The improved high

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If you've wondered about just how complicated the improved high frequency radios are, read on. We're about to try to blow away the clouds of confusion with simple, clear-cut facts.

The Improved High Frequency Radio (IHFR) will provide a much improved medium to long range secure voice and data transmission capabilities to the commander in the field compared to the older HF radios.

IHFR will be deployed to support the mission requirements of units not having single channel Tactical Satellite (TACSAT) but which require a longer range of communications than the VHF/FM, VRC-12 and (SINCGARS) system can provide. The IHFR system will provide reliable communications over a wide range of propagation conditions, eliminate the need for special skill operators through a reduction in operational complexity and provide for secure voice or data in non-frequency hopping operations in a manner which does not degrade the communications capabilities of the radio set or its electromagnetic environment. Improvements realized by the IHFR will include reduced life cycle costs and maintenance requirements, increased equipment reliability, and, therefore, an expanded equipment availability on the battlefield. IHFR will interoperate with the current family of HF radios in selected modes and will be capable of supporting low capacity data systems currently envisioned in the Army with no increase in personnel, prime movers or power generation equipment. The IHFR will also provide for an inherent survivability to withstand the degradation associated with nuclear effects, jamming or friendly interference effects. Besides hardening of components, the Preplanned Product Improvements (P3I) developments will include frequency hopping, automatic link establishment, link quality analysis, discrete addressing, and a serial tone 2.4 kbs data modem/cryptographic device capable of frequency hopping operation. The ability to automatically select operational channels with IHFR/P3I greatly increases the possibility of communications during the period following nuclear blasts (nuclear blackout).

Figure 1 shows the functional battlefield areas where IHFR communication nets would be used.

Weighing less than 14 pounds, the AN/PRC-104 (See Figure 2) utilizes advanced technology, LSI circuitry in a highly reliable, space-saving, modular package. This has brought about dramatic improvements in operational simplicity, mobility, ruggedness and tactical flexibility over current-generation, battlefield tactical HF radio equipment. Moreover, the modular design makes possible further upgrades in performance with advances in the state-of-the-art.

As a basic manpack, AN/PRC-104 is comprised of three compact subsystems: the RT-1209/URC receiver/exciter, the AM-6874 amplifier/antenna coupler and a battery pack. These units latch together to form a lightweight, rugged manpack system, easily carried in a standard rucksack or packframe.

The AN/PRC-104 is designed to interface with existing MIL-Standard accessories. These include handsets (H-189, H-250), headsets (K-140/Y), telegraph keys (KY-562-U), audio intercom systems (AN/VIC-1 and AN/VIC-2), secure voice unit (KY-65), secure data unit (KW-7 and KG-84), remote unit (AN/GRA-39), as well as radio teletypewriters (TT-4 and UGC-74) with the AM-6879 audio amplifier converter.

Simple operation and tactical flexibility characterize the AN/PRC-104. Its fully automatic, digital tuning permits upper sideband (USB), lower sideband (LSB), continuous wave (CW) or data modes, plus optional amplitude modulation equipment (AME) operation on any of 280,000 channels from 2 to 29.999 MHz. The highly stable frequency synthesizer allows frequency selection to 100 Hz

Battlefield functional area	Corps and below	Division and below	Brigade and below	Battalion and below
Maneuver	X	X	X	X
Artillery	X	X	X	X
Engineer	X	X	X	
Air Defense Artillery	X	X	X	X
Intelligence/EW	X	X	X	X
Air-Ground	X	X	X	X
Signal	X	X	X	
Military Police	X			
Command and Control	X	X	X	X

Figure 1.

