PUBLIC SAFETY
PSWN PROGRAM
WIRELESS NETWORK

Saving Lives and Property Through Improved Interoperability

DC Fire Metro Incident Project
Test Plan, Results, and Recommendations

Final

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PREFACE

The District of Columbia Fire and Rescue Department (DCFD) is a large, urban fire department charged with providing fire suppression, rescue, and emergency medical services to our Nation's capital. In addition to providing service to the usual urban environment, the DCFD also provides services to the Washington Metropolitan Area Transit Authority (WMATA) subway system where radio coverage has historically been poor and difficult to enhance. During calendar year 2000, several fires and medical emergencies occurred in the subway tunnel system requiring large, multi-agency responses. During these incidents, several critical failures in radio communications occurred, worsening an already challenging situation. These incidents, and the associated communications breakdowns, attracted widespread media coverage throughout the region. Even though the District of Columbia was in the process of implementing a new, state-of-the-art communications system for DCFD, communications capabilities both within the department and with other responding agencies needed immediate attention.

DCFD contacted the PSWN Program to request assistance in resolving this critical problem. At the time, the PSWN Program was considering testing the Incident Commanders Radio Interface (ICRI) unit, a portable interoperability device developed by Communications-Applied Technologies. This device seemed to meet the needs of DCFD, namely a highly transportable unit that was easy to use, easy to set up, and that enhanced radio communications capabilities in the subway tunnels. Additionally, this device would also be capable of assisting in linking DCFD radios to other public safety agencies responding to subway incidents.

This report describes the equipment procured and the testing process accomplished to learn the capabilities and limitations of the ICRI unit. It also highlights lessons learned and recommendations for improved usage that resulted from the laboratory and field testing portions of this project.

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1. INTRODUCTION

This *Test Plan, Results, and Recommendations* Report describes the set up procedures and tests performed, prior to delivering the Communications-Applied Technology (C-AT) Incident Commander's Radio Interface (ICRI) units to the District of Columbia Fire and Emergency Medical Services (EMS) Department. The objectives of this report are: to document a review of the functional design characteristics for each ICRI unit in its integrated mode; to document test results, observations, and recommendations; and, to highlight lessons learned during the evaluation process. This evaluation was necessary to ensure each system would fulfill its operational mission requirements, as well as to measure performance parameters within a laboratory environment and in the field.

1.1 Background

The Washington, DC Fire Department (DCFD) asked the Public Safety Wireless Network (PSWN) Program to assist in providing an interoperability solution addressing the need for command and control communications with other public safety and law enforcement agencies during an underground Metro station fire incident. During Metro station fire incidents, several first responders from different agencies provide assistance to the DCFD responders. These agencies, however, rely on radio units that operate on frequency bands other than the DCFD's frequency band. To mitigate this problem, DCFD, through its current working relationship with the PSWN Program, opted to implement the ICRI Integrated System. The ICRI Integrated System is designed to accomplish the following—

- Provide a highly portable, crossband and cross-system capability for mutual aid operations
- Interconnect with four public safety portable radios and a cellular telephone or landline telephone
- Ensure reliable radio links exist for emergency response teams operating in the Metro rail tunnels.

1.2 Purpose and Scope of the Test Plan

This test plan was developed to define objectives, scenarios, data and equipment requirements, equipment configurations, and the data analysis to be performed on the test results. It establishes pretest, test, and post-test responsibilities, and identifies facility personnel and equipment support requirements.

1.3 Test Objectives

The key objectives of the ICRI testing effort were to provide a laboratory evaluation and field tests to assess performance in support of an overall evaluation of the ICRI units. The results of this analysis provide DCFD with a comprehensive evaluation of the ICRI units, their capabilities, and their limitations. The laboratory evaluation included the following tests and procedures:

- Ease of set up assessment
- Crossband/cross-system interconnect capability verification
- Extended distance radio interface capability verification
- Landline telephone connection capability verification
- Cellular telephone capability verification
- Receiver desensitization (desense) and audio quality test through signal plus noise plus distortion to noise plus distortion (SINAD) ratio measurement
- Intrinsic delay and timely passing of audio signal test.

The field tests and procedures included the following:

- Assessment of channel noise interference
- Radio frequency (RF) coverage measurement
- Validation of operational scenarios.

Note: Environmental and reliability/availability tests were not performed as part of this evaluation.

2. SYSTEM COMPONENTS

The ICRI unit integrates four portable radios into a public safety wireless interoperability solution tailored for DCFD Metro station incident response. In addition, the ICRI unit can patch-in a remote portable radio located above ground through the supplied 250-foot radio interface cable. The ICRI unit can also patch-in a landline telephone or a cellular telephone. Figure 1 highlights the planned configuration.

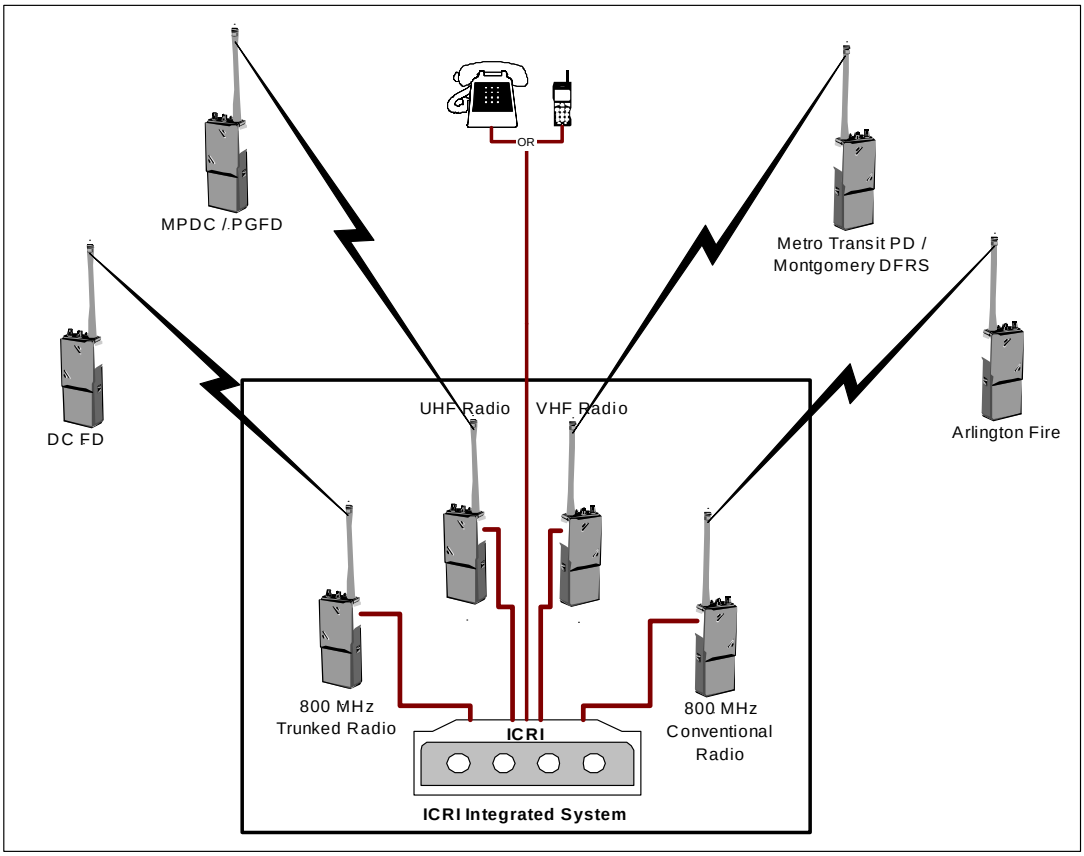


Figure 1
ICRI System Configuration

The PSWN Program provided DCFD with eight ICRI Integrated Systems. Each system was configured as shown in Figure 2. It should be noted that any portable radios used in conjunction with the ICRI Integrated System must be supplied by the participating agency. In addition, the PSWN Program provided no landline or cellular telephones as part of this solution. However, the operation and functionality of the telephone interconnect option was fully tested in accordance with the test procedures described in this document. Furthermore, the portable radios that comprise the integrated system are programmed in accordance with written authorization granted by the participating agencies.

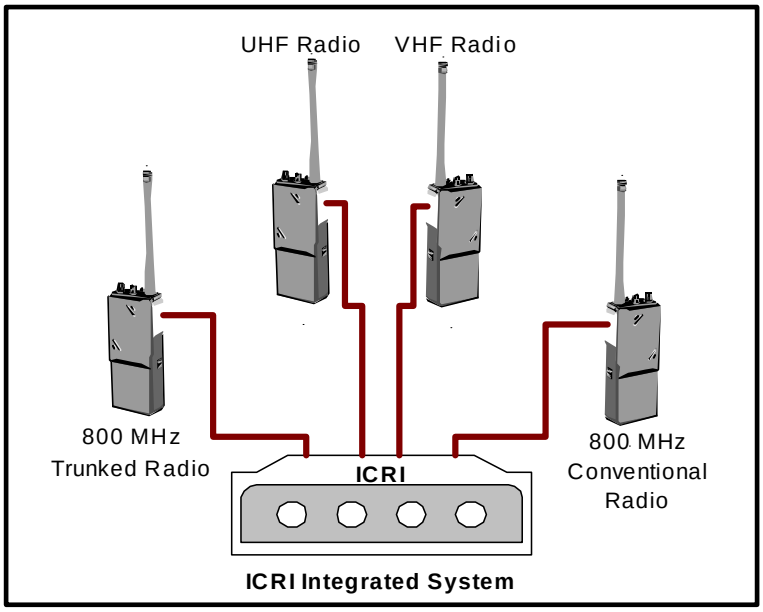


Figure 2
ICRI Integrated System

Each individual ICRI Integrated System is comprised of the following components:

- **ICRI Unit**. This unit has five radio interface ports (four standard ports, and one extended length [remote] radio interface port), one telephone interface port, , and a battery pack.
- **Radio Interface Cable.** Five cables are configured for connection to Motorola portable radios, either an HT-1000 or an XTS-3000.
- **Telephone Interface Cable.** One cable is supplied to interface with a cellular or landline telephone.
- **Extended Length Interface Radio Cable**. One 250-foot cable is supplied to interface to a trunked radio for communication with the aboveground trunked system.
- **Extended Battery Pack.** An additional battery pack is included for extended operation.
- **Hard Case.** A pelican-type case houses the ICRI, cables, and four portable radios.
- **Portable Radios.** Four Motorola portable radios are provided and configured as follows:
  - One HT-1000 Tier II portable radio, configured to operate in the Very High Frequency (VHF) 146–170 MHz band, with extra battery and individual battery charger
  - One HT-1000 Tier II portable radio, configured to operate in the Ultra High Frequency (UHF) 450–512 MHz band, with extra battery and individual battery charger
  - Two XTS-3000 Tier II portable radios (one operating in a trunked mode, and one in a conventional mode), configured to operate in the 800 MHz public safety band, with extra battery and individual battery charger.

3. TEST PLAN

This test plan describes each of the test procedures performed. Each set of procedures assumed that the person(s) performing the tests was familiar with the procedures and test equipment, as well as the operation of the supplied radios. In addition, each of the test procedures assumed the ICRI Integrated System was powered on and in its operational mode, as shown in Figure 2. It also assumed all radios were programmed as shown in Table 1 and had a fully charged battery.

Table 1
Below Grade Radio Frequency Assignments

Radio Type	Channel No.	Channel Name	RX Frequency Band (MHz)	TX Frequency Band (MHz)	Control
HT-1000 (UHF)	1	MPDC Citywide-1	460	460	PL
	2	PGFD Ch.4 (North)	490	490	PL
	3	PGFD Ch. 3 (South)	490	490	PL
HT-1000 (VHF)	1	Metro Transit PD (DCFD Old Ch 2)	150	150	PL
	2	Montgomery DFRS Channel 7	150	150	No PL
XTS-3000 (800) Radio #1	16	DCFD (talk around)	860	860	No PL
XTS-3000 (800) Radio #2	B3	DCFD	(Trunked channel)	(Trunked channel)	N/A

The above frequency list was identified by the DCFD for use during an emergency fire incident response to coordinate with respective cooperators. Authorization to use frequency channels, which were not assigned for use by the DCFD, was obtained from each of the respective agencies.

3.1 Test Approach

The PSWN Program conducted a two-tiered testing and evaluation of the ICRI Integrated System. The first tier consisted of laboratory hardware integration and bench testing; the second tier consisted of field verifications. This approach provided a subjective assessment of the ease of operation and ability to meet operational requirements, allowed the basic system performance to be tested, and enabled the determination of the essential operating parameters and limitations.

3.2 Hardware Integration and Bench Testing

As described in the system component section, several commercial off-the-shelf (COTS) devices are integrated to satisfy the interoperability requirement for this project. To ensure proper operation in accordance with project objectives, the following tests were conducted:

- Ease of set up assessment
- Crossband/cross-system interconnect capability verification
- Extended distance radio interface capability verification
- Landline telephone connection capability verification
- Cellular telephone capability verification
- Receiver desensitization (desense) and audio quality test through SINAD measurement
- Intrinsic delay and timely passing of audio signal test.

The following test equipment were used in order to perform the above mentioned tests:

- DC Power Supply (HP E3617A)
- Digital Mulitmeter (HP 34401A)
- Oscilloscope (HP 546465A)
- RF Communication Test Set (HP 8920A)

Detailed descriptions of each of these tests are provided below, however, the results from each test are described in Section 4, Results and Recommendations.

3.2.1 Ease of Setup Assessment

The goal of this test procedure was to address the ease of integration and assembly of the ICRI Integrated System. This test included initializing the system, assessing the configuration flexibility, and determining the likelihood of error. Because internal adjustments, such as audio level sensitivity or internal clocks, are undesirable, the effect of these features on system operation was also evaluated. These tests were accomplished to measure and quantify the degree of complexity and risk presented by the initialization process.

3.2.1.1 Test Description

Each ICRI Integrated System was connected as shown in Figure 2. The number and relative ease of the steps required to set up the individual unit quantified the complexity of the initialization process. Initialization reliability was measured by counting the successful versus unsuccessful system initialization occurrences.

3.2.1.2 Presentation of Results

The ease of setup and the initialization reliability were recorded and compared with vendor specifications.

3.2.2 Crossband/Cross-System Interconnect Capability Verification

The next step was to evaluate the ICRI Integrated system regarding its ability to support functional capabilities.

3.2.2.1 Test Description

Each of the agencies' radios depicted in Figure 1 (radios that are not part of the ICRI Integrated System) were checked by keying them up consecutively, pressing the push-to-talk (PTT) button, speaking into the radio, and repeating the words "Testing one, two, three, four, five." This procedure was repeated three times with a 30-second interval between tests.

3.2.2.2 Presentation of Results

Each frequency band and radio was recorded, along with the degree to which the ICRI Integrated System passed an audio signal to the other radios in the system. This was a subjective test and could have been influenced by individual radio performance. However, the ICRI unit was evaluated based on a pass/fail assessment of passing the audio signal across all attached radios and frequency bands.

3.2.3 Extended Distance Radio Interface Capability Verification

The ICRI units are equipped with an extended distance radio interface port to connect radios located 250 feet, or less, from the unit. This option is necessary to enable the ICRI Integrated System to communicate with subscriber units located above ground. This test was required to ensure the extended range did not affect the performance of the ICRI Integrated System or the patched audio signal quality.

3.2.3.1 Test Description

The XTS-3000 radio, in trunked mode, was disconnected from the ICRI unit, and the extended radio interface cable was used to connect the radio to the ICRI Integrated System. The test procedures described in Section 3.2.2.1 were executed to test this new configuration.

3.2.3.2 Presentation of Results

Each frequency band and radio was recorded, along with the degree to which the ICRI Integrated System passed the audio signal to all other radios in the system. This was a subjective test and could have been influenced by individual radio performance. However, the ICRI unit was evaluated based on a pass/fail assessment of passing the audio signal across all attached radios and frequency bands.

3.2.4 Landline Telephone Connection Capability Verification

The ICRI unit is equipped with a basic acoustic coupler telephone interface module to enable audio patching to a landline telephone. A test was required to verify this capability and to ensure proper operation as specified in the ICRI Integrated System technical documentation.

3.2.4.1 Test Description

The telephone interface cable (acoustic coupler) was used to connect the ICRI unit to a landline telephone, as described in the ICRI system manual. To run the test, a telephone call was established. After the call was established, the test procedures described in Section 3.2.2.1 were repeated.

3.2.4.2 Presentation of Results

Each frequency band and radio was recorded, along with the degree to which the ICRI Integrated System passed the audio signal to all other radios in the system and to the established telephone call. This was a subjective test and could have been influenced by individual radio performance and the quality of the landline telephone service. However, the ICRI unit was evaluated based on a pass/fail assessment of passing the audio signal across all attached radios and bands.

3.2.5 Cellular Telephone Connection Capability Verification

The ICRI unit is equipped with a basic acoustic coupler telephone interface module to enable audio patching to a cellular telephone. A test was required to verify this capability and to ensure proper operation as specified in the ICRI Integrated System technical documentation.

3.2.5.1 Test Description

The telephone interface cable (acoustic coupler) was used to connect the ICRI unit to a cellular telephone, as described in the ICRI system manual. To run the test, a cellular telephone call was established. After the call was established, the test procedures described in Section 3.2.2.1 were repeated.

3.2.5.2 Presentation of Results

Each frequency band and radio was recorded, along with the degree to which the ICRI Integrated System passed the audio signal to all other radios in the system and to the established cellular telephone call. This was a subjective test and could have been influenced by individual radio performance and the quality of the cellular telephone service. However, the ICRI unit was assessed based on how well it performed in passing the audio signal across all attached radios and frequency bands.

3.2.6 Receiver Desensitization (Desense) and Audio Quality Test Through SINAD Measurement

This test procedure measured the ICRI Integrated System's radio receiver desense in a laboratory environment. The receiver desense test is an industry standard test used to test whether the radios in the ICRI Integrated System interfered with each other. This test also measured the audio quality of the system through SINAD measurement.

