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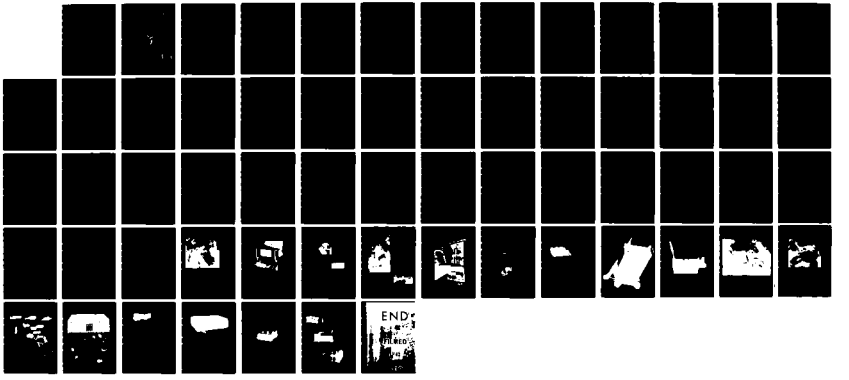

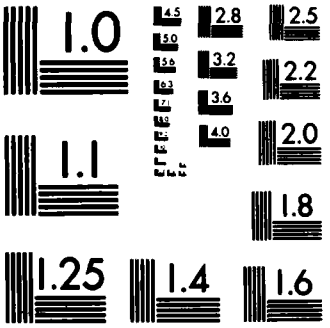

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MAINTENANCE COMMUNICATIONS FOR THE 1990's

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B.J.D. WILSON
MAJOR, USAFR

A.R. ROMERO
MSGT, USAFR

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"Throughout history, the outcome of conflict has been determined as much by the collection and proper use of good information to control forces as it has been by the quality and quantity of weaponry."

-William Clements, 1975

"If one could quantify the hours wasted by Air Force maintenance people waiting because they can't communicate, one could easily justify the expense of whatever new gadgets technology will bring."

-Alan A. Blomgren, 1982

"In every recent exercise... lack of communications has been cited as the glaring deficiency."

-MGen Doyle E. Larson, 1983

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Communications	Emergency Communications	TRI-TAC
Crash Recovery	Command and Control	MARS
Logistics	Ground Mobile Forces	Military Affiliate Radio System
Supply		

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

This study details weaknesses in the present maintenance communications system, especially radio and telephone voice circuits and data links. This study contends that the present system is a "force divider" that is not combat reliable nor effective in peacetime. Paper criticizes type of equipment now in use, system design, maintenance concept, and present procurement policy. Proposes an Advanced Maintenance Communications System using MILSPEC tactical equipment (TRI-TAC), hardened computers, encrypted data links, backup command-control radio circuits, and survivable maintenance control centers.

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MAINTENANCE COMMUNICATIONS FOR THE 1990's

OBJECTIVE

The objective of this study is to identify Logistics Command Control Communications elements needed by aircraft maintenance organizations in the 1990's from a user's perspective and to suggest systems that would fulfill those needs.

PURPOSE

We intend this study to serve as a basic resource to Major Air Command and Air Staff personnel in the preparation of Program Objective Memorandum (POM) initiatives and other long-range planning efforts.

BACKGROUND

An adequate and reliable maintenance communication system would be a powerful force multiplier for the Air Force. The present inflexible, inefficient system is a force divider.

In recent years, Air Force maintenance managers have not been assertive in identifying communications systems or hardware tailored to their specific mission requirements. This is the result of specialized knowledge, compartmentalized responsibility and the widespread understanding that others in the communication community have been planning for maintenance needs.

The systems available to maintenance thus far, while relatively inexpensive and serviceable in peacetime, do not meet wartime requirements for reliability, maintainability, and versatility.

This study outlines a logistics communication system for the 1990's designed to meet maintenance needs for voice and data circuits both at home station and at deployed locations.

METHODOLOGY

We drew on the knowledge and judgement of USAF Maintenance Officers and NCO's who have experienced a wide variety of operations - SAC main base, TAC Bare Base deployment, SEA deployment, emergency evacuations, special operations activities, air rescue operations, weather reconnaissance and MAC enroute support. In addition, we asked USAF Reservists with recent industry experience to provide input. Finally, we researched state-of-the-art systems and equipment data from commercial sources, while referring to Armed Forces Communications and Electronics Association (AFCEA) studies relating to future systems design. Although totally empirical, we feel that this study provides programmers and communications planners with a road map drawn from the user's point of view.

FORMAT

-Part A of this study summarizes our conclusions and recommendations

-Part B details problem areas now limiting effectiveness

-Part C outlines opportunities for mission enhancement

-Part D contains appendices of background data we have used and a source bibliography.

-Part E contains a partial listing of commercial resources.

NOTE

This study does not represent the official views of the U.S. Air Force nor any USAF agency. It reflects the personal opinions of the authors, who developed this study independently. Please note that certain extracts of copyright material have been used with permission. Further use of such material will require prior permission of the individual copyright owner. Throughout the report, references are made to specific manufacturers and models of equipment. This has been done only to provide the reader with a specific, detailed point of reference. No product indorsement is intended nor implied.

We sincerely hope that this study will assist USAF programmers in choosing among the many alternatives available for the 1990's and beyond.

BASCOMBE J. D. WILSON, Major USAFR

ANTONIO R. ROMERO, MSgt, USAFR

"The two most important elements of readiness for Commanders - after weapons and people - are logistics and the ability to communicate those logistics needs."

General Bryce Poe, II 1978

"The beauty of a system lies not in its technical sophistication or cleverness of implementation, but in what it will do for the user."

-MGEN Doyle E. Larson, 1981

[Part A]

CONCLUSIONS

1. Presently, there is no comprehensive logistics communication system.

2. Logistics communication capability is inadequate from the user's perspective.

   a. Present capability does not meet wartime need for reliability, maintainability and security.

   b. System does not provide adequate Command Control Communications (C^3) in peacetime.

   c. Present system architecture is not based on modern technology and structure.

3. A complete restructuring of Logistics Communications is now indicated.

4. A properly designed, standardized system will be cost effective and can be implemented by 1990. As the present equipment in use wears out and is replaced on an individual basis, a centrally controlled effort must be made to attain the maximum communications capability for the dollar spent.

"If logistics communications stops, the war stops!"

-General Bryce Poe, II
1978

RECOMMENDATIONS

1. A Maintenance Communications System be developed along the lines of Figures A-3, A-4, and A-5.

2. Aircraft Maintenance activities be included as users of the TRI-TAC communications system.

3. Centralized procurement of MILSPEC intrabase radio equipment for logistics users be instituted by AFLC, with funding of POM initiative shown in Figure A-6.

4. Maintenance Control Centers and Base Communication facilities be made into survivable shelters, with funding of POM initiative shown in Figure A-7.

5. Aircraft maintenance organizations become self-sufficient in repair of their own communications equipment.

6. Logistics computer systems (such as MMICS/CAMS) be portable, hardened, combat capable and self-sustaining.

7. Aircraft maintenance organizations receive upgraded real-time communications capabilities.

   a. Mobile and portable HF
   b. Satellite tactical terminals for contengencies
   c. Electronic mail (packet transmission and telefax)
   d. Upgraded telephone systems

8. AFLC through AFCC establish a Worldwide Logistics Contingency HF radio network to provide emergency logistics communications to any Air Force location needing a backup logistics circuit

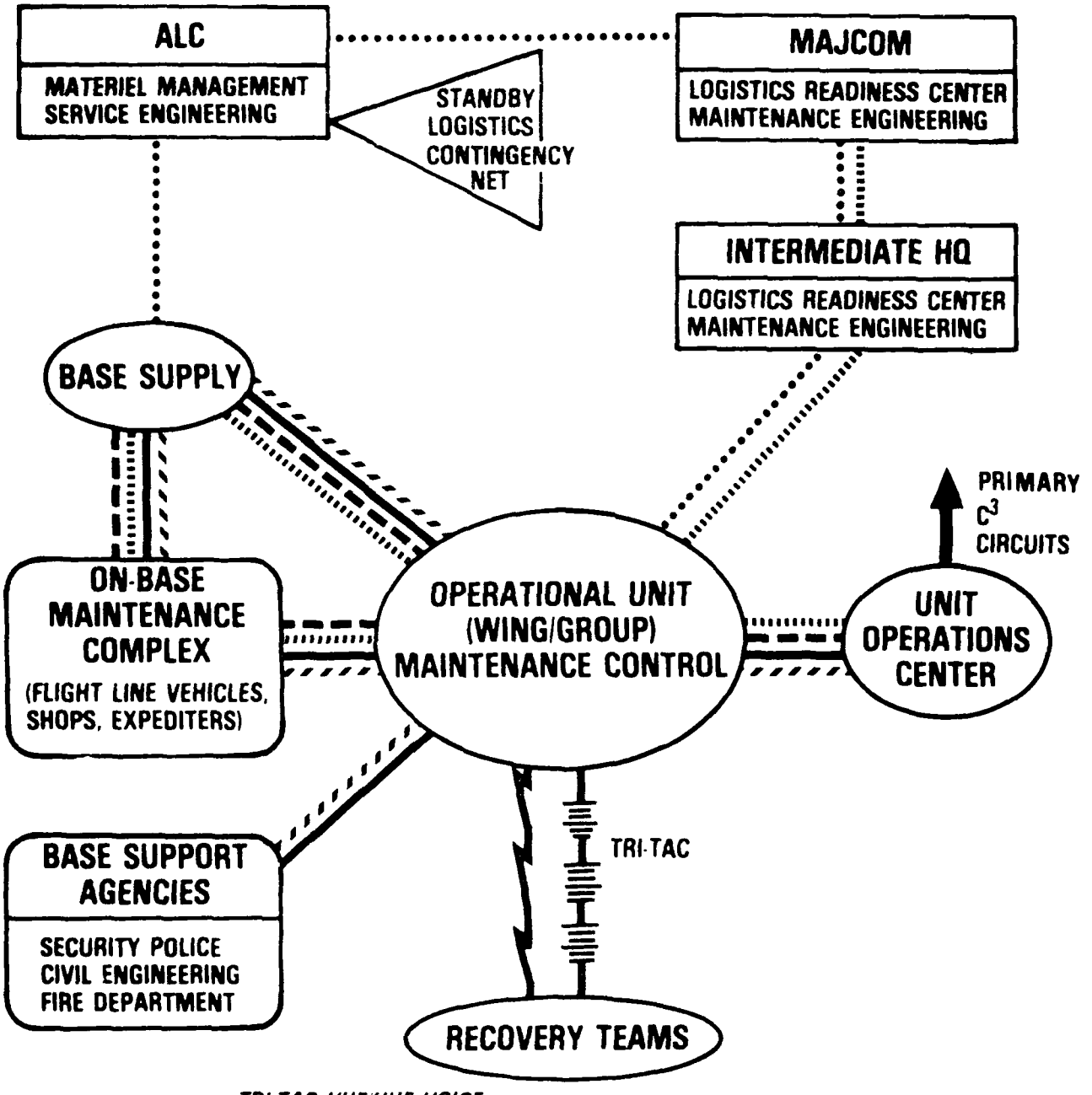
9. The USAF Logistics Management Center (AFLMC) undertake a comple study of logistics communications needs.

