

Reliable Priority-Access Communication Infrastructure for Major Outage Recovery Operations

(Phase I, Scoping Study)

Technical Report

Reliable Priority-Access Communication Infrastructure for Major Outage Recovery Operations

(Phase I, Scoping Study)

1002261

Final Report, November 2003

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PRODUCT DESCRIPTION

This report identifies and defines requirements for a **secure** Land Mobile Radio (LMR) voice and data communication system to ensure interoperability between utility companies and federal, state and local public safety agencies. The project defines a collaborative effort between the Electric Power Industry and the United States Government, specifically with the Department of Homeland Security (DHS). This report describes Phase I, which consists of a scoping study focused on the identification and definition of requirements to be satisfied by an LMR Pilot Project system that EPRI will design and implement in Phases II and III.

Results & Findings

Varying levels of complexity exist with radio systems currently owned and operated by EPRI stakeholders. The utilities surveyed in Phase I are security-conscious and actively employ information security practices and procedures. The typical use for LMR communications among the EPRI stakeholders surveyed is to maintain contact with field workers for scheduling or reallocating manpower to outage or other work locations. A limited need is perceived for data services other than simple low data rate status messages. Connectivity to facilitate electronic mail would be beneficial during extended outage restorations to provide contact with workers' families and for dissemination of general non-time-sensitive information.

Utilities use portable (hand-held) radios mainly for local area communication and coordination at outage locations. The overwhelming use of LMR today is from vehicle-mounted mobile units, including bucket trucks. More than one stakeholder expressed a requirement for remote connectivity to the utility's communications system from the bucket of a bucket truck or elsewhere outside the vehicle cab, but within the general vicinity of the vehicle. Power generation plants usually employ multiple segregated radio networks or separate trunked radio system talkgroups within the facility for use by different work crews or functions.

Challenges & Objectives

Electric utility systems are vulnerable to disruption at any time from the effects of natural and man-made disasters. Utility companies have conducted exhaustive research and effort to prevent service interruptions and, in the event of unforeseen outages, quickly restore full capacity and service. Reliable communication capability must exist both within a utility and between EPRI stakeholders and government emergency services respondents to effect rapid recovery operations during a major disruption in the power system. Communications ability was critical during the aftermath of the September 11, 2001 terrorist attacks and, more recently, the widespread blackout in August 2003. During this massive power outage, utility company LMR systems continued to operate even as the outage rendered commercial wireless networks virtually useless.

The Department of Homeland Security (DHS) has established the goal of blanketing the US with radio systems that can interoperate in the event of a national emergency. Protection of the nation's critical infrastructure, such as power generation and distribution facilities, is a major focus for the DHS to achieve its objectives.

One of the steps taken to provide radio interoperability capability is the installation of an LMR trunking system covering the State of Hawaii. Administrated by the Department of Defense, the ultimate goal of the Pacific Mobile Emergency Radio System (PACMERS) is to provide secure digital radio communications throughout the Pacific Rim for public safety, first responders, and other disaster relief agencies. Implementation of PACMERS has also begun in Alaska, and initial studies completed in Guam.

Applications, Values & Use

Radio communication systems are continuously evolving to incorporate new features and improve implementation of older features. Recommendations in this report reflect both the most current point in that evolution as well as innovations in development. Some of these innovations have potential for improving operational efficiency and security as well as providing lower cost options for system upgrades.

This Scoping Study report considers current and near-term technologies in radio system configuration. Functionality available through technology can provide utility companies interoperability between disparate radio systems; increased security by using encryption to protect sensitive information from interception by potentially hostile users; economic utilization of limited radio frequency resources; and increased operational efficiency.

EPRI Perspective

This is the only known program specifically targeted at improving both daily operations and outage recovery efficiency and security for the electric utility system through improvement of their radio systems.

Approach

The project team prepared this report by surveying EPRI stakeholders to identify their LMR voice and data communications requirements.

Keywords

Outage communications

Encryption

Land Mobile Radio

Secure digital radio communication

Interoperability

Trunked radio systems

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Phase II is the design and developmental phase consisting of identifying the design and engineering details to implement requirements defined in Phase I. Phase II will also consist of site surveys to identify existing infrastructure that can be leveraged to provide a cost effective systems design. In addition, an RF propagation coverage analysis will be performed in Phase II to show expected areas of coverage for the pilot project.

Phase III of the Pilot Project will implement the system design developed in Phase II. This includes installation, operational testing, user training, and performance testing.

1.2 Project Participants

The Electric Power Research Institute (EPRI) identified 18 Outage Mitigation and Recovery Program stakeholders as participants in Phase I of the Reliable Priority-Access Communication Infrastructure for Major Outage Recovery Operations Pilot Project. These stakeholders are a representative sample of utility companies with metropolitan and rural customers throughout the United States, including Alaska and Hawaii:

- Alabama Electric Cooperative, Inc.
- Arkansas Electric Cooperative Corp.
- California Dept of Water Resources
- Central Hudson Gas & Electric Corp.
- City Public Service, San Antonio
- Dairyland Power Cooperative
- Grant County Public Utility District
- Hawaiian Electric Co, Inc.
- Hoosier Energy Rural Electric Coop, Inc.
- Kansas City Power & Light Co.
- Lincoln Electric System
- MidAmerican Energy Co.
- Omaha Public Power District
- Public Service Co of New Mexico
- Public Service Electric & Gas Co.
- Tri-State G&T
- TVA & East Kentucky Power Cooperative, Inc.

2

SCOPING STUDY OVERVIEW

2.1 Objectives

Five primary objectives were established by EPRI for Phase I of the Pilot LMR Project, the Scoping Study:

- Coordinate with utility companies identified by EPRI representatives as Outage Mitigation and Recovery Program stakeholders, and the Department of Homeland Security to define the requirements for the design and developmental phase and for the Pilot Project implementation phase.
- Investigate and identify technical solutions to provide secure LMR capability that features interoperability with utility companies and federal, state, and local safety agencies for purposes of homeland security.
- Assess the three identified potential pilot locations, as well as others recommended by the EPRI Outage Mitigation and Recovery Program representative. Determine the best type of theater for demonstration of the Pilot Project LMR system capabilities and complementing technologies required to satisfy utility company needs and delineate the criteria for this determination.
- Provide a costing rough order of magnitude (ROM) for activities in Phases II and III of the Pilot Project. The Phase III ROM will be refreshed during Phase II.
- Identify project funding requirements and options.

2.2 Methodology

ISS interviewed key personnel representing EPRI Outage Mitigation and Recovery Program stakeholders. The objective was to identify and define LMR system requirements by:

- Assessing existing systems, capabilities and limitations, and
- Identifying information exchange requirements among and between utility companies and public safety and relief/response organizations.

ISS visited 4 utilities to conduct the survey interviews and completed the survey instrument with one utility company telephonically.

ISS also coordinated with LMR equipment manufacturers to identify new features and equipment under development that could have applicability to the Electric Power Industry.

Figure 2-1 provides an overview of the rough timeline of Phase I Scoping Study activities.

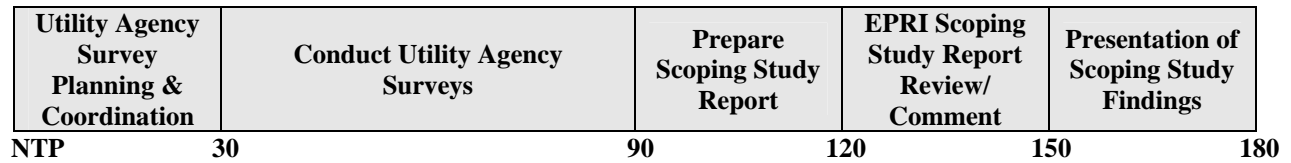


Figure 2-1
Phase I: Scoping Study Timeline

2.3 Participants

ISS conducted in-depth survey interviews with key personnel at several EPRI Outage Mitigation and Recovery stakeholder utilities. Surveys were conducted with:

- Central Hudson Gas and Electric Corporation
- Lincoln Electric System
- MidAmerican Energy Company
- Public Service Electric and Gas Company
- Tri-State Generation and Transmission Association, Incorporated

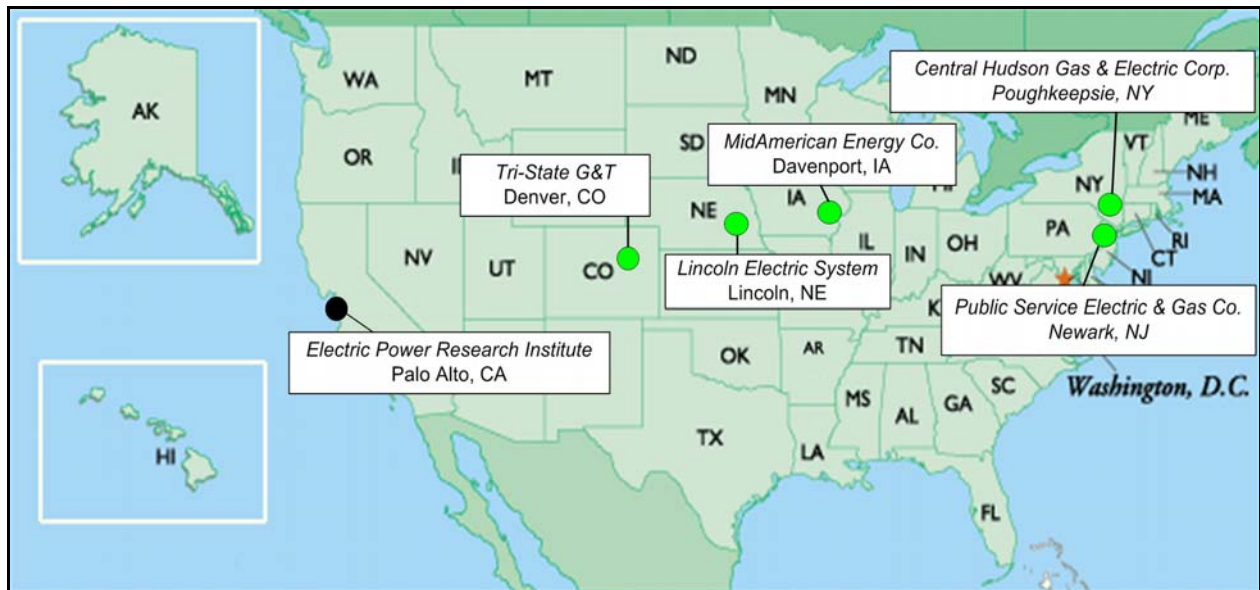


Figure 2-2
Stakeholders Surveyed

2.4 Technology

Trunked LMR radio technology is the most viable solution for the EPRI Pilot Project. Trunked radio systems get their name from the trunk line used in commercial telephone communications infrastructure. A trunk is a communications path between two or more points, typically between telephone exchanges or a telephone exchange and one or more users; that is, not dedicated to any one user. With the application of the trunking principal to radio communications, a radio channel is not dedicated to only one small group of users as in conventional radio systems.