3.2.6.1 Test Description

Figure 3 illustrates how the radio being tested was connected to a Hewlett Packard 8920A RF Communications Test System (HP8920A). One end of a directional coupler was connected to the antenna port on the radio unit under test, and the other end was connected to a 50-ohm termination port. The ICRI's "audio from radio," on port #5, and its isolated receiver port, were also connected to the HP8920A. The HP8920A was programmed to modulate a 1 kilohertz (kHz) tone signal on the operating frequency (see Table 1) of the radio under test. The HP8920A sent a modulated 1 kHz tone on the radio's tuned frequency through the portable radio antenna. The signal passed through the radio receiver, through the ICRI unit, through the "audio out" port on the ICRI unit, and finally into the HP8920A, which measured the received audio signal level. The HP8920A calculated a value by comparing the output signal (measured by noise plus distortion) against the input signal. This power ratio is the SINAD value. The signal generator output on the HP8920A was then adjusted until the SINAD meter indicated a reading of 12 decibels (dB). The output level of the signal generator was recorded in decibels above a milliwatt (dBm). The 50-ohm termination point was removed, and the radio antenna was connected to the directional coupler port. The signal generator was adjusted again until the SINAD meter displayed the same 12 dB SINAD reference point. The output level of the signal generator was recorded in dBm. The difference between the two recorded signal generator levels indicated the desense level. These test procedures were repeated for each type of radio and all its associated frequencies, as shown in Table 1.

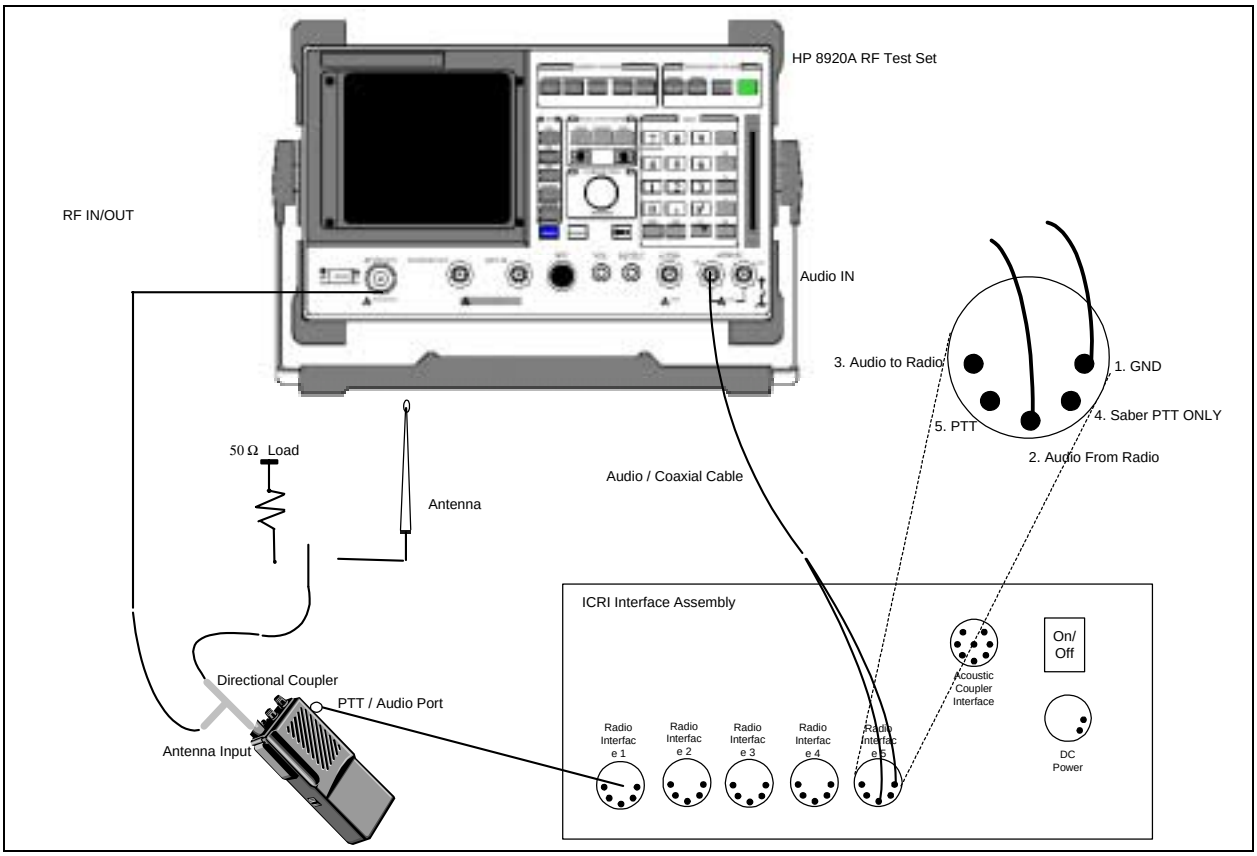


Figure 3
Receiver Desense Test Setup

3.2.6.2 Presentation of Results

Each type of frequency band and radio's desense value was recorded in dB for comparison with field test results, as well as to determine if the radios interfered with one another. The interference was evaluated on the basis of whether interference did or did not exist.

3.2.7 Intrinsic Delay and Timely Passing of Audio Signal Test

This test procedure measured the total time an ICRI Integrated System took to receive a signal from the radio antenna and to pass that signal to the ICRI unit's "audio out" port. This test was required to ensure the length of the delay would not interfere with emergency communications.

3.2.7.1 Test Description

Using a tee-connector, the "Audio Out" connector on the HP8920A was connected to the "A1" input on a Hewlett Packard 54645A oscilloscope (HP54645A) and to the ICRI Integrated System antenna input. The ICRI audio output was connected to the "A2" input on the HP54645A. The HP54645A dual-trace oscilloscope was adjusted so that one cycle of the trace was displayed. The oscilloscope was set to trigger on the A1 input. Finally, the difference between the peak time of A1 and the peak time of A2 was measured to determine the time delay. These test procedures were repeated for each type of radio and all its associated frequencies as shown in Table 1.

3.2.7.2 Presentation of Results

The intrinsic delay of each type of frequency band and radio was recorded in milliseconds, along with the degree to which the ICRI Integrated System passed the audio signal to all other radios in the system.

3.3 Field Testing and Verification

As described in Section 2, System Components, several COTS devices are integrated to satisfy the interoperability requirements for this project. To ensure proper operation in accordance with project objectives, the following field tests were conducted in a tunnel:

- Assessment of channel noise interference
- RF coverage measurement
- Validation of operational scenarios.

The following subsections describe each of these tests in detail.

3.3.1 Assessment of Channel Noise Interference

This test procedure measured the ICRI Integrated System desense at a Metro train station. It specifically took into account the typical operating environment for the ICRI Integrated System. There are several potential sources of noise in the intended operating environment that had to be considered. These sources include remote network terminals (i.e., trunking

computers), switching power supplies, commercial cellular or personal communications service (PCS) transmitters, adjacent RF channels, T-1 modems connected to the cellular or PCS stations, high-power frequency modulation (FM) and television transmitters, and electrical sources that power the Metro trains. This test provided a reference point for nominal interference levels expected in an in-tunnel environment. This reference was necessary to ensure the ICRI Integrated System was not in a desense mode resulting in the radio's receiver squelching the desired signal instead of the external interference signals. This test also provided the receiver effective sensitivity threshold necessary to correctly squelch the system for each of the operating frequency bands. The measured effective receiver sensitivity threshold also indicated how far the RF coverage could extend.

3.3.1.1 Test Description

The procedures for this test were the same as those described in Section 3.2.6, Receiver Desensitization (Desense) and Audio Quality Test Through SINAD Measurement.

3.3.1.2 Presentation of Results

This was a subjective test and could have been influenced by surrounding conditions at the specific time of measurement. Each type of frequency band and radio's desense value was recorded in dB for comparison with laboratory bench test results, and to determine if there was radio interference in the specified operating environment. The interference was evaluated on the basis of whether interference existed or not.

3.3.2 RF Coverage Measurement

This test procedure provided empirical RF propagation measurements sufficient to evaluate the RF coverage of the ICRI Integrated System in an in-tunnel environment. The test was conducted at the Metro Center station. Understandably, the RF coverage measurement was influenced by the layout of the particular tunnel. This test, however, provided a rough estimate of the projected RF coverage afforded by the ICRI Integrated System in any Metro Rail tunnel environment.

3.3.2.1 Test Description

The ICRI Integrated System was set up on the passenger-waiting platform. Because the location of the unit influences the RF coverage measurement, the exact location of the setup was recorded to provide a permanent point of reference. This reference location must be used for any subsequent measurements to ensure valid repetition or comparison of results. The signal generator, HP8920A, was set up close to the ICRI unit and was programmed with one of the provided transmit frequencies listed in Table 1. The transmit power on the signal generator was set to -30 dBm. The signal generator transmitted for 10-second intervals followed by a voice transmission. This scheme allowed for voice quality measurements to be recorded.

Using the Wireless Measurement System (WMS) and a tape measure, the received signal strength in dBm, along with the corresponding distance and angle from the ICRI unit (see Figure 4), was recorded from each of the ICRI Integrated System radios. To make this measurement, the WMS was programmed with one of the transmit frequencies from each frequency band listed

in Table 1. The WMS can record up to four simultaneous channels on different frequency bands. Using the WMS handheld controller, the received signal strength in dBm was recorded. This process was repeated every 10 meters until the received signal strength dropped to less than the effective receiver sensitivity threshold set by the manufacturer, for each of the measured frequency bands. This test procedure was repeated at 45-degree angle intervals around the ICRI Integrated System (see Figure 4).

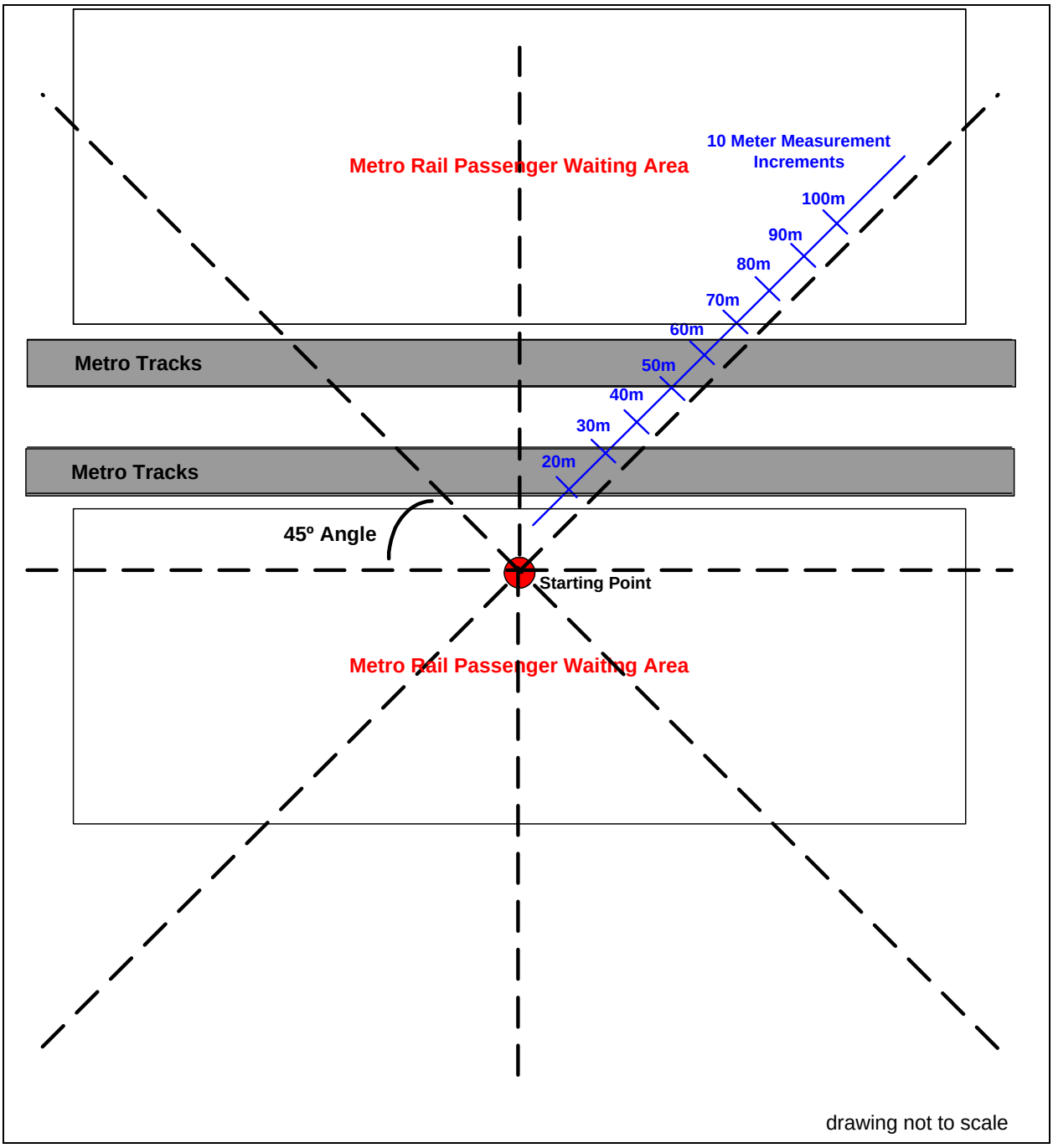


Figure 4
RF Coverage Measurement Setup

3.3.2.2 Presentation of Results

The ICRI performance was recorded and evaluated based on requirements for signal strength in a public safety environment. This was a subjective test and could have been influenced by surrounding conditions at the specific time of measurement. The results were presented in a graph depicting the recorded received signal strength versus the distance from the ICRI Integrated System for each of the measured frequency bands. In addition, a fit-to-curve formula was derived to provide an estimate for the received signal strength in a tunnel environment as a function of distance from the ICRI Integrated System. The associated speech measurements were based on the following scale:

- **Good**. Speech easily understood.
- **Average**. Speech understandable with slight effort. Occasional repetition required due to noise distortion.
- **Bad**. Speech present but unintelligible.

3.3.3 Validation of Operational Scenarios

This test attempted to validate the operation of the ICRI Integrated System in simulated operational scenarios. This test was conducted at a randomly chosen location within the Metro Center station and indicated the unit's potential operational limitations. This test had two phases, one to check communications from underground to the trunked system on the surface, and one to check communications from underground to a conventional radio on a different frequency band from the sending radio.

3.3.3.1 Test Description Phase 1

In this phase of the operational test, the procedure tested the ability of the ICRI Integrated System to relay communications from underground to the trunked system on the surface. In most situations, DCFD will be operating in talk around mode when underground and will be linked to an aboveground trunked talk group by the ICRI Integrated System's 250-foot cable. For this test, two 800 MHz radios were connected to the ICRI Integrated System. Radio #1 was set to the underground talk around channel that would normally be used during in-tunnel incident response. Radio #2 was connected to the 250-foot cable and was set to a trunked talk group that includes above-ground units. First, a test count of 1 to 10 was transmitted on the talk around channel (from each of the frequency bands). This transmission was then relayed through the ICRI Integrated system to the above ground system, on the selected trunked talk group. Next, a test count of 1 to 10 was transmitted on the trunked talk group. This transmission was then relayed through the ICRI Integrated system, to the talk around channel assigned to each of the frequency bands. This procedure was repeated for each of the frequency bands under consideration.

3.3.3.2 Test Description Phase 2

In this phase of the operational test, the procedure tested the ability of the ICRI Integrated System to relay underground communications to a conventional radio in a different frequency band, also operating underground. This test simulated the need for a DCFD unit to communicate while underground with a different public safety agency, such as Metro Transit Police or a suburban fire department that operates on a VHF or UHF band. For this test, one 800 MHz radio (#1) and one radio (#2) on either the VHF or UHF band was used. Radio #1 was set to a talk around channel normally used for underground incidents. Radio #2 was set to operate on the designated interoperability channel of another agency. First, a test count of 1 to 10 was transmitted on Radio #1 to the ICRI Integrated System. The ICRI Integrated System relayed the transmission to Radio #2 on the corresponding interoperability channel. Then, this procedure was reversed, i.e., the transmission was initiated on Radio #2 (VHF or UHF radio) and relayed to Radio #1. This procedure was repeated for each of the frequency bands under consideration.

3.3.3.3 Presentation of Results

The ICRI performance was recorded and observations were noted. Although this was a subjective test, it provided a validation of potential operational incident response scenarios in which the ICRI Integrated System could be used. For this test, the ICRI Integrated System was evaluated based on a pass/fail assessment of how the audio signal was passed across all attached radios and frequency bands.

4. RESULTS AND RECOMMENDATIONS

4.1 Hardware Integration and Testing Results

The lab test was performed in accordance with the test procedures described in Section 3.2. This section highlights the laboratory test performed and associated analysis results.

4.1.1 Ease of Setup Assessment Results

The ICRI Integrated System and all external equipment were connected and powered on as shown in Figure 1. To ensure proper operation, vendor specifications were evaluated for each unit. The eight ICRI units were individually tested for proper connectivity using voltage and resistance tests. One unit was found to have a grounded port (i.e., pin #2 on port #4 was short-circuited to the ground pin, pin #1); however, the manufacturer later repaired the port. After repair, all units operated according to the published specifications. Note: each port on the unit is configured to accommodate most Motorola radios, such as XTS-3000, HT-1000, and Sabers. During setup, a series of radio checks must be accomplished to ensure adequate volume levels are set on each radio for proper receipt of audio. This process proved to be time consuming, and could impact response time in an emergency situation.

4.1.2 Crossband/Cross-System Interconnect Capability Verification Results

This test evaluated the ICRI Integrated System functional test. All ICRI units passed audio signals across all attached radios and bands. There was a concentrated effort to tune all radios to the same transmit volume. The volume knob on each portable radio tunes the transmit volume when connected directly to the ICRI through the supplied patch cable. A process of trial and error indicated the ideal volume setting to be approximately a half turn from maximum setting for all radios, although different environments could cause slight changes to this setting.

4.1.3 Extended Distance Radio Interface Capability Verification Results

The ICRI Integrated Systems were tested with the 250 feet of radio interface cable provided with each unit. Using the provided radios, programmed with conventional VHF, UHF, and 800 MHz test frequencies, the system passed audio signals successfully across all HT-1000 radios. A failure occurred when operating the XTS-3000 in combination with the remote port (#5) of the ICRI unit and the 250-foot cable. The ICRI intrinsic impedance was severely changed, causing the Voice Operated Squelch (VOX) circuit to “lock,” resulting in the entire system being keyed up. The vendor was apprised of the problem and committed to correcting the error. The vendor stated that the fault was due to a match filter circuit being omitted from the remote port, thus requiring reconfiguration of the port in question.

