achieve the required purge volume.

- Submersible pump. Submersible pumps are generally constructed of plastic, rubber, and metal parts that could affect the analysis of samples for certain trace organics and inorganics. As a result, submersible pumps are normally only used to purge well heads. These pumps must be equipped with a check valve to prevent water from flowing back into the well after it has been in the pump. Submersible pumps are either powered by electricity or operated from a compressor. Some are battery powered and others can operate from compressed gas bottles. In most cases, when collecting samples for health risk assessments, you will not have the resources and infrastructure to support using submersible pumps. However, the following procedures are used to purge a well casing using a submersible pump just in case you have a situation where one is available.
    1. Determine the volume of water to be purged.
    2. Lay plastic sheathing around the well to prevent contamination of pumps, hoses, or lines.
    3. Assemble pump, hoses, and safety cable and lower the pump into the well.
    4. Attach a flow meter to the outlet to measure the volume of water purged.
    5. Attach power supply and purge well until the specified volume of water has been evacuated. Do not allow the pump to run dry.

- Non-gas contact bladder pump. These pumps are normally constructed of stainless steel and Teflon so they can be used for purging and sampling. The water only comes in contact with the inside of the Teflon bladder and Teflon tube. Some wells have permanently installed dedicated bladder pumps. The following procedures are used to purge a well casing using a non-gas contact bladder pump.
    1. Start with a decontaminated or dedicated pump.
    2. Determine the volume of water to be purged.

3. Lay plastic sheathing around the well to prevent contamination of pumps, hoses, or lines.
4. Assemble Teflon tubing, pump, and control box.
5. Attach a flow meter to the outlet to measure the volume of water purged.
6. Attach power supply and purge well until the specified volume of water has been evacuated.
7. Be sure to adjust flow rate of pump to prevent violent jolting of tubing as sample is drawn in.

- Suction pump. There are many types of suction pumps. They are: centrifugal, peristaltic, and diaphragm. Diaphragm pumps can be used for well evacuation at a fast pumping rate and sampling at a low pumping rate. Peristaltic pumps are low-volume pumps that use two rollers to squeeze flexible tubing, thereby creating suction. The tubing can be dedicated to each well to prevent cross-contamination. Peristaltic pumps require a power source. The following procedures are used to purge a well casing using a suction pump.
  1. Start with a decontaminated pump or dedicated tubing.
  2. Determine the volume of water to be purged.
  3. Lay plastic sheathing around the well to prevent contamination of pumps, hoses, or lines.
  4. Assemble pump, tubing, and power source, if necessary.
  5. Attach a flow meter to the outlet to measure the volume of water purged.
  6. Purge well until the specified volume of water has been evacuated.

- Inertia pump. Inertia pumps are manually operated. They are appropriate to use when wells are too deep to purge using a bailer or when the wells are too inaccessible to use other kinds of pumps. Inertia pumps are made of plastic and may be decontaminated or discarded after use. The following procedures are used to purge a well casing using a Suction pump.
  1. Start with a decontaminated or dedicated pump.
  2. Determine the volume of water to be purged.
  3. Lay plastic sheathing around the well to prevent contamination of pumps, hoses, or lines.
  4. Assemble pump and tubing and lower into the well casing.
  5. Pump the water into a 5-gallon pail until you achieve the required purge volume.

6.11.2.7 Sampling equipment and procedures. Ideally, sampling equipment should be completely inert, economical to use, easy to clean, sterilized, reusable, able to operate at remote sites without external power, and capable of delivering at variable rates of flow. The same devices used for purging are also available for withdrawing samples. None of the devices possess all of the ideal characteristics previously mentioned, therefore, you must select the device that is best suited for the conditions you encounter. Advantages, disadvantages, and operating procedures for each of the purging/withdrawal devices are as follows.

- Bailer. Bailers are the most appropriate device for collecting water for volatile analysis. Generally, bailers can provide an acceptable sample, provided that sampling personnel use extra care in the collection process. Sample procedures are as follows.

Table 6-8 - Advantages/Disadvantages of Purging/Sampling Devices (BEE EQS Course Handout #48)

Device	Advantages	Disadvantages
Bailer	• No power needed • Portable • Inexpensive • Minimal outgassing of VOCs while bailing • Readily available • Removes stagnant water first • Rapid, simple method for removing small volumes of water	• Time consuming • Transfer of sample may cause aeration
Submersible pump	• Portable • Relatively high pumping rate • Reliable • Does not require priming	• Can effect analysis of trace organics/inorganics • Heavy and cumbersome • Expensive • Power source required • Susceptible to damage from silt/sediment • Impractical for low yield or shallow wells
Non-gas contact bladder pump	• Maintains integrity of sample • Easy to use • Can use dedicated bladder and tubing	• Difficult to clean • Only useful to 100 feet of depth • Source of gas required (bottle or compressor)
Suction pump	• Portable • Inexpensive • Readily available	• Only useful to 25 feet of depth • Vacuum can cause loss of dissolved gases/VOCs • Pump must be primed • Vacuum difficult to maintain • May cause pH modifications
Inertia pump	• Portable • Inexpensive • Readily available • Rapid method for purging shallow wells	• Only useful to 70 feet of depth • May be time consuming • Labor intensive

1. Pre-label a sufficient number of sample containers.
2. Surround the well with clean plastic sheathing.
3. Attach a line to the bailer. If the bailer was used to purge the well, the same bailer and line <u>may be used</u> for sampling. If a different bailer is used, make sure it has been decontaminated.
4. lower the bailer slowly and gently into the well casing, taking care not to scrape the casing sides or splash the water. Stop lowering when you are adjacent to the screen.
5. Allow the bailer to fill then slowly and gently retrieve the bailer from the well. Avoid contact with the casing so as not to knock flakes of rust or other foreign matter into the bailer.
6. Remove the cap from the sample container and place it on the plastic sheet or in a location where it will not become contaminated.
7. Pour the sample slowly into the sample container, cap the container, and place it in the carrier.
8. Replace the well cap.
9. Log all samples in the logbook and on field data sheets.
10. Package samples and complete necessary paperwork for transportation to the laboratory or analyze the sample using your DREL 2010 laboratory and document results in the logbook.

- Submersible pump. Normally, submersible pumps are not used for sampling because they can effect analyses for trace organics and inorganics. In addition, when collecting samples for health risk assessments, you will probably not have the resources and infrastructure to support using a submersible pump.
- Non-gas contact bladder pump. You may find non-gas contact bladder pumps permanently installed in wells. These pumps are suitable for sampling shallow wells (less than 100 feet). They are difficult to clean but may be

used with dedicated tubing to avoid the decontaminating process. These pumps require a power supply and/or compressed gas supply (compressor). They are capable of variable flow which makes them ideal for purging and sampling. Sample procedures are as follows.

1. Pre-label a sufficient number of sample containers.
2. Turn on pump, increase cycle time, and reduce pressure to the minimum needed to get the sample to the surface.
3. Direct flow from outlet tube into sample container(s).
4. Cap container(s) and place in carrier.
5. Log all samples in the logbook and on field data sheets.
6. Remove tubing from the well casing and vigorously decontaminate the tubing and bladder or replace with new dedicated tubing and bladder.
7. Replace well cap.
8. Package samples and complete necessary paperwork for transportation to the laboratory or analyze the sample using your DREL 2010 laboratory and document results in the logbook

- Suction pump. In view of the disadvantages of suction pumps, they are not recommended for sampling purposes.
- Inertia pump. Inertia pumps can be used to collect samples. However, it is more common to purge with these pumps and sample with a bailer. The following procedures are used to collect a sample using an inertia pump just in case you have a situation where one is available.

1. Pre-label a sufficient number of sample containers.
2. Begin manually operating the pump. You can control the flow rate to meet your needs.
3. Direct flow from outlet tube into sample container(s).
4. Cap container(s) and place in carrier.
5. Log all samples in the logbook and on field data sheets.
6. Remove tubing from the well casing and vigorously decontaminate the tubing and pump or replace the pump with new one.
7. Replace well cap.
8. Package samples and complete necessary paperwork for transportation to the laboratory or analyze the sample using your DREL 2010 laboratory and document results in the logbook.

6.11.2.8 Filtering**.** For samples that require filtering, such as those that will be analyzed for total metals, the filter must be decontaminated prior to use and between uses. Two types of filter apparatus are available. The barrel type filter is pressurized with a bicycle pump after the water has been placed in the chamber. The pressure is maintained at 30 psi and forces the water through filter paper (normally 0.45 μm) into the sample container. The vacuum type filter involves two chambers. The chambers are separated by filter paper (normally 0.45 μm). The upper chamber holds the sample. A vacuum is drawn on the lower chamber using a hand pump. The water is pulled through the filter paper into the bottom chamber where it is then transferred into a sample container.

6.11.2.9 Sampling for volatile organics. Sampling for volatile organics requires minimal disturbance of the sample to limit volatilization and loss of volatile characteristics. Sample devices suitable for collection of volatile organic samples are positive displacement bladder pumps, syringe samplers, and bailers. The objective is to obtain a sample for analysis that has been subjected to a minimum amount of turbulence. Sample procedures are as follows.

1. Open clean vial and set cap in a clean place. When collecting duplicates, collect both samples at the same time.
2. Fill vial to just overflowing. Do not rinse the vial or allow it to overfill. There should be a convex meniscus on the top of the vial.
3. Carefully cap the vial. Place cap directly over the top and screw down firmly.
4. Invert the vial and tap gently. Observe for at least 10 seconds. If air bubbles appear, discard the sample and begin again. It is critical that no air becomes entrapped in the vial.

5. Place vial in its protective sleeve and place it in a cooler. Lay the vial on its side, not straight up.
6. The holding time for volatile organic samples is 7 days. Choose a transportation method that will assure the samples arrive at the laboratory in sufficient time to allow the samples to be analyzed before the holding time elapses.

6.11.3 Soil Gas Sampling. Soil gas monitoring is a quick means for identifying underground pollutants that could effect the quality of groundwater. Soil gas monitoring is not a sampling method for confirming actual groundwater contamination. However, it can be considered as a field screening method for identifying the existence of contamination that might effect the quality of groundwater. The soil gas monitoring process involves installing soil gas wells and screening/measuring organic levels in the soil gas using a portable screening device and/or sampling the soil gases using devices such as Tedlar bags, Tenax sorbent tubes, or SUMMA canisters.

6.11.3.1 Equipment/materials. Table 6-9 shows the equipment and material commonly needed for conducting soil gas sampling.

Table 6-9 - Soil Gas Sampling Equipment (BEE EQS Course Handout #48)

2 - 3 feet of ¼ in Teflon tubing	Portable photoionization detector or flame ionization detector
5 feet of ¼ in OD stainless steel tubing	Quick connect fitting for connecting PID, tubing probe, and pumps to vacuum box
Flexible wire used to clear the monitoring tube	Sample labels, field data sheets, logbook
Gilian pump	Slam bar
Ice chest	Soil gas probes
Metal detector	SUMMA canisters w/shipping cases
Modeling clay	Tedlar bags, (1 liter)
Portable gas chromatograph	Vacuum box for drawing a vacuum around Tedlar bags

6.11.3.2 Soil gas well installation. The first step in the process of soil gas sampling is to install a well to collect and monitor soil gases. A soil gas well is nothing more than a narrow 5 foot deep hole into which a sampling probe is installed. Installation procedures are as follows.

1. Use a slam bar to make a hole 5 feet deep.
2. Remove the slam bar being careful not to collapse the walls of the hole.
3. Insert a piece of metal wire that is slightly longer than the probe into the probe. Insert the probe into the hole to full depth. Pull the probe up 3 - 6 inches while holding the wire in place. Move the wire around to clear any soil that may have plugged the probe during installation. Remove the wire.
4. Using modeling clay, seal the hole where the probe exits the ground. This will prevent ambient air from entering the hole.

6.11.3.3 Screening with field instruments. Depending on the type of instrument available, you can monitor the soil gases for the presence of total organics using a portable photoionization detector (PID) or you can monitor for specific organics using a flame ionization detector (FID). Field screening procedures are as follows.

1. Evacuate the well volume using a Gilian pump. Attach the pump to the probe using a Teflon connector and run the pump for about 15 seconds.
2. Disconnect the pump and connect the PID or FID to the probe using a clean Teflon connector. Follow the manufacturer's instructions for operating and reading the detector.
3. Document the results in your logbook.

6.11.3.4 Using sampling devices. If screening devices are not available or you need more detailed data, use Tedlar bags, Tenax tubes, or SUMMA canisters to collect samples of soil gas. Information about the various devices and sampling procedures is as follows.

- Tedlar bags are one liter in size and are used to contain soil gases for analysis. Bags are normally stored in coolers for ease of handling and to prevent damage during transit. In addition, coolers keep the sample out of direct sunlight that helps insure sample integrity. Samples should be analyzed ASAP, preferably within 24 to 48 hours. Sample procedures using Tedlar bags are as follows.
  1. Evacuate the well volume using a Gilian pump. Attach the pump to the probe using a Teflon connector and run the pump for about 15 seconds.
  2. Disconnect the pump and connect the sampling train shown in Figure 6-10. The sampling train is designed so all parts exposed to the sample are either Teflon of stainless steel.
  3. Place the Tedlar bag inside vacuum box and attach it to the sampling port. Attach the sampling probe to the sampling port using a Teflon connector. Attach a Gilian pump to the evacuation port of the vacuum box.
  4. Draw a vacuum using the Gilian pump. The vacuum causes the bag to inflate which draws in the sample of soil gas.
  5. Break the vacuum by removing the line from the evacuation port. Remove the bag, and annotate sample label, field data sheet, and logbook. Do not paste label directly onto the bag. Do not mark the bag with a marking pen. Inks and adhesives may diffuse through the bag and contaminate the sample. Tie the label to the metal eyelets provided on the bag. In this case, do not use permanent markers as they normally contain volatile organics.

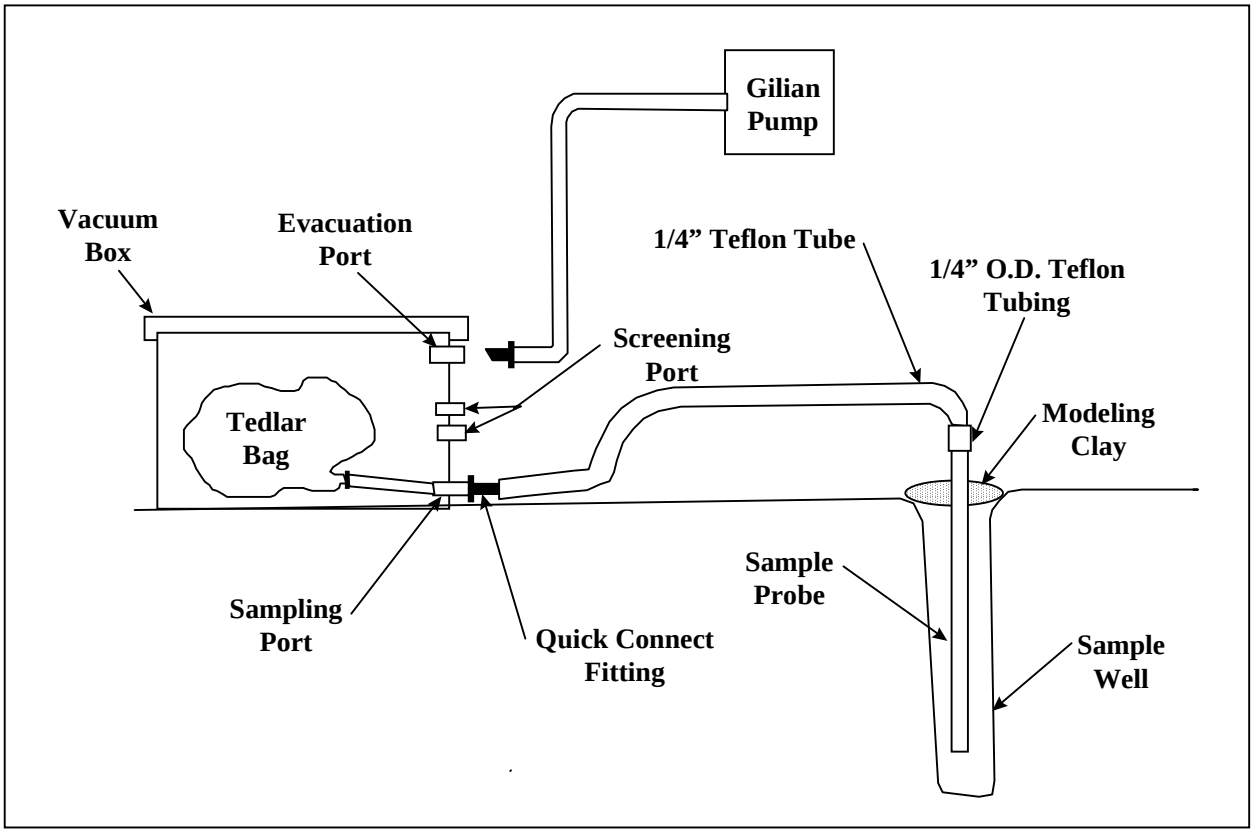


Figure 6-10 - Tedlar Bag Sample Train (BEE EQS Course Handout #48)

- Tenax tube sampling. When using Tenax or other types of detector tubes, soil gas samples are drawn through the tubes and captured in the detection media. Handling of the tubes must be kept to a minimum and operators must wear nylon or other lint-free gloves when handling is absolutely necessary. After sampling, detector tubes are sealed in clean culture tubes. Culture tubes are kept cool and wrapped in aluminum foil to reduce photodegradation of the sample. Tedlar bags are used to extract the sample from the well and then the soil gas is

drawn from the bag through the detector tubes. Additional items such as a syringe, adapters, fittings, Teflon tubing, and O-rings are needed to draw the soil gas through the detector tube. A gas chromatograph is used to analyze the soil gas that has been sorbed by the detector tube. Sample procedures are as follows.

1. Follow the procedures for filling the Tedlar bag.
2. Use nylon or other lint-free gloves when handling detector tubes.
3. Immediately before sampling, break one end of the sealed tube and remove the detector cartridge.
4. Connect the valve on the Tedlar bag to the sorbent tube adapter. Connect the sorbent tube adapter to the end of the sorbent tube that contains the white granular material.
5. Connect the sample syringe assembly to the other end of the sorbent tube.
6. Open the valve on the Tedlar bag.
7. Open the on/off valve on the sampling syringe.
8. Draw a predetermined volume of sample into the sorbent tube using the syringe. This may require more than one cycle of the syringe. If additional cycles are needed, close the on/off valve on syringe, empty the contents, and repeat the extraction process.
9. Wearing lint-free gloves, remove the tube from the sampling train. Place the detector tube in a stainless steel holder or culture tube and seal the ends with Teflon tape.
10. Annotate sample label, field data sheet, and logbook. Do not paste label directly onto the detector tube. Do not mark the detector tube with a marking pen. Attach the label to the stainless steel holder or culture tube. In this case, do not use permanent markers as they normally contain volatile organics.
11. Include a trip blank with each set of samples. The trip blank is treated exactly like a field sample, except that no soil gas is drawn through the tube.

- SUMMA canister sampling. SUMMA canisters (Figure 6-11) used for soil gas sampling have a 6-liter sample capacity and are certified clean by GC analysis before being utilized in the field. After sampling the canisters are stored and shipped in travel cases. Sampling procedures using SUMMA canisters are as follows.
  1. Evacuate the well volume using a Gilian pump. Attach the pump to the probe using a Teflon connector and run the pump for about 15 seconds.
  2. Disconnect the pump and connect a certified clean, evacuated SUMMA canister to the well probe using Teflon tubing.
  3. Open the valve of the SUMMA canister and allow the soil gas to be drawn into the canister by pressure equilibrium. This should take about 20 minutes for a 6 liter canister.
  4. Annotate sample label, field data sheet, and logbook. Attach label to the canister.

Figure 6-11 - SUMMA Canister (http://www.graseby.com/cans.htm)

6.11.3.5 Sample probe contamination. Check for sample probe contamination between sampling events by drawing ambient air through the probe using a Gilian pump. Check the air with a PID. If readings are higher than background levels, replace or decontaminate the probe. Probes can be decontaminated by drawing ambient air through the probes until background levels are achieved. Persistent contamination can be removed by washing the probe with methanol, and water, then letting it air dry.

6.11.3.6 Sample train contamination. The Teflon tubes forming the sample train should be changed daily. If visible contamination occurs, replace the tubes immediately. When sampling in highly contaminated areas, ambient air should be drawn through the sample train for 30 seconds between sample events. After purging, use the PID to verify decontamination.

6.11.3.7 Field blanks and trip standards. Where possible, place one Tedlar bag filled with ultra-zero grade air in each cooler prior to going into the field. This field blank should accompany the samples when being collected and when they are transported for analysis. A fresh blank is placed in the cooler prior to each sample day. Each cooler must also contain a Tedlar bag filled with a standard gas to use when calibrating the field screening device (PID, FID, etc.) A fresh trip standard is placed in the cooler prior to each sample day.

