

**Risk Assessment Methodology to Evaluate Public Risk
for Cleanup of Ordnance
at Formerly Used Defense Sites**

Prepared For

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By

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INTRODUCTION

The Defense Environmental Restoration Program (DERP) is congressionally mandated (Public Law 99-190 and 99-499) and directs the Secretary of Defense to carry out a program of environmental restoration. This mission of environmental restoration has been assigned to the U.S. Army Corps of Engineers (USACE).

The DERP Program allows for the restoration of both active Department of Defense (DoD) sites as well as sites that were formerly used by a DoD component. The program for restoration of active installations is commonly referred to as the Installation Restoration Program (IPR) while the program for restoration of former installations is known as Formerly Used Defense Sites (FUDS).

The DERP goals are (1) to provide for the identification, investigation and cleanup of contamination of hazardous and toxic wastes, (2) to correct other environmental damage which create an imminent and substantial endangerment to the public or the environment, and (3) to dispose of unsafe buildings and structures. The purpose of this paper is to discuss item 2 above with regard to unexploded ordnance on formerly used defense sites.

The Corps of Engineers has been actively establishing a data base of sites meeting the criteria of the DERP-FUDS. That inventory currently stands at over 7,050 sites that fall into the previously mentioned categories of contamination. Of these 7,050 sites, there have been identified 900 formerly used sites that have a high potential for ordnance contamination. With this magnitude of ordnance contaminated sites, it became evident to the USACE, that some mechanisms for evaluating the degree of risk and prioritizing any investigation and remediation effort would be necessary. In addition, due to the potential programmatic cost of the effort, some method(s) must be adopted to manage the public risks to an acceptable level.

RISK ASSESSMENT FOR PROJECT PRIORITIZATION

In the initial stages of development of a procedure to evaluate levels of ordnance contamination and prioritize remediation, it became evident that the real issue was public exposure to ordnance and explosive waste (OEW). Ordnance, unlike Hazardous and Toxic Wastes (HTW), was generally not mobile, in effect it had no medium such as groundwater for transport (the exceptions being erosion or ocean transport). The public generally had control of their exposure to OEW, in effect if you did not touch or disturb the OEW the risk was minimal.

The AR 385-10 and MIL-STD 882B establish policy and procedures for evaluating the risks associated with the operation of Army and DOD facilities and equipment. This procedure evaluates the probability of occurrence, as well as the severity of an occurrence. The combination of the two criteria in the form of a risk matrix provide management with a qualitative tool to evaluate the relative risk associated with operation of the particular facility or equipment.

In considering methods for evaluating OEW sites a similarity emerged in that the severity of a mishap was directly related to type of OEW, and the probability of a mishap was relevant to the potential for accessibility of the OEW to the public. Applying existing Army and DOD criteria and method to evaluate public risks to OEW would greatly simplify the acceptance of the method plus the method was a proven technique for evaluating risks. The primary differences were (1) that the risks being evaluated were not worker related, they were the general public and (2) the evaluation was not of facilities or equipment but of a piece of land.

HAZARD SEVERITY

In the development of the hazard severity, five general categories of EXO were identified. These categories included (1) conventional ordnance and ammunition (small arms ammunition to bombs), (2) pyrotechniques (incendiary, flares, etc.), (3) bulk high explosives (TNT, HMR, RDX, etc.), (4) propellants (solid and liquid), and (5) chemical agents/weapons (GB, VX, HD, BZ, etc.). Within these 5 categories, values were assigned from 0 to 25 based upon the expected hazard associated with public exposure to particular ordnance item. These values were subjective and based upon engineering experience and judgment of the USACE ordnance engineering and explosive safety staff. The Hazard Severity Table is provided by Table A.

TABLE A

HAZARD SEVERITY

Description Value	Level	Category	Value
CATASTROPHIC	I		≥21
CRITICAL	II		≥13 <21
MARGINAL	III		≥ 5 <13
NEGLIGIBLE	IV		< 5

HAZARD PROBABILITY

The hazard probability addresses area, extent, and accessibility of the OEW to the general public. The areas evaluated include (1) location of contamination (surface, subsurface, within pipes or vessels) (2) proximity to inhabited buildings or structures to the OEW site, (3) the number and type of structure (military, child care, hospital etc.), (4) accessibility of site to the public (i.e., barriers provided), and (5) site dynamics that could expose ordnance in the future such as erosion. Within these five categories and subcategories, values were assigned from 0 to 5 based on the potential exposure to the OEW. Again these values were based upon sound engineering, experience, and judgment of an ordnance engineering and explosive safety staff. The hazard probability table is provided by Table B.