4.1.4 Landline Telephone Connection Capability Verification Results

Each of the ICRI Integrated Systems were tested with the provided acoustic coupler telephone interface modules attached to a landline telephone. The modules successfully passed audio across all attached radios, and frequency bands. As mentioned earlier, this is a subjective test, and since volume levels fluctuate, results could change with different landline telephone sets.

The acoustic coupler is designed with a speaker and a microphone, each with elastic straps that cover the ends of the landline telephone handset. The acoustic coupler reacts to a certain volume level threshold, within a given environment. The equipment performed according to specifications; however, the volume levels during an actual fire incident might be too high for such a device to function properly. Such high noise level could cause feedback in the ICRI unit, which in turn could cause the VOX circuit to "lock," and key-up the unit erroneously. It is recommended that the acoustic coupler module only be used in a very limited capacity, possibly in a quieter environment such as a Metro kiosk.

4.1.5 Cellular Telephone Connection Capability Verification Results

The ICRI Integrated Systems were tested with the provided acoustic coupler telephone interface modules attached to a cellular phone. The results were unchanged from the results of the landline telephone as described in Section 4.1.4. This test could produce different results depending on the brand of cellular phone because of differing volume levels. To mitigate such problems, the user may opt to use the 2.5 mm phone jack interface cable to connect directly to the cellular phone and the ICRI unit. This would eliminate any feedback experienced when using the acoustic coupler.

4.1.6 Receiver Desensitization (Desense) and Audio Quality Test Through SINAD Measurement Results

The test procedure described in Section 3.2.6 was conducted in a laboratory environment. The results of the desense test were recorded in Table 2.

Table 2
Receiver Desense / SINAD Test Results

Frequency Band	50 Ohm Load @ 12 dB SINAD (dBm)	Antenna Load @ 12 dB SINAD (dBm)	Receiver Desense Level (dB)
VHF	-75.0	-52.7	22.3
UHF	-89.4	-84.3	5.1
800	-87.5	-88.5	1.0

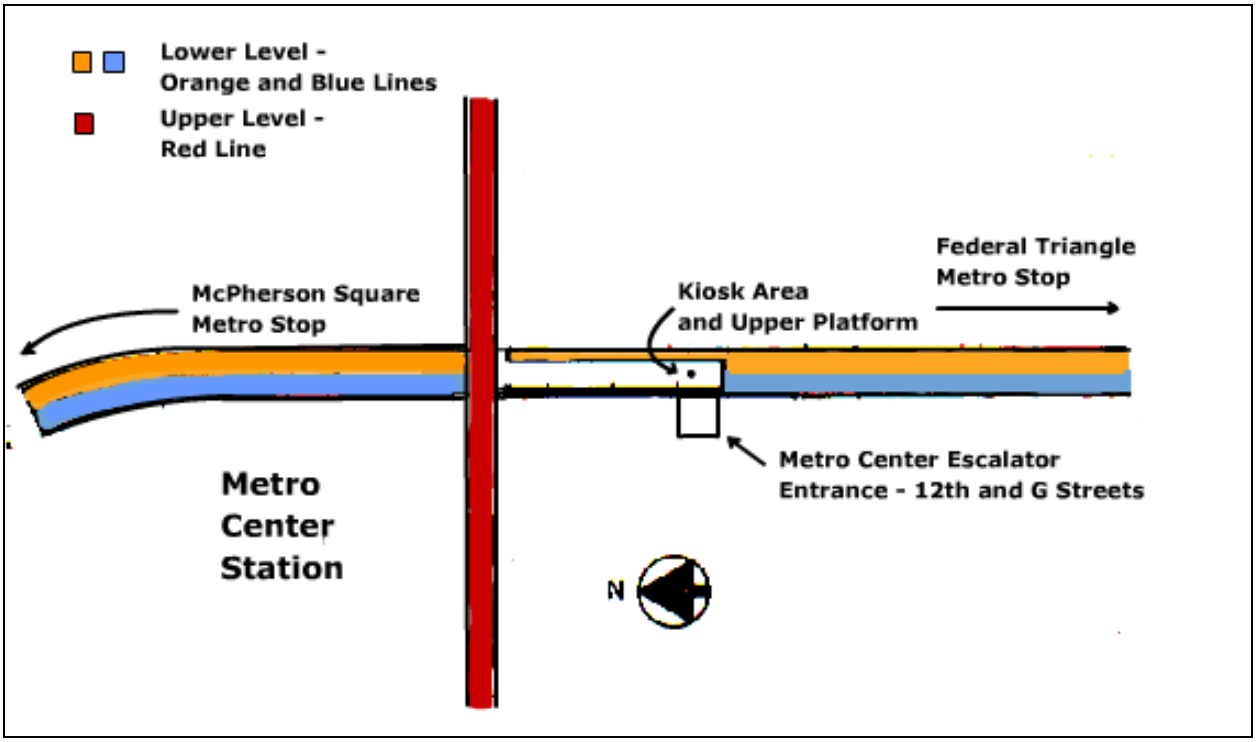
The data shows each radio's 12 dB SINAD threshold level when a 50-ohm load was attached to the antenna port of the respective radio (and not the prescribed antenna), and then when the prescribed antenna was attached to the radio. The difference between these two values is what is used to calculate the desense level. The data indicates the likelihood of radios or other equipment interfering with the ICRI unit during normal operation. The high desense level recorded for the VHF radio (22.3 dB) occurred because the laboratory was located next to a high power VHF transmit antenna tower. Hence, this environment skewed the results of this test. Nevertheless, the results showed that the radios operated normally.

4.1.7 Intrinsic Delay and Timely Passing of Audio Signal Test Results

The ICRI Integrated System was tested as described in Section 3.2.7. The test proved to be insignificant because of the negligible delay (approximately 50 ms) involved in passing an audio signal through the ICRI unit. The only delay to be concerned with was that of the DCFD trunked system. Typically, any trunked system has a delay associated with it for granting channel access. This delay should always be observed when using the system. Any users introduced to the system, including VHF and UHF users, should be aware of this delay, and should practice using the system before attempting to operate the system during an emergency incident response. Measured delay from the DCFD trunk system varied between 260 ms to 600 ms. Delay variations were due to system congestion status, distance from nearest repeater, and conditions at the nearest repeater site.

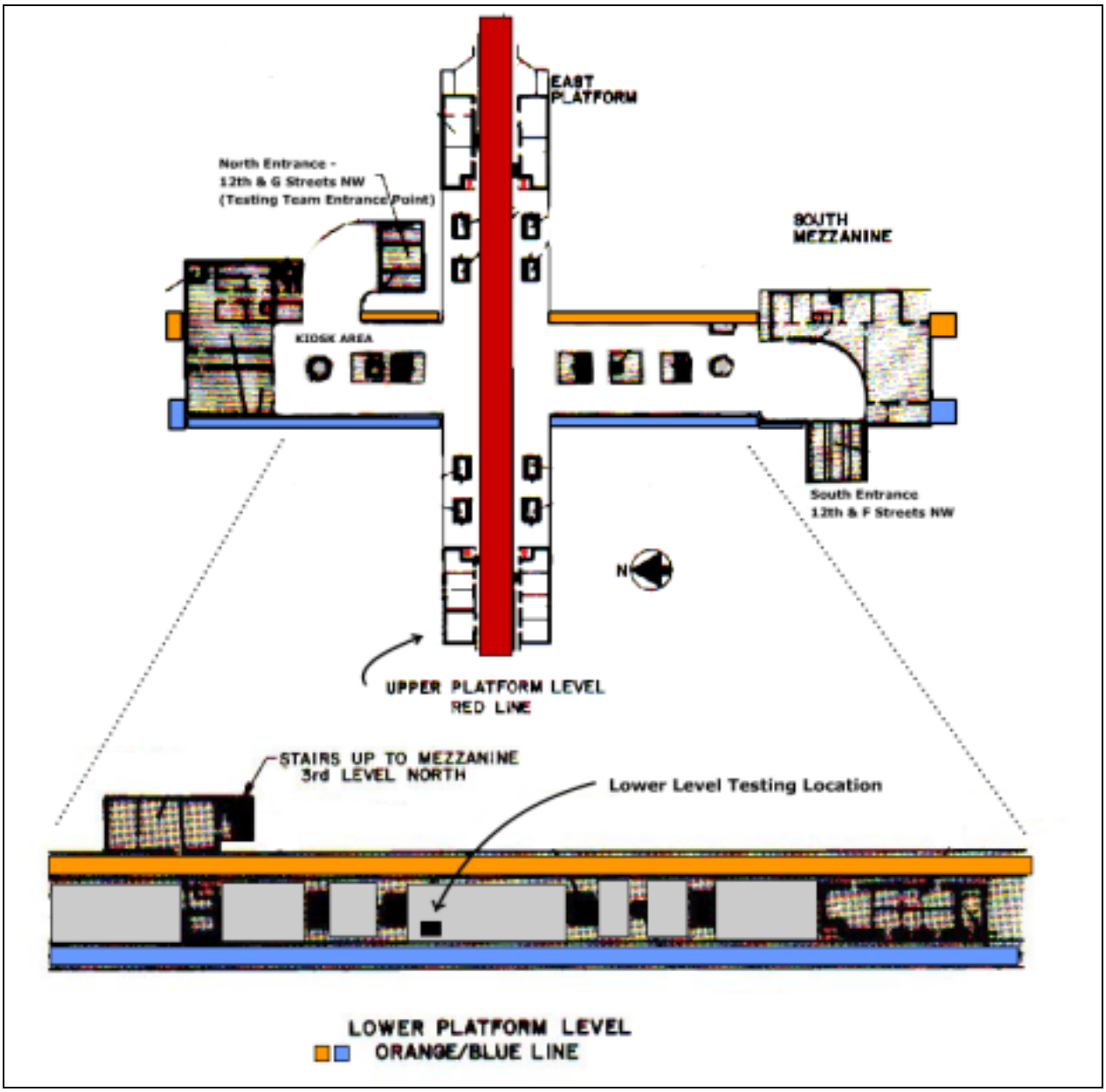
4.2 Field Testing and Verification Results

The field test, conducted in the Washington Metropolitan Area Transit Authority's (WMATA) Metro Center tunnel, was performed on April 30, 2001, from 1:00 a.m. until 5:00 a.m.. The test was performed under the supervision of DCFD, a member of WMATA, and PSWN Program personnel, along with Booz·Allen support staff. The ICRI Integrated System was placed in the center of the lowest tunnel, located on the Orange/Blue line as shown below in Figure 5 and Figure 6. Figure 7 and Figure 8 show the Metro stations on either side of the Metro Center Station. This section outlines the field test area, test performed and the results of the analysis accomplished (described in Section 3.3).



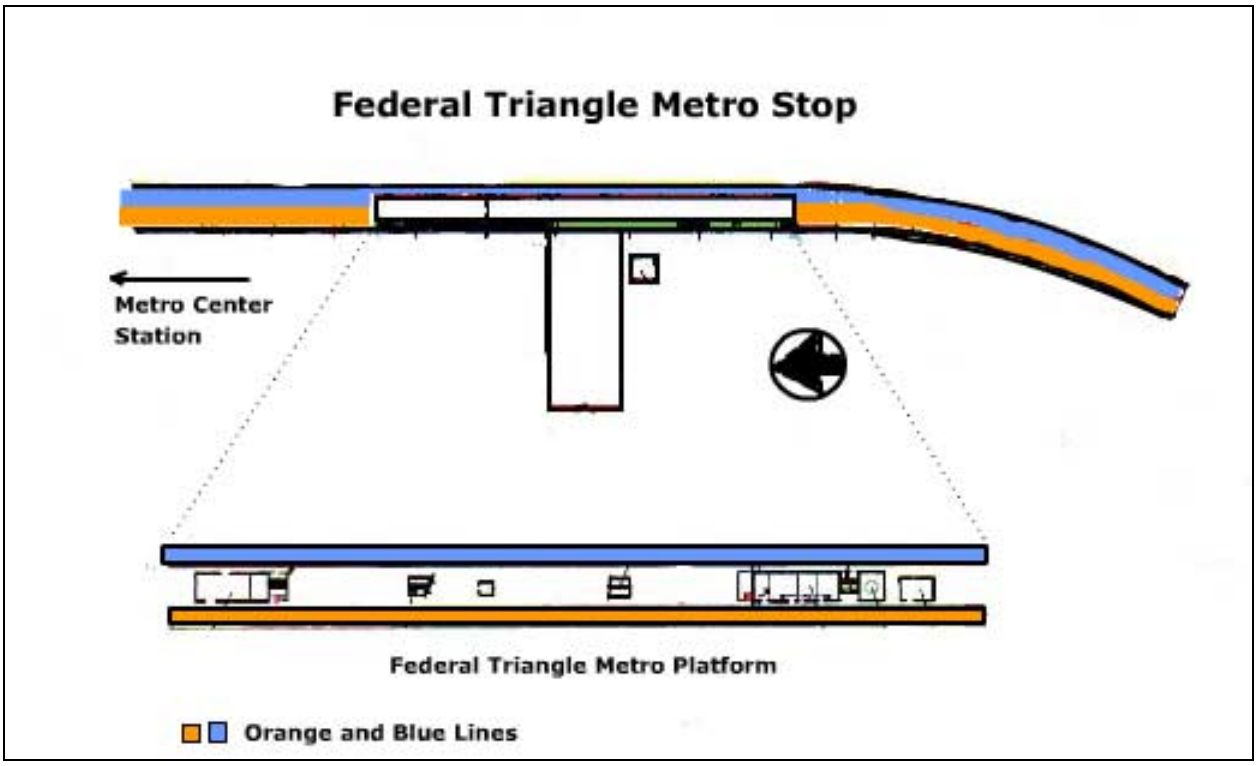
Courtesy DCFD

Figure 5
Metro Center Diagram #1



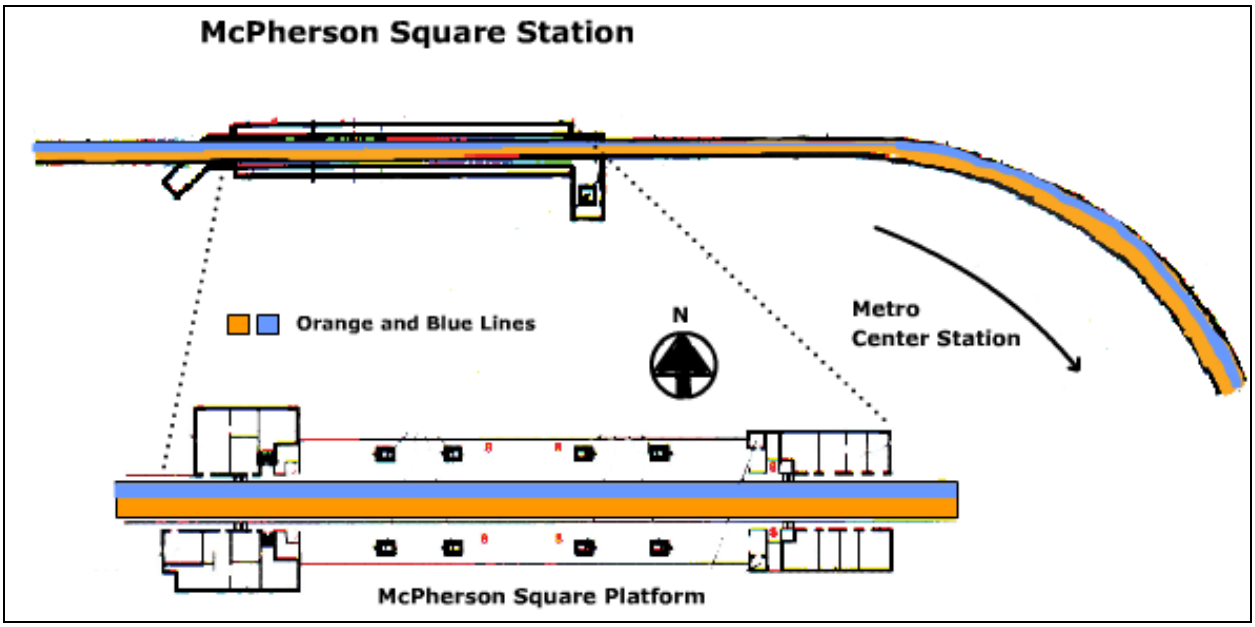
Courtesy DCFD

Figure 6
Metro Center Diagram #2



Courtesy DCFD

Figure 7
Federal Triangle Metro Station, North of Metro Center



Courtesy DCFD

Figure 8
McPherson Square Metro Station, South of Metro Center

4.2.1 Assessment of Channel Noise Interference Results

The test procedure described in Section 3.2.6 was conducted in a laboratory environment. The results of the desense test are recorded in Table 3.

Table 3
Receiver Desense Field Test / SINAD Results

Frequency Band	50 Ohm Load @ 12 dB SINAD (dBm)	Antenna Load @ 12 dB SINAD (dBm)	Receiver Desense Level (dB)
VHF	-74.5	-66.6	7.9
UHF	-83.2	-85.1	1.9
800	-82.4	-79.1	3.3

The data shows each radio's 12 dB SINAD threshold level when a 50-ohm load was attached to the antenna port of the respective radio (and not the prescribed antenna), and then when the prescribed antenna was attached to the radio. The difference between these two values is what is used to calculate the desense level. The data indicates the likelihood of radios or other equipment interfering with the ICRI unit during normal operation. These desense levels were used to adjust the receive sensitivity of the radio to account for noise and interference. This adjustment affects the range of the receiver. The receiver coverage range is proportional to the desense level, in that the higher the desense level, the lower the receiver coverage range. The user should be cautioned to high RF noise environment and should place the unit as close as possible to the incident scene.

