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EXPLOSIVE ORDNANCE ENGINEERING

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ABSTRACT

Explosive ordnance engineering is the technical evaluation of risk to the public associated with ordnance contaminated sites, the formulation of risk reduction measures, trade off analysis to compare alternate risk reduction measures and recommendation of the best alternative with respect to engineering judgments and public input. The analysis and evaluations must be mindful all factors normally associated with a full public interest review including a complete range of environmental considerations. We are now engaged in a formalized decision making process were simple solutions require detailed analysis to assure the validity of face value assumptions. We can no longer rely on DOD's or the general public's intolerance for ordnance related risk. Acceptable solutions must appraise environmental consequences, cost and public acceptance, along with safety consideration.

Explosive ordnance engineering is interdisciplinary planning, study, design, and remedial action involving ordnance and explosive waste contamination in accordance with CERCLA and the National Contingency Plan (NCP). Programmatic planning and decision making require engineering and other professional disciplines. They are - site inspections, engineering reports (remedial investigations), feasibility studies, engineering evaluations, cost analysis, miscellaneous route surveys, and others.

The Explosive ordnance mission has two major objectives:

a. To reduce risk to the general public through CERCLA response actions for sites contaminated with ordnance and explosive waste (OEW).

b. To execute response actions for sites contaminated with explosive ordnance with minimum risk to Government personnel and contractors.

This paper provides a descriptive overview of the authorities we are operating under, a definition of ordnance and explosive waste, a description of the ordnance contamination problem, disposal options, and an assessment of the regulatory climate this program operates under.

1. AUTHORITIES.

a. In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601 et seq.

b. In 1983, the Environmental Restoration Defense Account (ERDA) was established by Public Law 98-212. This congressionally directed fund was to be used for environmental restoration at Department of Defense (DOD) active installations and formerly used properties. The DOD designated the Army as the sole manager for environmental restoration at closed installations and formerly used properties. The Secretary of the Army assigned this mission to the Corps of Engineers (USACE) in 1984.

c. In 1986 Congress decided that explosive ordnance is a form of contamination that should be remediated under the Comprehensive Environmental Restoration and Compensation Liability Act (CERCLA). Chapter 160 of the Superfund Amendments and Reauthorization Act Amended CERCLA and established the Defense Environmental Restoration Program (DERP). The program goals are:

(1) The identification, investigation, research and development, and cleanup of contamination from hazardous substances, pollutants, and contaminants.

(2) Correction of environmental damage (such as detection and disposal of unexploded ordnance) which creates an imminent and substantial endangerment to the public health or welfare or to the environment.

(3) Demolition and removal of unsafe buildings and structures, including buildings and structures of the Department of Defense, at sites formerly used by or under the jurisdiction of the Secretary.

These goals gave rise to the hazardous and toxic waste mission. The explosive ordnance engineering mission, and the unsafe debris mission being exacted by the Corps of Engineers.

d. The DERP requires that a CERCLA response action be undertaken whenever such contamination is found at:

(1) Facilities or sites owned by, leased too, or otherwise possessed by the United States and under the jurisdiction of the Secretary of Defense.

(2) Facilities or sites that were under the jurisdiction of the Secretary of Defense and owned by, leased to, or otherwise possessed by the United States at the time of actions leading to contamination.

(3) Vessels owned or operated by the Department of Defense.

e. The National Contingency Plan (NCP) was established by the Clean Water Act of 1972. The NCP has been revised and broadened several times since then. Its purpose is to provide the organizational structure and procedures for remedial actions taken in response to the presence of hazardous substances, pollutants, and contaminations at a site. Section 105 of the 1980 CERCLA states that the NCP shall apply to all response actions taken as a result of CERCLA requirements.

f. In March 1990, the NCP became the National Oil and Hazardous Substances Pollution Contingency Plan given in 40 CFR part 300. Paragraph 300.120 states that "DOD will be the removal response authority with respect to incidents involving DOD military weapons and munitions, or weapons munitions under the jurisdiction, custody, and control of DOD.

2. ORDNANCE PROBLEM.

a. The use of explosive ordnance by the military predates the Revolutionary War. It is possible for ordnance items to remain dangerous for many, many years. Hazardous pieces or ordnance are still found occasionally on Civil War battlegrounds. Advances in materials make it likely that some of today's weapons will be lethal for hundreds of years. In the United States, former battlegrounds are not the most common types of sites containing OEW. Firing ranges and testing areas, munition manufacturing areas, weapon and ammunition storage areas, munition disposal areas, and weapon transport staging areas are all likely to contain OEW contamination.

b. Prior to about 1970, land burial of unneeded ordnance was an accepted practice if sea burial or demilitarization was not practical. If a facility handled ordnance at some time in the past, there is a good possibility that there are some ordnance burial pits at the site. Manufacturing processes were very poorly regulated for many years. Pipes, drain lines, and old structures can contain enough explosive residue to be dangerous. Washout lagoons near manufacturing plants can have virtually anything in them. Some are very hazardous, containing both OEW and hazardous and toxic waste (HTW) contaminants.

c. Not all OEW contamination in the Unites States consists of U.S. ordnance. During and after military campaigns, it has long been common practice for captured foreign weapons and ammunition to be brought into the United States for test and evaluation, or for disposal. After World War II, for example, train cars of foreign ordnance items were brought to munitions plants and eventually buried. This practice adds to the complexity of OEW remediation since very little of this foreign material even enters the inventory records.

d. Thorough recordkeeping was not an enforced requirement until recent decades. Very few of the older sites have accurate logs of what types of ordnance were used, where they were used, or how and where disposal took place. Even in cases where a previous attempt was made to clean up OEW at a facility, the remedial action generally produced only cursory records and few maps showing what was found where.

e. One of the strongest drivers making OEW contamination a serious concern now is the increasing value and scarcity of undeveloped land. At many active defense sites, space is at a premium. It is no longer economically acceptable to keep large sections of land from being used because of OEW contamination.