TABLE B

HAZARD PROBABILITY

Description	Level	Value
FREQUENT	A	≥27
PROBABLE	B	≥21 <27
OCCASIONAL	C	≥15 <21
REMOTE	D	≥ 8 <15
IMPROBABLE	E	<8

RISK MATRIX

While the probability of occurrence and hazard severity assess the risk to the public, a risk matrix must provide guidance to management on actions or mitigative measures that should be implemented. The risk matrix for OEW was developed to provide environmental managers with environmental remediation recommendation. This Risk Assessment Code (RAC) matrix is shown in Table C. During the initial phases of development of the RAC, 76 OEW sites with good historical information were selected to use as a verification phase for the overall procedure. These 76 sites were independently evaluated using the RAC. Upon completion of this initial assessment, adjustments and refinements were made to better reflect the actual risks of OEW contamination. There was nothing scientific or statistical concerning the verification only practical application of the RAC procedure that has provided a significant level of confidence to the users of the RAC in actual field applications.

TABLE C

Probability Level		FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
Severity Category:						
CATASTROPHIC	I	1	1	2	3	4
CRITICAL	II	1	2	3	4	5
MARGINAL	III	2	3	4	4	5
NEGLIGIBLE	IV	3	4	4	5	5

RISK ASSESSMENT CODE (RAC)

- RAC 1 Imminent Hazard - Emergency action required to mitigate the hazard or protect personnel (i.e., fencing, physical barrier, guards, etc.).
- RAC 2 Action required to mitigate hazard or protect personnel. Feasibility study is appropriate.
- RAC 3 Action required to evaluate potential threat to personnel. High priority confirmation study is appropriate.
- RAC 4 Action required to evaluate potential threat to personnel. Confirmation study is appropriate.
- RAC 5 No action required.

RISK ASSESSMENT FOR PROJECT ACTION ALTERNATIVES

The exact procedure for evaluating acceptable public risks are currently under development by USACE. The following discussion represents our initial OEW risk assessment work for defining methodology to evaluate public risks. This work was performed by Southwest Research Institute, San Antonio, Texas, under contract to the USAEDH.

Definition of Risk.

a. Since risk encompasses several factors, the elements that comprise risk need to be defined. A mishap is an unplanned, undesired event that results in harm to people, equipment, property and/or environment. The mishap may have occurred at some time in the past. In many instances, a past mishap triggers the risk assessment. The mishap may also be potential, as in a hazards analysis, which investigates the risk potential and assesses control alternatives. Without a real, or potential mishap there is no risk. Each mishap has two components, the probability of the mishap and its severity. The probability is the likelihood that the mishap will occur during the life of the system, or the life of the site.

b. In its most simple terms, risk is the probability of mishap multiplied by the severity. For a site remediation operation, risk is not a single number. It has a different value for each ordnance item and for each element of the survey, removal, and remedial actions. An additional confounding effect is that risk contains a perceived risk factor in which the public can "feel" that the risk is greater, or smaller, than the calculated risk. For instance, the perceived risk of a terrorist attack is far greater than the real risk. Similarly, the perceived risk of hazardous waste is often greater than the real risk. Perceived risk should be considered in any remedial action where the public, or local government is involved and has a voice in the type and extent of remediation that is contemplated. Perceived risk is not considered in assessing the need for remedial action. That assessment needs to be made on a technical/statistical basis.

c. The probability of a mishap must be assessed to provide an indicator of the risk. Probability always relates to an interval of time. In the assessment of a facility it relates to the life of the facility. In an assessment of site it relates to the life of the site, or to some arbitrary span of time. Five categories of probability rating are provided in MIL-STD-882B:

- (1) Category A - Frequent. "Likely to occur frequently."
- (2) Category B - Reasonably Probable. Likely to occur several times during the remedial operation, or during the life of the site.
- (3) Category C - Occasional. Likely to occur sometime during the remedial operation, or during the life of the site.
- (4) Category D - Remote. "So unlikely it can be assumed that this mishap will not occur."

- (5) Category E - Extremely Improbable. "Probability of occurrence cannot be distinguished from zero."

