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TECHNICAL REPORT NO. 74-88

RADIO-RETRANSMISSION SYSTEM

by

Stanley D. Peirce
Communications and Electronics Branch

June 1974

Final Report

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Aberdeen Proving Ground, Maryland 21005

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Two commercial radio retransmission devices were tested and evaluated for use by Military Police in CONUS. It was shown that such systems provide a useful and needed capability which permits MP's to remain in radio contact with their headquarters and other MP patrols without need to remain at their vehicle radios.

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INTRODUCTION

A military policeman in a car relies on his mobile radio for virtually all of his contact with command and support activities. Often, however, by the nature of the MP's duties he must leave the car and therefore remove himself from communication at what may be a very critical time. A sudden attack on a dismounted MP or an apparently routine assignment which turns into something more serious demands immediate action but under the present circumstances the request for support assistance or direction cannot be initiated until the MP is able to return to his automobile. The need for out-of-vehicle communication may occur under a wide variety of circumstances ranging from traffic control to the administration of first aid and the apprehension of criminals and the distances of the military policeman from his vehicle vary accordingly.

In order to provide suitable out-of-car communications, a lightweight hand held transceiver is desirable. Since such units necessarily have low power transmitters and relatively insensitive receivers, they must work through the mobile radio in the car in order to communicate with the MP desk.

As a result of discussion among the Task Officer, US Army Land Warfare Laboratory (LWL), and user respresntatives from the Provost Marshal General's Office, DA; HQ, Continental Army Command and the Military Police Agency, Ft. Gordon, GA, a requirement for radio retransmission systems was established to solve the above-described problems for MP's in Continental United States (CONUS). LWL then established a task to develop and provide evaluation systems which would allow the MP on foot to have the use of his mobile car radio from a reasonable distance away. Initially it was not known whether the necessary transceiver equipment would have to be developed or whether it might be commercially available. An investigation of the market determined that the mobile radios used by CONUS MP's as well as State Police and Highway Patrols were made by Motorola, Radio Corp of America (RCA) and to a lesser extent General Electric Corporation (GE). Also, it was discovered that two firms were just beginning to market retransmission systems tailored to operate with these mobile radios. It was therefore decided that the LWL effort should begin with an evaluation of the commercially available systems.

This report describes the operational test and evaluation of the commercial systems by military police at various CONUS Army installations.

DESCRIPTION OF SYSTEMS

The systems evaluated are of two types from two manufacturers. Public Systems, Inc "Mobile Radio Extender" is a two-way system. That is, the dismounted operator communicates to and from his car on a separate frequency from that of the net. Aerotron's "Relay One" is a simpler system which may be called a one-way system. The dismounted operator transmits to his car on a separate frequency from that of the net. He receives from the net directly on his portable receiver at the net frequency.

Two important features, the "Time-out Timer" and "Tone Activation" are required by the FCC and are incorporated in both the PSI and Aerotron systems. Situations are possible where a criminal could capture a hand portable from an MP, tape down the push-to-talk button and throw the unit away or hide it. As long as a retransmission equipped vehicle was in range, the mobile transmitter would have its carrier activated, thereby jamming the police net. After a set time, the "Time-out Timer" takes the mobile transmitter off the air and keeps it off until either the seized portable is recovered or the vehicle is moved out of range. Although, while this is happening, the particular vehicle is without communication, the net is not disturbed. In other possible situations, if the receiver in the retransmission unit in the vehicle had no special provision built in, any electromagnetic emission with a signal component within the receiver passband would activate the mobile transmitter and jam the police net. This could be inadvertent or by malicious intent. To eliminate this possibility, the retransmission systems are designed to respond only when there is a discrete subaudible tone provided by the "Tone Activation" on the portable radio's carrier.

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PUBLIC SYSTEM'S "Mobile Radio Extender System"

This system, hereinafter referred to as the MRE, functions in a manner similar to military tactical systems. In place of the squad radio there is a conventional "handy talkie" portable radio which operates on an independent frequency in the MP net band to provide a link to a similar transceiver in the MRE unit mounted in the MP sedan. A voice operated switch (VOX) in the MRE activates the mobile radio transmitter as a result of transmission from the portable. Another VOX switch activates the MRE transmitter to relay traffic from the MP net to the portable.