In conventional Mobile Radio systems, each group of users for a particular function would essentially have its own dedicated radio system. Each system would have enough capacity to handle the highest traffic period, but under normal conditions, the system would be underutilized.

As the name implies, all users in trunking systems share a common set of radio frequencies. This allows a small number of frequencies to be shared by a large number of users. In conventional radio systems, groups of users are always on the same radio channel. In trunking systems, whenever the push-to-talk (PTT) button is pressed, the system finds a free radio channel and assigns it to the call. A new radio channel is assigned for each press of the PTT button, even during the same conversation.

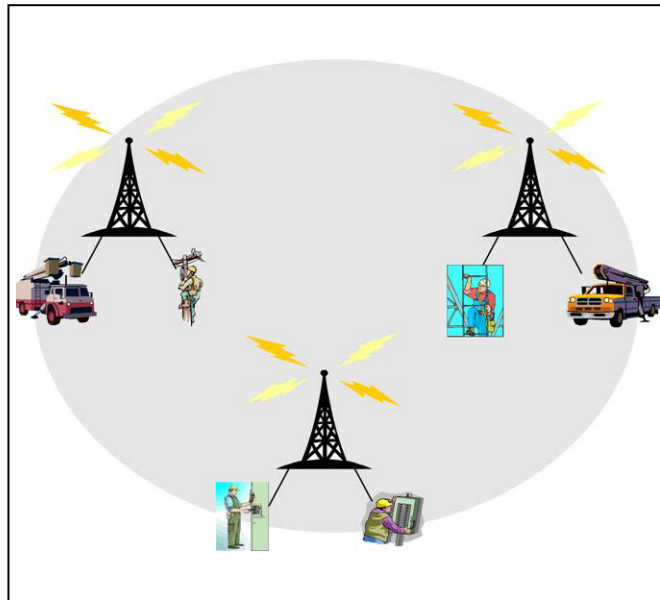


Figure 2-3
Conventional LMR System

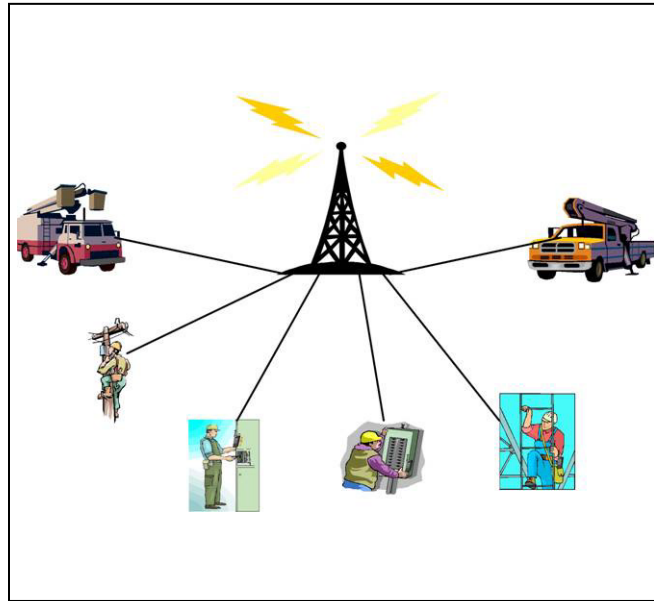


Figure 2-4
Trunked LMR System

If all channels are in use, the call is automatically queued until a new channel becomes free. Free channels are assigned to the queued calls on a first-in, first-out basis, unless there are overriding priorities assigned to the user or the group. By setting user priority levels, if only one channel is available and two employees both tried to make a call, the system would assign the channel to the one with higher priority.

Trunking controls to whom and for how long each user can speak, as well as the inherent priority each user possesses. Thus, a trunked system can be programmed to prevent excessive hold time.

For use in disasters, trunked radio systems can be pre-programmed so that users are instantly “dynamically regrouped”. This allows radios that normally would not communicate with one another to do so when necessary.

Trunked communications also allow radios to be programmed with emergency notification. If an employee becomes injured, the press of a single button can notify a dispatch location that an emergency exists. The dispatcher would receive an alarm and the identification information for the distressed user would be displayed.

2.5 Analog to Digital Conversion

Radio system backbone circuits are undergoing a metamorphosis from traditional analog audio signals to digitized packets of information transported via data networks. Gateways provide the conversion vehicle for adapting older systems to newer technology. In gateways, the analog signals are converted to Transmission Control Protocol/Internet Protocol (TCP/IP) packets, the basic communication language or protocol of the internet and local area networks. Transmission in this manner has been known in recent years as Voice-over IP (VoIP).

2.6 Secure Voice and Data Communications

The Advanced Encryption Standard (AES) is the most recent development in unclassified encryption standards approved by the National Institute of Standards and Technology (formerly the National Bureau of Standards). It is a necessary step in providing consistent encryption for both radio transmissions and the local or wide area networks employed for backbone distribution of radio signals. Prior to this standard, radio systems employed Data Encryption Standard – Output Feedback (DES-OFB) and data networks employed Triple Data Encryption Standard (3DES). AES is now being made available for both applications.

2.7 Pilot Project Standard

With the advent of digital radio in common formats (TDMA, CDMA, iDEN, GSM, TETRA, etc.), a technical design team initiated by the Association of Public Communications Officers (APCO) was tasked with developing a format well suited for Law Enforcement and Public Safety in the mid 1990's. This led to the Project 25 standard, now commonly known as "APCO P25." Among its strengths are security and interoperability.

ISS recommends use of the APCO P25 digital radio standard for enhanced security and to achieve EPRI interoperability objectives. Adopting APCO P25 as the Pilot Project Standard will ensure compatibility among electric power industry companies during mutual aid situations and also with federal, state, and local government agencies if needed during emergency situations. Since one main purpose for development of this standard was to provide compatibility, P25 compliant radio systems are a clearly superior choice over the use of conventional analog radios.

Conventional portable FM (Frequency Modulated) LMR radios all suffer from the same inherent issue: a total lack of privacy and secure communications. Legacy analog radio equipment operates on +/- 5KHZ FM bandwidths, with a transmitter power level of two to five watts. Any commonly available scanning receiver can monitor every conversation within a secure facility, from as far away as several statute miles. This represents a major potential for collection of information by terrorist organizations.

The P25 standard specifies a time based digital format, with an aggregate bit rate of 9600 bits per second. Maximum system deviation is only +/-1.8KHZ, as opposed to conventional FM at +/- 5KHZ, allowing for much higher bandwidth efficiency. This format allows the use of a fully encrypted system, with up to 144 bits of error correction, fully re-addressable from either a local terminal (from the repeater), or centralized location such as a dispatch center.

There are several additional features of an APCO P25 standards-based system that may be applicable to the EPRI user. As an example, a data channel is incorporated into each station and end user device. This would allow for many future applications, such as GPS location information or secure access to email.

Requiring that all participating OEM's comply with the entire design specification assures that no single vendor can unfairly compete or monopolize future equipment orders, or place their firm into any number of "failure to provide service" modes. This feature is known as Common Air Interface, or CAI.

2.7.1 Features of APCO 25

6.25 KHz Bandwidth (CQPSK) Modulation

The CQPSK modulator consists of a table look-up, the two outputs of which (I and Q) are Nyquist filtered and then amplitude modulated, in phase and quadrature phase, before summing. The information bits are processed by the look-up table to yield a 5-level I signal and a 5-level Q signal.

The I and Q signals are filtered with the Nyquist Raised Cosine Filter previously described. The I signal is then multiplied by the carrier and the Q signal is multiplied by the carrier after it has been delayed by 90 degrees. The modulated I and Q carriers are then summed together to yield the modulator output.

12.5KHz Bandwidth (C4FM) Modulation

The C4FM modulator consists of a Nyquist Raised Cosine Filter, cascaded with a shaping filter, cascaded with a frequency modulator.

Addressing

A very large number of radio addresses are provided, both for individual radios and talk-groups.

Aggregate Bit Rate

The aggregate bit rate is 9600 bits/s. In the case of data transmission, data packets basically consist of a header, containing overhead information, followed by data. In the case of digitized voice transmission, after the transmission of a header containing error protected overhead information, 2400 bits/s is devoted to periodically repeating the overhead information needed to allow for late entry (or the missed reception of the header).

C4FM Frequency Modulator

The deviation is +1.8 KHz for dibit 01, +0.6 KHz for dibit 00, -0.6 KHz for dibit 10, and -1.8 KHz for dibit 11.

C4FM Nyquist Filter

The dibits of information (i.e., 4800 symbols) are filtered with a raised cosine filter which satisfies the Nyquist criterion minimizing inter-symbol interference. The group delay of the filter is flat over the pass-band for $|f| < 2880$ Hz. The magnitude response of the filter is approximately 1 for $|f| < 1920$ Hz, $0.5 + 0.5 \cos(2(f/1920))$ for $1920 \text{ Hz} < |f| < 2880$ Hz, and 0 for $|f| > 2880$ Hz.

C4FM Shaping Filter

The shaping filter has a flat group delay over the band-pass for $|f| < 2880\text{Hz}$. The magnitude response of the filter for $|f| < 2880\text{ Hz}$ is $\sin(\pi f/4800)/(\pi f/4800)$.

Data Packet Data Blocks

Confirmed Data Blocks contain a 7-bit serial number (to allow for selective transmission), 9 bits of error detection on the entire block, and 14 octets of data. Unconfirmed Data Blocks contain 12 octets of data (note: a 32-bit error detection code is appended to the end of all data packets).

Data Packet Error Correction

Header Blocks normally use a rate 1/2 trellis coder for error correction. Unconfirmed data packets normally use a rate 1/2 trellis coder, while confirmed data packets normally use a rate 3/4 trellis coder. Interleaving is applied over Data Blocks.

Data Packet Header

The Header Block used for communications between a radio and a packet data node (i.e., switch) contains 10 octets of address and control information, followed by 2 octets of error detection coding. Information contained in the header includes: the identity of the Service Access Point to which the data is being directed, a manufacturers identification (to allow for non-standard functions), a logical link identifier to identify the sending radio of an inbound packet to a node and the receiving radio of a packet outbound from a node, the number of blocks to follow in the packet, the number of pad octets to fill out the last block, the sequence number of the packet, and the Fragment sequence number. For packet data communications directly between two radios, essentially two 12-octet Header Blocks are used at the beginning of each packet in order to convey the necessary address and control information. The header is preceded by 48 bits of synchronization and 64 bits of network identifier (to prevent confusion between radios in different networks).

Data Packet Structure

Data messages are divided into Fragments of less than 512 octets. Fragments are, in turn, divided into Blocks of M octets, where $M=12$ for unconfirmed messages and $M=16$ for confirmed messages (except Header Blocks are 12 octets in length). Note: a Fragment, preceded by header information, is defined as a Data Packet.