4.2.2 RF Coverage Measurement Results

The ICRI Integrated System was connected and powered on, as shown in Figure 2, with the test equipment attached as described in Section 3.3.2. The exact location of the test was the lower level of the Metro Center Station where the Blue/Orange and the Red lines intersect. Signal tests were completed in the tunnels leading toward both the Federal Triangle and the McPherson Square Metro stops on the Blue/Orange tracks. A series of 360-degree signal tests were also completed within and around the ticketing kiosk, and on the Red line directly above the ICRI unit. A 1 kHz test tone was successfully transmitted from the VHF, UHF, and 800 MHz radios, out to the testing radios and the WMS. The 1 kHz signal was sent every 10 seconds for the WMS measurement, followed by an audible "10 count" in between each pulse for audio quality testing. The radios were placed in 10 meter increments away from the ICRI unit. During each 10 second interval, a RF signal level in dBm was recorded using the WMS, for each 10 meter test. As this data was recorded, subjective audio quality measurements were taken from the output of each respective radio. The quality was recorded as good, average, or bad. The data for each test is included in Appendix A. Graphs depicting signal quality versus distance from the ICRI Integrated System are shown below in Figure 9 and Figure 10. These figures depict actual measurements as points on the graph. Also included in the figures are a best-fit curve, standard deviation curves, and the threshold for adequate signal sensitivity. The data indicates that 800 MHz signals travel significantly farther than do VHF or UHF signals, in a tunnel environment.

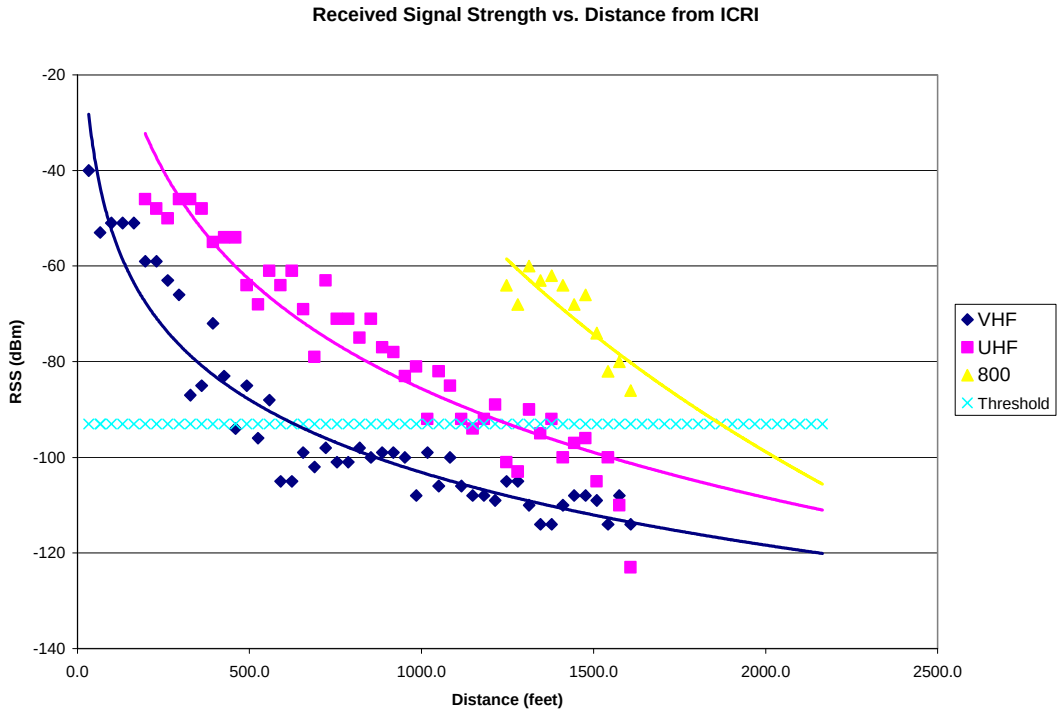


Figure 9
RSS Measured Toward Federal Triangle

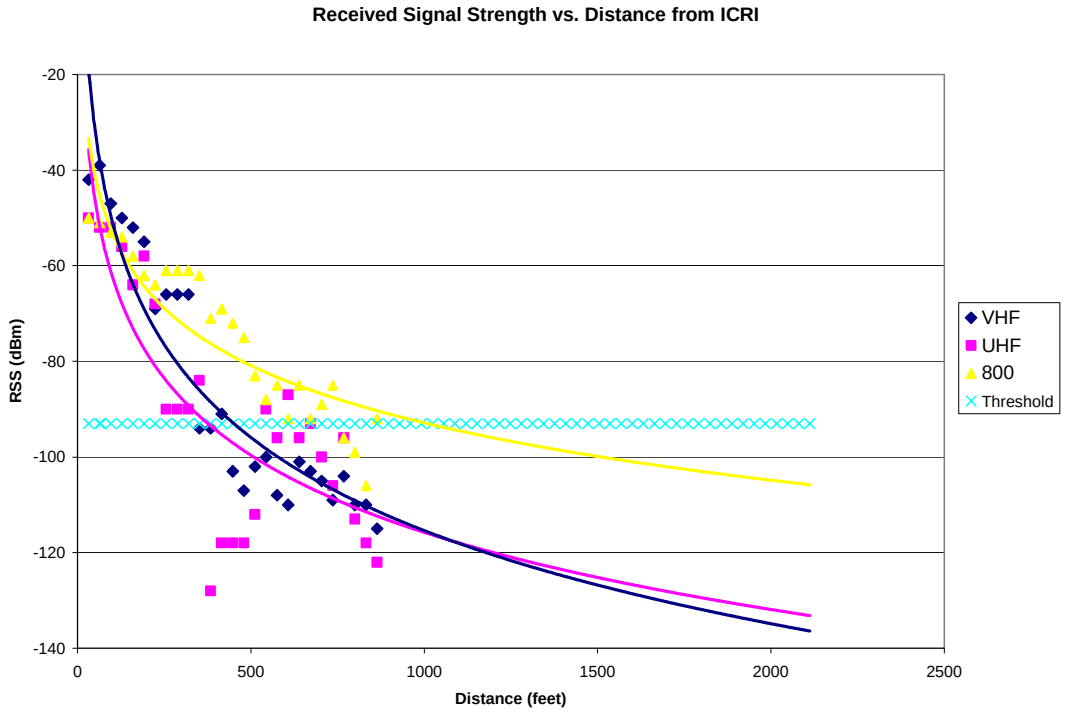


Figure 10
RSS Measured Toward McPherson Square

As originally stated, a 360-degree test was planned. Because the layout of the passenger waiting area at Metro Center, measurements were limited to two tests, one at 0 degrees, i.e., towards Federal Triangle and one at 180 degrees, i.e., towards McPherson Square. A few other measurements were also made for reference. With the ICRI unit located on the lower floor (Orange and Blue line), the received RF signal strength was measured inside the Metro Center ticketing kiosk on the upper level. The RF signal strength was measured with 360-degree, 10-meter wide surroundings on the outside of the kiosk. In addition, the RF signal strength on the upper level of Metro Center (Red line) was measured with 360-degree, 10-meter wide surroundings. All readings inside the upper-level passenger-waiting area showed successful transmissions of audio. Measurements inside the kiosk showed little change in performance from the measurements outside the kiosk. Table 4 shows a summary of the measurement analysis. This table highlights the expected RF coverage range from the ICRI Integrated System in different setup scenarios. These results were calculated based on data regression procedures and on interpolation of collected empirical data.

Table 4
Measurement Analysis

Location of ICRI Integrated System	Expected Range (feet)		
	VHF	UHF	800
On same floor with LOS to remote radios[1,4]	629	1,251	1,868
On same floor with Non-LOS to remote radios[1,4]	600–376	980–451	1,200–1,000
On different level (one floor difference)[1,2]	220	560	1,183
In kiosk on same floor[1,3]	630	983	1870
In kiosk on different floor (one floor difference)[1,3]	230	600	1000

1. Range is ±300 feet and subject to tunnel layout and measurement conditions.
2. Depends on distance between ICRI Integrated System, first curve in tunnel, and remote radios.
3. ICRI and local radios (not 250-foot extended) were placed in kiosk directly facing the shield window and not on the floor of the kiosk.
4. LOS = Line-of-Sight.

4.2.3 Validation of Operational Scenarios Results

The radios were integrated and tested as described in Section 3.3.3. For Phase 1, two 800 MHz XTS-3000 radios were attached to the ICRI Integrated System: one trunked radio connected above ground to a 250-foot cable, and another connected directly to the ICRI system. The radios were fully operational; however, a conflict occurred when the Motorola XTS-3000 radio, the 250-foot cable, and the ICRI remote unit, were used in combination with one another. The error occurred when an XTS-3000 radio attached to the 250-foot cable was enabled in a VOX mode. The XTS-3000 remained in a transmit mode, which caused the ICRI unit to lock up. This problem was brought to the vendor's attention for resolution. After witnessing the problem, the vendor concluded that the remote port was not configured to the same specifications as the other ports on the unit. The port needed to be reconfigured in the same manner as the other ports because the problem was only evident on the remote port. This problem was later corrected and the units were re-tested. All radios successfully passed all transmitted audio on all test bands to all other respective radios.

The Phase 2 scenario tested the ability of all radios to relay messages in the Metro tunnel environment. The VHF, UHF, and 800 MHz radios were all connected to the ICRI unit in a conventional mode. Three identical radios were spread out through the Metro station and tested for functionality with one another, per the test description. All radios successfully passed all transmitted audio on all test bands to all other respective radios.

4.3 Conclusions

The ICRI Integrated System provides a portable, battery-powered solution solving the common interoperability problem that exists among public safety agencies responding to Metro fire incidents in an underground environment. Table 5 and Table 6 highlight the test results, associated observations, and usage recommendations.

Table 5
Summary of Lab Test Results and Recommendations/Observations

Test Description	Results	Recommendations/Observations
Ease of Setup and Assembly Assessment	Vendor specifications were evaluated for each unit. All units operated according to the published specifications	Each port on the unit is configured to accommodate most Motorola radios, such as XTS-3000, HT-1000, and Sabers. During setup, a series of radio checks must be accomplished to ensure adequate volume levels are set on each radio for proper receipt of audio. This process proved to be time consuming, and could impact response time in an emergency situation
Crossband/Cross-System Interconnect Capability Verification	System passed audio signals across all radios directly connected to the ICRI using all test radios and bands	Volumes on each individual radio must be tuned before seamless operation. Radio checks should be performed before continuous operation
Extended Distance Radio Interface Capability Verification (250-foot Cable)	System passed audio signals across all radios directly connected to the ICRI unit, and to the extended port through the 250-foot cable.	For successful communications to occur with the aboveground trunked system, the user must receive adequate training to become comfortable with the delay time in a trunked environment and how it would affect the message relay
Landline Telephone Connection Capability Verification (Acoustic Coupler)	Modules successfully passed audio across all attached radios and bands	The background noise volume levels during an actual fire incident might be too high for such a device to function properly. High background noise levels cause feedback in the acoustic coupler module, which cause erroneous operation of the ICRI unit. It is recommended that the acoustic coupler module should only be used in a very limited capacity, possibly in a quieter environment such as a Metro kiosk
Cellular Telephone Capability Verification (Acoustic Coupler)	Modules successfully passed audio across all attached radios and bands	The background noise volume levels during an actual fire incident might be too high for such a device to function properly. High background noise level cause feedback in the acoustic coupler, which cause erroneous operation of the ICRI unit. It is recommended that the acoustic coupler module should only be used in a very limited capacity, possibly in a quieter environment such as a Metro kiosk. Alternatively, the user may opt to use a 2.5 mm phone jack interface cable to connect directly to the cellular phone and the ICRI unit. This would eliminate any feedback experienced when using the acoustic coupler.

Test Description	Results	Recommendations/Observations
Receiver Desense/ Audio Quality Test	A 1 kHz test signal was successfully passed through the VHF, UHF, and 800 MHz radios, with each radio's antenna port connected to a 50-ohm load and then to its respective antenna	High desense levels affect received RF coverage range. The user should be cautioned regarding use of the units in a high RF noise environment, and should place the unit as closely as possible to the incident scene
Intrinsic Delay Test	Negligible delay was experienced through the ICRI Integrated System when used with radios operating in a conventional mode. However, significant delay was introduced due to radio communication through a trunked system, which affects communication with radios operating in a conventional mode	ICRI Integrated System users, including VHF and UHF users, should be aware of delay through the trunked system and practice using the system before an emergency incident response

Table 6
Summary of Field Test Results and Recommendations/Observations

Test Description	Results	Recommendations/Observations
Receiver Desense/ Audio Quality Test	A 1kHz test signal was successfully passed through the VHF, UHF, and 800 MHz radios, with each radio's antenna port connected to a 50-Ohm Load and then to its respective antenna	The tunnel environment proved to be noisier, possibly due to electrical equipment operating in the background. The Verizon cellular leaky-coax cables could also be a source for increased RF noise, especially in the 800 MHz band
RF Coverage Measurement	Signal tests were completed in the tunnels leading toward both the Federal Triangle and the McPherson Square Metro stops on the Blue/Orange tracks. A series of 360-degree signal tests were also completed within and around the ticketing kiosk, and on the red line directly above the ICRI unit.	VHF and UHF signals faded at 629 feet and 1,251 feet, respectively, through a straight tunnel; and at 376 feet and 451 feet, respectively, through a curved tunnel. The 800 MHz signals performed well due to propagation properties at that frequency
Validation of Operational Scenarios	All radios successfully passed all transmitted audio on all test bands to all other respective radios	The user must receive adequate training to become comfortable with the delay time in a trunked environment and how it can affect the message relay

Other key observations:

- The bench test results demonstrated that all fully operational ICRI Integrated Systems performed according to vendor specifications. Operation of the units should be seamless once the unit is powered on and all respective radios are tuned to an appropriate setting.

- The acoustic coupler is recommended for use only when absolutely necessary. The coupler is quite sensitive to surrounding noise and could adversely affect emergency communications in a noisy environment. It is recommended to use the 2.5-mm phone jack directly with a cellular phone instead of the acoustic coupler. The vendor offers this option for use with cellular phones.

- The battery life of the unit is a concern. The unit runs on eight AA batteries. As tested, the batteries run for approximately 2 hours and 20 minutes before the warning light illuminates, and 3 hours and 20 minutes before the unit stops operation. With twin battery packs, total operation time is estimated to be a minimum of 4 hours and 40 minutes. At least 32 fresh batteries are recommended for use during an incident, which will provide at least 9 hours and 20 minutes of operation.

- During the field tests, the ICRI performed nominally. For successful communications to occur with the aboveground trunked system, the user must receive adequate training to become comfortable with the delay time in a trunked environment and how it would affect the message relay.

When operating the ICRI units in an underground scenario, such as in the Metro Center station, the data interpreted from the RF coverage results indicate that the unit should be placed as close as possible to the incident scene, thus obtaining the best coverage from the VHF and UHF radios. According to the empirical data, both the VHF and UHF RF coverage reached approximately 900 feet in a straight tunnel, before the audio signal was severely degraded. For a curved tunnel, or non-line-of-sight path to the ICRI unit, the RF coverage was limited to the direct path (i.e., the portion of the tunnel prior to the curvature) with lesser coverage than when compared against the straight tunnel measurements. With the 800 MHz radios, coverage was reported to be excellent from the middle of the Metro Center station toward the Federal Triangle Metro station (straight tunnel), and with no loss in audio quality reported. However, placing the ICRI unit as close as possible to an incident is still recommended. Testing the curved tunnel, i.e., toward the McPherson Square Metro station from the Metro Center station, produced weakened results. As shown in Figure 10 (page 22), the VHF, UHF, and 800 MHz radios performed significantly poorer than when compared against the results from the straight tunnel testing.

5. SUMMARY

This report describes the test plan and procedures performed to ensure the viability of the C-AT ICRI solution before delivery of the units to the DC Fire and EMS Department for the Metro incident interoperability project. In addition, this report documents the associated test results, observations, and recommendations.

The objectives of this report were to document and review the functional design characteristics of each ICRI unit in its integrated mode. This evaluation was necessary to ensure each unit will fulfill its operational mission requirements, as well as to measure performance parameters in a laboratory environment and in the field.

Specifically, this report described the tests and procedures accomplished to assess performance in support of an overall evaluation of the ICRI Integrated System. The results of this analysis will provide the DCFD with a comprehensive evaluation of the ICRI Integrated System, its capabilities, and its limitations. The laboratory tests and procedures included:

- Ease of set up assessment
- Cross-band/cross-system interconnect capability verification
- Extended distance radio interface capability verification
- Landline telephone connection capability verification
- Cellular telephone capability verification
- Receiver desense and audio quality test through SINAD measurement
- Intrinsic delay and timely passing of audio signal test.

The field tests and procedures included:

- Assessment of channel noise interference
- RF coverage measurement
- Validation of operational scenarios.

The results and recommendations section of this report documented the test results, associated observations, and recommendations that the DCFD should consider when using the ICRI Integrated System.