The "Time-out Timer" and "Tone Activation" features of the MRE were explained in the previous paragraph. Another important feature is a switch on the hand portable transceivers which control the subaudible activation tone. By placing the switch in the "local" or "portable" mode the tone is off. This permits patrols to communicate with each other without disturbing the MP net and without having their messages heard by others. It is important to note that when communicating in this mode, the MP's are still monitoring the net and may be called by the net.

There is one more important special feature, the circuitry for which is patented. In the situations where several patrol cars converge on a scene so that there are several MRE's within range of the portables, the retransmission system would break down unless coordinated action was taken to shut down all but one car. In the case of the MRE, this is not necessary because of the "Autoque" circuit. The first MRE to sense a carrier will activate its mobile radio. Then this circuit in the other MRE's constantly "looks" for the presence of a carrier on the vehicle radio frequency and if there is one the MRE will not come on. In other words in the situation where there are multiple MRE's, the Autoque prevents

the seisure of more than one mobile radio transceiver by an automatic selection process. This selection is random and the car chosen may change with each transmission. The MRE uses the mobile radio antenna on the MP car through the use of a diplexer. The portable link frequency must be separated by at least 3 megahertz from the net frequency. The MRE and the diplexer are normally mounted in the car's trunk alongside the mobile radio.

AEROTRON'S "Relay One"

Although this is a much less sophisticated system than the MRE, its acquisition cost was approximately comparable. However, it has certain limitations not found in the MRE System. The repeater unit in the car is a receiver only, using separate antenna from the mobile radio. The receiver has a VOX switch to turn on the mobile transmitter and it incorporates the "Time-out Timer" and "Tone Activation" features. The hand-held portables that LWL bought have a transmitter on 30.51 Megahertz for the link to the car. The portable receiver, however, is on the MP net frequency. To take care of the jam-up situation when several patrol cars converge on a scene, the portable's subaudible tone is paired to its car. Each system of portables and car unit uses a different discrete subaudible tone. This means that each portable can activate only the car with which it is paired. Also, because of the fact that the transmit and receive frequencies for a pair of portables are different they can communicate with each other only through a car. The "Relay One" is small and is normally mounted under the dash of the patrol car.

RESULTS

The systems were evaluated in Provost Marshal Office (PMO) vehicles at Aberdeen Proving Ground (APG), Ft. Gordon, GA and Ft. Hood, TX. The PSI systems were installed without difficulty by Post Comm/Elect personnel. The Aerotron units were installed by contractor personnel. The evaluation plan is given in Appendix A. A much less extensive evaluation of the "Relay One" was conducted because of its limitations.

APG Evaluation

The evaluation at APG was inconclusive. The APG MP's were previously equipped with hand portable transceivers operating on the MP net frequency. These units worked satisfactorily in the net from most patrol areas on post. For this reason the advantages of the retransmission capability were generally nullified.

Ft Gordon & Ft Hood Evaluations

The evaluations of the MRE at both Ft Gordon and Ft Hood were highly successful. It was found that having the retransmission capability greatly enhanced MP communications. The evaluation reports are attached as Appendixes B & C.

Current Status

All the retransmission systems procured are currently in use in MP vehicles as a permanent demonstration of this capability. Ten (10) PSI systems are in use by the PMO and 720th MP Battalion at Ft Hood. Two Aerotron systems are in use by the PMO at Ft Gordon. Each system has two portable transceivers.

All further work will be performed by US Army Electronic Command (ECOM), AMSEL-NL-N-4, Project Engineer, Lloyd C. Dathe, Ft Monmouth, NJ 07703, Autovon 99-52622, 52648.

For additional information on these systems the following manufacturers may be contacted directly:

Public Systems, Inc.
1197 E. Arques Ave
Sunnyvale, CA 94086
(408) 732-7900

Aerotron, Inc.
US Highway No. 1, North
Raleigh, NC
(919) 876-4620

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The use of commercially available retransmission equipment greatly enhance the communication capability of CONUS MP patrols.

2. The types of commercially available equipment tested are entirely adequate for CONUS MP use and no further development is required.

Recommendation

That the recommendations of the Ft Gordon and Ft Hood reports be implemented by ECOM.

