Risk and Risk Management in Military Munitions Response

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INTRODUCTION. The keystone to a successful Military Munitions Response (MMR) is risk management. Risk management is a thought process that should flow throughout the response. A risk process that can give a numerical prediction of risk for munitions concerns on MMR sites does not currently exist. However, we can assess the risk factors and manage the risk. This paper will discuss a MMR risk management thought process that is used throughout the response process. It will also cover a study that provides backup for the risk assessment and management. This paper focuses on the risk from a munition functioning and does not address any risk from munitions constituents.

MILITARY MUNITIONS RESPONSE RISK. Risk on a MMR site can be expressed in the potential for a completed pathway. A completed pathway occurs when an item functions and a receptor is impacted. The potential completed pathway cannot exist if any of the following is true:

- There is not a munitions and explosives of concern (MEC) presence on the site
- A receptor is not on the site
- There is no interaction between the MEC and the receptors

Conversely, the potential for there to be a completed pathway increases when the all of the following statements are potentially true:

- There is MEC presence on the site
- There is a receptor on the site
- The receptors interact with the MEC in a fashion that results in it functioning

Risk assessment on MMR sites focuses primarily on evaluating the potential for these three statements to be true. The MMR study and response alternatives analysis phase, usually conducted in an Engineering Evaluation and Cost Assessment (EE/CA) or a Remedial Investigation and Feasibility Study (RI/FS), is used to characterize the potential for a completed pathway before and after executing a response alternative.

The second part of this paper will focus on the behavioral factors involved in risk. The U.S. Army Corps of Engineers have conducted a study on past incidents involving MEC on properties that are in the public sector. The database developed during the study presents some interesting trends that will be discussed in the following sections.

DATABASE FOR ORDNANCE RELATED CIVILIAN ACCIDENTS. QuantiTech, Inc., was tasked with developing a database for ordnance related civilian accidents, using data primarily furnished by the St. Louis and Rock Island Districts of the U.S. Army Corps of Engineers. This study included a review and compilation of the pertinent civilian Munitions and Explosives of Concern (MEC) accident statistics, a spreadsheet summary of the resulting data, an analysis of the data, conversion of the database to Access, generation of charts and graphs summarizing the important findings, and a quality assurance check of the accident reports. The purpose of the study was to develop MEC related civilian accident information that may be used to assist in management of risk and to enhance risk communication to the public and stakeholders at various ordnance sites.

METHODOLOGY. Most of the accident data that contributed to the development of the database came from Archives Search Reports (ASRs) compiled or contracted by the St. Louis and Rock Island Corps Districts. In June 2002, the districts were asked to provide accident information from among 1,121 ASRs completed out of 2,280 identified MEC sites. (In many cases, multiple ASRs were completed on the same MEC property due to several ranges or Areas of Interest being present. Therefore, the total number of properties will be considerably less than the 2,280 MEC sites.) Additional data came from Rochelle R. Hance of the St. Louis Corps District and Robert E. Hoffman of the Rock Island District, a QuantiTech report on accidents developed in 1998, a list of accidents compiled by the Department of Defense Explosives Safety Board (DDESB), and the Corps' Project Information and Retrieval System (PIRS) on the Internet. 117 additional ASRs have been prepared between June 2002 and February 2004 (after the initial accident study), and have been reviewed without discovering any additional accident data. QuantiTech then sifted through this data, re-checked ASR information when available, and extracted relevant accident statistics and information, placing the results in Excel spreadsheet format with the following 31 columns:

1. Incident Number
2. Site Name
3. State in which site is located
4. Property Number
5. Program under which site is classified (FUDS or BRAC)
6. Year Site Closed
7. Site Acreage (approximate)
8. Historical Site Use (when under military control)
9. Past Clearance Action Information
10. Site Location Description (county in which site is located)
11. Year ASR Completed
12. Population in ASR (population density in persons/square mile around site)
13. Year Accident Occurred
14. Item Picked Up? (i.e., did accident involve a person moving the MEC item?)
15. Location of Accident (i.e., on site or off site)
16. Who Controlled Land? (e.g., private owner, government entity)