APPENDIX A
MEASURED RF DATA

Test from Metro Center toward Federal Triangle

Distance		RSSI Measurement (dB)			Audio Quality (Good/Average/Bad)		
Meters	Feet	VHF (Rx 1)	UHF (Rx 3)	800 (Rx 4)	VHF (Rx 1)	UHF (Rx 3)	800 (Rx 4)
0	0.0	-40	-40	-40	G	G	G
10	32.8	-40	-40	-40	G	G	G
20	65.6	-53	-50	-40	G	G	G
30	98.4	-51	-40	-40	G	G	G
40	131.2	-51	-49	-40	G	G	G
50	164.0	-51	-52	-48	G	G	G
60	196.8	-59	-46	-46	G	G	G
70	229.7	-59	-48	-45	G	G	G
80	262.5	-63	-50	-46	G	G	G
90	295.3	-66	-46	-46	G	G	G
100	328.1	-87	-46	-43	G	G	G
110	360.9	-85	-48	-52	G	G	G
120	393.7	-72	-55	-50	G	A	G
130	426.5	-83	-54	-58	G	G	G
140	459.3	-94	-54	-59	G	G	G
150	492.1	-85	-64	-65	G	G	G
160	524.9	-96	-68	-68	G	G	G
170	557.7	-88	-61	-66	G	G	G
180	590.5	-105	-64	-62	G	G	G
190	623.4	-105	-61	-76	G	G	G
200	656.2	-99	-69	-62	G	G	G
210	689.0	-102	-79	-64	G	G	G
220	721.8	-98	-63	-55	G	G	G
230	754.6	-101	-71	-58	A	A	G
240	787.4	-101	-71	-65	G	A	G
250	820.2	-98	-75	-57	G	GA	G
260	853.0	-100	-71	-72	G	G	G
270	885.8	-99	-77	-62	G	A	G
280	918.6	-99	-78	-65	G	A	G
290	951.4	-100	-83	-64	B	A	G
300	984.2	-108	-81	-72	B	A	G
310	1017.0	-99	-92	-60	B	A	G
320	1049.9	-106	-82	-69	B	A	G
330	1082.7	-100	-85	-65	B	BA	G
340	1115.5	-106	-92	-73	B	A	G
350	1148.3	-108	-94	-64	B	A	G
360	1181.1	-108	-92	-65	B	A	G
370	1213.9	-109	-89	-72	B	A	G
380	1246.7	-105	-101	-64	B	A	G
390	1279.5	-105	-103	-68	B	A	G
400	1312.3	-110	-90	-60	B	A	G
410	1345.1	-114	-95	-63	B	A	G
420	1377.9	-114	-92	-62	B	A	G
430	1410.7	-110	-100	-64	B	A	G
440	1443.6	-108	-97	-68	B	BA	G
450	1476.4	-108	-96	-66	B	BA	G
460	1509.2	-109	-105	-74	B	BA	G
470	1542.0	-114	-100	-82	B	BA	G
480	1574.8	-108	-110	-80	B	BA	G
490	1607.6	-114	-123	-86	B	BA	G

Test from Metro Center toward McPherson Square

Distance		RSSI Measurement (dB)			Audio Quality (Good/Average/Bad)		
Meters	Feet	VHF (Rx 1)	UHF (Rx 3)	800 (Rx 4)	VHF (Rx 1)	UHF (Rx 3)	800 (Rx 4)
0	0	-40	-40	-40	G	G	G
10	32	-42	-50	-50	G	G	G
20	64	-39	-52	-51	G	G	G
30	96	-47	-52	-53	G	G	G
40	128	-50	-56	-54	G	G	G
50	160	-52	-64	-58	G	G	G
60	192	-55	-58	-62	G	G	G
70	224	-69	-68	-64	G	G	G
80	256	-66	-90	-61	G	G	G
90	288	-66	-90	-61	A	A	G
100	320	-66	-90	-61	A	A	G
110	352	-94	-84	-62	A	A	G
120	384	-94	-128	-71	A	A	G
130	416	-91	-118	-69	A	A	G
140	448	-103	-118	-72	G	G	G
150	480	-107	-118	-75	G	G	G
160	512	-102	-112	-83	G	G	G
170	544	-100	-90	-88	NA	NA	G
180	576	-108	-96	-85	B	B	GA
190	608	-110	-87	-92	B	BA	G
200	640	-101	-96	-85	B	B	G
210	672	-103	-93	-92	B	B	G
220	704	-105	-100	-89	B	B	G
230	736	-109	-106	-85	B	B	G
240	768	-104	-96	-96	B	B	G
250	800	-110	-113	-99	B	B	G
260	832	-110	-118	-106	G	G	G
270	864	-115	-122	-92	G	G	A

APPENDIX B
ICRI NOMINAL SIGNAL LEVELS AND IMPEDANCE SPECIFICATIONS

COMMUNICATIONS-APPLIED TECHNOLGY
11250-14 Roger Bacon Drive Reston, VA 20190-5202 USA
voice: 703-481-0068, 800-229-3925 fax: 703-471-4428

FACSIMILE TRANSMITTAL

Number of Pages: 2
(including cover sheet)

DATE: March 30, 2001

TO: Khalid Syed, BAH

FAX: 703-902-3465

FROM: Seth Leyman

SUBJECT: ICRI specifications

Nominal Signal levels and Impedances of ICRI ports

Land Mobile Radio Interface (J1-J5 5pin locking DIN)

Input
nominal input level 0db adjusted with portable radio volume control
nominal input impedance 5K ohms load presented to radio.
Output
nominal -28 dbv mic. level to radio. Gain loss tolerance 2db.
nominal output impedance 2K ohms driving radio.
noise <-70 dbv from another radio port or wired cell phone. (Better than 40db s+n/n unweighted)
-60 dbv from acoustic coupler input when keyed. (32 db s+n/n unweighted)

Telephone Interface (8pin locking DIN)

Acoustic Coupler connection (wired input not selected)

input
nominal input level -60 db for -28 db to radio
nominal input impedance 40K ohm
output
nominal level to coupler 0db (-6dbv per leg to ground) Gain loss tolerance 2db.
nominal output impedance 100 ohms. (100 mw)
noise out <-70 dbv. (Better than 70db s+n/n unweighted)

Wired Cell Phone connection (select input grounded)

input
nominal input level -20 db v for -28 db to radio
nominal input impedance 10K ohm load to phone ear output.
output
nominal level -28 db to phone mic. input. Gain loss tolerance 2 db
nominal output impedance 10K ohm (no bias)
noise out <-70 dbv. (Better than 42db s+n/n unweighted)

Power Requirement

nominal 12 volts. 80 milliamps current.
Voltage safe operating range 11- 20 (rated to 24)
Good battery indicated by green OK VOLTAGE light greater than 11.1 volts 2% tolerance
Failing battery indicated by red LOW VOLTAGE light greater than 10.6 volts 2% tolerance less than good.
Note: The circuit is not regulated below the LOW threshold (no light) and the battery should be replaced immediately.

APPENDIX C
ODC EXPENDITURE REQUEST MEMORANDUMS

BOOZ-ALLEN & HAMILTON, INC.
Information Technology Team

Fair Oaks, Virginia
October 19, 2000

TO: Derek Siegle, Rick Murphy, McRae Smith

FROM: Joe Sifer

Re: Attached ODC Expenditure Request

CC: Don Ashley, Andrew Ponce, Khalid Syed, Jamie Ter Beest

Attached for review and approval, if you concur, is a request for ODC funds ($58,968.00) to procure the equipment needed to provide an interoperability solution for the Washington, D.C. Metro Fire Department Initiative. Specifically, the requested funds are for the acquisition of eight (8) complete Incident Commanders' Radio Interface (ICRI) units, support equipment and training from Communications-Applied Technology of Reston, VA. Please indicate approval/disapproval and sign as appropriate.

✓ Request Approved

_____ Request Not Approved

Program Managers:

Derek M. Siegle 11/3/00
Justice Date

Julio R Murphy 11-03-00
Treasury Date

Contract Authorization:

Don Ashley 11/7/00
COTR Date

Please return a signed copy to La'Cretia Wright for BAH record-keeping purposes.

COMMUNICATIONS-APPLIED TECHNOLOGY

11250-14 ROGER BACON DRIVE RESTON, VA 20190-5202
(703) 481-0068 FAX (703) 471-4428
FED ID # 54-1215868, CAGE CODE 0EEY2

[ ] INVOICE ORIGINAL
[ ] INVOICE COPY
[X] PACKING LIST
[ ] PRO FORMA INVOICE (LOAN)

NUMBER	9487
DATE	Mar 20, 2001
TERMS	Net 30 days

SOLD TO:

Curt Andrich
c/o Booz-Allen & Hamilton, Inc.
8283 Greensboro Dr.
McLean, VA 22102

SHIPPED TO:

SALES ORDER NUMBER	PURCHASE ORDER NUMBER	F.O.B. POINT	METHOD OF SHIPMENT
2K0177.1	77411DG	RESTON, VA	

LINE ITEM	MODEL PART NUMBER	DESCRIPTION	QTY ORDERED	QTY SHIPPED	QTY ON BACK ORDER	UNIT PRICE	EXTENDED PRICE
1	500.9240	ICRI w/ 4 ports	8	8	0	$4,000.00	$32,000.00
2	179.6205	Extended radio port installed	8	8	0	$1,000.00	$8,000.00
3	179.0630	XTS3000/HT1000 Radio interface cable, 5 each	8 lots	8 lots	0	$970.00	$7,760.00
4	179.6206	250' extended interface cable	8	0	8	$300.00	$0.00
5	179.0650	Telephone acoustic coupler	8	8	0	$85.00	$680.00
6	180.0450	ICRI 8 "AA" battery adaptor	8	8	0	$120.00	$960.00
7	160.3611	"AA" battery packs (2 each)	8 lots	8 lots	0	$76.00	$608.00
8	990.9601	Pelican case w/ foam insert	8	8	0	$620.00	$4,960.00
9	Not applicable	4 Hours training session for 10 trainers at client's location	1 lot	0	1 lot	$2,000.00	$0.00
10	Not applicable	Shop manuals (2 each)	1 lot	0	1 lot	$200.00	$0.00

SUBTOTAL	$54,968.00
Virginia Sales Tax	$2,473.56
SHIPPING	$0.00
TOTAL	$57,441.56
Less pre-payment (invoice 9455)	$40,157.00
Amount due	$17,284.56

CERTIFICATE OF COMPLIANCE

It is hereby certified that all articles in the quantities as sold are in full compliance with all of the requirements, specifications and drawings listed on contract 77411DG. Test reports are on file indicating materials are in conformance to specifications.

Seth Leyman
President

3/20/01
date

COMMUNICATIONS-APPLIED TECHNOLOGY

11250-14 ROGER BACON DRIVE RESTON, VA 20190-5202
(703) 481-0068 FAX (703) 471-4428
FED ID # 54-1215868, CAGE CODE 0EEY2

[ ] INVOICE ORIGINAL
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[X] PACKING LIST
[ ] PRO FORMA INVOICE (LOAN)

NUMBER	9487.1
DATE	Mar 21, 2001
TERMS	Net 30 days

SOLD TO:

Curt Andrich
c/o Booz-Allen & Hamilton, Inc.
8283 Greensboro Dr.
McLean, VA 22102

SHIPPED TO:

Public Safety Wireless Network
12015 Lee-Jackson Hwy
Suite 400
Fairfax, VA

SALES ORDER NUMBER	PURCHASE ORDER NUMBER	F.O.B. POINT	METHOD OF SHIPMENT
2K0177.1	77411DG	RESTON, VA	UPS GND

LINE ITEM	MODEL PART NUMBER	DESCRIPTION	QTY ORDERED	QTY SHIPPED	QTY ON BACK ORDER	UNIT PRICE	EXTENDED PRICE
4	179.6206	250' extended interface cable	8	8	0		$0.00
9	Not applicable	4 Hours training session for 10 trainers at client's location	1 lot	0	1 lot		$0.00
10	Not applicable	Shop manuals (2 each)	1 lot	0	1 lot		$0.00

SUBTOTAL	$0.00
Virginia Sales Tax	$0.00
SHIPPING	$0.00
TOTAL	$0.00

CERTIFICATE OF COMPLIANCE

It is hereby certified that all articles in the quantities as sold are in full compliance with all of the requirements, specifications and drawings listed on contract 77411DG. Test reports are on file indicating materials are in conformance to specifications.

Bravo for Seth Leyman

Seth Leyman
President

3/21/01
date

Communications-Applied Technology
CAGE Code 0EEY2, TIN 54-1215868

BAH/PSWN ICRI Production Status as of 2/7/01
Task # 2K0177.1
Delivery schedule for 2/28/01

Feature #	Quantity	Feature Description	Status
1	8 ea	ICRI with 4 Radio Interface Ports and 1 Telephone Interface Port	PCBs in-house, electrically tested and inspected. 95% components in-house and kitted; balance due at C-AT 2/12. Chassis out to be drilled and painted; due at C-AT 2/16 (silkscreen prepared). Nylon pouch approved and requirement on order; due at C-AT 2/20
2	8 ea	1 Extended Distance Radio Interface Port installed in ICRI	On order. Connectors and cable due at C-AT 2/12. Production drawings approved. In house production/test hours scheduled.
3	8 lots	5 Radio Interface Cables XTS-3000/HT-1000	40 cables on order. Connectors and cable due at C-AT 2/16. Production drawings approved. Sub-contract labor scheduled.
4	8 ea	1, 250' Terminated Cable to Extend Radio Interface Cable	On order. Connectors and cable due at C-AT 2/16. Production drawings approved. In house production/test hours scheduled.
5	8 ea	1, Telephone Interface Cable (Acoustic Coupler)	Connectors and cable due at C-AT 2/12 Production drawings approved. In house production/test hours scheduled.
6	8 ea	1, ICRI-to-8 "AA" battery pack adaptor	Cable in-house, adaptor parts due 2/16 Production drawings approved. Sub-contract labor scheduled.
7	8 lots	2, 8 "AA" battery packs	Unmodified housing due at C-AT 2/16. Production drawings approved. In house production/test hours scheduled.
8	8 ea	"Pelican" case with fitted foam insert for items 1-7 and 4 Motorola radios	Case and foam insert design approved. On order. Due at C-AT 2/16
9	1 lot	Four hour training session for 10 trainers at client specified site in DC area to include materials as specified in BAH letter to C-AT of 9-29-00	Material in process.
10	1 lot	2, Technical/shop manuals as specified in BAH letter to C-AT of 9-29-00	Material in process.

Prepared by [signature] President, 2/8/01
Name/Title Date

BOOZ·ALLEN & HAMILTON, INC.
Information Technology Team

February 21, 2001
Fair Oaks, VA

To: Derek Siegle, Rick Murphy

From: Joe Sifer

Re: **Government Approval to Issue a Partial Payment to C-AT Communications for Metro DC Fire Project and to Invoice Government for Same on Upcoming BAH ODC Invoice**

Cc: Don Ashley, Dave Williams, Andrew Ponce, Curt Andrich [redacted]

Please indicate your approval of the above captioned actions. See attached the partial-payment invoice C-AT would like paid. See also attached a progress report from Curt Andrich, based on the team's site visit to C-AT on February 8, 2001. As noted in this progress report, we concur that 70% completion is accurate and a fair basis for the partial payment.

Program Managers:

Derek M. Siegle 2/21/01
Justice Date

Julio R. Murphy 02-21-01
Treasury Date

Contract Authorization:

2/21/01
COTR Date

Please return a signed copy to La'Cretia Wright for BAH record-keeping purposes.

COMMUNICATIONS-APPLIED TECHNOLOGY

11250-14 ROGER BACON DRIVE RESTON, VA 20190-5202
(703) 481-0068 FAX (703) 471-4428
FED ID # 54-1215868, CAGE CODE 0EEY2

[X] INVOICE ORIGINAL
[ ] INVOICE COPY
[ ] PACKING LIST
[ ] PRO FORMA INVOICE (LOAN)

NUMBER	9455
DATE	February 20, 2001
TERMS	Payable Upon Receipt

SOLD TO:

Curt Andrich
c/o Booz-Allen & Hamilton, Inc.
8283 Greensboro Dr.
McLean, VA 22102

SHIPPED TO:

SALES ORDER NUMBER	PURCHASE ORDER NUMBER	F.O.B. POINT	METHOD OF SHIPMENT
2K0177	77411DG	RESTON, VA	

LINE ITEM	MODEL PART NUMBER	DESCRIPTION	QTY ORDERED	QTY SHIPPED	QTY ON BACK ORDER	UNIT PRICE	EXTENDED PRICE
1		Payment for 70% of the work completed on Items #1-8	1 lot	1 lot		$39,878.00	$39,878.00
							$0.00
							$0.00
							$0.00
							$0.00
							$0.00
							$0.00
			SUBTOTAL				$39,878.00
			SHIPPING				$0.00
			TOTAL				$39,878.00

NOTE: A finance charge of 2% per month-annual rate 24% - will be charged on all past due accounts; the purchaser agrees to pay collection costs, including a reasonable attorney's fee.

CERTIFICATE OF COMPLIANCE

It is hereby certified that all articles in the quantities as sold are in full compliance with all of the requirements, specifications and drawings listed on contract 77411DG. Test reports are on file indicating materials are in conformance to specifications.

Kmbo for Seth Leyman
Seth Leyman
President

2/20/01
date

APPENDIX D
ICRI SETUP AND OPERATING PROCEDURES

COMMUNICATIONS - APPLIED TECHNOLOGY
11250-14 Roger Bacon Drive Reston, Virginia 20190-5202
800-229-3925 (voice) 703-471-4428 (fax) http://www.c-at.com (internet)

Revision A

Setup and Operating Procedures

ICRI™

Incident Commanders' Radio Interface

A Rapidly Deployable Radio Interoperability Solution For Emergency Responders

TABLE OF CONTENTS:

Theory of Operation	1
Pre-Operational Activities	2
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Section 2: ICRI Power Supplies and Connections	5
Section 3: Land Mobile Radio Interfaces	9
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Set-up	15
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Theory of Operation

The ICRI is a quick setup device that can provide two, three, four, five or six public safety agencies with radio interoperability as a tactical situation is rapidly unfolding before them. The ICRI requires little manpower resource to move it into place, to enable it initially, or to maintain its operation over many hours. The ICRI was designed to provide full operational capabilities in as little as one minute after arrival on-scene and the ICRI can remain operational for 24 hours on 8 "AA" batteries. Multiple ICRI-based "nets" can be operated a single incident; multiple ICRI-based "nets" can be rapidly linked together without hand tool and/or adjustments.

In simplest terms, the ICRI performs two primary functions:

- Distributes audio received from one two-way radio to other radios, telephone or recording device connected to thte ICRI.
- Utilizes this same incoming audio to "key" the other radios connected to the ICRI.

The ICRI does not discriminate or evaluate the incoming audio so that delays are not inserted into the audio transfer or "keying" processes. Radios, telephones and/or recording devices connected to the ICRI are provided with the incoming essentially in real-time (an initial delay at keying to preserve the first syllables of incoming audio as the transmitters [including wide area, repeater-based "trunked" radio systems] are keyed up).

An ICRI contains up to six circuits that key the radios connected to the ICRI; these circuits are commonly referred to as "VOX" or "voice-activated switches." The ICRI uses these circuits to perform other controlling functions as well. Only the VOX directly connected to the incoming audio is used to key each of the other radios simultaneously (all other are temporarily disabled, preventing a second "voice" from causing a disruption in initial voice being distributed).

Pre-Operational Activities

Some pre-planning is necessary to ready the ICRI for use. The following should be accounted for before placing the ICRI on-line:

1. Predetermine what the power source will be for the ICRI and verify that the cable or battery pack is available.
2. Predetermine what brand and model of radios will be connected to the ICRI and that an "interconnect" cable for each radio is available.
3. Advise agencies that will need to supply a "spare" radio, for the radio interoperability, that the radio supplied must be known to operate properly and have at least one fully charged battery.

