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MOBILE MUNITIONS ASSESSMENT SYSTEM DEVELOPMENT

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ABSTRACT

The United States has been involved in the development, testing, storage and disposal of chemical weapons since World War I. As a result, there are numerous sites which contain the presence of chemical warfare materiel. This materiel is in the form of buried surplus munitions, munitions that did not detonate during testing and other forms. These items pose a significant human health and environmental hazard and must be disposed of properly.

The U.S. Army was tasked by the Department of Defense with the remediation of all non-stockpile chemical warfare materiel. To help comply with this tasking, the Army Project Manager for Nonstockpile Chemical Materiel is sponsoring the development of a Mobile Munitions Assessment System (MMAS). The system is being developed by the Idaho National Engineering Laboratory and Dugway Proving Ground. The purpose of the system is to inspect suspect munitions and containers, identify the fill, evaluate the fusing and firing train and analyze samples from the surrounding area to determine if chemical warfare materiel is present. The information gained from the application of the MMAS and other systems is intended to be used to establish the best method to handle and dispose of a given munition and its contents.

The MMAS is being developed in two phases. The first phase is the development of an initial response system. This system is intended to respond to emergency situations in cases where small quantities of munitions are found and an immediate assessment is required for safety or other reasons. The Phase I system will include a radiography system to assess the fill level and the status of the fusing and firing train, a Portable Isotopic Neutron Spectroscopy (PINS) system to identify the chemical elements in the fill, computer systems to record and store data, analytical equipment to monitor the immediate environment, a weather station, communication equipment, explosive ordinance disposal

equipment and all the necessary support equipment for near autonomous operation. The PINS system and the radiography systems have been used successfully in the field for several years.

The second phase of the MMAS project is the development of an assessment system that will be used at sites where large numbers of munitions are recovered. The Phase II system will include all the features of the Phase I system and will add Secondary Ion Mass Spectrometry (SIMS) to assess the presence of non-volatile chemical materiel on the surface of soil, vegetation, etc. near the munitions, phase determination to determine if the fill materiel is solid or liquid, freezing point determination to establish the materiel freezing point to aid in chemical identification and other support systems required for long term operations. The radiography equipment will likely be upgraded to real time capability. The goal of the Phase II MMAS system is to use several methods to establish the correct status and identity of the munition contents so that it can be properly handled, stored and disposed of safely.

The MMAS project is currently in the requirements development and preliminary design stage. Several system configurations were considered. These include housing the system in a truck, motor home, trailer or a shelter. Each configuration was evaluated against the operational requirements to determine which was the preferred approach. The system must be capable of being driven to a recovery site or being transported on a C-130 or larger aircraft. This requirement sets the maximum weight, length and height of the system. The MMAS will be self-contained to allow for near autonomous operation. All power and other utilities will be provided. The system is being designed for operation and setup by two operators. Most of the assessment equipment will be deployed outside the vehicle by the operators and the assessments will be completed in the field. The samples for the SIMS system will be analyzed