17. Land Use at Time of Accident (e.g., house, business)
18. Accident Cause/Circumstance
19. MEC Class Involved in Accident (e.g., fuze, mortar shell)
20. MEC Type Involved in Accident (e.g., 105mm mortar)
21. Item Surface or Subsurface (when discovered)
22. Total Number of Victims involved in incident
23. Number of Fatalities in incident
24. Victim ID Number (if more than one fatality, Victim 1, Victim 2, etc.)
25. Victim's Age (C - child, A - adult; also specific age if known)
26. Sex of Victim (M or F)
27. Number of Injuries in incident
28. Victim ID Number per injury
29. Victim's Age (same as #26 above except pertaining to injury)
30. Sex of Victim (same as #27 above except pertaining to injury)
31. Injury Type (specific if known)

The spreadsheet summarizing this information is shown in Appendix A of the *Development of A Database for Ordnance Related Civilian Accidents* report dated 31 January 2003. Not all columns in the spreadsheet could be completed due to lack of information. There were also a few accidents reported by DDESB for which no corroboration could be found. These were omitted from the database.

In order to statistically analyze the accident data, it was appropriate to convert the spreadsheet information to Access, thereby allowing queries to be developed. After this was accomplished, it was possible for various charts to be generated. These included charts showing a summary of historical civilian ordnance accidents by date of occurrence, by MEC class, and by cause and age of the victims. These are shown in Figures 1-7.

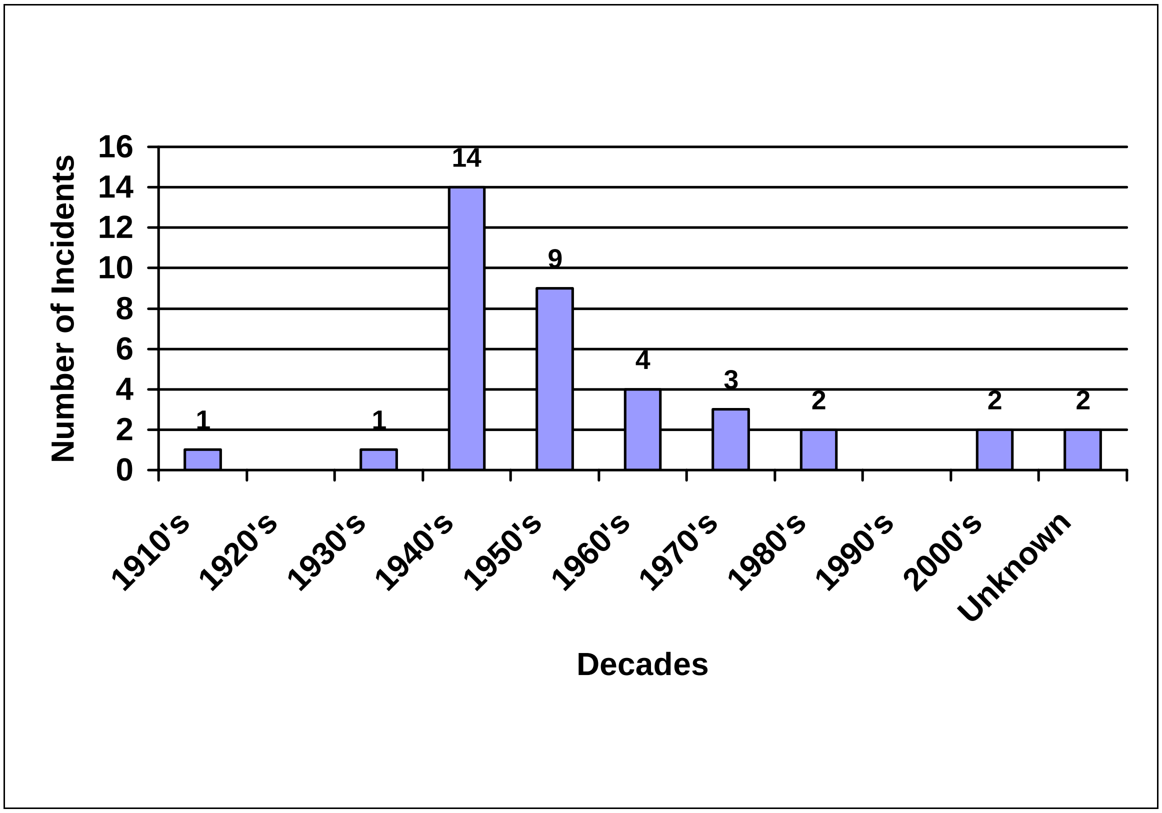

Figure 1. Number of MEC Incidents* by Decade

*(Each incident may involve multiple deaths/injuries)

