Special Report 81-20

September 1981

AD A107047

LEVEL II

MINE/COUNTERMINE PROBLEMS DURING WINTER WARFARE

Final Report of a Workshop

Virgil Lunardini, Editor

DTIC
ELECTE
NOV 10 1981
S D
D

DTIC FILE COPY

Prepared for
OFFICE OF THE CHIEF OF ENGINEERS
By
UNITED STATES ARMY CORPS OF ENGINEERS
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
HANOVER, NEW HAMPSHIRE, U.S.A.

Approved for public release; distribution unlimited.

81 11 09 172

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER Special Report 81-20	2. GOVT ACCESSION NO. AD-A107 047
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) MINE/COUNTERMINE PROBLEMS DURING WINTER WARFARE, Final Report of a Workshop	5. TYPE OF REPORT & PERIOD COVERED CRREL-SR-81-20
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Virgil Lunardini, Editor	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Cold Regions Research and Engineering Laboratory Hanover, New Hampshire 03755	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS DA Project 4A762730AT42 Task A, Work Unit 15
11. CONTROLLING OFFICE NAME AND ADDRESS Office of the Chief of Engineers Washington, D.C. 02314	12. REPORT DATE Sep[redacted]981
	13. NUMBER OF PAGES 49
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Antipersonnel mines	Mine clearance
Antitank mines	Mine countermeasures
Cold regions	Mine warfare
Cold weather	Scatterable mines
Land mines	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The possibility of modern warfare being waged under cold weather conditions has raised questions about the effectiveness of conventional and new mine systems during the winter. A workshop on mine/countermine winter warfare was held at the U.S. Army Cold Regions Research and Engineering Laboratory, 21-23 October 1980, to define problems related to cold climates. The designer, developer and user communities sent 22 representatives from 16 organizations outside of CRREL. Discussion papers were prepared by four groups, covering emplacement of mines, mine performance, detection of mines, and neutralization of mines. The emphasis was

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Abstract (cont'd)

on the unique problems of the winter environment. It appears that the U.S. has the capability to conduct defensive warfare during the summer but is not adequately prpared for mine/countermine winter warfare. Test and research programs are called for to compensate for the prior lack of consideration of the winter environment, to adequately winterize new mine/countermine systems, and to formulate appropriate doctrine for defensive winter warfare.

PREFACE

This report was edited by Dr. Virgil Lunardini, Mechanical Engineer, Applied Research Branch, Experimental Engineering Division, U.S. Army Cold Regions Research and Engineering Laboratory.

The study was conducted under DA Project 4A762730AT42, Task A, Work Unit 15, Mines and Countermines/Winter Combat Support.

The draft report was reviewed by all participants of the workshop, and corrections, comments and additions by the reviewers were incorporated. The final report was reviewed by D. Farrell and P. Richmond of CRREL. Appreciation is expressed for the assistance of the workshop participants, for the comments of all the reviewers, and for detailed input by Dr. R. Liston, P. Richmond, D. Farrell and Dr. G. Swinzow of CRREL.

Accession For
NTIS GRA&I X
DTIC TAB
Unannounced
Justification

By
Distribution/
Availability Codes

Dist	Avail and/or Special
A	

DTIC
ELECTE
NOV 10 1981
S D
D

CONTENTS

ACRONYMS AND DEFINITIONS

Organizations

AMSAA	Army Materiel Systems Analysis Agency
ARENBD	Army Engineer Board
ARRADCOM	Armament Research and Development Command
ARRCOM	Army Armament Materiel Readiness Command
CACDA	Combined Arms Combat Development Activity
CE	Corps of Engineers
CERL	Construction Engineering Research Laboratory
CRREL	Cold Regions Research and Engineering Laboratory
CRTC	Cold Regions Test Center
DARCOM	Materiel Development and Readiness Command
DDC	Defense Documentation Center
ERIM	Environmental Research Institute of Michigan (remote sensing center)
ETL	Engineer Topographic Laboratories
FSTC	Foreign Science and Technology Center
MERADCOM	Mobility Equipment Research and Development Command
OCE	Office of the Chief of Engineers
TECOM	Test and Evaluation Command
TIWG	Test Integrated Working Group
TRADOC	Training and Doctrine Command
USACDA	U.S. Army Combat Development Activity
USAES	U.S. Army Engineer School
WES	Waterways Experiment Station

Mine/countermine systems

ADAM	Artillery delivered antipersonnel mine
Ahkios	Scow-type over-snow supply sled
AMIDS	Airborne mine detector system
AN PRS-7	Hand held mine detector, dielectric - metallic
AN PSS-11	Vehicle-mounted detector, metal and nonmetal

AP	Antipersonnel
AT	Antitank
Bangalore Torpedo	Explosive device used to clear obstacles
DEVA-IPR	Development acceptance - individual process review
DT II A	Development test II A
FASCAM	Family of scatterable mines
FOE	Follow-on evaluation
Full Width Plow	Used with M-1 or counter obstacle vehicle
GATOR	Gator mine system delivered by aircraft
GEMSS	Ground emplaced mine scattering system
Giant Viper	British mine clearing device (rocket propelled line charge)
HE	High explosive
IOC	Initial operational capabilities
IPR	In progress review
IR	Infrared
LEA	Logistics evaluation activity
MICLIC	Mine clearing line charge
MOPMS	Modular pack mine system
M12	Antitank mine, practice
M14	Antipersonnel mine, blast type
M15	Antitank mine, pressure activated
M16A2	Antipersonnel mine, bounding type
M18A1	Antipersonnel mine, fixed direction fragmenting
M19	Antitank mine, nonmetalic
M20	Antitank mine, practice
M21	Antitank mine, shaped charge, pressure or tilt rod
M23	Chemical mine
M24	Antitank mine, off-route
M26	Antipersonnel mine, bounding type
M35	Antipersonnel mine, practice
M66	Antitank mine, off-route

M68	Antipersonnel mine, practice
M69	Antitank mine, practice
M57 Mine Layer	Towed device for emplacing M15 at mines either on surface or buried
M157	Explosive line charge emplaced with tank
M173	Rocket propelled line charge
OT II A	Operational test II A
Plow	Partial plow
POMINS	Portable man-installed neutralization system
RAAM	Remote antiarmor mine
R&D	Research and development
REMBASS	Remotely monitored battlefield sensor system
ROC	Required operational capability
Roller	Used to clear mines in front of tank
SLUFAE	Surface launched unit, fuel air explosive
UV	Ultraviolet
VS	Visible spectrum
VEMASID	Vehicle magnetic signature duplicator
VMRMD	Vehicle mounted road mine detector

MINE/COUNTERMINE PROBLEMS DURING WINTER WARFARE
Final Report of a Workshop

Virgil Lunardini, Editor

INTRODUCTION

The effect of the total winter environment on mine/countermine operations has not been adequately addressed in the past. This has caused some anxiety about the doctrine for and the effectiveness of conventional mine systems during winter warefare. A similar disregard for the effects of cold environments seems to have carried over to new mine systems that are now being designed or proposed.

During 1979, the Chief of Engineers (CE) directed that a mine/countermine program be developed and he designated WES* as the lead laboratory. The 5-year plan developed for the Corps of Engineers by WES is attached as Appendix A. CRREL was asked to formulate a mine/countermine program specifically addressing the problems of winter warfare. After meetings and discussions with appropriate organizations, including WES, USAES and TRADOC, a preliminary 5-year plan was proposed and is attached as Appendix B.

While formulating its plan, CRREL clearly saw that the winter environment had been seriously neglected. Thus the present workshop was organized to obtain input from the entire mine/countermine community. The express purpose of the workshop was to expose and define problems related to cold climates, as seen by the designers, developers, and users of the mine systems. CRREL would then be able to modify its 5-year plan so as to adequately treat these problems if they are not already covered in the plan and if they fall within the capabilities of CRREL. The workshop was attended by 22 representatives from 16 organizations outside of CRREL, in addition to CRREL personnel. The registration list is included in Appendix C.

For convenience the mine/countermine discussion was divided into four categories: emplacement, performance, detection, and neutralization. It is

*See list of acronyms and definitions.

apparent that these components are interrelated for a mine system, but the division is useful for focusing on specific problems. General discussions of the topics were carried out for the first day and a half, four working groups were formed to prepare subreports on each topic, and a complete draft report was then prepared and discussed on the last day. The agenda is included in Appendix C.

The discussions focused on the problems of mine systems during winter warfare. The winter environment includes the interaction of:

1. Snow - physical characteristics, depth, duration, areal extent.
2. Frozen ground - physical characteristics, depth, duration, beginning and end of freeze season.
3. Thawing ground - temperature and areal extent, physical properties.
4. Meteorology - temperature, snow, rain, sleet, hail, fog, ice fog, etc.

The workshop was specifically concerned with the overall interaction of mine systems with the above phenomena.

GENERAL SESSION

The workshop began with general discussion by all participants of mine/countermine systems. After this, four working groups were formed to cover the topics of emplacement, performance, detection, and neutralization. A suggested format used by the working groups is included in Appendix C. Each working group prepared a report and these were then combined into a draft report. This was followed up with a general discussion of the draft report and additions were made to it. The ammended report forms the next section of this summary and includes the specific problems and actions required. Some general comments, not covered in the draft report, follow.