Urban encroachment has caused ordnance activities to cease at many sites. These former defense properties now look very desirable to developers in sprawling municipalities. In fact, many ordnance contaminated sites are currently subdivisions, parks, and schools.

f. There are over 7,000 formerly used defense sites that have been sold to other Government organizations or to private corporations and citizens. About 1,100 of these sites have been associated with ordnance at some time in their history. All too often, the land use restrictions that were enacted where the DOD disposed of the property are forgotten or ignored. These formerly used defense sites (FUDS) are a special target of CERCLA response actions under the second goal of the Defense Environmental Restoration Program.

3. ORDNANCE AND EXPLOSIVE WASTE (OEW) DEFINED.

Ordnance and explosive waste (OEW) is a form of contamination that presents imminent hazards to exposed individuals. It is typically unique to military operations in that the material comprising the contamination was munitions or munitions related and generally designed to do damage to enemy personnel or material. Ordnance and explosive waste consists of the following types of materials:

a. bombs and warheads,

b. guided and ballistic missiles,

c. artillery, mortar, and rocket ammunition,

d. small arms ammunition,

e. antipersonnel and antitank land mines,

f. demolition charges,

g. pyrotechnics,

h. grenades,

i. torpedoes and depth charges,

j. containerized or uncontainerized high explosives and propellants,

k. materials depleted uranium projectiles,

l. chemical warfare materials (mustard, nerve, etc. agents),

m. components of the above items that are explosive in nature or otherwise designed to cause damage to personnel or materiel (e.g., fuzes, boosters, bursters, rocket motors),

n. soils with explosive constituents in concentrations sufficient to present an imminent safety hazard.

4. DISTINCTION BETWEEN OEW AND HTW.

a. The Defense Environmental Restoration Program that was created in 1986 by the Superfund Amendments and Reauthorization Act requires correction of several types of environmental damage. Ordnance and explosive waste that presents an imminent and substantial endangerment to the public or the environment must be eliminated. In addition, remedial action must be taken if hazardous and toxic waste (HTW) is present. The HTW program is more mature than explosive ordnance engineering and many professionals have grown to associate CERCLA response with HTW. DERP has three (3) goals including HTW, OEW, and unsafe debris.

b. The OEW and HTW contamination categories are separate and distinct. Neither one is a subset of the other.

c. There are some fundamental differences between the characteristics and behavior of OEW and HTW contamination. These differences make it necessary to use different remediation equipment, procedures, and safeguards for OEW and HTW environmental restoration efforts. Consequently, personnel skill requirements and training needs are also somewhat different between the two categories. The following paragraphs summarize factors that set OEW and HTW contamination apart. The distinctions represent the majority of cases, but are not absolute. Exceptions exist to all of them.

(1) Mobility. The HTW contaminants are generally more mobile than OEW contaminants. Hazardous and toxic waste products can move through the environment by direct contact with humans and animals, by becoming entrained in the air, by seeping through the soil, by mixing with groundwater or surface water, or by being absorbed into the food chain of humans and animals. Most of these mobility options do not apply to OEW, particularly not to cased explosive materials. Once deposited at a site, OEW typically remains at that site. There have been instances where OEW objects were moved by localized flooding and erosion. In some climates, the freeze and thaw cycle of the ground causes vertical movement of buried objects. About the only ways that OEW will move any significant distance are through ocean tidal action, or through a deliberate human action, e.g., a dredging operation, or a person collecting souvenirs.

(2) Chemical Determination. Laboratory analysis of soil, air and water samples collected at a HTW site can give an accurate indication of the type and concentration of chemical present. Similar determination cannot be made at the typical OEW site. It is too hazardous to attempt to open old ordnance items to sample the energetic materials inside. Examination of the exterior of an ordnance item often does not give a reliable indication of the interior contents. For example, a given

artillery shell design may get filled with inert simulant, any of a number of different explosives, a shaped charge, multiple explosive bomblets or mines, or chemical surety material (CSM). There are few external clues except paint to indicate the type of fill. At manufacturing and training sites, there can be a wide variety of ordnance items present. Discovery and identification of one ordnance item does not give much information about what type might be located a few feet away.

(3) Concentration. The severity of a HTW hazard and the type of response action selected are strong functions of the concentration level of the HTW remediation actions can stop. On the other hand, concentration has little meaning with respect to OEWcontamination, except in the case where uncased explosive is mixed with soil. OEW concentration is sometimes interpreted as the number of items present per unit volume, but this definition has serious shortcomings. It is difficult to quantify since OEW does not spread uniformly over an area. Also, the definition does not take into account the size of the items. There is no minimum acceptable concentration level associated with OEW. It only takes one item to produce a casualty.

(4) Population at Risk. The target population for HTW contamination can be very broad. Because of the mobility of the HTW, people can be placed at risk long distances from the source of contamination. People who have no direct contact at all with the contamination can still be affected through the food chain. This is not true for OEW. The population at risk is effectively limited to those people on the site who can have nearly direct personal contact with the OEW items.