Demodulator

The demodulator is capable of receiving both the C4FM and the CQPSK signals. It consists of a frequency modulation detector, followed by an Integrate and Dump Filter and then a stochastic gradient clock recovery device. The Integrate and Dump Filter has a flat group delay over the

band-pass for $|f| < 2880$ Hz. The magnitude response of the Integrate and Dump Filter, for $|f| < 2880$ Hz, is approximately $\sin(\pi f/4800)/(\pi f/4800)$.

Digitized Voice Coder Method

After evaluating several candidates, APCO 25 selected IMBE (Improved MultiBand Excitation) vocoder, operating at 4400 bits/s. An additional 2800 bits/s of forward error correction is added, for error correction of the digitized voice. IMBE has also been selected by INMARSAT, for use in digital voice maritime satellite communications.

Digitized Voice Frame Structure

The Header Word, transmitted at the start of every transmission, contains 120 bits of information and 528 bits of error correction. Voice Frames are 180 ms in length and pairs of Voice frames compose a 360 ms Superframe. The first of a pair of voice frames transmits, in addition to digitized voice and its error corrective coding, 72 bits of link control information, 168 bits of error corrective coding on the link control information, and 16 bits of embedded low-speed data signaling with 16 bits of error corrective coding. The second of the pair of voice frames transmits an additional 16 bits of low-speed data signaling with 16 bits of error corrective coding, 96 bits of encipherment information, and 144 bits of error protective coding on the encipherment information.

Digitized Voice Header Word

The header is preceded by 48 bits of synchronization signal and a 64-bit network identifier (to prevent confusion between radios in different networks). The 120 bits of information in the Header Word consists of 72 bits for the encipherment initialization vector, 8 bits for a manufacturer identifier, 8 bits to identify the encipherment algorithm, 16 bits to identify which encipherment key variable is being employed (in systems with multiple encipherment key variables), and 16 bits for the talkgroup address. Including error corrective coding, status symbols (22 bits) not described in this brief contribution, and preceding signaling, the header requires 82.5 ms for transmission.

Digitized Voice Encryption Information

The 96 bits of encipherment information consist of the three encipherment-related fields in the header: the 72-bit encipherment initialization vector, the 8-bit encipherment algorithm identifier, and the 16-bit encipherment key variable identifier. The encipherment information is protected by 144 bits of error corrective coding. Note: the encipherment process does not change during a transmission. The repeating of this information every 360 ms is primarily for late-entry by receiving radios.

Digitized Voice Link Control Information

As previously stated, 72 bits of link control information is contained in the first of each pair of Voice Frames. If the addressee is a talk-group, the link control information consists of 1 octet describing the type of information (e.g., talk-group type of transmission), 1 octet containing the manufacturer identifier, 1 bit indicating whether or not the transmission is of an emergency nature, 15 bits reserved for future use, 2 octets for the talk-group address, and 3 octets for the transmitting radio's identifier. If the addressee is another radio, the last 7 of the 9 octets consist of: 1 octet reserved for future use, 3 octets for the destination radio's identifier, and 3 octets for the transmitting radio's identifier. This information is protected with 168 bits of error corrective coding.

Encryption

Information required for decoding to take place (including the encoding initialization vector) is transmitted at the beginning of all transmissions, and is embedded in the signaling overhead throughout all digitized voice transmissions. This allows for the use of multiple encoding algorithms and "key variables". An adequate number of bits have been assigned to allow for even the highest (i.e., most secure) levels of encoding.

Error Protection

To provide for the maximum possible coverage (i.e., range of operation), a high degree of forward error correction and interleaving has been provided for. The mobile environment is subject to severe Rayleigh fading and the APCO 25 techniques have been designed to operate in bit error rate environments of up to 7 percent.

Flexible Modulation Method

A pair of modulation methods have been selected that utilize a common receiver. The first, which utilizes a constant-envelope 4-level Frequency Modulation (FM) variant, can utilize simple, high-efficiency amplifiers and has emissions that fit within a 12.5 KHz bandwidth. This method will be fielded in most equipment initially. The second, which utilizes a CQPSK variant with amplitude components, requires the use of highly linear or linearized amplifiers and has emissions that fit within a 6.25 KHz bandwidth. (The receiver, common to both, has a 6.25 KHz bandwidth.)

Low-Speed Data with Digitized Voice

A low-speed data channel is provided in the digitized voice frame structure. No application is currently defined. One application under discussion is to use the low-speed data channel for the transmission of accurate geographic location information.

Over The Air Re-Keying (OTAR)

One of the prime considerations in maintaining any secure radio network is the ability to handle the two most common violations of security: lost and stolen radios. Even using the most secure encrypted algorithm, when an operational radio cannot be accounted for, the entire system is to be considered “open” and compromised. APCO P25 does incorporate a solution for this, within the OTAR features.

As soon as the appropriate administrative procedures are initiated, all portable and control station equipment can be assigned a new crypto-key. This is done over the operating frequency of the local repeater device, ergo “Over The Air Re-Keying”. The route to the radio devices will be through an Ethernet WAN. OTAR operation does require that:

- The radio devices assigned to that facility are all turned on, to the proper frequency, and operable.
- They are receiving, with reasonable signal integrity, the transmissions from the repeater for that installation, or a future radio network transmitting device interfaced to the Unisys secure network.
- The portable or control radio device is operating in the APCO P25 digital environment.

The APCO 25 format also allows for any lost or stolen device to be disabled, either temporarily, or essentially permanently, as long as it is within receiving range of the transmitting radio network. This often results in the eventual recovery of that device, since it creates the impression of no longer having any value, commercially or as private property.


Talk-Group Operation

Unlike normal telephone operation, all members of a talkgroup can receive the transmissions of all other members of that talk-group. Members of a talk-group do not have to receive the beginning of a digitized voice transmission (i.e., late entry is provided for).

3 FINDINGS

Five stakeholder organizations were interviewed to identify their requirements for LMR for reliable Major Outage Recovery Operations communications. These utilities were also queried to identify their understanding of requirements the Pilot Project system should include to effectively demonstrate a capability that should extend across the Electric Power Industry. The survey instrument used is provided at Appendix B to this report. The survey results are presented as a table in Appendix C. Each stakeholder and its specific requirements are discussed below.

3.1 Central Hudson Gas and Electric Corporation

	POC: P. Haering
	Service area: 8 Counties; New York State
	Number of users: 625,000

Central Hudson Gas & Electric Corporation provides electricity and natural gas to approximately 625,000 customers in eight counties in the Mid-Hudson River Valley in New York State. Central Hudson Gas & Electric Corporation is a subsidiary of CH Energy Group, Inc, and is based in Poughkeepsie, NY. Central Hudson Gas & Electric currently uses a multiple site conventional LMR system. Voice requirements were identified for mobile and portable outside and low altitude aerial coverage for construction activities. Data communications at low data rate requirements were identified for mobile units only to facilitate service order transfer. Mobile assets identified include cars, vans, bucket trucks and line/pickup trucks. Voice and data coverage requirements are depicted in Table 3-1.

**Table 3-1
Central Hudson Electric & Gas Coverage Requirements**

Coverage Requirements															
Voice								Data							
Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote	Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote
✓	✓				✓			✓							

Required system features include group and private call capability and encryption for secure communications. Over-the-Air-Rekeying (OTAR) and dynamic talkgroup regrouping are also desired features for the Pilot Project system. A summary of required system features is provided in Table 3-2.

**Table 3-2
Central Hudson Electric & Gas Functional Requirements**


Functional Requirements								
Group Calls	Private Calls	Telephone Interconnect	Encryption	Dynamic Subscriber Unit Talkgroup Regrouping	Emergency Alarm	User ID/Alias Display	Over-the-Air Rekeying	Status Buttons
✓	✓		✓	✓	✓	✓	✓	✓

Features Central Hudson Electric & Gas believed would be beneficial to most utilities include:

- Radio to radio calling
- Paging
- Video monitoring
- SCADA data
- Distributed automation
- PC tablet wireless computer for inspection data transfer
- Automated meter reading data transfer, including remote reporting of power outages
- Outage mitigation by remote shut-off of selected customer feeds

Interoperability is required by Central Hudson Electric & Gas with the Federal Department of Transportation; State of New York Highway Department and New York State Police; County Sheriff and police and fire departments in four communities. Communications interoperability is also required with other utility companies across the service area for mutual aid.

3.2 Lincoln Electric System (LES)

	POC: N. Engleman
	Service area: 195 sq. mi. Lancaster County, Nebraska
	Number of users: ~ 117,000

Lincoln Electric System is the second largest electric utility in the state of Nebraska and the 22nd largest public power electric utility in the United States by number of retail customers. LES services approximately 117,000 customers across approximately 195 square miles within Lancaster County, and is based in Lincoln, NE.

Communications are provided within the Lincoln Electric System today by a four site conventional LMR system. Only mobile voice and data requirements were identified. No portable LMR capability is required. Data communications at low data rate requirements were identified for short text messages. Mobile assets identified include cars, vans, bucket trucks, backhoes, line/pickup trucks, and puller/test trailers. Voice and data coverage requirements are depicted in Table 3-3.

**Table 3-3
Lincoln Electric System Coverage Requirements**

Coverage Requirements															
Voice								Data							
Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote	Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote
✓								✓							

Required system features include group and private call capability, telephone interconnect and encryption for secure communications. Over-the-Air-Rekeying (OTAR) and dynamic talkgroup regrouping are also desired features for the Pilot Project system. A summary of required system features is provided in Table 3-4.

**Table 3-4
Lincoln Electric System Functional Requirements**


Functional Requirements								
Group Calls	Private Calls	Telephone Interconnect	Encryption	Dynamic Subscriber Unit Talkgroup Regrouping	Emergency Alarm	User ID/Alias Display	Over-the-Air Rekeying	Status Buttons
✓	✓	✓	✓	✓	✓	✓	✓	✓

Features Lincoln Electric System believed would be beneficial to most utilities include:

- Automated Vehicle Locator
- Remote testing
- Video monitoring
- Mobile repeater
- Email in vehicle for emergency communications for family contact and information dissemination
- Mobile outage location mapping
- Mobile customer information data accessibility

No interoperability requirements with Federal Government agencies were identified by Lincoln Electric System. Communications system interoperability is required with the Nebraska State Patrol, Lancaster County Sheriff’s Department, Lincoln city and local community police and fire departments. Lincoln Electric System also requires communications interoperability with other utility companies throughout Lancaster County and adjacent areas for mutual aid.

3.3 MidAmerican Energy Company

	POC: J. Mack
	Service area: 10,600 sq. mi. Iowa
	Number of users: 680,000 (Electric) 660,000 (Gas)

MidAmerican Energy Company is the largest utility in the state of Iowa and provides service to more than 680,000 electric and 660,000 natural gas customers across a 10,600 square mile area. MidAmerican Energy Company's service area stretches from Sioux Falls, South Dakota to the Quad Cities area on the Iowa/Illinois border and includes the metropolitan areas of Des Moines, Cedar Rapids, Sioux City, Waterloo, Iowa City, and Council Bluffs in Iowa; as well as the Quad Cities and Sioux Falls. MidAmerican Energy Company is based in Urbandale, IA.