Emplacement

The methods of emplacing mines or mine fields include:

1. Hand emplacement
2. M57 mine layer

3. GEMSS (M128)*

4. Artillery delivery (ADAM, RAAM)

5. Helicopter (M56) or aircraft dispersal (GATOR)

Common to all of the discussions was a concern for the lack of guidance for commanders with regard to virtually all aspects of the impact of cold weather environments on mine systems. While the possibility exists that this was simply a failure to incorporate available data into manuals, the consensus of the workshop participants seemed to be that little reliable data exist.

New concepts in surface laying of both conventional and FASCAM mines are being proposed, but doctrine has not yet been established. The merits of surface emplacement vs burial of mines were widely discussed. Proponents of surface emplacement argued that visible mines present adequate threat and obstruction, while opponents noted that surface mines are easier to bypass. The problem is compounded by a lack of data on the performance of mines in snow covered terrain or frozen ground. In any case, conventional mines are presently buried and must be maintained and replaced. Col. Baushke presented a briefing on the problems faced in Korea. The question of burial vs surface emplacement is critical to the doctrine, depending on the time available to emplace the mines. Apparently, some mix of surface and buried mines may be needed. The question of doctrine here is significant because it will determine the direction of research and testing and it should be resolved.

Another area of concern, emphasized by CACDA, was the mobility of emplacement systems in deep snow, thawing soils and freezing bodies of water (swamps in NATO countries, rice paddies in Korea). The performance of most emplacement systems in the winter has not been well documented.

Performance

A lack of winter data was identified and the problems can be categorized as:

*See Table D1 for details on the various mines.

1. Effect of emplacement in snow or thawing soil on performance.

2. Effect of snow or ice on activation mechanisms.

3. Effect of freeze/thaw cycles on reliability.

4. Effect of snow on fragment attenuation.

5. Stability of mines in snow.

CRTC presented a short movie on the performance of GEMSS and SLUFAE in Alaska during the winter. Quantitative data on system performance, not obvious from the film, were summarized by CRTC and are available in their test reports. Appendix D includes information on mines with cold weather problems.

Detection and neutralization

TRADOC is especially interested in the development of a capability for standoff detection of mines. A significant effort has been expended on remote sensing, but applying this expertise to mines and mine fields in the winter seems to be at a preliminary stage.

Knowledge of the performance of neutralization systems in snow requires investigation and testing. These systems include the Roller, Plow, MICLIC, and SLUFAE.

Threat capability

FSTC presented an overview of Soviet capability for winter warfare. This underlined the general impression that the Soviets far exceed NATO capabilities in this regard. The briefing did not deal directly with mine systems, but it seems reasonable to extrapolate Soviet superiority to this area also.

REVISED DRAFT REPORT OF WORKING GROUPS

Group 1. Emplacement of mines

J. Baushke
J. Clemens
J. Deaton
I. Howard
R. Liston (Chairman)
P. Richmond
T. Romanko
E. Underwood
R. Benn (attended more than one group)

I. Lack of cold weather information in manuals directing land mine use.

FSTC will conduct an in-depth literature search of all potential sources. Results will be sent to CRREL for evaluation and analysis, and preparation of the final product. If the literature search appears to be of value, a review will be published in the PS Magazine or similar appropriate publications.* The data will be used to further identify areas of research or testing that will produce urgently needed information, in addition to being used to improve manuals.

II. Determination of the performance of existing Korean mine fields.

Mines have been emplaced and are expected to function for 3 and 5 years (these survivability times need not apply to NATO countries). Field tests will be carried out under conditions of:

A. Frozen soil.

B. Snow covered soil.

C. Thawed soil.

The test details will be established subsequent to the forthcoming visit to Korea by AMSAA, ARRADCOM, CRREL and WES.

III. Cold weather emplacement of conventional mines.

An analysis should be made of the effectiveness of surface emplaced, buried, and a combination of surface emplaced and buried mines (including deployment in snow). If it can be established and verified that surface emplacement is adequate, then the task is complete**. If not, it will be necessary to establish the effectiveness of the current practice of burying mines in frozen soil and in snow covered terrain. This would include evaluation of the following specific systems and related problems:

A. Excavation of frozen soil and subsequent camouflage for hand emplacement and for the M57 mine layer.

---

*The review may merit publication under separate cover such as a TRADOC Bulletin or Battle Report.

**TRADOC must first determine that tests are required and then adopt test results into doctrine.

B. M18A1 (Claymore): Electrical leads may break when unfolded in severe cold.

C. M26 AP, M19 AT HE: Soldiers must remove gloves to emplace and arm (almost all conventional mines).

D. M16 AP with M605 fuze (bounding type):

   1. Weight 7-7/8 lb, transportation problem for soldiers moving with ahkios, true for any large quantity of mines.

   2. Prongs or trip wire may be ineffective if covered with new, deep snow, valid for most AP mines.

E. M14 AP nonmetallic and M26 AP: Easy to lose because of size.

F. M15 AT HE, heavy: Difficult to lay.

G. M21 AT, HE, heavy: Must be laid in or on solid ground (290 lb required for detonation).

H. M23 chemical VX: Weight 22-3/4 lb, transportation problem.

I. M56 scatterable mines: Must strike ground to arm and may not arm in deep snow.

J. M24: Off-route mine, discriminator may break when deployed under extreme cold.

K. ADAM: Trip wires may not deploy properly in snow.

L. RAAM: Disc-shaped mines may not lay flat enough for required lethality.

M. The final step will be to establish criteria for mine laying equipment that can operate in frozen soil and in snow.

IV. Emplacement of conventional AP mines in snow covered terrain.

Discussion was not sufficiently detailed to develop an approach. The problem will be identified during the Korean visit (see item III above for possible problems).

V. Emplacement of line charges or bangalore torpedoes in snow covered terrain.

This problem surfaced at the last moment and was not discussed in any depth.

VI. The following items were mentioned frequently during the general discussion:

A. Mobility of emplacement systems in snow, on thawing ground, and over ice: Deep snow, thawing ground and insufficient ice thickness may hinder dispensing of GEMSS, RAAM and ADAM (by M109 SP howitzer or M114 towed howitzer) and even MOPMS. The combination of small wheels and very high loads caused M113 shear pins to fail excessively while towing GEMSS. A review of the mobility tests and the determined limitations of the emplacement systems is needed, particularly for snow and thawing soils.

B. FASAM orientation after delivery into snow.

1. Orientation immediately after delivery.
2. Behavior in a snow pack during life of the mine.
3. Effect of unusual emplacement position, possibility of mine activating due to tipping as snow melts.

Group 2. Performance of mines in the winter environment

R. Ely
D. Farrell
W. Hanson
S. Pepe (Chairman)
I. Tarlow

I. General problems, conventional mines.

A. Activation under snow.
B. Snow acting as buffer to blast and fragments.
C. Activation/performance after freezing rain.
D. Frozen ground and buried mine degradation.
E. Orientation
1. Activation in snow.
2. Performance in snow.
3. Effect of tilt due to mine sinking deeper into soft snow base.
F. Effect of freeze/thaw cycles on activation, performance and migration (movements) in a snow-soil environment.

II. Specific problems, conventional mines.

A. AP mines.

- Tripwire and pressure plate activation under snow (M14, M16A2, M26).
- Bounding height and effective radius (M26, M16A2) in snow.
- Blast and fragment attenuation (M14) in snow.
- Effectiveness against cold weather clothing.

B. T mines.
- Tilt rod breaking or freezing in severe cold (M21).
- Off-route functioning (discriminator M24) under snow cover or ice cover.
- Off-route (M66) acoustic/IR/magnetic detection degradation in snow or ice.

III. FASCAM

A. General problems.

1. Increased minefield density needed because of reduced effectiveness with delivery in snow or on ice.
2. Battery life under winter conditions.
3. Orientation in snow (all members of FASCAM).
4. Movement in snow (orientation).
5. Performance/activation under snow.
6. Freeze/thaw cycles.
7. Freezing rain.

B. Specific problems.

1. AP mines.
   a) Trip line deployment in snow cover (M67/72 ADAM, M74 GEMSS, MOPMS), possibility of freezing in place.
   b) Degradation of fragments in snow (M74).
   c) Bounding height (M67/72) in snow.
   d) Wind/snow effects.
2. AT mines.
   a) Migration/activation interface.
   b) Interference of snow with clearing charge.
   c) Pressure detonation in snow (M56).
   d) Effect of detonation of mine on its side in 6 to 12 in. of snow, and trajectory of slug.

IV. Action required.

A. Search literature for test data (if any) available on all systems.

1. Continued close liaison, including visits to TECOM, AMSAA and ARRADCOM by CRREL.

2. Followup on Soviet capability to determine if there are any useful data available on mine/countermine winter operations; CRREL will query FSTC.

B. FASCAM (test program): Orientation in snow.

1. Degradation of performance and effect of snow on plate charge.

2. Degradation of trip line deployment.

3. Effect of snow on ADAM.

V. CRREL will accelerate its 5-year plan to address these questions as soon as possible and will coordinate with TECOM and AMSAA.

<u>Group 3. Neutralization of mines</u>

T. Aubin	J. Drake
B. Benedict	L. Ingram
R. Carn	B. Miller (Chariman)
	W. Mills

I. Conventional systems: SLUFAE, MICLIC, Roller, Plow.

A. SLUFAE

1. Status with regard to snow, ice, frozen ground, thawing ground, etc.

a) Test reports and data from CRTC.

b) CRTC and MERADCOM for additional data on performance.

