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COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES TABLE AS OF SEPTEMBER 1997

Cheri Bandy Foust
Energy Division
Oak Ridge National Laboratory

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COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES TABLE AS OF SEPTEMBER 1997

Cheri Bandy Foust
Oak Ridge National Laboratory

August 1998

Prepared for the

Federal Emergency Management Agency
Regulatory Service Coordination Unit

and

U.S. Army Center for Health Promotion and Preventive Medicine

by

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PREFACE

The perceived lack of applicable chemical agent guidelines, standards, interim standards, and control limits, has been an area of concern within the Chemical Stockpile Emergency Preparedness Program (CSEPP) planning community for some time. Despite the fact that there are a number of established concentration values, the appropriate uses of those values are not well documented, limiting their benefit to CSEPP.

The Oak Ridge National Laboratory (ORNL) in collaboration with the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), was tasked by the Federal Emergency Management Agency (FEMA) with identifying published chemical warfare agent guidelines, standards, interim standards, and control limits, and compiling that material along with information regarding their appropriate uses within the CSEPP, into a reference document. This document provides references, but does not provide the data and assumptions on which the exposure guidelines were based, or comment on the rationale or appropriateness of the given values. To do so is beyond the scope of work for this task. The Army accepts the accuracy of this version of the document as per its defined purpose. However, the Army has established a Work Group to assess the accuracy of the information contained in the source references. As information is clarified/modified, future versions of the document will be updated to reflect any necessary changes.

ACKNOWLEDGMENTS

The Oak Ridge National Laboratory (ORNL) Energy Division gratefully acknowledges contributions to this document from a number of individuals. ORNL wishes to acknowledge the valuable assistance and guidance received from Veronique Hauschild (Environmental Risk Assessment and Communication) and Jennifer Lindado Keetley (Hazardous and Medical Waste Program) of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). ORNL wishes to thank William J. B. Pringle (Environmental and Monitoring Office) and Dr. J. Richard Ward (Alternative Technologies and Approaches) of the U.S. Army Manager for Chemical Demilitarization Office; and other Army organizations for serving as reviewers. ORNL is also indebted to Dr. Annetta Watson (Life Sciences) of ORNL for serving as reviewer and providing technical guidance. Karen Bowman (Energy Division) of ORNL deserves thanks for her able editorial work and competent handling of a difficult assignment.

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ACRONYMS AND ABBREVIATIONS

C	celsius
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
ChE	cholinesterase
COT	Committee on Toxicology
CSEPP	Chemical Stockpile Emergency Preparedness Program
DA	U.S. Department of the Army
DHHS	U.S. Department of Health and Human Services
EPA	Environmental Protection Agency
F	fahrenheit
FEMA	Federal Emergency Management Agency
FR	*Federal Register*
GA	the chemical dimethylphosphoramidocyanidate
GB	the chemical isopropyl methylphosphonofluoridate
GD	the chemical phosphonofluoridic acid, methyl-1,2,2-trimethypropyl ester
H	the chemical levinstein mustard; mixture of 70% bis(2-chloroethyl) sulfide and 30% sulfur impurities produced by unstable levinstein process.
HD	levinstein mustard of bis(2-chloroethyl) sulfide
HT	a mixture of HD and bis(2-chloroethylthioethyl ether
IDLH	immediately dangerous to life or health
L	the chemical dichloro (2-chlorovinyl) arsine
L/day	liter per day
LD_{01}	calculated dose that is expected to cause death in 1% of the exposed population
m^3	cubic meter
μg/kg/day	microgram chemical per kilogram body weight per day
μg/L	microgram per liter
mg	milligram
mg/kg/day	milligram chemical per kilogram body weight per day
mg/m^3	milligram per cubic meter of air
$mg\text{-}min/m^3$	milligram minutes per cubic meter of air
min	minute
PPE	personal protective equipment
RAGS	Risk Assessment Guidance for Superfund
RBC-ChE	red blood cell cholinesterase
RfCs	reference concentrations
RfDs	reference doses
SCBA	self-contained breathing apparatus
TWA	time weighted average
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
VX	the chemical phosphonothioic acid, methyl-, S-(2-bis(1-methylethyl)amino)ethyl)0-ethylester

1. PURPOSE AND BACKGROUND

Public Law 99-145 requires the U.S. Department of the Army to dispose of the lethal chemical agents and munitions stockpile stored at eight Army installations throughout the continental United States and Johnston Atoll in the Pacific. Recognition by the U.S. Army that a potential threat to the public from continued storage was greater than the threat from transportation and demilitarization of chemical agents gave rise to the Chemical Stockpile Emergency Preparedness Program (CSEPP). CSEPP is a community emergency preparedness program complementing the Department of Defense's initiative to destroy domestic stockpiles of aged chemical warfare agent munitions. The Federal Emergency Management Agency (FEMA) and the U.S. Army jointly coordinate and direct the CSEPP. The *Compilation of Existing Chemical Agent Guidelines Table* was developed under the direction of FEMA and the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM).

The purpose of this Table is to identify established chemical warfare agent guidelines, standards, and interim standards as of September 1997, and place them in an explanatory context for ready use by the CSEPP community. This Table summarizes and organizes information from numerous agencies and review bodies responsible for recommending exposure guidelines [e.g., The Centers for Disease Control and Prevention (CDC), Committee on Toxicology (COT), Environmental Protection Agency (EPA), FEMA, Army and other federal agencies]. This Table provides references for the interested reader, but does not provide data and assumptions on which exposure guidelines were based, or comment on the rationale or appropriateness of the given values. To do so is beyond the scope of work for this task.

This Table provides a comprehensive list of military and civilian chemical agent guidelines, standards, interim standards, and control limits relevant to CSEPP (Table category definitions below). This Table was developed to assist CSEPP state, local, and Army installation planners in formulating and coordinating plans for chemical agent events that may occur at the eight chemical agent stockpile storage locations in the continental United States.

This Table is a "living document." The Table developers recommend it be periodically updated to reflect new or revised guidelines, standards, interim standards, and control limits. Some guidelines (standards, interim standards, etc.,) are continually under review as more information is acquired and as technology advances detection capabilities. Please contact Karen Cleveland of FEMA [(202) 646-3970 or karen.cleveland@fema.gov] for future editions, questions, etc. This Table was compiled by Cheri Bandy Foust of the Oak Ridge National Laboratory at the request of FEMA in collaboration with Veronique Hauschild and Jennifer Lindado Keetley of USACHPPM [(410) 671-5213 or Veronique_Hauschild@chppm-ccmail.apgea.army.mil]. For more information on each Table entry, please see Appendix A.

Control Limit. A recommendation for protecting human health from adverse effects of exposure to chemical agents. A measure established by the CDC (DHHS); compliance is not mandatory.

Guideline. A recommendation from a review body (e.g., Committee on Toxicology) providing guidance and information for use in establishing acceptable conduct or policy that does not endanger public and/or environmental health. A guideline is not a mandatory requirement.

Military Guideline. A recommendation from a military authority providing guidance and information for use in establishing acceptable military conduct or policy. A guideline is not a mandatory requirement.

Interim Military Standard. A measure established by a military authority to serve as a temporary standard until final requirements are approved and adopted; compliance is usually mandatory.

Military Standard. A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.

AIRBORNE EXPOSURE LIMITS

Category	Title (References footnoted; see page 22)	Information	Comments
Control Limit	*CONTROL LIMITS FOR CHEMICAL AGENTS FOR WORKERS IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).*[a] *Application: These limits are designed to protect the worker from unsafe concentrations of chemical agent in the work environment. Workers can be exposed to concentrations at or below these levels for 8 hours a day without suffering ill effects. The CDC concludes there to be little risk either of adverse health effects from long-term exposure to low doses or of delayed health effects from acute exposure.*	***Agent*** ***Workers*** *GA, GB* 1×10^{-4} *mg/m³* *VX* 1×10^{-5} *mg/m³* *H, HD, HT* 3×10^{-3} *mg/m³* *L* 3×10^{-3} *mg/m³* *Averaging time:* *8 hr time weighted average (TWA)*	*The CDC stated in their Final Recommendations for Protecting Human Health and Safety Against Potential Adverse Effects of Long-Term Exposure to Low Doses of Agents GA, GB, GD, VX, Mustard Agents (H, HD, HT) and Lewisite (L), that citizens near military depots where chemical weapons are stored expressed concerns about the potential for delayed effects of acute exposure and about the potential health effects of long-term exposure to low doses of agents. Low dose means an airborne concentration of agent below the control limits.* *The CDC concludes human health will be adequately protected from exposure to GA, GB, and VX vapor at the concentrations listed. Even long-term exposure to these concentrations would not create any adverse health effects. The CDC concludes the work place limits for mustard agent appear to provide adequate protection for workers during the limited time of potential exposure prior to disposal of these lethal agents.* *HT is measured as HD.* *See military standard, military airborne exposure limits for unmasked chemical agent workers. These CDC values have been incorporated by the military. The military added standards for GD.*

Control Limit. A recommendation for protecting human health from adverse effects of exposure to chemical agents. A measure established by the CDC (DHHS); compliance is not mandatory.

Category	Title (References footnoted; see page 22)	Information	Comments
AIRBORNE EXPOSURE LIMITS (continued)			
Control Limit	*CONTROL LIMITS FOR CHEMICAL AGENTS FOR THE GENERAL POPULATION IN mg/m³.[a]* *Application: These limits are designed to protect the general population (including children and elderly) from long-term exposure to low doses of chemical agent. The general population may be exposed to concentrations at or below these levels without suffering effects. The CDC concludes there to be little risk either of adverse health effects from long-term exposure to low doses or of delayed health effects from acute exposure.*	***Agent*** ***General population*** *GA, GB* 3×10^{-6} mg/m³ *VX* 3×10^{-6} mg/m³ *H, HD, HT* 1×10^{-4} mg/m³ *L* 3×10^{-3} mg/m³ *Averaging time:* *72 hr time weighted average (TWA)*	*The CDC stated in their Final Recommendations for Protecting Human Health and Safety Against Potential Adverse Effects of Long-Term Exposure to Low Doses of Agents GA, GB, GD, VX, Mustard Agents (H, HD, HT) and Lewisite (L), that citizens near military depots where chemical weapons are stored expressed concerns about the potential for delayed effects of acute exposure and about the potential health effects of long-term exposure to low doses of agents. Low dose means an airborne concentration of agent below the control limits.* *The CDC concludes human health will be adequately protected from exposure to GA, GB, and VX vapor at the concentrations listed. Even long-term exposure to these concentrations would not create any adverse health effects. The CDC concludes control of stack emissions and the work place air in accordance with the limits for mustard agent will amply protect the general population 1000 meters or more from a demilitarization site.* *HT is measured as HD.* *See military standard, military airborne exposure limits for non-agent workers and general population. The CDC values have been incorporated by the military. The military added standards for GD.*

Control Limit. A recommendation for protecting human health from adverse effects of exposure to chemical agents. A measure established by the CDC (DHHS): compliance is not mandatory.

Category	Title (References footnoted; see page 22)	Information	Comments
AIRBORNE EXPOSURE LIMITS (continued)			
Control Limit	*ALLOWABLE STACK CONCENTRATIONS IN mg/m³ FOR CHEMICAL AGENTS.*[a] *Application: To restrict incinerator emissions to concentrations well below those that would endanger public health.*	***Agent*** ***General population*** *GA, GB* 3×10^{-4} *mg/m³* *VX* 3×10^{-4} *mg/m³* *H, HD, HT* 3×10^{-2} *mg/m³* *L* 3×10^{-2} *mg/m³* *HT is measured as HD.*	*Usually allowable stack concentrations prove more restrictive than a limit set on health bases alone. These levels have been evaluated through air dispersion modeling of worst case credible events and conditions specific to each site to ensure that the control limits for general population and workers would not be exceeded as a consequence of releases at or below the allowable stack concentrations.* *These limits are primarily an engineering control limit. These limits should be attainable by a well-designed, well-operated incineration facility; give an early indication of upset conditions; and be accurately measurable in a timely manner.*
Control Limit. A recommendation for protecting human health from adverse effects of exposure to chemical agents. A measure established by the CDC (DHHS); compliance is not mandatory.			
Military Standard	***MILITARY IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH).***[b c] ***Application: To indicate to military personnel the levels at which a self-contained breathing apparatus (SCBAs) or supplied air respirators are required.***	***Agent*** ***Concentration*** ***GA, GB*** ***0.2 mg/m³*** ***GD*** ***0.06 mg/m³*** ***VX*** ***0.02 mg/m³*** ****HD/L IDLH values not formally established since workers will already be required to wear SCBAs or supplied air respirators at concentrations over 0.003 mg/m³ (or 3 x 10^{-3} mg/m³) due to concerns over carcinogenicity.***	***These values were established by the Army Surgeon General for military personnel solely for the purpose of establishing the concentrations at which SCBAs or supplied air respirators are required.***
Military Standard. A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.			