Definition of Severity.

a. Severity is the extent of damage, due to the mishap, to personnel, equipment, property, and/or the environment. Severity depends on the ordnance item, or the threat, the step in the remediation action in which the mishap is considered, and any severity-limiting control features that are incorporated into the remedial action.

b. Four categories of severity are established by MIL-STD-882B:

- (1) Category I - Catastrophic. May cause death.
- (2) Category II - Critical. May cause severe injury or severe occupational illness.
- (3) Category III - Marginal. May cause minor injury or minor occupational illness.
- (4) Category IV - Negligible. Probably would not affect personnel safety or health, but is a violation of applicable standards.

Definition of Exposure.

In risk assessment calculations the exposure is used for estimating the risk of transient events, such as the transit across an OEW site, or in assessing the risk of a phase of the remedial action operation. Exposure is the time that personnel, equipment, property, or environment are under the potential influence of the mishap. Exposure may be measured by the timewise intersection of the projected damage area with the exposed personnel, property, or equipment. Exposure assumes a transit of the energetic source, personnel, or the equipment through an area in which a mishap could occur. In general, the exposure is a function of the energy source, a proximity to the threat, the transit time, the likelihood of initiation of the ordnance item, and the cover protection that is afforded by natural and artificial barriers.

Establishing the Need for Remedial Action.

a. The formalized procedure for project approval and initiation entails the following elements:

(1) Inventory Project Report (INPR) by geographic Division. This report delineates and justifies the need for remedial action. It is typically initiated and approved by the Commanders of geographic Divisions.

(2) The U.S. Army Engineer Division, Huntsville (USAEDH) conducts a formal review of the INPR. If USAEDH concurs, USAEDH Safety develops a Risk Assessment Code (RAC) and a Program Estimate.

(3) Project approval is by USAEDH. Approval is followed by a work authorization directive (WAD).

b. In the final analysis, the need for remedial action depends on the risk to the population that intrudes on an OEW site. Many sites that were formerly used to manufacture, process, store, or test ordnance items are being absorbed into the infrastructure of cities, suburbs, and towns. As the land values increase there is a commensurate increase in risk for the population. Often, the incentive for the assessment is a mishap in which someone is harmed by an encounter with ordnance and explosive waste (OEW).

c. The need for remedial action is established by a risk assessment. The culmination of this risk assessment is the development of Risk Assessment Code (RAC). The RAC is a quantified expression of the risk associated with the hazard and is calculated by combining the elements of the hazard severity and the mishap probability. Given that a RAC is developed, the need for the remedial action is established by a set of RAC criteria which identifies the acceptability of the risk. These criteria are:

- (1) RAC 1 - Unacceptable level of risk.
- (2) RAC 2 - Undesired level of risk which must be controlled.
- (3) RAC 3 - Acceptable level of risk if adequate controls are effected.
- (4) RAC 4 - Acceptable level of risk without controls.
- (5) Remedial action is indicated for RAC 1, RAC 2, and RAC 3. Remedial action is not needed for RAC 4.

Selecting the Proper Action.

The definition of the level of remediation required is somewhat subjective. The RAC provides an approximate criteria for assessing if remedial action is needed. An assessment is still

needed on the type, and the amount, of remedial action. Several factors enter into the decision of the proper remedial action:

(1) Identify potential risk items. The greater the number of items, the higher the risk, the more thorough is the remedial action that is indicated. The type, or types, of items under consideration are the primary drivers in identifying the remedial options, since very lethal items severely drive the remedial options, and very innocuous items may require no action.

(2) Identify remediation options. The remedial action options are ranked from least to most severe: (1) No Action; (2) Fencing; (3) Land Use Restriction; and (4) Removal of OEW. "No action" produces no reduction in risk. "Removal of OEW" produces the greatest reduction in risk.

(3) Select proper remedial action. Ideally, the selection of the proper remedial action should be directly commensurate with the cost of the remediation effort. Often the cost of the remediation is greater than the dollar worth of the risk reduction. A management decision, then, is needed to select the proper level of remedial action that provides a real, and proper, level of risk reduction at an affordable cost. It is also recognized that public pressure of perceived risk tends to drive the remedial option selection toward the use of clearing the land of all OEW.

(4) Establish sufficiency of cleanup. The criteria for "clean" is established by the risk analysis. After the remedial action has been accomplished, the effectiveness of the remediation is compared to the pre-established level of cleanup.