APPENDIX A

EVALUATION PLAN RADIO RETRANSMISSION SYSTEM

EVALUATION PLAN
RADIO RETRANSMISSION SYSTEM

1. REFERENCES:

None.

2. INTRODUCTION: A Radio Retransmission System is used with the mobile radio in CONUS Military Police vehicles to permit the occupants of the vehicle to use their vehicular radio when they are engaged in an operation outside, and away from, the vehicle. The MP's are equipped with hand-held transceivers which communicate with a unit in the police car which in turn actuates the mobile radio.

3. BACKGROUND:

a. The Problem: There are many occasions when MP's have a need to transmit or receive while away from their vehicle. Sometimes such traffic is emergency, sometimes urgent, and sometimes a matter of time-saving convenience. A capability of communicating while away from the vehicle offers advantages that are needed by MP's for safety and improvement of law enforcement in their present day work.

b. History: LWL first became involved in retransmission systems for the standard tactical radios, VRC-12, PRC-77, etc. The principal need was to prevent a unit commander from making himself a target as a result of the need to be with the radio operator or with a vehicle in which the tactical radio was installed. He could communicate through these tactical radios from a position of safety. This same consideration applies at present to all MP's and all law enforcement officers. By having to be at their vehicles, they are where they are expected to be and they become the targets for snipers. In addition, there are many occasions when having to return to the vehicle to communicate interferes with the performance of an MP's duties. Examples are when directing traffic at the scene of an accident, calling for ambulances and calling for assistance while attempting to apprehend a thief or other violator. It was discovered that many of the law enforcement forces in the Nation are becoming aware of the advantages of having a retransmission capability.

c. Testing performed to date: Although no testing has been performed to date within the Army on systems for military police vehicles, it is known that testing has been performed by various civil police organizations throughout the country and that having such retransmission equipment provides advantages that are needed for safety and enforcement by police officers in their present day work.

4. DESCRIPTION OF MATERIAL: There are basically two types of retransmission systems. One might be called a two-way system and the other a one-way system.

a. One-way system: The hand-held transceiver, or handie-talkie, transmits on one frequency and receives on another. Transmit frequency is a special frequency for the retransmission system. The receive frequency is a frequency of the MP net in which the mobile radios are operating. Within the patrol car, there is a special receiver and a VOX switch that actuates the mobile radio transmitter when the remote patrolman is transmitting a message. The reply from the base station comes to the patrolman's hand-held transceiver directly on the MP net frequency. Hand-held receiving equipment is less sensitive than the vehicular installation; therefore, the base station to hand-held link can be limited to less than the maximum range of the mobile radio. Also, two officers on foot who wish to communicate privately through their hand-held transceivers cannot do so; they must use the mobile radio as a repeater.

b. Two-way system: In this system, the MP's are provided with hand-held transceivers that receive and transmit on the same frequency. In the patrol car there is a unit which consists of another transceiver to communicate with the hand-held transceivers and actuate the mobile transmitter in response to the patrolman's transmissions. It also transmits to the hand-held transceiver messages received from the base station on the mobile receiver. In this system, the maximum range that the MP can be away from his base station is determined solely by the capabilities of his mobile link. Furthermore, two MP's on foot may communicate privately with each other using their hand-held transceivers without activating the mobile radio in the MP net. Both types of systems will be evaluated under this plan.

5. DESCRIPTION OF OPERATION: Covered in Para. 4 above.

6. PURPOSE: The purpose of this evaluation is to determine the suitability of each of the systems for general Military Police use in CONUS.

7. TIME SCHEDULE:

a. Training: 1 day

b. Operation: 90 days

c. Questionnaire response: To be prepared concurrently during operation.

d. Report preparation: 30 days after evaluation.

8. PROCEDURE: Each Military Police vehicle in which the retransmission system is installed will be provided with two hand-held transceivers. The transceiver units will be employed during normal operations by evaluating personnel.

Procedures for control, issue and employment of the transceivers will be determined by the evaluating unit. Each unit will be furnished a battery charger and spare batteries so that the transceivers may be used on three shifts throughout the 24 hour period. The appropriate C&E personnel on the Post will be furnished maintenance manuals on the equipments.