(5) Onset of Effect. Exposures to HTW contaminants can produce near term and/or long term negative effects. In the case of long term consequences of exposure, a direct cause and effect relationship is often hard to establish for a given individual because the health of an exposed individual is also being affected by so many other stimuli and events unrelated to the HTW contamination. However, statistical assessments covering many years and many individuals have made it clear that prolonged exposure to HTW is a serious health hazard. The effects of ordnance and explosive waste exposures are much more immediate, and easier to measure. Most of the time, being in close proximity to OEW does not produce any lasting negative effect. When an OEW accident does occur, the result is immediate and there is little doubt about the cause and effect relationship.

(6) Control. An individual's control over HTW exposure can be very low. The contaminations generally are not obvious to the individual. The exposure path is often related to life requirements such as breathing, drinking, and eating, so options for avoiding contamination are limited. In contrast, an

individual's control over OEW exposure is usually higher. Being in close proximity to ordnance does not automatically lead to adverse effects. In most cases, the ordnance has to be disturbed in some way before a significant health hazard exists. Curiosity is the most common reason for disturbing an ordnance item. An adult who has been informed of the danger has total control over exposure.

d. It sometimes happens that both OEW and HTW coexist at the same site. In such a case, the ordnance hazard is dealt with first. The OEW remediation personnel must wear protective clothing to safeguard against HTW exposure. Subsequently, when the HTW remediation effort begins, it must be conducted using OEW safety protocols.

e. Ordnance and explosive waste cleanup operations fall under the control of the Department of Defense. Hazardous and toxic waste cleanup operations are under the jurisdiction of the Environmental Protection Agency (EPA). The Department of Defense consults with the EPA regarding environmental concerns, but the EPA does not have regulatory control of the OEW remediation operations. As long as the operations do not transfer OEW from the site, RCRA Part B permits are not required; nor are permits required from local or state Governments. In order to obtain this independence of operation, the DOD must substantiate that the OEW at a site is an imminent and substantial endangerment to the public or the environment in accordance with the provisions of the Superfund Amendments and Reauthorization Act.

5. EXPLOSIVE ORDNANCE UNDER NCP PROCEDURES.

a. NCP Process Overview. The overriding regulation for the OEW cleanup process is CERCLA. The format for the CERCLA response is given in the National Contingency Plan. The usual actions and decisions process associated with a CERCLA OEW response are shown in Figure

b. Preliminary Assessment.

(1) Many sites were "cleared" after World War II. However, OEW hazards exist due to encroachment and erosion. For instance, the techniques used to clear a site were, until relatively recently, quite limited in scope. Therefore, an old report of clearance activity must be weighed carefully to determine if additional clearance action is warranted.

(2) The preliminary assessment (PA) is performed by the local District and Division, and results in an Inventory Project Report (INPR), which is forwarded to the Huntsville Division. A preliminary assessment includes the following:

(a) a detailed description of the site,

(b) description of former site use,

(c) current site uses, ownership, and deed restrictions (results of real estate records review),

(d) detailed description of area inspected (site map is recommended),

(e) risk assessment code (required for OEW projects only).

(3) After the INPR is reviewed, either a project is assigned or a no further action (NOFA) report is filed for the record. The RAC score greatly influences the prioritization of work plans for future years. The program managers' office is developing a SOP for implementation priority which addresses ranking factors.

(4) The site priority list is constantly changing because the site evaluations trickle in over time. For example, an evaluation on a high priority site may be completed after work at some lower priority sites from the previous year started. The ranking of projects is constantly changing. Priorities and response plans are reevaluated after each action is complete. The process is iterative.

(5) A summary of the options available after an INPR is submitted is presented below. Further detail on these alternatives is presented in the sections that follow:

(a) Immediate time critical response needed. An interim removal action will be funded as an emergency response.

(b) An interim removal is needed, but it is not time critical. An Engineering Evaluations/Cost Analysis (EE/CA) will be funded to plan the interim removal action.

(c) Additional information is still needed. An additional site inspection will be funded.

(d) Significant cleanup will be needed. An RI/FS to guide the course of action is required.

(e) No further action required.

c. Site Investigation.

(1) If there is reason to believe that OEW may be at the site, a site investigation is programmed and performed.

(2) The results of the site inspection are used to decide what option to take next from the list of 5 given in the section above. For example, it may be decided that urgency is such that an immediate interim removal action is needed.

d. Engineering Evaluation/Cost Analysis (EE/CA).

(1) An EE/CA is best described as an abbreviated RI/FS and is also known as a scoping assessment. The goal is to do enough study to focus on interim removal or removal action.

(2) If an imminent hazard is judged to exist, there are not many options. Either a clean up is called for, or access can be restricted. OEW remediation offers few choices, unlike HTW where there is a myriad of remediation options. With OEW, the remediation choices are related more to the land use (i.e., who is at risk) than to the type of contamination.

(3) In any OEW remediation, cost estimation is very difficult. Experience to date indicates the cost estimates have been law at virtually every cleanup site. A big part of the problem is accurately estimating the quantity of OEW that will need to be cleaned up. The OEW does not generally get distributed in predictable fashion the way HTW distributes

itself. The OEW is not distributed according to natural laws that can be modeled. Geophysical readings give so many anomalies along with true readings that it is hard to sort out the OEW from the "background noise." Furthermore, the geophysical instruments only indicate the presence of "something," they don't identify the type of item that must be dealt with.