2. Action needed.

a) Search literature for any cold tests (DDC test reports), evaluate.

b) Additional testing if data not available. Possibly FOE, terminal effects of SLUFAE (materiel developer) and how SLUFAE is impeded by cold weather, performance limitations, etc.

3. Effect on doctrine or manuals: None proposed at this time, but must be considered; possible impact from literature search.

4. Responsible for action: MERADCOM is responsible for collecting and reporting. CRTC provides information as required on tests conducted in Alaska. MERADCOM/USAES evaluates.

B. MICLIC

1. Status

   a) Reports on U.S. line charges and U.K. Giant Viper, winter tests.

   b) WES analytical model modified for winter conditions.

2. Action needed.

   a) Literature search: Predicted blast effects vs depth and type of snow. Limited confirmation of WES model from firings. Placement depth of line charges, firing data on Giant Viper, M157, M173.

   b) Long term action depends upon data from part 1.

3. Effect on doctrine: Unknown.

4. Responsible for action: FSTC for general literature search. Groups at workshop can translate identified needs into action after FSTC provides copies of search to CRREL and USAES for analysis. Extract needed data (blast effect vs depth of burial, placement depth of line charge) and forward to appropriate workshop liaison.

C. Roller

1. Status: No data identified on cold climate limitations.

2. Action needed: Evaluate mobility and effectiveness degradation, effect of snow depth on Roller effectiveness. TRADOC/USAES/MERADCOM to develop this as part of the IPR position, i.e., evaluation of Roller in snow must follow DEVA-IPR.

3. Effect on doctrine: Unknown.

4. Responsible for action: TRADOC. USAES/MERADCOM, Lt. Col. Mills, OCE, will coordinate.

D. Plow

1. Status

a) Limited data identified.

b) ARENBD should be contacted.

2. Action needed, immediate: OT II A will be required so that cold weather testing will be incorporated.

3. Effect of doctrine: Depends on OT II A.

4. Responsible for action: TRADOC/DARCOM.

E. Overall action needed.

1. Incorporate CE labs into requirements staffing; lead, ACE/TRADOC.

2. Proposed systems: POMINS, VEMASID, full width plow.

a) All of the proposed systems have IOC's of FY86 or beyond. Testing will be accommodated so that snow/ice conditions will be addressed in either OT or DT. This should be in conjunction with DT II or OT II.

b) Future requirements documents will be routed to CE labs, specifically the ROC's for POMINS, VEMASID and the full width plow.

<u>Group 4. Detection of Mines</u>

R. Falls	A. Monahan
R. Gonano	A. Poulin
V. Lunardini (Chairman)	

I. Conventional systems (immediate access to mines).

A. It was felt that an AN PRS-7 was the most likely of all the systems to be adversely affected by snow and ice. Snow and ice have dielectric constants similar to plastic mines; therefore, the contrast between the mines and snow and ice may not be very high. This will produce small detection signals. A secondary problem is that deep snow prevents the antenna from coming within an effective range of the target. The combination of these two problems may result in poor detection of mines.

B. Status with regard to snow and ice: No immediately identifiable test data. Engineering Division Countermine Laboratory, MERADCOM, should be queried for latest modifications.

C. Action needed: Relatively simple tests should answer most questions on the effect of snow. A dielectric coefficient that is a function of snow or frozen ground could be plugged into a predictive model to initiate study.

D. Responsible agency: CRREL can follow this up with the cooperation of appropriate groups. Field tests can be combined with proposed tests on mines that will require detection in snow.

II. Remote sensing (IR, VS, UV, acoustic, etc.).

A. VMRMD, off-route mine det., AMIDS: These systems are all in the R&D stages, with some question as to their effectiveness, even under ideal conditions. Thus, the conclusions are vague with regard to winter warfare. There has been and is a very large R&D effort in remote sensing, in general, but the specific application to mine systems has been much more restricted. The effort here will be to define those characteristics of the winter warfare environment that are compatible with the available sensing equipment.

B. Specific data on mine systems: No systematic data are anticipated, but multi-band systems may have been tested on mines (possibly in winter). Followup with MERADCOM and ERIM-University of Michigan for data. CRREL will continue its literature search on remote sensing and the winter environment, and coordinate with the FSTC literature survey.

C. Performance of IR systems in snow: A program to evaluate system performance in snow layers could examine the following items.

1. Thermal signature of individual mines as a function of snow depth, density, and depth of mine burial.
2. Temperature gradient for mines in snow fields. CRREL has carried out considerable work on surface temperatures of cold regions environments and man-made structures. Adapt

these procedures and data for mine systems and coordinate with WES computer programs for non-winter surface temperatures.

3. Recognition of mine field patterns and background in snow covered terrain.

III. Mine laying activity.

Use of VS and IR seems like a viable approach. The following points need to be addressed: use of IR characteristics of tracks in snow, instantaneous recognition of mine laying activity, and definition of the unique characteristics (if any) of mine laying activity as opposed to normal activity. The effort here with regard to winter conditions is at a preliminary stage.

IV. Side looking radar.

This may be effective during adverse weather conditions, such as snow storms; further data are required.

V. Battlefield environment winter warfare, mine/countermine.

An effort should be undertaken to define how the winter environment affects mine/countermine. This could follow the example of the draft report, Battlefield Environment Obscuration Handbook*. Significant parameters for snow, ice, frozen or thawing ground, atmospheric components, etc., should be identified and made accessible. CRREL will incorporate this into its winter warfare mine/countermine plan if preliminary study shows this to be feasible.

SUMMARY AND RECOMMENDATIONS

The following problems and recommendations result from the draft report. Some of the questions can be answered quickly while others will require long term research and testing.

*Vol. I and II, 5 August 1980. SAI-80-00X-A, Science Applications Inc.

I. Immediate action.

A. Data on mine systems under winter conditions: FSTC will conduct an all source review and forward the results to CRREL and USAES for analysis. This should clarify the present state of our mine capability in a winter theater.

B. Field tests on emplaced conventional systems: The mine fields of Korea present an excellent opportunity to generate significant data under winter conditions. A visit to Korea will be made by AMSAA, CRREL and WES; Lt. Col. Mills will coordinate the effort for CE*.

C. Consideration of winter conditions on requirements documents: TRADOC will ensure that all requirements documents are sent to OCE for comment.

D. Field tests on Roller and Plow in snow: Evaluation of Roller and Plow should follow DEVA-IPR. Lt. Col. Mills will coordinate with TRADOC/USAES/MERADCOM.

E. Battlefield environment, winter warfare, mine/countermine: CRREL will perform a preliminary analysis of the possibility for quantification of winter environment information as it pertains to mine/countermine.

F. FASCAM orientation in snow: Winter tests should be carried out. CRREL will coordinate work with AMSAA, TECOM.

II. Research and test programs.

A. Emplacement

1. Surface vs buried - doctrine and performance.
2. Excavation of frozen soil for mines (hand, M57).
3. Arming in snow (M56, ADAM).
4. Effect of extreme temperature on breakage of electrical leads (M18A1), breakage of discriminator (M24), and use of gloves to emplace and arm (M19, M26 and others).
5. Effect of weight in snow (M15, M16, M23 and others).

---

*The visit to Korea took place during December 1980, research and test plans are being formulated

6. Stability in snow (M21, M23, M26 and others).
7. Mobility of emplacement systems in snow, on thawing ground, and over ice (GEMSS, M57 mine layer).

B. Performance
1. FASCAM - effect of orientation on performance.
2. Effect of snow on ADAM.
3. Effect of snow on all types of fragments.

C. Neutralization
1. Cold weather tests of SLUFAE to obtain quantitative data.
2. Study of force and stress transmission in snow and frozen ground.

D. Detection
1. Field tests of AN PRS-7 in snow.
2. Continue work on remote sensing under winter conditions.

The workshop revealed the present state of mine/countermine warfare, its complexity, and some deficiencies of winter warfare preparedness. Readiness, preparedness and defense capability depend upon personnel, materiel, doctrine and organization. It appears that the U.S. has the doctrine, organization, materiel and personnel to conduct limited defensive warfare during the summer. We are not adequately prepared for mine/countermine winter warfare.

Test programs are called for to compensate for prior lack of consideration of the winter environment. Research programs are called for to avoid the same inadequate winter readiness in proposed systems.

APPENDIX A: FIVE-YEAR PLAN FOR MINE/COUNTERMINE RESEARCH PROGRAM*

PART I: INTRODUCTION

A. Responsibility:

The research outlined in this plan will provide the technology base required to permit the Corps of Engineers (CE) to carry out its responsibilities in Mine Warfare as defined in AR 70-1, Army Research, Development and Acquisition and further described in FM 5-100, Engineering Operations; FM 90-7, Obstacles; FM 20-32, Landmine Warfare; and FM 31-10, Denial Operations and Barriers. Coordination necessary to carry out this plan has been undertaken and will be maintained on a continuing basis with the U.S. Army Mobility Equipment Research and Development Command, the U.S. Army Training and Doctrine Command, the U.S. Army Armament Research and Development Command, the U.S. Marine Corps Development and Engineer Command, and the U.S. Air Force Armament Laboratory.

