Using a Team Approach to Develop a Site-Specific Ordnance and Explosives (OE) Risk Assessment

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AERIAL VIEW - OE RANGES

ABSTRACT

To uniformly address the concerns posed by ordnance and explosives (OE), several installations/facilities need to incorporate an OE risk assessment into their projects. In some cases, the Project Team may decide to start with existing tools and work together to develop a risk assessment method to meet site-specific needs. The following approach has been developed to prepare a defensible, site-specific risk assessment based on currently existing OE risk assessment methods.

The Project Team should develop a Risk Assessment Focus Group assigned with the task of developing the risk assessment method. The Focus Group should be comprised of Department of Defense personnel, regulatory representatives, applicable contractor support personnel, and a facilitator (if needed). This group should work together to draft a risk assessment method to provide a description and estimate of the OE risk on the project area. In order to develop a method, the Project Team will conduct the following tasks:

1. Evaluate: The Team evaluates existing risk assessment methodologies to determine applicability and to establish a framework for the site-specific method.
2. Review: The Team reviews applicable methods, as determined during the evaluation step, for input factors and scoring criteria.
3. Select: During this step the Team selects the best approach.
4. Refine: The Team refines the chosen framework using risk assessment expertise, OE expert knowledge, and site-specific conditions
5. Develop: The Team then drafts the OE Risk Assessment Methodology and conducts a preliminary testing of the method.

6. Finalize: The Team further refines the method, based on team comments, preliminary testing and public comments.

These steps will be used to work with the entire Focus Group to gain an in-depth understanding of OE risk assessment, the factors that contribute to risk and how they affect the overall risk. By working together, the group can create a defensible, flexible, and straightforward approach.

This approach was used to develop a site-specific risk assessment method to support remedial decisions on a Base Realignment and Closure (BRAC) facility. Throughout the process we have identified several pitfalls, lessons learned and success stories that could be used on future risk assessment development and application on UXO/OE sites.

INTRODUCTION

This Former Fort Ord OE Risk Assessment Protocol was prepared in a combined effort of the Army, the California Environmental Protection Agency's Department of Toxic Substances Control (DTSC), the United States Environmental Protection Agency (EPA) and Malcolm Pirnie, Inc. The purpose of the presentation is to describe the scope of the ordnance and explosives (OE) problem and its differences from conventional chemical risks, the need for an explosives safety risk assessment protocol, the process used to develop an explosives risk assessment protocol, the resulting explosives safety risk assessment method and the key lessons learned from the development of the protocol.

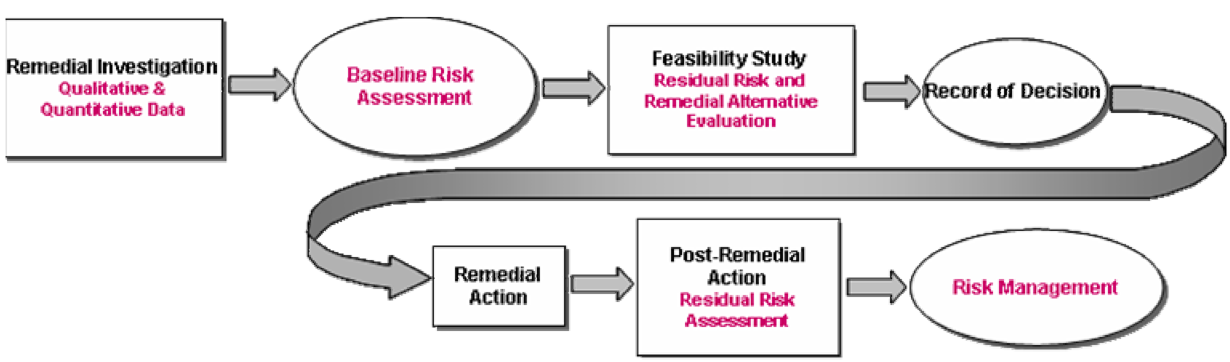
SCOPE OF ORDNANCE and EXPLOSIVES PROBLEM

The Department of Defense (DoD) under the Defense Environmental Restoration Act (DERA) is required to address all of the hazards posed by military munitions on property no longer being used for military training. These efforts are covered under the Military Munitions Response Program (MMRP). Initial estimates of formerly used (sites that are closed, transferred and transferring) property indicate over 16,000,000 acres potentially contain military munitions. The cost estimates to address these hazards range from 140 billion to over 1 trillion dollars. This cost variation is linked to the extent of remedial and response decisions. Therefore, establishing procedures and protocols for decision making is critical to ensure safely, efficiently and effectively executing the program.