(4) The EE/CA involves an assessment of what was used at the site based upon historical records. Estimates of the maximum penetrations, in the case of impact areas, and how much of the OEW presents a problem in the context of projected land use are made in order to recommend a cleanup depth.

e. Interim Removal Action.

(1) An Interim Removal Action (IRA) may be initiated in one of several modes: at a rapid pace as the result of a site visit which indicates that an urgent response is needed, or at a slower pace following completion of an EE/CA for a site. Imminent hazards which present substantial exposure are judged to require an urgent interim removal action to reduce the imminence of the threat before spending time on an EE/CA or a remedial design. Erection of a fence may sometimes be enough to reduce the emergency nature of the site.

(2) Minimal paperwork and approvals are used for emergency IRAs. A notice that the IRA will take place is sent out and the project is started. No interagency coordination or clearances are sought. Emergency IRA situations do not occur frequently. Real emergencies are generally handled some other way than by funding a CERCLA response.

(3) There is no formal design associated with an interim removal action. Standard removal techniques are used. Ordnance removal follows detection. The interim removal action is a dynamic process in response to an urgent threat. Environmental coordination is accomplished by allowing regulators to review and comment on the work plans.

(4) An after action report must be prepared following each interim removal action.

f. Remedial Investigation/Feasibility Study (RI/FS).

(1) The purpose of the remedial investigation/feasibility study (RI/FS) is to assess site conditions and evaluate alternatives to the extent necessary to select a remedy. Developing and conducting an RI/FS generally includes the following activities: project scoping, data collection, risk

assessment, and analysis of alternatives. The scope and timing of these activities should be tailored to the nature and complexity of the problem and the response alternatives being considered. RI/FS is used for larger and most complex sites, where it is difficult to clearly define problems present.

(2) The CERCLA and NCP goal is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste.

(3) The remedial investigation (RI) produces a thorough characterization of the site. The criteria given in the NCP to guide the feasibility study (FS) in selection of remedy are the following:

(a) overall protection of health and the environment,

(b) long-term effectiveness,

(c) short-term effectiveness,

(d) conformance with applicable and relevant and appropriate requirements (ARARS),

(e) reduction of toxicity, mobility, or volume through treatment,

(f) cost,

(g) State acceptance,

(h) community acceptance,

(i) implementability.

(4) All reasonable alternatives will be considered to address the hazards. Site control, including repurchase or purchase of limited interest to preclude unreasonable use of contaminated property, will be considered along with cleanup measures using traditional and innovative technologies.

(5) The RI/FS serves as both the decision guidance which leads to the record of decision (ROD) and as the environmental documentation.

g. Remedial Design/Remedial Action (RD/RA).

(1) The RD/RA stage includes the development of the actual design of the selected remedy and implementation of the remedy through construction. All RD/RA shall be in conformance with the remedy selected in the RI/FS and set forth in the record of decision (ROD) or other decision document for that site.

(2) All applicable federal, state, and local standards that are identified in the ROD for the action are met. USAEDH oversees design of project; if approved, the District may take over the project at the construction stage and administer the remedial action aspects.

(3) Guidance for the conduct of RD/RA activity is presented in 40 CFR 300.435. Preparation of a scope of work by USAEDH will guide remediation contractors in the preparation of their work plan and cost proposal. Contractors' work plans shall include a Quality Assurance Project Plan, a Site Safety & Health Plan, and a Field Sampling Plan if any analytical samples will be taken to demonstrate compliance with standards set forth in the record of decisions.

(4) Depth of cleanup is site specific and is limited by the state-of-the-art in detection technology. There is no statement or certification issued after an RA which states that the site is now "clean." No one can truthfully make such a statement. DOD 6055.9-STD, "Ammunition and Explosive Safety Standards," states that sites which go from active to former status must be cleaned up to be innocuous. This is sometimes unapproachable with today's technology. The practical standard is use of the best available technology. Land use restrictions are an option when an adequate confidence level cannot be assured. An after action report must be filed following every RA.

(5) Quality assurance checks are made throughout remedial actions. At the end of a project, a QA review is conducted.

(6) Community relations requirements for RD/RA are also specified by the NCP.

h. Post Remediation.

CERCLA requires that post remedial monitoring is required if the selected action allows any contamination to remain on site. Each site must be revisited at a minimum of every 5 years.

6. ORDNANCE AND EXPLOSIVE WASTE (OEW) DISPOSAL.

a. When OEW is found at a site, the location used for disposal is selected from three options:

(1) The OEW is destroyed or rendered safe in-place.

(2) The OEW is transported to a remote area on or in the general vicinity of the OEW site and destroyed.

(3) The OEW is transported off the OEW site to an active military installation and destroyed at the installation.

b. The main consideration when deciding which option to take is the imminence of the hazard. Two primary factors must be weighed: the suspected sensitivity of the OEW to movement and the level of public exposure. Transport of OEW increases the risk to the Government and contract personnel, and also increases public exposure. Consequently, the preferred option is to destroy the OEW in place, assuming it can be accomplished safely, and the least desirable option is to transport the material off the OEW site to an active military installation.

c. On-Site Demolition/Disposal.

(1) OEW items are usually disposed of on-site whenever the situation allows. This is in keeping with the primary criterion of minimizing public exposure to the OEW. RCRA permits and state/local blasting permits are not required for this action.

(2) Once OEW has been detected and exposed, the standard technique for destruction is to use a countercharge. This demolition charge is placed in contact with the OEW and detonated. The goal is to cause the sympathetic detonation of the ordnance and/or apply sufficient pressure and heat to completely neutralize the hazard. The countercharge is positioned to maximize the likelihood of complete destruction of the OEW while controlling and containing debris. After the detonation, the area is always carefully re-examined to make sure that destruction was complete.