The ICRI can be powered by a 9-volt DC battery or an aircraft 28-volt source. The LEDs on the ICRI provide information battery status, in particular, a reliable indication of a low voltage condition. *Note that if eight "AA batteries are used, the ICRI will continue operate to nominally for at least 2 hours after the "OK" LED is extinguished and the "LOW" LED has lit and then extinguished (batteries will provide a reduced duty cycle due to low quality, poor storage conditions before use, and/or low temperature during use).*

Among the possible power sources that can be used to power the ICRI are:

- 12 or 24 volt vehicle battery
- Vehicle cigarette lighter
- 115VAC (with an external adapter)
- BA590 "military"
- Commercial dry-cell battery (12V or greater)
- C-AT 12 volt battery pack (uses 8 "AA" batteries)
- Aircraft 28 volts DC

The ICRI's internal regulated power supply is both reverse polarity protected and fused, but it is important to check polarity of DC supplies before connecting them to the ICRI. *Note that the ICRI power input connector information appears on the bottom of the ICRI.*

SECTION 1: Set-up and Use Instructions

As a minimum, the following will be required for ICRI operation:

- ICRI assembly
- Power supply with interconnect cable to ICRI
- Two radio interface cables

Notes "A" though "D" are to be used when the ICRI has been delivered in a Pelican brand transit/storage case.

Notes "I" and "II" are to be used when the ICRI has been delivered in a fitted nylon pouch.

A. Opening the case may require relieving the partial vacuum that forms when the case has been relocated from one altitude to another (more than 1000'). Turn the knob, show in **FIGURE 1,** counter-clockwise; *be sure to close the purge valve after the pressure is released (turn clockwise) or the case will not be waterproof even with the lid latched.*

FIGURE 1

B. The Pelican case will appear as in **FIGURE 2** with radio interface cables located in the front recess. Note that a 1600 Series case will have cut-outs for the storage of four radios and a 1500 Series case will have two radio storage areas.

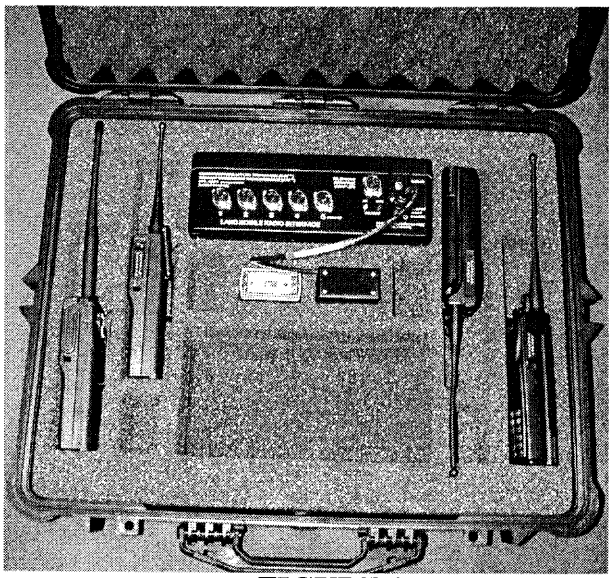


FIGURE 2

C. Additional cutouts are provided for the storage of an extra battery pack (a), and for the positioning of radios (b) during ICRI operations. **FIGURE 3.**

D. Abbreviated set-up instructions are printed on to the top cover of the ICRI assembly. Connector information, for radio, telephone, and power interconnect cables, is printed on the bottom of the ICRI assembly. Refer to **Appendices B** and **C**.

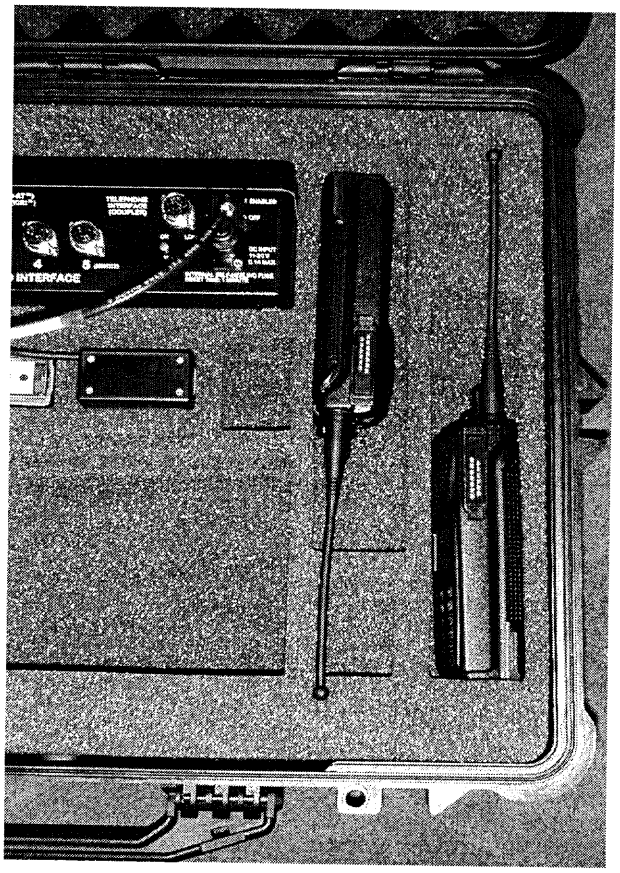


FIGURE 3

I. A storage compartment for cables and batteries is located at the rear of the pouch. (The internal strap prevents the ICRI from falling through the open zippered compartment. **FIGURE 4**.)

II. Abbreviated set-up instructions are printed onto the top cover of the ICRI assembly. Connector information for radio, telephone, and power interconnect cables is printed on the bottom of the ICRI assembly. Refer to **Appendices B and C.**

SECTION 2: ICRI POWER

2.1 If the C-AT battery pack (8 "AA" cells) is to be used to power the ICRI, the following instructions should be followed. **FIGURES 4, 5, 6, 7, 8.**

The battery housing is comprised of two parts; the exterior case and an internal tray. *NO TOOLS ARE NEEDED TO REMOVE THE TRAY AND REPLACE THE BATTERIES.*

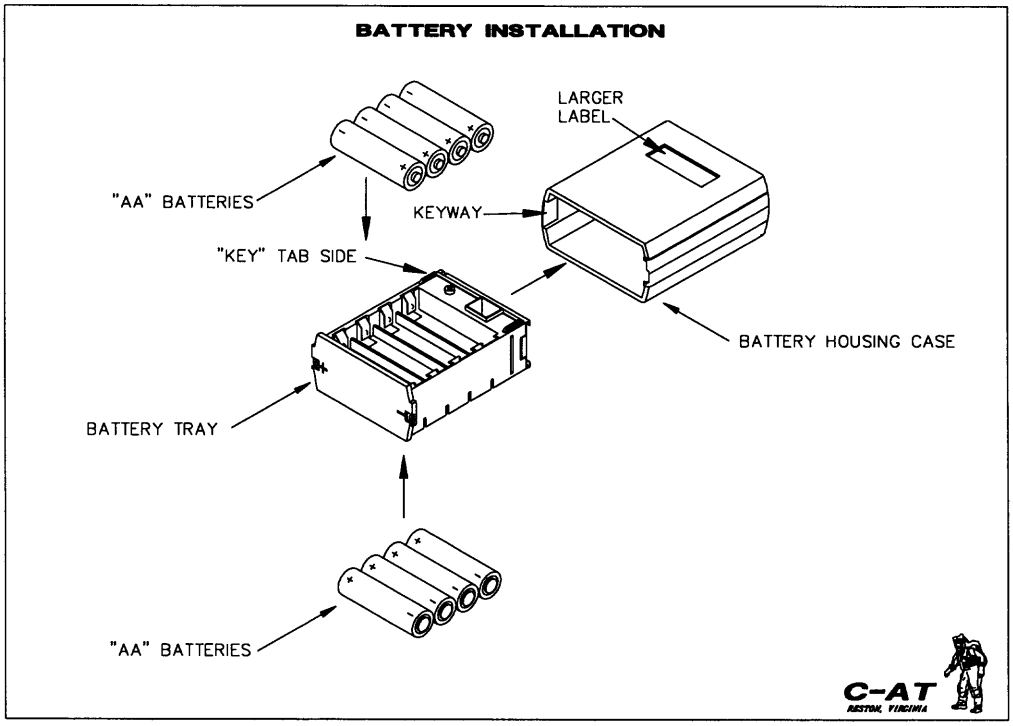


FIGURE 4

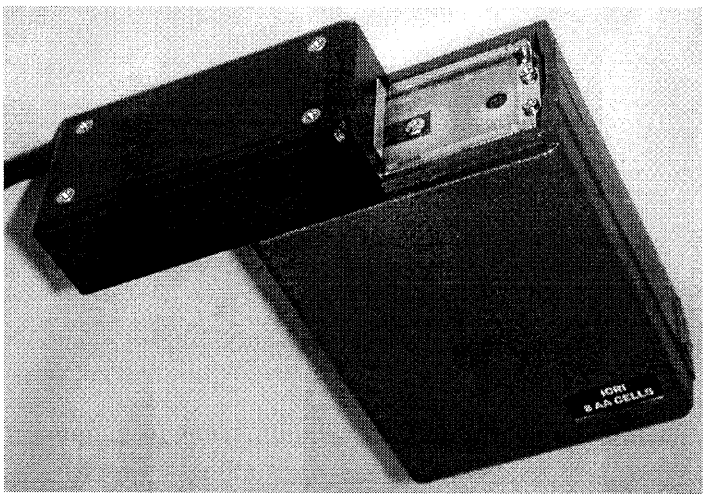


FIGURE 5

2.1.1 Hold the battery housing securely in the palm of the hand with metal battery terminal plate facing you with either label facing up. Push firmly on the center of the battery terminal plate, until the battery tray is released.

2.1.2 Remove old batteries and discard properly.

2.1.3 Replace the 8 "AA" alkaline batteries, observing polarity markings within the tray.

Note: There is a "key" tab on the side of the tray and a " keyway" inside of case.

2.1.4 To reinsert the tray into the case, make sure the tray's key goes in the keyed slot side of the case, **FIGURE 4**. Insert the tray into the housing from the bottom end of the case, pushing the tray until it "locks" into place. **FIGURE 6**.

2.1.5 To reinstall the assembled battery pack onto the adapter, align the slots on the top of the battery pack with the slide rails on the adapter. Slide the battery pack onto the adaptor until it "locks" in place and the edges of the battery pack are aligned with the edges of the adaptor. **FIGURE 5.**

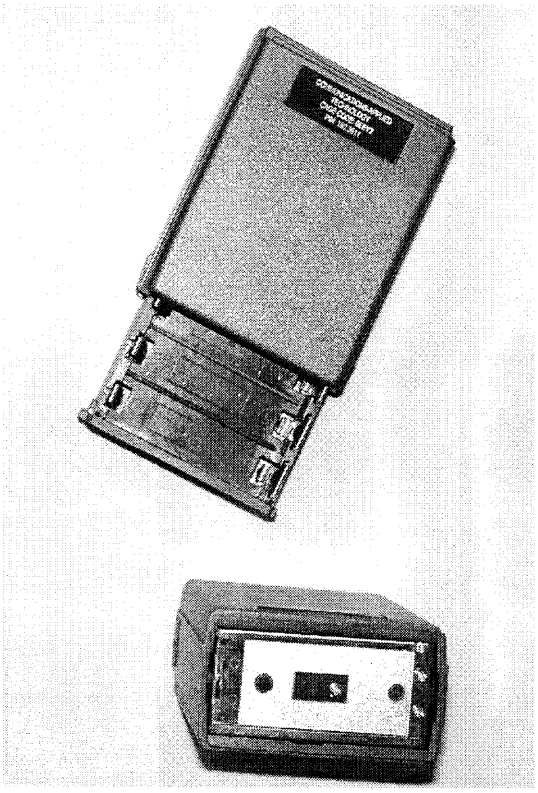


FIGURE 6

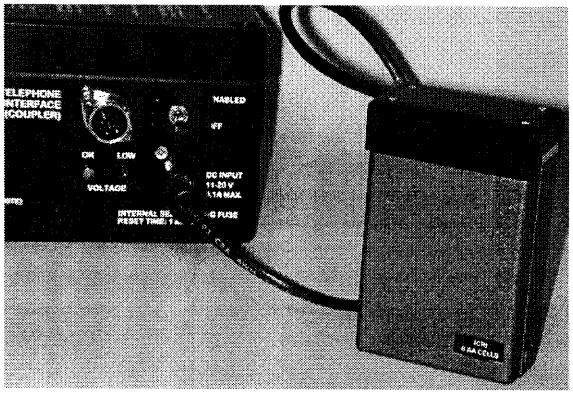


FIGURE 7

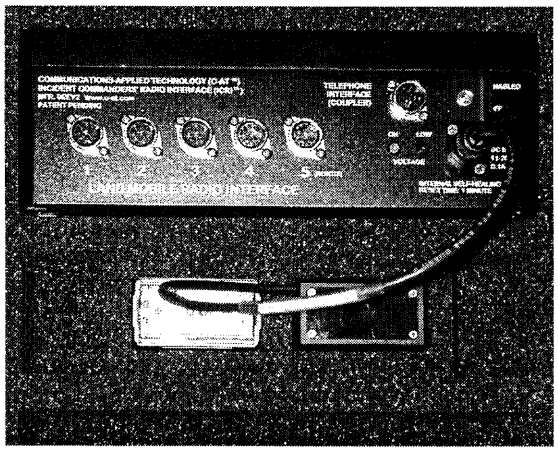


FIGURE 8

2.2.1 Powering the ICRI with an alternate DC source or through a vehicle cigarette lighter jack. This cable assembly consists of three subassemblies: (A) the universal interconnect cable, (B) the cigarette lighter plug/ locking in-line jack and (C) the alligator clips/locking in-line jack, **FIGURES 9 and 10.**

2.2.2 After selecting the DC source connect the in-line jack to the in-line plug. Note that the pins are polarized and the connection is made so that the jack's locking "blades" slide between the "blades" on the plug and the body of the plug.

2.2.3 Connect the assembled cable to the external DC source.

2.2.4 Connect the adapter's plug to the jack labeled **DC INPUT**.

Note: Align the plug's "key" with the jack's "keyway" before attempting to insert the plug.

2.2.5 To remove the plug hold the fluted part of the plug's barrel and pull straight out.

2.2.6 To separate the in-line socket *gently* lift one of the blades from the plug so that the locking mechanism is released. Then pull the plug and socket apart.

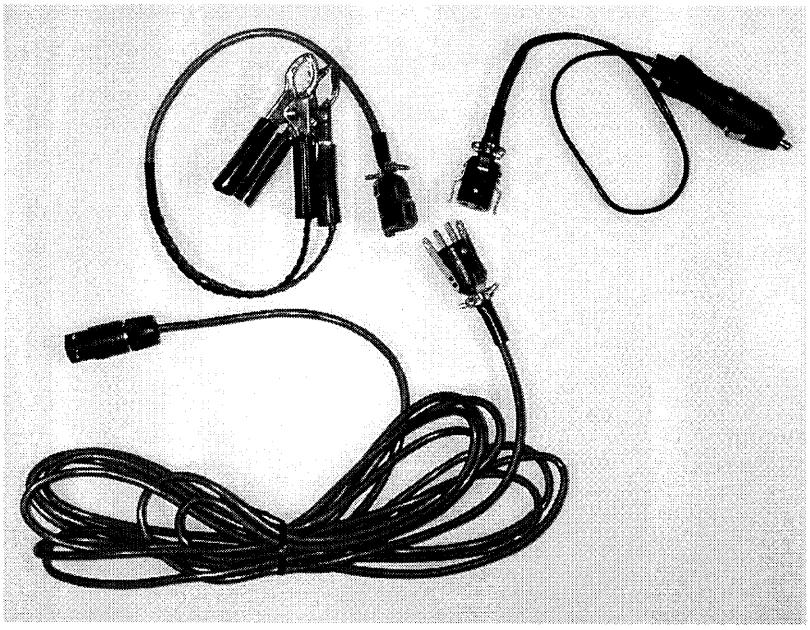


FIGURE 9

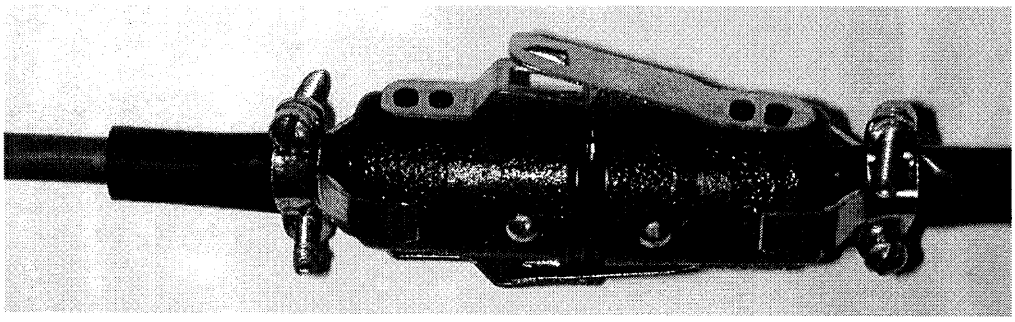


FIGURE 10

2.3.1 Power by AC. This power supply consists of two parts: (A) the three-prong AC power cable and (B) an AC to DC converter with an interconnect cable, **FIGURE 11.**

Note: The AC supply must not be used where the cables or converter can become wet.

2.3.2 Connect the power cord to the converter and to the DC source (110-120V, 60Hz).

2.3.3 Connect the adapter's plug to the jack labeled **DC INPUT**.

Note: Align the plug's "key" with the jack's "keyway" before attempting to insert the plug.

2.3.4 To remove the plug hold the fluted part of the plug's barrel and pull straight out.

FIGURE 11

SECTION 3: Land Mobile Radio Interface

NOTE: Radio interconnect cables are generally specific to a radio brand and model, although some manufacturer's use the same connector for several radio models. Interconnect cables provided by C-AT have a seven digit part number label on the cable. A chart crossing these numbers with the radio brands/models appear in ***Appendix A*** *of this document.*

3.1 Install the radio-end of the ICRI interconnect cable onto the radio, as you would install any radio accessory (i.e.: a shoulder speaker / microphone).

3.2 Tightening any locking screws is optional; but it is important that the connector be firmly seated against the radio so that good electrical contact is made. **FIGURE 11.**

3.3 Attach the other end of the cable to any of the **LAND MOBILE RADIO INTERFACE** jacks, labeled **1, 2, 3, 4** and **5. FIGURES 12 and 13.**

NOTE: The plug on the cable and the jack are "keyed". Be sure to align the key before inserting the plug on to the connector or the connection may be damaged.