Selection of Risk Assessment Methodology.

a. It is assumed that the reader is generally conversant with risk assessment methods. Several acceptable risk assessment methods are delineated in MIL-STD-882B. Each risk assessment method has its strengths and weaknesses. Typically the choice is less of utility than it is of familiarity by the analyst. Most of the methodologies can be used in a quantitative or a qualitative evaluation. Typically, the fault tree analysis, or some similar method, is most easily used for a quantitative analysis. The failure modes and effects analysis, or some similar method, is most easily used for a qualitative analysis.

b. Some analysis methodologies, such as the worst case scenario, are more easily adapted to an operation oriented problem. In such an analysis each operational step and decision is delineated sequentially and analyzed for what can fail in terms of operations and decisions. Such an analysis is particularly useful for defining and assessing training.

c. Often the analysis method is selected on the basis of failure data availability. If adequate, relevant data is available, the quantitative risk assessment is preferred since it provides an excellent means of assessing the risk, and hence, the alternative remediation methods. Conversely, where little, or no relevant failure data is available the analysis of choice has to be qualitative. Both methods are acceptable. The key is the use of a method that will provide a means of assessing if remediation is needed, and correlating the remediation method with the risk reduction attainable by the remediation.

d. Most often the analysis has little relevant data available and should use a qualitative risk assessment. One pseudo-quantitative risk assessment methodology that has been published is one that provides a quantitative index for each category and probability of the mishap and for each category of severity. The combined assessment, then, is one which allows the discernment of levels of risk into categories that are consistent across site assessments.

e. If one examines the probability and severity parameters relating to a "risk model" it is seen that the number of parameters is somewhat high, and the interrelationships that characterize the model are not easily established. Table D provides a very preliminary tabulation of some of the probability and severity parameters that are appropriate for a risk assessment. All of the probability parameters relate to the likelihood of initiating the energetic material. All of the severity parameters relate to characterizing the output of the energy material, or to the vulnerability of buildings and inhabitants to the output. Clearly, not all possible parameters are included since many parameters relate to the site specific geometry.

Conduct of Risk Assessment (RA).

The procedural flow for the conduct of a risk assessment has the elements shown in Figure 1.

(1) Develop threat list and threat distribution. As part of the problem definition the threats and threat distributions about the site are approximated. These data form the basis of defining the severity and the probability for the risk assessment.

(2) Develop probability of public encountering OEW. Past history is a reasonable indicator of the public encountering a threat during any traverse of the site. If the threat produces a damage zone that extends off of the site, more of the public could encounter the threat output.

Table D
PROBABILITY AND SEVERITY
PARAMETERS FOR A RISK ASSESSMENT

**PROBABILITY MODEL
PARAMETERS**

TYPE OF EXPLOSIVE

- Primary
- Secondary
- Insensitive
- Confinement Effects

TYPE OF PROPELLANT

- Double Base
- Single Base
- Configuration Effects
- Confinement Effects

**INTEGRITY OF
ORDNANCE ITEMS**

WEATHER

- Dry / Cold
- Moist / Warm

**SEVERITY MODEL
PARAMETERS**

TNT EQUIVALENCY
(EXPLOSIVE WEIGHT)

- Blast Pressure
- Blast Impulse

FRAGMENTATION

- Casing Material
- C/M
- TNT Equivalency

SITE CHARACTERISTICS

- Quantity-Distance
- Types Of Structures
- Types Of Inhabitants
- Fragment Barriers
- Traffic Characteristics

THERMAL RADIATION

- Energetic Mass
Or Pool Size
- Stefan-Boltzman Constant
- Flame Temperature

FUSE SENSITIVITY

DEPTH OF BURIAL

- Surface
- "Critical Depth"
- Below "Critical Depth"

SAFE SEPARATION

- Cased Effects
- Enclosure Effects
- Explosive Sensitivity
- Explosive Weight Effects

PYROTECHNIC MATERIAL

- Type Of Material
- Confinement Effects
- Configuration Effects
- Initiation Energy

(3) Develop severity profile for each threat. Severity profiles for the energetic output of each threat are produced by the threat characteristics. For explosive materials blast and fragments, primary and secondary, need to be considered. Pyrotechnic materials produce incendiary effects as well as potentially blast and fragment effects. Chemicals, in many forms, could produce toxic effects that are carried by the wind, or by the water, into contact with people, animals, or plants.