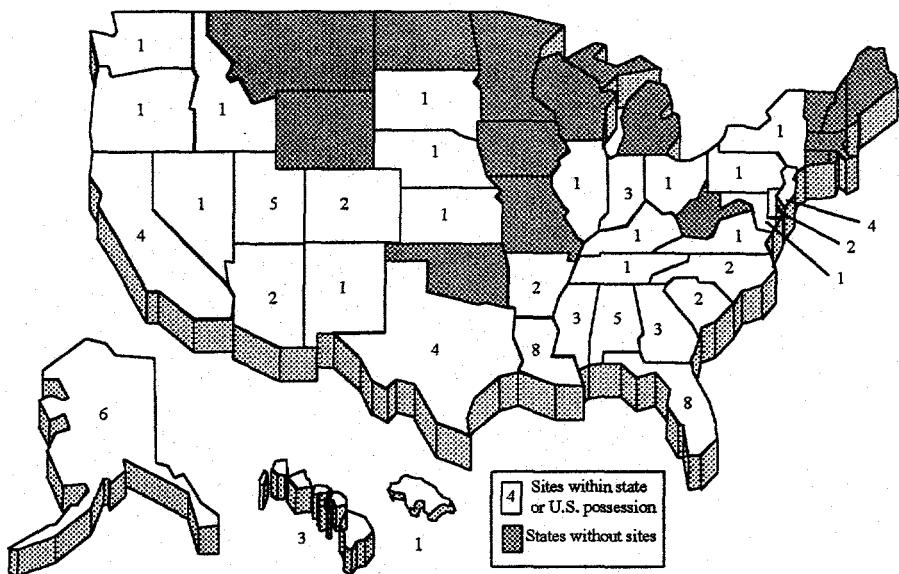


Figure 1: Potential CWM Burial Sites

inside the vehicle because of their small size and because the SIMS is less portable. The data will be transferred to the system data acquisition computers located in the trailer via transferable media. The data will then be sent electronically from the data acquisition computers to a central data collection center for archival and review by the Munitions Review Board. The Munitions Assessment Review Board (MARB) will use the MMAS data and other data to decide on the appropriate disposal method for each item. The MMAS is expected to significantly improve safety during remediation activities and also reduce the handling and disposal costs because of correct identification of the munitions and their contents.

INTRODUCTION AND HISTORY

The Chemical Stockpile Disposal Program (CSDP) was established in 1986 in accordance with Public Law 99-145 to destroy the United States stockpile of lethal unitary chemical agents and munitions. In the House Appropriations Report

101-822 accompanying the fiscal year 1991 Defense Appropriations Act, Congress noted that the CSDP did not include additional chemical warfare related materiel requiring demilitarization. Consequently, Congress directed the Department of Defense (DOD) to organize an overall program so that operational responsibility for all Defense Department chemical warfare activities rested within a single office which would be fully accountable for total program execution. On March 13, 1991, the Deputy Secretary of Defense directed that the Department of the Army (DA) be fully accountable for all DOD chemical warfare related materiel destruction and designated the Secretary of the Army as the Defense Executive Agent for this purpose. In 1992, DA officially established the U.S. Army Chemical Materiel Destruction Agency (USACMDA) with the expressed mission to execute chemical materiel destruction by providing centralized management for the demilitarization and disposal of the United States stockpile of lethal chemical warfare agents and munitions and all non-stockpile chemical materiel (NSCM)¹.

USACMDA established two Program Managers (now project managers) for the disposal effort. The Program Manager for Chemical demilitarization was given the responsibility for the destruction of the chemical stockpile as was declared in 1985. The Program Manager for Non-Stockpile Chemical materiel was given responsibility for the execution of Non-Stockpile Chemical Materiel (NSCMP), which includes the following:

- a. Chemical Warfare Materiel (CWM) buried during past disposal actions,
- b. CWM recovered from either burials, ranges or the public sector,
- c. binary chemical warfare munitions,
- d. former chemical warfare production facilities, and
- e. miscellaneous components manufactured specifically for use as or with chemical weapons, to include research and development quantities above treaty-permitted levels^{1,2}.

In October 1994, the official name of USACMDA was changed to the U.S. Army Chemical Demilitarization and Remediation Activity (USACDRA), and the organization was consolidated under the U.S. Army Chemical and Biological Defense Command (CBDCOM)¹.

In December 1994, the Under Secretary of Defense, Acquisition and Technology [USD(A&T)] designated the Chemical Demilitarization (Chem Demil) Program as an Acquisition Category (ACAT) I Defense Acquisition Board Program. With the designation as an ACAT I Program, the name changed again, from USACDRA to the U.S. Army Program Manager for Chemical Demilitarization (PMCD). The former Program Managers established by USACMDA were redesignated as the Project Manager for Chemical Stockpile Disposal (PMCS) and the Project Manager for Non-Stockpile Chemical Materiel (PMNSCM)¹. The MMAS is being developed for PMNSCM.

The November 1993 PMNSCM database indicates that CWM could have been buried in a total of 82 locations in 33 states, the U.S. Virgin Islands and the District of Columbia. Of the 82 locations, 48 are DOD installations and 34 are formerly used defense sites (FUDS). Some of these locations have multiple burial sites. As of October 1993, the total number of potential or confirmed CWM burial sites at the 82 locations is 215. This information is based on

preliminary documentation research. The actual number of sites with buried CWM cannot be confirmed until site characterization studies are concluded.²

Munitions that may be found at these potential burial sites include 4.2 -inch and Stokes mortar rounds, aerial bombs, rockets and projectiles, and containers of agent in both 55-gallon drums and ton containers. Potential chemical agents in these munitions and containers include blistering agents [mustard (H) and lewisite (L)], nerve agents (GA, GB and VX), blood agents [hydrogen cyanide (AC) and cyanogen chloride (CK)] and choking agent [phosgene (CG)]. Many burial sites also contain other hazardous substances such as white phosphorous (a screening smoke).²

The MMAS will provide for an assessment of the munitions and chemicals described in the previous paragraph at the locations defined in "a" through "f" above.