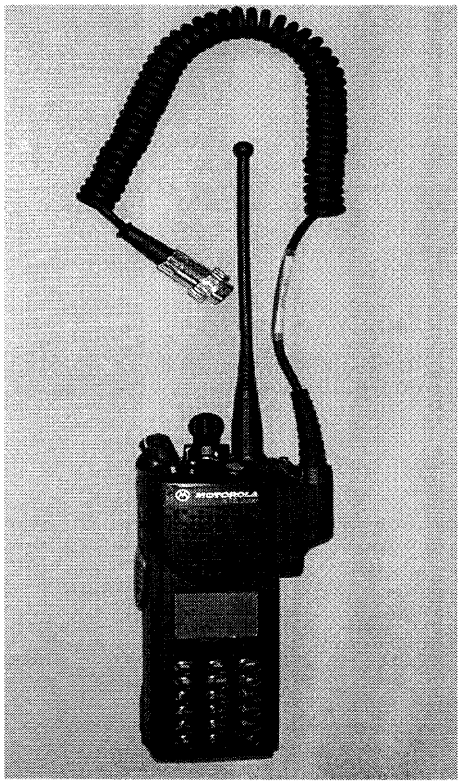


FIGURE 11

FIGURE 12

FIGURE 13

3.4 After the plug is fully seated on the jack, the locking ring on the plug should be turned clockwise until the ring cannot be turned further. **FIGURE 14**.

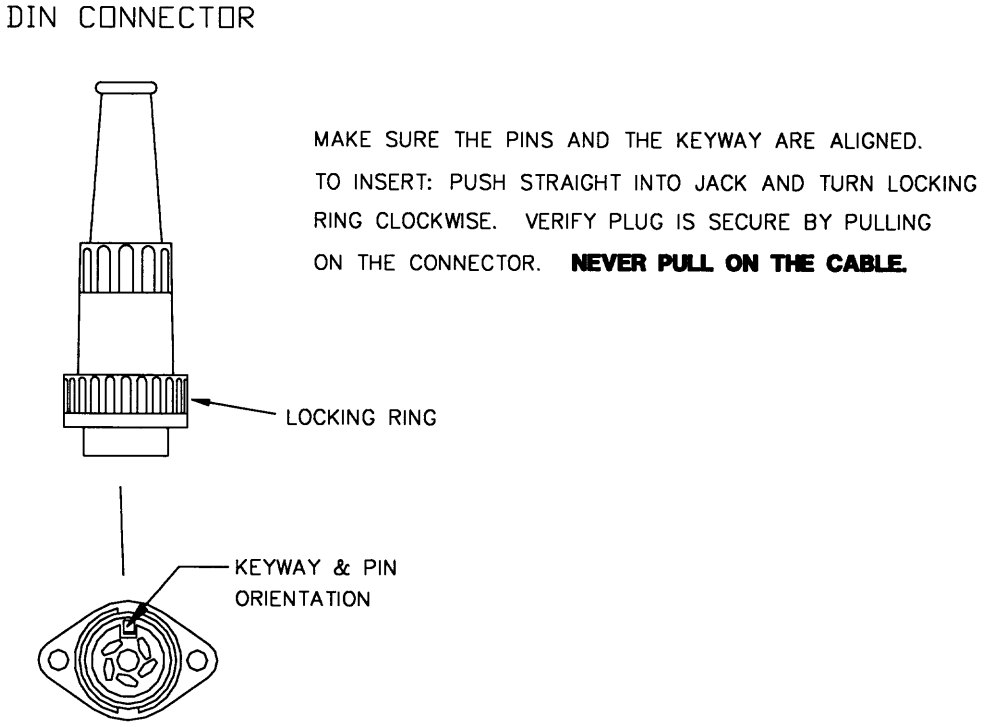


FIGURE 14

3.5 To remove the connector for cable storage, push inward on the locking ring and turn the ring counter clockwise to release the locking mechanism. Then pull the connector straight out of the jack. Hold the chrome barrel of the connector rather than the cable.

SECTION 4: TELEPHONE AND CELLULAR PHONE INTERFACE

NOTE: *If a land-line or cellular telephone will be linked through the ICRI to the 2-way radios, the "acoustic coupler" interconnect cable (part number 179.0650) can be used.*

If a cellular telephone with a 2.5mm "headset" jack will be linked through the ICRI to the 2-way radios, an interconnect cable (part number 179.0672) with a 2.5mm plug can be used.

4.1.1 The acoustic coupler, **FIGURE 15**, is installed on a telephone handset or cellular telephone by positioning the transducers over the speaker and microphone of the telephone. **FIGURES 16 and 17.**

4.1.2 Position the RED pad directly over the speaker (labeled **TO EARPIECE** on its cable) and secure by stretching the elastic strap over the handset/cell phone

4.1.3 Position the BLACK pad directly over the microphone (labeled **TO MOUTHPIECE** on its cable) and secure by stretching the elastic strap over the handset/cell phone. Based on the design of the cellular telephone, to place an out-going call may require moving the transducers in order to access the cell phone's keypad.

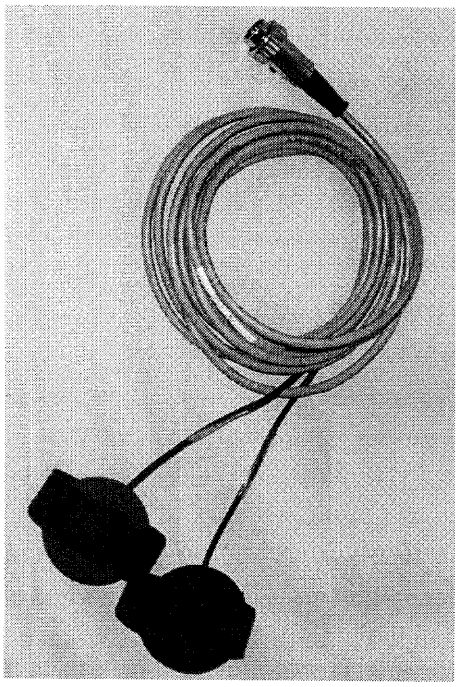


FIGURE 15

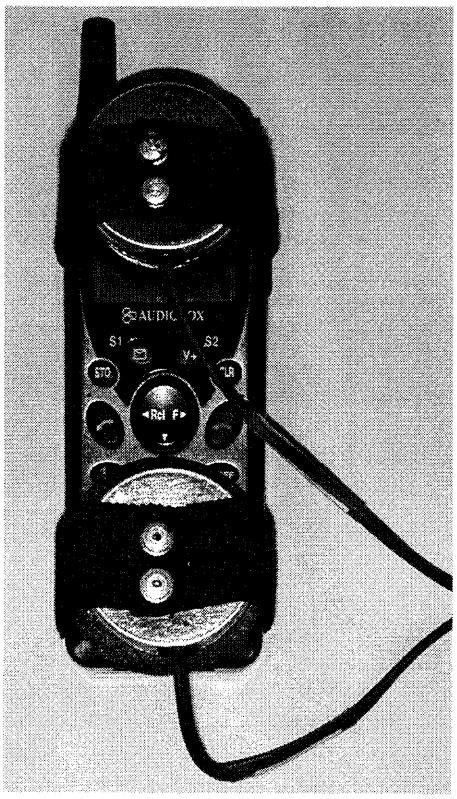


FIGURE 16

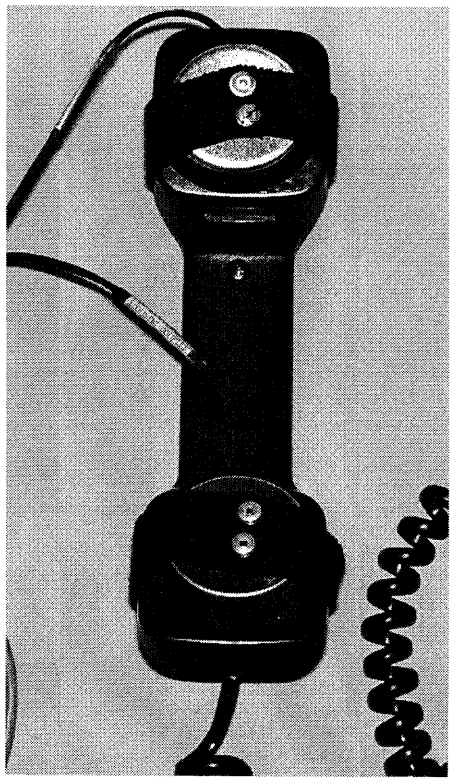


FIGURE 17

4.1.4 Plug into ICRI at jack labeled "Telephone Interface (Coupler)", **FIGURE 18.**

NOTE: The plug on the cable and the jack are "keyed". Be sure to align the key before inserting the plug on to the connector or the connection may be damaged.

4.1.5 After the plug is fully seated on the jack, the locking ring on the plug should be turned clockwise until the ring cannot be turned further. **FIGURE 19**.

FIGURE 18

4.1.6 Set telephone's earphone audio to a mid-level setting following the telephone's instructions.

4.1.7 After the interconnect cable from the repeater is connected to the telephone handset, a dial tone should be heard in the earphones of the portable radio and in the earpiece of the "local" handset.

4.1.8 Dial the telephone number of another telephone.

4.1.9 When the called party answers, use the portable radio's throat mic or a headset and begin to converse with called party.

4.1.10 To remove the connector for cable storage, push inward on the locking ring and turn the ring counter clockwise to release the locking mechanism. Then pull the connector straight out of the jack. Hold the chrome barrel of the connector rather than the cable.

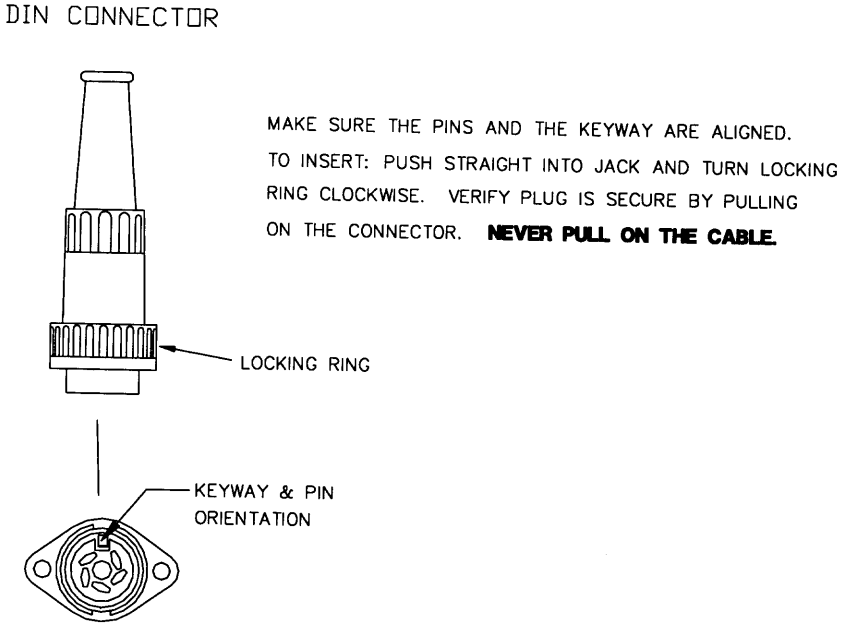


FIGURE 19

4.2.1 When connecting to a cellular telephone connect the small, single shaft connector to the headset jack on the cellular telephone. Be sure it is firmly seated in the telephone. **FIGURES 20 and 21.**

4.2.2 Plug into ICRI at jack labeled "Telephone Interface (Coupler)", **FIGURE 18.**

NOTE: The plug on the cable and the jack are "keyed". Be sure to align the key before inserting the plug on to the connector or the connection may be damaged.

4.2.3 After the plug is fully seated on the jack, the locking ring on the plug should be turned clockwise until the ring cannot be turned further. **FIGURE 19.**

4.2.4 Set telephone's earphone audio to a mid-level setting following the telephone's instructions.

4.2.5 After the interconnect cable from the repeater is connected to the telephone handset, a dial tone should be heard in the earphones of the portable radio and in the earpiece of the "local" handset.

4.2.6 Dial the telephone number of another telephone.

4.2.7 When the called party answers, use the portable radio's throat mic or a headset and begin to converse with called party.

4.2.8 To remove the connector for cable storage, push inward on the locking ring and turn the ring counter clockwise to release the locking mechanism. Then pull the connector straight out of the jack. Hold the chrome barrel of the connector rather than the cable.

FIGURE 20

FIGURE 21

SECTION 5: LINKING ICRIS

FIGURE 21

5.1.1 Connecting an interface cable, PN 179.0656, to the Telephone Interface jacks of two ICRIs will permit interoperability of more than five radios, **FIGURE 21**.

5.1.2 Plug into ICRI at jack labeled "Telephone Interface (Coupler)", **FIGURE 22.**

NOTE: The plug on the cable and the jack are "keyed". Be sure to align the key before inserting the plug on to the connector or the connection may be damaged.

FIGURE 22

5.1.3 After the plug is fully seated on the jack, the locking ring on the plug should be turned clockwise until the ring cannot be turned further. **FIGURE 23**.

5.1.4 To remove the connector for cable storage, push inward on the locking ring and turn the ring counter clockwise to release the locking mechanism. Then pull the connector straight out of the jack. Hold the chrome barrel of the connector rather than the cable.

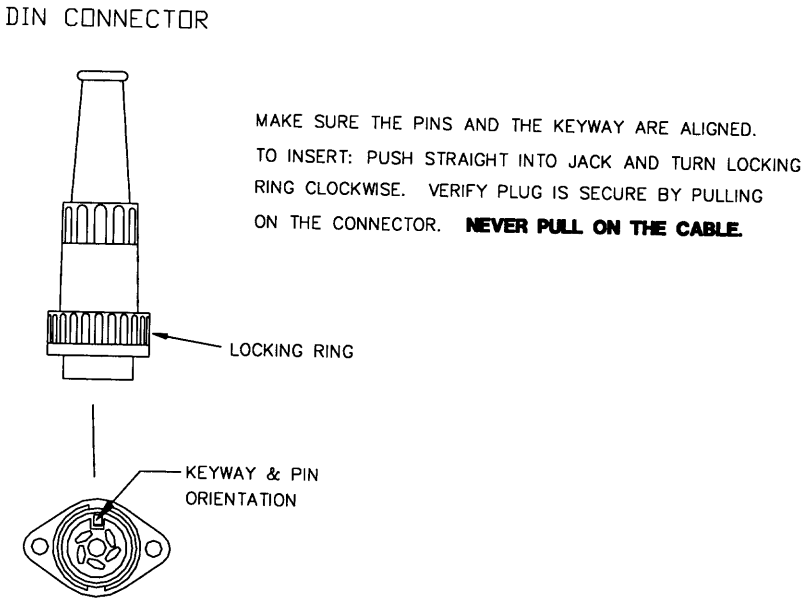
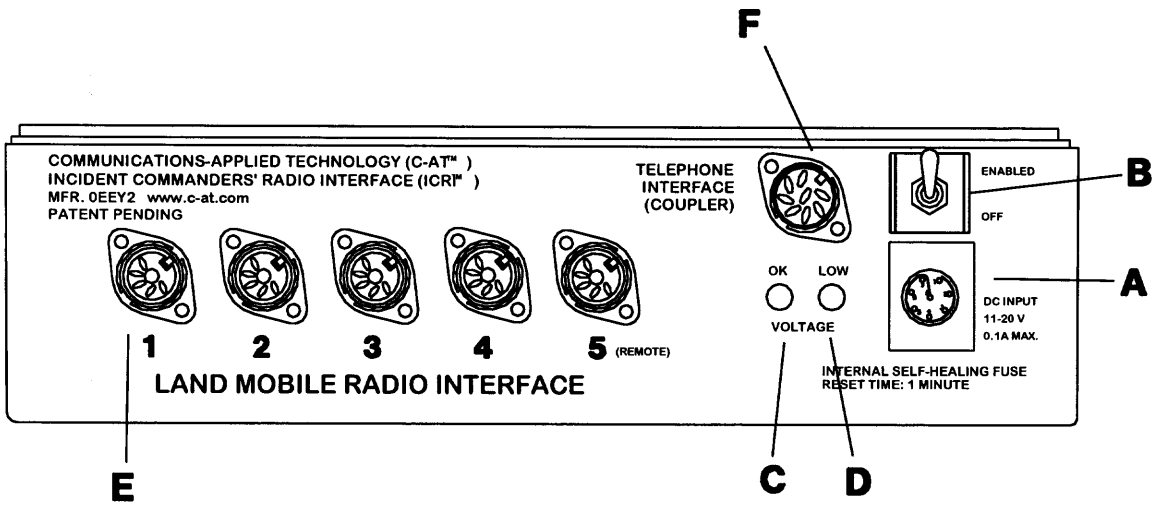


FIGURE 23

Setup:

1. After connecting a power source to the ICRI (A), turn on the ICRI at (B) so that power up and input voltage can be verified. If you need to use a DC source voltage between 9 and 10.4 volts, then neither the OK (C) nor the LOW (D) voltage LEDs will be lit, but the ICRI will be working.
2. Connect the radio interface cables to the ICRI. All five ICRI radio interface connections (E1-5) are electrically identical, so it is not important which jacks are used during ICRI operation.
3. Connect the radio interface cables to the radios.
4. Be sure the radios are on the channels assigned to the interoperability function.
5. Turn the radios on; place the radio volume controls at a mid-position between fully counter-clockwise and fully clockwise.
6. Connect the telephone if it will be used.
7. Turn on the telephone

FRONT PANEL:



DC INPUT JACK: **A**

This 8-pin locking-type jack is the input.

Pinout:

1- Power (+) Internally fused (self-healing, one minute reset time)
2- Gnd
3- 8 No connection

ON-OFF SWITCH: **B**

This switch is used to turn the ICRI "**ON**" and "**OFF**".