MidAmerican Energy Company currently uses an LMR system consisting of multiple separate systems spanning numerous sites from 3 previous operating companies. LMR is used in both Very-High-Frequency (VHF) and Ultra-High-Frequency (UHF) bands. Some coverage currently is provided via leased services.

Voice and data communications requirements were identified for only mobiles by MidAmerican Energy Company. There is no stated requirement for portable voice or data coverage, outside and low altitude aerial coverage for construction activities. Data communications at low data rate requirements were identified for short text messages. Mobile assets identified include cars, vans, bucket trucks, line/pickup trucks and diggers. Voice and data coverage requirements are depicted in Table 3-5.

Table 3-5
MidAmerican Energy Company Coverage Requirements

Coverage Requirements															
Voice								Data							
Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote	Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote
✓								✓							

Required system features include group and private call capability, telephone interconnect and encryption for secure communications. Over-the-Air-Rekeying (OTAR) is also a desired feature for the Pilot Project system. A summary of required system features is provided in Table 3-6.

**Table 3-6
MidAmerican Energy Company Functional Requirements**


Functional Requirements								
Group Calls	Private Calls	Telephone Interconnect	Encryption	Dynamic Subscriber Unit Talkgroup Regrouping	Emergency Alarm	User ID/Alias Display	Over-the-Air Rekeying	Status Buttons
✓	✓	✓	✓		✓	✓	✓	✓

Features MidAmerican Energy Company believes would be beneficial to most utilities include:

- External vehicle speakers
- Horn honk
- In-manhole coverage via vehicular repeater
- Mobile data terminal
- 50-60 talkgroup capacity
- Line load capacitor control
- Substation monitoring
- Load shedding
- Mapping of data provided by an outage management system

No interoperability requirements were identified by MidAmerican Energy Company with any Federal Government agency. Communications interoperability requirements were identified with the State of Iowa Commerce Commission, local police and fire departments and with other utility companies across the service area for mutual aid.

3.4 Public Service Electric and Gas Corporation (PSE&G)

	POC: B. Cornew
	Service area: 2,600 sq. mi across New Jersey
	Number of users: 2,000,000 (Electric) 1,600,000 (Gas)

Public Service Electric and Gas Corporation provides electricity to 2 million customers and natural gas to 1.6 million customers. The PSE&G services an area over 2,600 square miles in a diagonal corridor across the state of New Jersey from Bergen to Gloucester Counties. PSE&G is based in Newark, NJ.

LMR communications are provided throughout the Public Service Electric and Gas service area by a 10 site trunking system with a back up main site and digital microwave to all sites. A single site trunked system is also used at the utility's nuclear power plant. Voice requirements were identified for mobile and portable outside and underground to support work in airport tunnels. Remote voice coverage is also required. No data communications coverage requirements were identified. Coverage requirements are depicted in Table 3-7.

Table 3-7
Public Service Electric and Gas Corporation Coverage Requirements

Coverage Requirements															
Voice								Data							
Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote	Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote
✓	✓			✓			✓								

Required system features include group and private call capability and encryption for secure communications. Over-the-Air-Rekeying (OTAR) is also a desired feature for the Pilot Project system. A summary of required system features is provided in Table 3-8.

**Table 3-8
Public Service Electric and Gas Corporation Functional Requirements**


Functional Requirements								
Group Calls	Private Calls	Telephone Interconnect	Encryption	Dynamic Subscriber Unit Talkgroup Regrouping	Emergency Alarm	User ID/Alias Display	Over-the-Air Rekeying	Status Buttons
✓	✓		✓		✓	✓	✓	✓

Features Public Service Electric and Gas Corporation believes would be beneficial to most utilities include:

- Second speaker in some vehicles
- Mobile control head in some vehicles
- Transportable (suitcase sized) repeater
- Self-diagnostic radios
- Redundant circuitry in radios

Interoperability is required by Public Service Electric and Gas Corporation with the Federal Department of Transportation for natural gas pipeline safety; US Coast Guard for spill coordination; State of New Jersey Office of Emergency Management; county Offices of Emergency Management; and local police and fire departments. Public Service Electric and Gas Corporation also requires communications interoperability with other utility companies across the service area for mutual aid and the Mid-Atlantic Mutual Aid Group.

3.5 Tri-State Generation & Transmission Association, Inc. (Tri-State G&T)

 TRI-STATE Generation and Transmission Association, Inc.	POC: A. Mander
	Service area: 250,000 sq. mi Colorado, Nebraska, New Mexico and Wyoming
	Number of users: 1,000,000 (44 member systems)

Tri-State Generation & Transmission Association, Inc. supplies electricity wholesale to 44 member systems throughout the states of Colorado, Nebraska, New Mexico, and Wyoming. Tri-State G&T member utilities service an electricity customer base of approximately 1 million customers across 250,000 square miles. Tri-State G&T is based in Westminster, CO.

Today's LMR system supporting Tri-State G&T is comprised of 65 sites arranged in 11 zones. The system is multicast conventional LMR operating in the UHF spectrum in 16 frequency pairs. Voice requirements were identified for mobile, portable outside, portable inside and low altitude aerial coverage for aircraft patrolling power lines. Remote voice coverage is also a requirement. Data communications at low data rate requirements were identified for mobile units only to facilitate switching orders. Mobile assets identified include cars, bucket trucks, panel trucks, and Snow Cats.

Coverage requirements are depicted in Table 3-9.

Table 3-9
Tri-State G&T Coverage Requirements

Coverage Requirements															
Voice								Data							
Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote	Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote
✓	✓	✓			✓		✓	✓							

Required system features include group and private call capability, telephone interconnect and encryption for secure communications. Over-the-Air-Rekeying (OTAR) and dynamic talkgroup regrouping are also desired features for the Pilot Project system. A summary of required system features is provided in Table 3-10.

**Table 3-10
Tri-State G&T Functional Requirements**

Functional Requirements								
Group Calls	Private Calls	Telephone Interconnect	Encryption	Dynamic Subscriber Unit Talkgroup Regrouping	Emergency Alarm	User ID/Alias Display	Over-the-Air Rekeying	Status Buttons
✓	✓	✓	✓	✓	✓	✓	✓	✓

Features Tri-State G&T believes would be beneficial to most utilities include:

- Trunking
- High speed mobile data
- Dynamic bandwidth allocation for data
- SCADA
- Load scheduling
- Employee location
- Weather
- Transmission capacity

Communications system interoperability is required for Tri-State G&T with the Western Area Power Administration and its 44 member companies. No requirement was stated for LMR interoperability with any Federal, State, or local agency.

4

PILOT LOCATION

4.1 Selection Criteria

A location for the Pilot Project LMR system must be selected that typifies EPRI stakeholders to best demonstrate the capabilities of the pilot system features. Utilities discussed in Chapter 3 were surveyed to identify the characteristics that both the pilot location and system should include.

Selection of a suitable Pilot Project site is critical EPRI successfully achieving the objectives of the Pilot Program. The Pilot Project site needs to be a model that all other stakeholders can easily identify with and relate to. The site selected must be adequate to sufficiently address a majority of EPRI LMR requirements during the pilot evaluation. At the same time, care must be exercised in selecting the Pilot Project site to mitigate unnecessary risk to EPRI being able to successfully achieve the project's objectives.

For example, it may be desirable to select a pilot site large enough to require multiple repeater locations to demonstrate the wide area trunking capabilities of the Pilot System. However, undo risk and unnecessary expense would be encountered by selecting an area with arduous terrain with site preparation challenges that may present implementation schedule slippages or increase the likelihood of failing one or more coverage requirements during the evaluation of the Pilot System. The Pilot site needs to be representative of an EPRI stakeholder while providing a controlled, stable environment for testing and evaluation without untypical complications.

Based on observations during the surveys and knowledge of radio systems features available with current and near-term technology, ISS recommends the following criteria be considered by EPRI when selecting a Pilot Project location:

- Rural topography within the service area
- Urban topography within the service area
- Service area of sufficient size to require multiple repeaters for coverage
- Contingency plans exist for natural and man-made disasters
- Existing LMR system available for use in demonstrating interoperability with legacy systems
- Provider of electricity
- Provider of natural gas (to demonstrate applicability beyond EPRI)
- Interoperability requirements with Federal agencies

- Interoperability requirements with State agencies
- Interoperability requirements with local agencies

These evaluation criteria were used to rank the utilities interviewed during this Scoping Study phase of the Pilot Project. Data relevant to the Pilot Project selection criteria is provided in Table 4-1.

**Table 4-1
Stakeholder Ranking Against Pilot Project Selection Criteria**

		Stakeholder				
		Central Hudson Gas & Electric Corp	Lincoln Electric System	MidAmerican Energy Corp	Public Service Electric & Gas Co	Tri-State G&T
Selection criteria	Rural Topography	✓	✓	✓	✓	✓
	Urban Topography	✓	✓	✓	✓	✓
	Service Area	4	5	2	3	1
	Contingency Plans	✓	✓	✓	✓	✓
	Existing LMR System	✓	✓	✓	✓	✓
	Electricity Provider	✓	✓	✓	✓	✓
	Natural Gas Provider	✓		✓	✓	
	Federal Agency Interoperability	✓			✓	
	State Agency Interoperability	✓	✓	✓	✓	
	Local Agency Interoperability	✓	✓	✓	✓	

4.2 Coverage Recommendation

Table 4-2 provides the total coverage requirements identified during the Scoping Study.

**Table 4-2
Scoping Study Participant Coverage Requirements**

		Coverage Requirements																
		Voice							Data									
Stakeholders		Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote	Mobile	Portable Outside	In-Building	Over Water	Underground	Low Altitude in Air	High Altitude in Air	Remote	
		Central Hudson Gas & Electric Corp	✓	✓				✓			✓							
		Lincoln Electric System	✓								✓							
		MidAmerican Energy Corp	✓								✓							
		Public Service Electric & Gas Co	✓	✓			✓			✓								
		Tri-State G&T	✓	✓	✓			✓		✓	✓							

ISS recommends EPRI include coverage requirements in the Pilot Project system for all coverage requirements identified in the Scoping Study, regardless of stakeholder system.

- Voice
 - Mobile
 - Portable outside
 - Portable in-building
 - Low altitude in air
 - Remote
- Mobile Data

4.3 Functional Recommendation

Table 4-3 provides the LMR system functional requirements identified during the Scoping Study.