(3) Safety constraints may not always permit OEW disposal in-place. An alternative is to collect the items at a specific location on the site where destruction can safely take place. The countercharge destruction method can again be used to destroy the collected items. Burning is another destruction technique. Detonation or burning of explosive wastes are currently the most effective means of on-site OEW disposal.

(4) Burning has been a widely used ordnance disposal technique for many decades. It has disadvantages; however, that are now curtailing its use in many OEW remediation operations. An incendiary device is used to initiate burning of the OEW. Safety procedures must always prepare for the possibility that the burn will transition to a detonation. In particular, primary explosives such as lead azide, mercury fulminate, lead styphnate, and tetracene can be expected to detonate when involved in a fire. Some explosives give off toxic fumes when burned. Explosives that have been exposed to fire, but not completely destroyed must be treated with extreme care. Chemical and physical changes may have occurred that make the material much more sensitive than in its original state.

(5) The fuze is considered the most hazardous component of unexploded ordnance. The condition of the fuze is one of the factors considered when deciding whether or not to transport munitions. Often the fuze condition cannot be ascertained from an external examination of an unexploded ordnance item. In such cases, the fuze is assumed to be in the armed condition, and in-place destruction should be used. Piezoelectric fuzes are of particular concern. They are extremely sensitive and can fire at the slightest physical change.

d. Transport to an Installation.

(1) If OEW must be transported off-site for disposal, the provisions of 49 CFR 100-199, TM 9-1300-206, and state and local laws shall be followed.

(2) When a decision is made to transport OEW over public roads, a careful and detailed risk assessment should be conducted to select the route and timing that minimizes public exposure to the material. The risk analysis should take into consideration the following characteristics of the shipment and the alternative routes:

(a) number of transport vehicles to be used and the net explosive weight of each,

(b) vehicle accident statistics specific to the region,

(c) traffic density of candidate roads,

(d) population density along candidate routes,

(e) locations of significant public gathering places such as schools, hospitals, shopping malls, etc.,

(f) sensitive environmental areas traversed by the routes,

(g) availability of emergency response teams and equipment in the communities along the route.

e. Noise and Blast Control.

(1) Noise is one of the concerns for communities that are adjacent to proposed OEW remediation sites. It is very important that remediation plans include steps to reduce noise. Project personnel who participate in public hearings about the remedial action should be well versed on what noise reduction measures will be taken.

(2) The noise produced by a detonation is characterized by a high peak and a very short duration. At some distance from the explosion, exposure to a relatively high sound level (e.g., 140 db) will not produce physiological damage because the duration is so short. Repetitive exposures can; however, certainly be a nuisance that will produce complaints.

(3) The most straighforward way to reduce noise levels is to place limits on the amount of explosive material that can be detonated at one time. The benefit of reduced noise per detonation must be traded off against the increased number of detonations that will be required to dispose of a given amount of material.

(4) Detonations in open holes and trenches are the noisiest option. Digging a deeper hole or trench does little to reduce noise levels for the depths that are practical in most OEW scenarios. Tamping holes or trenches with fill material is an effective way to reduce the noise level.

(5) Weather conditions can have a significant effect on the noise characteristics of a detonation. A clear sky is the best condition for blasting operations. Heavy overcast can cause the sound to carry to greater distances.

(6) A computer program is available for predicting the noise levels from a detonation as a function of distance from the explosion. This program is based upon empirical data compiled from a large number of detonations under varying conditions. Scaling charge weight, burial depth, and observer distance allows the data to be applied to a variety of circumstances.

7. REGULATORY CLIMATE.

a. General.

(1) The Army is an environmentally conscious organization. Therefore, conduct of all program will ensure that the environment is protected to the greatest extent possible.

(2) DOD is the recognized national expert in matters relating to the safe handling and disposition of military munitions and ordnance. DOD and Army regulations governing transportation, storage, maintenance, inspections, safety, and security in handling of military munitions and ordnance are very stringent and provide maximum protection for personnel and the environment. Further, Section 300.120(C) of the Final National Contingency Plan state that DOD is the removal response authority for incidents involving military weapons and munitions. The USEPA has concurred in the preparation of AR 200-1 which requires that clearance of conventional ordnance from private lands be conducted under Ammunition and Explosives Safety Standards (AR 385-64). As stated in Section 1-4 of this document, the DOD is the lead agency for ordnance and explosive waste (OEW) remediation. Authority has been delegated to the Huntsville Division of the Corps of Engineers as a mandatory center of expertise (MCX) and Design Center. The EPA is the lead agency for hazardous and toxic waste (HTW) remediation, but within the USACE, the Missouri River Division is the MCX and Design Center for HTW.

(3) OEW removal activities do not require HTW-type or RCRA Part B permits from local, state, or federal agencies. USAEDH uses environmental regulators and state agencies as consultants regarding environmental and other concerns; however, no permits are solicited from environmental regulators or other agency in the remediation of OEW on or off site.

(4) There are distinctions between the following terms: act, regulations, guidance, and policy. They are defined as follows: the Act describes Congress' intent in statutory terms and gives the administrator of EPA or other Removal Response Authority the power to implement the Act. Regulations are published in the Federal Register and codified in the Code of Federal Regulations (CFR); they spell out how an Act's directives are to be carried out. Guidance is issued by the EPA or other Removal Response Authority to provide instructions on how a procedure must be conducted. Policy refers to statements developed by EPA or other Removal Response Authorities to provide instructions on how a procedure must be conducted or to outline a position on a particular topic.

b. Federal Regulations.