ADVANCED MAINTENANCE COMMUNICATIONS SYSTEM

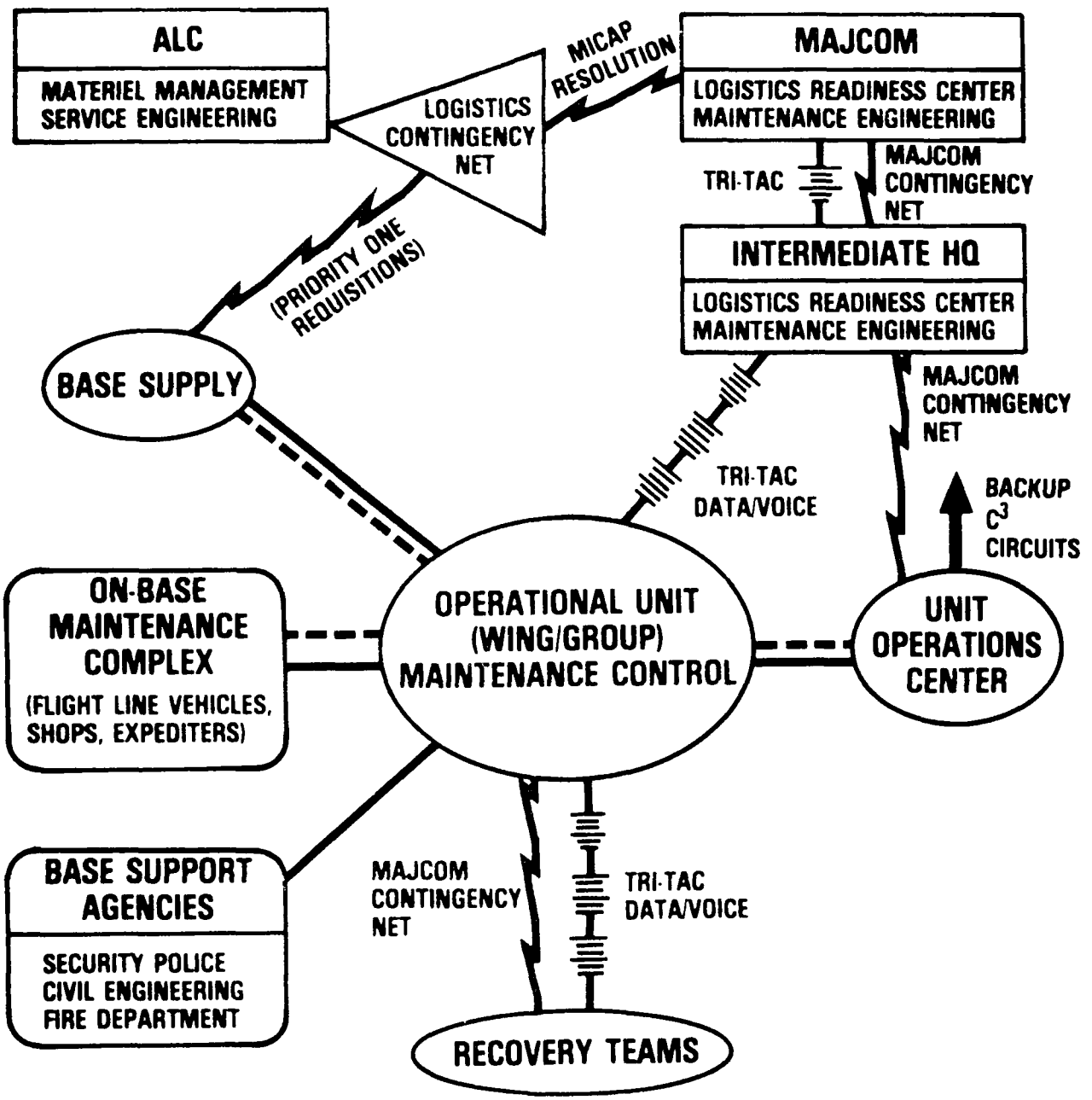
UNIT MAINTENANCE CONTROL

- TELEPHONE SYSTEM
  - AUTOVON SUBSCRIBER (4-WIRE)
  - ON BASE DIRECT LINES
  - RADIO-PHONE PATCHING
  - CALL DIRECTOR NETWORK
  - SECURE LINE TO COMMAND POST
- INTRABASE RADIO
  - SECURE VOICE (UHF OR VHF)
  - DATA LINK TO CAMS
  - TRI-TAC EQUIPMENT (VHF–UHF)
- OFFBASE RADIO
  - HF VOICE
  - TRI-TAC
  - TACTICAL SATELLITE (GROUND MOBILE FORCES – GMF)
- DATA SYSTEMS
  - CORE AUTOMATED MAINTENANCE SYSTEM (CAMS)
    - -- MOBILES LINKED BY RADIO
  - PACKET COMMUNICATIONS (ELECTRONIC MAIL)
  - DIGITAL FACSIMILE OVER COMMON USER CIRCUITS

ADVANCED MAINTENANCE COMMUNICATIONS SYSTEM (NORMAL CONDITIONS)



ADVANCED MAINTENANCE COMMUNICATIONS SYSTEM (EMERGENCY: AUTOVON/AUTODIN OUT)



GUIDANCE ITEM -- EXERCISE 86-A1

GUIDANCE TITLE: (U) Maintenance Communications (PE xxxxxx)

PDP # _____ CHANGE CONTROL NUMBER _____

PROGRAM ELEMENT CODES AFFECTED:

5711F	ANG	USAF: TACTICAL
USAFR	USAF: MOBILITY	USAF: STATEGIC

GUIDANCE NARRATIVE: Funds a program to upgrade logistics communications capability. Provides aircraft maintenance organizations with MILSPEC tactical equipment as phased replacement for non-combat capable equipment now in use. Funds an AFCC Logistics Contingency Communications System. Provides 3740 funds for depot maintenance of equipment. (Procurement after FY92 to reduce to $5M annually for replacement. Depot Maintenance to remain at $10M).

RESOURCE DATA: No force structure affected. Only fiscal impact is 3740 O&M funds and continuation of TRI-TAC procurement.

$M (FY86 Dollars)

Delta to FYDP	FY86	FY87	FY88	FY89	FY90	FY91	FY92
PE xxxxx							
Procurement	+12.0	+16.0	+18.0	+24.0	+24.0	+24.0	+18
3740	0	+2.0	+4.0	+6.0	+8.0	+10.0	+10

NO DIRECT MANPOWER

OPR: Air Staff Agency to be determined (LEX, XOK)

TYPE GUIDANCE: New Program

COORDINATION:

PAXFC	Panel Chairman (SU)	Panel Chairman (C3)

GUIDANCE ITEM -- EXERCISE 86-A1

GUIDANCE TITLE: (U) Hardening Maintenance and Communications Centers

PDP # _____ CHANGE CONTROL NUMBER _____

PROGRAM ELEMENT CODES AFFECTED

USAF: MOBILITY	USAF: STRATEGIC	ANG
USAF: TACTICAL	USAFR	___

GUIDANCE NARRATIVE: Funds a program to selectively relocate aircraft maintenance control centers and base communications centers to existing facilities with higher chemical warfare and radiation protection factors. Where less costly, funds hardening of existing facilities. Provides for survival shelter supplies and utilities. Includes cost of facility modification, relocation of communication lines and equipment, enhanced/filtered air conditioning and improved utilities.

RESOURCE DATA: No force structure affected. Fiscal impact is limited to RPMA and minor construction funds.

$M (FY86 Dollars) Delta to FYDP	FY86	FY87	FY88	FY89	FY90	FY91
RPMA	+4.0	+8.0	+10.0	+10.0	+10.0	+10.0
Minor Construction	+2.0	+4.0	+8.0	+8.0	+8.0	+8.0

NO DIRECT MANPOWER

OPR: Air Staff Agency to be determined (LEE)

TYPE GUIDANCE: New Program

COORDINATION:

_____ PAXFC

_____ Panel Chairman (SU)

PRESENT PROBLEMS

The problem area discussions on the following pages are intended to outline the most serious deficiencies the users now experience.

-Resolution of these deficiencies within the present FYDP is desperately needed.

-A POM initiative for $136 million invested over six years - with concurrent withdrawal and central pooling of $2 million per year local purchase funds - would resolve the most serious deficiencies by 1990.

"We are critically vulnerable to power outages, air conditioning failures and simple acts of sabotage."

Tactical Airlift Group Chief of Maintenance
1983

"Without communications, all I command is my desk."

General Curtis E. Lemay, 1952
General Thomas Power, 1956
General Lew Allen, 1978
et al

PROBLEM: Maintenance Radio equipment is not combat reliable because it is of commercial design (not MILSPEC), is not ruggedized, is not unit repairable and is not replaceable through military stockage.

DISCUSSION

Maintenance Intrabase Radio Nets are used to direct and control a unit's aircraft maintenance effort. Generally, a Maintenance Control Center with a VHF or UHF base station communicates by voice with a number of portable mobile or stations to coordinate repair and servicing of aircraft.

Such radio equipment is authorized in USAF Table of Allowance (TA) 660 and is locally procured form such major vendors as General Electic, Motorola, and RCA. Some bases have selected other vendors.

Radio maintenance is accomplished through contract with a local electronics repair shop which is usually a factory authorized service center. Funding for the equipment purchase is generally provided by the using organization (Budget Code 9). For high cost items of equipment (over $3000), the host base is obligated to fund the purchase. Some bases have leased their equipment from contractors. This is especially true for units with secure voice radios, pagers and other specialty items.

Problems are encountered when several radios are out of commission at once. Local repair shops require from several days to many months to obtain and install replacement components. With modern equipment having favorable Mean Time Between Failure (MTBF) in normal non-combat usage, a false sense of security is thereby induced. All our MTBF rates are based on peacetime use. Under rough combat conditions and around-the-clock use, MTBF will decrease drastically. No spare equipment is authorized nor on hand. No military in-house repair capability exists. The nearest repair facility may be thousands of miles away from a unit's wartime base of operations - and even there, spare parts may not be available.

Lead-time for procurement of replacement radios is also lengthy - 60 to 120 days under the best of circumstances. (When the Nuclear Regulatory Commission ordered replacement radio parts for their emergency response team at Three Mile Island - using the highest national emergency requisition priority - the parts took two weeks to obtain from the nation's largest radio manufacturer.)

RECOMMENDATIONS

1. All maintenance radio equipment should be standardized by MILSPEC and centrally procured (stock listed). The Air Force would immediately benefit from the economies of mass procurement while availability of on the shelf, standard equipment would benefit all users. (At present, the chief deterrent to central procurement appears to be the wide range of frequencies in use on intrabase radio networks and the previous economic impracticality of stocking such a variety of equipment. Modern technology has eliminated this limitation, as new equipment can cover a wide frequency range.

(cont'd next page)

2. Each maintenance organization should have 95% repair capability on all maintenance radio equipment. This would result in a small manpower additive for only the largest organizations and would have a minimum impact on others. Within flying units, the workload would be absorbed by unit Avionics Comm-Nav Shops. For items not locally repairable (NRTS), organic depot or contract overhaul should be provided by the Air Force Logistics Command (AFLC).

3. The equipment itself should reflect state-of-the-art in military ruggedness, reliability and maintainability. Using plug-in circuit cards, the equipment should be fully repairable under combat conditions within 15 minutes by a 5-level technician using any osciloscope, voltmeter and wattmeter.

PROBLEM: Maintenance radio equipment generally operates on only one or two frequencies and cannot be readily mobilized from one base to another without expensive modifications by a contractor.

DISCUSSION

Aircraft Maintenance teams have a heavy mobility commitment, both peacetime and wartime. Teams ranging in size from entire squadrons down to small crews are frequently deployed from one base to another to support operational commitments, exercises, weather evacuations and similar activities.

Upon arrival at deployment sites, maintenance crews usually do not have adequate intrabase communications nor effective command-control communications with home base. Intrabase radio equipment is of commercial design and is capable of operating on only a few channels. Most equipment has 1 or 2 channels, although some organizations have obtained equipment capable of 6 channels. Frequency changes are costly, time consuming and generally impractical. For most equipment now in use, this involves much more than simple crystal changes.

As a rule, each air base or deployment site has its own unique radio frequency allocation and there are no frequencies in common among host and visiting unit's equipment. On the contrary, visiting unit's equipment cam not be used at all since it would cause interference to other federal users in the deployment area.

RECOMMENDATIONS:

1. Interim: Synthesized, programmable frequency equipment should be the standard for future procurement.

2. Long-range: Aircraft maintenance should be included as a user in the TRI-TAC system, and TRI-TAC equipment should be obtained on a replacement basis for all maintenance organizations needing new radio equipment.