NATURE OF RISK: CHEMICAL and EXPLOSIVES SAFETY

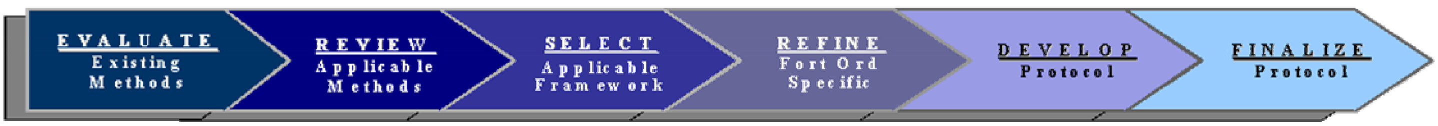
OE are anything related to munitions designed to cause damage to personnel or material through explosive force or incendiary action. OE can range in size from small grenades to bombs. OE risks exist where people can come into contact with, and disturb ordnance and explosives present on former ranges or training areas and the OE detonates or functions. These risks are associated with physical forces (e.g., thermal transfer, overpressure, fragmentation, and impact). Exposure to OE can occur if a receptor enters a range with OE, or if OE is removed from a range by a receptor. The threat from OE, however, typically results from a single encounter and may have one of three outcomes: no effect; injury; or death. In addition, more than one receptor, that is, individuals in the surrounding area, may be impacted by a single encounter. Therefore, the established methods for characterizing risk associated with chemical exposures are not directly applicable to characterizing OE risks.

Several methods exist for performing a risk assessment on OE-impacted sites; however, there is no OE risk assessment methodology that has been widely accepted, evaluated, and fully implemented for a variety OE sites. Thus, a site-specific OE risk assessment methodology is developed here to determine the current and future OE risk on property proposed for transfer at the former Fort Ord. Given the differences between OE risk and chemical risk, and in the absence of established preliminary remediation goals for OE, remediation goals need to be developed on a site-specific basis and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process will be adjusted to accommodate these difference in order to parallel the typical process for chemical risk. The general CERCLA process is illustrated below.

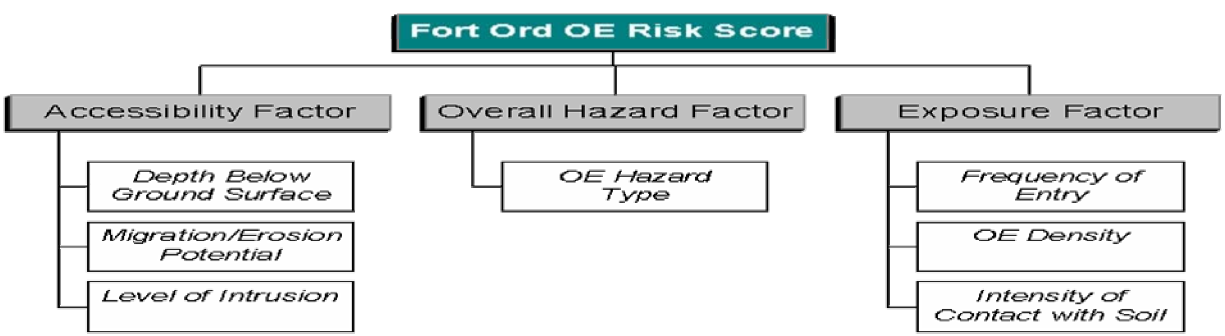


RISK ASSESSMENT DEVELOPMENT PROCESS

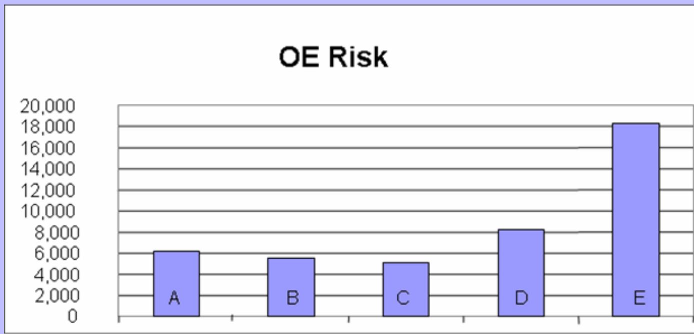
The general structure for the development of the risk assessment was that of a Delphi process. In this process, a group of experts reach a consensus as to a model or a set of appropriate data. The Army, through the Base Closure Team (BCT), formed an OE Risk Assessment Project Team representing different points of view and expertise. This team, comprised of Army, U.S. EPA, and CA-DTSC representatives and contractor personnel, was tasked with the development of a site-specific OE risk assessment protocol. This multi-disciplinary team consisted of risk assessors, trained OE experts, project managers and key decision-makers who worked together to develop objectives and plan the OE risk assessment process. Over the course of a year, the Project Team's experience with the site, OE risks, and risk assessment principles provided the basis for discussions of the approach and for coming to consensus on the protocol. The overall process included the following:



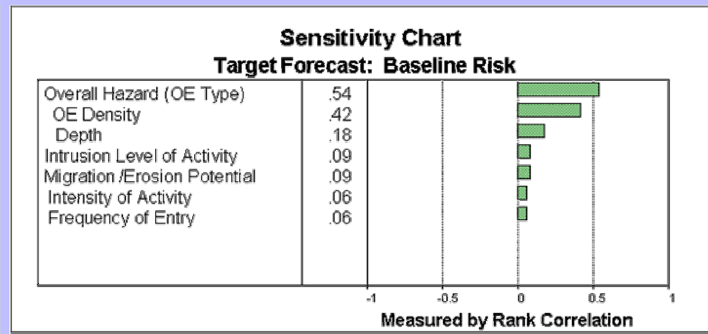
1. Evaluate: The Team evaluated ten existing OE risk assessment methodologies to determine applicability and to establish a framework for the Former Fort Ord approach.
2. Review: The Team reviewed applicable methods for input factors and scoring criteria. The Team also took into account the lessons learned from the development and attempts to implement these other methods. In particular, the shortcomings of trying to develop a risk assessment without the input of all interested parties was noted. This reinforced the applicability and appropriateness of using a team approach.
3. Select: After extensive review, the Team chose the Interim Range Rule Risk Methodology (IR3M) as the framework for the Former Fort Ord OE Risk Assessment Approach. Two other methodologies, Ordnance and Explosives Risk Impact Analysis (OERIA) and Adak Island Explosive Safety Hazard Assessment (Adak), were also selected to be used for certain key concepts and input parameters that could be used to modify the IR3M as appropriate to meet site specific conditions.
4. Refine: The Team, incorporating discussions and consensus decisions of numerous meetings, refined the chosen framework using risk assessment expertise, OE expert knowledge, and knowledge of site-specific conditions. Using the IR3M methodology as the template and incorporating appropriate portions of the Adak and OERIA methods, as well as incorporating site-specific conditions, the team identified the following as the key input factors to be used to assess OE risk:



5. Develop: Incorporating discussions and consensus decisions, the Team defined all of the specific input parameters for each of the input parameters identified during the refinement process. The Team identified OE Hazard Type, OE Density, and OE Depth as the input parameters that should be the primary drivers of the overall risk. In addition, the Team identified Frequency of Entry, Intensity of Contact with Soil, and Intrusion Level of Activity as secondary drivers with Migration/Erosion being a minor modifier. The Team drafted the Former Fort Ord OE Risk Assessment Approach and performed preliminary testing of the approach using deterministic and probabilistic sensitivity analysis. The results are shown below. In addition, three separate sub-groups performed a Beta test on two actual sites. The results of the sensitivity and Beta tests were used in the next step.