(1) Each of the major environmental acts impacts any remedial activity. A brief synopsis of those acts follows.

(2) The first major step taken by Congress in establishing a national charter for environmental protection and preservation was the National Environmental Policy Act (NEPA) of 1969. Its intent was to provide information to public officials and citizens on proposed actions so informed decisions could be made. It also requires incorporation of environmental evaluation with other project planning. The NEPA requirements are spelled out in 40 CFR, Parts 1500-1508.

(3) The Clean Water Act (CWA), enacted in 1972, was established to control pollutant discharges to navigable waters. A significant component of the CWA was the establishment of the National Oil and Hazardous Substances Pollution Contingency Plan, known more commonly as the National Contingency Plan (NCP). The NCP was revised in 1990 and is the primary guidance document for remedial response under CERCLA (to be discussed below).

(4) The Safe Drinking Water Act (SDWA) was enacted in 1974 to protect the nation's underground and surface drinking water supplies. The SDWA was amended in 1986 to establish a schedule which required EPA to regulate 83 specific chemical contaminants.

(5) The Toxic Substances Control Act of 1976 (TOSCA) established regulations controlling specific chemical substances or mixtures that pose an imminent hazard.

(6) In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLA provides the methodology for remediation of former operations, and is presented in 40 CFR Parts 300-311. CERCLA rules all environmental remedial actions. Part 300 sets forth the mechanism for implementing the NCP.

(7) The National Contingency Plan (NCP), as amended in 1990, defines the format for response, from planning, to decision making, to post remediation monitoring. The NCP was originally a component of the Clean Water Act. Paragraph 300.120(c) states that "DOD will be the removal response authority with respect to incidents involving DOD military weapons and munitions or weapons and munitions under the jurisdiction, custody and control of DOD." An important aspect is that permitting is not required for OEW response actions; this distinction is important because it facilitates quick response action.

(8) In 1983, the Environmental Restoration Defense Account (ERDA) was established to fund an expanded effort at active DOD installations and formerly used defense sites (FUDS). The DOD assigned management of FUDS to the Army, who then delegated the mission to the USACE in 1984.

(9) CERCLA was reauthorized and amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). Chapter 160 of SARA established the Defense Environmental Restoration Program (DERP). Goal two of the DERP calls for "correction of environmental damage (such as detection and disposal of unexploded ordnance) which creates an imminent and substantial endangerment to the public health or welfare or to the environment" at:

(a) A facility or site that is owned by, leased to, or otherwise possessed by the United States and under the jurisdiction of the Secretary of Defense. A facility or site that was under the jurisdiction of the Secretary of Defense and owned by, leased to, or otherwise possessed by the United States at the time of actions leading to contamination;

(b) A vessel owned or operated by the Department of Defense.

(10) Three categories of contamination are specified for the three situations listed above; they are:

(a) Hazardous Materials. The identification, investigation, research and development, and cleanup of contamination from hazardous substances, pollutants, and contaminants.

(b) Other Environmental Damage (including OEW). Correction of other environmental damage (such as the detection and disposal of unexploded ordnance) that creates an imminent and substantial danger to the public's health or welfare or to the environment.

(c) Unsafe Structures. Demolition and removal of unsafe buildings and structures, including DOD buildings and structures at sites formerly used by or under the jurisdiction of the Secretary of Defense.

(11) The broad goals of the Resource Conservation and Recovery Act (RCRA) are to: protect human health and the environment; to reduce waste, conserve energy and natural resources, and to reduce or eliminate the generation of hazardous waste.

(a) Three distinct and interrelated programs exist under RCRA and are defined under the following subtitles:

1. Subtitle D promotes environmentally sound disposal of hazardous waste. It provides technical standards for landfills and guidelines for state solid waste plans and financial aid to the States. It defines "solid waste," which turns out to be a very broad definition; it includes garbage, refuse, sludges, and other discarded materials, including solid, semisolid, liquid, or contained gaseous materials. Exceptions to the definition of "solid waste" are: domestic sewage in a sewer system, industrial wastewater regulated under the Clean Water Act, irrigation return flows, nuclear materials, and mining materials that are not removed from the ground during the extraction process.

2. Subtitle C established the "cradle to grave" management system for hazardous waste. It defines hazardous waste as a "solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may: (A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed." In simpler terms, a solid waste is hazardous if it meets one of the following four conditions: (1) exhibits a characteristic of a hazardous waste, (2) has been listed as a hazardous material, (3) is a mixture containing a hazardous waste, or (4) it is not excluded from regulation as a hazardous waste. The four characteristics of a hazardous waste are ignitibility, corrosivity, reactivity, and EP Toxicity. All treatment, storage, and disposal facilities (TSD) must comply with these regulations.

3. Subtitle I regulates petroleum product and hazardous substances (as defined under Superfund) stored in underground tasks.

(b) RCRA and CERCLA overlap in a number of ways. For disposal of Superfund wastes, material taken off-site must be treated or disposed of at a site with a RCRA permit; on-site treatment, storage or disposal must meet certain RCRA criteria. EPA now has two mechanisms for corrective action: Superfund and the 1984 RCRA amendments called the Hazardous and Solid Waste Amendments (HSWA). Both CERCLA and RCRA require action towards an imminent hazard.