PROBLEM: Maintenance crews are frequently without communications links to Maintenance Control when more than 15 miles from home base at the site of a crash or other recovery action.

DISCUSSION

Few Maintenance activities are more hazardous and in need of closer command control than crash recovery or emergency response.

Especially under combat conditions, but in peacetime as well, maintenance recovery crews need a method of summoning assistance, seeking technical guidance and obtaining parts.
At present, when more than about 3 to 10 miles from home base (typical VHF/UHF radio range) mobile and portable radio equipment is useless for liaision use. In most cases, telephone circuits are not nearby.

The Military Affiliate Radio System (MARS) provides some assistance as does the Civil Air Patrol (CAP) but these resources should not be our primary providers because of their lack of wartime mobility.

Each maintenance control needs a wireless voice capability reliable out to 150 miles for control of recovery teams. Ideally, this circuit would be encrypted.

RECOMMENDATION

Maintenance Control be equipped with a medium power, high frequency (HF) contingency radio. At least one portable/mobile radio should be assigned per organizational maintenance (OM) element.

A wide range of equipment is now available for this use. A few examples are:

AN/URC-96
SC-130 (Southcom, Inc.)
AN/PRC-104
KWM-380 (Rockwell International)

PROBLEM: Maintenance Control Centers generally have no backup to AUTOVON and the Common-user telephone network.

DISCUSSION:

While all DOD activities are vulnerable to AUTOVON and local telephone outage risks, few agencies cause a more immediate degradation of the mission than maintenance when unable to communicate.

For daily use, common user trunks provide the optimum in economy and flexibility. Nevertheless, studies have shown the common user system's vulnerability to sabotage, overloading and nuclear (including EMP) attack.

Maintenance Control Centers must have a survivable voice and data link with higher headquarters and Air Logistics Centers to insure rapid resolution of grounding situations as well as effective command control. This equipment, as well as the Maintenance Control facility itself, would additionally serve as a vital backup to the unit's Operations Center and base Command Post.

RECOMMENDATIONS:

1. Maintenance Controls be equipped with HF voice and data equipment capable of operating on the MAJCOM contingency net as a primary backup system. Typical equipment would include AN/URC-96, AN/ARC-191, or MSR-8000 (ITT-Mackay).

2. Maintenance Controls be equipped with tactical satellite (MILSATCOM) voice and data capability as a contingency backup. Maintenance would be a Ground Mobile Forces (GMF) system user. Typical equipment would be similar to AN/URC-100, AN/URC-101 or AN/URC-104.

ENHANCEMENT OPPORTUNITIES

The following statements of need outline specific areas for mission enhancement, attainment of economies and improved procedures.

There is some overlap with problem areas identified in Part A, and common solutions have been suggested.

STATEMENT OF NEED: Radios that can be quickly repaired at organizational level and returned to service within 15 minutes during combat conditions.

DISCUSSION:

In a combat environment, success or failure of the entire mission may depend on rapid, coordinated Maintenance/Munitions response. That response depends in large measure on the ability of maintenance activities to communicate among themselves and with the operations centers.

Presently, the radio equipment assigned to maintenance is not ruggedized, is not field repairable and is not supported by the military supply system. Finally, units do not have test equipment nor personnel trained to repair the assigned radios.

RECOMMENDATIONS:

1. Maintenance should be included as a user in the TRI-TAC system.

2. Maintenance should use and repair their own TRI-TAC equipment. (100% self sufficient).

STATEMENT OF NEED: Encrypted wireless data link between Maintenance Control and flight line vehicles with video (CRT/VDT) displays and keyboard entry terminal in selected vehicles.

DISCUSSION:

Maintenance Control and flight line activities must exchange high volumes of sensitive information, such as takeoff times, weapons configurations, combat damage, weapons and classified cargo movement, fuel loads and systems malfunctions.

This information could be handled faster, more securely and with greater accuracy if transmitted digitally and stored in a secure maintenance mini-computer located in Maintenance Control. Mobile terminals would be located in selected maintenance vehicles and linked to Maintenance Control by digitally encrypted radio. A limited number of hand-held data units should be employed by maintenance supervisors.

RECOMMENDATIONS:

1. Systems similar to MIL-TERM-280 should be authorized for flight line vehicles and maintenance controls. Equipment similar to RS232C (or RS 422) - portable data terminals - should be authorized for deployment use.

2. Portable equipment similar to Motorola RDX (handheld wireless data terminal), MA6248 (RACAL Digital Alphanumeric Message Terminal) or KY-879/P Key Message Terminal should be provided for maintenance supervisors.

3. This capability be made Increment 8 of the Core Automated Maintenance System (CAMS).

STATEMENT OF NEED: Maintenance Control afforded with high fallout protection factor (PF).

DISCUSSION:

Maintenance Control is the nerve center of maintenance. Emergency evacuation and relocation of Maintenance Control is costly in terms of lost effectiveness, degraded facilities and reduced maintenance capability.

Presently, no coordinated effort is made to insure that maintenance control is situated in a survivable facility.

Minimum planning and expense would be involved in placing these control centers in building basements or center floors.

RECOMMENDATIONS:

1. USAF/LEY specify that all new maintenance control centers be constructed with the highest practical fallout protection factor (PF).

2. MAJCOMS make improvement of existing maintenance controls an item of special interest.

3. A 5-year plan be implemented to provide a PF of 250 or higher to all fixed Maintenance Controls. In addition, 15 days stocks of emergency rations should be stored nearby.

STATEMENT OF NEED: Survivable Maintenance Computer System.

DISCUSSION:

The maintenance computer system aids immeasurably in the effective, efficient control of people and equipment.

The system, however, is not survivable as it is linked by telephone line to the central base computer. Many units without a host base computer center are linked to another base's computer by RJETS terminals. The system has numerous nodes of vulnerability and violates every principle of survivability.

If units learn to depend on this system in peacetime, it must be made dependable and deployable in wartime.

Phase IV main frame base computers will mitigate but not resolve this serious deficiency. Only a deployable, rugged, independent maintenance computer system can provide the wartime reliability and flexibility needed by logistics managers.

RECOMMENDATION:

1. The maintenance computer system (MMICS or CAMS) be evolved into an independent, small computer system.

2. Each Maintenance Control have its own fully deployable computer.

3. Each Maintenance Computer be linked with the Phase IV mainframe for interface with other base systems and RCS Report generation.

4. Maintenance organizations be provided a limited in-house hardware and software maintenance capability.

5. All equipment be MILSPEC, ruggedized and Tempest-approved. Typical equipment would include:

AN/UYK-41 (2M Bytes; 40 pounds; 100 watts; 10,00 hrs MTBF; 30 min repair)

AN/UYK-49 (1M Bytes; 10 pounds; 20 watts; 33,000 MTBF; 15 min repair)

STATEMENT OF NEED: Survivable communications link for off-base supply requisitions.

DISCUSIION:

Base supply (Demand Processing Center and MICAP Control) depend upon AUTOVON and AUTODIN exclusively for submitting off-base requisition to depots. If these common-user communications systems fail, no activity on an Air Force base will be able to order parts from off base, no matter how mission essential.

AFLC operates an HF radio Contingency Network for command-wide emergency liaison and command-control. The network is not designed to process base requisitions as non-AFLC bases are not linked to the net in any way. The net operates on USAF Military Affiliate Radio System (MARS) frequencies.

RECOMMENDATIONS:

1. Air Force Communication Command (AFCC) establish under the auspices of MARS, a world-wide Logistics Contingency Net to service all USAF installations.

2. Each base establish procedures and train radio operators to serve the emergency communications needs of maintenance, supply and transportation.

3. AFLC establish a means for routing and processing emergency requisitions transmitted through this world-wide Logistics Contingency Net.

STATEMENT OF NEED: Radio - Telephone system that allows two way patching on maintenance radio nets.

DISCUSSION:

Maintenance crews dispatched to aircraft frequently encounter problems that require immediate attention of Maintenance Officers, Technical Superintendants, Quality Assurance personnel, or higher level technicians.

Delays are caused when a maintenance controller must relay radio calls and pass information back and forth over the telephone to people in offices. Frequently, people from offices and shops must interrupt their own work and travel to the aircraft just to see the nature of the problem. At the same time, work on the aircraft has stopped.

Efficiency would be greatly enhanced by the ability to patch the telephone system into the maintenance radio net.

RECOMMENDATION:

Maintenance Controls should be equipped with a manually activated, voice operated radio-telephone patch and that this be specified in TA660 as a component of the base radio system.

STATEMENT OF NEED : Survivable communications link between Maintenance Control and Command Post/Operations Center.

DISCUSSION:

In almost all units, the only communications link between Maintenance Control and unit Command/Post Operations Center is a telephone, either manual dial or automatic switch (direct line).

This system is vulnerable to sabotage, equipment failure and EMP (Electromagnetic Pulse) damage.

Most units have no backup system. Although intrabase radios are used from time to time, none are specifically authorized for this purpose.

When units deploy, difficulties in setting up telephone circuits are often encountered.

RECOMMENDATIONS:

1. TA-660 should provide for an additional 10% of a unit's authorized intrabase radio equipment for backup/contingency use.

2. TA-660 should authorize each flying unit at least 10 sets of field telephones for emergency use should all other wired systems fail.

STATEMENT OF NEED: Survivable communications link between unit and higher headquarters.

DISCUSSION:

For most units, all Command Control Communications are provided by the host communications squadron. Few units have any in-house backup capability. Most bases do not have a viable HF radio or satellite link capability should AUTOVON or AUTODIN be lost. Those few bases with capability generally do not have high-volume capability and generally cannot meet the requirements of all units on base. There should be redundant backup equipment, trained operators, and a secure environment to insure that Command Control Communications (C3) will not be severed.

RECOMMENDATION:

1. Each base Command Post/Unit Operations Center should be equipped with both HF radio and satellite tactical user equipment as a backup to the base communications center for voice and data C3.

2. The base/unit maintenance control center should be equipped with backup equipment identical to the above.

3. Base Central Security Control (CSC) should be equipped with backup equipment identical to the above.

STATEMENT OF NEED: Long range radio link for deployed units, mobile repair teams, recovery teams and convoys.

DISCUSSION:

Maintenance radio nets are designed to provide only intrabase communications. Usually the VHF/UHF base stations and mobile units are limited to a range of about 3 to 10 miles. However, bases frequently send recovery teams, convoys, and deployment teams outside the base perimeter without any communications link.

Control of the maintenance effort, safety and reliability would be greatly enhanced by equipping these mobile teams with long range wireless capability.

RECOMMENDATIONS:

1. Maintenance control centers be equipped with MILSATCOM-Ground Mobile Forces Satellite and HF voice radio terminals.

2. Each maintenance complex be equipped with at least one mobile satellite and HF radio terminal.

STATEMENT OF NEED: Secure voice telephone circuit between Maintenance Control and Command Post/Operations Center.

DISCUSSION:

No other base agencies have a greater need for quickly passing sensitive and classified information than maintenance and operations. Presently, that is not possible except through time-consuming runners. Often, time does not permit use of runners and sensitive information is therefore compromised through telephone "talk around."

Maintenance and operations need a secure voice circuit to coordinate weapons loading, aircraft launch and recovery timing, configuration, classified cargo movement, combat damage assessment and other sensitive matters.

RECOMMENDATIONS:

1. A secure telephone circuit be installed between each Maintenance Control and the appropriate Command Post/Operations Center.

2. For mobile activities, TRI-TAC equipment capable of wire or wireless operation be provided.

3. For large units, an encrypted data circuit also be provided.

STATEMENT OF NEED: Radio and Telephone compatible with M-17A gas mask and follow-on CWDE.

DISCUSSION:

Present radio and telephone equipment cannot be effectively used by personnel wearing chemical warfare defense gas masks. Our basic communication system is therefore dangerously degraded.