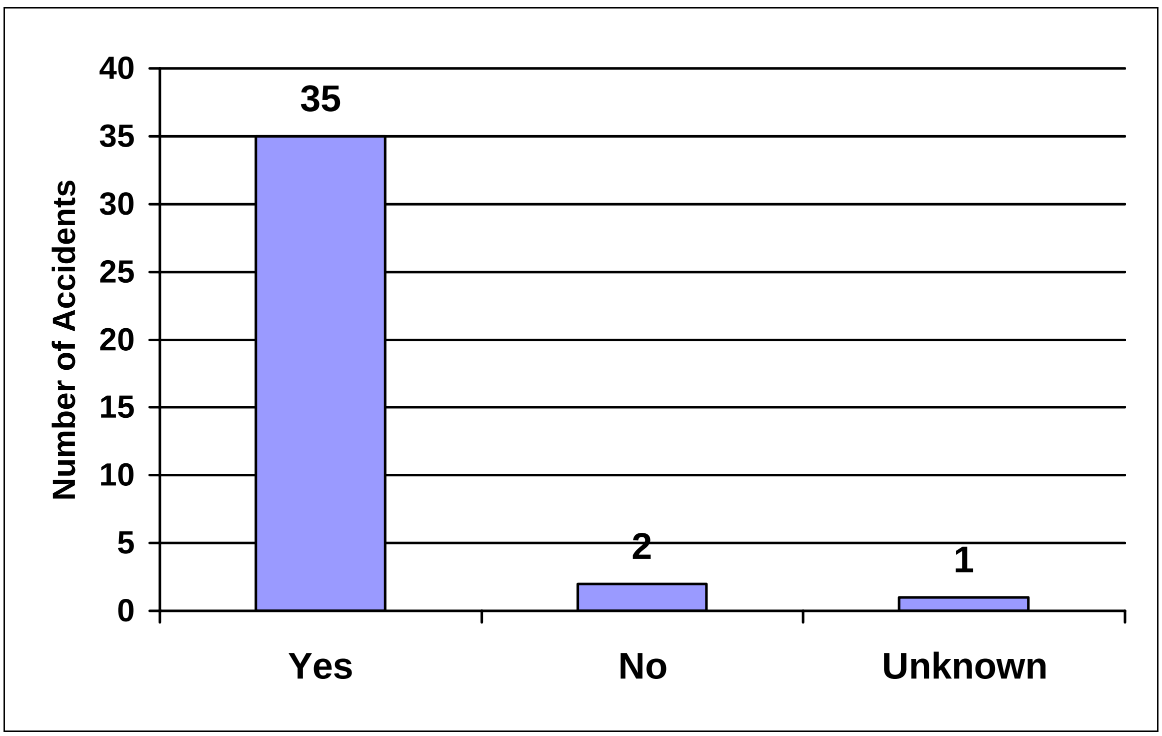

Figure 2. Number of Accidents Where MEC Item Was Picked Up (Yes/No)