Category	Title (References footnoted; see page 22)	Information	Comments
AIRBORNE EXPOSURE LIMITS (continued)			
Control Limit	*RECOMMENDED ACUTE THRESHOLD EFFECTS LEVELS FOR DETERMINING EMERGENCY EVACUATION DISTANCES IN THE CSEP PROGRAM IN MILLIGRAM MINUTES PER CUBIC METER OF AIR (mg-min/m³).*[d] *Application: A cumulative exposure that indicates the point at which civilians are to be evacuated in the event of a CSEPP chemical agent release.* *See military standard, military no significant effects dosage. CSEPP incorporated the military's values after review by the CDC.*	***Agent*** / ***Acute threshold effects level mg-min/m³*** *H, HD, HT* — *2.0* *L* — *2.0* *GB* — *0.5* *VX* — *0.4*	*These values will be used with the Army's D2PC air dispersion model for planning the evacuation of civilians in the event of a CSEPP chemical agent release.* *The CDC feels these values are protective of public health and safety. Human exposure to the acute threshold effects doses of GB and VX is actually at a lowest-observed-effect-level and could be exceeded without danger. Significant adverse effects would not be expected before considerably higher doses had been absorbed.*

Control Limit. A recommendation for protecting human health from adverse effects of exposure to chemical agents. A measure established by the CDC (DHHS); compliance is not mandatory.

Category	Title (References footnoted; see page 22)	Information	Comments
AIRBORNE EXPOSURE LIMITS (continued)			
Interim Military Standard	**PROPOSED CHRONIC REFERENCE CONCENTRATION (RfCs).[e]** **Application: The RfC can be used to calculate safe concentrations where persons may be at risk by inhalation of low levels of chemical agents over extended periods of time (i.e., chronic exposures).**	**These are currently being developed by USACHPPM. USACHPPM is coordinating this effort with the CDC.**	**The RfC is translated into acceptable media concentration levels by incorporating site-specific exposure assumptions (exposure factors). These exposure factors include information such as exposure frequency, exposure duration, estimated amount of contaminated material inhaled, inhalation rate, and body weight. These site-specific variables and the RfC will be incorporated into a health risk assessment according to USEPA-approved methodology and calculations.** **RfCs are similar to reference doses (RfDs). RfCs are applicable for airborne exposures (i.e., inhalation, or to breathe in) and RfDs are applicable for ingestion exposures (i.e., taken into the body by way of the digestive tract).**
Interim Military Standard. A measure established by a military authority to serve as a temporary standard until final requirements are approved and adopted; compliance is usually mandatory.			

Category	Title (References footnoted; see page 22)	Information	Comments
AIRBORNE EXPOSURE LIMITS (continued)			
Military Standard	*MILITARY NO SIGNIFICANT EFFECTS DOSAGE IN mg-min/m³.[c]* *Application: The lowest exposure which does not produce significant effects in the general population (to include more susceptible sub populations) in the event of a military chemical agent release. CSEPP incorporated the military's values as the CSEPP acute threshold effects level, however, CSEPP levels did not include a VX inhalation-deposition limit.*	*Agent* — *No significant effects dosage* *L/Mustard* — *2.0 mg-min/m³* *GB* — *0.5 mg-min/m³* *VX Vapor* — *0.4 mg-min/m³* *VX Inhalation-Deposition* — *0.011 mg/man*	*A vapor concentration which indicates the need to evacuate the general population in the event of a military chemical agent release.* *The military no significant effects dosage is that dose at which the general population would not experience permanent effects.*
Military Standard	*MILITARY AIRBORNE EXPOSURE LIMITS FOR UNMASKED CHEMICAL AGENT WORKERS IN mg/m³.[b]* *Application: To limit the concentration of airborne chemical agent in order to protect the health and safety of the worker.* *These limits are designed to protect the worker from unsafe concentrations of chemical agent in the work environment by establishing a limit above which respiratory protection is required. Workers can be exposed to concentrations at or below these levels for 8 hours a day, 40 hours a week, day after day, without known adverse health effects.*	*Agent* — *Workers* *GA/GB* — *.0001 mg/m³* *GD* — *.00003 mg/m³* *VX* — *.00001 mg/m³* *H, HD, HT** — *.003 mg/m³* *L* — *.003 mg/m³* *Averaging time:* — *8 hr time weighted average (TWA)* **All concentrations measured as L.*	*If these limits are exceeded, respiratory protection is required.* *The CDC's control limits for chemical agents for workers have been incorporated by the military. The military added standards for GD.*
Military Standard. A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.			

<table>
<tr><th>Category</th><th>Title
(References footnoted; see page 22)</th><th>Information</th><th>Comments</th></tr>
<tr><td colspan="4">AIRBORNE EXPOSURE LIMITS (continued)</td></tr>
<tr>
<td>Military Standard</td>
<td>MILITARY AIRBORNE EXPOSURE LIMITS FOR NON-AGENT WORKER AND GENERAL POPULATION IN mg/m³.[b]

Application: To limit the concentration of airborne chemical agent in order to protect the health and safety of the non-agent worker and the general population.

These limits are designed to protect the general population (including children and elderly) from low levels of chemical agent that may be present in the environment. Individuals may be exposed to concentrations at or below these levels without suffering adverse effects.</td>
<td>
<table>
<tr><th>Agent</th><th>Non-agent worker and general population</th><th>Non-agent worker and general population</th></tr>
<tr><td>GA/GB</td><td>.000003 mg/m³</td><td>.0001 mg/m³</td></tr>
<tr><td>GD</td><td>.000003 mg/m³</td><td>.00003 mg/m³</td></tr>
<tr><td>VX</td><td>.000003 mg/m³</td><td>.00001 mg/m³</td></tr>
<tr><td>H, HD, HT*</td><td>.0001 mg/m³</td><td>.003 mg/m³**</td></tr>
<tr><td>L</td><td>.003 mg/m³</td><td>.003 mg/m³</td></tr>
<tr><td>Averaging time:</td><td>72 hr time weighted average (TWA)</td><td>***Ceiling value</td></tr>
</table>
*HT is measured as HD.
**All concentrations measured as L.
***Ceiling value normally refers to the maximum exposure concentration at any time, for any duration.
</td>
<td>The military incorporated the CDC's control limits for chemical agents for the general population. The military added standards for GD.

These limits are concentrations which may reach unprotected people who are not occupationally exposed and which are not expected to cause adverse health or environmental effects.</td>
</tr>
<tr><td colspan="4">Military Standard. A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.</td></tr>
</table>

Category	Title (References footnoted; see page 22)	Information	Comments
AIRBORNE EXPOSURE LIMITS (continued)			
Military Standard	*MILITARY SOURCE STACK EMISSION LIMITS IN mg/m³.*[b] *Application: To restrict incinerator emissions to concentrations well below those that would endanger health.*	*Agent* — *General population* *GA/GB* — *.0003 mg/m³* *GD* — *.0001 mg/m³* *VX* — *.0003 mg/m³* *H, HD, HT* — *.03 mg/m³* *L* — *.03 mg/m³* *The CDC's control limits for stack emissions are the same as these limits, except that the CDC did not publish a value for GD.*	*Usually allowable stack concentrations prove more restrictive than a limit set on health bases alone. These levels have been evaluated through air dispersion modeling of worst case credible events and conditions specific to each site to ensure that the control limits for general population and workers would not be exceeded as a consequence of releases at or below the allowable stack concentrations.* *These limits are primarily an engineering standard. These limits should be attainable by a well-designed, well-operated incineration facility; give an early indication of upset conditions; and be accurately measurable in a timely manner.*
Military Standard	*MILITARY NO EFFECTS CONCENTRATIONS FOR CHEMICAL AGENTS GA, GB, GD, AND VX IN mg/m³.*[b] *Application: To ensure the protection of non-related military personnel. These concentrations are used in modeling algorithms to calculate hazard zones to determine areas of concern when, by the nature of operations, a release of agent is expected (such as in the case of emergency destruction, training, or maintenance operations).*	*Agent* — *Workers* *GA/GB* — *.000003 mg/m³* *GD* — *.000003 mg/m³* *VX* — *.000003 mg/m³*	*The CSEPP acute threshold effects levels and the military no significant effects levels are concentrations which indicate the need to evacuate the general population in the event of a military or CSEPP chemical agent release. The military no effects concentrations are used by the military to calculate hazard zones within the military installation boundaries.*

Military Standard. A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.

Category	Title (References footnoted; see page 22)	Information	Comments
		INGESTION EXPOSURE LIMITS	
Interim Military Standard	**PROPOSED CHRONIC REFERENCE DOSES (RfDs) IN MILLIGRAM CHEMICAL PER KILOGRAM BODY WEIGHT PER DAY (mg/kg/day).[e]** **Application: The RfD can be used to calculate safe drinking water levels, soil clean-up levels, safe food contaminant levels and other safe media-specific concentrations where persons may be at risk by ingestion of low levels of chemical agent contaminated media over extended periods of time (i.e., chronic exposures).** **Proposed RfDs are currently undergoing review by the Committee on Toxicology. The proposed RfDs are for human exposures.**	**Agent — Proposed reference dose RfD (mg/kg/day) — Other comments** **HD (Sulfur Mustard — 7E-06 (0.000007) — HD is also a known human carcinogen: proposed Oral Slope Factor = 0.095 (μg/L)$^{-1}$ proposed Inhalation Unit Risk = 8.5E-02 (μg/m^3)$^{-1}$** **Lewisite — 1E-04 (0.0001)** **GA (Nerve) — 4E-05 (0.00004)** **GB (Nerve) — 2E-05 (0.00002)** **GD (Nerve) — 4E-06 (0.000004)** **VX (Nerve) — 6E-07 (0.0000006)** **Refer to EPA's *Risk Assessment Guidance for Superfund (RAGS), 1989* for application of these numbers or contact the USACHPPM office indicated.[f]** **Environmental Risk Assessment and Communication** **U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM)** **Aberdeen Proving Ground, Maryland** **(410) 671-2953**	**The RfD is translated into acceptable media concentration levels by incorporating site-specific exposure assumptions (exposure factors). These exposure factors include information such as exposure frequency, exposure duration, estimated amount of contaminated soil/water/specific food ingested, ingestion rate, and body weight. These site-specific variables and the RfD will be incorporated into a health risk assessment according to USEPA- approved methodology and calculations. USACHPPM is currently developing a matrix of exposure factors that can be used to assess various types of exposure scenarios. For more information on reference doses and applications, please see the USACHPPM *Just the Facts Information Sheet* included as Appendix B to this information packet.**
Interim Military Standard. A measure established by a military authority to serve as a temporary standard until final requirements are approved and adopted; compliance is usually mandatory.			

Category	Title (References footnoted; see page 22)	Information	Comments
INGESTION EXPOSURE LIMITS (continued)			
	MILITARY FIELD DRINKING WATER LIMITS		
Military Guideline	Recommended field drinking water guidelines for selected chemical warfare agents in field drinking water in micrograms per liter (μg/L)/liters per day (L/day).[9] Application: A battlefield drinking water concentration which will protect military personnel against acute adverse health effects or performance-degrading effects for exposures of up to 7 days.	Recommended guidelines Agent / 5 L/day / 15 L/day GA (μg/L) 70.0 22.5 GB (μg/L) 13.8 4.6 GD (μg/L) 6.0 2.0 VX (μg/L) 7.5 2.5 Sulfur Mustard (μg/L) 140.0 47.0 L 80.0 27.0	This guideline was developed by the Committee on Toxicology for military personnel deployed in the battlefield and assumes (1) a 70 kg person consumes 5 to 15 L/day of drinking water depending on the climate, season, and intensity of work, (2) military personnel are not expected to be exposed to chemical agents for more than 7 days, (3) water contains no other toxic materials, and (4) there is no pre-existing cholinesterase (ChE) inhibition or concurrent use of any compounds causing ChE inhibition. This guideline provides the necessary flexibility to field commanders who must weigh the application of exposure recommendations against the need for adequate hydration, combat readiness, and mission success. The military recommends adherence to these guidelines, however, enforces the military DOD Tri-service field worker standards-short-term consumption.
Military Guideline. A recommendation from a military authority providing guidance and information for use in establishing acceptable military conduct or policy. A guideline is not a mandatory requirement.			