B. Purpose:

The purpose of the work described in this plan is to develop technology, concepts, and techniques to be used to develop new mine warfare tactics and equipment with concentration on standoff detection and neutralization. Emphasis will be placed on defining terrain/environmental signature anomalies created by mine placement activities and terrain/environmental factors relating to the deployment, emplacement, and effectiveness of mines. Also, in the area of neutralization, emphasis will be placed on developing and using rational quantitative methods for evaluating explosives and advanced concepts to defeat conventional and advanced mines and to assess the effect of mine placement conditions on explosive neutralization effectiveness. The results of the program will provide the answers required to:

a. Establish empirical and theoretical data bases to define the range and nature of terrain anomalies created by mine placement activities.

*Prepared by WES.

PRECEDING PAGE BLANK-NOT FILMED

b. Provide methods to locate and evaluate mined areas as a function of terrain and environmental changes.

c. Provide concepts and criteria for using explosives and simulated target signatures for neutralization.

d. Provide analytical models, concepts, and criteria to improve mine/countermine operations for transfer to equipment developers.

The products will be new guidelines and methods for developing all-terrain mine warfare equipment and providing substantive input into a revised and updated manual for mine warfare operations.

C. Scope:

This plan emphasizes the development of methods for realistically considering the battlefield environment in three technical areas: (a) Detection, (b) Neutralization, and (c) Mine Use. The products of the research will directly support the development of standoff detection methods by showing terrain and environmental anomalies created by mining activities and developing standoff neutralization techniques using explosives and target signature simulation. The plan also provides for recommended improvements in mine design and mine deployment procedures as a function of terrain and environmental conditions.

PART II: RESEARCH AND DEVELOPMENT PLAN

A. Description:

The plan is presented in Table A1. The program will be carried out primarily by CERL, CRREL, ETL, and WES in coordination with DARCOM elements, particularly MERADCOM. Initial efforts will be by WES and CRREL. ETL and CERL will support the Mine/Countermine Program through negotiations with WES as needed. WES, as Lead CE Laboratory, will provide technical coordination and oversight. Portions of this planned work began in FY80; it is anticipated that most of the remainder will begin in FY81. The milestone schedule follows this section.

Table A1. Five-y

[illegible]	[illegible] Mine Detection/Neutralization. Improved equipment techniques for the remote detection and rapid neutralization of landmines, both conventional and scatterable. Determine those terrain factors that control or significantly affect the process of emplacing mines and develop analytical methods for predicting effects of variations. Develop fast and reliable means for remote identification of minefields, including detection during tactical movements and the rapid location of individual mines. Develop [illegible] for area searching and [illegible] during assault operations against defended minefields, route clearance [illegible] of communications and logistic support, and enhancing the survivability of vehicles during the [illegible] of combat [illegible] capability is needed [illegible]. Provide techniques for the rapid [illegible] marking, mapping, recording, and transmission of information [illegible] hostile and friendly minefields, especially air or artillery delivered scatterable mine.	Mine Countermine	Detection: Technology and Technology Development; emphasis is on terrain and environmental science support of developer and users	AR [illegible] Army Research Development & Acquisition	• Terrain signature anomalies created by threat mechanical mine laying equipment have been defined. Terrain signatures of anomalies created by hand emplaced and remotely delivered mines are unaddressed. Sensing techniques that consistently differentiate mining operation induced anomalies from the terrain background with low false alarm rates are inadequate. • [illegible] methods for isolating and reducing areas of search and selecting optimum detection mechanisms are available. • There is no equipment or methodology for close-in rapid detection of remote emplaced mines which threat forces may employ. • No methodology exists for differentiation of mine type (CONV, NUC, CHEM) • Mine and minefield kill probabilities are [illegible] [illegible] deployment mode and environmental conditions. Effectiveness of minefields in all terrain and environmental settings is unknown. [illegible] • [illegible] • [illegible] • [illegible] • [illegible]

Table A1. Five-year plan for mine/countermine program.

Research Need	Product	Research Effort, Performing Laboratory, and Project	Priority	FY 80	FY 81	FY 82	FY [illegible]
● Terrain signature anomalies created by threat mechanical mine laying equipment have not been defined. Terrain signatures of anomalies created by ground emplaced and remotely delivered mines are inadequate. Sensing techniques that can consistently differentiate mining operation induced anomalies from the terrain background with low false alarm rates are inadequate.	● Empirical and predicted data base to define the range and dynamic nature of terrain signature (electromagnetic) anomalies created by threat mine laying equipment. Empirical and predicted data base to define the range and dynamic nature of terrain signature (electromagnetic, chemical, and biological) anomalies created by individually emplaced mines (surface and buried) and air delivered canisters. Analytical models for studying the contrast of mine induced terrain signature anomalies and terrain signatures as a function of selected terrain types and changes in environmental conditions, i.e., seasonal, diurnal and weather conditions.	● Standoff Detection of Minefields (WES, EL)	1	100	120	135	[illegible]
		● Data Collection Instrumentation Specification and Acquisition (WES, EL)	1	0	0	50	[illegible]
		● Field Experiments for Mine-Minefield Background Signature Characterization (WES, EL & CRREL)	1	0	0	200	[illegible]
		● False Alarm Mechanisms and Sources (WES, EL)	2	0	100	200	[illegible]
		● Signature Modeling for Detection Concept Evaluation (WES, EL)	1	0	0	0	[illegible]
		● Demonstration of Standoff Detection of Minefields (WES, EL)	3	0	0	0	
● A system method for rapid[illegible] and [illegible] of search and selecting optimal detection mechanics are not available.	● A tactical oriented terrain evaluation method for screening most probable threat mined areas. This will permit the field commander to employ a mix of sensors (electromagnetic, chemical and biological) and sensing methods (remote and contact) to locate mined areas at standoff distances, identify minefield boundaries and to locate individual mines as a function of terrain and environmental change.	● Rapid Selection Method for "Real Time" Standoff Detection System Based upon Environment and Terrain Conditions (WES, EL)	2	0	25	125	[illegible]
● [illegible]	● Terrain constraints on concepts and criteria for rapidly detecting the presence of threat emplaced air delivered mines.	● Close in Detection of Remotely Emplaced Mines (WES, EL)	2	0	0	100	[illegible]
● [illegible] rapid differentiation [illegible] types [illegible]	● Concepts and criteria for technique to rapidly differentiate mine types under combat conditions.	● Concept and Criteria for Differentiation of Mine Types (WES, EL)	2	0	0	100	[illegible]
● [illegible]	● Analytical models for evaluating minefield design as a function of threat, terrain and environmental conditions [illegible] Methods [illegible] threat, terrain, and environmental conditions [illegible] selecting minefield [illegible]	● Terrain Effects on Minefield Design and Emplacement (WES, EL)	1	50	130	100	[illegible]
		● Optimum Deployment of Mines in Built-Up Areas (WES, EL)	[illegible]	0	0	50	[illegible]
		● Mine Performance in Riverine and Other Aquatic Environments (WES, EL & GL)	1	0	0	[illegible]	
● [illegible]	● [illegible] terrain and environmental data [illegible] criteria [illegible]	● Terrain Characterization and Portrayal for Mine Design (WES, EL)	2	0	100	190	
		● Techniques for Mine Terrain Interaction Simulation (WES, EL)	2	0	200	250	
		● Mine and Countermine [illegible] Environments (CRREL)	1	80	330	500	[illegible]
● [illegible]	● [illegible]	● Terrain Characterization for Counter-Countermine Concepts (WES, EL)	2	0	150	150	[illegible]
		● [illegible] Detection of Remotely Delivered Mines (WES, EL)	2	0	75	150	[illegible]
● [illegible]	● [illegible]	● Environmental Effects on Minefield Concepts (WES, [illegible])	1	0	0	0	[illegible]
● [illegible]	● Concepts and criteria for [illegible] neutralization [illegible]	● Explosive Neutralization Uses, Concepts and Criteria (WES, SL)	1	100	160	150	[illegible]
		● Enhanced Performance Explosive Mine Neutralization System (WES, SL)	1	0	0	250	
		● Advanced Mine Neutralization Technique for Defeat of Various Fusing Systems (WES, SL)	1	0	0	[illegible]	
● [illegible]	● [illegible]	● Development of Advanced Analytical Mine Response Prediction Methodology (WES, SL)	2	0	120	150	
		● Assessing Remotely Delivered Mine Neutralization Concepts and Criteria (WES, EL)	2	0	0	200	
● [illegible]	● [illegible]	● Techniques for Signature Duplication (Non Magnetic) (WES, [illegible])	1	0	40	50	
● [illegible]	● [illegible]	● Mobility and Performance of Mechanical Mine Neutralization Equipment (WES, [illegible])	1	0	0	[illegible]	
		TOTALS					
		Priority 1		330	[illegible]	1585	[illegible]
		Priority 2		0	[illegible]	1615	
		Priority 3		0	[illegible]	[illegible]	
		GRAND TOTALS		330	[illegible]	320[illegible]	