6.11.3.8 Tedlar bag check. Remove one Tedlar bag from each case lot, fill it with ultra-zero grade air, and then check the air with a field screening instrument or portable GC. This will assure the cleanliness of the sample containers.

6.11.3.9 Duplicate samples. A minimum of 5 percent of all samples should be collected in duplicate (i.e., if 100 samples are collected, five samples should be duplicates).

6.12 Vegetation Medium. Stressed, discolored, or dead vegetation, can be an indication of soil, water, or air contamination. Accordingly, you must pay close attention to the condition of flora during all reconnaissance activities. However, many plants thrive quite well in spite of significant levels of contamination. There may be no outward signs to indicate a problem and yet a plant species may contain levels of contamination that could be toxic to human beings. This is especially true in the case of pesticide contamination in edible plants and throughout the food chain. A good example is the case of heptachlor in the Sate of Hawaii. In the early 1980s, all the milk supplies within the state had to be disposed of because of dangerously high concentrations of heptachlor. Heptachlor is an insecticide that was being used by pineapple farmers to control ants in the pineapple fields. There were no visible signs of contamination, and yet, the pineapple plants absorbed the heptachlor. After the pineapples were harvested, the farmers sold the pineapple plants to dairy farmers who fed the plants to their cows. Eventually, toxic concentrations of heptachlor showed up in the milk being produced by the cows. This demonstrates the importance of collecting and analyzing samples of flora in and around potential beddown sites.

6.12.1 Historical Data Review. Every effort should be made to review information about the site. For the kind of sites you will be sampling, your best approach is to ask local officials or residents about the history of the area. Attempt to determine past and present agricultural activities located in the area. Collect information that describes products used, emissions released, and/or wastes generated. Whenever possible, obtain site maps and aerial photographs that may detail past and present flora, and storage, process, and waste disposal locations.

6.12.2 Site Reconnaissance. A site reconnaissance is invaluable in assessing site conditions, evaluating areas of possible contamination, evaluating potential hazards, and developing a sampling plan. During the reconnaissance, fill data gaps left from the historical review by observing and documenting agricultural activities, manufacturing processes, waste disposal areas, landfills, and lagoons. Note stressed, discolored, or dead flora.

6.12.3 Vegetation Sampling. There is no EPA, or other approved methods, for the type of vegetation sampling you should carry out. However, to assure potential health risks are identified, you should sample all types of flora (grass, small plants, roots, fruit, vegetables, grains, etc.) at and around the beddown site. Collect healthy-looking as well as stressed vegetation. If you find evidence of stressed or dead flora, collect healthy-looking background samples of the same vegetation at some distance from the site. Place all samples in individual Ziplock bags. Every sample must be at

least two ounces. All samples should be sent to the Armstrong Laboratory, 2402 E. Drive, Brooks AFB, TX 78235-5114 (210-536-3626) for analysis.

Section 7
Environmental Emergency Response

SECTION 7 -ENVIRONMENTAL EMERGENCY RESPONSE

7.1 General. In accordance with USAF instructions, Bioenvironmental Engineering Services (BES) must be fully involved in disaster and emergency response programs. This involvement includes preparing for emergencies through effective planning and training and responding to disasters as members of disaster response teams. Planning and training are accomplished IAW USAF and MAJCOM guidance and is outside the scope of this field manual. This section addresses the third area of involvement - responding to disasters. General responsibilities assigned to the BES during emergency/disaster response include:

- Collecting, preparing, and analyzing environmental samples.
- Evaluating occupational, radiological, and environmental health hazards at accident/disaster scenes.
- Determining protective measures and equipment for personnel entering accident/disaster scenes.
- Advising on scene command on evacuation requirements.
- Determining the need for monitoring, contamination control, and decontamination of DOD personnel, equipment, property, or other resources.

7.2 Emergency Response Kits. To effectively accomplish emergency/disaster response duties, the BES should assemble a number of emergency response kits. Where additional supplies and equipment are needed for specific responses, material lists will be provided in appropriate subsections of this manual.

7.2.1 Environmental Sampling Kit(s). Every BES should assemble kit(s) consisting of materials that are used to perform environmental sampling. Contents of the kit(s) are determined locally. However, supplies include items such as shown in Table 7-1.

Table 7-1 - Environmental Sampling Kit(s)

Sample Type	Materials/Equipment
Surface water	Kemmerer bottles, bacon bomb sampler, Isco or Sigma composite water sampler, dip sampler, line and messengers, sample bottle preservatives, Ziplock bags, ice, cooler(s), buoys and anchors, DREL 2010 Laboratory
Groundwater	Water level indicator, depth sounder, steel brush, one-quart jars, bucket, Ziplock bags, sampling device (bailer, submersible pump, bladder pump, suction pump, or inertia pump), DREL 2010 Laboratory
Sediment	Bucket, wide-mouth jars w/Teflon-lined lids (4-oz, 8-oz, one-quart), shovel, spatula, scoop, trowel, bucket auger, extension rods, T-handle, sampling trier, sediment coring device, Ponar or Ekman dredge, nylon rope
Soil	Bucket, wide-mouth jars w/Teflon-lined lids (4-oz, 8-oz, one-quart), trier, scoop, trowel, bulb planter, soil coring device, thin-wall tube sampler, bucket auger
Water/wastewater	100 ml glass/plastic bottles, 125 mL glass/plastic bottles, 250 mL glass/plastic bottles, 1-quart amber bottles, 1-liter glass/plastic bottles/bags, 40 mL glass vials, turbidity meter, thermometer or direct reading instrument, pH meter, DO meter Isco or Sigma composite water sampler, DREL 2010 Laboratory
Air	Summa canisters, high volume air samplers, Staplex samplers, tenax tubes, polyurethane foam, sling physchrometer
Sample equipment decontamination	Non-phosphate detergent, selected solvents, long-handled brushes, drop cloths/plastic sheeting, trash bags/container, paper towels, galvanized tubs/buckets, tap water, distilled/deionized water, metal/plastic containers for waste wash solutions, pressurized sprayers, aluminum foil

7.2.2 Administrative Kit. Every BES office should assemble a kit of emergency administrative supplies. Contents of the kit are determined locally. However, minimum supplies include such items as paper, pens, pencils, indelible markers, chain of custody forms, field data sheets, sample tags, lab forms, staplers, staples, scissors, rubber bans,

gummed labels, rulers, scientific calculator, maps, plot plan, compass, tape measure, survey stakes, flags, camera and film, logbook, etc.

7.2.3 WBGT kit. The Wet-bulb globe temperature (WBGT) kit (NSN 6665-00-159-2218) consists of all the necessary thermometers, scales, and wicks to determine WBGT readings in ^{o}F. Wicks for the wet bulb thermometer must be wetted with distilled water and replaced regularly. Any buildup of metals or contaminants on the wick could result in inaccurate readings. Electronic digital readout WBGT meters are available commercially and can be substituted for the stock listed kit.

7.3 Emergency Responses. The following subsections address responsibilities and procedures for accidents, emergencies, and disasters associated with hydrazine, fuel spills, aircraft accidents/composite fibers, pesticides/toxic chemical spills, unexploded ordnance (UXO)/munitions, and natural disasters.

7.4 Hydrazine. Hydrazine has been used in liquid-fueled missile propulsion systems and in commercial industry for years. The Air Force buys, stores and transports different hydrazine fuels including anhydrous hydrazine (AH), methylhydrazine (MMH), dimethylhydrazine unsymmetrical (UDMH) and mixtures of hydrazine known as A-50 and H-70. Hydrazine fuels are flammable, toxic and corrosive. The MMH, UDMH, A-50, and H-70 are inhalation hazards. They are all clear colorless liquids with an ammonia-like or -fishy- odor. They are flammable over a wide range of vapor-air. The potential hazards from unprotected exposure to hydrazine vapors are dependent upon the concentration and duration of the exposure. You might experience acute effects such as dizziness, nausea, or even unconsciousness or chronic effects such as liver and kidney damage. These adverse effects would not be expected at vapor concentrations below one part per million. There are no studies that link cancer in humans to hydrazine exposure despite the long history (greater than 50 years) of hydrazine use in industry. Liquid contact may cause skin burns or eye damage.

7.4.1 Hydrazine Resupply. The Air Force contracts with the Olin Chemical Corporation for the manufacture of hydrazines. The fuels are produced at Olin's Lake Charles, LA., plant and blended and stored at Olin's McIntosh, AL., plant. Commercial carriers transport hydrazine to Air Force, National Aeronautics Space Administration (NASA), and defense contractor facilities throughout the country. The products are transported in bulk quantities by cargo tank trailer and by rail. Smaller quantities are transported in 55-gallon drums by truck. The San Antonio Air Logistics Center's Directorate of Aerospace Fuels Management at Kelly Air Force Base, TX., manages the procurement, transportation, storage and disposal of hydrazine for the Air Force.

7.4.2 Hydrazine Use In The Air Force. The most wide-spread use for hydrazine in the USAF is in the F-16. Instead of mechanical linkage or cables, the flight control surfaces on the F-16 receive electronic signals through a fly-by-wire system using actuators. The aircraft has one turbofan engine that provides power for all aircraft systems. If the F-16 should experience engine failure, electrical failure, or hydraulic failure, an emergency power unit (EPU) is automatically activated. This EPU supplies emergency power for the landing gear and flight control system. This allows the pilot to maintain control of the aircraft. The fuel used to power the EPU is H-70, a hydrazine and water mixture. Currently the F-16 is the only aircraft in the Air Force inventory that uses hydrazine. Each aircraft contains 6.8 gallons (56 lb) of hydrazine in a reinforced container (bottle). Some F-16 main operating bases have hydrazine plants. The plants use 55-gallon drums as bulk storage. Individual aircraft bottles are filled from the plant. Other F-16 bases obtain resupply by sending their empty aircraft bottles to depot or to a base that has a hydrazine plant. Whenever the bottles are out of the aircraft, they are stored in “caskets” to prevent damage and leaks.

7.4.3 Hydrazine Response Requirements. The most likely emergency response scenarios involving hydrazine would be a spill resulting from an F-16 crash, a storage and handling accident, or the crash of a commercial transportation truck carrying hydrazine. In such scenarios, the primary responsibilities of the BES are to assist in establishing the toxic corridor length (TCL), detect/monitor hydrazine vapors and liquid, advise on personal protective equipment (PPE) requirements, and assist in determining dilution ratios. Table 7-2 provides technical and other information on hydrazine.

Table 7-2 - Technical and Other Information on Hydrazine (ACC Checklist)

<table>
<tr><td rowspan="2">Physical Properties
Clear oily liquid
Odor similar to ammonia
Flash point: 154
Boiling point: 264°F
Very stable
Can be exploded by electrical shock</td><td>Other Properties
TLV: 0.1 ppm skin
Odor threshold: 3-5 ppm</td></tr>
<tr><td rowspan="2">Emergency Exposure Limits
At 30 ppm: 10 minutes
At 20 ppm: 30 minutes
At 10 ppm: 60 minutes
IDLH: 80 ppm in 30 minutes</td></tr>
<tr><td>Chemical Properties
Hypergolic when in contact with oxidizer
Corrosive
Soluble in water
Formula: H_2NNH_2
Specific gravity: 1.01
Vapor density: 1.1
Explosive limit: 4.7 percent</td></tr>
<tr><td>Required Protective Equipment
Coveralls
Impermeable gloves
Impermeable boots
Self-contained breathing apparatus</td></tr>
<tr><td colspan="2">Results of Exposure
Itching, burning, and swelling. Eye irritation - blindness. Inhaled vapors - irritation of nose, throat, and respiratory tract. Prolonged inhalation - dizziness, nausea, and hoarseness. Prolonged exposure - irreversible liver damage.</td></tr>
</table>

7.4.4 Emergency Procedures. In most cases the BES will respond to hydrazine emergencies as part of a base/installation disaster response team. Under such a scenario, the Medical Control Center (MCC) and the Wing Control Center will be the primary controlling activities for the BES. If the accident/spill site is located off base, a convoy assembly area will normally be established. At the accident/spill site an On-scene Commander will be in charge of the disaster response team. Attachment 7-1 provides recommended abbreviated response procedures. More specific information and procedures follow.

7.4.4.1 Toxic cordon. Toxic cordons are established at accident/spill sites to assure the health and safety of response and non-response personnel. The cordon is established by the On-scene Commander (OSC) based on calculated toxic corridor lengths (TCL). The TCL is the distance in feet, downwind from the spill, that must be evacuated. No one is allowed inside the cordon without a self-contained breathing apparatus and impermeable clothing until the spill is neutralized. In the Air Force, Weather personnel have an automated program that will calculate the TCL based on information provided from the crash scene. Accordingly, the BES provides the following information to Weather personnel so they can determine the TCL.

- name of the chemical
- wind speed in knots
- spill surface area in square feet
- temperature of the spilled liquid
- source strength (Q):

Source strength (Q):

$$Q = .000166\, V^{0.75}\, (A)\, (1 + .0043\, Tp^2)\, (Z)$$

Where:

Q = source strength in lb/min
V = wind speed in knots
A = spill area in square feet

Tp = temperature of spilled liquid in degrees centigrade (assume pool temperature is the same as ambient air temperature)
Z = given factor (0.333 for hydrazine)

If there are no AF Weather offices available, a worst case TCL can be determined by using Table 7-3. After you provide the worst case TCL to the OSC, you can calculate the actual TCL using the following formulas:

TCL = CF x DF

Where:

TCL = toxic corridor length in feet
CF = Chemical factor (1.19 for hydrazine)
DF = Diffusion factor

$$DF = Q^{0.513} (\hat{}T + 10)^{2.53}$$

Where:

$\hat{}$**T** = the difference in air temperature at 6 feet and 54 feet
NOTE: If delta T ($\hat{}$T) is not available from the Weather people, use one of the following average numbers:

Day time = -1 ^{o}C
Night time = +4 ^{o}C
Sunset/Sunrise = 0 ^{o}C

7.4.4.2 Spill cleanup/neutralization procedures. The steps in cleaning up a hydrazine spill are not complex. For the purpose of discussion, focus on a spill involving a defective or broken hydrazine (H-70) line on an F-16 located on a concrete parking ramp. Remember, the H-70 tank only contains 6.8 gallons of hydrazine. The first step is to clear all non-essential personnel from the cordon area. The response team is now in place and begins the second step; containing the spread. The team does this by placing polypropylene felt around the leading edge of the spill. Clean white cotton cloth may be substituted for the felt. The method used to contain the spill must account for the fact that the hydrazine must be diluted to a 1 percent concentration before it can be neutralized. If the dilution is not done first, an adverse exothermic reaction with the neutralizing agent will occur. If the volume of the containment area is not large enough to accommodate the dilution, a volume of water equal to the amount of hydrazine (1 to 1 ratio) may be added to control the fire hazard and limit evaporation. The partially diluted hydrazine can then be mopped up with polypropylene sponges or clean cotton cloths and transferred to containers where it can be further diluted and neutralized. After the hydrazine is diluted to a 1 percent solution, it can be neutralized with house-hold bleach (5 percent sodium hypochlorite) or with commercial HTH (a granular mixture of 65 percent calcium hypochlorite). The bleach or HTH should be added in small increments in a manner such that the vigorous bubbling stops before more is added. Note: The calculated volumes of pure neutralizing gent must never be added directly to undiluted hydrazine. Determine how much hydrazine is in the diluted spill and then calculate the volume of neutralizing agent to be added. Use 142 gallons of bleach to neutralize one gallon of 100 percent pure hydrazine. Use 60 pounds of HTH to neutralize each gallon of 100 percent pure hydrazine (see examples below). After the entire amount of HTH or household bleach has been added and the bubbling has stopped, the hydrazine should be completely neutralized. A chlorine residual should be present. To check for neutralization, collect 10 mls of the treated waste and add 1 gm (1/4 to ½ teaspoon) of potassium iodide. A slight increase in yellow color approximates a 5 ppm chlorine residual. Once neutralization is assured, the effluent can be released to the

sanitary or storm sewer. Finally, the spill area should be flushed with large amounts of water. If the flushing will go directly to grade, it may be necessary to neutralize the excess chlorine with sodium thiosulfate.

Examples of neutralizing solutions:

Use 17.5 gallons of household bleach to neutralize one pint of hydrazine

Use 7.5 lbs of HTH to neutralize one pint of hydrazine

Use 12.5 gallons of household bleach to neutralize one pint of H-70

Use 5.25 lbs of HTH to neutralize one pint of H-70

Table 7-3 - Estimated Toxic Corridor Length (in feet) for F-16 Hydrazine (H-70) (ACC Checklist)

Ambient Temperature	Wind Velocity (knots)					
	5	**7**	**10**	**15**	**18**	**20**
Daytime						
15 °C (59 °F)	56	64	73	86	92	96
20 °C (68 °F)	67	76	87	102	109	114
25 °C (77 °F)	77	88	101	118	127	132
30 °C (86 °F)	90	102	117	137	147	153
35 °C (95 °F)	102	116	133	156	167	174
Sunset/Sunrise						
15 °C (59 °F)	74	84	96	112	121	126
20 °C (68 °F)	87	99	114	133	142	148
25 °C (77 °F)	101	115	132	154	165	172
30 °C (86 °F)	117	133	153	179	192	200
35 °C (95 °F)	133	152	174	204	218	227
Night Time						
15 °C (59 °F)	173	196	225	263	282	294
20 °C (68 °F)	204	232	266	311	333	347
25 °C (77 °F)	238	271	310	363	389	405
30 °C (86 °F)	275	313	359	419	450	468
35 °C (95 °F)	313	356	408	477	512	533

NOTES: Assumes a worst case spill of entire contents of F-16 EPU (6.8 gallons); spilled on a hard surface such as concrete; surface area of spill is 100 ft^2. If you don't have the exact ambient temperature and wind speed, make an estimate. It is important to get the TCL to the OSC as soon as possible. You can always refine it later. The TCL (in feet) is the number where the ambient temperature row and wind speed column intersect

7.4.5 Emergency Response Material/Equipment. The following material/equipment should allow the BES to complete all processes and procedures associated with hydrazine emergencies.

- Hydrazine kit (pH paper, sodium thiosulfate, potassium iodide, polypropylene felt, 5 percent sodium hypochlorite solution (household bleach), HTH, 30 gallon container, polyethylene squeeze bottles of water)
- Charcoal detector tubes
- Universal sampling pumps
- Sipin, Monitaire, and Dupont sampling pumps
- Environmental sampling kit (para 7.2.1)
- Administrative supplies (para 7.2.2)
- WBGT kit (para 7.2.3)
- Personal Protective Equipment (PPE): coveralls, impermeable gloves and boots, and self-contained breathing apparatus

- Response procedures (one per individual)

7.4.6 Thermal Stress. When personnel are heavily suited in PPE and working in hot conditions, thermal loading can lead to heat stress. During emergency responses on hot weather, the BES must conduct wet-bulb globe temperature (WBGT) monitoring using the WBGT kit. If personnel are heavily suited in PPE, add 10 degrees to the WBGT reading to account for added thermal loading. Refer to Table 7-4 to determine work/rest regimes for various WBGT conditions. Advise the OSC of the need for adequate work/rest regimes. Advise response personnel of the signs and symptoms of heat stress and heat stroke (Table 7-5). Arrange for a rest area that is shaded and allows for maximum ventilation. In addition to adequate work/rest periods, the following measures should be taken to further prevent heat disorders. Attachment 7-2 provides recommended abbreviated procedures for thermal stress monitoring.

- Wear loose fitting clothing especially at the wrist, neck, and lower legs
- Drink large quantities of cool water
- Consume extra salt in the form of salt pills

Table 7-4 - Work/Rest Regimes Based on WBGT (^{o}F) (ACC Checklist)

	Workload		
Work/Rest Cycles (minutes)	**Light**	**Moderate**	**Heavy**
Continuous	86	80	77
45 work / 15 rest	87	82.4	78.6
30 work / 30 rest	88.9	84.9	82.2
15 work / 45 rest	90	88	86

Table 7-5 - Signs and Symptoms of Heat Stress (ACC Checklist)

Heat Stroke	Skin is hot, dry, and flush. Body core temperature rises. Failure of regulatory control. If left unchecked, could lead to delirium, convulsions, coma, or death.
Heat Exhaustion	Profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. Skin is cool and sometimes pale and clammy.
Heat Cramps	Painful intermittent spasms of the voluntary muscles. Usually occur after heavy sweating. The result of excess loss of salt.

7.5 Fuel Spills. The DoD uses a wide variety of petroleum fuels (Table 7-6). There is an effort to limit the Services to one grade of fuel on the battlefield - JP-8. However, as evidenced by Desert Storm, the U.S. and its allies may very well use a number of military and commercial fuels. Fuel is delivered to DoD installations in bulk quantities by virtually every mode of transportation - pipeline, tank truck, tank car, barge, and ocean tanker. Fuel is stored in above ground and underground storage tanks ranging in size from a few hundred gallons to millions of gallons. Many installations also receive and store fuel in a variety of containers such as 55-gallon drums, 5-gallon cans, bladders, bowsers, donuts, etc.