frequency radio and P3I

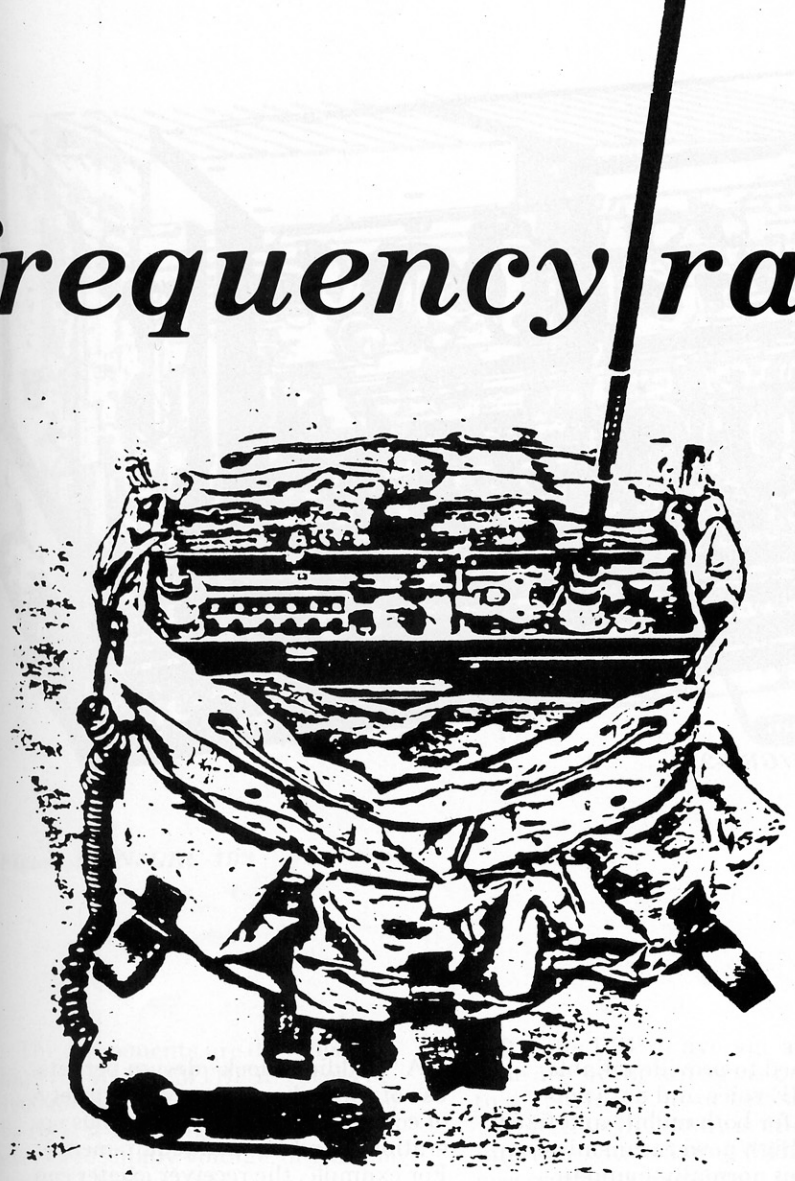

Figure 2. AN/PRC-104A

steps. This exceptional stability ensures calibration accuracy and obviates the need for fine-tuning (or clarifier) controls.

The fully automatic, digitally controlled antenna coupler allows efficient operation from a wide variety of tactical antennas including whips, slant wires, dipoles and high angle broadband near-vertical-incident-skywave designs (NVIS), such as the AS-2259. Typical tuning time is less than three seconds.

Effective operation under strenuous conditions is a hallmark of the AN/PRC-104. It has repeatedly exceeded its design failure rate of 2,500 hours mean-time-between-failure (MTBF).

The AN/GRC-123 (Figure 3) is the standard 20-watt lightweight, battlefield, vehicular radio portion of the Army's IHFR program.

Weighing slightly over thirty pounds, AN/GRC-213 integrates AN/PRC-104's proven, high-technology receiver/exciter and amplifier/antenna tuner into a highly efficient vehicle mount. The mount provides additional radio capability while preserving the manpack as a pull-out unit for extra-vehicular radio operations.

The same large scale integrated (LSI) circuits and modern design used in the AN/PRC-104 contribute to the increased reliability and tactical flexibility of AN/GRC-213 over earlier HF vehicular-base station radios. As a basic vehicular system, the compact 20-watt unit is made up of three subsystems: receiver/exciter, power amplifier/antenna coupler and vehicle mount unit. These snap together to form a rugged integral system that is easily installed in virtually any wheeled or tracked military vehicle.