The evaluating unit shall notify LWL immediately:

a. If a system is taken out of service for any reason.

b. Of any damage that may have occurred to any component.

c. Of any failure of any component.

9. TRAINING: As all MP personnel are familiar with the operation of hand-held radios and mobile vehicle radios, no extensive training is required. At the time when systems are turned over to the MP's, LWL will conduct a brief training period for appropriate personnel on how to charge and change the batteries in the hand-held units and how the retransmission equipments in the cars are operated.

10. SUPPORT REQUIREMENTS: LWL will arrange for the installation and operational check-out of the vehicular mounted components of the systems. It is not anticipated that any additional support will be required; however, should some equipment service be necessary, it will be provided either by off-Post firms obtained by request through LWL or by on-Post C&E facilities. Evaluation should not require the evaluating unit to provide additional personnel or special equipment.

11. SAFETY: It has been determined that the equipment does not have to be safety certified.

12. REPORTING PROCEDURE: After he has had ample time to become fully familiar with the performance of a system, each individual user is requested to complete the operator's questionnaire in as much detail as possible. The evaluating unit is requested to prepare a final report on each type of system, i.e. PSI VHF, Aerotron, and PSI UHF.

13. DISPOSITION OF THE ITEMS: To be determined upon completion of the evaluation.

OPERATOR'S QUESTIONNAIRE
RADIO RETRANSMISSION SYSTEM

OPERATOR'S NAME: _____

RANK: _____

UNIT: _____

VEHICLE NUMBER: _____

MODEL NUMBER OF HAND PORTABLE: _____

NATURE OF DUTIES: (i.e. traffic control, accident investigation, criminal investigation, security, patrolling, etc.) _____

NUMBER OF YEARS IN THE TYPE DUTY: _____

NUMBER OF DAYS YOU USED THE SYSTEM: _____

1. Were the instructions provided adequate to operate the system? Yes __ No __

2. Is the size and weight of the hand-held unit acceptable? Yes __ No __

3. Was the carrying case satisfactory? Yes __ No __

4. Was reliable performance obtained? Yes ___ No ___

5. Is it important that there be private communication between two hand-held units without activating the MP net? Yes __ No __

6. Does the mobile radio operate as effectively as before the retransmission unit was installed? Yes ___ No ___
Explain:

7. Did the system enhance the safety of unit personnel? Yes ___ No ___
Explain:

8. Was the system rugged enough to withstand normal field conditions? Yes __ No __
Explain:

9. Did you carry the hand-held unit out of the vehicle on each stop?
Yes ___ No ___
If no, explain:

10. Did you wear the unit on your belt while in the patrol vehicle?
Yes ___ No ___ If no, explain:

11. Did you wear the unit in your pocket while in the patrol vehicle?
Yes ___ No ___ Explain discomfort, if any:

12. Did you lose radio contact with the dispatcher at any time while using the hand-held unit? Yes ___ No ___ If yes, explain:

13. Do you feel that the equipment added to your safety while you were out of the vehicle? Yes ___ No ___ Describe incident(s) if related to actual use:

14. Was there any indication that the hand-held unit was unknowingly interfering with transmissions from other vehicles or stations? Yes ___ No ___
If yes, explain:

15. Did you encounter problems while working near other patrol vehicles which were equipped with retransmission systems? Yes ___ No ___ If yes, explain:

16. Was the hand-held unit used while you were separated from your vehicle by considerable distance? Yes ___ No ___ If yes, what distance? _____
Any problems?

17. Did you use the hand-held unit during a high-risk stop? Yes ___ No ___
If yes, list advantages and disadvantages:

18. When you were far away from the base, but still in mobile radio contact, was there any occasion when you could not establish communication by means of the hand-held unit? Yes ___ No ___

19. Were the number of batteries supplied for the portables adequate?
Yes ___ No ___

20. Did the hand-held unit have adequate range under all conditions?
Yes ___ No ___ Explain:

21. Do you have any general comments concerning the system, its usefulness in your operations or how it could be improved to be more suitable for your operations?