7.5.1 Fuel Spill Response. Based on the proliferation of fuel products, users, facilities and transportation equipment, an Air Force team could be called upon to respond to, an almost unlimited number, of fuel spill scenarios. Fortunately, the response requirements for the BES are rather straightforward. Primary duties of the BES are to estimate the spilled quantity, collect environmental samples, test for a limited number of physical characteristics, and perform explosive level monitoring. Attachment 7-3 provides recommended abbreviated fuel spill response procedures. More specific information and procedures follow.

Table 7-6 - Petroleum Fuels Used by The DoD

Fuel	Description
Jet A1	Commercial jet fuel
JP-4	Naphtha-based military jet fuel which is being phased out of service
JP-5	Kerosene-based military jet fuel, predominantly used by the Navy aboard aircraft carriers
JP-7	Thermally stable jet fuel only used in the SR-71 aircraft
JP-8	Military jet fuel that is replacing JP-4. Predominantly used by the Air Force and Army in CONUS and by all forces in joint theaters of operation
JP-10	Jet fuel used in cruise missiles
JPTS	Thermally stable jet fuel only used in the U-2 aircraft
MOGAS	Military gasoline used by all Services (normally nothing more than commercial gasoline)
Diesel	Generic term for a number of types of heating and transportation fuels. Widespread use throughout DoD.
Kerosene	Heating fuel (Less refined than diesel fuel)

7.5.1.1 Emergency response equipment. The following material/equipment should allow the BES to complete all processes and procedures associated with fuel spills.

- Combustible gas meter
- Environmental sampling kit
- Administrative supplies
- WBGT kit
- Dreager pump and tubes (benzene)
- Dissolved Oxygen meter
- Personal Protective Equipment (PPE): coveralls, impermeable gloves and boots, and respirator with organic vapor cartridges
- Response procedures (one per individual)

7.5.2 Soil and Vegetation Samples. Collect samples of soil and vegetation at and down gradient from the spill site. If spill is located on farm land, collect sufficient sample to perform a terrestrial bioassay. Coordinate with the laboratory on the quantity needed. Terrestrial bioassay measures the effect of fuel contamination on the ability of the soil to grow crops. Vegetation includes grass, small plants, roots, etc. Samples should be at least two ounces and must be placed in plastic bags. Background samples of similar vegetation should be collected some distance from the spill site for comparison purposes.

7.5.3 Water and Snow Samples. Petroleum spills in the water supply impart taste and odor, that may make the water aesthetically objectionable, and depending on the type, impart chemicals that may be potential carcinogens, (benzene) and other health risks, (toluene, xylene, MBTE). Sample the water and snow around the spill site in at least six (6) places. Collect background samples a some distance from the site. Sample all streams, wells, and surface water in or near the area. Bear in mind that well contamination will not be immediate, but may manifest itself after months or years of operation. Check any liquid run-off for contamination. The standard sample size should be one (1) liter.

7.5.4 Characteristic Testing. Perform temperature, dissolved oxygen, pH, and odor tests in and around the site. Perform explosive level monitoring at the spill site and in enclosed spaces surrounding the site such as pipes, culverts, separators, etc. Continue to perform explosive level monitoring until the containment and initial cleanup are complete. Advise the OSC of your findings.

7.5.5 Observations. Perform a reconnaissance in and around the site looking in ditches, lakes, streams for signs of damage such as fish kills. Look for signs of dead grass or foliage that could indicate fuel that has soaked into the ground. Look for signs of discoloration in and around the site. Advise the OSC and document all findings.

7.5.6 Thermal Stress. Refer to paragraph 7.4.6 above.

7.6 Aircraft Accidents/Composite Fibers. Many aircraft in the DoD inventory are composed of Carbon composite fiber materials. This material is made of long carbon fibers mixed with bonding and hardening agents (i.e., epoxy resins). The materials used consist of composite carbon/graphite, carbon/boron, and boron/tungsten. This forms a very strong lightweight plastic. Composite fiber materials are primarily used to form the aircraft skin. DoD aircraft that contain composite fiber material are shown in Table 7-7. If any of these aircraft crash, the wreckage will contain composite fiber materials that require special precautions and handling. Attachment 7-4 provides recommended abbreviated response procedures for aircraft accidents involving composite fiber materials. More detailed information and procedures follow.

7.6.1 Emergency Response Equipment. The following material/equipment should allow the BES to complete all processes and procedures associated with aircraft accidents/composite fiber emergencies.

- Administrative supplies
- WBGT kit
- Personal Protective Equipment (PPE): gloves, goggles, foul weather suit (or long-sleeve clothing), respirator (or gas mask), and dust masks (three boxes)
- Response procedures (one per individual)

Table 7-7 - DoD Aircraft Containing Composite Fiber Material (ACC Checklist)

A-7D	F-15
B-1	F-16
B-2	F-111 A through F
C-130	F-117
F-14	S-3A

7.6.2 Health Effects. The health hazards associated with composite fibers appear to be similar to the effects of fiberglass. Inhalation of carbon fibers can result in bronchial irritation. The material is sharp when broken and can cause skin irritation. Airborne fibers caused by burning are smaller than fibers created by cutting and can more easily enter deep into the lungs when inhaled. Composite fibers do not actually burn, but at temperatures greater than 850 degrees centigrade the diameter of the fiber decreases. The smaller the fiber diameter the greater potential for lung damage if inhaled. Composite materials may release fibers (graphite, boron, or carbon) during combustion. These fibers are not a significant environmental concern. However, the fibers create a health hazard when inhaled.

7.6.3 Effects on Electrical Systems. At one time there was concern about friable composite fibers causing short-circuits in electrical equipment. A USAF checklist (code name "Corker") addressed response actions for these situations. The Armstrong Laboratory has now confirmed that the electrical problems posed by composite fibers were over-rated and are no longer a concern.

7.6.4 Personal Protective Equipment. Personnel with potential exposure from fires involving aircraft containing composite fibers, especially emergency response personnel, must wear self contained breathing apparatus (SCBA) until the fire is put out. Once the fire is out, response personnel must wear dust respirators with eye goggles (or gas mask) until the crash site has been secured. Personnel should also wear long sleeve clothing and gloves to reduce the irritation caused by fiber contact with the skin.

7.6.5 Downwind Fiber Distribution. Airborne composite fibers are extremely light, therefore they can be carried considerable distances downwind from a crash site. Use Table 7-8 to determine probable downwind fiber

distribution. Recommend to the OSC that cordons be established until fires are out and airborne fibers have been knocked down with water mist or been treated with *fixative*.

Table 7-8 - Downwind Composite Fiber Distribution (ACC Checklist)

Wind Speed		Potential Downwind Distribution	
Knots	**MPH**	**Feet**	**Meters**
4-9	6-10	3445	1050
10-13	11-15	5085	1550
14-17	16-20	6725	2050

7.6.6 Handling Water. Water spray used to control airborne fibers and fire fighting water will have concentrations of composite fibers that should be contained if at all possible. All such wastewater should be drained into holes that have been excavated for that purpose or filtered prior to release. Burlap and cheese cloth are good expedient filter materials.

7.6.7 Treating the Wreckage. Only undamaged composite fiber material can be disposed of as usable property through the Defense Reutilization and Marketing Office (DRMO). Damaged material must be treated with a fixative. Fixative is nothing more than a water and floor wax mixture. The proper procedures are to treat the wreckage with the fixative and bag the material in durable plastic bags or seal the material with shrink wrap. The bagged or wrapped material must be labeled "Treated With a Fixative" and turned into DRMO with a certification that the material has been treated. In many CONUS and overseas locations, properly treated, bagged, and/or wrapped composite material can be disposed of as non-hazardous solid waste. Where DRMO is not available, Environmental personnel should check with State, Local, or Host Government agencies for proper disposal procedures.

7.6.8 Decontamination. Personnel and equipment that are actively involved in fire suppression, and searching, treating, or cleaning up wreckage may be heavily contaminated with composite fibers. Decontamination procedures are shown in Table 7-9.

Table 7-9 - Composite Fiber Decontamination Procedures (ACC Checklist)

Personnel	Remove clothing, brush, vacuum, or wash
Clothing	Vacuum and wash
Equipment	Vacuum and wash

7.6.9 Thermal Stress. Refer to paragraph 7.4.6 above

7.7 Natural Disasters. Worldwide DoD activities are subject to almost every type of natural disaster. Potential disasters such as floods, hurricanes, tornadoes, fires, severe weather, etc., can wreak havoc on exposed military personnel, facilities and equipment. While the disaster response force must be prepared to deal with all kinds of devastation, the BES is primarily concerned with contamination of drinking water. Other emergency procedures (fuel spills, hydrazine, composite fibers, pesticides, etc.) can also be used to respond to damage resulting from natural disasters.

7.7.1 Planning. When the natural disaster subsides, the BES must be ready to initiate installation-wide microbiological monitoring of the drinking water system. Scheduling and prioritization of the tests can be greatly facilitated if you attach a copy of your drinking water sampling plan (Section 1 of this manual) to the natural disaster response procedures at Attachment 7-5. Depending on facility and equipment damage, you may also have to initiate physical and chemical sampling at various points throughout the base. Your water vulnerability plan (Section 1 of this manual) will help you identify to disaster response forces the vulnerable locations that should be inspected for damage or contamination.

7.7.2 Monitoring. Test each drinking water monitoring point for microbiological contamination and free available chlorine (FAC). Repeat FAC tests 1 hour after the initial round of monitoring to determine chlorine demand. Establish a chlorine monitoring schedule accordingly. During initial and follow-up monitoring, look for facility/equipment damage that could result in pollution or contamination of the drinking water system. Ask the OSC to tell all response personnel to report facility/equipment damage that could cause contamination of the drinking water system. Establish physical and chemical sampling requirements based on your observations and reports from other response personnel.

7.7.3 Chlorine Levels. If flooding has occurred, tell the CE to increase chlorine levels to 5 ppm. If there is no flooding but you find FAC levels of less than two ppm, tell the CE to increase chlorine levels accordingly so that FAC is maintained at two ppm throughout the system.

7.7.4 Emergency Sanitation. A very important responsibility of the BES during disasters is to work closely with Public Affairs to provide guidance on proper disinfection/sterilization of drinking water. Emergency procedures are shown below. However, be sure to add warnings that people should not over sanitize the water. The tendency is to think if three drops are good, a cap full is much better. Over chlorination of drinking water could cause diarrhea that may lead a person to think the water is bad so more chlorination is needed.

- Boil water a minimum of 10 minutes, allow to cool
- Add three (3) drops of household bleach to each gallon of water and let stand for a minimum of thirty (30) minutes before consuming. It is recommended that the water sit longer if suspected of having been contaminated

7.7.5 Temperature Stress. In disasters where shelter has been destroyed and conditions are extremely hot or cold, the BES should advise the OSC about temperature stress. Paragraph 7.4.6 above and Attachment 2 provide information about heat stress and Table 7-10 provides information about the effects of cold temperatures and wind chill.

7.7.6 Public Health Surveillance. While monitoring of drinking water is the primary responsibility of the BES, surveillance of public health is a secondary responsibility. Natural disasters can interrupt electric power for days. As a result, cold and frozen food stocks may begin to spoil. In addition, damage or loss of power could result in loss of sewage disposal capabilities. Make sure you coordinate with Services and Civil Engineers on matters that could impact public health.

7.8 UXO/Munitions. Unexploded ordnance (UXO)/munitions response operations can occur in peacetime as well as various levels of conflict ranging from peacekeeping activities to all out nuclear war. UXO can be conventional munitions or nuclear, biological, and chemical (NBC) devices. UXO devices can be in the form of standard military munitions or ad hoc devices assembled by dissidents, militia, radicals, saboteurs, etc. UXO operations can occur in conjunction with the crash of an aircraft (friendly or hostile), or as a result of an attack by enemy missiles, bombs, artillery shells, etc. UXO devices can also be delivered via clandestine operations. Finally, UXO response operations could be needed as a result of storage, handling, or transportation accidents.

Table 7-10 - Wind Chill Factors (Vermont Department of Social Welfare's Web Server)

Temp °F	Wind Speed (MPH) 0	5	10	15	20	25	30	35
35	35	32	22	16	12	8	6	4
30	30	27	16	9	4	1	-2	-4
25	25	22	10	2	-3	-7	-10	-12
20	20	16	3	-5	-10	-15	-18	-20
15	15	11	-3	-11	-17	-22	-25	-27
10	10	6	-9	-18	-24	-29	-33	-35
5	5	0	-15	-25	-31	-36	-41	-43
0	0	-5	-22	-31	-39	-44	-49	-52
-5	-5	-10	-27	-38	-46	-51	-56	-58
-10	-10	-15	-34	-45	-53	-59	-64	-67
-15	-15	-21	-40	-51	-60	-66	-71	-74
-20	-20	-26	-46	-58	-67	-74	-79	-82

30°F or greater	**Chilly**: generally unpleasant
15 °F to 30 °F	**Cold**: very unpleasant
0 °F to 15 °F	**Very cold**: very unpleasant
-20 °F to 0 °F	**Bitter cold**: frostbite probable
-20 °F to -60 °F	**Frostbite likely**, outdoor activity dangerous
-60 °F or less	**Frigidity cold**: exposed flesh will freeze within a 30 seconds

7.8.1 UXO/Munitions Response. As with other accidents/disasters, the BES would most likely respond to UXO/munitions incidents along with a base/installation disaster response team. In situations where EOD personnel have determined that the UXO is a conventional munition, the primary function of the BES is thermal stress management. However, in the case of NBC UXOs, the BES must be prepared to monitor for radiation and chemical agents, advise on personal protective equipment (PPE) requirements, monitor radiation exposure, assist in contamination control and decontamination operations, and perform thermal stress monitoring. Under UXO/munitions response procedures, the Medical Control Center (MCC) and the Wing Control Center will be the primary controlling activities for the BES. If the UXO is located off base, a convoy assembly area will normally be established. At the actual site, an On-scene Commander will be in charge of the disaster response team. Attachment 7-6 provides recommended abbreviated response procedures. More specific information and procedures follow.

7.8.1.1 Emergency Response Material/Equipment**.** The following material/equipment should allow the BES to complete all processes and procedures associated with UXO/munitions responses.

- RADIAC gear (ADM-300, dosimeters, film badges)
- Staplex air samplers and tripods
- Portable generator and gas can.....
- Chemical agent alarms (M8A1, M90, ALAD)
- Chemical agent detectors (M256, M8 and M9 detector paper, M272
- NBC contamination marking set
- PPE (GCE, anticontamination coveralls, booties, hood, gloves, tape and SCBA)

- Environmental sample kit
- Administrative supplies
- WBGT kit
- Decontaminating solutions (DS2, HTH, STB, SID household bleach, soap, detergent, etc.)
- Response procedures (one per individual)

7.8.2 Approaching The UXO. Standard operating procedures call for establishing a command post (CP) at some distance from the site of the UXO. In situations where the response team knows the UXO is a conventional munition, the only precaution in approaching the site is to stay outside of the blast/fragmentation radius for the munitions involved. However, when the UXO is an NBC device, or when nothing is known about the munition, the response team must use more involved approach procedures. In such situations, the OSC may ask the BES to assist in detection operations. Approach procedures differ depending on whether the UXO is suspected to be a nuclear device or a chemical/biological weapon.

7.8.2.1 Nuclear device. The first rule is to always approach the site from an upwind location. If contamination is suspected, begin monitoring for radiation at least one mile from the site. The ADM-300 multi-function survey meter can be used to detect alpha, beta, and gamma radiation. Establish a cordon line wherever beta-gamma radiation readings of 2 mR/hr are encountered. If no beta-gamma is encountered, and if the type and condition of nuclear device have not been confirmed, an initial high explosive (HE) exclusion area with a 610-meter (2000 feet) fragmentation radius should be established. Actual selection of the approach route and command post site, and establishing exclusion areas are not the responsibility of the BES. However, you may be asked to operate a survey meter. In most cases, you will wear your gas mask or self-contained breathing apparatus (SCBA) when conducting approach operations. If radiation is encountered, you may also be asked to monitor and record personal dosimetry.

7.8.2.2 Chemical/biological (CB) weapons. As with nuclear devices, you must always approach a suspected CB UXO from an upwind location. If chemical contamination is suspected, begin monitoring the approach route using chemical agent monitors or detector paper (see paragraph 4.5.13). Since current field tests or monitors cannot detect biological contamination, an area cannot be considered free of biological contamination unless intelligence information or physical evidence (see paragraph 4.4.5) confirms it. If the type of CB weapon has not been confirmed an initial exclusion area of 450 meters (1476 feet) should be established and a downwind hazard area of 2000 meters (6560 feet) should be established (Figure 7-1). Actual selection of the approach route and command post site, and establishing exclusion areas are not the responsibility of the BES. However, you may be asked to operate a chemical agent monitor or use detector paper to monitor for contamination. In most cases, you will wear your gas mask and ground crew ensemble (GCE) when conducting approach operations.

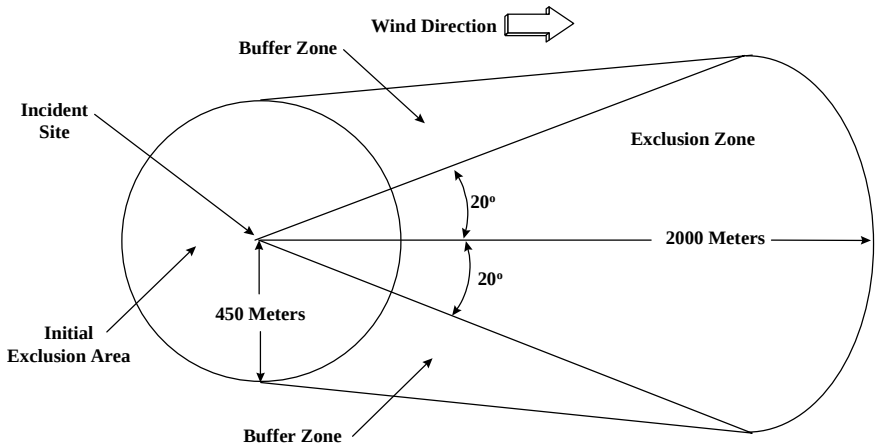


Figure 7-1 - Initial Downwind Hazard Area (Army FM 9-15)

7.8.3 Type of Device. After Explosive Ordnance Disposal (EOD) personnel have confirmed the type and condition of the device, the BES will have a much better idea of his/her level of involvement. If the device is confirmed to be a conventional munition, the BES should provide thermal stress monitoring IAW Attachment 7-2, Thermal Stress Monitoring Procedures. However, if EOD confirms it is a nuclear device or chemical/biological weapon, the BES must provide other assistance.

7.8.4 If a Nuclear Device. When the cordon line or initial exclusion area has been established, the BES must take initial background air samples using the Staplex air sampler (see procedures below). If at any time, you determine the disintegrations per minute to be greater than 100 dpm/m^3, advise the response team to put on their respirators. The response team must now determine if fissioning has occurred. Use the ADM-300 to monitor for beta-gamma radiation. Table 7-11 shows the meaning of various readings. If fissioning has not occurred, the primary job of the BES is to provide thermal stress monitoring (IAW Attachment 7-2) while EOD works to dearm the device. The OSC may have everyone but the EOD personnel evacuate to a safe distance to prepare for cleanup and decontamination should the device explode. If fissioning has occurred, the operation will probably shift from a UXO response to a Broken Arrow response.

Table 7-11 - Beta-Gamma Survey Readings (ACC Checklist)

Reading	Meaning
0 to 2 mR/hr	No nuclear yield, no components nearby
2 to 50 mR/hr	Presence of unfissioned material
Over 100 mR/hr	If found over a broad area, fission has occurred
Above 250 mR/hr	If found in isolated areas, it is normally due to a certain weapon part, not a nuclear yield

7.8.4.1 Broken Arrow response. If fissioning has occurred, the OSC will establish the 2 mR/hr cordon line. The first thing the BES must do is to determine if there are airborne levels of contamination. This is done using the Staplex air sampler and the formula for disintegrations per minute. The BES may also be asked to help monitor for surface alpha readings. The purpose of air sampling and alpha surface monitoring is to determine the need for PPE.

7.8.4.2 Air sampling. Airborne levels of contamination are determined by placing the Staplex at strategic locations around the site (Figure 7-2). Take the initial air sample at the control point for 15 minutes to establish the background radiation levels and to assure the control point is radiation free. Always face the Staplex into the wind at the breathing zone level (five feet). Take additional 15-minute readings at 90° intervals around the cordon. Following those initial samples, take secondary samples at the control point, the hot line entry point, and downwind from the site. Use Table 7-12 to determine downwind sampling points. The frequency of sampling is up to the OSC or person in charge.