The AM-7152 vehicle mount provides full input power protection, an audio amplifier for driving an LS-454 external speaker and an effective squelch tailored for HF operation. When interfaced to the standard AN/VIC-1 vehicle intercom system and VHF-FM radio, the vehicle mount also contains a feature which allows automatic retransmission of HF SSB signals to VHF-FM, or VHF-FM to HF SSB.

The vehicle adapter fits in the same footprint as the Army standard VHF-FM series of equipment: AN/VRC-12, AN/VRC-46, RT-524, etc. Power and audio intercom connections are fully compatible with this FM equipment.

The AN/GRC-213 is simple to operate. Controls can be changed even when the user wears gloves. The unit has pushbutton frequency selection of 280,000 channels from 2 to 29.9999 MHz in 100 Hz steps, selectable voice/data/cw modes on upper and lower sideband and fully automatic antenna tuning. The need for manual fine tuning following frequency selection is eliminated since the frequency synthesizer is locked to a temperature-compensated crystal oscillator that maintains frequency stability of one part in one million.

Operational antennas include the standard 16-foot vehicle whip resonant dipoles, certain longwires and the AS-2259 near-vertical-incidence-skywave designs (NVIS) antenna. Using LSI-controlled digital switching, the antenna tuner automatically matches the antenna.

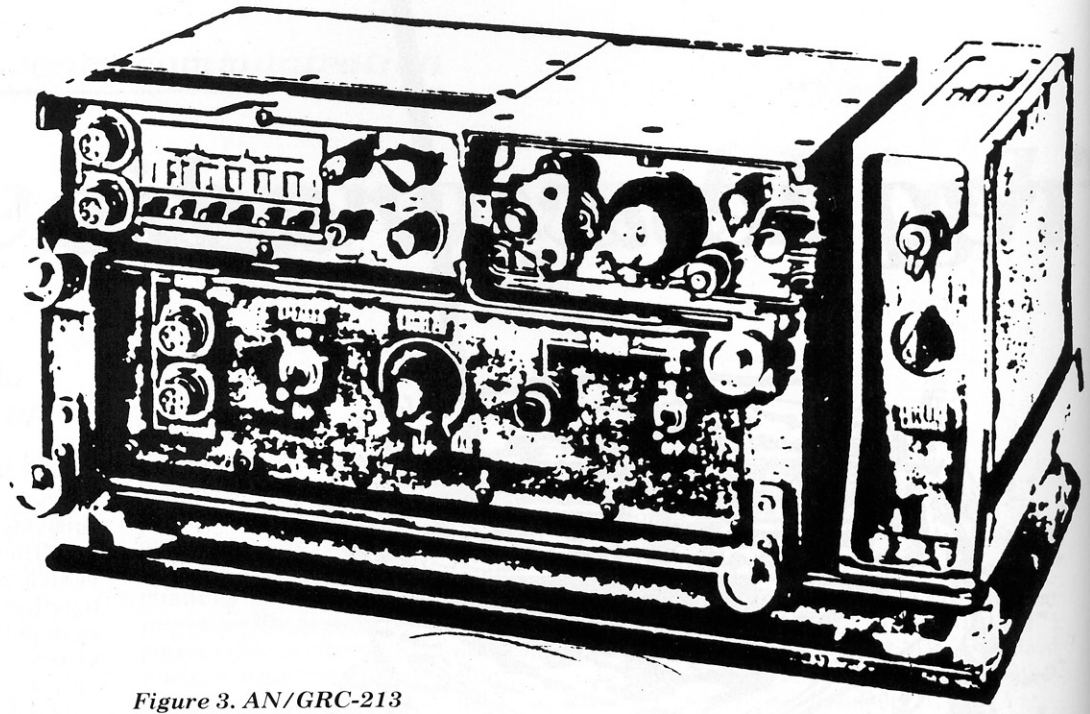

Figure 3. AN/GRC-213

If the VSWR is not 1.5:1 or better, an automatic retuning occurs in an average of three seconds. The radio has built-in protection against damage from high VSWR due to an open or shorted antenna connection as well as high-level receiver, front-end overload from nearby transmitters. The receiver will withstand a continuous input of 20 watts without damage. Automatic audio alarm signals warn the operator of low battery voltage, transmitter failure or an antenna tuning fault.