Category	Title (References footnoted; see page 22)	Information	Comments
INGESTION EXPOSURE LIMITS (continued)			
MILITARY FIELD DRINKING WATER LIMITS (continued)			
Military Standard	*DOD TRI-SERVICE FIELD WATER QUALITY STANDARDS - SHORT-TERM (7 CONSECUTIVE DAYS OR LESS) IN μg/L/L/day.*[h] *Application: Standards provide for the short-term safety of exposed military population based on anticipated duration of water consumption and the overall health of the military population.*	*Agent* — *Standard: 5 L/day, 15 L/day* *L (μg/L)* — *80, 27* *Sulfur Mustard (μg/L)* — *140, 47* *VX, GD, GB, GA (μg/L)* — *12, 4*	*This standard was developed for military personnel deployed in battlefield and assumes: (1) a 70 kg person consumes 5 to 15 L/day of drinking water depending on the climate season, and intensity of work (2) exposure would not be more than 7 days, and (3) water contains no other toxic materials. The military recommends adherence to the recommended field drinking water guidelines, however, the military enforces these standards.* *Note: See Appendix A (page A-21) for information regarding the DOD Tri-Service Field Water Quality Standards-Long-Term.*
***Military Standard.** A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.*			

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Category	Title (References footnoted; see page 22)	Information	Comments
		DERMAL EXPOSURE LIMITS	
Guideline	PROPOSED NO-EFFECTS CONTAMINATION DENSITY LEVELS FOR EMERGENCY RESPONDERS (DERMAL EXPOSURES).[i] Application: Exceedance of levels indicates the need for CSEPP emergency responder to don personal protective equipment (PPE). The principal route of exposure is dermal (i.e., skin contact).	**Agent** / **No effects contamination density** / **Exposure duration** Sulfur Mustard* — 0.02 mg/m^2 — ≥ 8 hrs VX — 0.002 mg/m^2 — = 4 hrs 0.0009 mg/m^2 — ≥ 8 hrs *Vapor concentration from this level of surface contamination does not exceed 0.0001 mg/m^3.	Assumes a 70 kg person and the population is defined as emergency responder, not general population. HT is measured as HD. No-effects is defined from text in reference [i] as the absence of red blood cell cholinesterase depression (RBC-ChE).
Guideline	PROPOSED LD_{01} CONTAMINATION DENSITY LEVELS FOR EMERGENCY RESPONDERS FOR AGENT VX (DERMAL EXPOSURES).[i] Application: One percent lethalities could be expected if levels are exceeded. The principal route of exposure is dermal (i.e., skin contact).	**Agent** / **Proposed LD_{01} contamination density (upper range; median to maximum)** / **Exposure duration** VX — 0.075 to 0.375 mg/m^2 — = 4 hrs 0.038 to 0.188 mg/m^2 — = 8 hrs 0.019 to 0.094 mg/m^2 — = 16 hrs	LD_{01} is the calculated dose that is expected to cause death in 1% of the exposed population. Assumes a 70 kg person and the population is defined as emergency responder, not general population.
Guideline. A recommendation from a review body (e.g., Committee on Toxicology) providing guidance and information for use in establishing acceptable conduct or policy that does not endanger public and/or environmental health. A guideline is not a mandatory requirement.			

COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES - SEPTEMBER 1997

Category	Title (References footnoted; see page 22)	Information	Comments
	DECONTAMINATION LIMITS AND PROCESSES		
Military Standard	*MILITARY ALTERNATIVE 5X MEASUREMENT (OFF-GAS AGENT CONCENTRATION).*[c] *Application: A concentration used to determine if items (e.g., equipment) have been decontaminated of the indicated agent.* *5X is a specific level of decontamination assigned to items which have been subject to liquid contamination or long-term vapor contamination. The 5X procedures will ensure that the total quantity of agent is less than the minimal health effects dosage as determined by the Surgeon General. One approved method for decontamination is heating the item to 538 degrees C (1000 degrees F) for 15 minutes. This is considered sufficient to destroy chemical agent molecules.*	*An alternative 5X methodology (health-risk based release concentrations) is under development and review by the DA Steering Committee for Chemical Agent Standards (USACHPPM lead).*	*Perform surface decontamination by CSEPP approved procedures (see Appendix L of the CSEPP Planning Guidance). Monitoring is required.* *Refer to the Army's Toxic Chemical Agent Safety Program, DA Pamphlet 385-61, Chapter 5 Decontamination and Disposal for decontamination of personnel, equipment, and facilities.*
Military Standard	*MILITARY DECONTAMINATION PROCEDURES FOR SELF AND BUDDY.* *Application: To provide military procedures for the decontamination of personnel. To eliminate an immediate threat to human life.*	*Refer to the Army's NBC Decontamination, Field Manual 3-5; Chemical and Biological Contamination Avoidance, Field Manual 3-3; Decontamination of Facilities and Equipment, Technical Bulletin 700-4, and; Toxic Chemical Agent Safety Program, DA Pamphlet 385-61.*	*Decontaminate as soon as possible. Decontaminate as far forward as possible. Decontaminate by priority.*
Military Standard. A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.			

COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES - SEPTEMBER 1997

Category	Title (References footnoted; see page 22)	Information	Comments
DECONTAMINATION LIMITS AND PROCESSES (continued)			
Military Standard	*MILITARY DECONTAMINATION PROCEDURES FOR PATIENTS, HEALTH CARE PROVIDERS, AND FACILITIES.* *Application: To provide military procedures for the decontamination of patients at medical stations. Procedures must be in place to prevent the spread of contamination to health care providers and facilities.*	*Refer to the Army's NBC Decontamination, Field Manual 3-5; Chemical and Biological Contamination Avoidance, Field Manual 3-3; Decontamination of Facilities and Equipment, Technical Bulletin 700-4, and; Toxic Chemical Agent Safety Program, DA Pamphlet 385-61.*	*Decontaminate as soon as possible. Decontaminate as far forward as possible. Decontaminate by priority.*
Military Standard	*MILITARY DECONTAMINATION PROCEDURES FOR EQUIPMENT.* *Application: To provide military procedures for the decontamination of equipment.*	*Refer to the Army's NBC Decontamination, Field Manual 3-5; Chemical and Biological Contamination Avoidance, Field Manual 3-3; Decontamination of Facilities and Equipment, Technical Bulletin 700-4, and; Toxic Chemical Agent Safety Program, DA Pamphlet 385-61.*	*Decontaminate by priority.*
Military Standard	*MILITARY DECONTAMINATION PROCEDURES FOR HUMAN REMAINS.*[j] *Application: To ensure human remains have no detectable agent greater than the military airborne exposure limits for unmasked chemical agent workers before release for public burial.*	*Agent* — *Human remains after decontamination* *GA/GB* — *.0001 mg/m³* *GD* — *.00003 mg/m³* *VX* — *.00001 mg/m³* *H, HD, HT** — *.003 mg/m³* *L* — *.003 mg/m³* **All concentrations measured as L.*	*Decontamination procedures (i.e., hypochlorite wash/soak) are performed. Military gross level detection equipment is used to determine if gross level contamination still exists. If not, remains are checked by low level detection equipment to confirm remains meet the required standards.*

Military Standard. A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.

COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES - SEPTEMBER 1997

Category	Title (References footnoted; see page 22)	Information	Comments
DECONTAMINATION LIMITS AND PROCESSES (continued)			
Military Standard	***MILITARY DISPOSAL PROCEDURES FOR DECONTAMINATION WASTES.*** ***Application: To ensure decontamination wastes are managed and disposed of in accordance with applicable federal, state, and local laws, regulations, policies, and procedures.***	***Refer to the Army's NBC Decontamination, Field Manual 3-5; Chemical and Biological Contamination Avoidance, Field Manual 3-3; Decontamination of Facilities and Equipment, Technical Bulletin 700-4, and; Toxic Chemical Agent Safety Program, DA Pamphlet 385-61.*** ***Refer to the Code of Federal Regulations, Title 49, Parts 171-177, Hazardous Materials Regulations, and Part 178 Shipping Container Specifications, and; Code of Federal Regulations, Title 40, Parts 260-265 and 270, Regulations for the Management of Hazardous Waste.*** ***Refer to appropriate state and local laws, regulations, policies, and procedures.***	***Refer to the military alternative 5X decontamination measurement.***
Military Standard. A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.			
Guideline	CSEPP SELF AND OTHERS DECONTAMINATION PROCEDURES.[k] Application: To provide guidance on how to plan (i.e., priorities and procedures) for decontamination in the event of a CSEPP chemical agent release.	Refer to Appendix L (Guideline L.4, page L-7) of the CSEPP Planning Guidance.	The first decontamination priority is people; second is essential equipment (e.g., ambulances), and; third is less critical assets such as livestock, private property and croplands. Decontaminate as soon as possible. Decontaminate only what is necessary. Decontaminate as close to the contaminated area as possible. Do it fast - do it right! Refer to military standards for self and buddy decontamination.
Guideline. A recommendation from a review body (e.g., Committee on Toxicology) providing guidance and information for use in establishing acceptable conduct or policy that does not endanger public and/or environmental health. A guideline is not a mandatory requirement.			

COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES - SEPTEMBER 1997

Category	Title (References footnoted; see page 22)	Information	Comments
DECONTAMINATION LIMITS AND PROCESSES (continued)			
Guideline	CSEPP DECONTAMINATION PROCEDURES FOR PATIENTS, HEALTH CARE PROVIDERS, AND FACILITIES.[k] Application: To provide guidance on how to plan (i.e., priorities and procedures) for decontamination of patients by health care providers in the event of a CSEPP chemical agent release.	Refer to Appendix L (Guidelines L.5, L.6, and L.7, starting page L-8) of the CSEPP Planning Guidance.	The interaction between decontamination and the provision of medical services is particularly important. Medical attention, including decontamination must be provided to all people who need it, however, procedures must be in place to prevent the spread of contamination to health care providers and facilities. Refer to military standards for patients, healthcare providers, and facilities.
Guideline	CSEPP RESPONSE PHASE DECONTAMINATION PROCEDURES FOR EQUIPMENT.[k] Application: To provide guidance on how to plan (i.e., priorities and procedures) for decontamination of equipment in the event of a CSEPP chemical agent release.	Refer to Appendix L (Guideline L.5, page L-8) of the CSEPP Planning Guidance.	Decontaminate only essential equipment like ambulances. Refer to military standards for equipment.
Guideline	CSEPP DECONTAMINATION OF HUMAN REMAINS.[l] Application: To provide guidance on how to plan (i.e., priorities and procedures) for the decontamination of human remains in accordance with all applicable federal, state, and local laws, regulations, policies, and procedures in the event of a CSEPP chemical agent release.	Refer to Appendix M (Guideline M.5, page M-15) of the CSEPP Planning Guidance.	Refer to military standards for human remains.

Guideline. A recommendation from a review body (e.g., Committee on Toxicology) providing guidance and information for use in establishing acceptable conduct or policy that does not endanger public and/or environmental health. A guideline is not a mandatory requirement.

COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES - SEPTEMBER 1997

Category	Title (References footnoted; see page 22)	Information	Comments
DECONTAMINATION LIMITS AND PROCESSES (continued)			
Guideline	CSEPP DISPOSAL OF DECONTAMINATION WASTES.[k, l] Application: To provide guidance on how to plan (i.e., priorities and procedures) for the disposal of decontamination wastes in accordance with all applicable federal, state, and local laws, regulations, policies, and procedures in the event of a CSEPP chemical agent release.	Refer to Appendix L (Guideline L.5, page L-8) and Appendix M (Guidelines M.4 and M.5, page M-13) of the CSEPP Planning Guidance. Refer to the Code of Federal Regulations, Title 49, Parts 171-177, Hazardous Materials Regulations, and Part 178 Shipping Container Specifications, and; Code of Federal Regulations, Title 40, Parts 260-265 and 270, Regulations for the Management of Hazardous Waste. Refer to appropriate state and local laws; regulations, policies, and procedures.	Refer to military standards on disposal of decontamination wastes.
Guideline	CSEPP RECOVERY PHASE DECONTAMINATION PROCEDURES.[k, l] Application: To provide guidance on how to plan (i.e., priorities and procedures) for recovery phase decontamination in the event of a CSEPP chemical agent release.	Refer to Appendix M (Guidelines M.2 through M.9, starting page M-11) of the CSEPP Planning Guidance.	Establish a list of priorities like: (1) critical assets (2) livestock and companion animals (3) drinking water (4) personal property (5) real estate and terrain (6) incidental personal property (7) fodder, feed, and crops
Guideline	CSEPP REENTRY AND RESTORATION DECONTAMINATION PROCEDURES.[k,l] Application: To provide guidance on how to plan (i.e., priorities and procedures) for reentry and restoration decontamination in the event of a CSEPP chemical agent release.	Refer to Appendix M (Guidelines M.11 through M.18, starting page M-25) of the CSEPP Planning Guidance.	Establish a list of priorities like: (1) livestock and companion animals (2) vegetation used as food, and surface water sources used as drinking water (3) surfaces with which humans are likely to come in contact (e.g., structures, vehicles) (4) soil (5) meat and milk (6) non-drinking water supplies
Guideline. A recommendation from a review body (e.g., Committee on Toxicology) providing guidance and information for use in establishing acceptable conduct or policy that does not endanger public and/or environmental health. A guideline is not a mandatory requirement.			

COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES - SEPTEMBER 1997

Category	Title (References footnoted; see page 22)	Information	Comments
CHEMICAL SURETY LIMITS AND PROCESSES			
Military Standard	***MILITARY CHEMICAL SURETY LABORATORY SAFETY STANDARDS.*** ***Application: To ensure laboratory safety through established military standards and applicable federal, state, and local laws, regulations, policies, and procedures.***	***Refer to the Army's Toxic Chemical Agent Safety Program, DA Pamphlet 385-61, and; Nuclear and Chemical Weapons and Material, Chemical Surety, AR 50-6.*** ***Refer to the Code of Federal Regulations, Title 29, Part 1450, Occupational Exposure to Hazardous Chemicals in Laboratories.*** ***Refer to appropriate state and local laws, regulations, policies, and procedures.***	***These standards (military and federal) are a valid method of eliminating/reducing the unique hazards associated with research and development laboratory operations (agent operations and storage).***
Military Standard. A measure established by a military authority; military compliance is mandatory. A limit that cannot be exceeded without endangerment or action.			
Guideline	CSEPP CHEMICAL SURETY LABORATORY SAFETY GUIDELINES.[k,l] Application: To provide guidance on how to plan (i.e., priorities and procedures) for laboratory safety through all applicable federal, state, and local laws, regulations, policies, and procedures in the event of a CSEPP chemical agent release.	Refer to Appendix M (Guideline M.16, page M-29) of the CSEPP Planning Guidance. Refer to the Code of Federal Regulations, Title 29, Part 1450, Occupational Exposure to Hazardous Chemicals in Laboratories. Refer to appropriate state and local laws, regulations, policies, and procedures.	Protocols for sample handling and analysis to ensure accurate and reliable laboratory results (includes chain of custody, holding temperatures for environmental samples, shipping notification requirements and quality control procedures, etc.). There are a limited number of qualified analytical chemical surety laboratories. Refer to the military standards for chemical surety laboratory safety standards.
Guideline. A recommendation from a review body (e.g., Committee on Toxicology) providing guidance and information for use in establishing acceptable conduct or policy that does not endanger public and/or environmental health. A guideline is not a mandatory requirement.			

COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES - SEPTEMBER 1997

Category	Title (References footnoted; see page 22)	Information	Comments
		MISCELLANEOUS	
Guideline	SAMPLING PROTOCOLS. Application: Protocols for sample collection handling and analysis to ensure accurate, reliable samples and laboratory analysis. The information is needed to characterize the boundaries of agent distribution and identify "hot spots" in the environment.	Under development by USACHPPM.	The protocols under development will be based on existing, standard EPA environmental sampling and risk assessment protocols. The EPA guidance and procedures are designed for collecting and evaluating chemical contaminants in the environment and are directly applicable to addressing potential chemical agent contamination. Certain chemical unique parameters as well as site specific must be incorporated in sampling plans. The USACHPPM is developing the protocol that will incorporate both the standard practices and areas requiring specific site/chemical input.
Guideline. A recommendation from a review body (e.g., Committee on Toxicology) providing guidance and information for use in establishing acceptable conduct or policy that does not endanger public and/or environmental health. A guideline is not a mandatory requirement.			

REFERENCES

[a]The Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services (DHHS) 1988. *Final Recommendations for Protecting Human Health and Safety Against Potential Adverse Effects of Long-Term Exposure to Low Doses of Agents GA, GB, VX, Mustard Agents (H, HD, HT), and Lewisite (L), Federal Register,* Vol. 53 No. 50, page 8504, Tuesday, March 15, 1988 (53 *FR* 8504).

[b]U.S. Department of the Army (DA). *Army Chemical Agent Safety Program,* Army Regulation 385-61 (AR 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (February 21, 1997).

[c]U.S. Department of the Army (DA). *Toxic Chemical Agent Safety Standards*, DA Pamphlet 385-61 (DA 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (March 31, 1997).

[d]Thacker, Stephen B., M.D., M.Sc., Assistant Surgeon General, Acting Director, National Center for Environmental Health, Centers for Disease Control and Prevention DHHS, letter to Colonel James M. Coverstone, Deputy for Chemical Demilitarization, Office of the Assistant Secretary of the Army *Recommended Acute Threshold Effects Levels for CSEPP Program* (June 24, 1994).

[e]O'Donnell, Francis L., COL MC, Director of Health Services, U.S. Department of the Army, Office of the Surgeon General, memo to Deputy Assistant Secretary of the Army for Environmental Safety, and Occupational Health, et al., *Interim Chronic Toxicological Criteria for Chemical Warfare Compounds* (Aug 19, 1996). Gaydos, Joel C., COL, MC, Director, Clinical Preventive Medicine, U.S. Department of the Army, Center for Health Promotion and Preventive Medicine, memo to Francis L. O'Donnell, COL, MC, Director of Health Services, U.S. Department of the Army, Office of the Surgeon General, *Interim Chronic Toxicological Criteria for Chemical Warfare Compounds* (June 4, 1996).

[f]U.S. Environmental Protection Agency, EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A), Interim Final,* Office of Emergency and Remedial Response, Washington, DC, December 1989.

[g]Committee on Toxicology (COT) 1995. *Guidelines for Chemical Warfare Agents in Military Field Drinking Water*. Subcommittee on Guidelines for Military Field Drinking Water Quality, Committee on Toxicology, National Research Council. National Academy Press, Washington, DC (80pp).

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[h]U.S. Department of the Army (DA) (in review). *Occupational and Environmental Health: Sanitary Control and Surveillance of Field Water Supplies.* TB MED 577, Department of the Army Headquarters, Washington, DC (Draft, June 1996).

[i]Reutter, S.A., E. J. Olajos, R. J. Mioduszewski and A. Watson 1994. *White Paper - Validation of Contact Hazard Toxicity Estimates for Agents VX and HD, Phase II* ERDEC-SP-017. Edgewood Research Development Engineering Center, U.S. Army Chemical and Biological Defense Command, Aberdeen Proving Ground, MD (February 1994).

[j]Elam, Fred E., Major General, U.S. Department of the Army, Office of the Deputy Chief of Staff for Logistics, memo to Vice Chief of Staff, *Joint Procedures for Decontaminating Human Remains in Operation Desert Storm,* (February 26, 1991), U.S. Department of the Army, Office of the Deputy Chief of Staff for Logistics, Washington, DC.

[k]Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1996. *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program,* Washington, DC, FEMA 1996.

[l]Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1997. Planning Guidelines for Recovery Phase Activity, Appendix M to the *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program,* Washington, DC, FEMA 1997.

Code of Federal Regulations (*CFR*), Title 49, Parts 171-177, Hazardous Materials Regulations, and Part 178 Shipping Container Specifications.

Code of Federal Regulations (*CFR*), Title 40, Parts 260-265 and 270, Regulations for the Management of Hazardous Waste.

Code of Federal Regulations (*CFR*), Title 29, Part 1450, Occupational Exposure to Hazardous Chemicals in Laboratories.

U.S. Department of the Army (DA) 1993. *NBC Decontamination,* Field Manual FM 3-5, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA) 1992. *Chemical and Biological Contamination Avoidance,* Field Manual FM 3-3, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). *Decontamination of Facilities and Equipment,* Technical Bulletin TB 700-4, Headquarters, U.S. Department of the Army, Washington, DC.

REFERENCES (continued)

U.S. Department of the Army (DA). *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GB, GD, and VX*, DA Pamphlet 40-8 (DA 40-8). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT*, DA Pamphlet 40-173 (DA 40-173). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). *Nuclear and Chemical Weapons and Material, Chemical Surety*, Army Regulation (AR) 50-6, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA), Headquarters 1991. *Chemical Accident/Incident Response and Assistance (CAIRA) Operations*, DA Pamphlet 50-6, Commander, U.S. Army Nuclear and Chemical Agency, Springfield, VA.

U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). *Detailed and General Facts About Chemical Agents TG 218*, Technical Guide 218 (TG 218). U.S. Department of the Army, Aberdeen Proving Ground, MD.

APPENDIX A

DETAILED BACKGROUND INFORMATION ON THE COMPILATION OF EXISTING CHEMICAL AGENT GUIDELINES AS OF SEPTEMBER 1997 TABLE

AIRBORNE EXPOSURE LIMITS

CATEGORY

Control Limit

ITEM

CONTROL LIMITS FOR CHEMICAL AGENTS FOR WORKERS IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

PURPOSE/USES

These limits are designed to protect the worker from unsafe concentrations of chemical agent in the work environment. Workers can be exposed to concentrations at or below these levels for 8 hours a day without suffering ill effects. The CDC concludes there to be little risk either of adverse health effects from long-term exposure to low doses or of delayed health effects from acute exposure.

INFORMATION

Agent	***Workers***
GA, GB	1×10^{-4} mg/m^3
VX	1×10^{-5} mg/m^3
H, HD, HT	3×10^{-3} mg/m^3
L	3×10^{-3} mg/m^3
Averaging time:	*8 hr time weighted average (TWA)*

REFERENCES

The Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services (DHHS) 1988. Final Recommendations for Protecting Human Health and Safety Against Potential Adverse Effects of Long-Term Exposure to Low Doses of Agents GA, GB, VX, Mustard Agents (H, HD, HT), and Lewisite (L), Federal Register, Vol. 53 No. 50, page 8504, Tuesday, March 15, 1988 (53FR 8504).

COMMENTS

The CDC stated in their Final Recommendations for Protecting Human Health and Safety Against Potential Adverse Effects of Long-Term Exposure to Low Doses of Agents GA, GB, GD, VX, Mustard Agents (H, HD, HT) and Lewisite (L), that citizens near military depots where chemical weapons are stored expressed concerns about the potential for delayed effects of acute exposure and about the

ITEM (Continued)

CONTROL LIMITS FOR CHEMICAL AGENTS FOR WORKERS IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

COMMENTS

potential health effects of long-term exposure to low doses of agents. Low dose means an airborne concentration of agent below the control limits.

The CDC concludes human health will be adequately protected from exposure to GA, GB, and VX vapor at the concentrations listed. Even long-term exposure to these concentrations would not create any adverse health effects. The CDC concludes the work place limits for mustard agent appear to provide adequate protection for workers during the limited time of potential exposure prior to disposal of these lethal agents.

Almost all (99.97%) of the vapor released by HT is mustard agent. HT control limits will therefore be identical with those for HD with concentrations measured as HD.