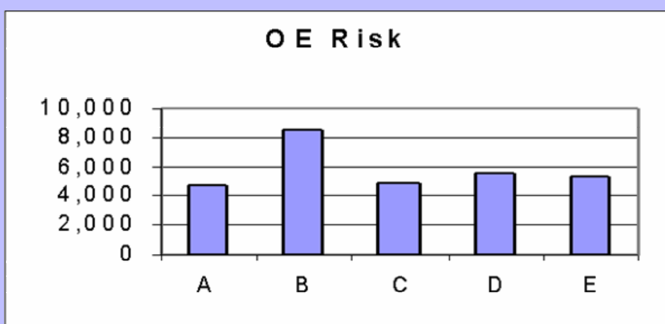


Deterministic Sensitivity Analysis

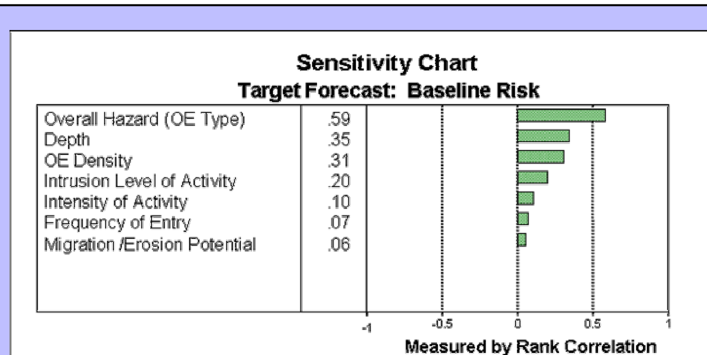


Probabilistic Sensitivity Analysis

6. Finalize: After analysis of the initial sensitivity analysis and the results of the Beta test, the Team further refined the Protocol. The initial sensitivity analysis showed that only two input parameters, OE Hazard Type and OE Density, were primary risk drivers as opposed to the initial identification of primary and secondary drivers. Therefore, the Team further modified the Protocol to more accurately reflect the initial identification of primary and secondary drivers as well as to incorporate lessons learned from the Beta tests. Sensitivity analyses of the modified Protocol are shown below.



Deterministic Sensitivity Analysis

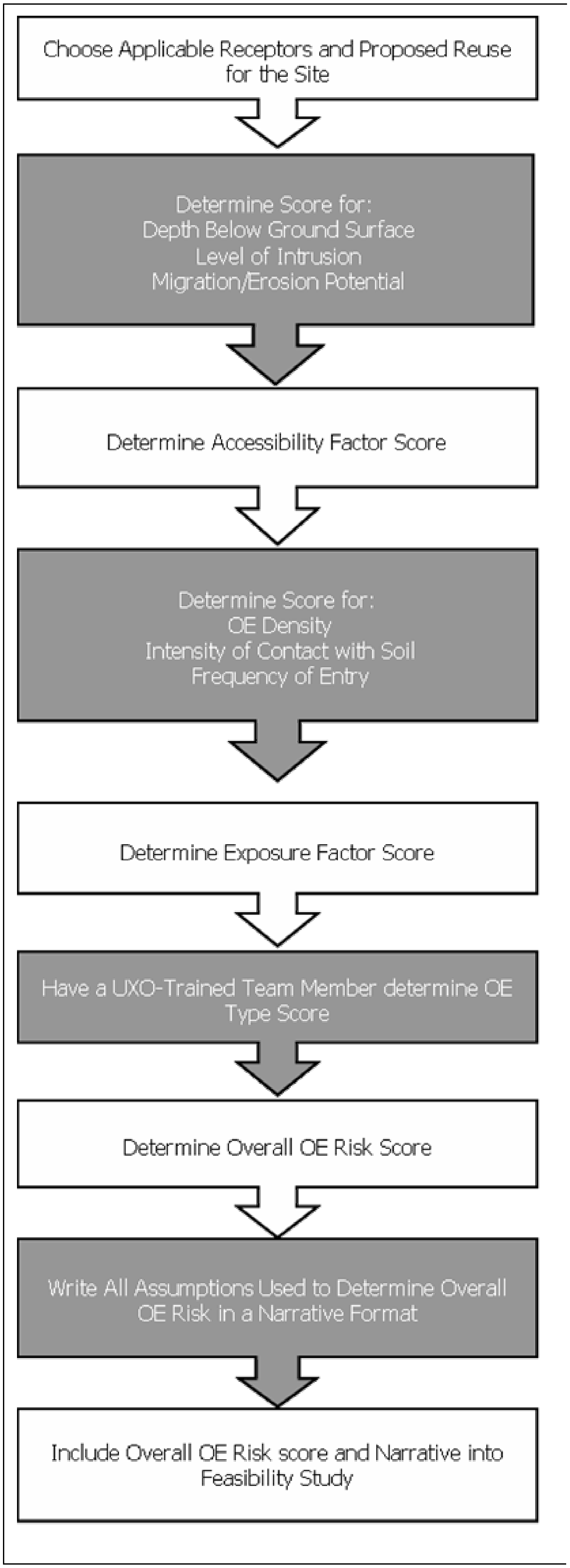


Probabilistic Sensitivity Analysis

The Consensus of the Team was that the modified Protocol along with public review is a defensible, flexible, and straightforward approach that is capable of assessing OE risks at the former Ft. Ord site.

EXPLOSIVES SAFETY RISK ASSESSMENT METHOD

In general, the OE Risk at a site can be determined by answering four questions: 1) How likely is it that the OE items are accessible? 2) How likely is it that someone will be exposed to the OE item? 3) How hazardous is the OE item itself? And 4) How do the accessibility of the OE item, the likelihood of exposure, and the level of hazard combine to define the Overall OE Risk for the site? The general steps used to perform an OE risk assessment using the OE Risk Assessment Protocol are illustrated below.