**Table 4-3
Scoping Study Participant Pilot Project Feature Requirements**

		Functional Requirements								
		Group Calls	Private Calls	Telephone Interconnect	Encryption	Dynamic Subscriber Unit Talkgroup Regrouping	Emergency Alarm	User ID/Alias Display	Over-the-Air Rekeying	Status Buttons
Stakeholders	Central Hudson Gas & Electric Corp	✓	✓		✓	✓	✓	✓	✓	✓
	Lincoln Electric System	✓	✓	✓	✓	✓	✓	✓	✓	✓
	MidAmerican Energy Corp	✓	✓	✓	✓		✓	✓	✓	✓
	Public Service Electric & Gas Co	✓	✓		✓		✓	✓	✓	✓
	Tri-State G&T	✓	✓	✓	✓	✓	✓	✓	✓	✓

ISS recommends EPRI include system features in the Pilot Project system for all functional requirements identified in the Scoping Study, regardless of stakeholder system. Furthermore, ISS recommends EPRI include the following functional requirements in the Pilot Project system:

- Use of trunked digital radio systems where conventional systems are currently employed.
- Interoperability of radio systems by adherence to the APCO Project 25 standard.
- Application of AES encryption as specified by the National Institute of Standards and Technology to ensure secure voice and data communications.
- Vehicular repeater for portable radio use in the vicinity of designated vehicles. This will allow use of portable radios from the bucket of a bucket truck to effectively have the same range as mobile radios installed in vehicles.
- Use of radio system “gateways” to allow the interface of legacy analog radio equipment to the digital Pilot Project system.
- Use of the UHF frequency band vice VHF. This will afford better coverage in urban areas due to the reflection and not present significant signal strength loss in rural wooded areas.

4.4 Research Objectives

- Evaluation of secure trunked digital encrypted radio systems as compared to conventional analog systems with no encryption.
- Development and evaluation of a compact vehicular radio repeater that can serve as both a standard encrypted mobile radio for use within the vehicle and as a radio frequency repeater that is transparent to encryption when accessed via a handheld radio outside of the vehicle. Radio equipment manufacturers have indicated willingness to collaborate with EPRI in this development.
- Evaluation of radio system “gateways”.

5

PHASE II & III PLANNING

The Scoping Study, Phase I of the EPRI LMR Pilot Project, identified and defined the requirements for the Pilot Project system and recommended a location for the Pilot Demonstration. Phase II of the Project will include site surveys and result in a design for a LMR system to support the Phase I identified requirements. Phase III of the Project will procure, install, and demonstrate the capabilities of the Pilot Project system.

The tasks involved in each of the three Phases are provided in Figure 5-1.

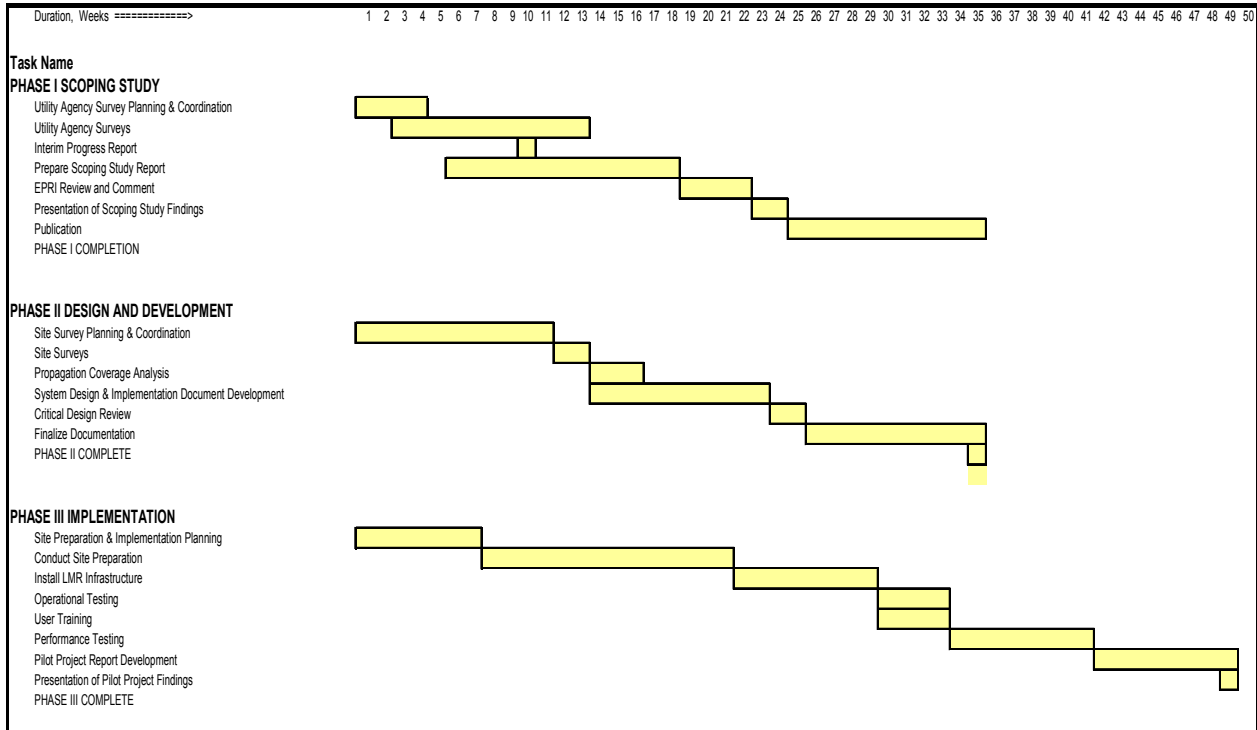


Figure 5-1
Pilot Project Activities by Phase and Time (rough)

5.1 Phase II: Design and Development

In the Design and Development Phase, EPRI requires a comprehensive System Design and Site Analysis (SD/SA) to document the requirements and specifications for a new LMR system. The end-state LMR system will provide radio communications for EPRI stakeholder personnel during both daily and emergency operations. SD/SA activities shall be comprised of site

surveys, user interviews, preliminary system design, design review and will result in delivery of a System Design & Implementation Document (SDID). The SDID document shall describe the requirements and technical specifications of a “turnkey” LMR system.

The new system must provide a digital, secure trunking system to meet coverage requirements as determined during the site survey and be comprised of at least two independent trunking system zones. The system must interface to a minimum of one conventional analog repeater through a radio system gateway. Additionally, the system must include at least one compact vehicular repeater capable of operating as both a standard encrypted mobile radio for use within the vehicle and as a radio frequency repeater that is transparent to encryption when accessed via a handheld radio outside of the vehicle.

In Phase II, EPRI will contract to perform the following tasks:

- Site Survey
- User Interviews
- System Design
- Site Selection
- Coverage Analysis
- Frequency Analysis
- System Loading Analysis
- Migration Plan

Contractor deliverables in Phase II will include a Site Survey and User Interviews Report and a System Design and Implementation Document.

5.2 Phase III: Implementation

In the Implementation Phase, EPRI requires a turnkey, digital, trunked, APCO Project 25-compliant LMR system. Frequency assignments will be governed by the Federal Communications Commission (FCC) or policy directives of the National Telecommunications Information Administration (NTIA) in the event authorizations are government supplied. The Pilot System implemented in Phase III is required to allow interoperability and frequency optimization with federal agencies.

EPRI will contract to obtain, install (to include site preparation) and maintain a turnkey, standards-compliant, trunked LMR system. The contractor shall provide options for fee-for-service, lease, and purchase LMR system(s) to satisfy requirements identified in Phase II.

Additional contractor responsibilities in Phase III may include:

- Refreshment of Phase II Design
- Site Preparation

- Integration of Pilot System with Emergency 911 Dispatch Systems
- Development of Frequency Plan
- Procurement Services
- System Maintenance Services
- System Management Services
- Development of Contingency Plans
- End User and System Operator Training

5.3 Funding Requirements

Rough order of magnitude (ROM) costing information is provided for budgetary use only in this product. Vendor solicitation is necessary for EPRI to establish and negotiate actual costs for services desired in Phases II and III of the Pilot Project. Selection of specific location and inclusion of functional requirements can have significant impact on the ROM costing provided here for both phases remaining. Costs provided assume the pilot site location is MidAmerican Energy Company and the functional requirements are those recommended in this Scoping Study report.

A rough order of magnitude estimated cost for Phase II for site survey and system design work is \$500-600K for contractor's work and excludes EPRI's component.

A rough order of magnitude estimated cost for Phase III for implementation of the Pilot Project system is \$10-16M for contractor's work and excludes EPRI's component. This figure includes costs associated with program management of the site preparation, equipment manufacture, equipment procurement, shipping, installation, systems management and maintenance during the demonstration portion of Phase III. This figure does not include costs that may be required for new facilities to house equipment, towers or site modifications necessary to install the Pilot Project system equipment. This figure also is based on an assumption the Phase III period will be as outlined in this Scoping Study report. No microwave or fiber costs associated with communications between sites are included in this figure.

Estimated costs for Phase III will be refreshed as part of the Phase II activities. Greater fidelity can be gained when a specific system design is determined by EPRI.

Funding of Phases II and III of the pilot project will likely require EPRI to combine monies from multiple sources.

Utility systems are deemed part of the country's critical infrastructure as defined by the Department of Homeland Security (DHS). As such, a utility company can qualify for Federal grants for purchase and implementation of equipment to support security of the country's critical infrastructure.

In fiscal year 2003, grant authority concerning critical infrastructure was disseminated from the DHS Office of Domestic Preparedness to all states and territories for administration of the grants. It is reasonable to expect future Federal grant opportunities will be administered in a similar manner.

The Pilot Project may also qualify for a DHS National Institute of Justice (NIJ) Science and Technology grant for evaluation of technology used in public safety.

Federal and state grants are made available for specific periods of time after a solicitation for grant submissions is published by the offering agency. These solicitations are normally issued annually. Interested parties may submit grant applications by the deadline established in the solicitation. The agency then evaluates all received grant applications and makes award of grants based on the qualifying criteria also published in the solicitation.

Details on the latest DHS grant process may be found in the FY 2003 State DHS Grant Program.

EPRI tailored collaboration may also be used as a funding source. The Pilot Project has the objective to demonstrate capability relevant across the EPRI membership base.

Funding of the pilot project will likely be a combination of these sources. The EPRI stakeholder(s) selected for the Pilot Project implementation should be prepared to assume costs not covered by government grants or EPRI Tailored Collaboration. All equipment provided under the Pilot Project will remain with these stakeholders at the conclusion of the demonstration in Phase III and become the core architecture for any additional radio system needs.

5.4 Project Timeline

The timelines presented in Figures 5-1 and 5-2 are very rough, subject to refinement, best depict the significant events projected to occur during the remainder of the Pilot Project. The numbers represent days elapsed since the beginning of the process and the end of the significant event.