(c) RCRA's relationship with other environmental acts can be summarized as follows:

1. Clean Air Act: defines the performance standards for air emissions from any TSD.

2. Clean Water Act: any TSD that discharges to a sewer that leads to a Publicity Owned Treatment Works (POTW) must comply with pre-treatment standards. Any discharge to a navigable water must comply with the National Pollutant Discharge Elimination System permitting system.

3. Safe Drinking Water Act: the maximum contaminant levels (MCL) of this Act may be used in ground water monitoring programs at RCRA sites.

4. Toxic Substances Control Act: any facility that handles hazardous waste containing cited chemicals at specified concentrations is regulated under this act as well.

(d) Ordnance found on FUDS may require expedited responses, which includes the resulting treatment and transportation involved to the extent necessary to abate the immediate threat. EOD emergency response action required to abate an immediate safety threat to personnel or property is not subject to regulation under RCRA. Emergency response threat to personnel or property is not subject to regulation under RCRA. Emergency response action is a CERCLA action. Any HTW residue at an open burning/open detonation (OB/OD) site will be cleaned up to applicable standard.

(12) Labor safety laws are embodied in the requirements of the Occupational Safety and Health Administration (OSHA) requirements published in 29 CFR 1910.

(13) Department of Transportation (DOT) requirements are very strict about the use of proper packaging and markings for the shipment of hazardous and toxic materials. Additional detail on the DOT labeling requirements is presented in the previous chapter under training requirements. The DOT regulations are published in 49 CFR Part 173.

(a) Analytical samples that will be collected from streams, ponds, lakes, wells, and soils that are not expected to be contaminated with hazardous materials may be considered to be low concentration (less than 10 ppm of any one contaminant), or environmental samples. Samples of soils and materials collected

from drums, storage tanks, or visibly contaminated wells, ponds, or lagoons, and leachates from hazardous waste sites, should be shipped as medium concentration (greater than 10 ppm and less than 15% of any one contaminant), or hazardous material samples. (Preservation of a sample with acid or sodium hydroxide to the required pH does not, by itself, make a sample hazardous.)

(b) The transportation of surety material without escort by a Technical Escort Unit (TEU) is prohibited. Under no circumstances may civilian aircraft be used for transport of surety material, including dilate material. Military requirements supersede DOT requirements in the case of surety material. Transportation of analytical samples may be by civilian personnel provided the material meets dilute criteria; however, under no circumstances may vehicles used for transport be civilian owned. AR 50-6 is under review and may impact response operations.

(14) Public affairs coordination must be conducted in accordance with the directives for a CERCLA response action as described in the NCP, 40 CFP 300.

c. State and Local Regulations.

(1) No state and local regulations apply to OEW remediation activities; however, the remediation designers and project managers give due consideration to local requirements. The fact that one is doing OEW remedial work does not provide exemption from state and local laws. The objective of the Corps is to be sensitive to the wishes of the local population in accomplishing its goals. Permits will not be sought by the Corps prior to an OEW remediation.

(2) Local and State organizations play an important role in assisting Corps engineers to understand the special concerns of a community or region and what needs to be protected. The Corps will respect and respond to these concerns.

d. Army Regulations.

(1) This bulletin will not attempt to list every Army regulation that may apply to ordnance and environmental remediation. However, some of the more important policy documents are as follows.

(2) 385-16, "System Safety Engineering and Management," establishes responsibilities, requirements, and procedures for risk definition, acceptance, and management. It encompasses all aspects of systems or facilities throughout their life cycle.

The definition of responsibilities is quite detailed. Policy is defined and objectives are stated. Sample formats for documentation of risk assessment and safety releases are provided. further, it reviews risk acceptance criteria via a decision authority matrix.

(3) AR 200-1, "Environmental Protection and Enhancement," prescribes Department of Army responsibilities, policies, and procedures to preserve and protect environmental quality. Definition of responsibilities is broken down into management and commands. It incorporates all relevant requirement for air and water pollution; solid and hazardous waste management; research and development; noise, radon, and asbestos control and abatement; contingency planning and emergency response; and application of CERCLA requirements under the installation restoration program. The guidance presented under "Environmental Restoration Programs" applies to Formerly Used Defense Sites.

(a) It states that the Army will "protect the health and safety of installation personnel and the public and the quality of the environment by identifying and addressing, in a timely manner, the threats posed by uncontrolled hazardous materials on or from Army activities and FUDS." It further states that the Army will address explosive ordnance as defined in AR 75-14 and unexploded ordnance as defined in AR 75-15, in CERCLA activities.

(b) Under "CERCLA requirements," it directs DOD to conduct research on improved methods; requires notification of EPA, State and local authorities; provides opportunity for EPA, State and local authorities to review and comment on plans; establishes a technical review committee; and calls for annual report to congress on the DERP.

(4) AR 50-6, "Chemical Surety," applies to all personnel involved with chemical surety material (CSM), including RDTE solutions, with the exception of Army National Guard or U.S. Army Reserve personnel. It implements the chemical surety program, which defines the facets of safety, security, and reliability, including: accountability of munitions, compliance with safety, security, certification of personnel, accident response, and established procedures to implement plan requirements.

(a) Requirements of the chemical personnel reliability program (CPRP) are detailed. Qualifications of personnel, security clearance, suitability for duty, training requirements, recordkeeping, and medical evaluation and continuing monitoring are covered. Exact procedures are defined for qualification and disqualification for personnel.