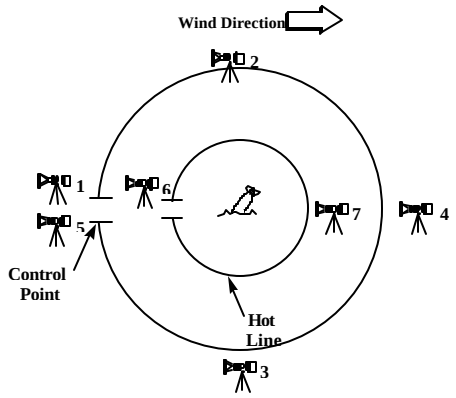


Figure 7-2 - Staplex Positioning Points

Table 7-12 - Secondary Air Sampling Distances Based on Wind Speed (90750 CDC)

Wind Speed	Distance From Site
6-10 MPH (4-9 knots)	3500 feet (1000 meters)
11-15 MPH (10-13 knots)	5100 feet (1500 meters)
16-20 MPH (14-17 knots)	6700 feet (2000 meters)
Above 20 MPH (above 17 knots)	8400 feet (2500 meters)

7.8.4.3 Calculating disintegrations per minute. The Staplex is run for about 15 minutes or until 1000 cubic feet of air has been pulled through the sampler. The ADM-300 meter with alpha probe is used to measure the amount of contamination that has been absorbed by the filter paper. The reading is taken in counts per minute (cpm). The alpha probe is run diagonally across the filter paper two times. The value for cpm is the average of the two readings. After you determine the cpm for each sample, you must calculate the disintegrations per minute per cubic meter (dpm/m^3). The following formula is used:

$$\mathbf{dpm/m^3} = \frac{\mathbf{cpm \times 35.3 \times Af}}{\mathbf{0.5 \times Ef \times F \times Ec \times Ac \times Fr \times T}} = \frac{\mathbf{cpm \times 4200}}{\mathbf{Fr \times T\ (min)}}$$

Where:

cpm = counts per minute
35.3 = conversion factor for feet^3 per meter^3
Af = collection area of Staplex filter paper in cm^2
Ef = collection efficiency of filter paper
F = self absorption factor of filter paper
Ec = counting efficiency of ADM-300
Ac = active detection area in cm^2 of alpha probe
V = total volume of air that passed through Staplex (ft^3)
[V = flow rate in cfm (Fr) x sampling time in min (T)]

Notes: The Staplex filter holder reduces the collection area of 8" x 10" filter paper from 516 cm^2 to 406 cm^2 . The self absorption factor of the filter paper is 50 percent (0.5). The collection efficiency varies according to the size of the particles being collected (approximately 0.5 for one micron particles). The counting efficiency of the ADM-300 alpha probe is 30 percent (0.3). The active area of the ADM-300 alpha probe is 92 cm^2.
Once you have calculated the dpm/m^3, use Table 7-13 to determine respiratory protection requirements. Advise the OSC of your findings.

Table 7-13 - Respiratory Protection Based on Airborne Alpha Contamination (90750 CDC)

Airborne Alpha Concentration	Respiratory Protection
Below 100 dpm/m^2	None
100 - 10,000 dpm/m^2	Full-face with high efficiency particulate air filter (HEPA) such as M-17
Above 10,000 dpm/m^2	Self-contained breathing apparatus

7.8.4.4 Alpha surface monitoring. Alpha surface monitoring is used to determine PPE for total body protection. The ADM-300 detection meter with the AP-100 probe is used to determine alpha micro Curies per square meter (µCi/m^2) of plutonium radiation on various surfaces (rocks, vegetation, buildings, soil, etc.) near the site. Table 7-14 is used to determine mask and body protection requirements based on surface radiation. Note: plutonium contamination in microgram per square meter (µg/m^2) is also provided for situations where RADIAC meters measure in those units.

Table 7-14 - PPE Based on Plutonium Concentrations (ACC Checklist)

Plutonium Contamination (mCi/m^2)	Plutonium Contamination (mg/m^2)	Mask Type	Body Protection
163,934 and above	10,000 and above	SCBA	Full[1]
16,393 - 163,933	1,000 - 9,999	Gas Mask (M-17 or MCU-2/P)	Full[1]
1,639 - 16,392	100 - 999	Gas Mask (M-17 or MCU-2/P)	Partial[2]
1 - 1,638	1 - 99	None	Minimal[3]

Note 1: Anticontamination coveralls, booties, hood, gloves, and tape all openings
Note 2: Boots, Gloves, and tape all openings
Note 3: Boots

7.8.4.5 Radiation exposure. The Air Force radiation exposure limit is 3.0 roentgen equivalent man (rem) per calendar quarter. Stay times and contamination levels that produce exposures greater than 500 mrems per exposure event are allowable only upon direction of the OCS. The best way to monitor radiation exposure is for response personnel to wear pocket dosimeters while they are working within the cordon area. Read dosimeters each time a worker comes out of the work area and document the dose on an individual radiological dose record such as shown in Figure 7-3. If there are not enough dosimeters to go around, have one person in a work crew wear the dosimeter and annotate the same dose readings for everyone in the work crew. If dosimeters are not available, use an ADM-300 to measure the dose rate at the time of entry and the time of exit and use the following formula to calculate total dose.

$$D = \frac{(R_1 + R_2) \times t}{2}$$

Where:

D = dose in rads = dose in rems (for gamma radiation)
R_1 and R_2 = fallout intensities in R/hr at the beginning and end of exposure
t = time of exposure in hours

INDIVIDUAL RADIOLOGICAL DOSE RECORD									NAME							
DATE:																
TIME:	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
LOCATION:																
DOSE FOR PERIOD:																
ACCUMULATED DOSE:																
RETURN BEFORE DOSE:																
REMARKS/EVENTS:																
DATE:																
TIME:	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
LOCATION:																
DOSE FOR PERIOD:																
ACCUMULATED DOSE:																
RETURN BEFORE DOSE:																
REMARKS/EVENTS:																

Figure 7-3 - Individual Radiological Dose Record (90750 CDC)

7.8.4.6 Biological sampling. The area of concern during a Broken Arrow accident is the area contaminated by radioactive material at levels of 16,393 $\mu Ci/m^2$ (1000 $\mu g/m^2$) or greater. This area usually extends 350 feet from the site. Response personnel exposed to levels of 16,393 $\mu Ci/m^2$ or greater are likely to exceed their maximum permissible body burden for radioactive materials. Where such concentrations are encountered, the BES should recommend implementation of urine sampling and nasal swipes. All samples should be sent to the Armstrong Laboratory, 2402 E. Drive, Brooks AFB, TX 78235-5114 (210-536-3626) for analysis.

- Twenty-four hour urine samples are used to determine individual body burden levels. Samples should be taken from everyone working in the 16,393 $\mu Ci/m^2$ contaminated area. Random samples should be taken from other personnel involved in the operation who were outside of the highly contaminated area. Samples should also be taken from several people who were not involved in the response to be used as controls. Samples must be collected in laboratory specimen containers. Do not add any chemicals or reagents as preservatives. Discard the first morning voiding and collect all subsequent voidings for the next 24 hours. Label the samples with the name, rank, SSN and organization of the individual, the reason the sample was collected, the date of possible exposure, the date the sample was collected, and the individual's assigned response team.

- Nasal swipes are taken from the same group of people as identified above. Take the swipes when personnel come through the decontamination (decon) line. Use a biological culture applicator moistened with distilled water, to take the swipes. A moistened q-tip can be used as a substitute. Use a separate applicator for each nostril. Place the applicators in their culture tube and place the tubes in an envelope. If using q-tips, place the q-tips in a plastic bag (e.g., zip lock bag) and place the bag into an envelope. Label the envelope with the name, rank, SSN and organization of the individual, the reason the swipe was collected, the date of possible exposure, the date the swipe was collected, and the individual's assigned response team.

7.8.4.7 Environmental sample collection. Environmental samples are taken to provide baseline documentation of contamination in and around the site. Samples are taken from the soil, vegetation, ash, water and snow, and various surfaces. Label all samples with the reason the sample was taken, the date of possible exposure, and the date the sample was taken. All samples should be sent to the Armstrong Laboratory, 2402 E. Drive, Brooks AFB, TX 78235-5114 (210-536-3626) for analysis.

- Take soil samples before, during, and after recovery/cleanup operations. Take at least six samples during the recovery/cleanup. Take background samples at some distance from the scene for comparison control. Take the sample by pushing the open end of an ointment tin into the ground. Dig it up and the sample stays in the tin. An alternate procedure is to dig a one square foot by two inch deep sample from the ground and place it in a plastic bag. For gamma spectrometry plus alpha and/or gross beta, two kilograms of soil are needed. For gross alpha and/or gross beta, only 100 grams of soil are needed. If you need specific alpha and/or beta radionuclide testing, consult Armstrong Lab for instructions.

- Take vegetation samples before, during, and after recovery/cleanup operations. Collect samples of grass, small plants, rocks, etc. Collect background samples at some distance from the site for control purposes. Place samples in individual plastic bags Each sample must be at least two ounces.

- Take at least four samples of ash from different locations in the debris. Place the samples in individual plastic bags.

- Collect at least six samples of water and snow from the immediate area of the site. Make sure the samples are not contaminated with fuel, oil, or foam. Collect water and snow samples at some distance from the site for control purposes. Collect water samples from all streams, wells, and run-off in or near the site. Use one liter containers to collect the samples.

- Take surface swipes using filter paper that has been folded into three or four inch squares. Swipe tires, outer surfaces, seats, steering wheels, floor panels, and foot pedals of all vehicles and equipment used in the recovery/cleanup operation. Swipe outside and inside surfaces of any buildings in or near the site. Swipe exterior surfaces (rocks, trees, structures, etc.) downwind from the site. The actual swipe is taken by rubbing the

filter paper in one direction over a square foot of surface area. Then take another swipe of the same surface at 90 degrees from the first. Fold all swipes with exposed side in and place in envelopes.

7.8.4.8 Radiation decontamination operations. Decontamination (decon) operations are normally performed by special decon crews. However, the BES should be prepared to assist if needed. Accordingly, you must understand the basics of decon operations. Contamination control is one of the biggest problems resulting from a nuclear weapon accident or incident. All personnel, vehicles, and equipment used in the recovery/cleanup will have to be decontaminated at designated locations. Decontamination is performed by thoroughly washing with soap and water and rechecking for contamination using RADIAC meters (ADM-300 or other). Personnel leaving the contaminated area go through decon at the hot line exit point. Decontamination consists of removing PPE (anti-C coveralls, boots, hoods, etc.) and monitoring the person for beta/gamma contamination using a RADIAC meter. If contamination is still present, the person must remove all inner clothing and shower thoroughly with soap and water. The decon crew must wear the same PPE as those who are working in the contaminated area. Contaminated PPE and wash water must be collected and disposed of as radioactive waste. Decon areas are also established for vehicles and equipment. Vacuum, wash with soap and water, and recheck all vehicles and equipment for contamination. Repeat the process if contamination is still present. Collect vacuum bags, used washing supplies (rags, sponges, brushes, etc.), and wash water and dispose of as radioactive waste.

7.8.5 If a CB Weapon. When the initial exclusion area has been established, EOD personnel will, if possible, determine the type and condition of the weapon - is it a chemical or biological weapon, has it detonated or released its payload. If the weapon is intact, the primary job of the BES is to provide thermal stress monitoring (IAW Attachment 7-2) while EOD works to dearm the weapon. The OSC may have everyone but the EOD personnel evacuate to a safe distance to prepare for cleanup and decontamination should the weapon explode. If the weapon has detonated or released its payload, the operation will probably shift from a UXO response to decontamination and cleanup of chemical or biological contamination.

7.8.5.1 CB weapon response. Until the CB agent has been identified, all response personnel must wear the full ground crew ensemble (GCE) while in the exclusion area. The GCE consists of the gas mask, overgarment, black footwear covers or green vinyl overboot, gloves, and hood. Initial reconnaissance is performed using chemical agent alarms - M43A1, M90 or AN/PSR-2 (see Section 4). Response personnel probe into the area until they get a chemical alarm or until they reach the detonation site. If no chemical agents are detected, response personnel must perform a detailed reconnaissance for both biological and chemical agents as discussed in Section 4. Actual contamination should be marked for subsequent decontamination using the NBC contamination marking set (Figure 4-22 and Figure 4-23). If no agents are confirmed but there is physical evidence of possible biological contamination, the entire exclusion area must be marked and controlled as off-limits until the results of your samples are received from the laboratory. CB contamination should be neutralized as discussed in paragraphs 4.4.6 and 4.5.16.

7.8.6 Thermal Stress. Refer to paragraph 7.4.6 above

7.9 Pesticide/Toxic Chemical Spills. In most cases the BES will respond to pesticide and other toxic chemical spills as part of a base/installation disaster response team. Under such a scenario, the Medical Control Center (MCC) and the Wing Control Center will be the primary controlling activities for the BES. If the accident/spill site is located off base, a convoy assembly area will normally be established. At the accident/spill site an On-scene Commander will be in charge of the disaster response team. Normally, the primary duties of the BES are to calculate the *source strength* of the chemical, collect environmental samples, advise on PPE, and provide thermal stress monitoring. Attachment 7-7 provides recommended abbreviated response procedures. More specific information and procedures follow.

7.9.1 Emergency Response Equipment. The following material/equipment should allow the BES to complete all processes and procedures associated with pesticide/toxic chemical spills.

- Explosive meter
- Environmental sampling kit

- Administrative supplies
- WBGT kit
- Dreager pump and tubes
- Dissolved Oxygen meter
- Personal Protective Equipment (PPE): coveralls, impermeable gloves and boots, and respirator (or gas mask)
- Response procedures (one per individual)
- American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) handbook

7.9.2 Toxic Cordon. Toxic cordons are established at accident/spill sites to assure the health and safety of response and non-response personnel. The cordon is established by the On-scene Commander (OSC) based on calculated toxic corridor lengths (TCL). The TCL is the distance in feet, downwind from the spill, that must be evacuated. No one is allowed inside the cordon without a self-contained breathing apparatus and impermeable clothing until the spill is neutralized. In the Air Force, Weather personnel have an automated program called AFTOX that will calculate the TCL based on information provided from the crash scene. Accordingly, the BES provides the following information to Weather personnel so they can determine the TCL.

- name of the chemical
- wind speed in knots
- spill surface area in square feet
- temperature of the spilled liquid
- source strength (Q)

Source Strength (Q):

$$Q = .000166\, V^{0.75} (A)(1 + .0043\, Tp^2)(Z)$$

Where:

Q = source strength in lb/min
V = wind speed in knots
A = spill area in square feet
Tp = temperature of spilled liquid in degrees centigrade (assume pool temperature is the same as ambient air temperature)
Z = given factor (see Table 7-15)

Note: The source strength formula was developed for hydrazine. The Z-factor is used to convert the formula for use with other chemicals. If the chemical in question is not listed in Table 7-15, you can calculate the Z-factor using the following formula:

$$Z = \frac{Vp_1 \times GMV_1}{Vp_h \times GMV_h} = \frac{Vp_1 \times GMV_1}{0.31 \times 32.045} = \frac{Vp_1 \times GMV_1}{9.934}$$

Where:

Z = dimensionless factor
Vp_1 = vapor pressure of the chemical in question (in same units as Vp_h)
GMV_1 = gram molecular weight of the chemical in question
Vp_h = vapor pressure of hydrazine (in same units as Vp_1)

GMV_h = gram molecular weight of hydrazine

If there are no AF Weather offices available, you can calculate the actual TCL using the following formulas:

TCL = CF x DF

Where:

TCL = toxic corridor length in feet
CF = $30.476 (Cp \times GMW)^{-0.513}$
DF = $Q^{0.513} (\hat{}T + 10)^{2.53}$

Where:

Cp = ppm used for short term exposure limit (TWA, STEL, or ceiling limit from ACGIH TLV handbook)
GMW = gram molecular weight (Table 7-15)
Q = source strength in lb/min
$\hat{}$T = the difference in air temperature at 6 feet and 54 feet
NOTE: If delta T ($\hat{}$T) is not available from the Weather people, use one of the following average numbers:

Day time = -1 ^{o}C
Night time = +4 ^{o}C
Sunset/Sunrise = 0 ^{O}C

7.9.3 Vegetation Samples. Collect samples of vegetation at and down gradient from the spill site. Vegetation includes grass, small plants, roots, etc. Samples should be at least two ounces and must be placed in plastic bags. Background samples of similar vegetation should be collected some distance from the spill site for comparison purposes.

7.9.4 Water and Snow Samples. Sample the water and snow around the spill site in at least six (6) places. Collect background samples aT some distance from the site. Sample all streams, wells, and surface water in or near the area. Check any liquid run-off for contamination. The standard sample size should be one (1) liter.

7.9.5 Characteristic Testing. Perform temperature, dissolved oxygen, pH, and odor tests in and around the site. If appropriate, perform explosive level monitoring at the spill site and in enclosed spaces surrounding the site such as pipes, culverts, separators, etc. Continue to perform explosive level monitoring until the containment and initial cleanup are complete. Advise the OSC of your findings.

7.9.6 Observations. Perform a reconnaissance in and around the site looking in ditches, lakes, streams for signs of damage such as fish kills. Look for signs of dead grass or foliage that could indicate fuel that has soaked into the ground. Look for signs of discoloration in and around the site. Advise the OSC and document all findings.

7.9.7 Thermal Stress Monitoring. Refer to paragraph 7.4.6 above.

Table 7-15 - Selected Toxic Chemical Parameters (USN CHRIS)

Substance	Cp (ppm)	GMW	CF	Vapor Pressure (psi @ 80°F)	Z Factor
ACETALDEHYDE	25	44.054	0.838	18.610	82.53
ACETONE	500	58.081	0.156	4.790	28.01
ACETONITRILE	40	41.050	0.683	1.810	7.48
ACROLEIN	0.1	56.065	12.586	8.700	49.10
ACRYLIC ACID	2	72.060	2.380	0.116	0.84
ALLYL ALCOHOL	2	58.081	2.658	0.524	3.06
ALLYL CHLORIDE	1	76.526	3.293	7.370	56.77
AMMONIA	25	17.030	1.365	157.000	269.15
ANILINE	2	93.130	2.086	0.008	0.07
BENZENE	0.5	78.115	4.650	1.990	15.65
BENZYL CHLORIDE	1	126.580	2.544	0.030	0.38
BROMINE PENTAFLUORIDE	0.1	174.896	7.021	8.430	148.42
BROMOFORM	0.5	252.770	2.546	37.080	943.50
BUTADIENE (1 3)	2	54.092	2.757	36.050	196.30
BUTANE	800	58.124	0.123	37.080	216.96
BUTYL ALCOHOL(n) (BUTANOL-1)	50	74.120	0.450	0.137	1.02
BUTYL ALCOHOL(sec) (BUTANOL-2)	100	74.120	0.315	0.373	2.78
BUTYL ALCOHOL(-t)	100	74.124	0.315	0.908	6.78
CARBON DISULFIDE	10	76.139	1.013	7.400	56.72
CARBON TETRACHLORIDE	5	153.820	1.008	2.420	37.47
CHLORINE	0.5	70.906	4.886	115.383	823.57
CHLORINE PENTAFLUORIDE	0.3	130.445	4.645	58.760	771.59
CHLORINE TRIFLUORIDE	0.1	92.448	9.738	26.600	247.55
CHLOROBENZENE	10	112.560	0.829	0.269	3.05
CHLOROFORM	10	119.390	0.804	4.120	49.52
CRESOL(-m)	5	108.140	1.208	0.017	0.19
CRESOL(-o)	5	108.150	1.208	0.017	0.19
CRESOL(-p)	5	108.140	1.208	0.017	0.19
CUMENE (ISOPROPYL BENZENE)	50	120.200	0.351	0.328	3.97
CYCLOHEXANE	300	84.160	0.168	1.980	16.77
DICHLOROBENZENE (1 2) (-o)	25	147.010	0.452	0.035	0.52
DICHLOROBENZENE (1 4) (-p)	10	147.010	0.723	0.035	0.52
DICHLOROETHYLENE (1 2)	200	96.940	0.193	5.390	52.60
DICHLOROPROPANE (1 2)	75	112.990	0.294	4.200	47.77
DIMETHYLANILINE (n n)	5	121.180	1.139	1 mm of Hg @ 68°F	0.38
DIMETHYLHYDRAZINE (UDMH)	0.01	60.099	39.573	3.260	19.72
DIOXANE (1 4)	25	88.100	0.588	0.730	6.47
EPICHLOROHYDRIN	0.5	92.526	4.263	0.360	3.35
ETHANOL	1000	46.070	0.123	1.220	5.66
ETHYL ACRYLATE	5	100.120	1.256	0.770	7.76
ETHYL BENZENE	100	106.170	0.262	7 mm of Hg @ 68°F	2.32
ETHYL CHLORIDE	100	64.515	0.339	24.730	160.61
ETHYLENE DICHLORIDE	10	98.960	0.886	1.630	16.24
ETHYLENE GLYCOL	0.05	62.069	17.047	0.002	0.01
ETHYLENE OXIDE	1	44.054	4.371	26.680	118.32
FLUORINE	1	37.997	4.716	14.700	56.23
FORMALDEHYDE (37%)	0.03	22.490	37.293	0.042	0.10
FORMALDEHYDE (56%)	0.03	24.780	35.483	0.042	0.10