REQUIREMENTS

When suspect CWM is located in the field the Army must establish the condition of the firing train and/or determine the contents of the munition or container. The equipment contained on board the MMAS is required to satisfy these needs. Specifically the MMAS equipment is required to do the following:

- a. identify the munition contents (i.e. the chemical elements),
- b. determine the munition fill level,
- c. determine the phase (solid or liquid) of the munition contents,
- d. determine the status of the munition firing train,
- e. record, store, save and transmit the collected data,
- f. provide weather information,
- g. provide utilities (power, communications, ect.),
- h. provide an integrated transportation system and working environment,
- i. monitor the environment (air, soil, vegetation, etc.) at the remediation site for chemicals.

- j. determine the freezing point of the chemical.

There are many important reasons to meet the requirements listed above. The most obvious reason is safety. Accurate knowledge of the status of the firing train is critical to the proper handling and disposition of the munition. Likewise, accurate identification of the chemical is important to safety and proper handling. Proper chemical identification is also important for storage of the items prior to disposal. Regulations require that certain chemicals not be stored together for safety reasons.

There are many cost considerations which require accurate identification of the chemical and determination of the firing train status. Incorrect information can lead to handling and disposal methods that are expensive and unneeded in some cases. MMAS must provide accurate and complete records to the decision makers so that proper disposition of the munitions is achieved. These records are also needed for historical reasons and to address future issues related to the remediation efforts at the various sites.

The MMAS is expected to assess the MARB build an element of trust with federal, state and local regulating agencies by providing accurate and complete information on recovered munitions and other items. The value of this trust is very significant.

DEVELOPMENT PHASES

The MMAS project is divided into two phases. This first phase (Phase I) involves developing an assessment system that consists of immediately available technology. These technologies are portable isotopic neutron spectroscopy (PINS), radiography, vapor detection (air monitoring) and data acquisition. In addition the Phase I MMAS will have the following support and utility subsystems:

- a. explosive ordinance disposal equipment
- b. local and cellular communications,
- c. weather station and supporting hardware and software for dispersion analysis,
- d. audio/video equipment,
- e. electrical generators,
- f. etc.

The above subsystems and associated equipment are assembled in a truck and trailer combination which is designed to travel long distances to remediation sites. In addition the truck and trailer is designed to be shipped on a C-130 aircraft.

Two Phase I MMAS systems will be built. The first system is a prototype that will be used to gain experience with the MMAS concept and the second will incorporate knowledge and improvements learned from the first system fabrication and testing. The Phase I MMAS systems are intended to be used for the initial response at recovery and remediation sites.

The second phase of the MMAS project (Phase II) involves the design and development of a state-of-the-art system that benefits from the knowledge and experience gained from the first phase. This second system would include the Phase I systems and would add Secondary Ion Mass Spectroscopy (SIMS), a revised data system, a chemical fill materiel freezing point determination system and a chemical fill material phase (solid or liquid) determination system. In addition the radiography system will be upgraded to provide real time x-ray capability. The Phase II MMAS system is intended for use at larger remediations sites where operations will continue for several months.

Phase I of the MMAS project will be conducted in FY96 to FY98. The first prototype will be delivered during February of 1997. Phase II will be conducted between FY96 to FY 00. The first Phase II prototype will be delivered during February of 1999.

SYSTEM DESCRIPTION

The preliminary design of the Phase I system is nearly complete. A trade study (See Table 1) was completed to determine the best design for the Phase I system. Four configurations were considered as follows: van/truck, Army shelter, motor home and a truck and trailer combination. A truck and trailer combination was chosen based on the the selection criteria shown in Table 1. The current vehicle design is similar to the design chosen by the team designing the Rapid Response System (RRS) for the Army. The trailer is a 24 foot 5th wheel design with a modified overhang that allows the electrical generators to be stored and transported on the truck bed. The truck is a standard Ford 1-ton which is configured and rated to tow a 12,500 pound trailer. The Phase I MMAS trailer and its contents are predicted to weigh less than 10,000 pounds. The trailer is designed with air ride suspension to reduce the shock and vibration loads on the

equipment that it carries.