APPENDIX B

REPORT OF EVALUATION -- PSI RADIO RETRANSMISSION SYSTEM
8 JAN 1974

DEPARTMENT OF THE ARMY MAJ O'Malley/bm/780-4747
HEADQUARTERS, UNITED STATES ARMY MILITARY POLICE SCHOOL
FORT GORDON, GEORGIA 30905

ATSJ-CTD-MS

SUBJECT: Report of Evaluation -- PSI Radio Retransmission System

Commander
US Army Land Warfare Laboratory
ATTN: Communcations (Mr. S. Pierce)
Aberdeen Proving Ground, Maryland 21005

1. An evaluation of the subject system has been completed by the US Army Military Police School and the Installation Provost Marshal Office, Fort Gordon, Georgia, during the period 1 September to 30 November 1973.

2. General Background of the Evaluation:

a. The evaluation was conducted at the request of Mr. Stanley Pierce, USALWL, who suggested that three commercial systems could be made available at Fort Gordon for use by Military Police. The purpose of the evaluation was to determine if the PSI Radio Retransmission System was suitable for general military police use in CONUS.

b. Three retransmission systems were shipped to Fort Gordon and installed in three MP sedans during the period 28-30 August 1973, by representatives of Post Signal. Mr. Jim White, PSI Sales Representative, and Mr. Stanley Pierce, USALWL, assisted in the installation and briefed representatives of USAMPS and the PM Office on the methods of operating retransmission system and other pertinent features of the system.

3. Findings:

a. Communications personnel were able to install all equipment without special training. The mean installation time was 1 hour 30 minutes. Special tools and equipment were not needed to accomplish installation.

b. The cable assembly from the vehicular control unit to the radio gear in the trunk was not long enough to permit flexibility of mounting in the trunk.

c. Most MP sedans have radios wired to the ignition. This presents a problem when using the retransmission system. If allowed to remain in this configuration, vehicle could not be locked and is thus subject to theft.

d. The size and weight of the system, especially the transceiver, is compatible with other equipment used by MP and does not interfere with MPs in performance of their duties.

e. The tie down strap for the carrying case covers one input jack for one earplug.

f. The earplug cord is too long. There is no pocket or tiedown feature for the earplugs.

g. The carry case does not have features available which permit tie down of the antenna.

4. The following comments refer to operational use of the system:

a. The potential employment of the system is virtually without limit; i.e., traffic accident investigation, traffic control operations, security checks, surveillance operations, canine patrols, foot patrols, recovery from sniper attack, coordinated raids or searches, and confinement operations.

b. The system was used under the following type situations at Fort Gordon during the evaluation period:

(1) Entering a building to make apprehension.

(2) While taking normal breaks; for example, for chow.

(3) While working at traffic control points.

(4) While investigating accidents.

(5) During foot pursuit of a subject.

c. During operational use, the system was found to perform satisfactorily. In the local mode, distances up to 400 meters were achieved. This distance occurred during situations where both transceivers were outdoors and when one transceiver was indoors in a basement surrounded by packing materials and other equipment. In the remote mode, the system operated up to 8/10 mile from the vehicular control unit.

ATSJ-CTD-MS 8 JAN 1974

SUBJECT: Report of Evaluation -- PSI Radio Retransmission System

d. There were situations in which poor reception was noted. It is believed, though, that this resulted primarily from weak batteries.

5. Conclusions:

a. That the PSI Radio Retransmission System is suitable for military police use at Fort Gordon.

b. That the PSI system enhances military police operations under a wide variety of circumstances.

c. That the PSI system provides for an extra margin of safety, by permitting continuous radio contact between military police and the operations center (MP desk).

d. That the problems cited in paragraphs 3 and 4 above are essentially minor in nature. Instances of unreliability can be overcome through experience and more detailed administrative procedures.

6. Recommendations:

a. That another evaluation of this equipment be initiated between USALWL and a military police unit. USAMPS will assist in this effort if desired.

b. That, if a second evaluation proves successful, type classification actions be initiated by USALWL.