Table 7-15 - (Con't)

Substance	Cp (ppm)	GMW	CF	Vapor Pressure (psi @ 80°F)	Z Factor
FORMALDEHYDE(PURE)	0.03	30.030	32.152	0.042	0.13
FREON 12	1000	120.910	0.075	159.600	1942.55
HYDRAZINE	0.01	32.045	54.639	0.310	1.00
HYDRAZINE (50%)	0.01	53.000	42.209	3.100	16.54
HYDRAZINE (70%)	0.01	27.800	58.771	0.119	0.33
HYDROGEN CHLORIDE	5	36.460	2.109	808.790	2968.45
HYDROGEN CYANIDE	4.7	27.060	2.537	15.310	41.70
HYDROGEN FLUORIDE	3	20.006	3.730	18.700	37.66
HYDROGEN SULFIDE	10	34.080	1.530	326.600	1120.45
ISOPROPANOL (2-PROPANOL)	500	60.097	0.154	0.953	5.77
ISOPROPYL ETHER	250	102.178	0.167	3.080	31.68
MESITYL OXIDE	15	98.146	0.722	0.250	2.47
METHANOL	200	32.040	0.340	2.580	8.32
METHYL ETHYL KETONE	200	72.108	0.224	1.910	13.86
METHYL IODIDE	2	141.940	1.681	400 mm of Hg @ 68°F	177.18
METHYL ISOBUTYL KETONE	50	100.162	0.386	0.422	4.25
METHYL METHACRYLATE	100	100.100	0.270	0.840	8.46
METHYLENE CHLORIDE	50	84.933	0.420	9.240	79.00
MONOMETHYLHYDRAZINE (MMH)	0.01	46.072	45.354	1.030	4.78
NITRIC ACID (PURE)	2	63.020	2.549	1.290	8.18
NITRIC ACID, INHIBITED RED FUMING	2	63.013	2.549	2.70	17.13
NITROBENZENE	1	123.110	2.580	0.006	0.07
NITROGEN DIOXIDE	3	46.008	2.433	15.700	72.71
NITROGEN TETROXIDE	5	92.016	1.312	18.910	175.16
NITROGEN TRIFLUORIDE	10	71.000	1.050	14.700	105.06
NITROPROPANE	10	89.090	0.935	0.420	3.77
OXYGEN DIFLUORIDE	0.05	53.996	18.310	4306.000	23405.27
PENTABORANE	0.005	63.127	55.065	4.000	25.42
PERCHLORYL FLUORIDE	3	102.450	1.614	176.100	1816.14
PHENOL	5	94.114	1.297	0.017	0.16
PHOSGENE	0.1	98.920	9.405	28.310	281.90
PROPANE	2500	44.097	0.079	123.480	548.13
PROPYLENE OXIDE	20	58.080	0.816	11.110	64.96
PYRIDINE	5	79.100	1.418	0.439	3.50
STYRENE	20	104.153	0.605	0.137	1.44
SULFUR DIOXIDE	2	64.060	2.528	55.030	354.87
TETRACHLOROETHANE (1 1 2 2)	1	167.860	2.201	0.161	2.72
TETRACHLOROETHYLENE	25	165.830	0.425	0.425	7.09
TOLUENE	50	92.142	0.402	0.600	5.57
TOLUIDINE (-o)	2	107.160	1.941	0.3 mm of Hg @ 68°F	0.10
TRICHLOROETHANE (1 1 1)	350	133.420	0.123	2.660	35.73
TRICHLOROETHANE (1 1 2)	10	133.410	0.760	2.660	35.72
TRICHLOROETHYLENE	50	131.340	0.335	1.510	19.96
TRICHLOROTRIFLUOROETHANE	1000	187.377	0.060	6.500	122.60
TRIMETHYLBENZENE (1 3 5)	25	120.200	0.501	2 mm of Hg @ 68°F	0.75
VINYL ACETATE	10	86.090	0.951	2.430	21.06
VINYL CHLORIDE	5	62.499	1.600	60.480	380.51
VINYLIDENE CHLORIDE	5	96.940	1.277	12.360	120.61
XYLENE (-m)	100	106.169	0.262	0.177	1.89
XYLENE (-o)	100	106.170	0.262	0.141	1.51
XYLENE (-p)	100	106.170	0.262	0.187	2.00

Attachment 7-1 - Hydrazine Response Procedures

INITIAL NOTIFICATION

1. Assemble BES team members.
2. Obtain information from Medical Control Center (MCC).
   a. Situation summary.
   b. Site coordinates/location.
   c. Wind speed and direction.
   d. Type of container, e.g. F-16, storage tank, servicing cart, transport truck, etc.
   e. Convoy assembly point (if appropriate).
3. Assemble response equipment.
   a. Hydrazine sampling kit (pH paper, sodium thiosulfate, potassium iodide, etc.).
   b. Charcoal detector tubes.
   c. Universal sampling pumps.
   d. Sipin, Monitaire, and Dupont sampling pumps.
   e. High-test hypochlorite (HTH) and chlorine capsules.
   f. Environmental sampling kit
   g. Administrative supplies.
   h. WBGT kit.
   i. Personal Protective Equipment (PPE): coveralls, impermeable gloves and boots, and self-contained.
   j. breathing apparatus.
   k. Response procedures (one per individual).
5. Advise headquarters Bioenvironmental Engineering (BEE) office of situation.
6. Plot the location of the accident/spill and determine the best up-wind approach route.
7. Notify the MCC that BES is enroute to the accident/spill site or convoy assembly point.

OFF-BASE RESPONSE

1. Go to convoy assembly point and report in.
2. Notify MCC that BES is at the convoy assembly point.
3. Ensure driver attends the convoy briefing.
4. Double check equipment, supplies, and PPE.
5. Once at the accident/spill site, follow the on-base response procedures.

ON-BASE RESPONSE

1. Notify the MCC that you are at the spill site.
2. Report to the OSC.
3. Ensure no one enters the site without self-contained breathing apparatus and impervious clothing.
4. Have empty 30 to 55 gallon containers brought to site.

5. Estimate quantity spilled.

6. Provide following information to Weather personnel so they can determine the Toxic Corridor Length (TCL).

- name of the chemical
- wind speed in knots
- spill surface area in square feet
- temperature of the spilled liquid

7. Estimate worst case TCL using the following table.

Ambient Temperature	Wind Velocity (knots)					
	5	**7**	**10**	**15**	**18**	**20**
Daytime						
15 ^{o}C (59 ^{o}F)	56	64	73	86	92	96
20 ^{o}C (68 ^{o}F)	67	76	87	102	109	114
25 ^{o}C (77 ^{o}F)	77	88	101	118	127	132
30 ^{o}C (86 ^{o}F)	90	102	117	137	147	153
35 ^{o}C (95 ^{o}F)	102	116	133	156	167	174
Sunset/Sunrise						
15 ^{o}C (59 ^{o}F)	74	84	96	112	121	126
20 ^{o}C (68 ^{o}F)	87	99	114	133	142	148
25 ^{o}C (77 ^{o}F)	101	115	132	154	165	172
30 ^{o}C (86 ^{o}F)	117	133	153	179	192	200
35 ^{o}C (95 ^{o}F)	133	152	174	204	218	227
Night Time						
15 ^{o}C (59 ^{o}F)	173	196	225	263	282	294
20 ^{o}C (68 ^{o}F)	204	232	266	311	333	347
25 ^{o}C (77 ^{o}F)	238	271	310	363	389	405
30 ^{o}C (86 ^{o}F)	275	313	359	419	450	468
35 ^{o}C (95 ^{o}F)	313	356	408	477	512	533

NOTES: Assumes a worst case spill of entire contents of F-16 EPU (6.8 gallons); spilled on a hard surface such as concrete; surface area of spill is 100 ft^2. If you don't have the exact ambient temperature and wind speed, make an estimate. It is important to get the TCL to the OSC as soon as possible. You can always refine it later. The TCL (in feet) is the number where the ambient temperature row and wind speed column intersect

8. If no weather people are available, calculate the actual TCL using the following formulas.

TCL (lb/min) = CF x DF

Where:
CF = Chemical factor (1.19 for hydrazine)
DF = Diffusion factor

$$DF = Q^{0.513} (\hat{}T + 10)^{2.53}$$

Where:

$\hat{}T$ = the difference in air temperature at 6 feet and 54 feet
NOTE: If delta T ($\hat{}T$) is not available from the Weather people, use one of the following average numbers:

Day time = -1 ^{o}C
Night time = +4 ^{o}C
Sunset/Sunrise = 0 ^{o}C

$$Q = (.000166\ V^{0.75})\ (A)\ (1 + .0043\ Tp^{2})\ (Z)$$

Where:

V = wind speed in knots
A = spill area in square feet
Tp = temperature of spilled liquid in degrees centigrade (assume pool temperature is the same as ambient air temperature)
Z = given factor (0.333 for hydrazine)

9. Monitor site using pH paper and detector tubes.
10. Contain the spill.
11. Use water to dilute spill to 1 percent hydrazine concentration.
12. Neutralize with HTH or household bleach (5 percent solution).

Examples:

Use 17.5 gallons of household bleach to neutralize one pint of hydrazine

Use 7.5 lbs of HTH to neutralize one pint of hydrazine

Use 12.5 gallons of household bleach to neutralize one pint of H-70

Use 5.25 lbs of HTH to neutralize one pint of H-70.....

Note: Solid HTH should never be added to undiluted hydrazine since a fire could result

13. HTH or household bleach must be added slowly and in small increments. Vigorous bubbling action will be observed.

14. After the entire amount of HTH or household bleach has been added and the bubbling has stopped, the hydrazine should be completely neutralized. A chlorine residual should be present. To check for neutralization, collect 10 mls of the treated waste and add 1 gm (1/4 to ½ teaspoon) of potassium iodide. A slight increase in yellow color approximates a 5 ppm chlorine residual. Once neutralization is assured, the effluent can be released to the sanitary sewer.

15. Excess chlorine (>5 ppm) may have to be neutralized with sodium thiosulfate.

16. Consider heat stress as a potential problem during hot weather, if response personnel are in PPE.

POST RESPONSE

1. Repack response gear.
2. Conduct debrief with all BES personnel to reinforce lessons learned.
3. Prepare after-actions report to document BES involvement and actions.

Attachment 7-2 - Thermal Stress Monitoring Procedures

1. Monitor for thermal stress during emergency responses in hot weather.

2. Conduct wet-bulb globe temperature (WBGT) monitoring at the accident/spill site using the WBGT kit.

3. Consider added thermal loading resulting from wearing of heavy personnel protective equipment (PPE).

As a rule, add 10 degrees to the WBGT reading if personnel are heavily suited in PPE.

4. Use the following table to determine work/rest regimes for various WBGT conditions.

	Workload		
Work/Rest Cycles (minutes)	**Light**	**Moderate**	**Heavy**
Continuous	86	80	77
45 work / 15 rest	87	82.4	78.6
30 work / 30 rest	88.9	84.9	82.2
15 work / 45 rest	90	88	86

5. Advise the OSC of the need for work/rest regimes to preclude heat induces illness. Also, advise that response personnel need to drink fluids/liquids to avoid heat induced illness.

6. Advise response personnel on the following signs and symptoms of heat induced illness.

Heat Stroke	Skin is hot, dry, and flush. Body core temperature rises. Failure of regulatory control. If left unchecked, could lead to delirium, convulsions, coma, or death.
Heat Exhaustion	Profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. Skin is cool and sometimes pale and clammy.
Heat Cramps	Painful intermittent spasms of the voluntary muscles. Usually occur after heavy sweating. The result of excess loss of salt.

7. Advise response personnel of the following measures to prevent heat disorders.

- Wear loose fitting clothing especially at the wrist, neck, and lower legs

- Drink large quantities of cool water
- Consume extra salt in the form of salt pills

8. Arrange/request for a rest area that is shaded and allows for maximum ventilation.

Attachment 7-3 - Fuel Spill Response Procedures

INITIAL NOTIFICATION

1. Assemble BES team members.
2. Obtain information from Medical Control Center (MCC).
   a. Situation summary.
   b. Site coordinates/location.
   c. Wind speed and direction.
   d. Source of spill.
   e. Type of fuel.
   f. Convoy assembly point (if appropriate).
3. Assemble response equipment.
   a. Explosive meter.
   b. Environmental sampling kit.
   c. Administrative supplies .
   d. WBGT kit.
   e. Dreager pump and tubes.
   f. Dissolved Oxygen meter
   g. Personal Protective Equipment (PPE): coveralls, impermeable gloves and boots, and respirator (or gas mask).
   h. Response procedures (one per individual).
4. Advise headquarters Bioenvironmental Engineering (BEE) office of situation.
5. Plot the location of the spill and determine the best up-wind approach route.
6. Notify the MCC that BES is enroute to the spill site or convoy assembly point.

OFF-BASE RESPONSE

1. Go to convoy assembly point and report in.
2. Notify MCC that BES is at the convoy assembly point.
3. Ensure driver attends the convoy briefing.
4. Double check equipment, supplies, and PPE.
5. Once at the spill site, follow the on-base response procedures.

ON-BASE RESPONSE

1. Notify the MCC that you are at the spill site.
2. Park your vehicle so that it is up-wind.
3. Report to the OSC.
4. Attend initial situation briefing.
5. Estimate quantity spilled.
6. Consult storm drain map or survey the area to determine where the fuel will drain to or be washed to by the fire department.

7. Determine if the spill constitutes a threat to the public or endangers water shed areas or aquatic animals and/or birds.
8. Collect water and vegetation samples.
9. Perform temperature, dissolved oxygen, pH, and odor tests.
10. Perform explosive level monitoring at spill site and in enclosed spaces (pipes, culverts, separators, etc.). Advise OSC of findings.
11. Advise OSC and fire department on containment of the spill.
12. Observe water ways for evidence of fish kills. Look for signs of dead grass or foliage. Look for signs of discoloration in and around the site. Advise the OSC and document all findings.
13. Consider heat stress as a potential problem during hot weather, if response personnel are in PPE.

POST RESPONSE

1. Repack response gear.
2. Conduct debrief with all BES personnel to reinforce lessons learned.
3. Prepare after-actions report to document BES involvement and actions.

Attachment 7-4 - Aircraft Accidents/Composite Material Response Procedures

INITIAL NOTIFICATION

1. Assemble BES team members.
2. Obtain information from Medical Control Center (MCC).
   a. Situation summary.
   b. Site coordinates/location.
   c. Wind speed and direction.
   d. Type of fuel.
   e. Convoy assembly point (if appropriate).
3. Assemble response equipment.
   a. Administrative supplies.
   b. WBGT kit.
   c. Personal Protective Equipment (PPE): gloves, goggles, foul weather suit (or long-sleeve clothing), respirator (or gas mask), and dust masks (three boxes).
   d. Response procedures (one per individual).
5. Advise headquarters Bioenvironmental Engineering (BEE) office of situation.
6. Plot the location of the accident/crash and determine the best up-wind approach route.
7. Notify the MCC that BES is enroute to the spill site or convoy assembly point.

OFF-BASE RESPONSE

1. Go to convoy assembly point and report in.
2. Notify MCC that BES is at the convoy assembly point.
3. Ensure driver attends the convoy briefing.
4. Double check equipment, supplies, and PPE.
5. Once at the accident/crash site, follow the on-base response procedures.

ON-BASE RESPONSE

1. Notify the MCC that you are at the accident/crash site.
2. Park your vehicle so that it is up-wind.
3. Report to the OSC.
4. Attend initial situation briefing.
5. Advise on the need for protective equipment.
   a. Respirator, dust mask or gas mask.
   b. Long sleeve clothing.
   c. Gloves.
   d. Goggles/face shield.
6. Advise OSC that you have dust masks for response personnel who did not bring a respirator.
7. Advise the OSC on fiber suppression, decontamination, and waste disposal procedures.
8. Estimate the downwind fiber distribution pattern using the table below and advise the OSC of cordon requirements.

Wind Speed		Potential Downwind Distribution	
Knots	**MPH**	**Feet**	**Meters**
4-9	6-10	3,445	1,050
10-13	11-15	5,085	1,550
14-17	16-20	6,725	2,050

9. Recommend use of water spray for control of airborne fibers.
10. Advise of the requirement to contain and dispose or filter water run off from the site.
11. Consider heat stress as a potential problem during hot weather, if response personnel are in PPE.

POST RESPONSE

1. Repack response gear.
2. Conduct debrief with all BES personnel to reinforce lessons learned.
3. Prepare after-actions report to document BES involvement and actions.

Attachment 7-5 - Natural Disaster Response Procedures

PRIMARY RESPONSIBILITY - DRINKING WATER SURVEILLANCE

1. Initiate microbiological testing at all drinking water monitoring points. Use Drinking Water Sampling Plan and Water Vulnerability Assessment as resources.
2. Monitor chlorine levels.
   a. Take initial chlorine readings at all monitoring locations.
   b. Repeat chlorine testing 1 hour later to determine chlorine demand.
   c. Establish chlorine monitoring schedule.
3. Survey water distribution system for water line breaks.
4. Coordinate surveillance efforts with CE.
5. Coordinate activities to obtain alternate water supplies, if necessary.
6. Survey installation for potential chemical, fuel, sewage, etc. pollution that might contaminate the water supply.
7. If flooding has occurred, recommend CE increase chlorine levels in the drinking water system to 5 ppm.
8. Coordinate with Public Affairs on drinking water disinfection and sterilization procedures.
   - Boil water a minimum of 10 minutes, allow to cool
   - Add three (3) drops of household bleach to each gallon of water and let stand for a minimum of thirty (30) minutes before consuming. It is recommended that the water sit longer if suspected of having been contaminated

Caution: Be sure to add warnings that people should not over sanitize the water. The tendency is to think if three drops are good, a cap full is much better. Over chlorination of drinking water could cause diarrhea that may lead a person to think the water is bad so more chlorination is needed.

SECONDARY RESPONSIBILITY - PUBLIC HEALTH SURVEILLANCE

1. If electrical power is lost for any length of time, coordinate with Services on the inspection and disposal of food supplies that may have spoiled.

2. Coordinate with CE on potential health impacts associated with the loss of sewage disposal capabilities resulting from damage to the system or loss of electrical power.

3. Advise the OSC on temperature stress. Use Thermal Stress Monitoring Procedures to avoid heat stress injuries and the following table for potential effects of cold temperatures.

Temp °F	Wind Speed (MPH) 0	5	10	15	20	25	30	35
35	35	32	22	16	12	8	6	4
30	30	27	16	9	4	1	-2	-4
25	25	22	10	2	-3	-7	-10	-12
20	20	16	3	-5	-10	-15	-18	-20
15	15	11	-3	-11	-17	-22	-25	-27
10	10	6	-9	-18	-24	-29	-33	-35
5	5	0	-15	-25	-31	-36	-41	-43
0	0	-5	-22	-31	-39	-44	-49	-52
-5	-5	-10	-27	-38	-46	-51	-56	-58
-10	-10	-15	-34	-45	-53	-59	-64	-67
-15	-15	-21	-40	-51	-60	-66	-71	-74
-20	-20	-26	-46	-58	-67	-74	-79	-82

30°F or greater	**Chilly**: generally unpleasant
15 °F to 30 °F	**Cold**: very unpleasant
0 °F to 15 °F	**Very cold**: very unpleasant
-20 °F to 0 °F	**Bitter cold**: frostbite probable
-20 °F to -60 °F	**Frostbite likely**, outdoor activity dangerous
-60 °F or less	**Frigidity cold**: exposed flesh will freeze within 30 seconds

Attachment 7-6 - UXO/munitions Response Procedures

INITIAL NOTIFICATION

1. Assemble BES team members.
2. Obtain information from Medical Control Center (MCC) Situation summary.
   a. Site coordinates/location.
   b. Wind speed and direction.
   c. Type of UXO, munition, aircraft, delivery vehicle, etc.
   d. Convoy assembly point (if appropriate).
3. Assemble response equipment.
   a. RADIAC gear (ADM-300, dosimeters, film badges).
   b. Staplex air samplers and tripods.
   c. Portable generator and gas can
   d. Chemical agent alarms (M8A1, M90, ALAD).
   e. Chemical agent detectors (M256, M8 and M9 detector paper, M272.
   f. NBC contamination marking set.
   g. PPE (GCE, anticontamination coveralls, booties, hood, gloves, tape and SCBA).
   h. Environmental sample kit.
   i. Administrative supplies.
   j. WBGT kit.
   k. Decontaminating solutions (DS2, HTH, STB, SID household bleach, soap, detergent, etc.).
   l. Response procedures (one per individual).
5. Advise headquarters Bioenvironmental Engineering (BEE) office of situation.
6. Plot the location of the UXO/munition and determine the best up-wind approach route.
7. Notify the MCC that BES is enroute to the site or convoy assembly point.