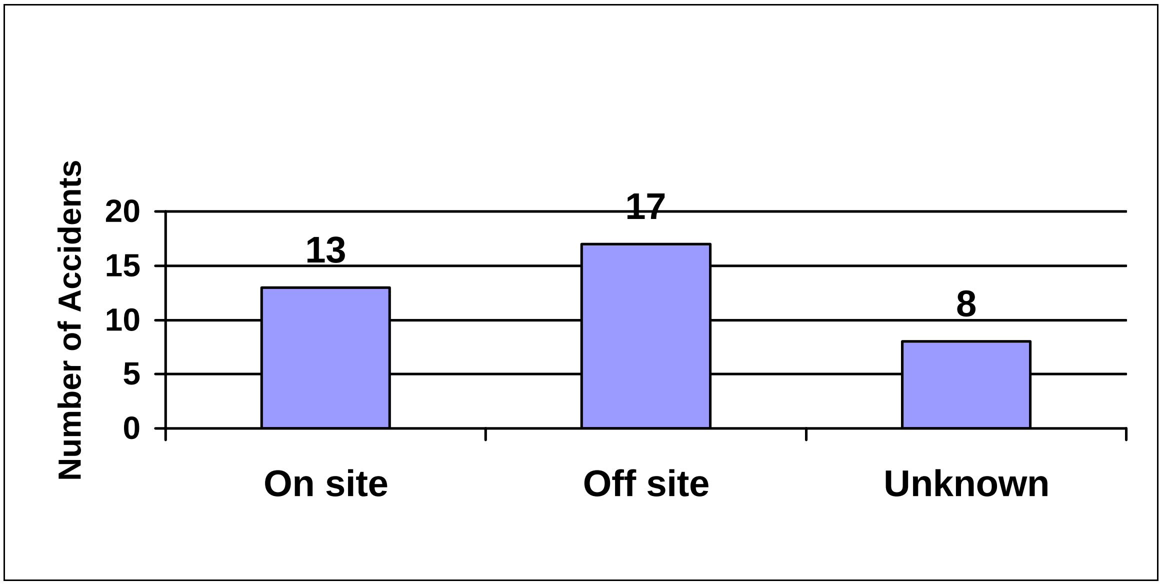

Figure 3. Number of Accidents that Occurred On or Off Site

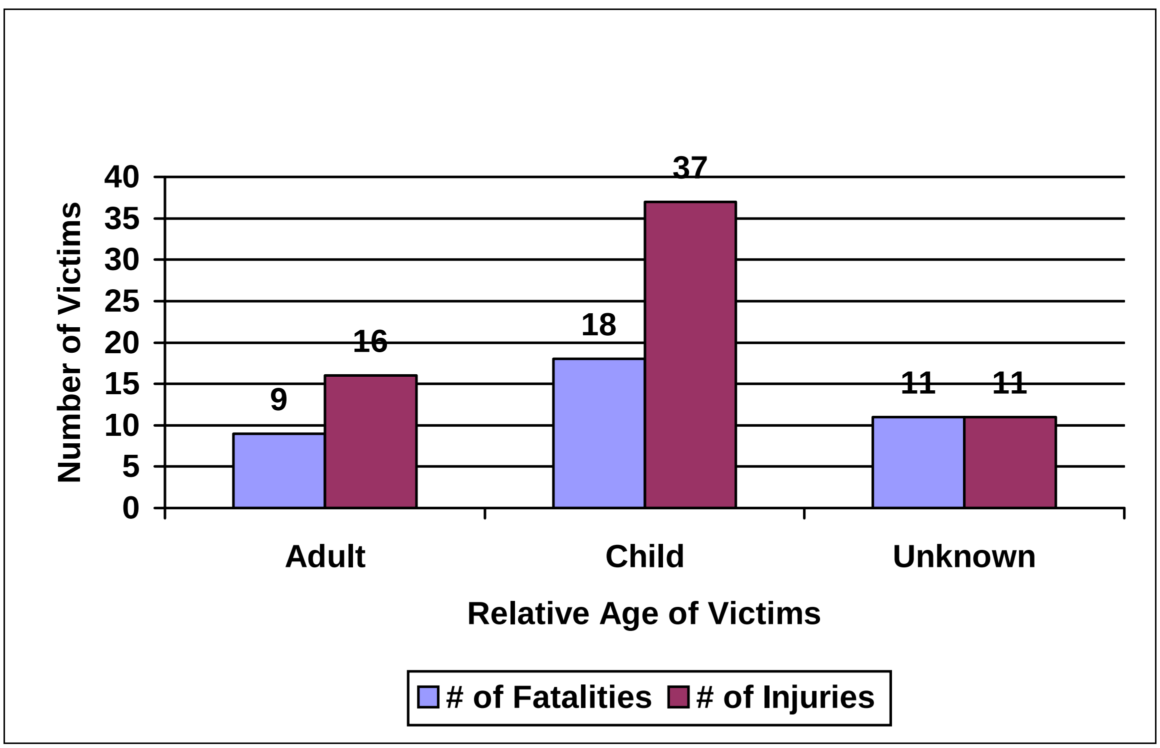

Figure 4. Number of Victims by Relative Age

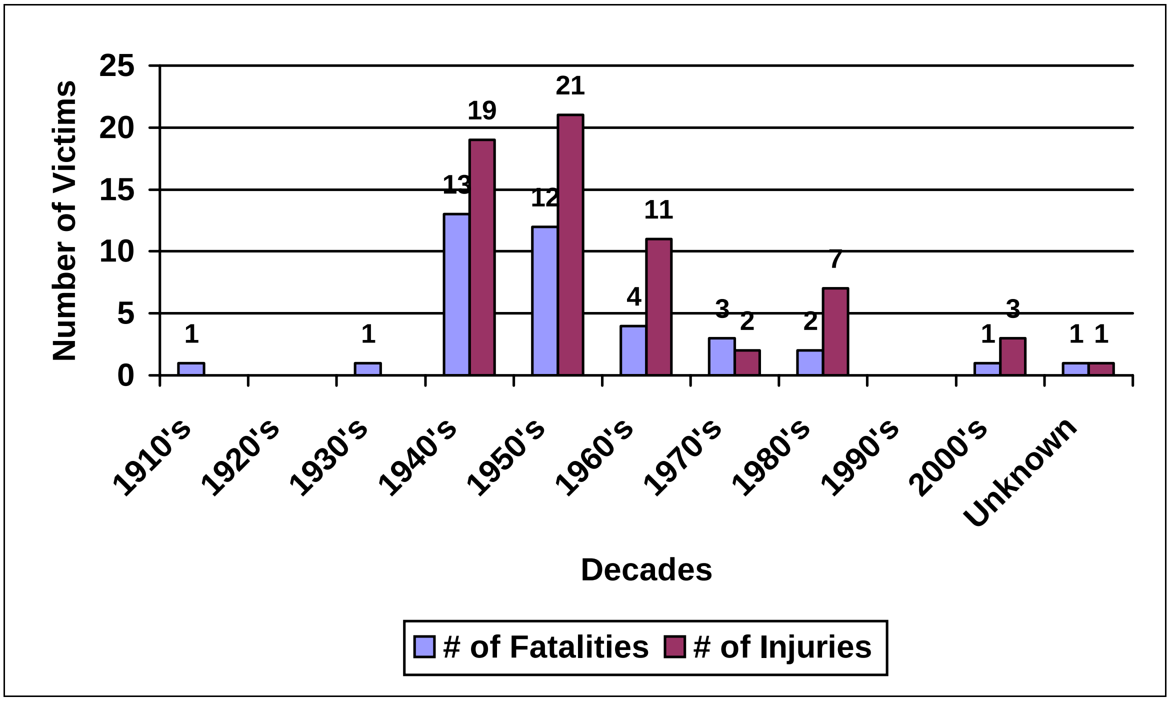