Schedule ... FY	Item	Priority	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	Remarks
			Schedule and Funding							
16		1	100	120	135	160	195	220	250	Ongoing, AT22
5		2	0	0	50	50	50	0	0	
1		1	0	0	200	150	220	20	50	Planned, AT40
2		2	0	100	200	250	250	250	100	
5	(WES, ED)	1	0	0	0	50	130	300	150	Planned, AT40
	(WES, ED)	3	0	0	0	0	0	100	[illegible]	Planned, DT08
1	... Detection ... (WES, ED)	2	0	25	125	125	125	150	75	
1	(WES, ED)	2	[illegible]	0	100	100	100	100	100	
1	(WES, ED)	2	0	0	100	100	100	100	100	
0		1	[illegible]	130	100	100	100	100	100	Ongoing, AT40
0		[illegible]	[illegible]	0	50	60	150	150	50	Planned, AT40 under Military Operations in Urbanized Terrain
0				0	50	100	100	100	200	Planned, AT40
0		2	0	100	190	330	320	290	50	
0		[illegible]	[illegible]	200	250	250	250	250	250	
0		[illegible]	80	330	500	455	460	505	450	Ongoing, AT42
0		[illegible]	[illegible]	150	150	200	150	150	150	
0		[illegible]	[illegible]	75	150	150	150	50	0	
0		[illegible]	[illegible]	0	0	50	0	0	0	Planned, AT40
150		[illegible]	[illegible]	160	150	150	150	150	100	Ongoing, AT40
250	(WES, ED)	[illegible]	[illegible]	0	250	200	150	100	0	Planned, AT40
[illegible]		[illegible]	0	0	0	150	200	300	450	Planned, AT40
150		2	0	120	150	80	50	50	50	
200			0	0	200	200	0	0	0	
50		[illegible]		30	50	50	50	180	280	Planned, AT40
[illegible]		[illegible]	[illegible]	0	[illegible]	50	50	0	0	
	TOTALS									
1585		Priority 1	[illegible]	[illegible]	1585	[illegible]	2016	2125	2080	
1615		Priority 2	[illegible]	920	1615	1785	1495	1390	875	
0		Priority 3	[illegible]	0	0	0	0	100	300	
3200		GRAND TOTAL	[illegible]	1540	[illegible]	[illegible]	3509	3615	3255	

B. Investment Strategy:

The investment strategy is to develop the technology needed to meet the CE responsibility in Mine/Countermine Warfare and defeat anticipated intensive use of mine warfare by threat forces. The use of mines and their effectiveness have increased in all wars of this century. The advent of remotely delivered mines has added a new dimension to offensive mining which provides the field commander new options and, conversely, poses new threats. Mines are a major threat to the mobility of all ground forces. U.S. combat doctrine requires high mobility; threat tactics emphasize extensive use of mines. In light of the increasing threat it is imperative to develop a real-time capability to allow field commanders to identify minefields at standoff distances and to provide them with rapid minefield neutralization techniques to maintain battlefield mobility critical to success and survivability of U.S. forces.

A fundamental detection problem is determining a method(s) of detecting mines/mine activity anywhere in the battlefield during all categories of tactical operations under all conditions of terrain and environment. This proposed research emphasizes identifying detection methods and techniques which focus on terrain and environmental anomalies created by mine placement activities and the mine's introduction into the environment.

With exception of fuel-air-explosive devices, current neutralization techniques are generally refinements of explosive and mechanical methods used during World War II. Neutralization is addressed in the research to develop new concepts and criteria for ordnance, concepts, and methods for simulated target signature mine detonation, and development of recommended performance characteristics for use of mechanical neutralization equipment in different terrain and environmental conditions.

Improved mobility and counter mobility options for field commanders are addressed in the proposed research by the development of decision criteria for real-time standoff detection technique application, and criteria for optimum employment of mines under varying conditions of terrain, environment, and tactical situation.

The return on investment and technology transfer related to this work will be accomplished and accelerated by: (a) aggressive and total coordination with user and materiel development agencies; (b) publication of technical reports on new results, criteria, and methods of application in various mine/countermine warfare activities; and (c) publication of updated and revised editions of applicable mine warfare field and technical manuals.

Milestone schedule

Milestone*	Estimated completion date
Complete study on the shock wave transmission pressure, tripline fuses performance, and fragment attenuation in snow environments	Sept '81
Develop baseline data for:	
Evaluating the difference between mine induced terrain signature anomalies and other terrain signature anomalies	Sept '82
Terrain and environmental data for use in mine/countermine design criteria	Sept '82
Blast signatures for explosive neutralization ordnance	Sept '82
Mechanical response of mines	Sept '82
Complete study of GEMSS and M57 mine layer performance in snow. Complete tests of pressure/tripwire activation in snow and freezing rain	Sept '82
Develop analytical models for:	Sept '83

*Milestones include publication of appropriate technical reports, TM's, and FM's.

Evaluating the difference between mine induced terrain signature anomalies and other terrain signature anomalies — Sept '83

Evaluating effectiveness of minefield design as a function of threat, terrain, and environmental conditions — Sept '83

Response of mines to effects of blast and shock from mine clearing munition and mechanical methods — Sept '83

Develop test programs to investigate remotely emplaced mine performance, including tripwire deployment and anti-disturbance features in winter environments — Sept '83

Develop methods to employ current mine clearing munitions to increase cleared zone and enhance kill of non-impulse mines — Sept '84

Develop terrain/climate analysis and portrayal systems for effective mine deployment — Sept '85

Criteria and methodology for minefield breaching with explosives and signature duplications — Sept '85

Criteria for employment of standoff detection systems — Sept '85

Develop concepts for clearing remotely emplaced and other mines with various fusing methods — Sept '85

Complete investigation of winter environment impacts on remotely emplaced mine performance — Sept '86

Demonstrate standoff detection of minefields — Sept '86

APPENDIX B: CRREL 5-YEAR PLAN, MINE/COUNTERMINE

Mine and countermine performance in cold environments

Project/Technical Area/Work Unit: 4A762730AT42/A/15

a. The objectives of this work unit are: (1) to investigate the performance of conventional and scatterable mines, deployment systems, detection and clearance equipment in winter and cold regions environments, and (2) to identify those sensitive areas of the world where the use of these systems are likely to be severely limited during winter months.

Liaisons with other DOD agencies such as MERADCOM, ARRADCOM, WES, and USAES will be established to determine high priority problem areas. Investigations of the installation, functioning, lethality, location and removal of mines under winter conditions will be conducted. Laboratory experiments and field tests will be conducted as deemed necessary. Stress wave transmission and attenuation in snow, ice and frozen soil will be considered.

The overall plan is to examine mine/countermine materiel in regard to winter use, and address related questions and problems of the combat engineering community. Current technology will be applied to the solution of specific operational problems where possible, e.g. to determine the ice thickness required to support GEMSS. In other areas where current technology is inadequate, theoretical analyses with confirmation by laboratory and/or field tests will be required. The information generated, to the maximum extent possible, will be in mine-independent format so that it will apply to both current and future mine/countermine systems. Contact with USAES, USACDA, ARRADCOM, PM Selected Ammunition, MERADCOM, WES and other agencies with mine/countermine interests will be developed and maintained.

b. Work to be accomplished in FY81:

1. Arrange for loan of FASCAM delivery systems for study of terminal repose angle of mines in snow.

2. Continue literature survey on mine performance and numerical techniques for predicting penetration and velocity decay of fragments in snow or other soft materials.

3. Develop fragment simulation capability.

PRECEDING PAGE BLANK-NOT FILMED

4. Pressure mine/snow interaction investigations will continue; trip wire activation and emplacement techniques will be examined when inert mines become available and are instrumented. Optimal emplacement techniques in snow covered terrain and guidelines for determining snow covered minefield effectiveness will be determined. Plans will be formulated for required field tests.

5. Over snow mobility calculations for mine laying systems and minimum ice thickness requirements for lake and river surface mining operations will continue. Results of these calculations will provide guidelines for efficient mining operating in snow and ice covered areas.

	Milestones	Estimated completion date
1.	Design instrumentation for laboratory study of snow effects on tripwires	January 1981
2.	Complete RPG-7 tests	February 1981
3.	Draft report on literature review of shock wave transmission in snow	March 1981
4.	Complete field tests of snow effect on activation of pressure mines	March 1981
5.	Complete mine fragment simulation tests in snow	March 1981
6.	Conduct field tests of FASCAM delivery systems in snow	April 1981
7.	Draft report on low density snow tests	June 1981
8.	Construction contract for statically detonated mines	June 1981
9.	Draft RPG-7 report written	July 1981
10.	Draft mine fragment report written	August 1981
11.	Complete laboratory testing of snow interaction with pressure activated mines	September 1981
12.	Design instrumentation for laboratory study of force transmission in snow layers	September 1981
13.	Complete simulation of AP mine fragment attenuation in snow	September 1981

14. Complete design of stress instrumentation for ice/frozen ground — September 1981

15. Initiate study of large caliber projectile penetration in snow and other deformable media — September 1981

16. Complete a review of firing records and required operating conditions; correlate with climates in selected countries in cold regions and incorporate FSTC data — September 1981

17. Draft FASCAM report written — September 1981

18. Prepare report on snow depth limitation for GEMSS and M57 mine layers — April 1982

19. Provide technology transfer on ice thickness requirements of GEMSS and M57 mine layers — April 1982

20. Complete field tests of overpressure devices and pressure/tripwire activation in snow — April 1982

21. Complete statistical analysis to estimate the scope of the work required to establish degradation effects of snow on AT mines as a function of orientation after delivery — September 1982

22. Complete laboratory tests on effects of freezing rain on conventional mines — September 1982

23. Provide technology transfer on critical frost depth for M57 mine burial operations — September 1982

24. Complete report on pressure/tripwire activation in snow — March 1983

25. Complete report on freezing rain effects on conventional mines — March 1983

26. Develop test program to study FASCAM tripwire deployment and anti-disturbance features — March 1983

27. Complete report of field tests of FASCAM delivery systems in snow and statistical analysis of final angle of repose after delivery — September 1983

28. Complete report on overpressure devices, shock-wave transmission in snow — September 1985

29. Complete arena tests of FASCAM AP mines in snow, correlation with laboratory results, and analysis of degradation effects on both AP and AT mines — April 1986

30. Complete report on FASCAM tripwire and anti-disturbance tests — September 1986

31. Complete comprehensive report on performance of scatterable mines buried in snow — September 1986

Final product and when available

The final product will be the series of reports identified in the milestones listed above. The reports will be available shortly after the completion of each phase of the planned program.