OFF-BASE RESPONSE

1. Go to convoy assembly point and report in.
2. Notify MCC that BES is at the convoy assembly point.
3. Ensure driver attends the convoy briefing.
4. Double check equipment, supplies, and PPE.
5. Turn on RADIAC gear and chemical agent alarms.
6. Once at the UXO/munition site, follow the on-base response procedures.

ON-BASE RESPONSE

1. Notify the MCC that you are at the site.
2. Report to the OSC.
3. Attend situation briefing.
4. If EOD confirms the UXO is a conventional munition, the primary function of the BES is to monitor response personnel for thermal stress (Attachment 7-

2). If a nuclear device, go to the NUCLEAR RESPONSE portion of this attachment. If a CB weapon, go to CHEMICAL/BIOLOGICAL RESPONSE portion of this attachment.

NUCLEAR RESPONSE

1. Approach the site from an upwind location. If contamination is suspected, begin monitoring for radiation at least one mile from the site using the ADM-300.

2. Establish cordon line wherever beta-gamma radiation readings of 2 mR/hr are encountered.

3. If asked, participate in approach operations by operating a survey meter. Wear your gas mask or self contained breathing apparatus (SCBA).

4. If no beta-gamma radiation is encountered, and if the type and condition of nuclear device has not been confirmed, an initial high explosive (HE) exclusion area with a 610 meters (2000 feet) fragmentation radius will be established by OSC.

5. Take initial background air samples using the Staplex air sampler. If at any time, you determine the disintegrations per minute to be greater than 100 dpm/m^3, advise the response team to put on their respirators.

6. Use the ADM-300 to monitor for beta-gamma radiation to determine if fissioning has occurred. The following table shows the meaning of various readings. If fissioning has occurred, the OSC will establish the 2 mR/hr cordon line.

Reading	Meaning
0 to 2 mR/hr	No nuclear yield, no components nearby
2 to 50 mR/hr	Presence of unfissioned material
Over 100 mR/hr	If found over a broad area, fission has occurred
Above 250 mR/hr	If found in isolated areas, it is normally due to a certain weapon part, not a nuclear yield

7. Sample for airborne alpha radiation using the Staplex air sampler. Take the initial air sample at the control point for 15 minutes to establish the background radiation levels and to assure the control point is radiation free. Always face the Staplex into the wind at the breathing zone level (five feet). Take additional 15 minute readings at 90° intervals around the cordon. Following those initial samples, take secondary samples at the control point, the hot line entry point, and downwind from the site. Use the following table to determine downwind sampling points.

Wind Speed	Distance From Site
6-10 MPH (4-9 knots)	3500 feet (1000 meters)
11-15 MPH (10-13 knots)	5100 feet (1500 meters)
16-20 MPH (14-17 knots)	6700 feet (2000 meters)
Above 20 MPH (above 17 knots)	8400 feet (2500 meters)

8. Calculating disintegrations per minute by running the Staplex for about 15 minutes or until 1000 cubic feet of air has been pulled through the sampler. Use ADM-300 meter with alpha probe to measure the amount of contamination that has been absorbed by the filter paper. Take the reading in counts per minute (cpm). Run alpha probe diagonally across the filter paper two times. The value for cpm is the average of the two readings. Calculate the disintegrations per minute per cubic meter (dpm/m^3) using the following formula

$$\mathbf{dpm/m^3} = \frac{\mathbf{cpm \times 35.3 \times Af}}{\mathbf{0.5 \times Ef \times F \times Ec \times Ac \times Fr \times T}} = \frac{\mathbf{cpm \times 4200}}{\mathbf{Fr \times T\ (min)}}$$

Where:

cpm = counts per minute
35.3 = conversion factor for feet3 per meter3
Af = collection area of Staplex filter paper in cm2
Ef = collection efficiency of filter paper

F = self absorption factor of filter paper
Ec = counting efficiency of ADM-300
Ac = active detection area in cm^2 of alpha probe
V = total volume of air that passed through Staplex (ft^3)
[V = flow rate in cfm (Fr) x sampling time in min (T)]

Notes: The Staplex filter holder reduces the collection area of 8" x 10" filter paper from 516 cm^2 to 406 cm^2 . The self absorption factor of the filter paper is 50 percent (0.5). The collection efficiency varies according to the size of the particles being collected (approximately 0.5 for one micron particles). The counting efficiency of the ADM-300 alpha probe is 30 percent (0.3). The active area of the ADM-300 alpha probe is 92 cm^2.

Once you have calculated the dpm/m^3, use the following table to determine respiratory protection requirements. Advise the OSC of your findings.

Airborne Alpha Concentration	**Respiratory Protection**
Below 100 dpm/m^2	None
100 - 10,000 dpm/m^2	Full-face with high efficiency particulate air filter (HEPA) such as M-17
Above 10,000 dpm/m^2	Self-contained breathing apparatus

9. Measure for alpha radiation on rocks, vegetation, buildings, soil, etc., using ADM-300. Use the following table to determine mask and body protection requirements. Note: plutonium contamination in microgram per square meter (µg/m^2) is also provided for situations where RADIAC meters measure in those units.

Plutonium Contamination (µCi/m^2)	**Plutonium Contamination (µg/m^2)**	**Mask Type**	**Body Protection**
163,934 and above	10,000 and above	SCBA	Full[1]
16,393 - 163,933	1,000 - 9,999	Gas Mask (M-17 or MCU-2/P)	Full[1]
1,639 - 16,392	100 - 999	Gas Mask (M-17 or MCU-2/P)	Partial[2]
1 - 1,638	1 - 99	None	Minimal[3]

Note 1: Anticontamination coveralls, booties, hood, gloves, and tape all openings

Note 2: Boots, Gloves, and tape all openings

Note 3: Boots

10. Use dosimeters and/or ADM-300 to monitor radiation exposure. USAF radiation exposure limit is 3.0 roentgen equivalent man (rem) per calendar quarter. Exposures greater than 500 mrem per exposure event are allowable only upon direction of the OCS. Use the following formula to calculate total dose.

$$D = \frac{(R_1 + R_2) \times t}{2}$$

Where:

D = dose in rads = dose in rems (for gamma radiation)

R_1 and R_2 = fallout intensities in R/hr at the beginning and end of exposure

t = time of exposure in hours

11. Record exposure/dose of response team personnel on the following form (or similar).

INDIVIDUAL RADIOLOGICAL DOSE RECORD									NAME							
DATE:																
TIME:	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
LOCATION:																
DOSE FOR PERIOD:																
ACCUMULATED DOSE:																
RETURN BEFORE DOSE:																
REMARKS/EVENTS:																
DATE:																
TIME:	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
LOCATION:																
DOSE FOR PERIOD:																
ACCUMULATED DOSE:																
RETURN BEFORE DOSE:																
REMARKS/EVENTS:																

12. If the area is contaminated by radioactive material at levels of 16,393 $\mu Ci/m^2$ (1000 $\mu g/m^2$) or greater, implement urine sampling and nasal swipes. All samples should be sent to the Armstrong Laboratory, 2402 E Drive, Brooks AFB, TX 78235-5114 (210-536-3626) for analysis.

a. Take 24-hour urine samples from everyone working in the 16,393 µCi/m2 contaminated area. Take random samples from other personnel involved in the operation who were outside of the highly contaminated area. Take samples from several people who were not involved in the response to be used as controls. Samples must be collected in laboratory specimen containers. Do not add any chemicals or reagents as preservatives. Discard the first morning voiding and collect all subsequent voidings for the next 24 hours. Label the samples with the name, rank, SSN and organization of the individual, the reason the sample was collected, the

date of possible exposure, the date the sample was collected, and the individual's assigned response team.

b. Take nasal swipes from personnel as they come through the decontamination (decon) line. Use a biological culture applicator moistened with distilled water or a moistened q-tip. Use a separate applicator for each nostril. Place the applicators in their culture tube and place the tubes in an envelope. If using q-tips, place the q-tips in a plastic bag (e.g., zip lock bag) and place the bag into an envelope. Label the envelope with the name, rank, SSN and organization of the individual, the reason the swipe was collected, the date of possible exposure, the date the swipe was collected, and the individual's assigned response team.

13. Take environmental samples to provide baseline documentation of contamination in and around the site. Take samples from the soil, vegetation, ash, water and snow, and various surfaces. Label all samples with the reason the sample was taken, the date of possible exposure, and the date the sample was taken. Send all samples to the Armstrong Laboratory, 2402 E Drive, Brooks AFB, TX 78235-5114 (210-536-3626) for analysis.

a. Take soil samples before, during, and after recovery/cleanup operations. Take at least six samples during the recovery/cleanup. Take background samples at some distance from the scene for comparison control. Take samples by pushing the open end of an ointment tin into the ground. Dig up the tin and the sample stays inside. An alternate procedure is to dig a one square foot by two inch deep sample from the ground and place it in a plastic bag. For gamma spectrometry plus alpha and/or gross beta, two kilograms of soil are needed. For gross alpha and/or gross beta, only 100 grams of soil are needed. If you need specific alpha and/or beta radionuclide testing, consult Armstrong Lab for instructions.

b. Take vegetation samples before, during, and after recovery/cleanup operations. Collect samples of grass, small plants, rocks, etc. Collect background samples at some distance from the site for control purposes. Place samples in individual plastic bags Each sample must be at least two ounces.

c. Take at least four samples of ash from different locations in the debris. Place the samples in individual plastic bags.

d. Collect at least six samples of water and snow from the immediate area of the site. Make sure the samples are not contaminated with fuel, oil, or foam. Collect water and snow samples at some distance from the site for control purposes. Collect water samples from all streams, wells, and run-off in or near the site. Use one liter containers to collect the samples.

e. Take surface swipes using filter paper that has been folded into three or four inch squares. Swipe tires, outer surfaces, seats, steering wheels, floor panels, and foot pedals of all vehicles and equipment used in the recovery/cleanup operation. Swipe outside and inside surfaces of any buildings in or near the site. Swipe exterior surfaces (rocks, trees, structures, etc.) downwind from the site. Take swipes by rubbing the filter paper in one direction over a square foot of surface area. Then take another swipe of the same surface at 90 degrees from the first. Fold all swipes with exposed side in and place in envelopes.

14. Decontamination (decon) operations are normally performed by special decon crews. However, the BES should be prepared to assist if needed. All personnel, vehicles, and equipment used in the recovery/cleanup have to be decontaminated. Decontamination is performed by thoroughly washing with soap and water and rechecking for contamination using RADIAC meters (ADM-300 or other).

a. Personnel leaving the contaminated area go through decon at the hot line exit point. Removing PPE (anti-C coveralls, boots, hoods, etc.) and monitor the person for beta/gamma contamination using a RADIAC meter. If contamination is still present, the person must remove all inner clothing and shower thoroughly with soap and water. The decon crew must wear the same PPE as those who are working in the contaminated area. Contaminated PPE and wash water must be collected and disposed of as radioactive waste.

b. Vacuum, wash with soap and water, and recheck all vehicles and equipment for contamination. Repeat the process if contamination is still present. Collect vacuum bags, used washing supplies (rags, sponges, brushes, etc.), and wash water and dispose of as radioactive waste.

CHEMICAL/BIOLOGICAL RESPONSE

1. Approach CB UXO from an upwind location. Since current field tests or monitors cannot detect biological contamination, an area cannot be considered free of biological contamination unless intelligence information or physical evidence confirms it.

2. If asked, participate in approach operations by operating a survey meter. Wear your gas mask and ground crew ensemble (GCE).

3. If the type of CB weapon has not been confirmed, the OSC will establish an initial exclusion area of 450 meters (1476 feet) around the site and 2000 meters (6560 feet) downwind.

4. Until the CB agent has been identified, all response personnel must wear the full ground crew ensemble (GCE) while in the exclusion area.

5. Using chemical agent alarms, probe into the area until you get a chemical alarm or until you reach the detonation site.

6. If no chemical agents are detected, perform a detailed reconnaissance for both biological and chemical agents

a. There are several methods of collecting suspected biological agent samples, such as collecting samples of earth and vegetation, taking wet or dry swab samples, and collecting aerosol samples using an impinger. During a sampling survey, note the condition of the soil in the vicinity of bomb bursts. Liquid, damp soil, or oddly colored dust around a bomb crater could be an indication of BW agents. Any unusual circumstances, objects, or other details should be documented so that an accurate appraisal can be made after samples are analyzed. Keep detailed data about each sample, such as the time and place of the sample, weather conditions, elapsed time since the attack/accident, and a general description of the appearance of the area. You should also be alert for the possibility of duds. You might be able to obtain a sample of pure agent from an unexploded or undamaged delivery vehicle.

b. Look for chemical contamination in shell craters; low lying areas such as ravines, drainage ditches, and stream beds, and in wooded areas or areas covered with high grass or underbrush. Use the M256 test kit to test for airborne concentrations of nerve, blood, and blister agents. Use M8 and M9 detector paper to test suspected liquid nerve or blister

agent. Use the M272 kit to detect harmful levels of cyanide (AC), mustard (HD), lewisite (L), and nerve agents (GA, GB, GD, VX) in all water sources in the area.

7. Mark contamination for subsequent decontamination using the NBC contamination marking set.

8. If no agents are confirmed but there is physical evidence of possible biological contamination, mark the entire exclusion area and control it as off-limits until the results of samples are received from the laboratory.

9 Decontamination (decon) operations are normally performed by special decon crews. However, the BES should be prepared to assist if needed. There are four basic types of standard decontaminants - super tropical bleach (STB), decontaminating standard number 2 (DS2), high-test hypochlorite (HTH), and skin irritant decontaminant (SID).

a. Use STB to decontaminate mustard, Lewisite, and nerve agents. STB is very caustic and reacts with water to produce heat and toxic or corrosive vapors. Do not store STB with or near flammables. When handling STB, wear your individual protective equipment. For manual application use swabs, brushes, or brooms, to apply slurry (equal parts (by weight) of STB and water). When used in a 500-gallon power-driven decontaminating apparatus, mix 1300 pounds of STB and 225 gallons, approximately 1800 pounds, of water. For dry application, mix two parts of STB to three parts of earth or other dry material. Use dry mix in shuffle boxes or place it under equipment that is being decontaminated.

b. Ready-to-use DS2 effectively decontaminates all known toxic chemical agents. Apply DS2 to contaminated surfaces and leave for 30 minutes before rinsing with water. DS2 is very irritating to the skin and eyes. Wear individual protective equipment when using it. DS2 has a low flash point so do not use it on heat-producing devices or running engines.

c. Use HTH to decontaminate individuals and personal protective equipment. HTH is effective against Lewisite and V-nerve agents. Dissolve 6 ounces of HTH and 6 ounces of detergent in 12 gallons of water to make a decontamination solution.

d. Use Skin irritant decontaminant (SID) to neutralize the skin irritating properties of riot control agents CS and CN. Locally manufacture SID by mixing 2 and 1/2 cups of 70 percent isopropyl alcohol with 1 cup water, 1/2 cup of glycerin, and 2 level tablespoons of sodium bisulfate. Spray or pour SID directly on contaminated skin and rub in with the hand.

POST RESPONSE

1. Repack response gear.
2. Conduct debrief with all BES personnel to reinforce lessons learned.
3. Prepare after-actions report to document BES involvement and actions.

Attachment 7-7 - Pesticide/Toxic Chemical spills

INITIAL NOTIFICATION

1. Assemble BES team members.
2. Obtain information from Medical Control Center (MCC).
   a. Situation summary.
   b. Site coordinates/location.
   c. Wind speed and direction.
   d. Type of container, e.g. F-16, storage tank, servicing cart, transport truck, etc.
   e. Convoy assembly point (if appropriate).
3. Assemble response equipment.
   a. Explosive meter.
   b. Charcoal detector tubes.
   c. Universal sampling pumps.
   d. Sipin, Monitaire, and Dupont sampling pumps.
   e. Dissolved Oxygen meter.
   f. Environmental sampling kit
   g. Administrative supplies.
   h. WBGT kit.
   i. Personal Protective Equipment (PPE): coveralls, impermeable gloves and boots, and self-contained breathing apparatus.
   j. Response procedures (one per individual).
   k. American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) Handbook.
4. Advise headquarters Bioenvironmental Engineering (BEE) office of situation.
5. Plot the location of the accident/spill and determine the best up-wind approach route.
6. Notify the MCC that BES is enroute to the accident/spill site or convoy assembly point.

OFF-BASE RESPONSE

1. Go to convoy assembly point and report in.
2. Notify MCC that BES is at the convoy assembly point.
3. Ensure driver attends the convoy briefing.
4. Double check equipment, supplies, and PPE.
5. Once at the accident/spill site, follow the on-base response procedures.

ON-BASE RESPONSE

1. Notify the MCC that you are at the spill site.
2. Report to the OSC.
3. Ensure no one enters the site without self-contained breathing apparatus and impervious clothing.

4. Estimate quantity spilled.

5. Provide following information to Weather personnel so they can determine the TCL.

- name of the chemical
- wind speed in knots
- spill surface area in square feet
- temperature of the spilled liquid
- source strength (Q)

Source Strength (Q):

$$Q = .000166\ V^{0.75}\ (A)\ (1 + .0043\ Tp^2)\ (Z)$$

Where:

Q = source strength in lb/min

V = wind speed in knots

A = spill area in square feet

Tp = temperature of spilled liquid in degrees centigrade (assume pool temperature is the same as ambient air temperature)

Z = given factor (see Table below)

Note: The source strength formula was developed for hydrazine. The Z-factor is used to convert the formula for use with other chemicals. If the chemical in question is not listed in the Table below, you can calculate the Z-factor using the following formula:

$$Z = \frac{Vp_1 \times GMV_1}{Vp_h \times GMV_h} = \frac{Vp_1 \times GMV_1}{0.31 \times 32.045} = \frac{Vp_1 \times GMV_1}{9.934}$$

Where:

Z = dimensionless factor

Vp_1 = vapor pressure of the chemical in question (in same units as Vp_h)

GMV_1 = gram molecular weight of the chemical in question

Vp_h = vapor pressure of hydrazine (in same units as Vp_1)

GMV_h = gram molecular weight of hydrazine

If there are no AF Weather offices available, you can calculate the actual TCL using the following formulas:

$$TCL = CF \times DF$$

Where:

TCL = toxic corridor length in feet

and

$$CF = 30.476\ (Cp \times GMW)^{-0.513}$$

$$DF = Q^{0.513}\ (\hat{}T + 10)^{2.53}$$

Where:

Cp = ppm used for short term public emergency limit (TWA, STEL, ceiling limit) from ACGIH TLV handbook

GMW = gram molecular weight (see Table below)

Q = source strength in lb/min

$\hat{}T$ = the difference in air temperature at 6 feet and 54 feet

NOTE: If delta T ($\hat{}T$) is not available from the Weather people, use one of the following average numbers:

Day time = -1 ^oC

Night time = +4 ^{o}C

Sunset/Sunrise = 0 ^{o}C

6. Collect samples of vegetation at and down gradient from the spill site. Collect background samples a some distance from the site.

7. Sample the water and snow around the spill site in at least six (6) places. Collect background samples a some distance from the site. The standard sample size should be one (1) liter.

8. Perform temperature, dissolved oxygen, pH, and odor tests in and around the site. If appropriate, perform explosive level monitoring at the spill site and in enclosed spaces surrounding the site such as pipes, culverts, separators, etc. Continue to perform explosive level monitoring until the containment and initial cleanup are complete. Advise the OSC of your findings.

9. Perform a reconnaissance in and around the site looking in ditches, lakes, streams for signs of damage such as fish kills. Look for signs of dead grass or foliage that could indicate fuel that has soaked into the ground. Look for signs of discoloration in and around the site. Advise the OSC and document all findings.

10. Consider heat stress as a potential problem during hot weather, if response personnel are in PPE.

POST RESPONSE

1. Repack response gear.
2. Conduct debrief with all BES personnel to reinforce lessons learned.
3. Prepare after-actions report to document BES involvement and actions.