(b) Procedures for transportation of CSM are specified. Public LAW 91-212 (5) USC 1511-1518) as amended by PL 91-441 establishes specific provisions to be followed. Movement is governed by class of agent and generally requires technical escort and armed guards. "Safety and security will not be compromised in any way for the sake of economy or ease of operations." Emergency disposal may be conducted free of the prior approval restrictions imposed by Public Law 91-120, 91-121, and 91-441. CSM found on an installation or in the public domain which does not have a military mission will be transported by EOD or technical escort unit (TEU) personnel to the closest installation that has a CSM storage or demilitarization mission for that particular type of CSM.

(c) Chemical Accident and Incident Response and Assistance (CAIRA) refers to a specific set of circumstances and required responses. Responsibilities are defined and reporting procedures are outlined. Specific actions to be taken for public affairs action are defined with examples.

(d) The safety program for chemical surety programs is defined: safety and health considerations, monitoring for agents, first aid, medical surveillance, security alert facilities, and hazard markings.

1. A hazard analysis incorporating a maximum credible event (MCE) consistent with Department of Defense Explosives Safety Board (DDESB) Technical Paper No. 10 will be completed and will accompany the preliminary site plan.

2. Minimum levels of protective clothing will be established by following the criteria in TM 9-1300-206.

3. Personal protective equipment (PPE) will be tested and certified according to procedures specified every three months.

4. Facilities for showering and change out of PPE must be provided. Facilities will be configured and clearly marked to allow segregation of clean and potentially contaminated articles.

5. A dedicated emergency vehicle must be available during all work hours.

6. A decontamination facility must be set up at the site with a minimum of five personnel trained to operate it.

7. Drinking, eating, and smoking are prohibited in limited areas.

8. Personnel working with nerve agents must be checked for symptoms of agent poisoning 30 minutes after leaving the work area and prior to leaving the installation.

9. Personnel working with chemical agents must carry medical alert identification at all times.

10. Workplace monitoring must be carried out during all work hours. Perimeter monitoring should be carried out continuously if there is a possibility of causing a release through agitation of soil or other means. Expert assistance is imperative in the design and operation of the monitoring system.

(e) Procedures to deal with counterintelligence and operational security are specified. Important point for this purpose are procedures for reporting threats and significant incidents.

(f) Accountability requirements for chemical surety material is defined, the significance of which must not be underestimated.

(g) CPRP supplemental guidance for contractor operations is presented.

(h) Procedures for fitting of protective masks is defined in detail.

(5) AR 50-6-1, "Chemical Agent Security Program," applies to all personnel involved with chemical surety materiel (CSM) including RDTE solutions, with the exception of Army National Guard or U.S. Army Reserve personnel. It defines minimum requirements for physical security of CSM in the possession of the Army. It applies to the storage and transportation of CSM worldwide in peacetime and within the continental U.S. during wartime. Coverage includes: responsibilities, policy, national security considerations, inspections, the two-person concept, security planning, vulnerability assessment, and tactical defense planning. It also discusses perimeter security and storage requirements, support facilities, security procedures, key and lock controls, security forces and training, security during transport of CSM, and demilitarization processing facility requirements.

(6) DA Pam 50-6, "Chemical Accident or Incident Response and Assistance (CAIRA) Operations," directs that EOD personnel, assisted by the technical escort unit (TEU) will locate, secure, and render safe all explosively hazardous munitions and seal or containerize any remaining leaking agent containers or munitions. RCRA will not apply until the CM has been determined to be safe, and if possible, transported to the nearest CM installation.

(7) "Safety Provisions for Contracts Involving Chemical Surety Materiel and other Related Military-Unique Chemical Compounds," July 1988, US Army Chemical Research, Development and Engineering Center Safety Office, Aberdeen Proving Ground, Maryland, provides a succinct definition of the requirements for contractors involved in chemical surety work.

(8) HNDP 385-3-1, "Facility System Safety Program Manual," describes the elements of a Facility System Safety (FASS) program. The various analysis techniques used to assess hazards and risk in a FASS are presented and guidance is given for which analysis technique is most appropriate at various stages of facility design and construction. Topics discussed include: risk assessment methods, hazard controls, energy trace and barrier analysis, fault tree analysis, and failure modes and effects analysis.

(9) DOD 6055-9 STD, "Ammunition and Explosives Safety Standards," addresses DOD property contaminated with ammunition and explosives.

(a) Disposal policy is summarized as follows: permanent contamination is unacceptable, disposal by burial or discharge into waterways is unacceptable, burial at sea is acceptable only with certain restrictions.

(b) Each site must maintain permanent records and maps identifying contaminated areas. Contaminated areas must be well marked.

(c) Plans for site activity must be reviewed and approved by the DDESB. Use of contaminated land is restricted to activities that do not disturb the ground below the depth cleared by the decontamination method. Mineral exploration, drilling, and mining are prohibited on contaminated lands and such activity must be separated from contaminated lands by appropriate explosives safety distances and public exclusion distances.

(10) AMC-R 385-100, "Safety Manual," is a comprehensive manual for all manner of activity. Standards for construction, protective clothing, storage of military peculiar items, fire protection, quantity-distance tables, explosives shipment, and transportation are included. One important point made is that the open pit burning of lethal or incapacitating agents or agent filled munitions in any quantity is prohibited.

SUMMARY

This paper describes the explosive ordnance engineering requirements associated with CERCLA response actions at sites contaminated with ordnance and explosive waste. The challenges of explosive ordnance engineering is to incorporate engineering principles, environmental sensitivity, public awareness, and economic reality into what was a unilateral decision process for explosive ordnance disposal and safety personnel.