(4) Develop a RAC profile for each threat. The risk for each threat will, most likely, be different. Threats with recommended acceptability criteria less than 4 will need additional evaluation, and will be included as site threats. At some sites several threat types are extant at the same location. For instance, a firing range impact area could have been used for direct-fire weapons and indirect-fire rockets. A composite RAC profile can be made for the threat types, or the worst case threat can be used.

(5) Develop a RAC for the site. The site RAC provides a characteristic indicator of the hazard related to the site. If several areas of the site are evaluated the RAC may reflect a composite or a worst case, whichever is more appropriate. The site could also be subdivided into areas and a RAC developed for each area.

(6) Develop alternative remediation strategy. Each threat, and/or each site area, that has a RAC less than 4 will need a remediation strategy.

(7) Develop RAC for each remediation strategy. This provides an indicator of the risk reduction available through each remediation alternative.

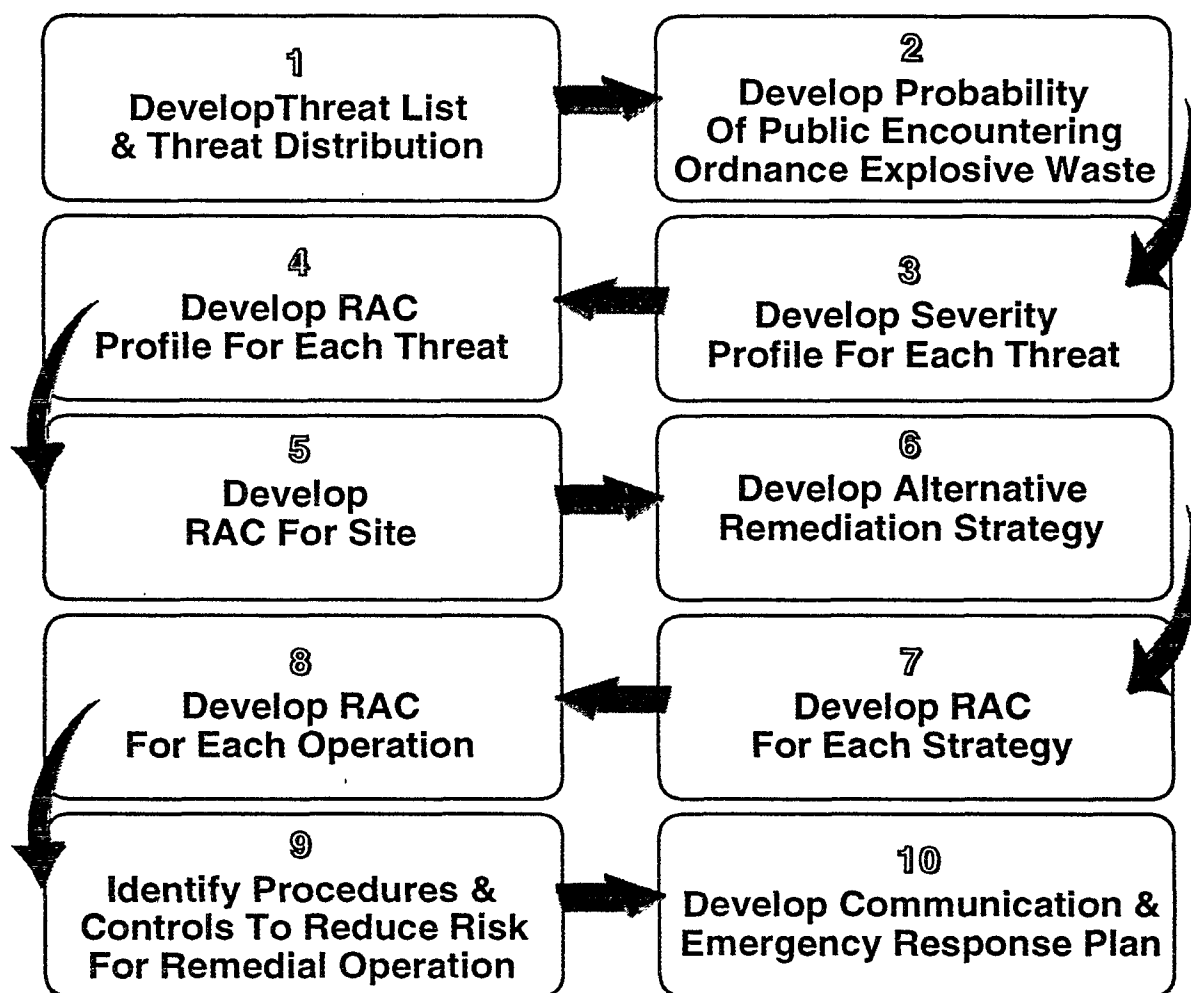
(8) Develop RAC for each remediation operation. Site remediation is not without its hazards. An assessment of the remediation operational risks is appropriate so that risks can be identified and controlled.