RECOMMENDATIONS:

1. A study be initiated to resolve this equipment limitation.

2. In the interim, commands should explore ways to overcome this serious limitation, such as:

a. Pre-recorded voice tapes for use in transmitting instructions.

b. Non-verbal backup systems, such as signalling lights, horns, sirens, flags or flares.

c. Portable chalk boards.

d. Digital data systems (Portable, radio-linked computer terminals, such as packet transmission systems).

STATEMENT OF NEED: Portable radios capable of being tuned to any USAF Maintenance Net frequency.

DISCUSSION

1. Maintenance units frequently deploy to other bases and require a portable communications system. Radio frequencies are generally not compatible among different bases. Rechannelization of radios is a costly and lengthy process involving procurement from commercial vendors and awarding of installation contracts. These delays and equipment limits would be unacceptable in wartime as they would seriously impair mission accomplishment.

2. Maintenance units may deploy either as an entity (taking with them a full set of mobility equipment) or small repair teams may be detached.

a. In the first case, the entire maintenance radio net should be capable of being deployed and retuned either to an authorized open frequency or to the maintenance frequency of the host unit.

b. In the second case, small repair teams should be able to tune their equipement to the frequency of any nearby maintenance control.

3. Maintenance nets are presently categorized as Non-Tactical Intrabase Nets. This policy warrants review in light of the mobile nature of maintenance teams especially those Tactical Air, Rescue, and Special Operations units.

PRESENT LIMITATIONS

1. AUTHORIZATIONS: CONUS Maintenance frequency authorizations are generally in four government bands:

a. 132-138 MHz (VHF)
b. 148-153 MHz (VHF)
c. 162-173 MHz (VHF)
d. 336-420 MHz (UHF)

Available equipment is not generally interchangeable or tuneable between bands, although such technology now exists. USAF could direct a transfer of frequency assignments and equipment to align similar nets in each band. For example, Commanders Nets could be situated in the 450MHz band, all Security Police in the 162MHz band, and all Maintenance in the 148MHZ band.

From this base, future procurement of tunable equipment would allow base-to-base mobility. In the interim, crystal changes would allow for some limited radio mobility.

2. Funds. Presently, no funds are programmed for a wholesale restructure of the non-tactical maintenance radio nets.

(Cont'd next page)

OPTIONS AVAILABLE

1. Fully synthesized, broad-band and multi-band commerical units
2. TRI-TAC MILSPEC equipment
3. New generation equipment

RECOMMENDATIONS

1. As an interim measure, all procurement of maintenance radios should be of the fully synthesized, broad-band, user-tunable type.

2. For the long term, Maintenance should be assigned standardized tactical radio equipment (TRI-TAC) and a POM initiative should be undertaken to fund for this conversion.

STATEMENT OF NEED: Telephone system that allows multiple call conferencing in Maintenance Control.

DISCUSSION:

Maintenance Control is the nerve center of the maintenance complex. Over 95% of the maintenance control centers in the Air Force are equipped with 1960's technology telephone equipment that does not provide the flexibility and efficiency now enjoyed by comparable control centers in private industry and other branches of government.

The result is equipment-induced organizational inefficiency.
A poorly coordinated maintenance effort results in wasted manhours, increased aircraft down-time and reduced mission reliability.

Modern call directors in Maintenance Control would permit rapid conferencing among controllers, shop supervisors and dispatched technicians. Further, Maintenance Control could initiate local and long distance conferencing for resolution of unusual repair procedures, as well as the proper sequencing of jobs to speed up the repair process.

RECOMMENDATION:

All Air Force Maintenance Controls will be equipped with a telephone system similar to the Bell Dimension (TM) system, with special conferencing, forwarding and auto-dial features.

STATEMENT OF NEED: Electronic Mail Terminal for Maintenance

DISCUSSION:

Aircraft maintenance organizations transmit large volumes of data regarding aircraft status and performance, repair cycle data, engine status, fuel consumption, manhour utilization and over 60 other categories of information gathered through the Maintenance Cost System, Maintenance Data Collection and the Maintenance Management Information and Control System.

Presently, when higher headquarters or logistics depots require real-time data (as opposed to end-of-period-reports), maintenance control and production analysis must extract the data and forward it in written form (message, letter, computer printout).

The flow of information and its proper use would be greatly enhanced if the system were designed to allow direct callup of data (without involving unit personnel) or if maintenance anaylsis could directly transmit their graphs, analysis charts and annotated listings by facimile.

In addition, maintenance technicians dealing with unusual malfunctions should be able to sketch mechanical drawings of their problems and transmit these directly to air logistics centers, supporting engineers or maintenance managers at higher headquarters. By so doing, aircraft grounded for major repairs would be returned to service many days sooner.

Finally, electronic mail terminals would eleminate the need for about 30% of the lengthy AUTOVON calls made by maintenance organizations for relaying detailed technical data and status reports.

RECOMMENDATIONS:

1. Each base have at least one facsimile terminal located for convenient use by the maintenance complex.

a. Facsimile terminals should be reggedized and capable of digital eneryption.

b. Typical equipment would include AN/UXC-4.

2. Each MMICS/CAMS terminal be capable of sending data messages directly to any other such terminal anywhere in the MAJCOM.

3. Maintenance organizations with mobility missions be equipped with ruggedized, encrypted portable terminals similar to PD-6500 with RS422 (Interstate electronics model conforming to MIL-E-5400R, MIL-E-16400G, MIL-S-901C) and MIL-TERM-280.

"Communications dominate war. Broadly considered, communications is the most important single element in strategy, political or military."

-Alfred Mahan

"I wonder if Custer needs anything over there at the Little Big Horn"

-General Terry

"If only Terry were here with his Gatling Guns!"

-Custer

We gratefully acknowledge the following individuals for their contibution of time, talents and technical expertise to this report. These individuals, of course, may not individually agree with recommendations of this study and their assistance to us does not imply indorsement of our conclusions:

Ray Bednarsky, Lt Col, USMC (Office of CNO)
Command essential systems; MARS network design; deployable systems; digital links.

Alan Blomgren, Major, USAFR (934TAG)
Emergency backup systems. Communications systems vulnerability.

John Canaris (DAFC, Sacramento ALC) Military Affiliate Radio System. Contingency net concepts.

John Colombo, Major, USAFR (927TAG)
Maintenance Control design and deployment limitations.

John T. Gleason, Colonel, USAF (JCS-J4)
Deployment Concepts. Strategic Mobility.

William E. Kratch, DAFC (403RWRW)
Portable and Emergency Systems; Satellite links; System architecture; network analysis; equipment configuration.

George E. Levya, Major, USAF (HQ USAF/REXRL)
Cost projections, POM initiatives process. SEA communications repair process.

David H. Minton, Lt Cmdr, USN(Ret)
Emergency systems design. Lessons learned from the Agadir earthquake disaster. Air Force crash recovery communications difficulties. Data links.

Dennis I. O'Quinn, Lt Col, USA
Communication Security; Southeast Asia joint service projects; advanced technology; cost projections; long haul circuits.

Also, special thanks to Kim Harbison for typing and Doris Hampton for proofreading. Their patience is truly appreciated.

SOURCE BIBLIOGRAPHY

AGNEW, Carson E., Cost Effectiveness Anyalysis of the Naval Modular Automated Communications System, Mathematics, Inc., Princeton, NJ, 1978.

Air Force Systems Command, Joint Tactical Information Distribution System (Booklet-undated).

BALDWIN, Edward R. (Colonel, USA), "SINCGARS - The Army's Frequency Hopping, Jam Resistant Combat Radio," Signal, November 1982, p. 21-25.

BEDROSIAN, Edward, A Passive Communications Satellite for Survivable Command and Control, The Rand Corp., Santa Monica, CA, 1981.

BORKLUND, C. W., "Military Communications. The What Is Much Tougher Than The 'How'," Government Executive, June 1976, p. 21-28.

BOYES, Jon L. (VAdm, USN-Ret), "Evolutionary Acquisition," Signal, March 1983, p. 9.

CAMPEN, Alan D. (Colonel, USAF-Ret), "Electronics - Just Another Element of Warfare," Signal, April 1981, p. 17-20

"Command, Control Capability Upgraded," Aviation Week & Space Technology, Feb 7, 1983, p. 71-73

Computer Sciences Corp., Tactical Automated Reporting Capability, CSC, Mooestown, NJ, 1972.

CUSHMAN, John H. (Lt Gen, USA-Ret), "Air-Land Battle Mastery and C2 Systems," Signal, March 1983, p.45-51.

DAVIS, Ruth M., "The Imperatives of Electronic Superiority, "Air Force Magazine, July 1979, p. 55-59.

DALEY, Robert F. and Nielson, Donald L., A Review of National Security - Emergency Preparedness Telecommunications Policy, SRI International, Arlington, VA, 1981.

DERFLER, Frank J. (Major, USAR), "Sea Breezes," Signal, May/June 1981, p. 139-140.

EINSAPHR, William E., "AFCC Looks Into Future of Telecommunications," Air Force Communications Command Press Release, Scott AFB, IL, 15 Feb 83.

FAURER, Lincoln D. (Lt Gen, USAF), "Signal Security - The Forgotten Element of Electronic Warfare," Signal, April 1983, p. 57.

FRANK, Robert E. (Colonel, USAF) and TOTSCH, James P. (Captain, USAF), "Logistics Information 'Management Support' System," Air Force Journal of Logistics, Fall 1982, p. 5-6.

FRISBEE, John R., "Electronics - The Great Equalizer," Air Force Magazine, July 1977, p. 6.

GARBER, Vitalij, "NATO C3: Key Element of Future Deterrence," Signal, December 1982, p. 23.

GRAVELY, Samuel L. (VAdm, USN-Ret), "Integrated Information Display System - A Decision Aid," Signal, March 1983, p.53-60.

GRAVELY, Samuel L. (VAdm, USN), "DCA's Route to Readiness, "Air Force Magazine, July 1979, p.84-92.

HERRES, Robert (Lt Gen, USAF), "C3 Priorities and Pressures," Signal, May 1983, p. 65-80.

KELLY, Clinton W. "Video Teleconferencing for Crisis Applications," Signal, July 1982, p. 27-36.

KLEIN, Melville H., "Computer Security," Signal, April 1983, p. 11-19.

KOHLER, Foy D., "War Survival In Soviet Strategy," Air Force Magazine, July 1976, p. 90-96.

KRAUSE, Hans-Peter (Lt Col, German Army) and ROSS, Dieter, "Tactical VHF Radio Communications in the German Army," Signal, November 1982, p. 27-32.

KYLE, Deborah M. and MEYER, Deborah G., "Has NATO C3I Gone Haywire?" Armed Forces Journal International, December 1982, p. 56-74.

LARSON, Doyle E. (MGen,USAF), "Exploiting Electronic Warfare," Air Force Magazine, July 1981, p. 75-81.

LARSON, Doyle E. (MGen, USAF), "C3CM: Lessons Learned - Where Do We Go From Here?," Signal, April 1983, p. 37-40.

LARSON, Doyle E. (MGen, USAF), "En Garde," Signal, April 1981, p. 9-11.

LATHAM, Donald C., "C3I Budget Initiatives for the 1990's," Signal, March 1983, p.13

LAWRENCE, D. B., "Soviet Radioelectronic Combat," Air Force Magazine, March 1982, P. 88-91.

LEUPPERT, Frederick W., Advanced Technology Direction and Control Communications Systems, MITRE Corp., McLean, VA, 1979.

LUDINSKY, C. J., "Basic Requirements for Base Support Communications," MITRE Corp., Bedford, MA, March 1983.

MARQUIS, Dennis C., "New Directions in NATO C3," Signal, December 1982, p. 39-42.

MARSH, Robert T. (General, USAF), "Electronic Trends and Challenges," Air Force Magazine, July 1981, p. 38-41.

MARTIN, Harry V., "Air-Land Battle 2000....," Military Electronics/Countermeasures, January 1983, p. 28-36.