Figure 5. Number of Victims by Decade

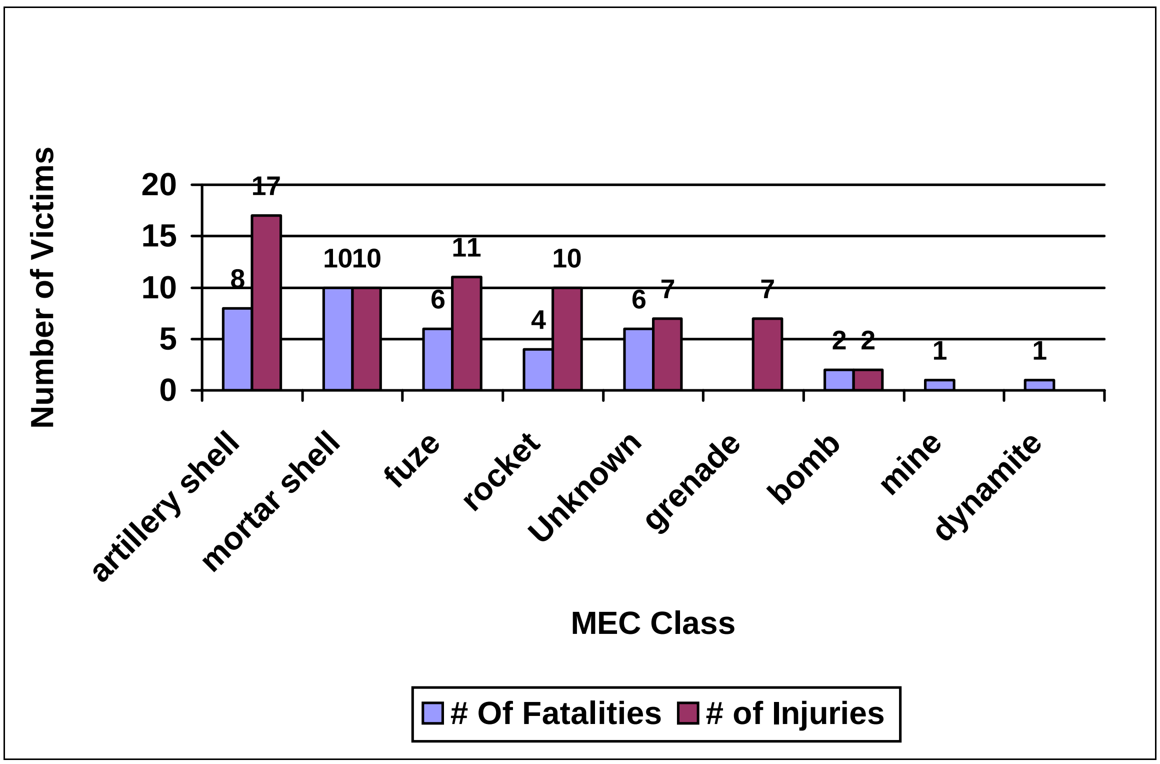

Figure 6. Number of Victims by MEC Class

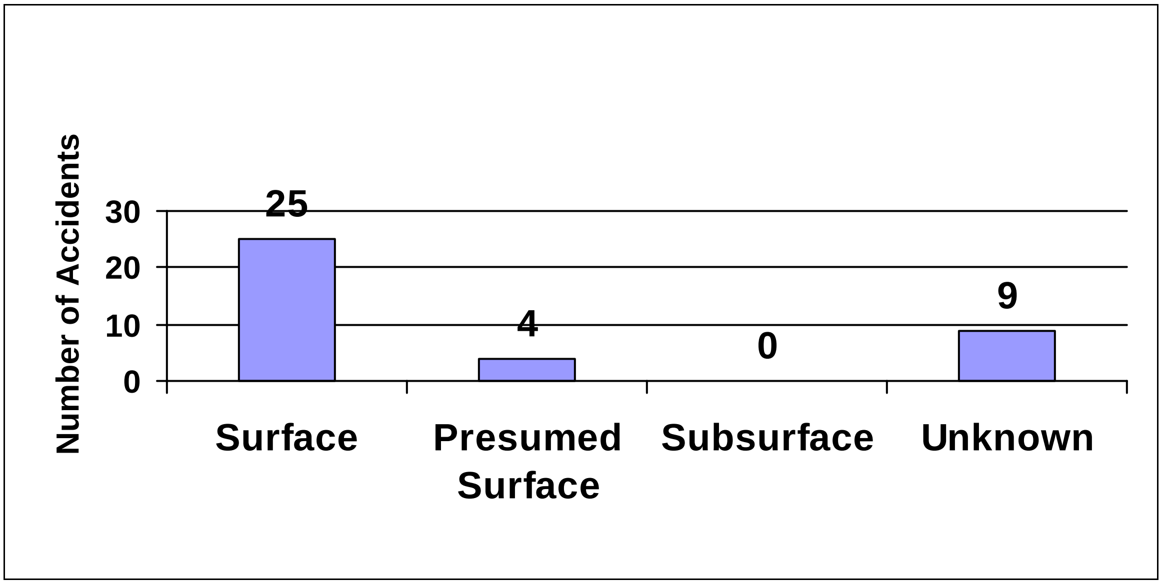

Figure 7. Number of Accidents by Surface/Presumed Surface* / Subsurface

*Based on historical information regarding accident

Finally, a quality assurance check was performed on the original accident data to verify accuracy, detect discrepancies, and update the database if necessary.