Mine emplacement in cold regions

Project/Area/Work Unit 4A762730AT42/A/-

The objective of this work unit is to evaluate the effectiveness of mine emplacement systems when the terrain is snow covered or the soil is frozen or when both conditions exist. The emphasis for air delivery systems will be on terrain that is snow covered prior to emplacement of the mines and on which the snow cover remains or increases and on terrain which becomes snow covered subsequent to emplacement of the mines. Emplacement systems which involve burial of mines will be investigated as they operate in frozen soil and in thawing soil. The problems associated with thawing soils will include the mobility of the prime mover of the emplacement device. In addition, the effect of thawing soil on the detonation system will be included as a part of the emplacement process.

Milestones	Estimated completion date
1. Design of experimental program	December 1981
2. Completion of first interim report	September 1982
3. Completion of study of emplacement of air delivered mines in an existing snow cover	April 1983

4. Completion of tests of emplacement systems operating in frozen soil — July 1983
5. Completion of second interim report — September 1983
6. Completion of study of emplacement of air delivered mines subsequently covered with snow — April 1984
7. Completion of third interim report — September 1984
8. Completion of fourth interim report — September 1985
9. Completion of tests of emplacement systems operating in thawing soils — April 1986
10. Completion of final report — September 1986

Final product and when available

The final product will be a comprehensive technical report detailing the results of the investigation of both surface emplacement and burial emplacement systems. The report will include an annex that can be incorporated into manuals dealing with the emplacement of mines and mine fields. The report will be available at the end of FY86.

Mine detection in cold regions

Project/Area/Work Unit 4A762730AT42/A/-

The objective of this work unit is to develop techniques and propose equipment for the detection of mines and mine fields emplaced in snow covered terain and in frozen soil and to detect mine laying activities under conditions of reduced visibility caused by low temperature phenomena. If mines are to be bypassed or neutralized it is obvious that their location must be identified accurately and quickly. There has been almost no effort expended in studying the cold weather mine detection problem. CRREL conducted a low-key study of ways to detect mines using chemical apparatus to analyze air samples obtained with "sniffers" and demonstrated that it was possible to detect the presence of mines, but the method was far too slow to be acceptable and it was not evident that the time could be reduced significantly. Thus, the first step in the study will have to involve the determination of feasible ways to detect mines by remote means. Analysis of the various methods will establish which are most promising and will indicate how the study should proceed. In general, the study will follow a sequence of identification of detection methods; selection of the most promising method; conduct tests in snow covered terrain and in frozen soil; and finally, recommend the specifications for prototype equipment.

The problem of detecting mine laying operations will be particularly concerned with detection methods for conditions in which conventional observation is either hampered or prevented by a cold weather obscurant. It is anticipated that this phase of the study may benefit from the battlefield obscuration program in progress at CRREL. The sensing systems which are found to function in blowing snow and in fog may be adapted for the detection of activities rather than stationary targets.

Milestones	Estimated completion date
1. Review detection methods (apparatus)*	March 1983
2. Select optimum methods	June 1983
3. Complete first interim report	September 1983
4. Evaluate optimum methods in snow covered terrain	April 1984
5. Complete second interim report	September 1984
6. Evaluate optimum methods in frozen terrain	April 1985
7. Analyze results of battle obscuration program for optimum sensors	July 1985
8. Complete third interim report	September 1985
9. Prepare recommendation for prototype equipment	October 1985
10. Evaluate sensors in fog	April 1986
11. Complete fourth interim report	September 1986
12. Evaluate sensors in blowing snow	April 1987
13. Prepare recommendations for prototype equipment	July 1987
14. Complete final report	September 1987

*When "method" referred to, it is assumed that apparatus is involved.

Final product and when available

There will be two final products in the form of recommendations for systems to detect mines and mine laying activities. The former will be available in the first quarter of FY86 and the latter will be available at the end of FY87.

Mine neutralization in cold regions

Project/Area/Work Unit 4A762730AT42/A/-

The objective of this work unit is to develop techniques for the neutralization of mines and minefields which are in either snow covered terrain or in frozen soil. The investigation will consider both mechanical and explosive neutralization systems. The air delivery emplacement systems will likely be affected more by snow cover than by frozen soil, particularly if the snow is deep and existed prior to emplacement of the mines. It is assumed that the performance of explosive neutralization systems will be reduced more by snow than by frozen soil. Thus, the neutralization of air delivered mines in deep snow by explosive means will receive early, special attention. Simultaneously, the neutralization of mines emplaced in frozen soil by mechanical means will be studied in the laboratory. Three conditions will be examined: mines emplaced in soil which is subsequently frozen; mines emplaced in frozen soil which remains frozen; mines emplaced in frozen soil which is either thawed or in the process of thawing.

Milestones	Estimated completion date
1. Design of experimental program	December 1981
2. Establishment of performance of explosive systems in snow-free terrain	August 1982
3. Establishment of relationship among pressure, burial depth, and load for mechanical systems	August 1982
4. Completion of first interim report	September 1982
5. Establishment of the relationship among the pressure at the soil-snow interface and snow depth and density	April 1983

6.	Completion of study of mechanical systems for mines emplaced in soil which is subsequently frozen	August 1983
7.	Completion of second interim report	September 1983
8.	Establishment of the relationship among snow depth and density and the soil/snow interface pressure for mechanical systems	April 1984
9.	Completion of study of mechanical systems for mines buried in frozen soil which remains frozen	August 1984
10.	Completion of third interim report	September 1985
11.	Completion of study of mechanical systems for mines buried in frozen soil which subsequently thaws	August 1986
12.	Completion of final report	September 1986

Final product and when available

The final product will be a comprehensive technical report which identifies the effectiveness of neutralization systems in snow covered terrain and frozen soil and it will be available at the end of FY86.

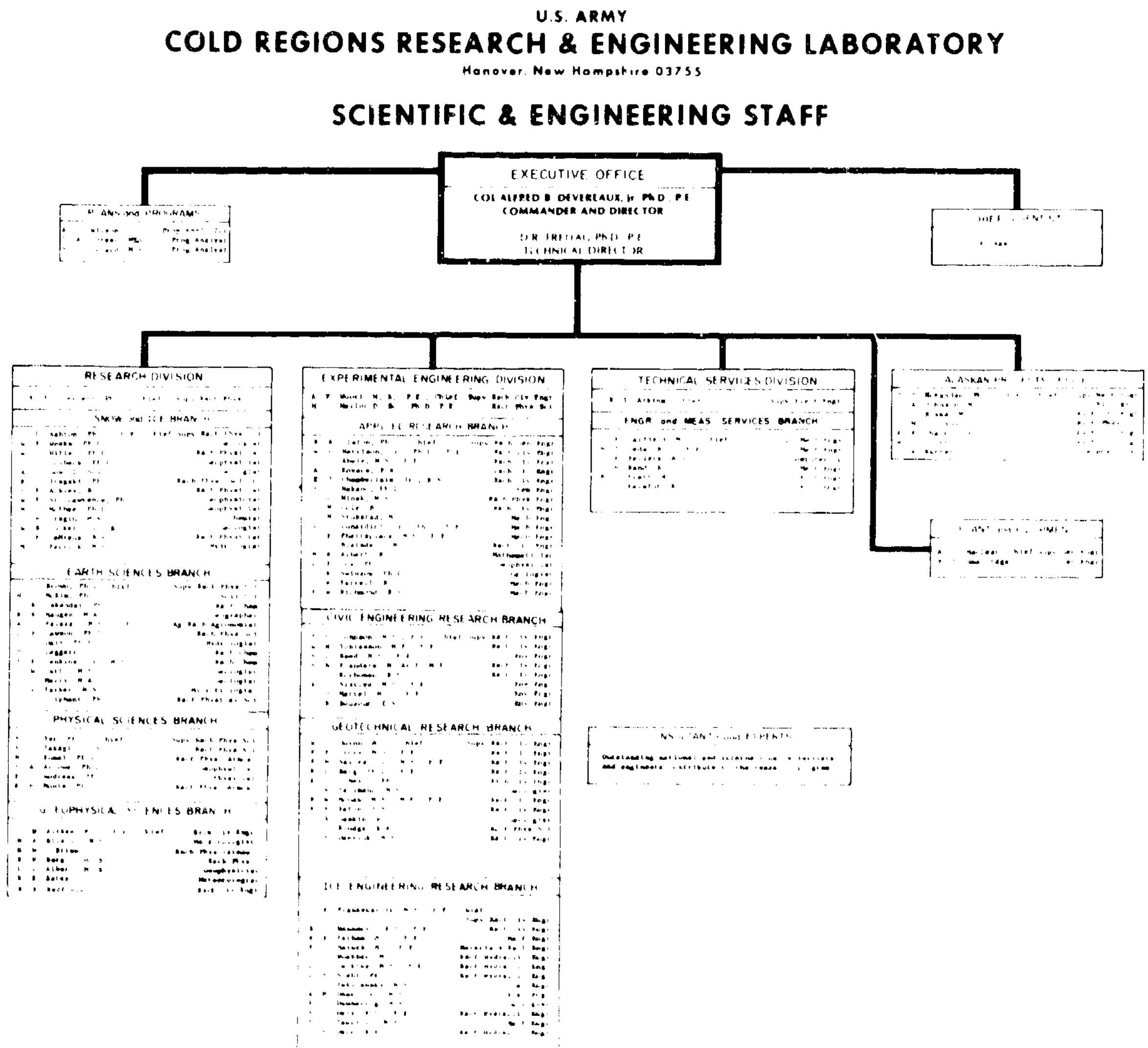

Figure B1. CRREL organization chart as of 20 February 1981.