The vehicle radio system consists of just seven modules and three easily accessible circuit cards which are contained in three basic subsystems; the RT-1209 receiver/exciter, the AM-6874RF amplifier/coupler and the AM-7152 audio amplifier vehicle adapter. In the field, maintenance is accomplished in seconds by replacement of the subsystems which are linked together with quick-release clamps and cable connectors. For more complex maintenance levels, replacement of the radio modules and vehicle adapter cards is easily facilitated. The mean-time-to-repair is less than 30 minutes.

Because of extensive use of LSI, conservatively rated high quality components and proven military equipment packaging techniques, dependability in the field is assured. Under test the radio has repeatedly demonstrated more than a 1,600 hour MTBF.

Weighing in at slightly less than 150 pounds, the AN/GRC-193A (See Figure 4) is an extremely rugged, 100/400 watt HF radio set.

It is designed to provide reliable, long range HF voice and data communications for both mobile and fixed stations. Its high-power transmission capability, not normally found in mobile installations, provides reliable communications in the most demanding environments.

An important operational feature allows the radio set to be tuned by simply selecting a frequency and keying the unit. All other tuning functions, including antenna tuning, are performed automatically.

The AN/GRC-193A is designed and tested to withstand extremes of shock and vibration encountered in the most severe mobile applications. The entire radio is completely sealed and is immediately operational even after submersion under 3 feet (.9 meter) of water.

The radio will operate continuously in key down 400 watt FSK (teletypewriter) mode. It is fully protected against "open" or "shorted" antennas and conditions of extreme heat.

A "building block" design permits use of the radio set in a wide variety of configurations to meet various operational and tactical requirements. For example, the receiver exciter can be located up to 300 feet (91 m) from the power amplifier to provide convenient, full-frequency remote-control operation. The antenna coupler can be deployed up to 300 feet from the power amplifier for tactical security in field operations.

Modular design, employing visual status indicators, provides easy modular-level troubleshooting and repair for full field maintainability.

The main components of the AN/GRC-193A Radio Set are the RT-1209 receiver-exciter, AM-6545 power amplifier, CU-2064 antenna coupler, amplifier-converter AM-6879/URC for the RT-1209 and AN/GRC-193 rack assembly for vehicle mounting and interconnecting the individual components.

The system is also compatible with TTY (UGC-74) remote audio (GRA-39C) and secure voice equipment and the PP-7333 AC-DC power supply. Self-test and fault isolation indicators simplify maintenance.