The general layout of the trailer is shown in Figure 2. The back of the trailer is configured primarily for storage of the nondestructive examination equipment (NDE) which is used in the field. The NDE equipment is stored in handling containers that can be easily loaded on the truck and moved close to the remediation site. The middle of the trailer houses the computer systems, communications, instrumentation, audio/video equipment, work stations and all reference and training material. The front (overhang) of the trailer houses the heating, ventilating and air conditioning system, the air ride suspension controls and numerous instrument racks.

Lighting (12 volt and 120 volt) is provided inside the trailer. The 12 volt lighting is for temporary use only. Exterior lights are provided at each corner of the trailer. These lights are recessed so that they do not have to be removed during travel. The 120 volt lighting is powered by a 12 kilowatt generator that is located on the truck or deployed within 100 feet of the trailer. This generator also powers all the active systems located in the trailer. A 6.5 kilowatt generator is used for power at the location of the item that is being inspected. Electrical connections are provided on the outside of the trailer to allow the system to be powered by facility power.

The MMAS is equipped with a standard cellular telephone system both in the truck and the trailer. In addition the cellular phone will have access to the "Skycell" system so that there are no black-out areas in the United States. Two weather stations are included in the MMAS. One has a 10 meter mast and is located at the trailer and the other has a 3 meter mast and is located down-wind of the remediation site.

Redundant computer systems are contained in the MMAS. These systems are used to store and process data from the NDE systems and to transmit the data to a central data collection location. Audio and video equipment is maintained on-board the MMAS so that historical records of the activities can be provided.

The truck will have numerous storage compartments that will contain the majority of the standard explosive ordinance disposal (EOD) equipment. This storage location was chosen because there may be emergency cases where only the EOD equipment is required and therefore only the truck would be taken to the site.

OPERATIONAL SCENARIO

There are many different operational scenarios for the MMAS. As mentioned above, the MMAS truck could be used for an EOD activity, or NDE equipment could be removed from the trailer and transported to a site using the truck or a helicopter. The later is a very easy operation because all the NDE equipment is containerized and is easy to handle and transport. The normal expected operational scenario will be to drive or fly (on a C-130, C-141, C-17 or C-5) the MMAS truck and trailer to the remediation site. At the remediation site, the equipment will be deployed generally as shown in Figure 3.

The trailer will be deployed upwind of the remediation site and outside the hot zone. The truck will then be disconnected from the trailer and driven to the selected location for the generator that supplies power to the trailer. The truck hoist will be used to off load the generator. The electrical leads will be connected to the trailer and power will be supplied to the trailer. The subsystems in the trailer will then be powered up.

The truck will then be used to transfer the NDE systems from the trailer to a staging area, upwind, and just outside the hot zone. The NDE systems and the 6.5 kilowatt generator will be unloaded and the truck will now be available for other tasks at the site. The air monitoring equipment and the weather station will be deployed (and powered-up) at the site prior to use of the NDE equipment.

Generally, the radiography system will be the first MMAS NDE system used to examine a munition at the remediation site. The radiography system will determine firing train status and detect munition fill level if the munition is liquid filled. After the munition has been examined by the radiography system the PINS system will be used to determine the chemical elements in the fill materiel. The data obtained by PINS and from the radiograph will be input to the data acquisition computers located on board the trailer. The information on these computers can be transferred to Dugway Proving Ground or Aberdeen Proving Ground for review by subject area experts. Based on the information obtained from the radiography and the PINS assay, a decision will be made on further handling and storage of the munition. If the Phase II MMAS system is being used, the operators will have the option of determining the phase (solid or liquid) of the contents and also the option of determining the freezing point of the liquid. The phase determination system and the freezing point determination systems are located in the Phase II vehicle. Knowledge of the phase and the freezing point provides additional supporting data to aid