APPENDIX C: INFORMATION ON THE MINE/COUNTERMINE WORKSHOP
USACRREL, HANOVER, NEW HAMPSHIRE, 21-23 OCTOBER 1980

Registration list

Aubin, Maj. Thomas, U.S. Army Engineer School, Fort Belvoir, VA 22060; AV 354-4005/4294.

Baushke, Col. James L., Deputy Assistant Chief of Staff Engineer (CFEN), ROKUS Combined Forces Command, Seoul, Korea (APO San Francisco 96301). 376-38-7470.

Benedict, Cpt. William, U.S. Army Combined Arms Development Activity, ATTN: ATZL-CAM-IM, Fort Leavenworth, KS 66027; AV 552-2096-4547.

Benn, Bob, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180; FTS 542-2683.

Carn, Robert, U.S. Army Materiel Systems Analysis Agency, ATTN: DRXSY-GB, Aberdeen Proving Ground, MD 21005.

Clemens, Maj. Judd, U.S. Army Combat Development Activity, Fort Richardson, AK 99505; AV 317-863-1201

Deaton, James, U.S. Army Foreign Science and Technology Center, ATTN: DRXST-BA2, Charlottesville, VA 22901; AV 274-7686.

Drake, James, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180.

Ely, Maj. Richard, U.S. Army Foreign Science and Technology Center, ATTN: DRXST-BA2, Charlottesville, VA 22901; AV 274-7686/7688.

Falls, Robert, U.S. Army Engineer Topographic Laboratories, ATTN: GSL, Fort Belvoir, VA 22060; (703) 664-1456.

Gonano, Dr. Roland, U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA 22060.

Hanson, Lt. Col. Wayne, U.S. Army Cold Regions Test Center, ATTN: STECR-OP, Fort Greeley, AK 98733; AV 317-872-3219.

Howard, Lt. Col. John W., HQDA (DAEN-ZCM), Washington, DC 20310; AV 225-211/1125.

Ingram, Leo, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180; FTS 542-2705.

PRECEDING PAGE BLANK-NOT FILMED

Miller, Maj. William, U.S. Army Training and Doctrine Command, ATTN: ATCD-MM, Fort Monroe, VA 23651; AV 680-2285.

Mills, Lt. Col. W.C., HQDA (DAEN-RDM), Washington, DC 20314; FTS 272-0259.

Monahan, Maj. Alfred, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180.

Pepe, Salvatore, U.S. Army Armament Research and Development Command, ATTN: DRDAR-DPT, Building 171 North, Dover, NJ 07801.

Poulin, Dr. Ambrose, U.S. Army Engineer Topographic Laboratories, ATTN: IR-A, Fort Belvoir, VA 22060; (703) 664-4895.

Romanko, Thomas, U.S. Army Materiel Systems Analysis Agency, Aberdeen Proving Ground, MD 21005.

Tarlow, Irving, U.S. Army Natick Research and Development Laboratories, ATTN: DRDNE-EM, Natick, MA 01760; AV 955-2351.

Underwood, Elton H., U.S. Army Engineers Study Center, 6500 Brooks Lane, Washington, DC 20315; AV 292-2961.

U.S. Army Cold Regions Research & Engineering Laboratory	Autovon 684-3XXX
P.O. Box 282	FTS 834-8XXX
Hanover, NH 03755	(603) 643-3200

Devereaux, Jr., Col. Alfred B., former Commander and Director.

Collins, Lt. Col. Nicholas H., Deputy/Military Programs, Ext. 202/203.

Aitken, George W., Supervisory Research Physical Scientist, Ext. 357/482.

Albert, Donald G., Geophysicist, Ext. 354.

Albert, Mary R., Mathematician, Ext. 248.

Farrell, Dennis R., Mechanical Engineer, Ext. 212.

Liston, Ronald A., Supervisory Research General Engineer, X-208.

Lunardini, Virgil J., Mechanical Engineer, Ext. 326.

Richmond, Paul W., Mechanical Engineer, Ext. 362.

Swinzow, George K., Geologist, Ext. 332.

Wojtkun, Cpt. Gregory, former Research and Development Coordinator.

Agenda

21 October 1980

0830 - 1600	Opening remarks: Col. Devereaux
0900 - 0930	Outline of present and proposed Mine/Countermine R&D (WES). Impact of cold environment on equipment and research plan (CRREL)
0930 - 1200	Emplacement of mines in field; vehicle mobility for mine laying; participant input and discussion (R. Liston, CRREL coordinator)
1030 - 1045	Coffee
1200 - 1230	Review of emplaced mine/countermine systems in Korea
1230 - 1330	Lunch
1330 - 1400	Soviet winter warfare capability
1400 - 1415	SLUFAE, GEMSS tests in Alaska
1415 - 1500	Performance of mines, effect of snow, ice fragment attenuation, etc., participant input (G. Aitken, CRREL coordinator)
1500 - 1515	Coffee
1515 - 1600	Continue with formulation and discussion of specific problems, presentations by participants
1600 - 1700	Tour of CRREL
1900 - 1930	Cocktails
1930	Dinner at Sheraton North Country Inn

22 October

0900 - 1015	Neutralization of mines, force transmission in snow, frozen ground, effect on mines and doctrine, participant input (V. Lunardini, CRREL coordinator)
1015 - 1030	Coffee
1030 - 1200	Continue with formulation of specific problems and discussion of systems for neutralization; participant presentations
1200 - 1300	Lunch
1300 - 1530	Working Groups to prepare discussion papers

1530 - 1800	Combine Working Groups' reports into one draft report for comment

23 October

0900 - 1200	Review of draft report (V. Lunardini, CRREL coordinator)
0900 - 0930	Emplacement
0930 - 1000	Performance
1000 - 1015	Coffee
1015 - 1045	Neutralization
1045 - 1100	Detection
1100 - 1200	Summary

Guide for working groups

Winter warfare - cold climate effects on mine/countermine systems.

I. Conventional system - in current use.

II. Proposed systems - all others.

1. Status with regard to snow, ice, frozen ground, thawing ground, etc.
   - A. Current data.
   - B. Is data available elswhere? If so, point of contact, etc.
2. Action needed.
   - A. Immediate - (Korea, NATO, other).
   - B. Long term.
3. Effect on doctrine/engineering manuals, etc.
4. Who is responsible for action? (Not necessarily who will actually conduct studies).
5. How can groups represented at workshops cooperate to translate identified needs into concrete action?

APPENDIX D: MINE WARFARE, BACKGROUND INFORMATION

Concept statement for mine warfare*

1. PURPOSE:

a. The purpose of this concept statement is to set forth an operational concept for the employment of land mines.

b. U.S. military forces must be capable of employing mines anywhere on the battlefield to support combat operations in a wide variety of tactical situations. Modern threat forces are generally composed of mobile, balanced fighting forces of all arms, organized, equipped and trained to establish and maintain a high tempo of offensive action. Offensive momentum will be built up and sustained by massing numerically superior, armor heavy combined arms forces, employed in echelons. Rates of advance up to 30-50 kilometers a day in a nonnuclear war, and 60-100 kilometers a day in a nuclear war are set forth as threat goals. The impressive quantities of modern, mobile, survivable weapons systems in the hands of threat forces, coupled with a traditional emphasis on speed and offensive action, establish the need for U.S. forces to field flexible and versatile tacics, techniques, and weapons systems. Land mines are an essential element in any scheme designed to delay, disrupt, or stop threat force momentum, deny threat use of key terrain, canalize threat force movement, reduce threat force mobility, and decrease threat's numerical superiority.

2. LIMITATIONS: This statement does not deal with mine warfare which includes the use of biological agents in land mines.

3. OPERATIONAL CONCEPT:

a. General:

(1) The principal objectives of land mine operations are to delay, disrupt, destroy, or canalize enemy forces.

(2) All U.S. Army units should be trained and equipped to conduct land mine operations.

*Prepared by TRADOC/USAES.

(3) Mine operations may be conducted anywhere on the battlefield during offensive, defensive, retrograde, and rear area combat operations.