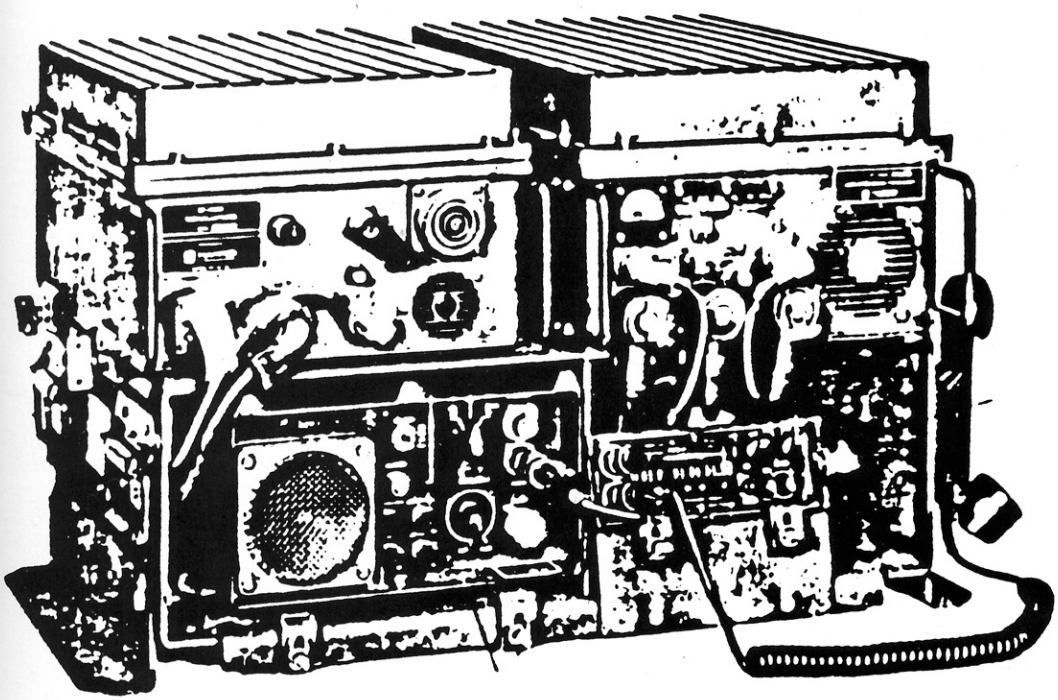

Figure 4. AN/GRC-193

The components are designed for high reliability (MTBF in excess of 1000 hours) and cannot be damaged by reversed polarity DC lines, excessive supply voltage, or extreme ambient temperatures.

The RT-1209/URC is a common unit also used in the AN/PRC-104 and AN/GRC-213. It provides USB or LSB voice, CW or data operation on any one of 280,000 channels spaced at 100 Hz intervals through the 2 to 30 MHz range.

The AM-6545 is a fully automatic, high efficiency, 2 to 30 MHz RF power amplifier with integral power supply, control circuits, and heat exchanger. This fully militarized and submersible power amplifying unit has a rated continuous duty power output of 400 watts PEP or average under worst case environmental conditions.

The CU-2064 antenna coupler is a fully-automatic, high-frequency, antenna matching unit. All matching elements and control circuitry are contained in a single unit. This coupler will tune 15 and 35 foot whip antennas, doublet antennas, and the AS-2259 antenna. The CU-2064 has a rated power handling capability of 400 watts PEP or average and will tune any of the antennas listed above to a VSWR of 1.4:1 or better.

The AN/GRC-193A is designed to interface with existing MIL-Standard accessories as mentioned above.

In the post-1988 time frame, future communications security (COMSEC) equipment will replace both earlier devices for voice and data COMSEC.

Pre-planned product improvements (P3I) are being investigated to increase the usefulness, provide jamming protection and maintain the state-of-the-art status of the IHFR radios. Considerable work has been accomplished and successfully tested to provide ECCM and EMP improvements for the IHFR radios. These improvements will be modularized and designed to enhance utility of the IHFR extending the life of the IHFR family of radios well into the 21st century and providing state-of-the-art capabilities throughout the IHFR life cycle.

Adaptive and Enhanced ECCM capabilities.

The adaptive and enhanced ECCM PIPs will expand the capabilities of the IHFR by providing the following microprocessor controlled adaptive functions:

- A system protocol (Net Control Unit). A user station/radio which incorporates a Net Control Unit becomes a NCS. The NCS system itself can perform the following types of operations: selective or group calling between the NCS and user station/radios for voice, data or message; selective calling between individual user station/radios with the user station/radio responding; calling from the user station/radio to the NCS, with the NCS responding; silent station contact, no response.
- Automatic Link Establishment (ALE). A user radio is entered into the net by receiving and responding to an ALE call from the NCS. Before net entry, the user radio will be continuously changing channels after a listening mode on each channel. Except when performing operational checks, or transmitting, the user radio is always in a listening mode, that is, it's checking for correlation on a selective call (SELCAL) and/or a net call (NETCAL) code and reading the receiver modem output. When the user radio correlation checking results in recognition of his SELCAL code, the radio exits the listening routine and goes to the transmit mode. If the user radio was assigned radio silent status, the response to an ALE call will be

Gen. John J. Pershing on leadership:
A competent leader can get efficient service from poor troops; while, on the contrary, an incapable leader can demoralize the best of troops.

the same except the transmit signal generated will not go on-the-air. ALE requires no operator action.