MCCORMICK, Philip H. and COHEN, Andrew, "Securing Military Communications: an Old Problem/A New Threat," Signal, April 1983, p. 29-32.

MCDONALD, Thomas B., "RDJTF C4IS Support," Signal, November 1982, p. 35-42.

MEYER, Edward C. (General, USA), "Banquet Address," Signal, August 1981, p. 28-31.

MORGENSTERN, John C., "C2 Systems Acquisition: The Requirements Problem," Signal, May 1983, p. 117-122.

PEPPERS, Jerome G., "Maintenance in the Era 1990-2000," Maintenance Management Programs, Vol II, Air Force Institute of Technology, Wright Patterson AFB, OH, July 1971, p. 162-172.

REED, Thomas C., "Great Commentary: Military Information Systems," Signal, March 1983, p. 11.

POE, Bryce (General, USAF), "Logistics, Communications, and Readiness," Command Control and Communications Newsletter, (USAF Recurring Publication AFRP 100-1), Vol. 16, No. 4 15 October, p. 1-2.

RIENZI, Thomas M. (Lt Gen, USA-Ret), "The Transition in NATO Communications," Signal, September 1979, p. 31-35.

SLAY, Alton D. (Lt Gen, USAF), "An Air Force Avionics Policy," Air Force Magazine, July 1977, p. 30-39.

STALLINGS, William, "Local Network Overview," Signal, January 1983, p. 39-44.

THOMPSON, Butler, Thomas (British Royal Signals), "Falkland Islands War - A Signaler's Viewpoint," Signal, May 1983, p. 105-115.

TRAIN, Harry D. (Admira, USN), "NATO - The Status of C3," Signal, December 1982, p. 27.

WADE, James P., "The Challenge of Modernization in Electronic Warfare," Defense, March 1983, p. 17-20.

WAKS, Norman, "Inherent Conflicts in C2 Systems Acquisition," Signal, May 1983, p. 83-93.

WEATHERUP, G. R., HF Tactical Communication Circuits - Terminal and Link Performance, Rome Air Development Center, Griffis AFB, NY, 1975.

"Why C3I is the Pentagon's Top Priority," Goverment Executive, p. 14-20.

WOOD, A. R. (Captain, Royal Navy), "War in the South Atlantic - The Naval Communications Challenge," Signal, December 1982, p. 84-86.

ULSAMER, Edgar, "C3: Modern Warfare's Nervous System," Air Force Magazine, July 1981, p. 53-81.

ULSAMER, Edgar, "C3 - Technological Edge for the 80's," Air Force Magazine, July 1982, p. 54-58.

ULSAMER, Edgar, "Machine Intelligence Shapes Global C3 Nets," Air Force Magazine, July 1977, p. 66-72.

ULSAMER, Edgar, "The Growing, Changing Role of C3I," Air Force Magazine, July 1979, p. 36-48.

ZIERNICKI, Robert S. (Colonel, USAF-Ret), "Avionics: The Road Ahead," Air Force Magazine, July 1979, p. 67-75.

The following items of equipment are illustrated for the purpose of demonstrating the range of technology presently available to meet the needs identified by this study.

No product indorsement is intended nor implied. Actual suitability of products vendors and manufactures is not known.

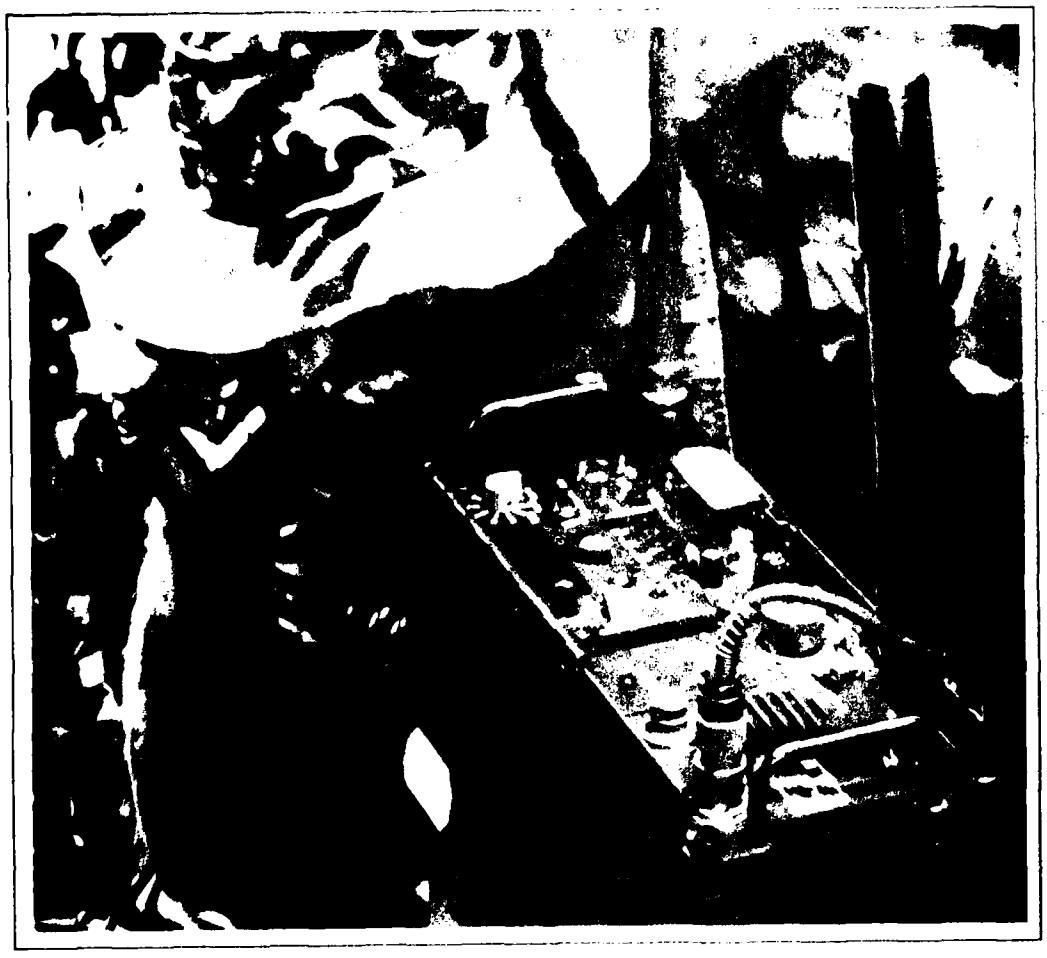
NOTE: Many manufactures make similar products. No attempt has been made to select the most suitable product out of a competing group. The following illustrations were selected primarily on the basis of availability of photographs and descriptions not covered by copyright. They should be used to survey the general features of typical equipment.

NO INFLUENCE OF SOURCE SELECTION IS INTENDED.

"Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur."

-Air Marshall Guilio Douhet, 1928

VHF and UHF ... Satellite link



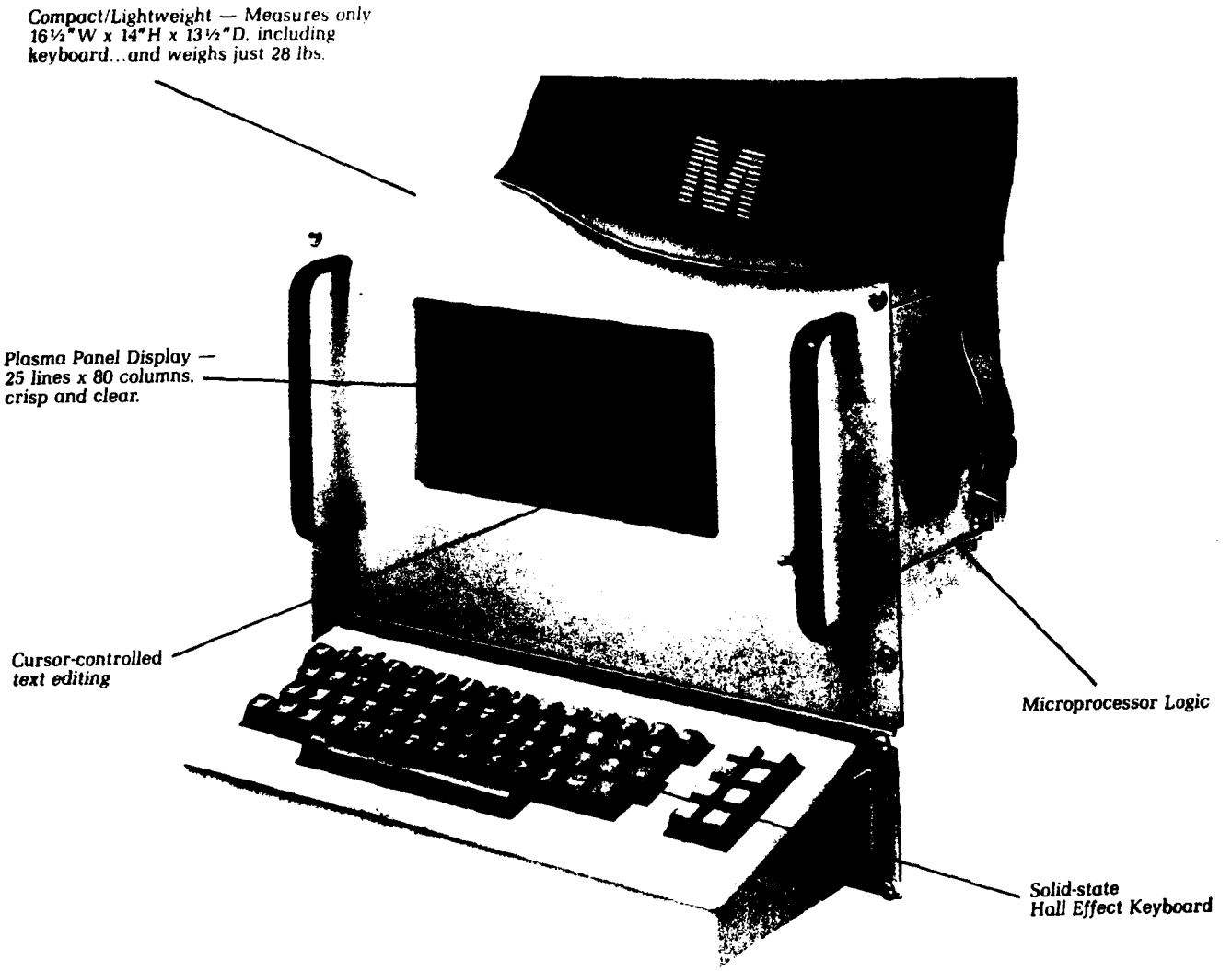
Featuring signal compatibility with existing AN/VRC-12's and AN/PRC-77's.

With 9320 frequency synthesized channels in 25 kHz steps across two bands . . . 30-88 MHz and 225-400 MHz. Any combination of eight presets are automatically scanned and switched into immediate action.

Plus . . . Satellite communications . . . secure voice compatibility . . . and [illegible] modes.