Selected Toxic Chemical Parameters (USN CHRIS)

Substance	Cp (ppm)	GMW	CF	Vapor Pressure (psi @ 80°F)	Z Factor
ACETALDEHYDE	25	44.054	0.838	18.610	82.53
ACETONE	500	58.081	0.156	4.790	28.01
ACETONITRILE	40	41.050	0.683	1.810	7.48
ACROLEIN	0.1	56.065	12.586	8.700	49.10
ACRYLIC ACID	2	72.060	2.380	0.116	0.84
ALLYL ALCOHOL	2	58.081	2.658	0.524	3.06
ALLYL CHLORIDE	1	76.526	3.293	7.370	56.77
AMMONIA	25	17.030	1.365	157.000	269.15
ANILINE	2	93.130	2.086	0.008	0.07
BENZENE	0.5	78.115	4.650	1.990	15.65
BENZYL CHLORIDE	1	126.580	2.544	0.030	0.38
BROMINE PENTAFLUORIDE	0.1	174.896	7.021	8.430	148.42
BROMOFORM	0.5	252.770	2.546	37.080	943.50
BUTADIENE (1 3)	2	54.092	2.757	36.050	196.30
BUTANE	800	58.124	0.123	37.080	216.96
BUTYL ALCOHOL(n) (BUTANOL-1)	50	74.120	0.450	0.137	1.02
BUTYL ALCOHOL(sec) (BUTANOL-2)	100	74.120	0.315	0.373	2.78
BUTYL ALCOHOL(-t)	100	74.124	0.315	0.908	6.78
CARBON DISULFIDE	10	76.139	1.013	7.400	56.72
CARBON TETRACHLORIDE	5	153.820	1.008	2.420	37.47
CHLORINE	0.5	70.906	4.886	115.383	823.57
CHLORINE PENTAFLUORIDE	0.3	130.445	4.645	58.760	771.59
CHLORINE TRIFLUORIDE	0.1	92.448	9.738	26.600	247.55
CHLOROBENZENE	10	112.560	0.829	0.269	3.05
CHLOROFORM	10	119.390	0.804	4.120	49.52
CRESOL(-m)	5	108.140	1.208	0.017	0.19
CRESOL(-o)	5	108.150	1.208	0.017	0.19
CRESOL(-p)	5	108.140	1.208	0.017	0.19
CUMENE (ISOPROPYL BENZENE)	50	120.200	0.351	0.328	3.97
CYCLOHEXANE	300	84.160	0.168	1.980	16.77
DICHLOROBENZENE (1 2) (-o)	25	147.010	0.452	0.035	0.52
DICHLOROBENZENE (1 4) (-p)	10	147.010	0.723	0.035	0.52
DICHLOROETHYLENE (1 2)	200	96.940	0.193	5.390	52.60
DICHLOROPROPANE (1 2)	75	112.990	0.294	4.200	47.77
DIMETHYLANILINE (n n)	5	121.180	1.139	1 mm of Hg @ 68°F	0.38
DIMETHYLHYDRAZINE (UDMH)	0.01	60.099	39.573	3.260	19.72
DIOXANE (1 4)	25	88.100	0.588	0.730	6.47
EPICHLOROHYDRIN	0.5	92.526	4.263	0.360	3.35
ETHANOL	1000	46.070	0.123	1.220	5.66
ETHYL ACRYLATE	5	100.120	1.256	0.770	7.76
ETHYL BENZENE	100	106.170	0.262	7 mm of Hg @ 68°F	2.32
ETHYL CHLORIDE	100	64.515	0.339	24.730	160.61
ETHYLENE DICHLORIDE	10	98.960	0.886	1.630	16.24
ETHYLENE GLYCOL	0.05	62.069	17.047	0.002	0.01
ETHYLENE OXIDE	1	44.054	4.371	26.680	118.32
FLUORINE	1	37.997	4.716	14.700	56.23
FORMALDEHYDE (37%)	0.03	22.490	37.293	0.042	0.10
FORMALDEHYDE (56%)	0.03	24.780	35.483	0.042	0.10
FORMALDEHYDE(PURE)	0.03	30.030	32.152	0.042	0.13

	Cp			Vapor Pressure	

Substance	(ppm)	GMW	CF	(psi @ 80°F)	Z Factor
FREON 12	1000	120.910	0.075	159.600	1942.55
HYDRAZINE	0.01	32.045	54.639	0.310	1.00
HYDRAZINE (50%)	0.01	53.000	42.209	3.100	16.54
HYDRAZINE (70%)	0.01	27.800	58.771	0.119	0.33
HYDROGEN CHLORIDE	5	36.460	2.109	808.790	2968.45
HYDROGEN CYANIDE	4.7	27.060	2.537	15.310	41.70
HYDROGEN FLUORIDE	3	20.006	3.730	18.700	37.66
HYDROGEN SULFIDE	10	34.080	1.530	326.600	1120.45
ISOPROPANOL (2-PROPANOL)	500	60.097	0.154	0.953	5.77
ISOPROPYL ETHER	250	102.178	0.167	3.080	31.68
MESITYL OXIDE	15	98.146	0.722	0.250	2.47
METHANOL	200	32.040	0.340	2.580	8.32
METHYL ETHYL KETONE	200	72.108	0.224	1.910	13.86
METHYL IODIDE	2	141.940	1.681	400 mm of Hg @ 68°F	177.18
METHYL ISOBUTYL KETONE	50	100.162	0.386	0.422	4.25
METHYL METHACRYLATE	100	100.100	0.270	0.840	8.46
METHYLENE CHLORIDE	50	84.933	0.420	9.240	79.00
MONOMETHYLHYDRAZINE (MMH)	0.01	46.072	45.354	1.030	4.78
NITRIC ACID (PURE)	2	63.020	2.549	1.290	8.18
NITRIC ACID, INHIBITED RED FUMING	2	63.013	2.549	2.70	17.13
NITROBENZENE	1	123.110	2.580	0.006	0.07
NITROGEN DIOXIDE	3	46.008	2.433	15.700	72.71
NITROGEN TETROXIDE	5	92.016	1.312	18.910	175.16
NITROGEN TRIFLUORIDE	10	71.000	1.050	14.700	105.06
NITROPROPANE	10	89.090	0.935	0.420	3.77
OXYGEN DIFLUORIDE	0.05	53.996	18.310	4306.000	23405.27
PENTABORANE	0.005	63.127	55.065	4.000	25.42
PERCHLORYL FLUORIDE	3	102.450	1.614	176.100	1816.14
PHENOL	5	94.114	1.297	0.017	0.16
PHOSGENE	0.1	98.920	9.405	28.310	281.90
PROPANE	2500	44.097	0.079	123.480	548.13
PROPYLENE OXIDE	20	58.080	0.816	11.110	64.96
PYRIDINE	5	79.100	1.418	0.439	3.50
STYRENE	20	104.153	0.605	0.137	1.44
SULFUR DIOXIDE	2	64.060	2.528	55.030	354.87
TETRACHLOROETHANE (1 1 2 2)	1	167.860	2.201	0.161	2.72
TETRACHLOROETHYLENE	25	165.830	0.425	0.425	7.09
TOLUENE	50	92.142	0.402	0.600	5.57
TOLUIDINE (-o)	2	107.160	1.941	0.3 mm of Hg @ 68°F	0.10
TRICHLOROETHANE (1 1 1)	350	133.420	0.123	2.660	35.73
TRICHLOROETHANE (1 1 2)	10	133.410	0.760	2.660	35.72
TRICHLOROETHYLENE	50	131.340	0.335	1.510	19.96
TRICHLOROTRIFLUOROETHANE	1000	187.377	0.060	6.500	122.60
TRIMETHYLBENZENE (1 3 5)	25	120.200	0.501	2 mm of Hg @ 68°F	0.75
VINYL ACETATE	10	86.090	0.951	2.430	21.06
VINYL CHLORIDE	5	62.499	1.600	60.480	380.51
VINYLIDENE CHLORIDE	5	96.940	1.277	12.360	120.61
XYLENE (-m)	100	106.169	0.262	0.177	1.89
XYLENE (-o)	100	106.170	0.262	0.141	1.51
XYLENE (-p)	100	106.170	0.262	0.187	2.00

Appendix A - References

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PRO-ACT Technical Inquiry 8592, Composite Fiber Hazards/Fire, 4 Mar 96
Radiation Units, http://www.orcbs.msu.edu
SUMMA Canisters, http://www.graseby.com/cans.htm
USN CHRIS
Water Vulnerability Assessments, Armstrong Lab, Brooks AFB, April 91
Wind Chill Factors, http://www.dsw.state.vt.us

Appendix B - Periodic Table

Periodic Table

Atomic Number
Symbol
Atomic Mass

	1												13	14	15	16	17	18
1	1 H 1.01																	2 He 4
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.9	36 Kr 83.8
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.9	54 Xe 131.3
6	55 Cs 132.91	56 Ba 137.33		72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.20	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra 226.03		104 Rf (261)	105 Ha (262)	106 Sg (263)	107 Ns (262)	108 Hs (265)	109 Mt (266)	110 Uun (267)	111 Uuu (272)	112 Uub (277)						

(Parentheses indicate mass of most stable isotope)

Lanthanide Series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide Series	89 Ac 227.03	90 Th 232.03	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Element Names

Ac - Actinium	Cs - Cesium	K - Potassium	Pa - Protactium	Sr - Strontium
Ag - Silver	Cu - Copper	Kr - Krypton	Pb - Lead	Ta - Tantalum
Al - Aluminum	Dy - Dysprosium	La - Lanthanum	Pd - Palladium	Tb - Terbium
Am - Americium	Er - Erbium	Li - Lithium	Pm - Promethium	Tc - Technetium
Ar - Argon	Es - Einsteinium	Lr - Lawrencium	Po - Polonium	Te - Tellurium
As - Arsenic	Eu - Europium	Lu - Lutetium	Pr -Praseodymium	Th - Thorium
At - Astatine	F - Fluorine	Md - Mendelevium	Pt - Platinum	Ti - Titanium
Au - Gold	Fe - Iron	Mg - Magnesium	Pu - Plutonium	Tl - Thallium
B - Boron	Fm - Fermium	Mn - Manganese	Ra - Radium	Tm - Thulium
Ba - Barium	Fr - Francium	Mo - Molybdenum	Rb - Rubidium	U - Uranium
Be - Beryllium	Ga - Gallium	Mt - Meitnerium	Re - Rhenium	Uub - Ununbium
Bi - Bismuth	Gd - Gadolinium	N - Nitrogen	Rf - Rutherfordium	Uun - Ununnilium
Bk - Berkelium	Ge - Germanium	Na- Sodium	Rh - Rhodium	Uuu - Unununium
Br - Bromine	H - Hydrogen	Nb - Niobium	Rn - Radon	V - Vanadium
C - Carbon	Ha - Hahnium	Nd - Neodymium	Ru - Ruthenium	W - Tungsten
Ca - Calcium	He - Helium	Ne - Neon	S - Sulfur	Xe - Xenon
Cd - Cadmium	Hf - Hafnium	Ni - Nickel	Sb - Antimony	Y - Yttrium
Ce - Cerium	Hg - Mercury	No - Nobelium	Sc - Scandium	Yb - Ytterbium
Cf - Califonium	Ho - Holmium	Np - Neptunium	Se - Selenium	Zn- Zinc
Cl - Chlorine	Hs - Hassium	Ns - Neilsborium	Sg - Seaborgium	Zr - Zirconium
Cm - Curium	I - Iodine	O - Oxygen	Si - Silicon	
Co - Cobalt	In - Indium	Os - Osmium	Sm - Samarium	
Cr - Chromium	Ir - Iridium	P - Phosphorus	Sn - Tin	

Appendix C - Forms

WATER POINT INSPECTION REPORT For use of this form, see FM 10-52; the proponent agency is TRADOC	DATE

TO	FROM *(Organization)*

WATER POINT INSPECTION	WATER POINT	INSPECTION RATING
NAME OF MAP COORDINATES	DATE	INSPECTOR

Residual Chlorine

FILTER OUTLET *(ppm)*	DISTRIBUTING NOZZLE *(ppm)*

Condition of

1. WATER POINT *(List defects and improvements of layout.)*

2. EQUIPMENT *(Tanks, hose, nozzles, etc.)*

3. ENGINES *(List numbers of those needing repair.)*

4. PERSONNEL *(Note sanitation, personal equipment.)*

REMARKS

TYPED OR PRINTED NAME AND GRADE	SIGNATURE

DA FORM 1715-R, FEB 85 EDITION OF JUN 61 IS OBSOLETE USAPPC V1.00

DAILY WATER ISSUE LOG

For use of this form, see FM 10-52-1; the proponent agency is TRADOC

WATER POINT NO.	NCO IN CHARGE	DATE

TIME	AMOUNT *(Gallons)*	PICKED UP BY *(Using Unit)*
	TOTAL	

REMARKS

WATER POINT DAILY PRODUCTION SUMMARY For use of this form, see FM 10-52; the proponent agency is TRADOC	DATE

PART I- ERDLATORS

TO	FROM *(Organization)*

WATER POINT NO.	HOURS OPERATION	PRODUCTION *(Gallons)*	GASOLINE *(Gallons)*	OIL *(Quarts)*	CHEMICALS USED			
					FERRIC CHLORIDE	LIMESTONE	CALCIUM HYPOCHLORITE	ACTIVATED CARBON
DAILY TOTAL								

TYPED OR PRINTED NAME AND GRADE	SIGNATURE

DA FORM 1716-R, FEB 85 EDITION OF JUN 61 IS OBSOLETE USAPPC V1.00

WATER POINT DAILY DISTRIBUTION SUMMARY

For use of this form, see FM 10-52; the proponent agency is TRADOC

DATE

TO

FROM (Organization)

CONSUMING UNITS	WATER POINTS								TOTAL	GAL. PER MAN

TYPED OR PRINTED NAME AND GRADE

SIGNATURE

DA FORM 1717-R, FEB 85 EDITION OF JUN 61 IS OBSOLETE USAPPC V1.00

DAILY WATER PRODUCTION LOG - ROWPU

For use of this form, see FM 10-52-1; the proponent agency is TRADOC

SHIFT NO.

PART I. HOURLY CHEMICAL DOSAGE LOG

WATER POINT NO./ROWPU NO.

NCO IN CHARGE

DATE

TIME		CITRIC ACID		SODIUM HEX		CHLORINE		POLYMER		pH		CHLORINE RESIDUAL (ppm)	REMARKS
ON	OFF	KNOB SETTING	CHARGE (Lb.)	KNOB SETTING	CHARGE (Lb.)	KNOB SETTING	CHARGE (Lb.)	KNOB SETTING	CHARGE (ml)	RAW	FIBERS		
Chemicals Used												SIGNATURE OF NCO IN CHARGE WHEN COMPLETED	
Chemicals On Hand													

DA FORM 1713-R, MAY 91 EDITION OF FEB 85 IS OBSOLETE USAPPC V1.00

DAILY WATER PRODUCTION LOG - ROW PU

For use of this form, see FM 10-52-1; the proponent agency is TRADOC

SHIFT NO.

PART I. HOURLY CHEMICAL DOSAGE LOG

WATER POINT NO./ROW PU NO.

NCO IN CHARGE

DATE

TIME		CITRIC ACID		SODIUM HEX		CHLORINE		POLYMER		pH		CHLORINE RESIDUAL (ppm)	REMARKS
ON	OFF	KNOB SETTING	CHARGE (Lb.)	KNOB SETTING	CHARGE (Lb.)	KNOB SETTING	CHARGE (Lb.)	KNOB SETTING	CHARGE (ml)	RAW	FIBERS		
Chemicals Used												SIGNATURE OF NCO IN CHARGE WHEN COMPLETED	
Chemicals On Hand													

DA FORM 1713-R, MAY 91 EDITION OF FEB 85 IS OBSOLETE USAPPC V1.00

HAZARDOUS WASTE PROFILE SHEET

PART 1

A. GENERAL INFORMATION

WASTE PROFILE NO. _____

1. GENERATOR NAME

2. FACILITY ADDRESS

3. GENERATOR USEPA ID

4. GENERATOR STATE ID

5. ZIP CODE

6. TECHNICAL CONTACT

7. TITLE

PHONE

8. 1. NAME OF WASTE _____
2. USEPA/or/STATE WASTE CODE(S) _____
3. PROCESS GENERATING WASTE _____
4. PROJECTED ANNUAL VOLUME/UNITS _____/_____ 5. MODE OF COLLECTION _____
6. IS THIS WASTE A DIOXIN LISTED WASTE AS DEFINED IN 40 CFR 261.31 (e.g., F020, F021, F022, F023, F026, F027, OR F028)? ☐ YES ☐ NO
7. IS THIS WASTE RESTRICTED FROM LAND DISPOSAL (40 CFR 268)? ☐ YES ☐ NO
   HAS AN EXEMPTION BEEN GRANTED? ☐ YES ☐ NO
   DOES THE WASTE MEET APPLICABLE TREATMENT STANDARDS? ☐ YES ☐ NO
   REFERENCE STANDARDS _____

PART II

1. MATERIAL CHARACTERIZATION
(OPTIONAL - NOT REQUIRED

COLOR _____

DENSITY _____ BTU/LB_____

_____

TOTAL SOLIDS _____ ASH CONTENT_____

LAYERING:

☐ MULTILAYERED ☐ BILAYERED ☐ SINGLE PHASE

RCRA CHARACTERISTICS

PHYSICAL STATE: ☐ SOLID ☐ LIQUID ☐ SEMI-SOLID
☐ GAS ☐ OTHER

TREATMENT GROUP: ☐ WASTEWATER ☐ NON-WASTEWATER

☐ IGNITABLE (D001) ☐ REACTIVE (D003)

☐ FLASHPOINT (F) _____ ☐ WATER REACTIVE

☐ HIGH TOC (>10%) ☐ CYANIDE REACTIVE

☐ LOW TOC (<10%) ☐ SULFIDE REACTIVE

☐ CORROSIVE (D002) ☐ TOXICITY CHARACTERISTICS
pH _____ (SEE REVERSE FOR LISTING)

☐ CORRODES STEEL

4. MATERIAL COMPOSITION

COMPONENT	CONCENTRATION	RANGE

TOTAL _____ 100%

5. SHIPPING INFORMATION

DOT HAZARDOUS MATERIAL ☐ YES ☐ NO

PROPER SHIPPING NAME _____

3. CHEMICAL COMPOSITION (ppm or mg/L)

COPPER _____ PHENOLICS_____

NICKEL _____ TOTAL HALOGENS _____

ZINC _____ VOLATILE ORGANICS _____

CHROMIUM: HEX _____ PCB: _____

(OTHER) _____

NOTE: EXPLOSIVES, SHOCK SENSITIVE, PYROPHORIC, RADIOACTIVE AND ETIOLOGICAL WASTE NORMALLY ARE NOT ACCEPTED BY THE DRMO

UN OR

HAZARD CLASS _____ N.A. NO _____

ADDITIONAL DESCRIPTION _____

METHOD OF SHIPMENT ☐ BULK ☐ DRUM ☐ OTHER

CERCLA REPORTABLE QUANTITY (RQ)_____

EMERGENCY RESPONSE GUIDE PAGE

DOT PUBLICATION 5800.4 PAGE NO _____ EDITION (YR) _____

SPECIAL HANDLING INFORMATION _____

6. GENERATOR CERTIFICATION

BASIS FOR INFORMATION

☐ CHEMICAL ANALYSIS (ATTACHED TEST RESULTS)

☐ USER KNOWLEDGE (ATTACHED SUPPORTING DOCUMENTS Explain how and why these documents comply with RCRA requirements) _____

I _____, HEREBY CERTIFY THAT ALL INFORMATION SUBMITTED IN THIS AND ALL ATTACHED DOCUMENTS IS TO THE BEST OF MY KNOWLEDGE AN ACCURATE REPRESENTATION OF THE WASTE TURNED IN TO THE DRMO. ALL KNOWN OR SUSPECTED HAZARDS HAVE BEEN DISCLOSED

SIGNATURE OF GENERATOR'S REPRESENTATIVE

DATE

DRMS FORM 1930

GENERIC SAMPLE ANALYSIS REQUEST FORM

REPORT WILL BE SENT TO	NAME OF COMPANY			REQUEST DATE	
	ADDRESS NUMBER STREET		CITY	STATE	ZIP CODE
	PHONE NUMBER	FAX NUMBER	CONTACT		
BILLING WILL BE SENT TO	NAME OF COMPANY			REQUEST DATE	
	ADDRESS NUMBER STREET		CITY	STATE	ZIP CODE
	PHONE NUMBER	CONTACT	PO NUMBER		
SAMPLING DATA	COLLECTOR'S NAME			PHONE NUMBER	
	NAME OF COMPANY, DISPOSAL SITE				
	ADDRESS NUMBER STREET	CITY		STATE	ZIP CODE

COLLECTOR'S SAMPLE NUMBER	LAB SAMPLE NUMBER	TYPE OF SAMPLE	DATE AND TIME OF SAMPLE	ANALYSIS REQUIRED

ADDITIONAL INFORMATION					
RESULTS	STANDARD	PLUS	DATE EXPECTED		
RECEIVED BY	SIGNATURE	TITLE	DATE	TIME	

INDUSTRIAL HYGIENE AIR SAMPLING DATA

OEHL Use

Mail Samples To: _____

ARMSTRONG LABORATORY

Occupational & Environmental Health Directorate
2402 E. Drive, Bldg 140
Brooks AFB, Texas 78235-5114
(210) 536-3626 DSN: 240-3626

☐ ROUTINE

☐ PRIORITY *(pre-arrange with analyst)*

☐ CHAIN OF CUSTODY

AUTHORIZATION NUMBER:

Sampling Site Identifier

BASE WHERE SAMPLE COLLECTED

DATE/TIME COLLECTED: _____ YY/MM/DD 24 HR

DATE/TIME RECEIVED: _____ YY/MM/DD 24 HR

SAMPLE SITE DESCRIPTION (BLDG, NUMBER/LOCATION/AREA)

SAMPLE COLLECTED BY (NAME, GRADE, AFSC)

SIGNATURE

DSN

MAIL REPORTS TO:
(USE ASSIGNED BASE CODE)

ORIGINAL
COPY 1
COPY 2

Reason Submitted: E
(F3 For Selection)

Store at _____ °C

Armstrong Lab PID:
(AL Use Only)

Manufacturer & Lot#:

ARMSTRONG LAB SAMPLE NUMBER:				
BASE SAMPLE NUMBER:				
Collection Media Code: *(One per sampling form)*				
A	Analyte			
	CAS Nbr.			
B	Analyte			
	CAS Nbr.			
C	Analyte			
	CAS Nbr.			
D	Analyte			
	CAS Nbr.			
E	Analyte			
	CAS Nbr.			
Vol. Sampled (L)				
Pump/Dosimeter #				

Description *(Name, NSN, Mil-Spec, etc.)*

☐ Supporting Bulk Sample Included ☐ MSDS Attached

REMARKS:

AF Form 2750

BULK/COMMERCIAL PRODUCT SAMPLING DATA

OEHL USE ONLY

Mail Samples To:

ARMSTRONG LABORATORY

Occupational & Environmental Health Directorate
2402 E. Drive, Bldg 140
Brooks AFB, Texas 78235-5114
(210) 536-3626 DSN: 240-3626

☐ ROUTINE
☐ PRIORITY *(pre-arrange with analyst)*
☐ CHAIN OF CUSTODY

AUTHORIZATION NUMBER:

SAMPLING SITE IDENTIFIER

BASE WHERE SAMPLE COLLECTED

DATE/TIME COLLECTED: AM

SAMPLE SITE DESCRIPTION (BLDG. NUMBER/LOCATION/AREA)

DATE/TIME RECEIVED: AM

SOURCE BEING SAMPLED

SAMPLE COLLECTED BY (NAME, GRADE, AFSC)

SIGNATURE DSN

EXISTING CONTROLS (Personal protective equipment, Engineering Admin.)