- Discrete Addressing. There are three types of calls from the NCS or from another user station that must be recognized and acted upon by the user station. Associated with these calls are messages that tell the user station whether the call is a request for voice communications, a request for data communications, or a two-digit message number display that has a prearranged meaning to the operator. The three types of calls are: SELCAL: this is a call to one user station only; NETCAL: this is a call to all user stations and GROUP CALL: this is a call to all user stations which have the same channel number assignment.
- Link Quality Analysis (LQA). LQA is initiated by the NCS by transmitting a coded message to the user station in question, up to four times. In between transmissions the user station transmits the same message back to the NCS. Both stations monitor the number of good receptions. The NCU then displays LQA-BEST, GOOD, AVERAGE, POOR or BAD. By performing LQA on several channels the operator can determine the best channel at the time.
- Enhanced Electronic Counter-Countermeasures (ECCM). The Enhanced ECCM capability in the IHFR systems will be incorporated by frequency-hopping.
- Serial Tone 2.4 kbs modem. This modem is being developed to operate, in spite of the degradation that might be encountered, over a typical tactical HF link. Send and receive data with a bit error rate low enough to permit acceptable communications with the particular terminal device being used. This modem will be frequency hopping compatible with data rates ranging from 75 bps to 2400 bps and contain automatic error correction.

The Army has a significant inventory of HF radio equipments, typified by the high power vehicular AN/GRC-106 and the lower power, manpack AN/PRC-74. All are manually tuned and require a skilled Signal MOS operator. Fielded during the late 1950's and early 1960's, these radios, because of early (old) technology and design practices characteristic of the time, are operationally complex, difficult to maintain, and increasingly unreliable. The AN/GRC-106 has long demonstrated an unacceptable MTBF rate. Support has become extremely difficult and costly because of the ever increasing demand for parts—which, because of the technology, are either not available or are costly to procure—and the high level of skill required of the repairers.

As a result of these deficiencies, HQ DA has directed to replace these radios with a new family of HF radios capable of meeting the Army's current requirements which can be product-improved to meet the Army's requirements for the future. This is the IHFR/P3I family of radios. The scheduled fielding for the IHFR sets is in early 1985. Some selected units in the Army have had the IHFR equipment since early 1983.

Ease of operation is a cornerstone of the IHFR/P3I program. The easy-to-access controls and automated tuning features are key in reducing radio downtime and lost communications due to poor training or unskilled personnel. Non-technical personnel regularly learn to successfully operate the radio equipment given minimal 10-20 minute instruction.

The high level of commonality between the IHFR equipment offers benefits in reduction of operator familiarization/training and maintenance training, as well as a reduction in overall Integrated Logistic System (ILS) costs.

As military operations continue to become more sophisticated, HF communications are becoming an even more integral part of military technology, and major efforts, such as the IHFR/P3I program, are being expanded to optimize its capacity and capability.

IHFR/P3I will provide the Army with an adaptive, highly reliable, secure and ECM resistant means of both short and long haul tactical HF communications in the post-84 time period. The P3Is will extend the life of the IHFR family of radios well into the 21st century.

Meeting the modern battlefield HF communications requirements will require the imaginative use of the entire HF spectrum to provide flexibility and to deter the enemies' efforts to disrupt vital communications links. The Army fully realizes the need for modern HF communications systems and has developed programs to meet this goal such as the IHFR/P3I discussed above, Nap-of-the-Earth (NOE) and REGENCY NET.

The Army can only be as effective as the command and control communications systems allow it to be.

SFC Epps is assigned to the Directorate of Combat Developments. He is the primary point of contact for HF communications systems requirements. He is a graduate of advance Signal and Armor NCOES courses.