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Recommendations for Protecting Human Health Against Potential Adverse Effects of Long-Term Exposure to Low Doses of Chemical Warfare Agents

In 1970, Congress gave the Department of Health and Human Services (DHHS) responsibility for reviewing Department of Defense (DOD) plans for transporting and/or disposing of certain chemical agents and making recommendations for the protection of human health and safety (Public Law (Pub. L.) 91-121/441 (50 USC 1512)). DHHS has delegated this authority to CDC. In 1985, Congress passed Pub. L. 99-145 (50 USC 1521), which mandates destruction of the present stockpile of selected chemical agents by September 30, 1994. The specific agents are listed below. In the absence of federal regulatory standards, DOD developed safety and health standards for handling these agents. In reviewing these standards and making its recommendations, CDC sought the assistance of a working group of experts.

The national stockpile of chemical agents includes six chemicals: Nerve Agents GA (Tabun or ethyl N,N-dimethylphosphoramidocyanidate) GB (Sarin or isopropyl methylphosphonofluoridate) VX (S-(2-diisopropylaminoethyl) O-ethyl methyl phosphonothiolate) Vesicants/Blister Agents H, HD (Sulfur mustard or di-2-chloroethyl sulfide) T (Bis(2-chloroethylthioethyl) ether) L (Lewisite or dichloro (2-chlorovinyl) arsine) Like a number of widely used insecticides, the nerve agents GA, GB, and VX are organic compounds containing phosphorus (organophosphorus compounds). They affect nerves, muscles, and glands by inhibiting acetyl cholinesterase, an enzyme required for proper function of these tissues. H and L (an organic compound containing arsenic) are vesicants. They cause chemical burns or blisters of the skin and mucous membranes, such as the conjunctiva of the eyes and the mucosa of airways. The bulk of the national stockpile consists of H, VX, and GB; therefore, CDC, through open meetings, convened a working group of experts to consider adverse effects of acute exposure to these agents.

In 1987, DOD published an environmental impact statement that discussed options for destroying the national chemical stockpile. The preferred alternative was onsite incineration. DOD proposed building an incinerator at each of eight locations and burning the agent for complete chemical breakdown. The recommended control limits are based on air concentrations (Table 1). During public meetings held at each of the eight sites, citizens voiced their concerns about chronic low-level exposure to the agents and the delayed effects that acute exposure might cause. To resolve questions about these concerns, CDC gathered data on these agents and held an open meeting with the working group on September 29-30, 1987, in Atlanta, Georgia. The group discussed the potential health hazards that might result from the destruction of the stockpile, including organophosphate-induced delayed neuropathy, electroencephalographic (EEG) changes, cancer, birth defects, and keratitis. The group studied published and unpublished reports of all potential adverse effects, including carcinogenicity, mutagenicity, and

teratogenicity, for the aforementioned agents. In addition, the U.S. Army Surgeon General's Office summarized a number of studies now under way or recently completed for agents GB, VX, HD, and L.

Nerve degeneration is considered an unlikely outcome either from acute intoxication with any of the nerve agents or from long-term exposure to them. Given the difficulty of demonstrating EEG changes and the absence of clinically significant effects even if the EEG changes are present, members of the working group considered the EEG changes reported after intoxication with GB to be questionable. None of the nerve agents have been shown to be mutagenic or carcinogenic. Results of recently completed studies on GB and initial reports of studies on VX indicate no teratogenic effect.

Available epidemiologic data indicate that H is a human carcinogen. Although the data suggest that H is less potent than such other known human carcinogens, as smoking, radon, and chromates they do not permit an estimate of the carcinogenic potency or the exact degree of the carcinogenic risk with confidence. Very little information is available on the long-term toxicity of agent T, which has much lower volatility than H, with which it is mixed. It is not expected to constitute an airborne hazard unless H is also present at concentrations much higher than permitted. Recommended control limits for agent T are therefore identical to those for H.

Toxicologic information specific to L is sparse. More is known about arsenic-containing compounds in general, but caution must be used in extrapolation. Some evidence suggests that L might be a carcinogen. The recommended control concentration limit, 0.003 mg/m³ (measured as L), in air should be adequate to protect public health. The Occupational Safety and Health Administration (OSHA) has promulgated a standard of 0.5 mg/m³ (measured as arsenic) for organic arsenic concentrations in workplace air. The National Institute for Occupational Safety and Health (NIOSH) has recommended a standard of 0.002 mg/m³ for all forms of arsenic. The proposed L control limits are lower than the existing OSHA occupational standard for organic arsenic by a factor of approximately 500 and are lower than the NIOSH recommended standard by a factor of 2.

Reported by: Special Programs Group, Office of the Director, Center for Environmental Health and Injury Control, Centers for Disease Control.

Editorial Note

Editorial Note: CDC, in its continuous oversight of demilitarization activity, routinely examines each of the eight chemical storage sites in the United States and a chemical munitions incineration facility that has been in operation in Utah since 1979. Consideration is given to the population centers in the surrounding communities at depots. Standard operating procedures for agent handling and worker safety are also observed. This experience indicates that the control limits in Table 1 are attainable. Questions related to the nerve agents have been relatively easy to resolve. The information bases are fairly complete, and there appears to be little risk either of adverse health effects from long-term exposure to low doses or of delayed health effects from acute exposure.

Exposure to or contact with H by any route--respiratory, skin, or oral--should be limited to the extent practicable. This can be accomplished by use of appropriate engineering controls, personal protective equipment, and work practices. Concentrations in the workplace and surrounding air should be measured and verified by instruments that can reliably detect concentrations at or below the control limits. At this time, the most sensitive monitors can reliably measure 0.003 mg/m³ of H and L in the workplace air. Because of dispersion and dilution, this level would be adequate protection for the general population.

The members of the working group also considered DOD's proposal for agent stack emission levels during incineration. These limits should be 1) attainable by a well-designed, constructed, and operated incineration facility, 2) capable of offering an early indication of disturbed operating conditions, and 3) able to be accurately measured in a timely manner. The allowable stack concentrations proposed by DOD meet these criteria and appear to restrict emissions to concentrations well below those that would endanger health. They must be evaluated by air dispersion modeling of credible worst-case events and conditions specific to each site to ensure that they will not result in emissions exceeding the permissible level for the general population and the workplace.

On the basis of the evidence reviewed, members of the working group concluded that human health will be adequately protected from exposure to the chemical agents at the recommended concentrations in this report. Even long-term exposure to these concentrations would not create adverse health effects. The relatively short duration of the disposal program provides an additional margin of safety.

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