The L exposure limits for workers and the general population will remain constant because toxicological information specific to L is sparse. The L limit in air is equivalent to 0.001 mg/m^3 measured as arsenic and should be adequate to protect public health. L is an organic compound containing arsenic.

See military standard, military airborne exposure limits for unmasked chemical agent workers. These CDC values have been incorporated by the military. The military added standards for GD.

AIRBORNE EXPOSURE LIMITS

CATEGORY

Control Limit

ITEM

CONTROL LIMITS FOR CHEMICAL AGENTS FOR THE GENERAL POPULATION IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

PURPOSE/USES

These limits are designed to protect the general population (including children and elderly) from long-term exposure to low doses of chemical agent. The general population may be exposed to concentrations at or below these levels without suffering effects. The CDC concludes there to be little risk either of adverse health effects from long-term exposure to low doses or of delayed health effects from acute exposure.

INFORMATION

Agent	***General population***
GA, GB	3×10^{-6} *mg/m*^{3}
VX	3×10^{-6} *mg/m*^{3}
H, HD, HT	1×10^{-4} *mg/m*^{3}
L	3×10^{-3} *mg/m*^{3}
Averaging time:	*72 hr time weighted average (TWA)*

REFERENCES

The Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services (DHHS) 1988. Final Recommendations for Protecting Human Health and Safety Against Potential Adverse Effects of Long-Term Exposure to Low Doses of Agents GA, GB, VX, Mustard Agents (H, HD, HT), and Lewisite (L), Federal Register, Vol. 53 No. 50, page 8504, Tuesday, March 15, 1988 (53FR 8504).

ITEM (Continued)

CONTROL LIMITS FOR CHEMICAL AGENTS FOR THE GENERAL POPULATION IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

COMMENTS

The CDC stated in their Final Recommendations for Protecting Human Health and Safety Against Potential Adverse Effects of Long-Term Exposure to Low Doses of Agents GA, GB, GD, VX, Mustard Agents (H, HD, HT) and Lewisite (L), that citizens near military depots where chemical weapons are stored expressed concerns about the potential for delayed effects of acute exposure and about the potential health effects of long-term exposure to low doses of agents. Low dose means an airborne concentration of agent below the control limits.

The CDC concludes human health will be adequately protected from exposure to GA, GB, and VX vapor at the concentrations listed. Even long-term exposure to these concentrations would not create any adverse health effects. The CDC concludes control of stack emissions and the work place air in accordance with the limits for mustard agent will amply protect the general population 1000 meters or more from a demilitarization site.

Almost all (99.97%) of the vapor released by HT is mustard agent. HT control limits will therefore be identical with those for HD with concentrations measured as HD.

The L exposure limits for workers and the general population will remain constant because toxicological information specific to L is sparse. The L limit in air is equivalent to 0.001 mg/m^3 measured as arsenic and should be adequate to protect public health. L is an organic compound containing arsenic.

See military standard, military airborne exposure limits for non-agent workers and general population. The CDC values have been incorporated by the military. The military added standards for GD.

AIRBORNE EXPOSURE LIMITS

CATEGORY

Control Limit

ITEM

ALLOWABLE STACK CONCENTRATIONS IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3) FOR CHEMICAL AGENTS.

PURPOSE/USES

To restrict incinerator emissions to concentrations well below those that would endanger health.

INFORMATION

Agent	*General population*
GA, GB	3×10^{-4} *mg/m³*
VX	3×10^{-4} *mg/m³*
H, HD, HT	3×10^{-2} *mg/m³*
L	3×10^{-2} *mg/m³*

HT is measured as HD.

REFERENCES

The Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services (DHHS) 1988. Final Recommendations for Protecting Human Health and Safety Against Potential Adverse Effects of Long-Term Exposure to Low Doses of Agents GA, GB, VX, Mustard Agents (H, HD, HT), and Lewisite (L), Federal Register, Vol. 53 No. 50, page 8504, Tuesday, March 15, 1988 (53FR 8504).

COMMENTS

Usually allowable stack concentrations prove more restrictive than a limit set on health bases alone. These levels have been evaluated through air dispersion modeling of worst case credible events and conditions specific to each site to ensure that the control limits for general population and workers would not be exceeded as a consequence of releases at or below the allowable stack concentrations.

These limits are primarily an engineering control limit. These limits should be attainable by a well-designed, well-constructed, and well-operated incineration facility; give an early indication of upset conditions; and be accurately measurable in a timely manner.

AIRBORNE EXPOSURE LIMITS

CATEGORY

Military Standard

ITEM

MILITARY IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH) VALUE IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

PURPOSE/USES

To indicate to military personnel the levels at which self-contained breathing apparatus (SCBA) or supplied air respirators are required.

INFORMATION

Agent	*Concentration*
GA, GB	*0.2 mg/m^3*
GD	*0.06 mg/m^3*
VX	*0.02 mg/m^3*

**HD/L IDLH not formally established since any concentration over the 8 hour TWA (0.003 mg/m^3 or 3 x 10^{-3} mg/m^3) requires either a SCBA or supplied air respirator due to concerns over carcinogenicity.*

REFERENCES

U.S. Department of the Army (DA). Army Chemical Agent Safety Program, Army Regulation 385-61 (AR 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (February 28, 1997).

COMMENTS

These values were established by the Army Surgeon General for military personnel solely for the purpose of establishing the concentrations at which SCBAs or supplied air respirators are required. IDLH values are only established by the National Institute of Occupational Safety and Health (NIOSH).

AIRBORNE EXPOSURE LIMITS

CATEGORY

Control Limit

ITEM

RECOMMENDED ACUTE THRESHOLD EFFECTS LEVELS FOR DETERMINING EMERGENCY EVACUATION DISTANCES IN THE CSEPP PROGRAM IN MILLIGRAM MINUTES PER CUBIC METER OF AIR (mg-min/m^3).

PURPOSE/USES

A cumulative exposure that indicates the point at which civilians are to be evacuated in the event of a CSEPP chemical agent release.

INFORMATION

Agent	***Acute threshold effect level mg-min/m^3***
H, HD, HT	*2.0*
L	*2.0*
GB	*0.5*
VX	*0.4*

REFERENCES

Thacker, Stephen B., M.D., M.Sc., Assistant Surgeon General, Acting Director, National Center for Environmental Health, Centers for Disease Control and Prevention, DHHS, letter to Colonel James M. Coverstone, Deputy for Chemical Demilitarization, Office of the Assistant Secretary of the Army Recommended Acute Threshold Effects Levels for CSEPP Program (June 24, 1994).

COMMENTS

These values will be used with the Army's D2PC air dispersion model for planning the evacuation of civilians in the event of a CSEPP chemical agent release. The CDC feels these values are protective of public health and safety. Human exposure to the acute threshold effects doses of GB and VX is actually at a lowest-observed-effect-level and could be exceeded without danger. Significant adverse effects would not be expected before considerably higher doses had been absorbed.

See military standard, military no significant effects dosage. CSEPP incorporated the military's values after review by the CDC.

AIRBORNE EXPOSURE LIMITS

CATEGORY

Interim Military Standard

ITEM

ARMY PROPOSED CHRONIC REFERENCE CONCENTRATION (RfCs).

PURPOSE/USES

The RfC can be used to calculate safe concentrations where persons may be at risk by inhalation of low levels of chemical agents over extended periods of time (i.e., chronic exposures).

INFORMATION

These are currently being developed by USACHPPM. USACHPPM is coordinating this effort with the CDC.

REFERENCES

O'Donnell, Francis L., COL MC, Director of Health Services, U.S. Department of the Army, Office of the Surgeon General, memo to Deputy Assistant Secretary of the Army for Environmental Safety, and Occupational Health, et al., *Interim Chronic Toxicological Criteria for Chemical Warfare Compounds* (Aug 19, 1996). Gaydos, Joel C., COL, MC, Director, Clinical Preventive Medicine, U.S. Department of the Army, Center for Health Promotion and Preventive Medicine, memo to Francis L. O'Donnell, COL, MC, Director of Health Services, U.S. Department of the Army, Office of the Surgeon General, *Interim Chronic Toxicological Criteria for Chemical Warfare Compounds (*June 4, 1996).

COMMENTS

The RfC is translated into acceptable media concentration levels by incorporating site-specific exposure assumptions (exposure factors). These exposure factors include information such as exposure frequency, exposure duration, estimated amount of contaminated material inhaled, inhalation rate, and body weight. These site-specific variables and the RfC will be incorporated into a health risk assessment according to USEPA- approved methodology and calculations.

RfCs are similar to reference doses (RfDs). RfCs are applicable for airborne exposures (i.e., inhalation, or to breathe in) and RfDs are applicable for ingestion exposures (i.e., taken into the body by way of the digestive tract).

AIRBORNE EXPOSURE LIMITS

CATEGORY

Military Standard

ITEM

MILITARY NO SIGNIFICANT EFFECTS DOSAGE IN MILLIGRAM MINUTES PER CUBIC METER OF AIR ($mg\text{-}min/m^3$).

PURPOSE/USES

The lowest exposure level which does not produce significant effects in the general population (to include more susceptible sub populations) in the event of a military chemical agent release. CSEPP incorporated the military values as the CSEPP acute threshold effects level (after review by the CDC), however, CSEPP levels did not include a VX inhalation-deposition limit.

INFORMATION

Agent	*No significant effects dosage*
L/Mustard	*2.0 $mg\text{-}min/m^3$*
GB	*0.5 $mg\text{-}min/m^3$*
VX Vapor	*0.4 $mg\text{-}min/m^3$*
VX Inhalation-Deposition	*0.011 mg/man*

REFERENCES

U.S. Department of the Army (DA). Toxic Chemical Agent Safety Standards, DA Pamphlet 385-61 (DA 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC March 31, 1997).

COMMENTS

A vapor concentration which indicates the need to evacuate the general population in the event of a military chemical agent release.

The military no significant effects dosage is that dose at which the general population would not experience permanent effects.

AIRBORNE EXPOSURE LIMITS

CATEGORY

Military Standard

ITEM

MILITARY AIRBORNE EXPOSURE LIMITS FOR UNMASKED CHEMICAL AGENT WORKERS IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

PURPOSE/USES

To limit the concentration of airborne chemical agent in order to protect the health and safety of the worker. These limits are designed to protect the worker from unsafe concentrations of chemical agent in the work environment by establishing a limit above which respiratory protection is required. Workers can be exposed to concentrations at or below these levels for 8 hours a day, 40 hours a week, day after day, without known adverse health effects.

INFORMATION

Agent	*Workers*
GA, GB	*.0001 mg/m^3*
GD	*.00003 mg/m^3*
VX	*.00001 mg/m^3*
*H, HD, HT**	*.003 mg/m^3*
L	*.003 mg/m^3*
Averaging time:	*8 hr time weighted average (TWA)*

**All concentrations are measured as L.*

REFERENCES

U.S. Department of the Army (DA). Army Chemical Agent Safety Program, Army Regulation 385-61 (AR 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (February 28, 1997).

COMMENTS

The CDC's control limits for chemical agents for workers have been incorporated by the military. The military added standards of GD.

ITEM (Continued)

MILITARY AIRBORNE EXPOSURE LIMITS FOR UNMASKED CHEMICAL AGENT WORKERS IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

COMMENTS

If these limits are exceeded, respiratory protection is required. Refer to Table 2-1 Respiratory Protection Equipment for Regulated Areas in the Army Chemical Agent Safety Program AR 385-61, for the required respiratory equipment at various exposure levels.

AIRBORNE EXPOSURE LIMITS

CATEGORY

Military Standard

ITEM

MILITARY AIRBORNE EXPOSURE LIMITS FOR NON-AGENT WORKER AND GENERAL POPULATION IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

PURPOSE/USES

To limit the concentration of airborne chemical agent in order to protect the health and safety of the non-agent worker and the general population.