MAIL REPORTS TO: *(USE ASSIGNED BASE CODE)*

ORIGINAL
COPY 1
COPY 2

REASON SUBMITTED: (F3 FOR SELECTION) E

Armstrong Lab PID: *(AL Use Only)*

ARMSTRONG LAB SAMPLE NUMBER:			
BASE SAMPLE NUMBER:			
A	Method/Analyte (F3 FOR SELECTION)		
	CAS Nbr.		
B	Method/Analyte (F3 FOR SELECTION)		
	CAS Nbr.		
C	Method/Analyte (F3 FOR SELECTION)		
	CAS Nbr.		
D	Method/Analyte (F3 FOR SELECTION)		
	CAS Nbr.		
E	Method/Analyte (F3 FOR SELECTION)		
	CAS Nbr.		
Material Name			
Lot #			
NSN *(FSN)*			
Spec *(Mil or Fed)*			
Manufacturer			
Description of Material Usage and Nearby Industrial Processes			

REMARKS:

AF FORM 2751

INORGANICS ANALYSIS REQUEST FORM	OEHL USE ONLY:		

Mail Samples To: _____

ARMSTRONG LABORATORY
Occupational & Environmental Health Directorate/OEA
2402 E. Drive, Bldg 140
Brooks AFB, Texas 78235-5114
(210) 536-3626 DSN: 240-3626

REASON SUBMITTED (F3 FOR SELECTION)	E	IS SAMPLE FOR STATE DRINKING WATER COMPLIANCE UNDER PHASE II to V of the FSDWA? System Name: System Number:	

DATE/TIME COLLECTED: AM	AUTHORIZATION NUMBER:
DATE/TIME RECEIVED BY LAB: AM	
DATE ANALYSIS COMPLETED:	SAMPLING SITE IDENTIFIER
ON-SITE ANALYTICAL RESULTS	
WATER TEMPERATURE °C / pH units / COLLECTION METHOD ☐ GRAB ☐ COMPOSITE	BASE WHERE SAMPLE COLLECTED
HOW WAS THE SAMPLE PRESERVED? ☐ None: Grp G Only ☐ H_2SO_4: Grps A-C, E ☐ NaOH: Grp D Only ☐ Zinc Acetate: Grp J Only	SAMPLING SITE DESCRIPTION (BLDG. NUMBER/LOCATION/WELL #)
SAMPLE LOCATION: ☐ Source ☐ Pt of Entry ☐ Distribution ☐ Other: _____	SAMPLE COLLECTED BY (NAME, GRADE, AFSC)
WATER TREATMENT: ☐ Raw ☐ Chlorination ☐ Fluoridation ☐ Other: _____	SIGNATURE / DSN

MAIL REPORTS TO (CIRCLE IF CHANGED)		
	ORIGINAL	
	COPY 1	
	COPY 2	

BASE SAMPLE NUMBER		OEHL PID (AL/OEA USE ONLY)	

PARAMETER		PARAMETER	
GROUP A		**GROUP G**	
Chemical Oxygen Demand	mg/L	Acidity, Total	mg/L
Organic Carbon	mg/L	Alkalinity, Total	mg/L
		Alkalinity, Bicarbonate	mg/L
GROUP B		Bromide	mg/L
Oil & Grease	mg/L	Carbon Dioxide	mg/L
TPH	mg/L	Chloride	mg/L
		Color	Units
GROUP C		Fluoride	mg/L
Ammonia	mg/L	Residue, Total	mg/L
Kjeldahl Nitrogen	mg/L	Residue, Filterable (TDS)	mg/L
Nitrate	mg/L	Residue, Nonfilterable	mg/L
Nitrite	mg/L	Residue, Settleable	mg/L
Orthophosphate	mg/L	Residue, Volatile	mg/L
Phosphorus, Total	mg/L	Silica	mg/L
		Specific Conductance	Umhos
GROUP D		Sulfate	mg/L
Cyanide, Total	mg/L	Surfactans-MBAS	mg/L
Cyanide, Free	mg/L	Turbidity	Units
		Langlier Index	
GROUP E		PH	Units
Phenols	ug/L	**GROUP J**	
		Sulfides	mg/L

REMARKS:	CHEMIST:
	REVIEWED BY:
AF FORM 2752A	APPROVED BY:

ORGANICS ANALYSIS REQUEST FORM

OEHL Use Only:

Mail Samples To: _____

ARMSTRONG LABORATORY

Occupational & Environmental Health Directorate/OEA
2402 E. Drive, Bldg 140
Brooks AFB, Texas 78235-5114
(210) 536-3626 DSN: 240-3626

REASON SUBMITTED (F3 for Selection) **E**

IS SAMPLE FOR STATE DRINKING WATER COMPLIANCE UNDER PHASE II to V of the FSDWA? ☐

System Name: _____ **System Number:** _____

DATE/TIME COLLECTED: _____ YY/MM/DD _____ 24 Hr

DATE/TIME RECEIVED: _____ YY/MM/DD _____ 24 Hr

AUTHORIZATION NUMBER:

SAMPLING SITE IDENTIFIER

SAMPLE LOCATION: ☐ **SOURCE** ☐ **PT OF ENTRY** ☐ **DISTRIBUTION** ☐ **OTHER:** _____

BASE WHERE SAMPLE COLLECTED

WATER TREATMENT: ☐ **RAW** ☐ **CHLORINATION** ☐ **FLUORIDATION** ☐ **OTHER:** _____

SAMPLE SITE DESCRIPTION (BLDG, NUMBER/LOCATION/AREA)

HOW WAS THE SAMPLE PRESERVED? ☐ **UNPRESERVED** ☐ **SULFURIC ACID** ☐ **SODIUM HYDROXIDE** ☐ **NITRIC ACID** ☐ **SODIUM THIOSULFATE** ☐ **HYDROCHLORIC ACID**

SAMPLE COLLECTED BY (NAME, GRADE, AFSC)

COLLECTION METHOD ☐ **GRAB** ☐ **COMPOSITE**

SIGNATURE

DSN

MAIL REPORTS TO:

(USE ASSIGNED BASE CODE)

ORIGINAL

COPY 1

COPY 2

ARMSTRONG LAB SAMPLE NUMBER

Armstrong Lab PID: *(AL Use Only)*

BASE SAMPLE NUMBER:

EPA Method: (F3 for Selection) _____

Contaminants	Contaminants	Contaminants
1	21	41
2	22	42
3	23	43
4	24	44
5	25	45
6	26	46
7	27	47
8	28	48
9	29	49
10	30	50
11	31	51
12	32	52
13	33	53
14	34	54
15	35	55
16	36	56
17	37	57
18	38	58
19	39	59
20	40	60

REMARKS:

AF FORM 2752B

METALS ANALYSIS REQUEST FORM (GROUP F)	OEHL USE ONLY:	

Mail Samples To: _____

ARMSTRONG LABORATORY
Occupational & Environmental Health Directorate/OEA
2402 E. Drive, Bldg 140
Brooks AFB, Texas 78235-5114
(210) 536-3626 DSN: 240-3626

REASON SUBMITTED (F3 FOR SELECTION) E	IS SAMPLE FOR STATE DRINKING WATER COMPLIANCE UNDER PHASE II to V of the FSDWA? System Name: System Number:
DATE/TIME COLLECTED: AM	AUTHORIZATION NUMBER:
DATE/TIME RECEIVED BY LAB: AM	
DATE ANALYSIS COMPLETED:	SAMPLING SITE IDENTIFIER
ON-SITE ANALYTICAL RESULTS	
COLLECTION METHOD ☐ GRAB ☐ COMPOSITE	BASE WHERE SAMPLE COLLECTED
HOW WAS THE SAMPLE PRESERVED? ☐ Nitric Acid ☐ None: Chromium, Hexavalent Only (24 hrs HT)	SAMPLING SITE DESCRIPTION (BLDG. NUMBER/LOCATION/WELL #)
SAMPLE LOCATION: ☐ Source ☐ Pt of Entry ☐ Distribution ☐ Other: _____	SAMPLE COLLECTED BY (NAME, GRADE, AFSC)
WATER TREATMENT: ☐ Raw ☐ Chlorination ☐ Fluoridation ☐ Other: _____	SIGNATURE / DSN

MAIL REPORTS TO (CIRCLE IF CHANGED)		
	ORIGINAL	
	COPY 1	
	COPY 2	

BASE SAMPLE NUMBER		OEHL PID (AL/OEA USE ONLY)	

PARAMETER	GROUP F		ADDITIONALLY FOR WASTEWATER METALS CHOOSE FROM THE FOLLOWING SET OF ANAYLYTES	
	Antimony	mg/L	Aluminum	mg/L
	Arsenic	mg/L	Boron	mg/L
	Barium	mg/L	Calcium	mg/L
	Beryllium	mg/L	Cobalt	mg/L
	Cadmium	mg/L	Iron	mg/L
	Chromium	mg/L	Magnesium	mg/L
	Chromium, hexavalent	mg/L	Manganese	mg/L
	Copper	mg/L	Molybdenium	mg/L
	Lead	mg/L	Potassium	mg/L
	Mercury	mg/L	Silver	mg/L
	Nickel	mg/L	Vanadium	mg/L
	Selenium	mg/L	Zinc	mg/L
	Sodium	mg/L		
	Thallium	mg/L		
		mg/L		
		mg/L		

REMARKS:	CHEMIST:
	REVIEWED BY:
AF FORM 2752C	APPROVED BY:

SAMPLE LABEL

Collector:
Sample Number:
Place of Collection:
Date Sampled:
Time Sampled:
Field Information:

Chain-Of-Custody Form

PROJECT NO.	PROJECT NAME					NO. OF CONTAINERS	PARAMETERS							INDUSTRIAL HYGIENE SAMPLE	Y / N
SAMPLER *(Signature)*					*(Printed name)*										
FIELD SAMPLE NUMBER	DATE	TIME	COMP.	GRAB	STATION LOCATION									REMARKS	

Relinquished by: *(Signature)*	DATE/TIME	Received by: *(Signature)*	Relinquished by: *(Signature)*	DATE/TIME	Received by: *(Signature)*	DATE/TIME
(Printed name)		*(Printed name)*	*(Printed name)*		*(Printed name)*	

Relinquished by: *(Signature)*	DATE/TIME	Received for laboratory by: *(Signature)*	DATE/TIME	Remarks
(Printed name)		*(Printed name)*		

WATER RECONNAISSANCE REPORT For use of this form, see FM 10-52-1; the proponent agency is TRADOC	DATE	TIME OF RECONNAISSANCE

REPORTED BY *(Name, grade, organization)*

FORWARDED TO *(Name and Organization)*

MAP COORDINATES OF WATER SOURCE

1. Quality-Quantity

TYPE OF SOURCE	TDS	TEMPERATURE
TURBIDITY *(Estimate)*	pH TEST	QUANTITY

2. Site Conditions

SECURITY

DRAINAGE-SOIL TYPE

TERRAIN

BIVOUAC

DISTANCE TO CONSUMERS	ROADS

2. SKETCH OF AREA *(Show road net and traffic circulation.) (Use reverse side for additional sketches, if necessary.)*

Appendix D - Acronyms

ACRONYMS

2-PAM Cl	pralidoxime chloride
AC	Hydrogen Cyanide
ACGIH	American Conference of Governmental Industrial Hygienists
AFI	Air Force Instruction
AFOSH	Air Force Occupational Safety and Health
AFPAM	Air Force Pamphlet
AH	anhydrous hydrazine
ALAD	Automatic Liquid Agent Detector
ALI	Annual Limit of Intake
anti-C	anti contamination
API	Armor Piercing/Incendiary
ASTM	American Society of Test Methods
atm	atmospheres
ATSDR	Agency for Toxic Substances and Disease Registry
atto	Standard metric prefix for the factor 10^{-18} ; Standard symbol is a
AWS	Air Weather Service
BDU	battle dress uniform
BES	Bioenvironmental Engineering Services
BIDS	Biological Integrated Detection System
BOD	Biochemical Oxygen Demand
BTU	British Thermal Unit
BW	biological warfare
BZ	3-quinuclidinyl benzilate
C4I	command, control, communications, computers, and intelligence
CAD	Chemical Agent Detector
CAM	Chemical Agent Monitor
CAS	Chemical Abstract Service
CCA	Contamination Control Area
CCT	Contamination Control Teams
CDC	Center for Disease Control
centi	Standard metric prefix for the factor 10^{-2} ; Standard symbol is c
CFD	coded field duplicate
cfm	cubic feet per minute
CFR	Code of Federal regulations
CG	Phosgene
cGy	centiGray
CK	Cyanogen Chloride
CN	Chloracetophenone
COD	chemical oxygen demand
CP	command post
cpm	counts per minute.
CPR	cardiopulmonary resuscitation
CR	Dibenzoxazepine
CS	Orthochlorobenzylidene-malononitrile
CSA	Chlorosulphonic acid fog
Ct	concentration time
CW	chemical warfare
CX	Halogenated Oxime-Phosgene oxime
DA	diphenylchlorarsine
DAC	derived air concentration
DC	diphenylcyanarsine .
DCG	disaster control group
DE	diatomaceous earth

ACRONYMS

deci	Standard metric prefix for the factor 10^{-1} ; Standard symbol is d
decon	decontamination
deka	Standard metric prefix for the factor 10^{1} ; Standard symbol is da
DLA	Defense Logistics Agency
DO	dissolved oxygen
DOT	Department of Transportation
DP	Diphosgene
dpm/m^3	disintegrations per minute per cubic meter
DPST	Disaster Preparedness Support Team
DRF	disaster response force
DRMO	Defense Reutilization and Marketing Office
DRMS	Defense Reutilization and Marketing Service
DS2	decontaminating standard number 2
DU	depleted Uranium
DWTP	domestic wastewater treatment plant
EMP	electromagnetic pulse
EOD	explosive ordnance disposal
EPA	Environmental Protection Agency
EPU	emergency power unit
ETO	ethylene oxide
exa	Standard metric prefix for the factor 10^{18} ; Standard symbol is E
FAC	free available chlorine
FAWPSS	Forward Area Water Point Supply System
FC	fecal coliform
FD	Field Duplicate
femto	Standard metric prefix for the factor 10^{-15} ; Standard symbol is f
FGS	foreign governing standard
FM	Titanium Tetrachloride cloud
GA	Tabun
GB	Sarin
GCE	ground crew ensemble
GD	Soman
giga	Standard metric prefix for the factor 10^{9} ; Standard symbol is G
G-M	Geiger-Mueller
GMW	gram molecular weight
gph	gallon per hour
GVO	green vinyl overboots
Gy	Gray
H-70	mixture of 70 percent hydrazine and 30 percent water
HC	Zinc Chloride smoke
HD	Sulfur Mustard gas
HE	high explosive
hecto	Standard metric prefix for the factor 10^{2} ; Standard symbol is h
HEPA	high efficiency particulate air filter
HN	Nitrogen Mustard gas
HPC	heterotrophic plate count
HTH	high-test hypochlorite
HW	hazardous waste
HWMP	Hazardous Waste Management Plan
HWPS	hazardous waste profile sheet
IATA	International Air Transport Association
IAW	in accordance with
IBADS	Interim Biological Agent Detection System
ICAM	Improved Chemical Agent Monitor

ACRONYMS

ICt_{50}	incapacitating concentration time 50
ID_{50}	incapacitating dose 50
ISO	International Organization for Standardization
IWTP	industrial wastewater treatment plant
JCAD	Joint Chemical Agent Detector
JCS	Joint Chief of Staff
JS-LIST	Joint Service Lightweight Integrated Suit Technology
kilo	Standard metric prefix for the factor 10^3 ; Standard symbol is k
KN	known positive
Kt	kilotons
kW	Kilowatt
L	Lewisite
LCt_{50}	lethal concentration time 50
LD_{50}	lethal dose 50
LNBCRS	Light NBC Reconnaissance System
LSCAD	Lightweight Standoff Chemical Agent Detector
LSD	D-lysergic acid diethylamide
MACP	Mortuary Affairs Collection Point
MADCP	Mortuary Affairs Decontamination Collection Point
MAP	Management Action Plan
MCC	Medical Control Center
MEA	Monothanolamine
mega	Standard metric prefix for the factor 10^6 ; Standard symbol is M
micro	Standard metric prefix for the factor 10^{-6} ; Standard symbol is μ
$\mu Ci/m^2$	micro Curies per square meter
$\mu g/m^2$	microgram per square meter
milli	Standard metric prefix for the factor 10^{-3} ; Standard symbol is m
MMH	methylhydrazine
mmHg	millimeters of mercury
MOPP	mission oriented protection posture
mR/hr	milli roentgens per hour
MREs	meals ready to eat
MS/MSD	matrix spike/matrix spike duplicate
MSDS	material safety data Sheet
NA	nerve agents
nano	Standard metric prefix for the factor 10^{-9} ; Standard symbol is n
NAPP	nerve agent pyridostigmine pretreatment
NASA	National Aeronautics Space Administration(
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological, and Chemical
NCFD	Non-Coded Field Duplicate
NRC	Nuclear Regulatory Commission
NSN	National Stock Number
OELs	occupational exposure limits
OP	Organophospate
OSC	On Scene Commander
OSHA	Occupational Safety and Health Agency
PAM Team	Preventive Aerospace Maintenance Team
PCB	Polychlorinated Biphenyl
PELs	Permissible Exposure Limits
peta	Standard metric prefix for the factor 10^{15} ; Standard symbol is P
pico	Standard metric prefix for the factor 10^{-12} ; Standard symbol is p
POC	point of contact

ACRONYMS

PPE	personal protective equipment
ppm	parts Per Million
psi	pounds per square inch
PWS/DS	Potable Water Storage and Distribution System
QA	quality Assurance
QC	quality Control
QSTAG	Quadripartite Standardization Agreement
R/hr	rads per hour
rad	radiation absorbed dose
RADIAC	radiation detection, measurement, and computation
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
ROWPU	Reverse Osmosis Water Purification Unit
RP	red phosphorus
SCBA	self-contained breathing apparatus
SEB	staphylococcal enterotoxin
SID	skin irritant decontaminant
SMFT	Semitrailer-Mounted Fabric Tank
SPEL	short term public emergency limit
SSN	social security number
STANAG	Standardization Agreement
STB	super tropical bleach
STELs	short-term exposure limits
TCL	Toxic Corridor Length
TCL	toxic corridor length
TCLP	Toxic Characteristic Leaching Procedure
tera	Standard metric prefix for the factor 10^{12} ; Standard symbol is T
TH	thermite
TLV	Threshold Limit Values
TMEP	Theater Mortuary Evacuation Point
TOC	Total Organic Carbon
TWA	time-weighted average
UDMH	dimethylhydrazine unsymmetrical
UXO	unexploded ordnance
Vp	Vapor Pressure
WBGT	wet-bulb globe temperature

Appendix E - UTCs

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