(4) Land mine warfare employment techniques include:

- Employing mines in deliberate patterns or randomly to create obstacles to mobility and destroy or damage weapon systems. In this fashion it is possible to improve protection for flanks, rear areas, and fortified positions.
- Delivering mines by artillery, rocket or aircraft to interdict threat reinforcing or follow-on forces.

b. Operational Considerations:

(1) Offensive Operations: The maneuver commander may use antipersonnel (AP), antitank (AT), nuclear, or chemical mines to:

- Deny the use of terrain, block or canalize threat forces, reducing the ability to mass.
- Disrupt or delay commitment of threat reserves and follow-on forces.
- Isolate an objective.
- Interdict reinforcing threat forces.
- Disrupt or delay threat retrograde operations.
- Protect his flanks and rear.

(2) Defensive and Retrograde Operations:

- The maneuver commander may use mines to:
  - Disrupt, delay and destroy.
  - Kill advancing threat forces, reserves and follow-on echelons.
  - Reduce threat mobility.
  - Defend fighting positions.
  - Defend his own flanks and rear.

(3) Rear Area Combat Operations: Mines may be employed in rear areas to protect installations, built-up areas, logistical operations and facilities, and to deny threat use of good landing/drop zones.

c. Responsibilities:

(1) Maneuver commanders are responsible for mine operations in forward areas.

(2) DISCOM/COSCOM* commanders are responsible for mine operations in rear areas.

(3) Combat engineer commanders are responsible to the maneuver commander as his primary source of mine warfare capability.

(4) Field artillery, aviation, and other designated commanders will emplace scatterable mines using organic delivery systems.

(5) Units designated by the maneuver or rear area commander will provide personnel and transportation resources to assist combat engineers during mine operations.

(6) All units are responsible for developing and executing plans to protect their own positions using mines.

Types of mines with potential cold weather problems**

1. M18A1 (Claymore): Electrical leads may break when unfolded in severe cold.
2. M26 AP: Must remove gloves to emplace and arm.
3. M16A2 AP with M605 Fuze (Bounding Type):
   a. Weighs 7-7/8 lb (transportation problem for soldiers moving with ahkios).
   b. Prongs or trip wire may be ineffective if covered with new, deep snow.
4. M14 AP Nonmetallic and M26 AP:
   a. Easy to lose in snow because of size.
   b. Heavy snow will negate blast effect.
5. M15 AT HE, Heavy:
   a. Rubber moisture seals may break in severe cold.
   b. Difficult to lay.
6. M21 AT, HE, Heavy:
   a. Extension rod may break in severe cold.
   b. Must be laid in or on solid ground (290 lb required for detonation).

*Division Support Command/Corps Support Command
**Prepared by Maj. J. Clemens, U.S.A. Combat Development Activity, 9 October 1980.

7. M19 AT HE: Must remove gloves to emplace and arm.

8. M23 Chemical: Weighs 22-3/4 lb (transportation problem). Doctrine outlining use of chemical mines in extreme cold is severely limited.

9. M56 Scatterable Mines: Must strike ground to arm — may not arm in deep snow.

10. Firing Devices: Must remove gloves to use.

Employing mines in winter*

Current Doctrine:

a. Don't use mines in drifting snow.

b. Mines laid in snow should be painted white.

c. Lay mines on top of ground when snow is 4 in. to 10 in. deep.

d. Lay mines on platform in soft snow over 10 in. deep.

e. Bury mines if snow is less than 4 in. deep w/pressure plate protruding above ground.

f. Command detonated mines are more reliable than pressure detonated mines.

g. Place mines in plastic bags.

Problems:

a. Winds can cover or uncover mines in snowfields.

b. Mines may tilt or shift in soft snow or tundra.

c. Heavy snowfalls on minefield will reduce blast effect.

d. Extension rod on AT M21 mine may break if frozen.

e. Trip wires on mines may be useless if buried under recent snow. Same for prongs.

f. Trip wire may break if subjected to severe cold.

g. Minefield is difficult to mark in snow and may be impossible to recover if new snow covers field.

h. Mines will be extremely difficult to emplace in frozen ground.

i. Use of bounding mines (M16A1) may be limited if covered with new, heavy snow.

*Prepared by Maj. J. Clemens, U.S.A. Combat Development Activity, 9 October 1980.

j. Must remove gloves to arm mines.

k. Transporting mines will cause logistics problems.

l. Mine detectors using standard batteries may be ineffective in severe cold.

m. Fuzes and mines may fail to detonate if moisture enters mechanisms.

Table D1. Characteristics of mines.

Conventional land mines

Nomenclature	Characteristics	Main Charge	Dimensions	Weight	Material	Fuze	Activation
M12	Antitank, practice (simulates M15)	Smoke	Diameter - 13.25 in. Height - 3.5 in.	20 lbs	Steel	M604	Depress pressure plate, 391-739 lbs.
M14	Antipersonnel, blast type	Tetryl	Diameter - 2.2 in. Height - 1.6 in.	3.5 oz	Plastic	Integral	Depress pressure plate, 20-35 lbs.
M15	Antitank, pressure activated	Comp B	Diameter - 13.25 in. Height - 4.91 in.	31.5 lbs	Steel	M603	Depress pressure plate, 350-750 lbs.
M16A2	Antipersonnel, bounding type	TNT	Diameter - 4.05 in. Height - 7.82 in.	6.25 lbs	Steel	M605	Tripwire or depress prong (8-45 lbs).
M18A1	Antipersonnel, fixed direction fragmenting	Comp C4	Thickness - 1.9 in. Width - 8.5 in. Height - 3.2 in.	3.5 lbs	Plastic	-	Tripwire or command detonated.
M19	Antitank, non metalic	Comp B	Width (square) - 13.1 in. Height 3.7 in.	27.7 lbs	Plastic	M606	Depress pressure plate, 300-500 lbs.
M20	Antitank, practice (simulates M15)	Smoke	Diameter - 13.25 in. Height - 4.91 in.	31.5 lbs	Steel	M604	Depress pressure plate, 391-739 lbs.
M21	Antitank, shaped charge, pressure or tiltrod	Comp H-6	Diameter - 9.0 in. Height - 8 in.	17.51 lbs	Steel	M607	Tilt rod, 3.75 lbs, or 290 lbs on pressure ring
M23	Chemical mine	VX agent	Diameter - 13 in. Height - 5 in.	22.9 lbs	Steel	M603 M608	Pressure or boobytrap.
M24	Antitank, off route mine, range 30 m	Comp B	(Rocket) Length - 23.55 in. Diameter - 3.5 in.	18 lbs	Steel	-	Pressure on two adjacent, 2.6 m segments of an 11 m plastic covered activated switch.
M26	Antipersonnel, bounding type	Comp B	Diameter - 3.1 in. Height - 3.7 in.	2.2 lbs	AL/Steel	Integral	Tripwire or pressure (14-28 lbs).
M55	Antipersonnel, practice (simulates M26)	Blue dye powder	Diameter - 3.1 in. Height - 3.7 in.	2.2 lbs	AL/Steel	Integral	Tripwire or pressure (14-28 lbs).
M66	Antitank, offroute mine - not fielded, same as M24 but uses geophones & infrared sensors						
M68	Antipersonnel, practice (simulates M18A1)		Same as M18A1	3.5 lbs	Plastic	-	For emplacement & arming practice.
M69	Antitank, practice (simulates M66) not fielded						

Table D1. (cont'd).

Family of scatterable mines

Nomenclature	System Name	Method of Delivery	Mine Type	Mine Weight	Main Charge	Activation	Self-destruct Time
M56	M56	Helicopter	AT/Blast	5.6 lbs	Comp H6	Pressure/Antidisturbance	Long
M70	RAAM	155 mm Howitzer	AT/Plate	5 lbs	RDX	Magnetic	Short
M73	RAAM	155 mm Howitzer	AT/Plate	5 lbs	RDX	Magnetic	Long
M67	ADAM	155 mm Howitzer	AP/Bounding	1 lb	PBX	Tripwire	Short
M72	ADAM	155 mm Howitzer	AP/Bounding	1 lb	PBX	Tripwire	Long
M74	GEMSS	M128 Ground Vehicle Dispenser	AP/Blast	4 lbs	Comp B	Tripwire	Long
M75	GEMSS	M128 Ground Vehicle Dispenser	AT/Plate	4 lbs	RDX/ESTANE	Magnetic	Long
BLU 91/B	GATOR	Aircraft	AT/Plate	4 lbs	RDX/ESTANE	Magnetic	Long
BLU 92/B	GATOR	Aircraft	AP/Blast	4 lbs	Comp B	Tripwire	Long
XM78	MOPMS	Ground emplaced	AT/Plate	4 lbs	RDX/ESTANE	Magnetic	Adjustable
XM77	MOPMS	Ground emplaced	AP/Blast	4 lbs	Comp B	Tripwire	Adjustable

Abbreviations:

RAAM Remote Anti Armor Mine
ADAM Artillery Delivered Antipersonnel Mine
GEMSS - Ground Emplaced Mine Scattering System
GATOR - Gator Mine System
MOPMS - Modular Pack Mine System

Composition of Explosives:

Tetryl: 2,4,6 Trinitrophenylmethylnitramine
Comp B: 60-40 cyclotol (60% RDX, 39.9% TNT, 1% desensitizer)
TNT: 2,4,6 trinitrotoluene
Comp C4: 91% RDX, 2.1% polyisobutylene, 1.6% motor oil, 5.3% di-(2-ethylhexyl) sebacate
Comp H6: no data
VX Agent: A chemical nerve agent
RDX: Cyclotrimethylenetrinitramine
PBX: no data
RDX/ESTANE: no data