Site Survey Planning & Coordination	Conduct Site Survey	Prepare Propagation Coverage Analysis	Prepare System Design & Implementation Document	Critical Design Review	Finalize System Design & Implementation Document	
NTP	30	50	90	120	130	180

Figure 5-2
Phase II: Pilot LMR Project Design and Development Timeline

Site Preparation & Implementation Planning	Conduct Site Preparation	Install LMR Infrastructure	Operational Testing User Training	Performance Testing	Prepare Pilot Project Report	Present Pilot Project Findings	
NTP	45	120	180	210	270	330	360

Figure 5-3
Phase III: Pilot LMR Project Implementation Timeline

Specific tasks to be performed in Phase II are provided in a draft Statement of Work at Appendix D. A draft Statement of Work for specific tasks for Phase III is provided at Appendix E. The Phase III Statement of Work will also be refreshed at the conclusion of Phase II as more specificity of the work required for the Pilot Project system design will be a product of that phase.

Prior to the beginning of Phase II, a lead time of 6-12 months should be anticipated for funding acquisition. The amount of time is dependent on, among other factors, when the calls for grant submissions are made by government agencies.

Another item that traditionally has a long lead time is the receipt of frequency approvals. Requests for any new frequencies or modifications to old frequency authorizations should be submitted prior to the start of Phase III and can also take 6-12 months or longer for approval by all the necessary Federal and State regulatory agencies.

A

UNITED TELECOM COUNCIL STATEMENT ON AUGUST 2003 POWER OUTAGES

WASHINGTON – The massive power outage around the Great Lakes yesterday offered a conspicuous example of the strengths and weaknesses of the nation's electrical utility system. While investigation and work to prevent future such incidents will focus on the physical infrastructure, telecommunications was a key component of the event.

"The cyber- and telecom-based control systems did their job in shutting down portions of the system to prevent catastrophic damage," said Bill Moroney, President/CEO of the United Telecom Council (UTC) today in a statement. "And since the event, utility land mobile systems have been vitally important in the restoration process."

Using their internal communications systems, utility crews throughout the northern United States and southeastern Canada worked throughout the night to restore power in affected areas, and nearly all customers - estimated at more than 15 million -- were expected to be back on-line by the end of the day Friday. By contrast, all commercial wireless systems in affected areas were down within a short time after the blackout, due to congestion and the lack of backup power to transmitting sites.

"Once the damage is repaired, the electrical industry will turn to investigating the exact source of Thursday's event," said Moroney. "We look forward to working with our member companies, the North American Electrical Reliability Council (NERC), and all appropriate industry and government bodies to help to determine the causes of this week's blackout and the necessary steps required to ensure the American and Canadian public that it is not repeated."

UTC was heartened to hear that a cyber attack was not expected to be the cause of the power failure; however, the cascading shutdown effect would be similar should control systems suffer interference from outside sources. The event, which lasted only nine seconds, but affected approximately ten percent of the peak load of the eastern half of the U.S. and Canada, demonstrates dramatically what could happen if the communications systems that control our power systems were penetrated. These systems, generally known as Supervisory Control and Data Acquisition systems (SCADA), as well as the private voice and data communications systems on which personnel rely, have never been more important.

Founded in 1948, UTC represents the telecommunications interests of electric and gas utilities, water companies, gas pipelines and other critical infrastructure entities, along with their technology partners. UTC is a global federation of direct business members and affiliated trade associations representing over 10,000 organizations serving all corners of the world and virtually every community in North America. More information is available at www.utc.org.

Source: United Telecom Council Release, August 15, 2003

B

SURVEY INSTRUMENT

Section 1.0 General

Section 1.1 Contacts/Personnel Participating in Survey

POC/Interviewee #1:

Title:

Address:

Phone:

Email:

Area of Responsibility:

Section 1.2 Logistics

Location to meet customer for survey, if applicable: See POC address

City:

State:

County:

Closest Airport:

Personnel Security Requirements:

Comments:

Section 1.3 Operations/ Organization

Mission:

Organizational Structure:

Interoperability with Federal Agencies:

Interoperability with State Agencies:

Interoperability with Local Public Safety Agencies:

Interoperability with other Agencies outside of area:

Section 2.0 System Requirements

Section 2.1 General

(notes)

Section 2.2 Voice Coverage Requirements

Mobile Coverage Required?

Portable Outside Coverage Required?

Portable In-building Coverage Required?

Water Coverage Required?

Underground Voice Coverage Required?

Low altitude air voice coverage required?

High altitude air voice coverage required?

Remote Voice Coverage Required?

Is a desktop study sufficient for coverage testing?

Is field testing of mobile signal strength required?

Is mobile voice quality testing required?

Is portable voice quality testing required?

Is portable in-building testing required?

Section 2.3 Data Coverage Requirements

- Mobile Coverage Required?
- Portable Outside Coverage Required?
- Portable In-building Coverage Required?
- Water Coverage Required?
- Underground Data Coverage Required?
- Low altitude air data coverage required?
- High altitude air voice coverage required?
- Remote Data Coverage Required?
- Is a desktop study sufficient for coverage testing?
- Is portable in-building testing required?

Section 2.4 Point-to-Point Connectivity Circuits

- Media:
- Additional capacity required for future expansion?
- Will additional capacity be leased out?
- Reuse existing sites for expansions if possible?

Section 2.5 Required/ Desired System Features

- Group calls?
- Private calls?
- Telephone Interconnect?
- Encryption?
- Site registration?
- Dynamic subscriber unit talkgroup regrouping?

Emergency alarm?

User ID/Alias?

Over-the-Air Rekeying?

Status Buttons?

Back-up Site?

Special Requirements:

Section 3.0 Dispatch and Control Center

Console Quantity:

Control Station Quantity:

Console Furniture Required?

Logging Recorder Required?

Instant Recall Feature Required?

Integration with Legacy Systems Required?

LAN Integration Required?

Telephone System Integration Required?

Paging System Integration Required?

CAD System Required?

Reports Management Required?

GPS/AVL Display Required?

Mutual Aid Patching?

Other:

Section 4.0 Mobile Assets

Car:

Vans:

Bucket Truck:

Crane:

Backhoe:

Lineman Truck/Pick-up:

Section 5.0 Operations & Maintenance

24-Hour Help Desk Required?

Help Response Time: 4 hours

Channel Management Required?

Configuration Management Required?

Fleet Mapping required?

Inventory Management Required?

Real-Time or Periodic System Performance Reports Required?

Section 6.0 Training

Dispatcher Training Required?

Multiple Shift Training Sessions?

Periodic Retraining Required?

Radio User Training Required?

Multiple Shift Training Sessions?

Periodic Retraining Required?

Technical Manager Training Required?

Multiple Shift Training Sessions?

Periodic Retraining Required?

Management Training Required?

Multiple Shift Training Sessions?

Periodic Retraining Required?

Section 7.0 New Radio System Features

Standard Availability Features Desired:

New Feature Suggestions:

C

SURVEY RESULTS

	Central Hudson Gas and Electric	Lincoln Electric System	MidAmerican Energy System	Public Service Electric and Gas Corporation	Tri-State Generation and Transmission Association, Inc.
1.0 Operations/ Organization					
Mission	Gas and electric distribution	Provide energy and services of superior value and enhance growth and development of the Greater Lincoln Area	To deliver the exceptional personal service the customer deserves	Mission: Provide combined electric and gas utilities. Goals: Uninterrupted and economical electricity and gas.	Cooperative generation and transmission of electric power. Goals: Uninterrupted and economical electricity.
Organizational Structure	3 divisions: Customer Service, Operations, Transportation	3 divisions: Construction, Operations, Maintenance	Energy Marketing Division Utility Division	Four electric operating divisions – Palisades, Metropolitan, Central, North Three gas operating divisions – South, Central, North Operations groups – Transmission, Electric Operations Center, Gas Operations Center	Comprised of multiple cooperative members
Interoperability with Federal Agencies	DOT	None	None	DOT for gas pipeline safety, Coast Guard for spills	Western Area Power Administration (WAPA)
Interoperability with State Agencies	Highway Dept. and State Police	State Police	Commerce Commission	Office of Emergency Management (OEM)	Highway Department (radio interop not required)
Interoperability with Local Public Safety Agencies	Police and Fire in 4 communities	Police and Fire	Police and Fire	County OEM, Police, Fire	City and county police/fire (radio interop not required)
Interoperability with other Agencies outside of area	Other utility companies for mutual aid	Other utility companies for mutual aid	Other utility companies for mutual aid	Other utility companies, Mid Atlantic Mutual Aid Group	Member companies

Survey Results

	Central Hudson Gas and Electric	Lincoln Electric System	MidAmerican Energy System	Public Service Electric and Gas Corporation	Tri-State Generation and Transmission Association, Inc.
2.0 System Requirements					
2.1 General					
	Current system is multiple site conventional.	Current system is 4-site conventional	Current system consists of multiple separate systems spanning numerous sites from previous 3 operating companies. Both VHF and UHF band radios. Some coverage is provided by leased service thru 4 SMR sites.	Expanded coverage from the current system. A project is underway to accomplish this. Single-site trunking system at the nuclear power plant Intrinsically safe radios for use at the Port Authority Tunnel coverage at the airport Current system is a 10 site trunking system with back-up main site and digital microwave to all sites.	Current system is 65 sites arranged in 11 zones Current system is multicast conventional UHF in 16 frequency pairs
2.2 Voice Coverage					
Mobile Coverage	Yes	Yes	Yes	Yes	Yes
Portable Outside Coverage	Yes (with mobile repeater)	No	No	Yes	Yes
Portable In-building Coverage	No	No	No	No	Yes – at power plant
Water Coverage	No	No	No	No	No
Underground Voice Coverage	No	No	No	Yes – in airport tunnels	No
Low altitude air voice coverage	Yes (possibly for construction)	No	No	No	Yes – aircraft patrolling power lines
High altitude air voice coverage	No	No	No	No	No
Remote Voice Coverage	No	No	No	Yes – at a remote switch	Yes – phone patch is used for this
Desktop study sufficient for coverage testing?	No	Yes	No	No	Yes
Field testing of mobile signal strength	Yes	No	Yes	Yes	No

	Central Hudson Gas and Electric	Lincoln Electric System	MidAmerican Energy System	Public Service Electric and Gas Corporation	Tri-State Generation and Transmission Association, Inc.
Mobile voice quality testing	Yes	No	Yes	Yes	No
Portable voice quality testing	Yes	No	No	Yes	No
Portable in-building testing	No	No	No	No	No
2.3 Data Coverage					
Mobile Coverage	Yes – Service order transfer (low data rate)	Yes – Short text messages (low data rate)	Yes – Short text messages (low data rate)	No	Yes – low rate for switching orders
Portable Outside Coverage	No	No	No	No	No
Portable In-building Coverage	No	No	No	No	No
Water Coverage	No	No	No	No	No
Underground Data Coverage	No	No	No	No	No
Low altitude air data coverage	No	No	No	No	No
High altitude air voice coverage	No	No	No	No	No
Remote Data Coverage	No	No	No	No	No
Is a desktop study sufficient for coverage testing?	No	Yes	No	N/A	No
Portable in-building testing	N/A	N/A	N/A	N/A	No
2.4 Point to Point Connectivity Circuits					
Media	T1	Owned Fiber	Owned microwave and fiber	Existing digital microwave plus commercial T-1 back-up	Existing private microwave and fiber
Additional capacity required for future expansion?	Yes – Additional T1	No	Yes	Yes	Yes
Will additional capacity be leased out?	No	Yes	No	No	Yes