INFORMATION

Agent	*Non-agent worker and general population*	*Non-agent worker and general population*
GA, GB	*.000003 mg/m^3*	*.0001 mg/m^3*
GD	*.000003 mg/m^3*	*.00003 mg/m^3*
VX	*.000003 mg/m^3*	*.00001 mg/m^3*
*H, HD, HT**	*.0001 mg/m^3*	*.003 mg/m^3***
L	*.003 mg/m^3*	*.003 mg/m^3*
Averaging time:	*72 hr time weighted average (TWA)*	****Ceiling value*

**HT is measured as HD.*
***All concentrations are measured as L.*
****Ceiling value normally refers to the maximum exposure concentration at any time, for any duration.*

REFERENCES

U.S. Department of the Army (DA). Army Chemical Agent Safety Program, Army Regulation 385-61 (AR 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (February 28, 1997).

COMMENTS

The military incorporated the CDC's control limits for chemical agents for the general population. The military added standards for GD.

ITEM (Continued)

MILITARY AIRBORNE EXPOSURE LIMITS FOR NON-AGENT WORKER AND GENERAL POPULATION IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

COMMENTS

These limits are concentrations which may reach unprotected people who are not occupationally exposed and which are not expected to cause adverse health or environmental effects.

The limits are designed to protect the general population (including children and elderly) from low levels of chemical agent that may be present in the environment. Individuals may be exposed to concentrations at or below these levels without suffering adverse effects.

AIRBORNE EXPOSURE LIMITS

CATEGORY

Military Standard

ITEM

MILITARY SOURCE STACK EMISSION LIMITS IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

PURPOSE/USES

To restrict incinerator emissions to concentrations well below those that would endanger health.

INFORMATION

Agent	*General population*
GA, GB	*.0003 mg/m^3*
GD	*.0001 mg/m^3*
VX	*.0003 mg/m^3*
H, HD, HT	*.03 mg/m^3*
L	*.03 mg/m^3*

REFERENCES

U.S. Department of the Army (DA). Army Chemical Agent Safety Program, Army Regulation 385-61 (AR 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (February 28, 1997).

COMMENTS

Usually allowable stack concentrations prove more restrictive than a limit set on health bases alone. These levels have been evaluated through air dispersion modeling of worst case credible events and conditions specific to each site to ensure that the standards for general population and workers would not be exceeded as a consequence of releases at or below the allowable stack concentrations.

These limits are primarily an engineering standard. These limits should be attainable by a well-designed, well-operated incineration facility; give an early indication of upset conditions; and be accurately measurable in a timely manner.

The CDC's limits are the same as these limits, except that, the CDC did not publish a value for GD.

AIRBORNE EXPOSURE LIMITS

CATEGORY

Military Standard

ITEM

MILITARY NO EFFECTS CONCENTRATIONS FOR CHEMICAL AGENTS GA, GB, GD, AND VX IN MILLIGRAMS PER CUBIC METER OF AIR (mg/m^3).

PURPOSE/USES

To ensure the protection of non-related military personnel. These concentrations are used in modeling algorithms to calculate hazard zones to determine areas of concern when, by the nature of operations, a release of agent is expected (such as in the case of emergency destruction, training, or maintenance operations).

INFORMATION

Agent	*Concentration (mg/m^3)*
GA, GB	*.000003 mg/m^3*
GD	*.000003 mg/m^3*
VX	*.000003 mg/m^3*

REFERENCES

U.S. Department of the Army (DA). Army Chemical Agent Safety Program, Army Regulation 385-61 (AR 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (February 28, 1997).

COMMENTS

The CSEPP acute threshold effects levels and the military no significant effects levels are concentrations which indicate the need to evacuate the general population in the event of a military or CSEPP chemical agent release. The military no effects concentrations are used by the military to calculate hazard zones within the military installation boundaries.

INGESTION EXPOSURE LIMITS

CATEGORY

Interim Military Standard

ITEM

ARMY PROPOSED CHRONIC REFERENCE DOSES (RfDs) IN MILLIGRAM CHEMICAL PER KILOGRAM BODY WEIGHT PER DAY (mg/kg/day).

PURPOSE/USES

The RfD can be used to calculate safe drinking water levels, soil clean-up levels, safe food contaminant levels and other safe media-specific concentrations where persons may be at risk by ingestion of low levels of chemical agent contaminated media over extended periods of time (i.e., chronic exposures).

INFORMATION

Agent	Proposed reference dose RfD (mg/kg/day)		Other comments
HD (Sulfur Mustard)	7E-06	(0.000007)	HD is also a known human carcinogen: proposed Oral Slope Factor =0.095(μg/kg/day^{-1} proposed Drinking Water Unit Risk = 0.003 (μg/L)$^{-1}$ proposed Inhalation Unit Risk = 8.5E-02 (μg/m^3)$^{-1}$
Lewisite	1E-04	(0.0001)	
GA (Nerve)	4E-05	(0.00004)	
GB (Nerve)	2E-05	(0.00002)	
GD (Nerve)	4E-06	(0.000004)	
VX (Nerve)	6E-07	(0.0000006)	

REFERENCES

O'Donnell, Francis L., COL MC, Director of Health Services, U.S. Department of the Army, Office of the Surgeon General, memo to Deputy Assistant Secretary of the Army for Environmental Safety, and Occupational Health, et al., *Interim Chronic Toxicological Criteria for Chemical Warfare Compounds* (Aug 19, 1996). Gaydos, Joel C., COL, MC, Director, Clinical Preventive Medicine, U.S. Department of the Army, Center for Health Promotion and Preventive Medicine, memo to Francis L. O'Donnell, COL, MC, Director of Health Services, U.S. Department of the Army, Office of the Surgeon General, *Interim Chronic Toxicological Criteria for Chemical Warfare Compounds (*June 4, 1996).

ITEM (Continued)

ARMY PROPOSED CHRONIC REFERENCE DOSES (RfDs) IN MILLIGRAM CHEMICAL PER KILOGRAM BODY WEIGHT PER DAY (mg/kg/day).

COMMENTS

The RfD is translated into acceptable media concentration levels by incorporating site-specific exposure assumptions (exposure factors). These exposure factors include information such as exposure frequency, exposure duration, estimated amount of contaminated soil/water/specific food ingested, ingestion rate, and body weight. These site-specific variables and the RfD will be incorporated into a health risk assessment according to USEPA- approved methodology and calculations. USACHPPM (http://chppm-www.apgea.army.mil/default.htm) is currently developing a matrix of exposure factors that can be used to assess various exposure scenarios. For more information on reference doses and applications, please see the USACHPPM *Just the Facts Information Sheet* included as Appendix B to this information packet.

The proposed RfDs are currently undergoing review by the Committee on Toxicology. The proposed RfDs are for human exposures.

INGESTION EXPOSURE LIMITS

MILITARY FIELD DRINKING WATER LIMITS

CATEGORY

Military Guideline

ITEM

Recommended field drinking water guidelines for selected chemical warfare agents in field drinking water in micrograms per liters (μg/L)/liters per day (L/day).

PURPOSE/USES

A battlefield drinking water concentration which will protect military personnel against acute adverse health effects or performance-degrading effects for exposures of up to 7 days.

INFORMATION

	Recommended guidelines	
Agent	5 L/day	15 L/day
GA (μg/L)	70.0	22.5
GB (μg/L)	13.8	4.6
GD (μg/L)	6.0	2.0
VX (μg/L)	7.5	2.5
Sulfur Mustard (μG/L)	140.0	47.0
L (μg/L)	80.0	27.0

REFERENCES

Committee on Toxicology (COT) 1995. *Guidelines for Chemical Warfare Agents in Military Field Drinking Water.* Subcommittee on Guidelines for Military Field Drinking Water Quality, Committee on Toxicology, National Research Council. National Academy Press, Washington, DC (80pp).

ITEM (Continued)

Recommended field drinking water guidelines for selected chemical warfare agents in field drinking water in micrograms per liters (μg/L)/liters per day (L/day).

COMMENTS

This guideline was developed by the Committee on Toxicology (COT) for military personnel deployed in the battlefield and assumes (1) a 70 kg person consumes 5 to 15 L/day of drinking water depending on the climate, season, and intensity of work, (2) military personnel are not expected to be exposed to chemical agents for more than 7 days, (3) water contains no other toxic material, and (4) there is no pre-existing cholinesterase (ChE) inhibition or concurrent use of any compounds causing ChE inhibition.

This guideline provides the necessary flexibility to field commanders who must weigh the application of exposure recommendations against the need for adequate hydration, combat readiness, and mission success. The military recommends adherence to these guidelines, however, enforces the military dod tri-service field water standards-short-term consumption.

INGESTION EXPOSURE LIMITS

MILITARY FIELD DRINKING WATER LIMITS

CATEGORY

Military Standard

ITEM

DOD TRI-SERVICE FIELD WATER QUALITY STANDARDS-LONG-TERM (LESS THAN 1 YEAR).

PURPOSE/USES

Standards provide for the long-term safety of exposed military population based on anticipated duration of water consumption and the overall health of the military population.

INFORMATION

Long-term standards as presented by the military in the Occupational and Environmental Health: Sanitary Control and Surveillance of Field Water Supplies, TBMED577, March 1986, are being superseded and currently under development by USACHPPMs Soldier Exposure Criteria Working Group (see reference below).

REFERENCES

U.S. Department of the Army (DA) (in review). Occupational and Environmental Health: Sanitary Control and Surveillance of Field Water Supplies. TB MED 577, Department of the Army Headquarters, Washington, DC (Draft, June 1996).

COMMENTS

There is not yet enough data to set a practical long-term standard. Consumption of contaminated water by military personnel for more than 7 days is unlikely.

INGESTION EXPOSURE LIMITS

MILITARY FIELD DRINKING WATER LIMITS

CATEGORY

Military Standard

ITEM

DOD TRI-SERVICE FIELD WATER QUALITY STANDARDS-SHORT-TERM (7 CONSECUTIVE DAYS OR LESS) IN MICROGRAMS PER LITER (μg/L)/LITERS PER DAY (L/day).

PURPOSE/USES

Standards provide for the short-term safety of exposed military population based on anticipated duration of water consumption and the overall health of the military population.

INFORMATION

Agent	*Standard*	
	5 L/day	*15 L/day*
L (μg/L)	*80.0*	*27.0*
Sulfur Mustard (μg/L)	*140.0*	*47.0*
VX, GD, GB, GA (μg/L)	*12.0*	*4.0*

REFERENCES

U.S. Department of the Army (DA) (in review). Occupational and Environmental Health: Sanitary Control and Surveillance of Field Water Supplies. TB MED 577, Department of the Army Headquarters, Washington, DC (Draft, June 1996).

COMMENTS

This standard was developed for military personnel deployed in the battlefield and assumes: (1) a 70 kg person consumes 5 to 15 L/day of drinking water depending on the climate, season, and intensity of work (2) exposure would not be more than 7 days, and (3) water contains no other toxic materials.

The recommended field drinking water guidelines were developed by the Committee on Toxicology (COT). The military recommends adherence to the COTs guidelines, however, the military enforces these standards. *See page A-21 for DOD Field Water Quality Standards-Long-Term.*

DERMAL EXPOSURE LIMITS

CATEGORY

Guideline

ITEM

PROPOSED NO-EFFECTS CONTAMINATION DENSITY LEVELS FOR EMERGENCY RESPONDERS (DERMAL EXPOSURES) IN MILLIGRAMS OF AGENT PER SQUARE METER OF SURFACE AREA (mg/m^2).

PURPOSE/USES

Exceedance of levels indicates the need for CSEPP emergency responders to don personal protective equipment (PPE). The principal route of exposure is dermal (i.e., skin contact).

INFORMATION

Agent	No-effects contamination density	Exposure duration
Sulfur Mustard*	0.02 mg/m^2	≥ 8 hrs
VX	0.002 mg/m^2	= 4 hrs
	0.0009 mg/m^2	≥ 8 hrs

*Vapor concentration from this level of surface contamination does not exceed 0.0001 mg/m^3.

REFERENCES

Reutter, S.A., E. J. Olajos, R. J. Mioduszewski and A. Watson 1994. *White Paper - Validation of Contact Hazard Toxicity Estimates for Agents VX and HD, Phase II* ERDEC-SP-017. Edgewood Research Development Engineering Center, US Army Chemical and Biological Defense Command, Aberdeen Proving Ground, MD (February 1994).

COMMENTS

Assumes a 70 kg person and the population is defined as emergency responder, not general population. HT is measured as HD.

No-effects is defined from the text in the reference as the absence of red blood cell cholinesterase depression (RBC-ChE).