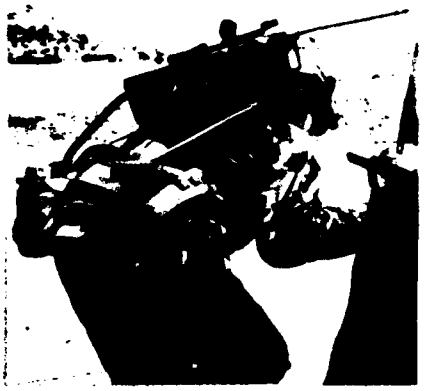
Illustrated: Motorola AN/VRC-[illegible]

MILSPEC Computer Terminals



Illustrated: MILTOPE Corporation MIL-TERM-280

Satellite and Line-of-Sight VHF/UHF

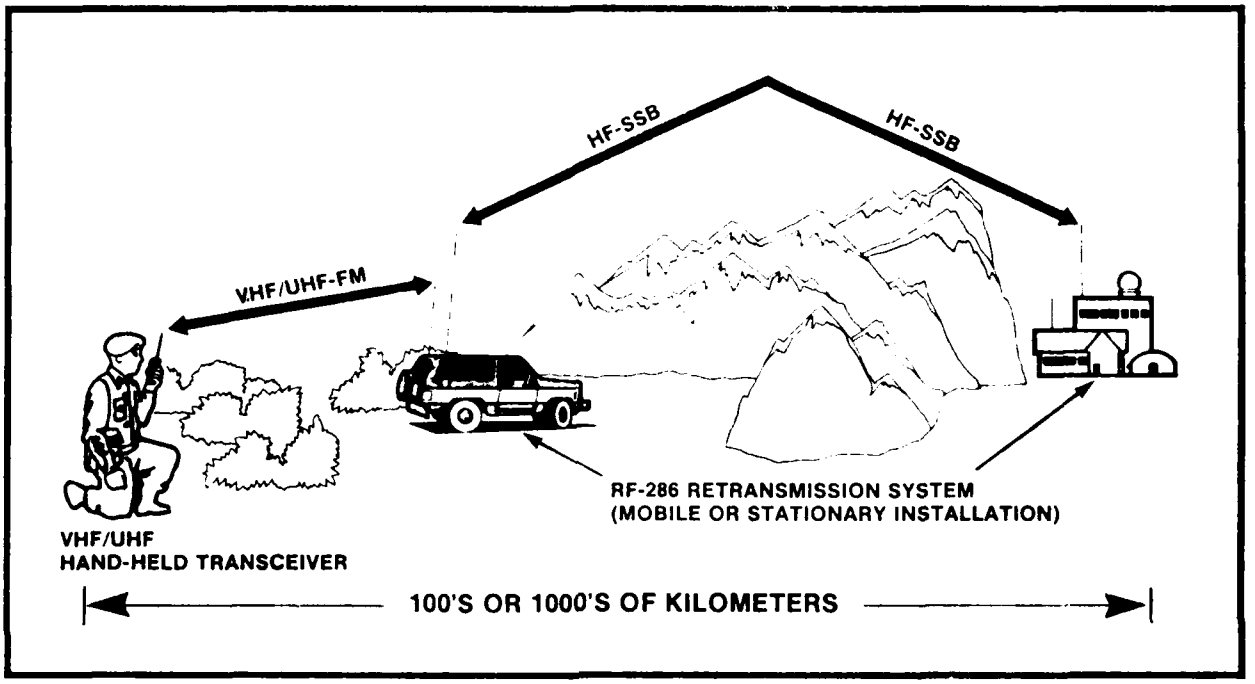


Illustrated: Motorola AN/URC-100 and AN/URC-101

HF Equipment can be lightweight and portable

Illustration: Cubic Communication "Ambassador"

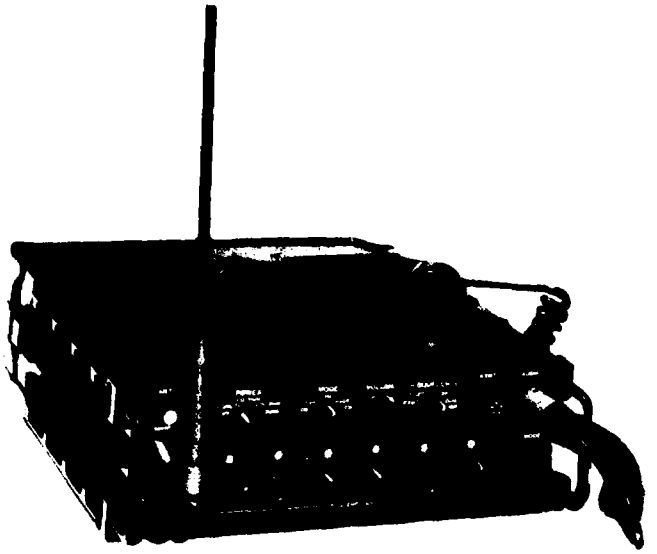
TALK UP TO HALF WAY AROUND THE WORLD WITH A HAND-HELD RADIO



RF-286-CU
CONTROL
UNIT

HF Equipment can be rugged and lightweight... and combined with VHF capability

Voice or Data



SYSTEM

Frequency Range	2.0000 to 75.9999 MHz
Channel Spacing	100 Hz
Modes	USB, AM, CW, FSK - 2 to 76 MHz FM - 30 to 76 MHz
Frequency Control	Digital Synthesizer, referenced to TCXO
Frequency Drift	5 parts in 10^7 for all service conditions
Temperature	-46°C to +71°C
Weight (less battery)	20.5 lbs. max.

Size	Height	Depth	Width
Inches	4	12	13
Centimeters	10	30	33

Vibration	2G, hard mounted
Reliability (MTBF)	1800 hours
Maintainability (MTTR)	15 minutes

Illustrated: Cincinnati Electronics AN/PRC-70

Portable VHF

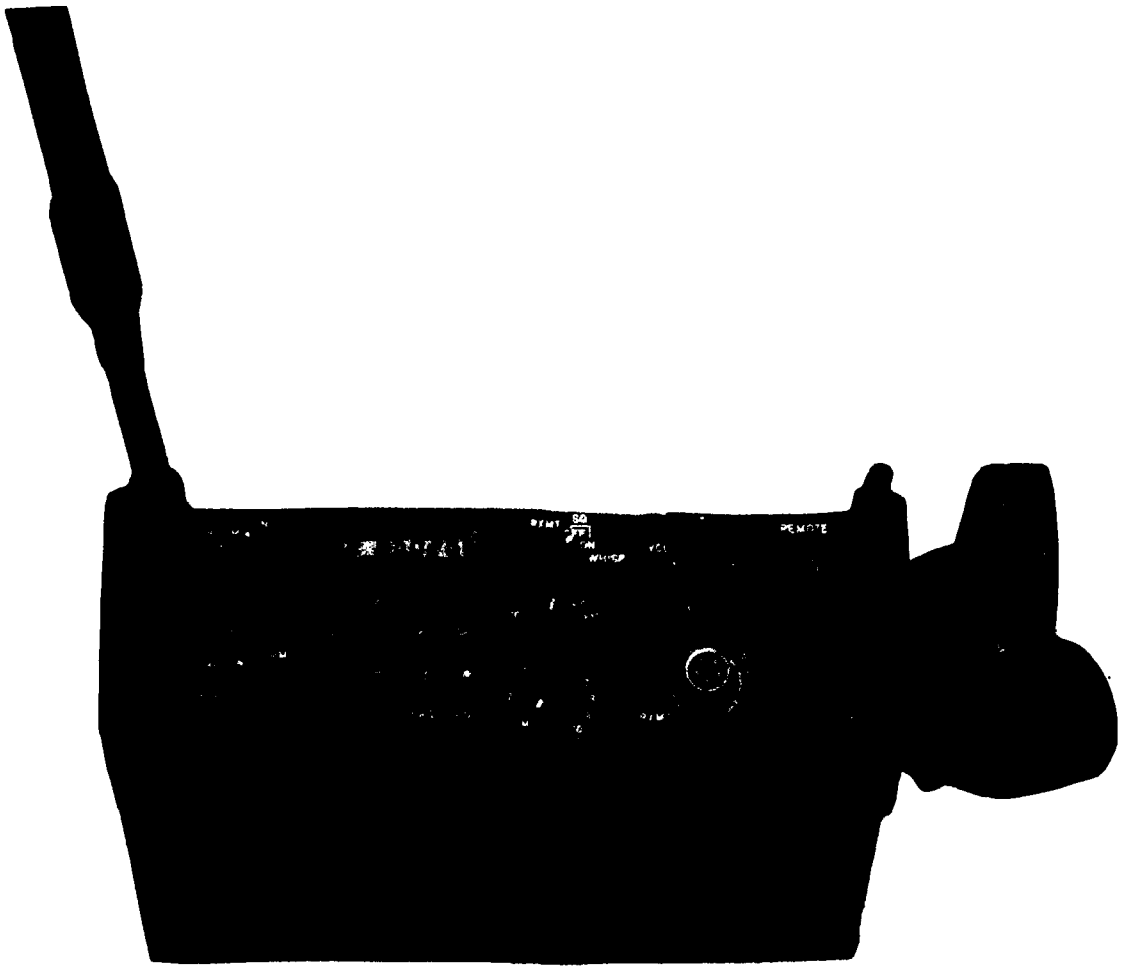
Frequency Hopping. Transmission frequency changes hundreds of times per second on a preprogrammed, pseudo-random pattern. Jamming, detection, direction-finding and monitoring are virtually impossible.

Self-Test Capability. Built-in self-test features make full performance testing fast and simple, even in the field. This is the only set available with an LED readout that identifies the individual module responsible for a fault.

Secure Voice Compatibility. The unit is fully compatible with TSEC/KY-57 (VINSON) Communications Security Equipment in either ECCM frequency-hopping or fixed-frequency operations.

Easy to Operate—Two control operation makes it easy to use, and it features unique half-duplex mode for extended area coverage. It is fully compatible with all fixed-frequency VHF tactical radio systems in use today.

Illustrated: Harris AN/PRC-117



Manufacturer Claims:
2320 Channels 30-[illegible]MHz
4 watts or 5[illegible] watts
COMSEC Capable
Digital data [illegible]

Note: [illegible]

Illustrated: [illegible]

A portable MMICS teminal would benefit maintenance

Data Interface:
Transmission rate: 1200 baud 300 baud
Information rate: 720 180
Modulation: Baseband

Connectors:
Audio: 7 pin to radio
Ancillary: 7 pin to printer asynchronous data interface

Power Requirements:
11-32 Volts DC

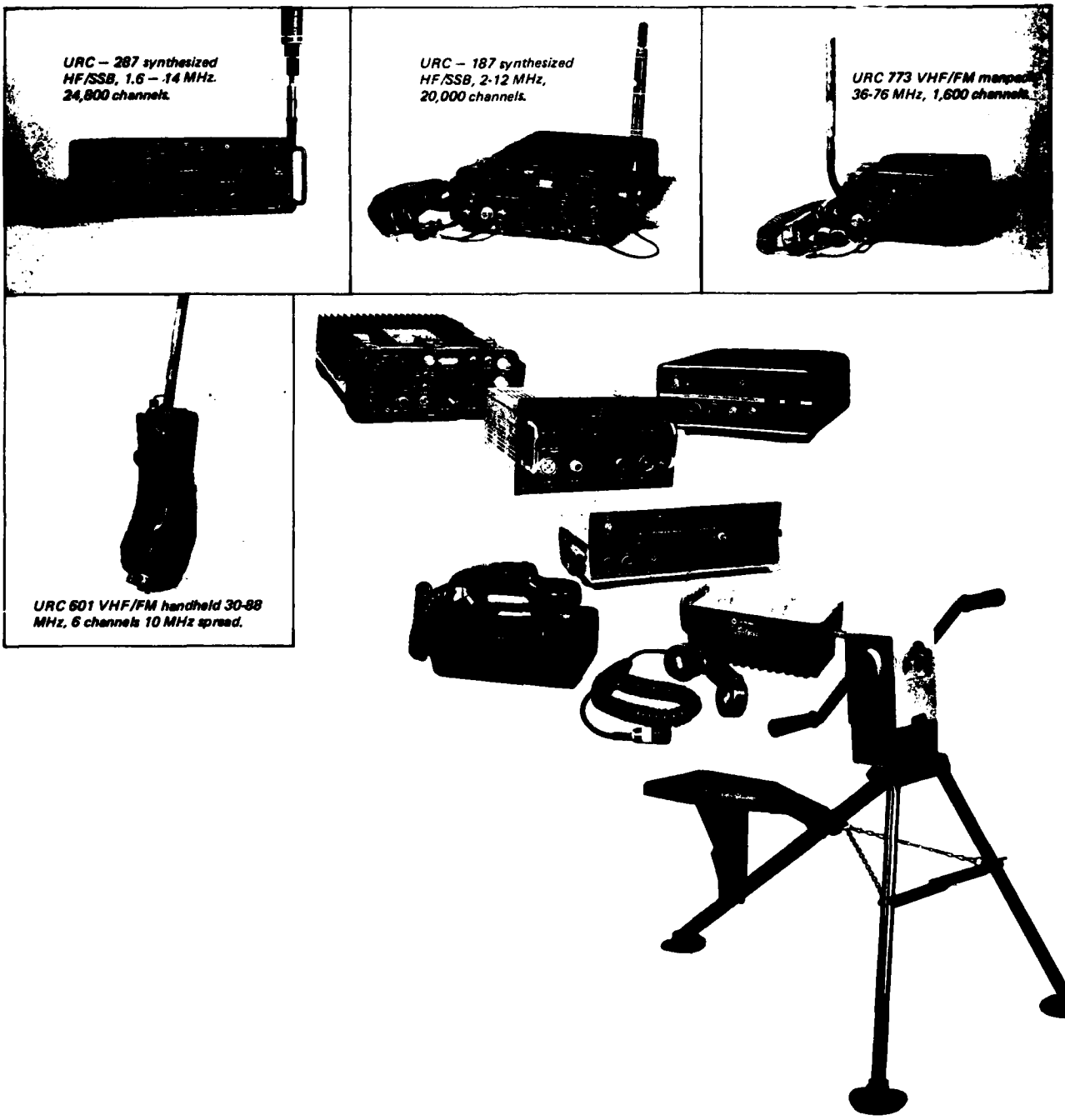
Temperature Range:
Operating: $-20^{o}C$ to $+55^{o}C$
Storage: $-40^{o}C$ to $70^{o}C$