Survey Results

	Central Hudson Gas and Electric	Lincoln Electric System	MidAmerican Energy System	Public Service Electric and Gas Corporation	Tri-State Generation and Transmission Association, Inc.
Reuse existing sites for expansions if possible?	Yes	N/A	Yes	Yes	Yes
2.5 Required/ Desired System Features					
Group calls	Yes	Yes	Yes	Yes	Yes
Private calls	Yes	Yes	Yes	Yes	Yes
Telephone Interconnect	No	Yes	Yes	No	Yes
Encryption	Yes	Yes	Yes	Yes	Yes
Site registration	Yes	Yes	Yes	Yes	Yes
Dynamic subscriber unit talkgroup regrouping	Yes	Yes	No	No	Yes
Emergency alarm	Yes	Yes	Yes	Yes	Yes
User ID/Alias	Yes	Yes	Yes	Yes	Yes
Over-the-Air Rekeying	Yes	Yes	Yes	Yes	Yes
Status Buttons	Yes	Yes	Yes	Yes	Yes
Back-up Site	Yes	No	Yes	Yes	Yes
Special Requirements	External vehicle speakers	Lapel microphones Hardhat-compatible headsets	External vehicle speakers Horn honk In-manhole coverage via vehicular repeater Mobile data terminal (MDT) inclusion (matching current 8Kbps rate is acceptable)	2 nd speaker and mobile control head in some vehicles.	N/A
3.0 Dispatch and Control Center Requirements					
Console Quantity	0	3	14	8-12	10
Control Station Quantity	5	6	9	Numerous	0
Console Furniture	No	N/A	No	Yes	Yes
Logging Recorder	Yes	Yes	Yes	Yes	Yes

	Central Hudson Gas and Electric	Lincoln Electric System	MidAmerican Energy System	Public Service Electric and Gas Corporation	Tri-State Generation and Transmission Association, Inc.
Instant Recall Feature	No	No	No	No	Yes
Integration with Legacy Systems	No	No	Yes	Yes	No
LAN Integration	No	No	Yes	Yes	Yes
Telephone System Integration	Yes	No	No	Yes	Yes
Paging System Integration	Yes	Yes	Yes	No	No
CAD System	Yes	Yes	Yes	Yes	Yes
Reports Management	Yes	Yes	Yes	Yes (raw data only)	Yes
GPS/AVL Display	No	Yes	Yes	No	Yes
Mutual Aid Patching	No	No	No	Yes	Yes
Other	Outage Management System	None	None	RF headsets for dispatch operators	Integrate SCADA, load scheduling, employee location, weather, transmission capacity
4.0 Mobile Assets					
Car	50	35	50	POC declined providing this information for dissemination	100
Vans	100	35	100		0
Bucket Truck	80	5	200		20
Crane	0	0	0		0
Backhoe	0	6	0		0
Lineman Truck/Pick-up	250	41	400		
Other		2 Puller/Test Trailers	200 Digger Derricks		

Survey Results

	Central Hudson Gas and Electric	Lincoln Electric System	MidAmerican Energy System	Public Service Electric and Gas Corporation	Tri-State Generation and Transmission Association, Inc.
5.0 Operations & Maintenance Requirements					
24-Hour Help Desk	Yes	No	No	Yes	No
Help Response Time	4 hours	N/A	N/A	4 hours	N/A
Channel Management	Yes	No	Yes	No	No
Configuration Management	No	Yes	Yes	No	No
Fleet Mapping	Yes	Yes	Yes	Yes	No
Inventory Management	No	Yes	Yes	No	No
Real-Time or Periodic System Performance Reports	Yes	No	Yes	No	Yes
6.0 Training Requirements					
Dispatcher Training	YES Multiple Shift Sessions: Yes Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: No	YES Multiple Shift Sessions: Yes Periodic Retraining: Yes	YES Multiple Shift Sessions: Yes Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: No
Radio User Training Required	YES Multiple Shift Sessions: No Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: No	YES Multiple Shift Sessions: Yes Periodic Retraining: Y	YES Multiple Shift Sessions: Yes Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: No
Technical Manager Training Required	YES Multiple Shift Sessions: No Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: Yes	YES Multiple Shift Sessions: No Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: No
Management Training Required	YES Multiple Shift Sessions: No Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: No	YES Multiple Shift Sessions: Yes Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: No	YES Multiple Shift Sessions: No Periodic Retraining: No

	Central Hudson Gas and Electric	Lincoln Electric System	MidAmerican Energy System	Public Service Electric and Gas Corporation	Tri-State Generation and Transmission Association, Inc.
7.0 New Radio System Features					
Standard Availability Features Desired	Radio-to-radio calls Paging	AVL Mobile Data Dynamic Regrouping Horn Honk	50-60 talkgroups	Transportable (suitcase) repeater	Trunking
New Feature Suggestions	Video Monitoring SCADA data Distributed automation PC tablet wireless computer for inspection of data transfer Automated meter reading data transfer, including remote report of power outage Outage mitigation by remote shutoff of selected customer feeds	Remote Testing Mobile Repeater (for wireless handset or portable) Email in vehicle (during disaster for family contact and information dissemination) Mobile outage location mapping Mobile customer information data AVL mapping in vehicle	Line load capacitor control Substation monitoring Load shedding Mapping of data provided by an outage management system	Self-diagnostic radios Redundant circuitry in radios.	High speed mobile data Dynamic bandwidth allocation for data

D

PHASE II STATEMENT OF WORK

System Design and Development

1. Needs Statement

EPRI requires a comprehensive System Design and Site Analysis (SD/SA) to document the requirements and specifications for a new land mobile radio (LMR) system. The end-state LMR system will provide radio communications for EPRI stakeholder personnel during both daily and emergency operations. SD/SA activities shall be comprised of site surveys, user interviews, preliminary system design, design review and will result in delivery of a System Design & Implementation Document (SDID). The SDID document shall describe the requirements and technical specifications of a “turnkey” LMR system. The subject areas to be covered in the SDID are listed under the ‘System Design & Implementation Document’ section of this Statement of Work.

2. Design Objectives for New System

The new system must provide a digital, secure trunking system to meet coverage requirements as determined during the site survey and be comprised of at least two independent trunking system zones. The system must interface to a minimum of one conventional analog repeater through a radio system gateway. Additionally, the system must include at least one compact vehicular repeater capable of operating as both a standard encrypted mobile radio for use within the vehicle and as a radio frequency repeater that is transparent to encryption when accessed via a handheld radio outside of the vehicle.

3. Contractor Tasks

3.1 Site Survey

The Contractor shall perform site survey to evaluate the existing EPRI stakeholder communication system and subscriber equipment. During the site survey, the Contractor shall assess the terrain and examine existing sites for suitability of use in the new LMR system. The Contractor shall note the condition of existing sites to determine necessary site preparation work.

3.2 User Interviews

The Contractor, in coordination with EPRI, shall interview representatives from key radio user groups. The Contractor shall document each interview on an interview form. At a minimum, the Contractor shall gather information about:

- user requirements
- operational use
- required and desired radio features and capabilities
- radio use locations
- types and quantities of radio equipment and accessories
- talkgroup plans
- required interoperability

The Contractor shall interview the current LMR system manager(s) to determine diagnostic and maintenance requirements. The Contractor shall interview dispatch console operators and managers to obtain functional requirements. The Contractor may suggest other individuals to interview. The preliminary findings from the site survey and user interview results shall be documented in the Site Survey and User Interview Report (see Section 6 – Deliverables).

4.0 EPRI Responsibilities

EPRI shall provide the following in support of the Site Survey:

- Access to all sites, including transportation to remote sites which are inaccessible by passenger vehicle.
- An escort who can provide the Survey Team with access and authorization to enter any existing or proposed system equipment site.
- A single point of contact (POC) for the Project and for each facility, and a minimum of one alternate POC, for the purposes of coordinating events with Contractor's POC.
- Facilities to conduct required meetings.

5.0 System Design

The Contractor shall use the information gathered during the Site Survey and User Interviews to recommend a specific LMR communications system design. The design shall address current and future EPRI needs. The System Design shall address the following paragraphs in this section.

5.1 System Infrastructure

The Contractor shall recommend an appropriate infrastructure design. The Contractor shall identify existing infrastructure equipment (base, repeaters, desktop consoles, dispatch operator positions) that can be reused or upgraded for use on the new system design. If additional materials or labor are necessary to upgrade the existing equipment, the Contractor shall provide an estimate for these. The Contractor shall analyze and compare upgrade versus new equipment purchase estimates. The analysis results shall be presented jointly in the SDID.

5.2 Site Locations

The Contractor shall assess site locations indicated for the system master infrastructure site and other remote sites. The Contractor may provide information to assist EPRI to select the most appropriate locations. This information may include level of coverage delivered and estimated effort for site preparation. The Contractor shall note the site support and site preparation necessary for these locations. These shall be described in the Site Support Specification section of the SDID. Site locations shall be expressed in longitude and latitude.

5.3 Coverage Analysis

The Contractor shall perform an in-depth RF coverage analysis and provide coverage prediction maps for each proposed RF site. The coverage prediction shall be performed using three (3) arc second U.S. Geological Survey database. The coverage computation shall use a tile-by-tile method to allow data points to be evenly spaced throughout the coverage area. The Contractor shall assume mobile radio antenna height at roof level of a standard passenger vehicle. The coverage maps are to be provided as part of the SDID, and should display 95% coverage reliability for mobile, both talk-in (radio unit to repeater) and talk-out (repeater to radio unit). Coverage design must accommodate all modes of radio operation, including secure, digital, narrowband use.

5.4 Frequency Analysis

The Contractor shall analyze the EPRI provided frequencies and generate a frequency plan. The frequency analysis should include, at a minimum, a transmitter noise/receiver desense and intermodulation study for each RF site. If any intermodulation or RF interference issues exist, the Contractor shall make recommendations for filtering equipment or changes in the frequency plan. The Contractor shall submit results of the frequency analysis as part of the SDID.

5.5 System Loading Analysis

The Contractor shall perform system traffic loading modeling and simulation analysis to determine the optimal voice channel plan for the system. The Contractor shall use a 2% average grade of service as a general guideline for proper channelization.

5.6 Connectivity Design

The Contractor shall specify the system connectivity requirements for each RF, dispatch console, and system manager terminal site. The Contractor shall recommend microwave, T1 facilities or leased analog lines in each case. The Connectivity Requirements shall be included in the SDID.

5.7 Interface Design

The Contractor shall specify interfaces to enable the system to interoperate with the following all existing radio equipment not made redundant by the design. The Contractor should, where practicable, specify interfaces into the existing nets.