DERMAL EXPOSURE LIMITS

CATEGORY

Guideline

ITEM

PROPOSED LD_{01} CONTAMINATION DENSITY LEVELS FOR EMERGENCY RESPONDERS FOR AGENT VX (DERMAL EXPOSURES) IN MILLIGRAMS OF AGENT PER SQUARE METER OF SURFACE AREA (mg/m^2).

PURPOSE/USES

One percent lethalities could be expected if levels are exceeded. The principal route of exposure is dermal (i.e., skin contact).

INFORMATION

Agent	Proposed LD_{01} contamination density (upper range; median to maximum)	Exposure duration
VX	0.075 to 0.375 mg/m^2	= 4 hrs
	0.038 to 0.188 mg/m^2	= 8 hrs
	0.019 to 0.094 mg/m^2	= 16 hrs

REFERENCES

Reutter, S.A., E. J. Olajos, R. J. Mioduszewski and A. Watson 1994. *White Paper - Validation of Contact Hazard Toxicity Estimates for Agents VX and HD, Phase II* ERDEC-SP-017. Edgewood Research Development Engineering Center, US Army Chemical and Biological Defense Command, Aberdeen Proving Ground, MD (February 1994).

COMMENTS

LD_{01} is the calculated dose that is expected to cause death in 1% of the exposed population. Assumes a 70 kg person and the population is defined as emergency responder, not general population.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Military Standard

ITEM

MILITARY ALTERNATIVE 5X DECONTAMINATION MEASUREMENT (OFF-GAS AGENT CONCENTRATION).

PURPOSE/USES

A concentration used to determine if items (e.g., equipment) have been decontaminated of the indicated agent.

INFORMATION

An alternative 5X methodology (health-risk based release concentrations) is under development by the DA Steering Committee for Chemical Agent Standards (USACHPPM lead).

REFERENCES

U.S. Department of the Army (DA). Toxic Chemical Agent Safety Standards, Army Regulation 385-61 (DA 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (March 31, 1997).

COMMENTS

5X is a specific level of decontamination assigned to items which have been subject to liquid contamination or long-term vapor contamination. The 5X procedures will ensure that the total quantity of agent is less than the minimal health effects dosage as determined by the Surgeon General. One approved method for decontamination is heating the item to 538 degrees C (1000 degrees F) for 15 minutes. This is considered sufficient to destroy chemical agent molecules. Refer to DA Pamphlet 385-61, Chapter 5 Decontamination and Disposal for decontamination of personnel, equipment, and facilities.

Perform surface decontamination according to CSEPP approved procedures (see Appendix L of the CSEPP Planning Guidance). Monitoring is required.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Military Standard

ITEM

MILITARY DECONTAMINATION PROCEDURES FOR SELF AND BUDDY.

PURPOSES/USES

To provide military procedures for the decontamination of personnel. To eliminate an immediate threat to human life.

INFORMATION

Refer to the Army's NBC Decontamination, Field Manual 3-5; Chemical and Biological Contamination Avoidance, Field Manual 3-3; Decontamination of Facilities and Equipment, Technical Bulletin 700-4, and; Toxic Chemical Agent Safety Program, DA Pamphlet 385-61.

REFERENCES

U.S. Department of the Army (DA) 1993. NBC Decontamination, Field Manual FM 3-5, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA) 1992. Chemical and Biological Contamination Avoidance, Field Manual FM 3-3, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). Decontamination of Facilities and Equipment, Technical Bulletin TB 700-4, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). Toxic Chemical Agent Safety Standards, DA Pamphlet 385-61 (DA 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (March 31, 1997).

COMMENTS

Decontaminate as soon as possible. Decontaminate as far forward as possible. Decontaminate by priority.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Military Standard

ITEM

MILITARY DECONTAMINATION PROCEDURES FOR PATIENTS, HEALTH CARE PROVIDERS, AND FACILITIES.

PURPOSES/USES

To provide military procedures for the decontamination of patients at medical stations. Procedures must be in place to prevent the spread of contamination to health care providers and facilities.

INFORMATION

Refer to the Army's NBC Decontamination, Field Manual 3-5; Chemical and Biological Contamination Avoidance, Field Manual 3-3; Decontamination of Facilities and Equipment, Technical Bulletin 700-4, and; Toxic Chemical Agent Safety Program, DA Pamphlet 385-61.

REFERENCES

U.S. Department of the Army (DA) 1993. NBC Decontamination, Field Manual FM 3-5, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA) 1992. Chemical and Biological Contamination Avoidance, Field Manual FM 3-3, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). Decontamination of Facilities and Equipment, Technical Bulletin TB 700-4, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). Toxic Chemical Agent Safety Standards, DA Pamphlet 385-61 (DA 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (March 31, 1997).

COMMENTS

Decontaminate as soon as possible. Decontaminate by priority.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Military Standard

ITEM

MILITARY DECONTAMINATION PROCEDURES FOR EQUIPMENT.

PURPOSES/USES

To provide military procedures for the decontamination of equipment.

INFORMATION

Refer to the Army's NBC Decontamination, Field Manual 3-5; Chemical and Biological Contamination Avoidance, Field Manual 3-3; Decontamination of Facilities and Equipment, Technical Bulletin 700-4, and; Toxic Chemical Agent Safety Program, DA Pamphlet 385-61.

REFERENCES

U.S. Department of the Army (DA) 1993. NBC Decontamination, Field Manual FM 3-5, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA) 1992. Chemical and Biological Contamination Avoidance, Field Manual FM 3-3, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). Decontamination of Facilities and Equipment, Technical Bulletin TB 700-4, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). Toxic Chemical Agent Safety Standards, DA Pamphlet 385-61 (DA 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (March 31, 1997).

COMMENTS

Decontaminate by priority.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Military Standard

ITEM

MILITARY DECONTAMINATION PROCEDURES FOR HUMAN REMAINS.

PURPOSES/USES

To provide military procedures to ensure human remains have no detectable agent greater than the military airborne exposure limits for unmasked chemical agent workers before release for public burial.

INFORMATION

Agent	*Human remains after decontamination*
GA/GB	*.0001 mg/m^3*
GD	*.00003 mg/m^3*
VX	*.00001 mg/m^3*
*H, HD, HT**	*.003 mg/m^3*
L	*.003 mg/m^3*

**All concentrations measured as L.*

REFERENCES

Elam, Fred E., Major General, U.S. Department of the Army, Office of the Deputy Chief of Staff for Logistics, memo to Vice Chief of Staff, Joint Procedures for Decontaminating Human Remains in Operation Desert Storm, (February 26, 1991), U.S. Department of the Army, Office of the Deputy Chief of Staff for Logistics, Washington, DC.

COMMENTS

Decontamination procedures (i.e., hypochlorite wash/soak) are performed. Military gross level detection equipment is used to determine if gross level contamination still exists. If not, remains are checked by low level detection equipment to confirm remains meet the required standards.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Military Standard

ITEM

MILITARY DISPOSAL PROCEDURES FOR DECONTAMINATION WASTES.

PURPOSES/USES

To provide military procedures to ensure decontamination wastes are managed and disposed of in accordance with applicable federal, state, and local laws, regulations, policies, and procedures.

INFORMATION

Refer to the Army's NBC Decontamination, Field Manual 3-5; Chemical and Biological Contamination Avoidance, Field Manual 3-3; Decontamination of Facilities and Equipment, Technical Bulletin 700-4, and; Toxic Chemical Agent Safety Program, DA Pamphlet 385-61.

Refer to the Code of Federal Regulations, Title 49, Parts 171-177, Hazardous Materials Regulations, and Part 178 Shipping Container Specifications, and; Code of Federal Regulations, Title 40, Parts 260-265 and 270, Regulations for the Management of Hazardous Waste.

Refer to appropriate state and local laws, regulations, policies, and procedures.

REFERENCES

U.S. Department of the Army (DA) 1993. NBC Decontamination, Field Manual FM 3-5, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA) 1992. Chemical and Biological Contamination Avoidance, Field Manual FM 3-3, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). Decontamination of Facilities and Equipment, Technical Bulletin TB 700-4, Headquarters, U.S. Department of the Army, Washington, DC.

U.S. Department of the Army (DA). Toxic Chemical Agent Safety Standards, DA Pamphlet 385-61 (DA 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (March 31, 1997).

***ITEM* (Continued)**

MILITARY DISPOSAL PROCEDURES FOR DECONTAMINATION WASTES.

REFERENCES

Code of Federal Regulations, Title 49, Parts 171-177, Hazardous Materials Regulations, and Part 178 Shipping Container Specifications.

Code of Federal Regulations, Title 40, Parts 260-265 and 270, Regulations for the Management of Hazardous Waste.

COMMENTS

Refer to the military alternative 5X decontamination measurement.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Guideline

ITEM

CSEPP SELF AND OTHERS DECONTAMINATION PROCEDURES.

PURPOSES/USES

To provide guidance on how to plan (i.e., priorities and procedures) for decontamination in the event of a CSEPP chemical agent release.

INFORMATION

Refer to Appendix L (Guideline L.4, page L-7) of the CSEPP Planning Guidance.

REFERENCES

Federal Emergency Management Agency (FEMA) and US Department of Army (DA) 1996. *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*, Washington, DC, FEMA 1996.

COMMENTS

The first decontamination priority is people; second is essential equipment (e.g., ambulances), and; third is less critical assets such as livestock, private property, and croplands.

Decontaminate as soon as possible. Decontaminate only what is necessary. Decontaminate as close to the contaminated area as possible.

Do it fast - do it right!

Refer to military standards for self and buddy decontamination.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Guideline

ITEM

CSEPP DECONTAMINATION PROCEDURES FOR PATIENTS, HEALTH CARE PROVIDERS, AND FACILITIES.

PURPOSES/USES

To provide guidance on how to plan (i.e., priorities and procedures) for decontamination of patients by health care providers in the event of a CSEPP chemical agent release.

INFORMATION

Refer to Appendix L (Guidelines L.5, L.6, and L.7, starting page L-8) of the CSEPP Planning Guidance.

REFERENCES

Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1996. *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*, Washington, DC, FEMA 1996.

COMMENTS

The interaction between decontamination and the provision of medical services in particularly important. Medical attention, including decontamination must be provided to all people who need it, however, procedures must be in place to prevent the spread of contamination to health care providers and facilities.

Refer to military standards for patients, health care providers, and facilities.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Guideline

ITEM

CSEPP RESPONSE PHASE DECONTAMINATION PROCEDURES FOR EQUIPMENT.

PURPOSES/USES

To provide guidance on how to plan (i.e., priorities and procedures) for decontamination of equipment in the event of a CSEPP chemical agent release.

INFORMATION

Refer to Appendix L (Guidelines L.5 page L-8) of the CSEPP Planning Guidance.

REFERENCES

Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1996. *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*, Washington, DC, FEMA 1996.

COMMENTS

Decontaminate only essential equipment like ambulances.

Refer to military standards for equipment.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Guideline

ITEM

CSEPP DECONTAMINATION OF HUMAN REMAINS.

PURPOSES/USES

To provide guidance on how to plan (i.e., priorities and procedures) for the decontamination of human remains in accordance with all applicable federal, state, and local laws, regulations, policies, and procedures in the event of a CSEPP chemical agent release.

INFORMATION

Refer to Appendix M (Guideline M.5, starting page M-15) of the CSEPP Planning Guidance.

REFERENCES

Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1997. Planning Guidelines for Recovery Phase Activity, Appendix M to the *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*, Washington, DC, FEMA 1997.

COMMENTS

Refer to military standards for human remains.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Guideline

ITEM

CSEPP DISPOSAL OF DECONTAMINATION WASTES.

PURPOSES/USES

To provide guidance on how to plan (i.e., priorities and procedures) for the disposal of decontamination wastes in accordance with all applicable federal, state, and local laws, regulations, policies, and procedures in the event of a CSEPP chemical agent release.

INFORMATION

Refer to Appendix L (Guideline L.5, page L-8) and Appendix M (Guidelines M.4 and M.5, starting page M-13) of the CSEPP Planning Guidance.

Refer to the Code of Federal Regulations, Title 49, Parts 171-177, Hazardous Materials Regulations, and Part 178 Shipping Container Specifications, and; Code of Federal Regulations, Title 40, Parts 260-265 and 270, Regulations for the Management of Hazardous Waste.