Mechanical:
Enclosure: Lightweight case, fully sealed
Dimensions:
Height: 2-1/2" (63 mm.)
Width: 9" (230 mm.)
Depth: 9" (230 mm.)
Weight: 6 lbs. (2.5 kg.)

Illustration: RACAL MA6248(KY-879/P)

-over-

Range of HF and VHF products

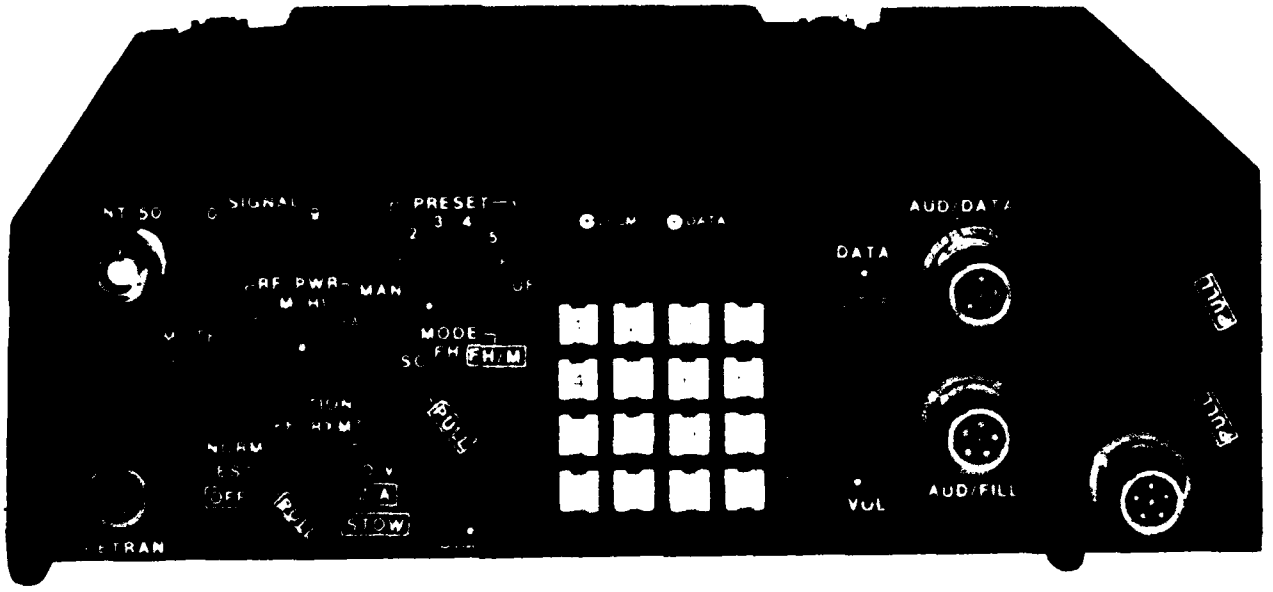


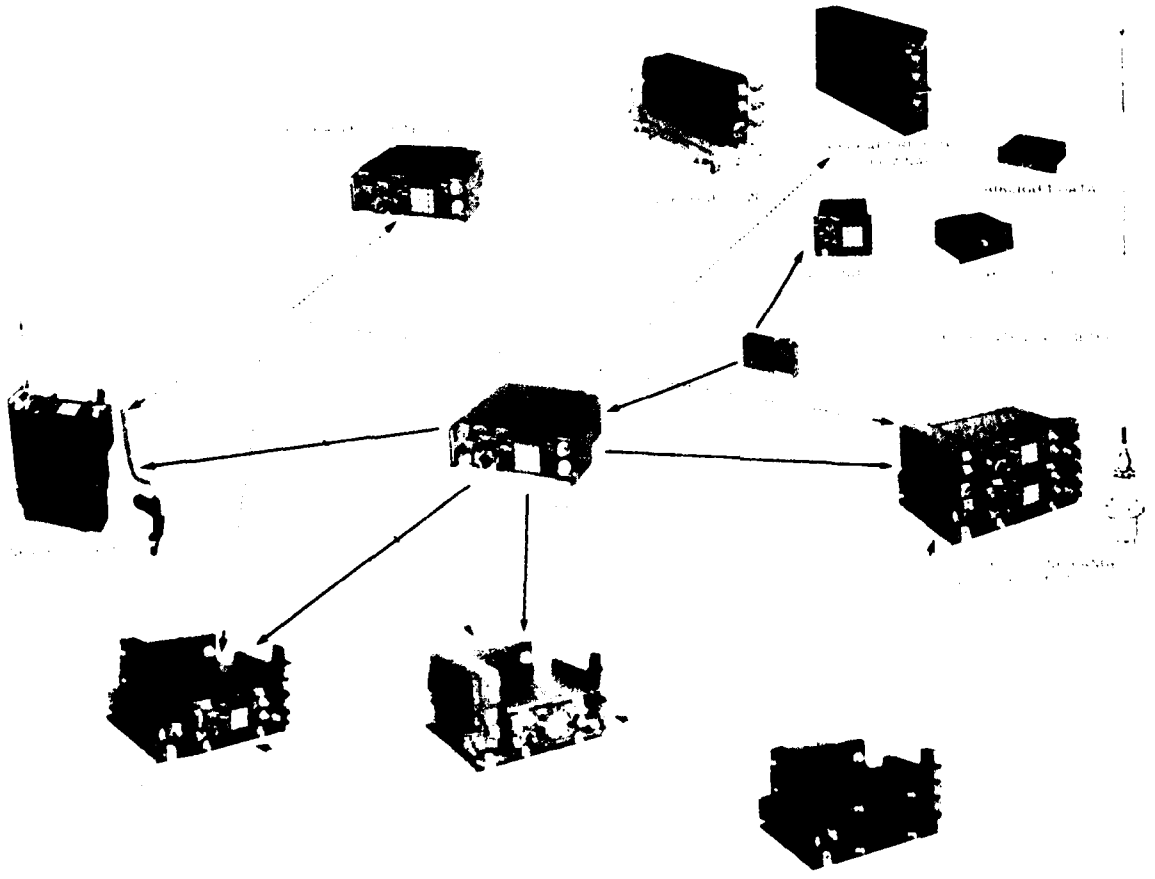
Illustrated: Veteran's Electronics Communications, Inc (Manila)

Note: Foreign Origin

Voice or Digital Tactical Radio

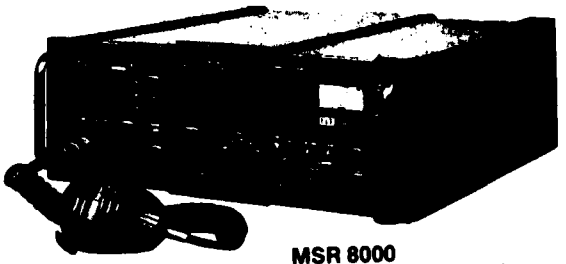
Frequency Range	30.00 to 87.975 MHz
Modulation Type	Frequency modulation (binary or analog)
Channels	2320





Illustrated

Voice/Data HF

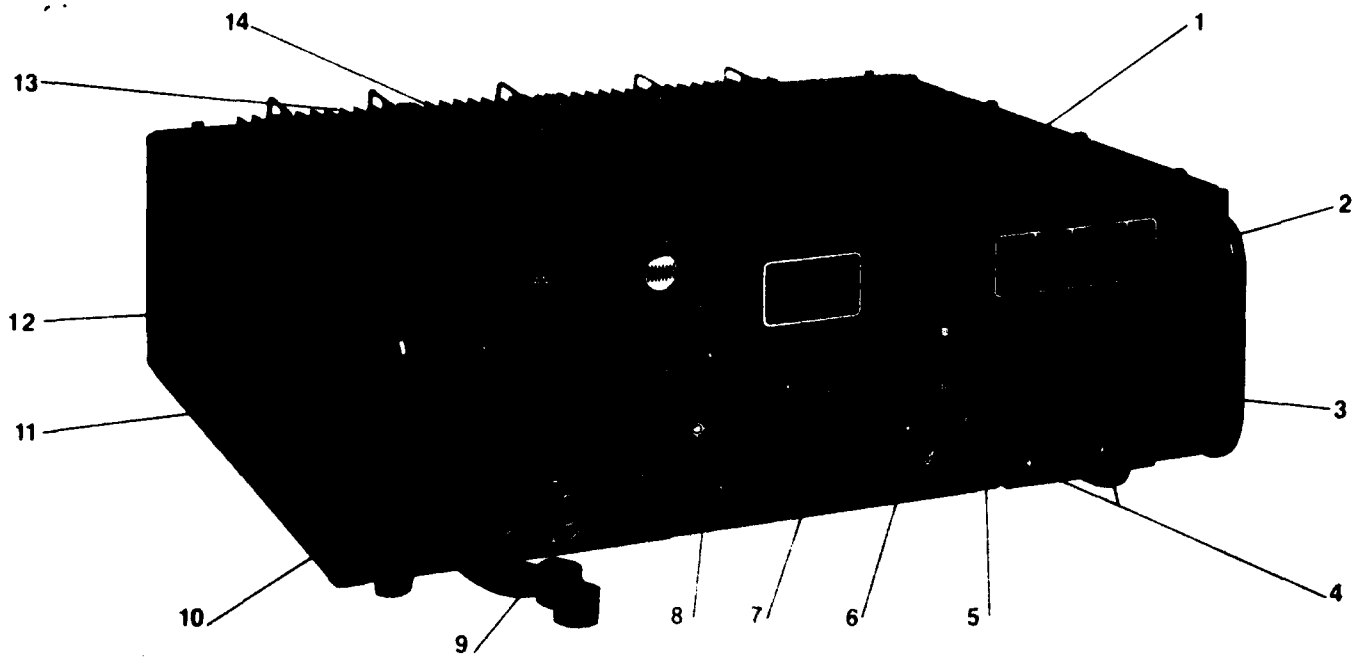


MSR 8000
125 watt synthesized,
vehicular transceiver.