(9) Identify procedures and controls to reduce risk to RAC 3 or higher for each remedial operation.

(10) Develop communication and emergency response plan. This plan provides a standing operating procedure for control of remedial operations that are hazardous and responding to mishaps in a manner that minimizes the severity of casualties.

FIGURE 1

RISK ASSESSMENT PROCEDURAL FLOW



METHODS OF RISK REDUCTION

Reduce Probability.

Since risk has three components, probability, severity, and exposure, a reduction in any of the components produces a commensurate reduction in the risk. A reduction in the probability of a mishap can be effected by:

a. Removal of the threat. Clearly this is the most effective, and most likely the most costly, option. It does provide the most environmentally acceptable option and one which is most acceptable to the public.

b. Imposition of a barrier that is not an attractive nuisance, e.g., not a fence, moat, or covering. This is a restrictive option that can only be considered if the barrier is viable control and if the surface and subsurface water is not threatened by the OEW.

c. Imposition of warnings, e.g., signs, sensors with warning signals. The cost-benefit trade of this option is not usually viable. It can, however, be used in remote areas where the encounter probability between the threat and the population is very low.

d. Imposition of surveillance. This entails the use of sensors, monitors, and warning signals. As with (c) this option has limited application as a remedial action. However, it is viable as a temporary measure shortly before, or during, the conduct of remedial action.

e. Public education. This is a two edged sword. The public should be educated on the site, its threats to their well-being, and the remedial actions that are being taken. It is not a remediation option in itself, but it can reduce the risk of being coupled with an effective remediation option. If the public disagrees with the findings and the implementation of the remediation, public pressure is virtually assured to increase the remediation level.

Reduce Severity.

Reduction of the severity can be accomplished in several ways, all of which reduce the level of the threat, place a barrier between the threat and the population at risk, or increase the separation between the threat and the population at risk. The level of the threat can be reduced by:

(1) Removing the threats. This option also reduces the probability of encountering a threat.

(2) Partial removal of the dominant threats. For instance, surface threats, large threats, and the most lethal threats can be removed, leaving deeply buried and small OEW threats that produce low levels of severity.

(3) Neutralize. Chemical or biological neutralization are options to neutralize the threat in place. The threat can also be neutralized by incineration or, if appropriate, by detonation.

(4) Barrier. Placing a protective structure between the exposed population and the threat is one option of reducing the severity. Placing distance between is another option. Such an option may be achievable through zoning restrictions.

Reduce Exposure.

Reduction of exposure provides a reduction in the probability of an encounter with the threat. The main options in reducing the exposure include reducing the frequency of encounter by re-routing away from the threat radius of influence, or by restricting traffic to a pre-determined daily flow. Exposure reduction is not typically a viable risk reduction option.

SELECTION OF THE REMEDIATION METHOD

Alternatives.

a. The recommended acceptability criteria (RAC) provides the basis of establishing the need for remedial action. A RAC of 3 or lower indicates that some kind of remedial action is needed. A decision is then needed to establish whether the remediation method selected is to be a short term, or a permanent solution. Short term solutions are acceptable only if they are closely followed by permanent solutions. A short term solution reduces the immediate risk enough to secure the danger to the population. The long term solution provides a permanent risk reduction.

b. In selecting the remediation alternative it is initially desirable to delineate and rank each alternative solely on technical merit. After the technical ranking is achieved each alternative can be costed and ranked. Typically the cost ranking is not coincident with the technical ranking. Judgment, such as a weighted scale, is then needed to provide an additional basis for selecting the "best" remedial method.

Mandated Alternatives.

One problem with a risk assessment that produces a dollar value of the risk is that the value of a life, or a group of lives, is difficult to quantify in a manner that is universally satisfactory. One judgment that is used is to select the

remediation action that removes the threat when imminent or demonstrated threat to life or environment is indicated. Another typical mandated alternative is to select a remediation method that complies with a Federal, State, or local regulation. The "cost" of non-compliance is typically greater than the cost to comply.