PHASE I MMAS VEHICLE DECISION MATRIX								
10: EXCEEDS THE REQUIREMENT, 5: MEETS THE MINIMUM REQUIREMENT, 0: DOES NOT MEET THE REQUIREMENT								
ISSUE	TRUCK/VAN		MOTORHOME		TRAILER		SHELTER	
TRANSPORT ON C-141 OR 130	0	TOO TALL, 12 + FEET, C-5 OK	6	MUST BE SPECIAL BUILT, EXPENSIVE	9	DROP AXLE REQUIRED	8	ADDITIONAL HANDLING EQUIPMENT
OFF-ROAD CAPABLE	9	OK IF NOT IN MUD OR SAND	5	MINIMAL CAPABILITY	8	COULD BE TOWED BY A TRACKED VEHICLE	4	SPECIAL TRUCK, CRANE TO UNLOAD
WORKING SPACE	8	24' VAN LENGTH 8' WIDTH	9	UP TO 35' LENGTH, 7' WIDTH	10	UP TO 40' LENGTH, 8' WIDTH	10	MANY LARGE SIZES AVAILABLE
TOWING (GENERATOR)	10	NO PROBLEM WITH TOWING	8	LIMITED TOWING	0	NOT CAPABLE	6	TRANSPORT VEHICLE COULD TOW
OPERATIONAL CONVENIENCE	10	SELF-CONTAINED	10	SELF-CONTAINED	7	TRACTOR REQUIRED	3	TRUCK AND CRANE REQUIRED
INITIAL COST	8	\$50K	3	\$100K	10	\$30K	3	\$100K ARMY \$50K COM.
OPERATING COST	7	MAINTAIN TRUCK	7	MAINTAIN MOTORHOME	10	TRACTOR USED WHEN REQUIRED	5	TRUCK AND CRANE REQUIRED
DELIVERY	8	4-6 MONTHS	5	6-8 MONTHS	9	3-6 MONTHS	8	4-6 MONTHS
EASE OF MODIFICATION	8	RECENT EXPERIENCE	8	SAME AS TRUCK	8	SAME AS TRUCK	6	EXTERNAL STRUCTURE
VIBRATION DAMPING	9	AIR RIDE SUSPENSION POSSIBLE	10	AIR RIDE SUSPENSION ROUTINE	6	SPRING SUSPENSION TYPICAL	5	SPECIAL TRUCK REQUIRED
SITE TRANSPORTATION	5	NOT USABLE DURING OPERATION	5	NOT USABLE DURING OPERATION	10	CAN BE USED AT ANY TIME	0	NO VEHICLE
TOTAL:	82		76		87		58	
THE ISSUES ARE NOT WEIGHTED IN IMPORTANCE.								