1. Determine the applicable Receptors to be assessed based on current and future land use.

2. Score the Depth Below Ground Surface based on the depth of the OE items and site conditions. Score the Level of Intrusion based on the appropriate Receptor(s). Score the Migration/Erosion Potential for the site based on site-specific conditions. This information will be gathered during the remedial investigation (RI) and will also be based on the information gathered in step one.

3. Determine the Accessibility Factor Score using the scores for Depth Below Ground Surface, Level of Intrusion, and Migration/Erosion Potential determined in step two. The scores of the factors determined in step two are combined to give a single Accessibility Score that will be used in step seven to assess Overall Risk.

4. Score the OE Density based on the site conditions, Depth of OE and Level of Intrusion. Score the Intensity of Contact with Soil based on Receptor type and site conditions. Score the Frequency of Entry based on the site conditions and the type of Receptor. This information will be gathered during the remedial investigation (RI) and will also be based on the information gathered in step one.

5. Determine the Exposure Factor Score using the scores for OE Density, Intensity of Contact with Soil and Frequency of Entry determined in step four. The scores of the factors determined in step four are combined to give a single Exposure Score that will be used in step seven to assess Overall Risk

6. Have an UXO-Trained Expert determine the OE Type. The UXO-Trained Expert then assigns an OE Hazard Score based on the type of OE. This information will be gathered during the remedial investigation (RI). This score will be used in step seven to assess Overall Risk.

7. Determine the Overall OE Risk for the selected Receptor(s) using the Accessibility Factor Score, the Exposure Factor Score and the OE Hazard Score. Address all applicable current and future land uses and Receptors.

8. Document and justify all assumptions. Provide the rationale and justification for the selection of each score for each input factor.

9. Include the Overall OE Risk Score and supporting narrative in the Feasibility Study for use in comparing remedial alternatives and for input into the Risk Management Process.

The Table to the right illustrates the determination of a final Overall Risk Score using the OE Risk Assessment Protocol. In this example the final overall risk score of "D" was determined by following the procedures shown above and by using the Matrix Table to the right developed for Type One OE. The input factors for OE Type, Accessibility and Exposure are:

- OE Type has been scored as One - OE that will cause an injury
- Accessibility has been scored as Four – OE items likely to be accessible.
- Exposure has been scored as Four – Receptor is likely to be exposed.

OE Type	Accessibility	1. Least Potential for Exposure	2. Not likely to be Exposed	3. May be Exposed	4. Likely to be Exposed	5. Greatest Potential for Exposure
1. OE that will cause an injury(a)	1. Least Potential for Accessibility	A	A	A	B	B
	2. Not likely to be Accessible	A	B	B	B	B
	3. May be Accessible	A	B	B	C	C
	4. Likely to be Accessible	B	B	C	D	D
	5. Greatest Potential for Accessibility	B	C	D	D	D

a. OE that will cause an injury (flesh wound or a minor burn), in extreme cases could cause major injury or death, to an individual if functioned by an individual's activities.

These three Scores are then used as shown at the right to determine the final Overall Risk Score for the site.

VIETNAM ERA PROJECTILES – 84mm and 90mm-HEAT

KEY LESSONS LEARNED

1. Including the regulatory agencies in the development of the methods to "calculate" and define the input parameters and the final overall risk score increased acceptance by all parties.
2. The OE Risk Assessment Protocol is more transparent than the IR3M and as a result acceptance was fostered.
3. Although time consuming, taking small steps was the only way to reach agreement. This was necessary to allow sufficient time fostering consensus.
4. Our analysis of the Protocol through statistics could have been more thorough, however, given that the scoring was to be qualitative, it would likely not have greatly increased our confidence in the overall score.
5. Setting up decisions for the input factors prior to developing the risk assessment matrices was useful. For example, being able to reference the OE type classification when determining how to set up the matrices was more realistic than trying to "imagine" what type of OE items would be classified as worst case.
6. Setting up the decision matrix tables for determining input factor scores and the final overall risk score prior to determining the OE risk for a site makes the process more "objective" as opposed to the "subjective" nature of some of the other OE Risk assessment methods.

WORLD WAR I ERA – 2.36 INCH ROCKETS – PARTIALLY EXCAVATED

WORLD WAR II ERA – M29 RIFLE GRENADE

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