Application of Advanced Technology.

a. There is a rapidly developing civilian market for remediation of hazardous waste sites. Advanced technology is being developed to make such remediation efforts more effective and efficient. Detection technology is being developed to allow detection and identification of chemicals without intimate contact between the detector and the chemical. Air quality compliance, however, is not yet certifiable on a real-time basis.

b. Biodegradation of exposed energetic materials and chemicals has a growing potential. Current technology uses extant bioagents for the degradation process. Genetic engineering is a potential technology that can be used to develop agents that biodegrade materials which are hazardous to clean up.

c. The use of on-site "portable" incinerators is becoming more common as site clearances are mandated in the civilian sector of the market. Mobile infrared incineration systems can provide destruction removal efficiency (DRE) factors of 99.9999% for the destruction of PCBs, with the ability to process up to 165 tons of waste per day.

Community Relations.

Community relations often have a strong influence in the determination of the remediation method selected, and its extent. There is a growing tendency for special interest groups, that are not a part of the community, to influence the sensitivity of the community to a perceived level of risk that far exceeds the actual risk. A community relation plan provides the mechanism of establishing, and considering, the community's attitudes toward the site remediation effort. Of particular importance is assurance that the community's interests are considered in all assessments, decisions, and actions. If changes to the remedial action plan are needed those changes should be disseminated to the community leaders.

Selection Rationale.

The cost-risk relation is the foundation for a remediation selection rationale. In actuality it is a cost-remediation alternative relation. The procedure is straight forward:
(1) cost each alternative; (2) grossly quantify the risk

reduction to each remediation alternative; and (3) develop a cost-risk reduction curve. Needed is the predetermined risk criteria that should have been developed at the start of the risk assessment. Based on this criteria, select the remediation alternative that just meets the required level of risk reduction. The cost-risk reduction curve is typically a series of step functions, rather than a smooth curve. Before one remediation method is selected as the sole method, examine the data to see if a lower cost alternative is possible through the selection of more than one remediation method. The residual risk is seen to decrease as each risk reduction option is implemented. At the same time, there is a commensurate increase in cost that is not proportional to the decrease in risk reduction.

Other Potential Alternatives.

The ever increasing cost of remediation will eventually force the government to consider other alternatives for remediation. It is believed that these alternatives will serve to relieve the initial extensive remediation cost either through some sort of escrow funding or through cost sharing with property owners.

Escrow Funding.

Escrow funding is a principle where by the eminent hazard (i.e., surface/near surface) would be remediated and residual risks would be remediated as the potential for public exposure increased. Implementation would be to set aside an amount of money in an escrow fund. When the need would arise to address an OEW hazard, for example, due to utility construction, sufficient funds would be available to provide adequate OEW clearance without the long term project work cycle that now transpires.

Property Value Enhancement.

Much of the property exsessed by the government was done at a significantly reduced price to offset the decreased value of the property due to OEW contamination. This was acceptable at the time due to the original intended land use of the property. As the land use needs have changed, property owners are now requesting remediation projects on these properties. Such remediation will enhance the value of the property then resulting in the potential of significant personal financial gain from this government effort. This author is proposing for consideration, a concept whereby the property owner would share in any property value enhancement of their property. The concept is in an early discussion stage with many legal considerations; however, it is a concept worthy of consideration.

SUMMARY

The Huntsville Division has been designated as the U.S. Army Corps of Engineers Mandatory Center of Expertise (MCX) and Design Center for Explosive Ordnance Engineering for the Army. With this designation, the Huntsville Division has demonstrated an element of technical capability and experience that is necessary to evaluate and remediate sites contaminated with EXO.

This paper has discussed the history of the DERP-FUDS for unexploded ordnance and the development of the RAC procedure for EXO contamination. In addition, this paper has presented the preliminary methodology development now being considered by USAEDH for project risk assessment and remediation alternatives.

The EXO is a safety and environmental hazard that has resulted in unreasonable risks to the general public, contractors, and Army personnel. It is felt that Army RAC procedures provide our environmental program managers with the necessary tools to evaluate public risks and make the appropriate decision concerning remediation of EXO contaminated sites. The program manager for EXO at the Huntsville Division is Mr. Robert Wilcox at 205-955-5802. The technical manager is Mr. C. David Douthat at 205-955-5785. The mailing address is U.S. Army Corps of Engineers, Huntsville Division, P.O. Box 1600, ATTN: CEHND-ED-SY/David Douthat or ATTN: CEHND-PM/Rob Wilcox, Huntsville, AL 35807-4301.