Refer to appropriate state and local laws, regulations, policies, and procedures.

REFERENCES

Code of Federal Regulations (*CFR*), Title 49, Parts 171-177, Hazardous Materials Regulations, and Part 178 Shipping Container Specifications.

Code of Federal Regulations (*CFR*), Title 40, Parts 260-265 and 270, Regulations for the Management of Hazardous Waste.

Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1996. *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*, Washington, DC, FEMA 1996.

Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1997. Planning Guidelines for Recovery Phase Activity, Appendix M to the *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*, Washington, DC, FEMA 1997.

COMMENTS

Refer to military standards on the disposal of decontamination wastes.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Guideline

ITEM

CSEPP RECOVERY PHASE DECONTAMINATION PROCEDURES.

PURPOSES/USES

To provide guidance on how to plan (i.e., priorities and procedures) for recovery phase decontamination in the event of a CSEPP chemical agent release.

INFORMATION

Refer to Appendix M (Guidelines M.2 through M.9, starting page M-11) of the CSEPP Planning Guidance.

REFERENCES

Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1997. Planning Guidelines for Recovery Phase Activity, Appendix M to the *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*, Washington, DC, FEMA 1997.

COMMENTS

Establish a list of priorities like - (1) critical assets, (2) livestock and companion animals, (3) drinking water, (4) personal property, (5) real estate and terrain, (6) incidental personal property, and (7) fodder, feed, and crops.

DECONTAMINATION LIMITS AND PROCESSES

CATEGORY

Guideline

ITEM

CSEPP REENTRY AND RESTORATION DECONTAMINATION PROCEDURES.

PURPOSES/USES

To provide guidance on how to plan (i.e., priorities and procedures) for reentry and restoration decontamination in the event of a CSEPP chemical agent release.

INFORMATION

Refer to Appendix M (Guidelines M.11 through M.18, starting page M-25) of the CSEPP Planning Guidance.

REFERENCES

Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1997. Planning Guidelines for Recovery Phase Activity, Appendix M to the *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*, Washington, DC, FEMA 1997.

COMMENTS

Establish a list of priorities like - (1) livestock and companion animals, (2) vegetation used as food, and surface water sources used as drinking water, (3) surfaces with which humans are likely to come in contact (e.g., structures, vehicles), (4) soil, (5) meat and milk, and (6) non-drinking water supplies.

CHEMICAL SURETY LIMITS AND PROCESSES

CATEGORY

Military Standard

ITEM

MILITARY CHEMICAL SURETY LABORATORY SAFETY STANDARDS.

PURPOSES/USES

To ensure laboratory safety through established military standards and applicable federal, state, and local laws, regulations, policies, and procedures.

INFORMATION

Refer to the Army's Toxic Chemical Agent Safety Program, DA Pamphlet 385-61, and; Nuclear and Chemical Weapons and Material, Chemical Surety, AR 50-6.

Refer to the Code of Federal Regulations, Title 29, Part 1450, Occupational Exposure to Hazardous Chemicals in Laboratories.

Refer to appropriate state and local laws, regulations, policies, and procedures.

REFERENCES

U.S. Department of the Army (DA). Toxic Chemical Agent Safety Standards, DA Pamphlet 385-61 (DA 385-61). Army Safety Office, Headquarters, U.S. Department of the Army, Washington, DC (March 31, 1997).

U.S. Department of the Army (DA). Nuclear and Chemical Weapons and Material, Chemical Surety, Army Regulation (AR) 50-6, Headquarters, U.S. Department of the Army, Washington, DC.

Code of Federal Regulations (CFR), Title 40, Part 1450, Occupational Exposure to Hazardous Chemicals in Laboratories.

COMMENTS

These standards (military and federal) are a valid method of eliminating/reducing the unique hazards associated with research and development laboratory operations (agent operations and storage).

CHEMICAL SURETY LIMITS AND PROCESSES

CATEGORY

Guideline

ITEM

CSEPP CHEMICAL SURETY LABORATORY SAFETY GUIDELINES.

PURPOSE/USES

To provide guidance on how to plan (i.e, priorities and procedures) for laboratory safety through all applicable federal, state, and local laws, regulations, policies, and procedures in the event of a CSEPP chemical agent release.

INFORMATION

Refer to Appendix M (Guideline M.16, page M-29) of the CSEPP Planning Guidance.

Refer to Code of Federal Regulations (*CFR*), Title 40, Part 1450, Occupational Exposure to Hazardous Chemicals in Laboratories.

Refer to applicable state and local laws, regulations, policies, and procedures.

REFERENCES

Code of Federal Regulations (*CFR*), Title 40, Part 1450, Occupational Exposure to Hazardous Chemicals in Laboratories.

Federal Emergency Management Agency (FEMA) and U.S. Department of Army (DA) 1997. Planning Guidelines for Recovery Phase Activity, Appendix M to the *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*, Washington, DC, FEMA 1997.

COMMENTS

Protocols for sample handling and analysis to ensure accurate and reliable laboratory results (includes chain of custody, holding temperatures for environmental samples, shipping notification requirements and quality control procedures, etc.). There are a limited number of qualified analytical chemical surety laboratories.

Refer to the military standards for chemical surety laboratory safety standards.

MISCELLANEOUS

CATEGORY

Guideline

ITEM

SAMPLING PROTOCOLS.

PURPOSE/USES

Protocols for sample collection handling and analysis to ensure accurate, reliable samples and laboratory analysis. The information is needed to characterize the boundaries of agent distribution and identify "hot spots" in the environment.

INFORMATION

Under development by USACHPPM.

REFERENCES

COMMENTS

The protocols under development will be based on existing, standard EPA environmental sampling and risk assessment protocols. The EPA guidance and procedures are designed for collecting and evaluating chemical contaminants in the environment and are directly applicable to addressing potential chemical agent contamination. Certain chemical unique parameters as well as site-specific parameters must be incorporated in sampling plans. The USACHPPM is developing the protocol that will incorporate both the standard practices and areas requiring specific site/chemical input.

APPENDIX B

USACHPPM "JUST THE FACTS" INFORMATION SHEET ON REFERENCE DOSE

SEPTEMBER 1997

APPENDIX B
USACHPPM "JUST THE FACTS" INFORMATION SHEET ON REFERENCE DOSE
SEPTEMBER 1997

U.S. Army Center for Health Promotion and Preventive Medicine

Just the Facts 91-007-0297

Reference Dose

Reference Dose (RfD). RfD is an estimate, with an uncertainty spanning perhaps an order of magnitude or greater, of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime.[2] RfD doses are expressed in units of milligram chemical per kilogram body weight per day (mg/kg/da). They are used in evaluating the potential noncarcinogenic effects associated with exposure periods of between 7 years (approximately 10 percent of a human lifetime) and a lifetime. RfDs are applicable to the oral exposure pathway, such as from ingestion of contaminated soil or water. RfDs for the majority of the contaminants of concern at Superfund Program cleanup sites are listed by the United States Environmental Protection Agency (USEPA) in its Integrated Risk Information System (IRIS), or Health Effects Assessment Summary Tables (HEAST).[3]

Dose-Response Assessments. This is the process of quantitatively evaluating toxicity information and characterizing the relationship between the dose of a contaminant administered or received and the incidence of adverse health effects in the exposed population. From a quantitative dose-response relationship, toxicity values are derived that are used in the risk characterization step to estimate the likelihood of adverse effects occurring in humans at different exposure levels[2]. In the case of noncancer critical effects, the USEPA terms this toxicity value the RfD.

Selection of the Critical Data. Estimating an RfD for a given compound requires consideration of subchronic or chronic toxicity data, identification of a critical effect, identification of a Lowest-Observed-Adverse Effect Level (LOAEL) or a No-Observed Adverse-Effect Level (NOAEL), and use of the uncertainty factor (UF) and modifying factor (MF) protocol.[2] All available studies examining the toxicity of a chemical following exposure by the oral route are to be gathered and judged for their scientific merit. Occasionally, studies based on other exposure routes are considered, and the data adjusted for application to the oral route by means of standard assumptions. Any differences between studies are to be reconciled and an overall evaluation reached. If adequate human data are available, these should be used as the

References.

1. Cicmanec, J.L., M.L. Dourson and R.C. Hertzberg, Noncancer Risk Assessment: Present and Emerging Issues," Chapter 17, in Fan, A. M. and L.W. Chang (eds), *Toxicology and Risk Assessment: Principles, Methods, and Applications*, Marcel Dekker, Inc., New York, NY, 1996.

2. U.S. Environmental Protection Agency, EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A), Interim Final*, Office of Emergency and Remedial Response, Washington, DC, December, 1989.

3. U.S. Environmental Protection Agency, *Integrated Risk Information System (IRIS), Online*, Environmental Criteria and Assessment Office, Cincinnati, OH, 1990.

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APPENDIX B
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basis for an RfD. Otherwise, data from animal studies are to be used.[2] Scientific judgment must be exercised during the selection process. In the absence of a species that is clearly the most relevant, USEPA assumes that humans are at least as sensitive to the substance as the most sensitive animal species tested. Therefore, as a matter of science policy, the study on the most sensitive species is selected as the critical study for the basis of the RfD.

NOAEL. The NOAEL is the highest experimental dose of a chemical at which there is no statistically or biologically significant increase in frequency or severity of an adverse effect (including the critical toxic effect) in individuals in an exposed group when compared with individuals in an appropriate control group. Some effects may be produced at this level, but they are not considered to be adverse, nor precursors to specific adverse effects. The NOAEL is one of the most important data points obtained from the study of the dose-response relationships and is the primary measurement upon which the quantitative assessment of the human risk is based. The NOAEL selection is based in part on the assumption that, if the critical toxic effect is prevented, then all toxic effects are prevented.

LOAEL. In dose-response experiments, the LOAEL is defined as the lowest exposure level at which there are statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group.[2] The effect thus characterized, after adjustment for species differences, is referred to as the critical toxic effect. In some studies, only a LOAEL rather than a NOAEL is available.

Selection of UFs and MFs. UFs are adjustments in the NOAEL or LOAEL to accommodate areas of scientific uncertainty inherent in most toxicity data sets. Currently, UFs from 1 to 10 each are applied to extrapolate from animals to humans (UF_H), to provide protection for unusually sensitive individuals if the animal species in the critical study is more sensitive to a chemical than humans (UF_A), to expand from subchronic to chronic exposure (UF_S), to estimate a NOAEL from the LOAEL (UF_L) and to reflect deficiencies in the data base (UF_D). Lower UFs may be applied in instances where they can be justified. For example, a non-adverse critical effect which is symptomatic of more serious effects at higher levels (e.g., moderate changes in blood cholinesterase levels), requires a lower UF (e.g., UF=3) than adverse toxic effects (e.g., liver damage). In calculating the composite UF, the product should reflect the imprecision of the overall UF determination (e.g., 3 x 3 is 10). The maximum total UF applied in the derivation of an RfD is 10,000.[1]

There may be additional uncertainties in estimating an RfD such as scientific uncertainties in the key study, study design anomalies, or chemical specific issues. In these instances, an MF greater than zero but ≤ 10 is applied to account for these considerations. The default value for the MF is 1.

Derivation of Reference Dose. The RfD is derived from the NOAEL or LOAEL by consistent application of UFs that reflect various types of data sets used to estimate RfDs. The RfD is calculated as follows:

$$RfD = \frac{\text{NOAEL or LOAEL}}{UF_H \times UF_A \times UF_S \times UF_L \times UF_D \times MF}$$

Application. The RfD can be used to calculate safe drinking water levels, soil cleanup levels, safe food contaminant levels, and other "safe" media-specific concentrations where persons may be at risk by ingesting contaminated portions of that media. The RfD is translated into these safe media concentrations levels by incorporating site-specific information called exposure factors. These exposure factors include information such as exposure frequency, exposure duration, estimated amount of contaminated soil/water/specific food ingested, ingestion rate, and body weight. These site-specific variables and the RfD are incorporated into a health risk assessment according to USEPA-approved methodologies and calculations.[2] Thus "safe" environmental standards are backcalculated from the toxicological reference point (i.e., the RfD). The actual determination of whether a material is "safe" will be dependent on the situation.

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