Table 1: Vehicle Configuration Selection Criteria

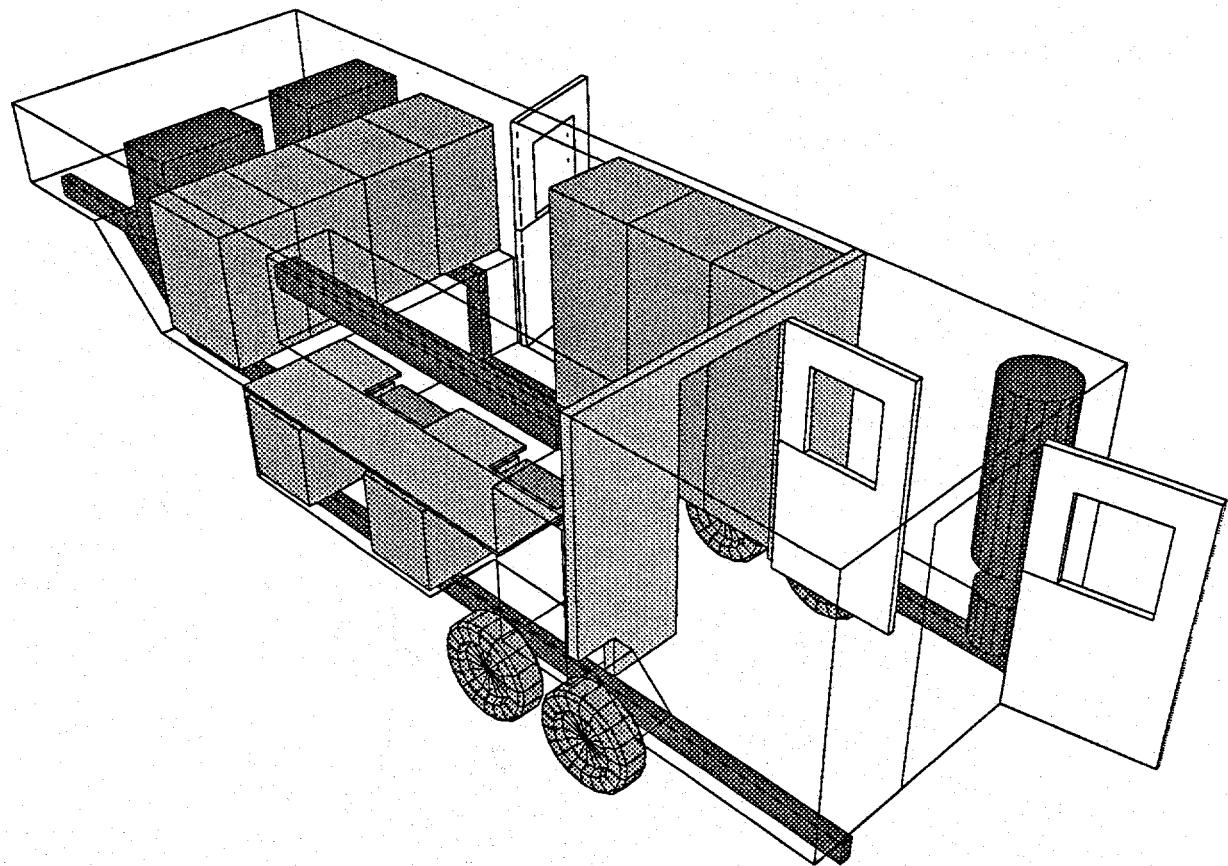


Figure 2: General Layout of MMA trailer

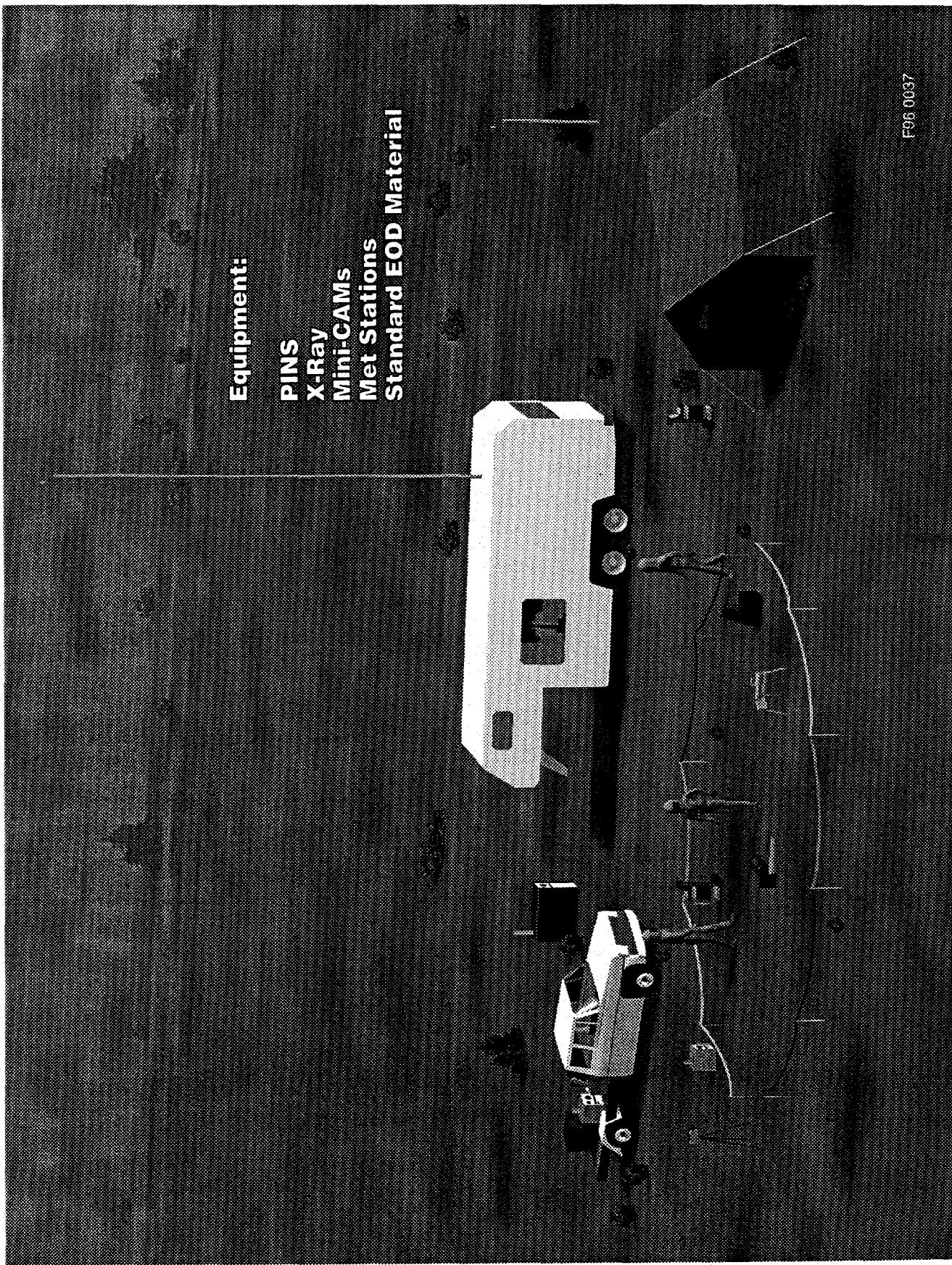


Figure 3. MMAS Deployment Scenario

in the correct identification of the munition's contents. Data from these systems is also fed to the data acquisition computers.

SIMS will be used to test the soil and vegetation near the munition for non-volatile chemicals. Data from the MMAS weather station, GPS station and the air monitors is continuously routed to the data acquisition computers during a site remediation activity. This information, along with the information from the NDE systems provides a historical record of the activity for future use.

Exit from the site proceeds approximately in reverse of the setup. Monitoring of the equipment for chemical contamination is required as is cleaning of some of the equipment that is used. Standard equipment and materials are used for this operation.

The MMAS can operate nearly autonomously at a remediation site. There are two exceptions to this however. The MMAS does not have equipment on board to recharge the SCUBA tanks and it will be necessary to obtain gasoline for the generators. The truck is available to obtain these items from local vendors or from the Army Post if the operation is occurring there.

STATUS

The MMAS project is in the preliminary design stage for the Phase I system. The truck and trailer have been purchased as well as numerous other equipment items. Modifications to the truck will begin in March of 1996 and assembly of the trailer will begin in April of 1996. Testing of the Phase I prototype will begin in October of 1996 at Dugway Proving Ground. Delivery of the first Phase I prototype to the Army is scheduled for February of 1997.