General

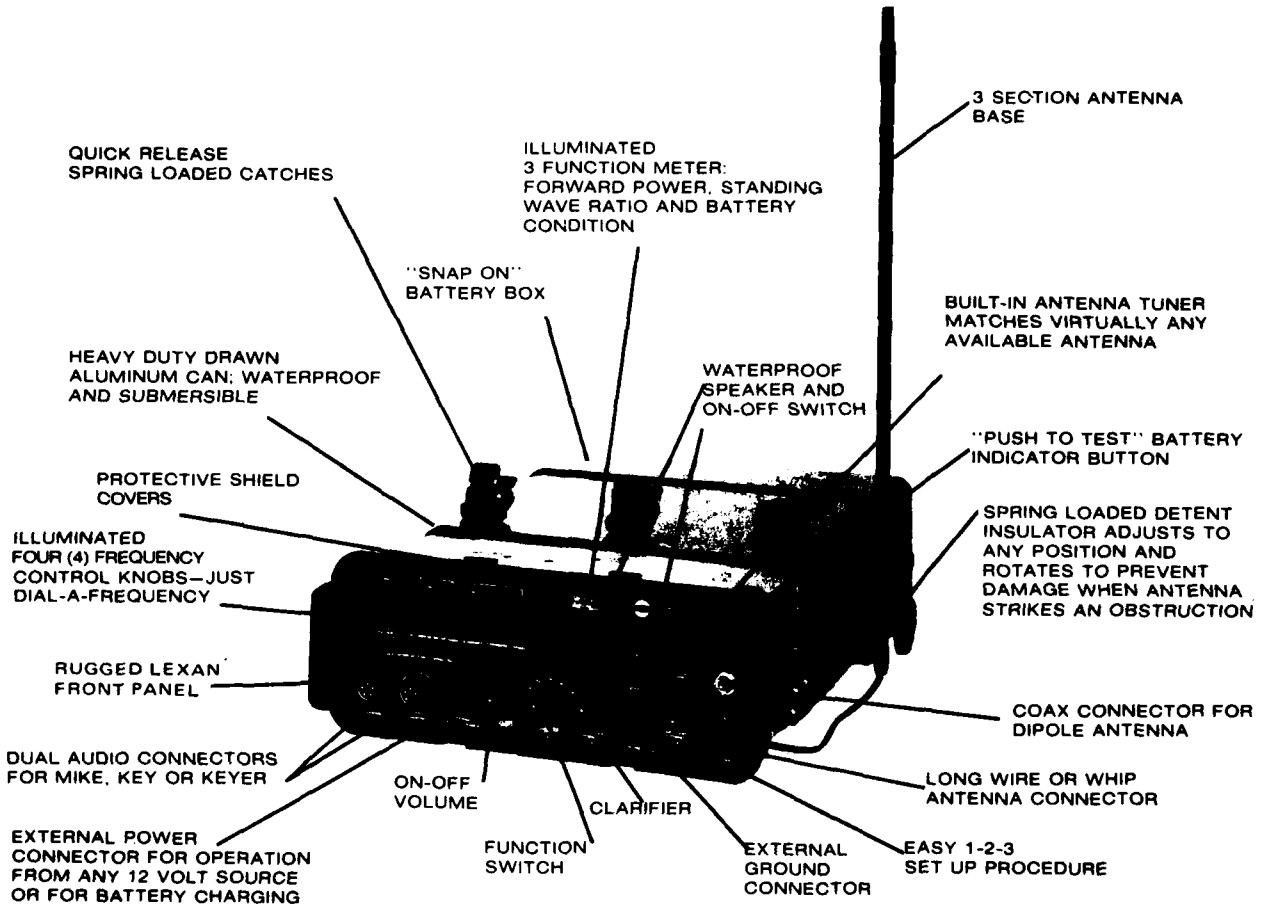
Frequency Range:	1.6 to 30 MHz (100 Hz increments)
Channel Storage:	10 (simplex or half duplex - field programmable)
Stability:	1×10^{-6}
Modes of Operation:	LSB, USB, AME, CW, FSK (with optional modem and blower)
Power Input:	12 or 24 VDC: External PS for 32 VDC or 115/230 VAC, 50/60 Hz
Temperature Range:	-30°C to +55°C (to +65°C at reduced performance)
Humidity:	95% at 50°C
Shock:	MIL STD 810C, method 516.2, Figure 2, Proc. 1 (with shock mounts)
Vibration:	MIL STD 810C, method 514.2, Figure 6, Curve V (with shock mounts)
Enclosure:	MIL STD 108E, Table II, splash proof
Size:	L-14" (35.5 cm); W-14.5" (36.8 cm); H-5.2" (13.2 cm); exclusive of controls, connectors and heatsink
Weight:	30 lbs. (13.6 kg)

Illustrated: ITT Mackay, MSR-8000

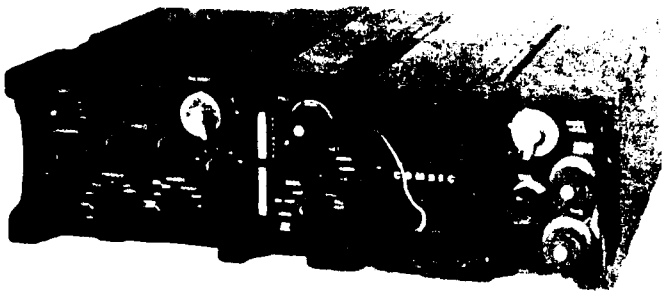


1) Lit meter monitors VSWR for antenna check. Also reads signal level, power out and DC input volts. 2) Gas discharge display readable in bright sunlight—instantly shows transmit and receive frequencies. Filter dims readout for safe night operation. 3) Keyboard frequency entry. Simplex and semi-duplex finger-tip control. 4) Up and down keys give 100 Hz steps. Last display digit tracks. 5) Tune and ready lights for antenna coupler status indication. 6) BFO for continuous razor sharp receiver tuning. On/Off indicator light. 7) Function switch USB/LSB/AME/CW/FSK—remote position transfers all functions including frequency selection to remote control accessory. 8) Dual concentric knobs control 600 ohm line output audio and speaker/handset volume. 9) Dual audio sockets for microphone, handset, CW key or keyer. 10) Moisture proof 3 watt speaker with splash proof cover. 11) Speaker On/Off for security. 12) Rugged Mil Spec case. Splashproof/Dustproof. 13) Oversize heatsink for extended duty cycle operation without overheating. Fully protected against DC overvoltage and antenna opens and shorts. 14) 100 Watts PEP and Average.

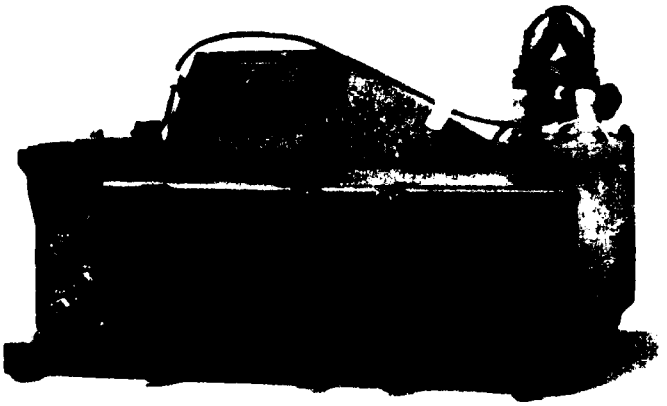
Backpack HF



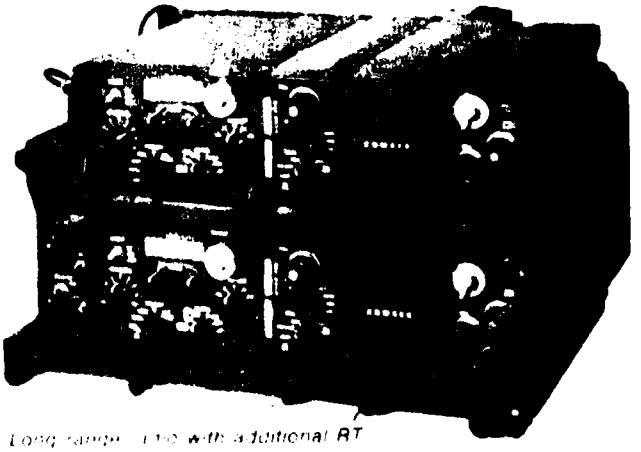
Illustrated: SOUTHCOM International SCD-130D "Patrolfone"



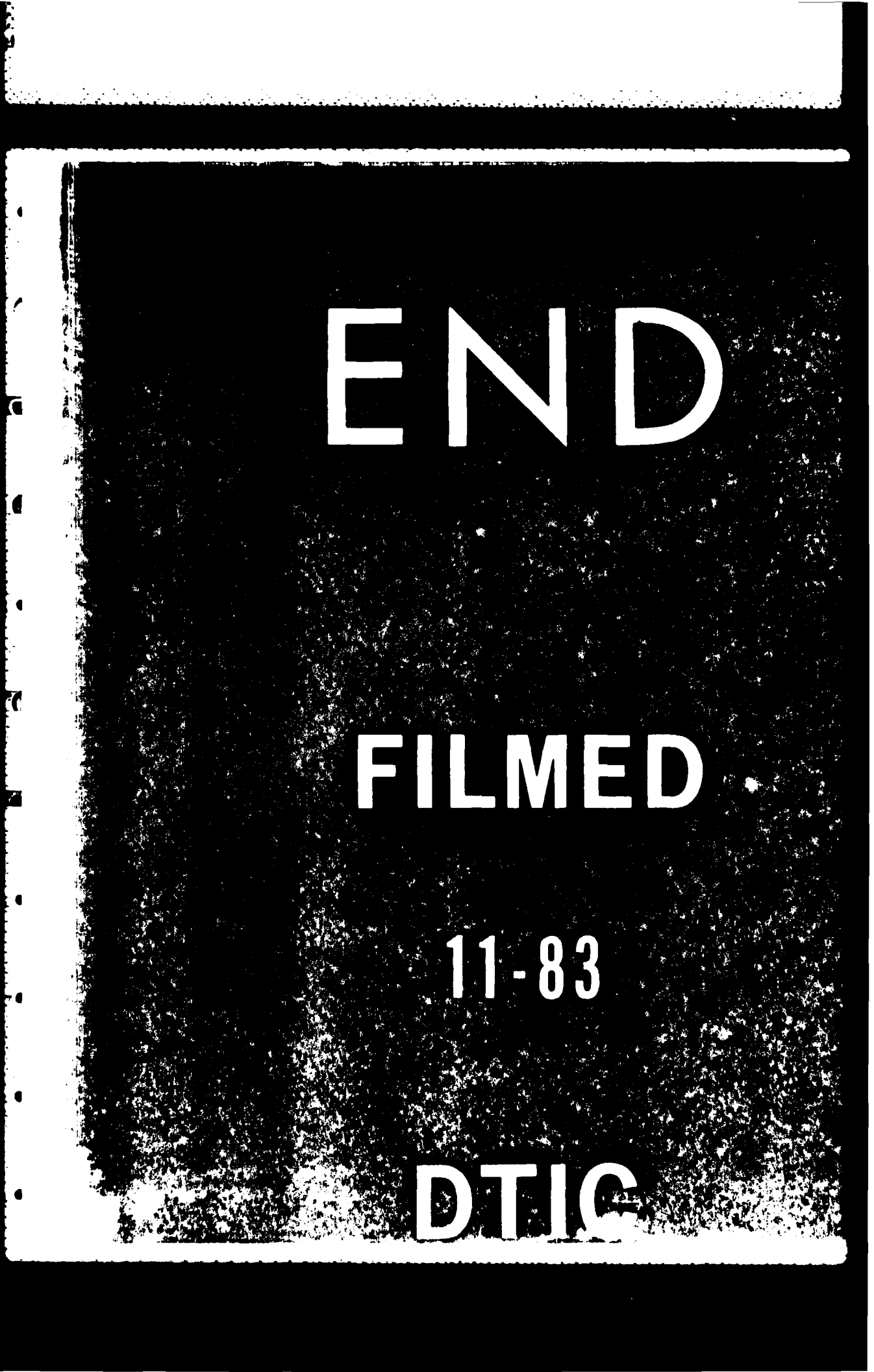
"Full-up" manpack radio



Applique



Long range [illegible] with additional RT


END
FILMED
11-83
DTIC