OK VOLTAGE LED: **C**

This LED indicate the following:

"Green" lit: input voltage 11.2 or greater

LOW VOLTAGE LED: **D**

This LED indicate the following:

"Red" lit: input voltage 9.8 to 11.1 volts

Note: If neither is lit, the ICRI will operate on voltage as low as 9V and as high as 30VDC

RADIO INTERFACE JACK (1 thru 5) **E**

This 5-pin locking-type jack is

Pinout:

1- Gnd
2- Audio from radio
3- Audio to radio
4- P-T-T Enable (Motorola® Saber/Astro-Saber) only
5- P-T-T Enable (except Motorola Saber and Motorola P Series Radios)

TELEPHONE INTERFACE (COUPLER) JACK: **F**

This 8-pin locking-type jack is

Pinout:

1- Audio to Telephone (input to telephone's microphone)
2- Audio from Telephone (output from telephone's speaker)
3- To phone
4- From phone
5- Shield Gnd

CELL PHONE INTERFACE JACK: **F**

This 8-pin locking-type jack is

Pinout:

1-4- N/A
5- Shield
6- Required jumper
7- To phone
8- From phone

Appendix A

Incident Commanders' Radio Interface™

ICRI™

PATENT PENDING

PART DESCRIPTION	C-AT PART NUMBER
ICRI (Incident Commanders' Radio Interface) assembly, with 4 radio I/O ports and 1 telephone I/O port. Supplied with padded carrying case	500.9240
Motorola™ models MT-1000, HT-600, HT-2000, MT-300, MTX-800, MTX-820S, MTX-900 & Radius P-200 interface cable	179.0640
Motorola™ models MT-2000, JT-1000, HT-1000, MTS-2000, MTX-6000, MTX-838 & XTS-3000 interface cable	179.0630
Motorola™ models Astro/Saber, Saber I, II, and III interface cable	179.0710
Radio adaptor cable with 12-pin Hirose™ termination	179.1910
Com-Net Ericsson ™ MPA radio interface cable	179.0660
Com-Net Ericsson ™ MRK radio interface cable	179.0661
Com-Net Ericsson ™ LPE 200 radio interface cable	179.0662
Com-Net Ericsson ™ Jaguar radio interface cable	179.0733
Com-Net Ericsson ™ Panther radio interface cable	179.0732
Bendix King ™ LMH radio interface cable	179.0670
Bendix King ™ LPH radio interface cable	179.0671
250' universal extension cable (used in conjunction with 179.6205 and any radio interface cable)	179.6206
5th radio I/O port configured for extended physical separation between ICRI and radio.	179.6205
5th radio I/O port configured for standard separation between ICRI and radio.	179.6207
ICRI to 8 "AA" battery pack adaptor	180.0450
8 "AA" battery pack	160.3611
Cellular telephone (generic, acoustic coupler) interface cable	179.0650
Direct connection cable to cellular telephone headset jack (2.5mm plug)	179.0672
SINCGARS and other "green gear" radio interface cable (U-229/U connector)	179.0600
Aircraft intercom interface (fixed / rotary wing, civilian / commercial intercom systems)	Contact mfgr
ICRI-to-ICRI link cable to expand # of linked radios (note: requires use of both telephone interface ports)	179.0656
DC input cable, dual mode (alligator clips and vehicle cigarette lighter plug)	179.0730
115V AC adaptor	320.0431
Motorola Interface P-1225	179.0634
Motorola MCS-2000	179.0635
Motorola Spectra	179.0636
ICRI link to ICRI	179.0656

NOTE: Other radio interface cables are available. Please request a quotation.

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APPENDIX B

SET-UP INSTRUCTIONS FOR THE ICRI™

1. SELECT THE POWER SOURCE TO BE USED: 12 V "AA" ALKALINE BATTERY PACK, 115V AC, OR VEHICLE SUPPLIED DC.

2. CONNECT THE EXTERNAL POWER SUPPLY TO THE ICRI USING EITHER THE "AA" ALKALINE BATTERY PACK, THE 115V AC CONVERTER, OR THE CIGARETTE LIGHTER ADATOR. THE CONNECTOR IS "KEYED"; DO NOT ATTEMPT TO FORCE THE CONNECTOR INTO THE JACK ON THE ICRI.

NOTE: TO REMOVE THE CONNECTOR, PULL ON THE BACK OF THE CONNECTOR BODY INSTEAD OF TWISTING OR TURNING THE CONNECTOR.

3. TURN ON THE ICRI. THE RED OR GREEN LIGHT BELOW THE POWER SWITCH SHOULD BE LIT.

NOTE: IF NEITHER LIGHT IS LIT, VERIFY THAT THE POWER SOURCE IS PROPERLY CONNECTED AT BOTH ENDS. THE RED LIGHT INDICATES THAT THE SOURCE VOLTAGE IS ENOUGH TO OPERATE THE ICRI, BUT IF THE SOURCE IS "AA" BATTERIES THEN THEY SHOULD BE CHANGED TO FRESH ONES AT THE EARLIEST OPPORTUNITY.

4. CONNECT THE RADIO OR TELEPHONE INTERFACE CABLES TO THE ICRI. THE CONNECTORS ARE "KEYED": DO NOT ATTEMPT TO FORCE A CONNECTOR INTO THE JACKS ON THE ICRI. WHEN THE CONNECTORS ARE SEATED ON THE JACKS, TURN THE "RING" CLOCKWISE TO LOCK THE CONNECTOR IN-PLACE.

NOTE: TO REMOVE THE CONNECTOR, TURN THE "RING" COUNTER-CLOCKWISE TO UNLOCK THE CONNECTOR, AND THEN PULL ON THE CONNECTOR BODY INSTEAD OF TWISTING OR TURNING THE CONNECTOR.

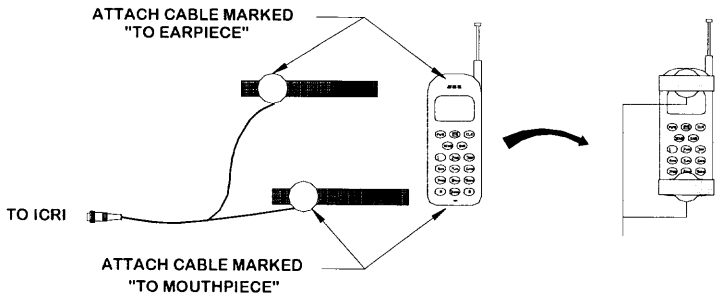
5. BEFORE CONNECTING A RADIO, LANDLINE TELEPHONE OR CELLULAR TELEPHONE TO THE ICRI VERIFY THAT IT IS WORKING NORMALLY AND HAS A FULLY CHARGED BATTERY. THEN TURN OFF THE RADIO OR TELEPHONE.

6. CONNECT THE RADIO INTERFACE CABLE(S) TO THE RADIO(S).

7. TURN ON THE RADIO(S) AND PLACE THE RADIO VOLUME CONTROL(S) IN A MID POSITION OF THE KNOB'S ROTATION.

NOTE: THE RADIOS DO NOT HAVE TO BE SEPARATED BY ANY PARTICULAR DISTANCE, BUT THEY SHOULD NOT BE SET ON TOP OF ONE ANOTHER.

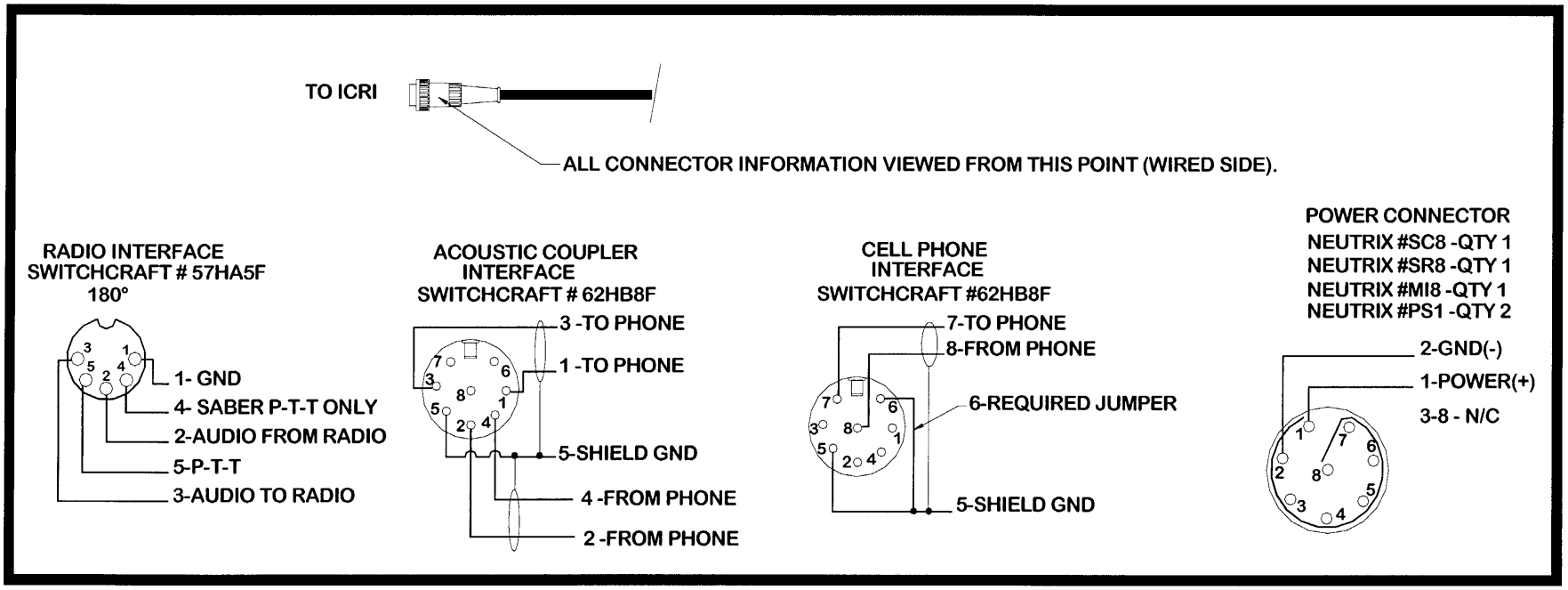
8. IF THE TELEPHONE INTERFACE IS USED, THE ATTACHMENT OF THE ACOUSTIC COUPLER SHOULD BE MADE ACCORDING TO THE FOLLOWING DIAGRAM:



NOTE: CONNECTOR PIN-OUT INFORMATION IS LOCATED ON THE BOTTOM OF THE CHASSIS OF THE ICRI.

TOP COVER OF THE ICRI

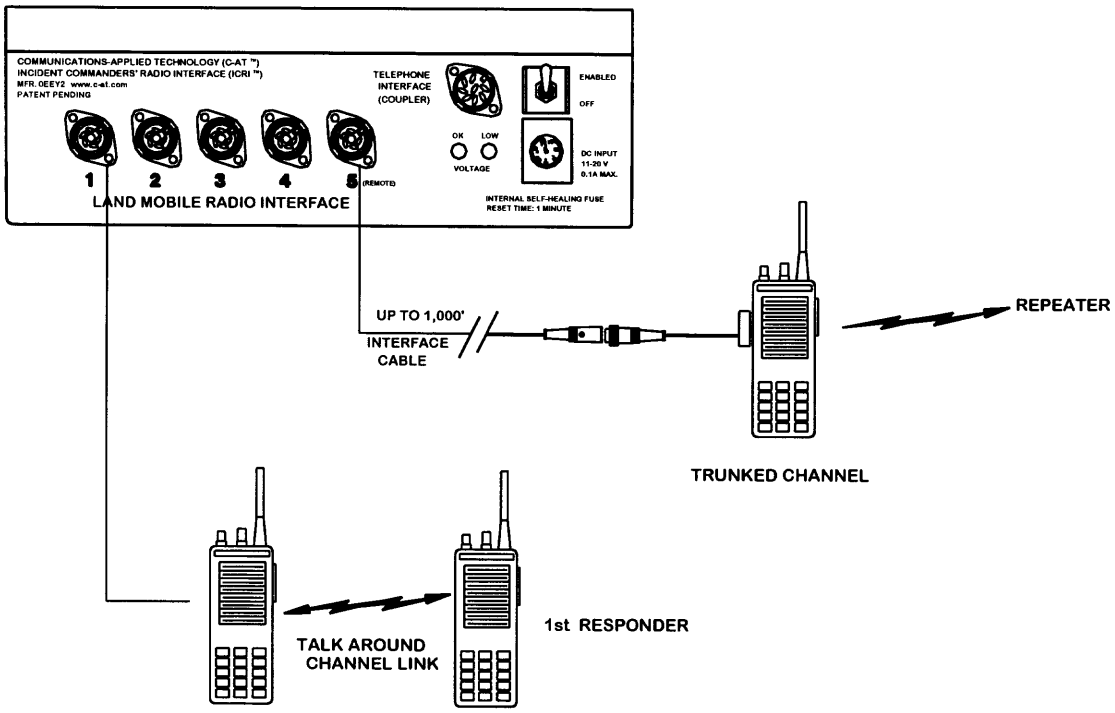
APPENDIX C



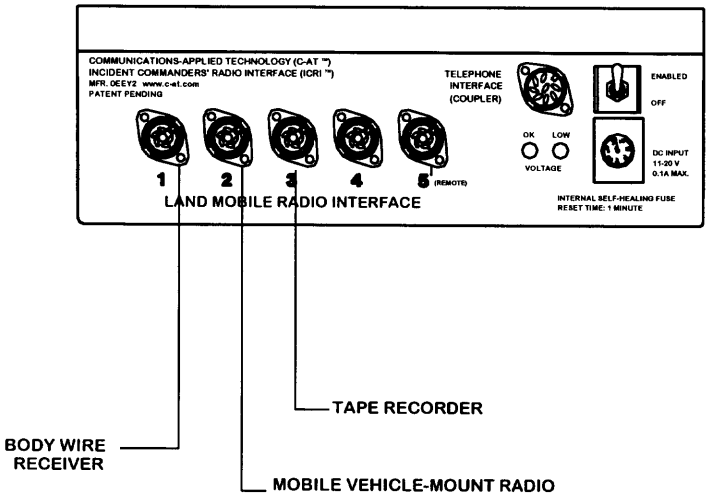
BOTTOM OF ICRI CHASSIS

APPENDIX D

BELOW GRADE OR IN-BUILDING LINK TO TRUNKED REPEATER

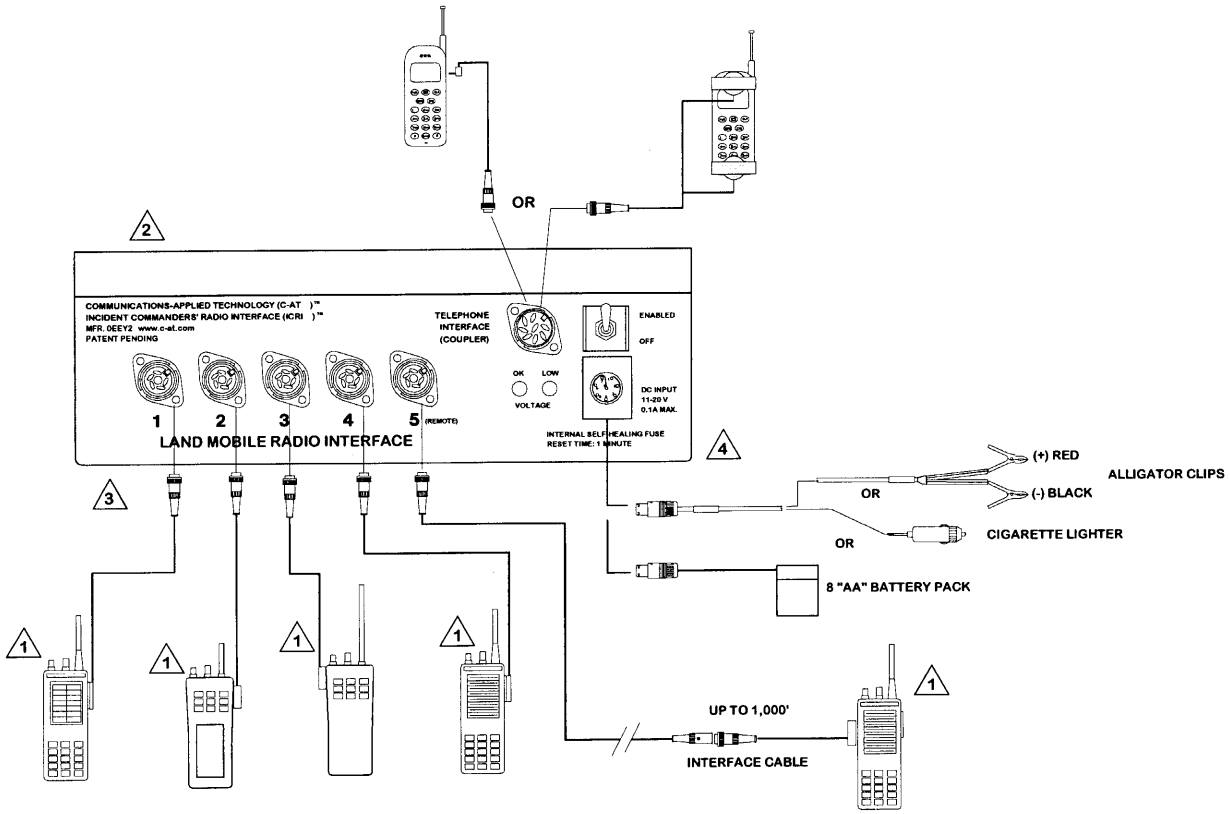


ICRI ALTERNATE APPLICATIONS



ICRI WITH ATTACHMENTS

(NOTE: NOT TO SCALE)



1. PORTS ARE NOT RADIO SPECIFIC (PORTABLE OR MOBILE RADIO CAN BE USED.)
2. USER INSTRUCTIONS ON TOP COVER.
3. INTERCONNECT CABLE TECHNICAL NOTES ON BOTTOM SIDE.
4. INTERNAL SELF-RESETTING FUSE, 1 MINUTE RESET.

APPENDIX E
LIST OF ACRONYMS

APPENDIX E—LIST OF ACRONYMS

C-AT	Communications-Applied Technology
COTS	Commercial Off-the-Shelf
dB	Decibels
dBm	Decibels Above One Milliwatt
DCFD	District of Columbia Fire Department
GND	Electrical Ground
EMS	Emergency Medical Services
FM	Frequency Modulation
ICRI	Incident Commander's Radio Interface
kHz	Kilohertz
LOS	Line-of-Sight
MHz	Megahertz
ms	Milliseconds
mm	Millimeter
ODC	Other Direct Costs
PCS	Personal Communications Service
PL	Private Line
PSWN	Public Safety Wireless Network
PTT	Push-to-Talk
RF	Radio Frequency
SINAD	Signal plus Noise plus Distortion to Noise plus Distortion
WMS	Wireless Measurement System
UHF	Ultra High Frequency
VHF	Very High Frequency
VOX	Voice Operated Squelch
WMATA	Washington Area Metropolitan Area Transit Authority