SIMS, phase determination, freezing point determination, real time radiography and improved air monitoring will be added to the MMAS Phase II prototype. Research and development has started on these systems and will continue through FY96 and FY97. Assembly of the Phase II prototype will begin in FY98. The Phase II prototype will be delivered to the Army in February of 1999.

CONCLUSIONS

The MMAS systems will provide the following information on recovered chemical weapons material and the remediation site:

- a. chemical elements in the fill,
- b. munition fill level,
- c. phase (solid or liquid) of the fill materiel,
- d. freezing point of the fill material,
- e. status of the firing train
- f. volatile chemicals in the air
- g. non-volatile chemicals on soil, vegetation, etc.
- h. weather data

All the data from the MMAS systems will be recorded, stored and saved so that accurate historical records are maintained on all items. In addition the data will be contained in a format that can be readily used by the Munitions Review Board.

The MMAS provides an integrated transportation system and working environment for the operators. All utility and communication equipment is provided to allow nearly autonomous operation at a remediation site.

The MMAS will be an extremely valuable tool for use at chemical weapon materiel remediation sites. Knowledge gained from the NDE systems will allow the Army to make more informed decisions on the disposition of recovered chemical weapons materiel. This will lead to improved safety, reduced costs, reduced remediation time and increased confidence in the remediation process being conducted.

REFERENCES

1. U.S. Army Program Manager for Chemical Demilitarization, Non-Stockpile Chemical Materiel Program Implementation Plan, August 1995.
2. Program Manager for Non Stockpile Chemical Materiel, Non-Stockpile Chemical Materiel Program, Survey and Analysis Report, November 1993.