DATABASE RESULTS. As of February 2004, 1,238 ASRs had been completed by the Rock Island and St. Louis Districts. Although not all properties have ASRs developed to date, the study nevertheless revealed several important facts. The earliest documented civilian accident occurred in 1913 at Sabine Pass in Texas. Including that accident, there have only been 38 documented ordnance related incidents involving civilians among 32 ordnance sites scattered around the 50 United States, Virgin Islands, and Puerto Rico. There were 102 victims (since several incidents affected more than one individual), including 38 who died and 64 who were injured. Seventy-five percent of the victims were children, in the incidents where ages were known. Where accident dates were known, approximately 61% of the incidents occurred in the 1940s and 1950s, in the years immediately following site closure. The causes of these incidents were categorized as to whether or not the item was picked up (in 92% of the cases it was). The MEC classes contributing to the largest number of victims were artillery shells, mortar shells, and fuzes. In all cases for which complete information was available, the MEC item contributing to the accident was located on the surface of the ground.

QUALITY ASSURANCE. A quality assurance (QA) check was performed on the accident information provided by the Rock Island and St. Louis Districts. This check consisted of reviewing a sample of the ASRs that have been completed to date for any information pertaining to a civilian ordnance accident. A minimum sample size of 10% of the ASRs compiled was chosen for review. The ASRs chosen were picked randomly from a list of the 1,121 ASRs completed as of June 2002.

Forty-one of the 408 ASRs compiled by Rock Island District were reviewed (approximately 10%). No additional information documenting civilian MEC accidents was found. Seventy-one of the 713 ASRs compiled by St. Louis District were reviewed (approximately 10%). During this review, a MEC incident that occurred at Carlsbad Precision Bombing Range #11 in the late 1940s was discovered. Because information about an additional accident was discovered during the QA, an additional 5% of the ASRs compiled by the St. Louis District were reviewed. This resulted in a total of 112 (approximately 15.7%) ASRs compiled by St. Louis District that were reviewed with no additional information on accidents found during the second QA.

DATABASE TRENDS. The main trends noted that should greatly influence responses conducted are that none of the accidents found are known to be the result of subsurface ordnance and that 35 of the 38 accidents resulted when the item was picked up.

RISK MANAGEMENT. As said earlier in the paper, the response alternatives are constructed to reduce the potential for a completed pathway, or in other words, reduce the potential for an accident. While we cannot eliminate the risk, we can reduce or manage the risk. The process for developing the alternatives can be summarized by the following principles:

- If you reduce the quantity of MEC on the site, you lower the risk
- If you reduce the number of receptors on the site, you lower the risk
- If you reduce the potential for interaction between the receptors and the MEC, you lower the risk

- If you control the behavior of the receptors, you lower the risk

When developing the response alternatives, all of these principles should be considered.

The first principle is the one most focused on since it is a permanent action. If you take away a MEC item, there is a reduction, by some amount, in the potential that a receptor may find any MEC item.

The second principle focuses on the other aspect of the exposure equation. If you reduce the number of receptors on a site, the aggregate risk on that site is reduced. The fewer receptors on the site result in less potential for finding any MEC items.

The last two principles deal with changing the activities and actions of receptors on the site. If the activities that the receptors can conduct to those that do not result in contact with any MEC items, the risk is reduced. And finally, the risk is reduced if the receptors notify the correct authorities of the location of the MEC item found and do not pick up the item.

CONCLUSION. In conclusion, while a method of calculating risks on a MMR site does not currently exist, we can reduce the risk by lowering the potential for the MEC to be present, receptors to be present, interaction between the MEC and a receptor, and harmful behaviors of the receptors.