7. The equipment used in this evaluation is being returned to your office separately.

FOR THE COMMANDANT:

HOUSTON C. HILL
LTC, MPC
Assistant Adjutant

APPENDIX C

REPORT OF EVALUATION -- PSI RADIO RETRANSMISSION SYSTEM
16 MAY 1974

DEPARTMENT OF THE ARMY
HEADQUARTERS 720TH MILITARY POLICE BATTALION
Fort Hood, Texas 76544

720-S3 16 May 1974

SUBJECT: Report of Evaluation -- PSI Radio Retransmission System

Commander
US Army Land Warfare Laboratory
ATTN: Communications (Mr. S. Peirce)
Aberdeen Proving Ground, Maryland 21005

1. The evaluation of the subject system has been completed by the III Corps Provost Marshal Office and the 720th Military Police Battalion during the period 18 March to 13 May 1974.

2. General Background of the Evaluation:

a. The evaluation was conducted at the request of Mr. Stanley Peirce, USALWL, in coordination with CPT Joseph Weston II and LT Paul S. Marshall, Jr., of the S3 Section, 720th MP Bn. and the III Corps Provost Marshal Operations Section. The purpose of the evaluation was to determine if the PSI Radio Retransmission System was suitable for general military police use in CONUS. This evaluation is a follow up evaluation to the one conducted at Ft Gordon by USAMPS during the period 1 September to 30 November 1973.

b. Five (5) retransmission systems were shipped to Ft Hood and installed in five MP sdeans during the period 13 - 15 March 1974 by post communication personnel. Mr. Peirce of USALWL and a representative of Public Systems, Inc. assisted in the installation and briefed the battalion and Provost Marshal personnel on the methods of operating the retransmission system and other pertinent features of the system.

3. Findings:

a. Communications personnel were able to install all equipment without special training. The installation time was approximately two hours. Special tools and equipment are not needed to accomplish installation.

b. Sedans which had the radios wired to the ignition required some rewiring so that the vehicle could be locked while MP's were away from the vehicle.

c. The size and weight of the system, especially the transceiver, is compatible with other equipment used by the MP and does not interfere with MP's in the performance of their duties.

d. The transceiver case should have a clip rather than a strap to fasten it to the web belt. This would facilitate handling of the radio and would provide an additional degree of protection for the radio because it would not have to be taken from the case to be used.

q e. The tie down strap for the carrying case covers the input jack for the ear plug.

f. The ear plug cord is toolong and there is no pocket or tiedown feature for the earplug. Additionally, the earplug feature is of little use to the road duty MP, although it greatly enhances the use of the system in MPI/CID type operations.

g. The transceiver should have a retractable antenna.

h. The transceiver should have a second crystal available to cut down on the amount of radio traffic in the local mode.

i. The equipment is extremely durable and reliable. Only one minor repair was made on the equipment which required the replacement of a fuze in a set of batteries.

4. The following comments refer to the operational use of the system:

a. The potential employment of the system is virtually without limit; i.e., traffic accident investigations, traffic control operations, security checks, surveillance operations, canine patrols, foot patrols, raids, etc.

b. The system was used under the following type situations at Ft Hood during the initial evaluation:

(1) Entering a building to make an investigation.

(2) While taking normal breaks; for example, meals.

(3) While working quick reaction missions.

(4) While working crowd control details,

(5) While doing plain clothes surveillance of suspects.

(6) While working high crime areas with foot/dog patrols.

c. During operational use, the system was found to perform satisfactorily. In the local mode, distances of up to 800 meters were achieved. This distance was achieved when both transceivers were out of doors and when one unit was indoors. In remote mode, the system operated up to 1 mile from the vehicle.

d. There were instances in which poor reception was noted. It is believed that this resulted from weak batteries.

5. Conclusions:

a. That the PSI Radio Retransmission System is suitable for military police use at Ft Hood.

b. That the PSI system provides for an extra margin of safety by permitting continuous radio contact between military policemen and the MP desk.

c. That the PSI system enhances MP operations under a wide variety of circumstances.

d. That minor operational problems can be overcome with more experience and more detailed administrative procedures.

6. Recommendations:

a. That more PSI units be provided Ft Hood in order to conduct more evaluations and actions be initiated to provide PSI units for MP use CONUS wide.

FOR THE COMMANDER:

LARRY D. CAROTHERS
1LT, MPC
Adjutant

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US Army Standardization Group, Australia
c/o American Embassy
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Senior Standardization Representative 1
US Army Standardization Group, UK
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Canadian Forces Headquarters
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Aberdeen Proving Ground, MD 21005

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