5.8 Migration Planning

The Contractor should, where practicable, incorporate any existing EPRI stakeholder equipment in the new design. The Contractor shall establish a plan for the EPRI stakeholder to migrate from the existing system to the new system. The Migration Plan shall be included in the SDID.

5.9 Reliability

The Contractor shall suggest alternatives to maximize system reliability.

5.10 Dispatch Consoles

With input from radio system users, the Contractor shall determine the suitable number and locations of the console dispatch positions. The Contractor shall identify the appropriate connectivity and the electrical power required.

5.11 System Management Terminals

The Contractor shall recommend an appropriate location for the system management terminal (SMT). The SMT will be used for diagnostics, programming, and maintenance of the system. The Contractor shall identify the appropriate connectivity and the electrical power required.

5.12 Subscriber Units

The Contractor shall recommend suitable mobiles, portables, and desktop subscriber units with features and functionalities required by radio users. The Contractor shall identify existing subscriber units that can be reused or upgraded for use on the new system design. The Contractor shall provide estimates for upgrading the subscribers. The Contractor shall determine the number of new portables, mobiles, and desktop consoles necessary. All portables, mobiles and desktop units shall operate in analog, digital, wideband, narrowband, clear, or secure mode. This flexibility will facilitate mutual-aid interoperability between federal, state, and local entities.

5.13 Critical Design Review (CDR)

EPRI representatives and the Contractor's survey team will meet for the Critical Design Review (CDR). The purpose of this meeting is for EPRI personnel to thoroughly review the communication system design being recommended by the Contractor, resolve any questions, and modify the design as necessary. The Contractor will conduct a presentation that will describe the recommended LMR system solution, predicted coverage area, major equipment components, equipment site support requirements, system design alternatives, the services necessary to implement the system, and a budgetary price estimate. At the conclusion of the meeting, the system design will be finalized and participants will have a clear understanding of the communication design. The CDR shall be conducted at the appropriate EPRI stakeholder location.

6. Deliverables

6.1 Site Survey and User Interviews Report

The overall findings and conclusions from the site survey and user interview results shall be documented in a report. The report shall state the current state of EPRI communications system. The report shall state the assessed current and possible future needs of the radio users. The site survey report will cover the design requirements and shall offer preliminary design considerations. The report shall also describe recommended site locations (and site assessments), available antenna height, interoperability needs, current system limitations, secure communication needs, console operator needs, and subscriber radio requirements. Issues for consideration or that require resolution will be identified in the report. Areas of concern noted during the survey will be addressed with EPRI during the CDR.

6.2 System Design & Implementation Document (SDID)

Upon completion of the final system design, the Contractor shall submit the SDID in one hardcopy and one CD ROM format.

The System Design section of the SDID shall include the engineering design analysis documentation used to arrive at the recommended LMR system design. It shall also include a complete description of the design and shall include:

- System Description and Diagram(s)
- RF coverage analysis (for each site and for the entire system)
- Frequency analysis
- System Loading analysis
- Generic Equipment List
- Connectivity diagrams/list
- Migration plan (from current system to new system)

The Site Support Specification section shall cover site development, site preparation, and other site support issues for all key infrastructure equipment locations (repeater stations, system “hub” equipment, dispatch consoles, etc.). It will describe specifications for required site preparation necessary for the installation of required fixed network equipment (FNE). All site work must be specified using a recognized LMR site development standard. In their proposal, the Contractor shall describe the standard that will be followed.

The Site Support Specification section will also specify all preparation work that must be completed prior to commencement of equipment installation. The Contractor shall identify if new road construction shall be necessary to access a site. Specifications will include tower and shelter requirements related to size, location, orientation, electrical needs, grounding, HVAC, lighting, needed equipment space, and floors and foundations. It shall include the following items (as appropriate).

- A site layout plan (top view) of the equipment
- Equipment specifications to include height, length, width, and weight
- An engineering drawing depicting location and orientation of the equipment shelter, wall penetrations, and any required tower
- Electrical equipment and power requisites
- Environmental requirements for housing communication equipment
- Grounding requirements
- Connectivity requirements
- Appropriate system drawings and tables

6.3 Project Budgeting Information

As part of the SD/SA effort, the Contractor shall provide budgetary pricing information for a “turnkey” system implementation effort. The Contractor will propose a fee-for-service, lease, and purchase plan for the backbone infrastructure and subscriber equipment. At a minimum, the budgetary pricing information shall include the following areas:

- LMR System Infrastructure equipment
- LMR System Implementation services
- Site Development (including towers, buildings, other site equipment)
- Subscriber equipment
- Estimate to modify/upgrade existing equipment for new system
- Optional system enhancements
- Ongoing system support

7. Project Schedule

The System Design Analysis (SDA) and all related documentation shall be completed no later than 90 days after completion of the Site Survey. The Contractor shall describe their established process for projects of this magnitude, with emphasis on a comprehensive approach. The Contractor shall identify key milestones for the system design process. The Contractor shall describe the milestones with reference to days after contract award. The schedule shall include, but is not limited to:

- Site Survey/User Interviews
- Site Survey and User Interviews Report
- Submittal of Draft SDA (EPRI will be given an opportunity to review the draft and submit any changes or required clarifications to the report.)
- Critical Design Review (CDR)
- Submittal of Final SDA

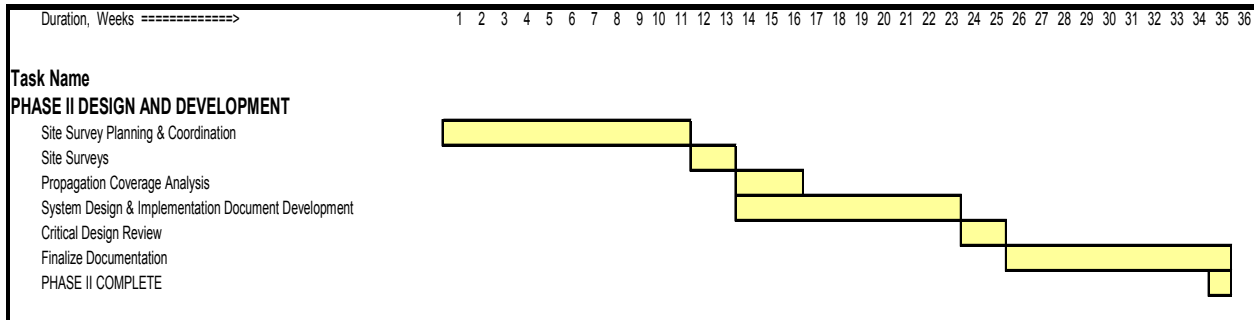


Figure D-1
Phase II Project Schedule (rough)

E

PHASE III STATEMENT OF WORK

Pilot System Implementation

1. Needs Statement

The Electric Power Research Institute (EPRI) requires a digital, trunked, Land Mobile Radio (LMR) system. This task is to provide and implement a turnkey, APCO Project 25-compliant LMR system. Frequency assignments may be governed by the Federal Communications Commission (FCC) or policy directives of the National Telecommunications Information Administration (NTIA) in the event authorizations are government supplied. The Contractor shall provide a system that allows interoperability and frequency optimization with federal agencies. This task will be contingent on continuous funding allocations.

2. Contractor Tasks

The EPRI requires the Contractor to obtain, install (to include site preparation) and maintain a turnkey, standards-compliant, trunked LMR system. The Contractor shall provide options for fee-for-service, lease, and purchase LMR system(s) to satisfy requirements based on the requirements and site selected in Phase II. Additional requirements will be addressed through contract modification. Where implemented as a fee-for-service, the Contractor shall remain the owner and/or lessor, and charge the EPRI stakeholder accordingly for its use.

The LMR system shall be APCO Project 25-compliant. Any new APCO 25 guidelines published during the course of the project will be incorporated by contract modification. As a minimum, the LMR system shall immediately meet the APCO Project 25 Common Air Interface (CAI) standards.

It will be the responsibility of the EPRI stakeholder to acquire authorization and license for use of radio frequency spectrum prior to implementation of the turnkey LMR system. The Contractor shall not proceed with acquiring and implementing LMR system resources until the EPRI stakeholder makes notice to the Contractor that frequencies are acquired. The Contractor shall hold harmless EPRI and the EPRI stakeholder in these matters.

The Contractor shall propose a fee-for-service, lease, and purchase plan for the backbone infrastructure. The plan shall identify the cost per site. A common backbone equipment suite shall be used.

The Contractor shall propose a separate multi-vendor subscriber plan for a variety of handheld radios with and without keypad features, mobile radio units, dispatch consoles, and base stations. All applicable equipment shall contain AES encryption. The subscriber plan shall include fee-for-service, lease, and purchase fee structures with and without maintenance, as well as maintenance and programming fees for existing equipment. The subscriber plan shall include the communications support to interface with the central controller. The Contractor shall also provide a subscriber plan for contingency lease periods. The Contractor shall identify the required notification periods for receipt of the contingency equipment in support of exercises.

The backbone infrastructure plan and the multi-vendor subscriber equipment plans shall include integration of existing EPRI stakeholder owned equipment. EPRI requires buy-out options be included in the fee-for-service and lease plans. The Contractor shall include as a separate line item, program administration and management.

The EPRI stakeholder will provide the existing designs, referred to as System Design Analysis (SDA), with equipment lists. The Contractor shall evaluate, re-engineer if required, and refresh the designs based on the current requirements. New backbone efforts will require initial engineering designs, unless provided. The LMR system shall be engineered to include an air to ground and a maritime interface. If at any time the system fails, the Contractor is required to re-evaluate, refresh the design, and implement new equipment and procedures as necessary and directed by task order modification.

3. Contractor Responsibilities

The Contractor is responsible for obtaining, installing (to include all necessary site preparation), and maintaining a state-of-the-art LMR system through technology refreshment and insertion.

The Contractor shall engineer and/or refresh the provided designs, install, maintain and manage a turnkey, trunked LMR system consisting of radio repeater sites, antenna systems and a central controller for radio repeater integration. The Contractor shall plan, implement, and/or integrate, EPRI stakeholder equipment/commercial connectivity to central controller. Utilization of EPRI stakeholder leased lines or microwave, where available, is authorized and encouraged. The system must be capable of using the Improved Multi-Band Excitation (IMBE) vocoder. Where applicable, the Contractor shall integrate the LMR system with emergency 911 dispatch systems. The Contractor shall provide coverage and performance reliability of 95% for mobile, both talk-in (radio unit to repeater) and talk-out (repeater to radio unit).

3.1 Site Preparation

The Contractor shall perform site surveys and analyses, if required, of the EPRI stakeholder sites identified in the SDID or identified through task order modification. The Contractor shall identify support construction requirements, and if necessary, design and perform support construction at the option of the EPRI stakeholder. The Contractor shall prepare sites for equipment installation. This includes, but is not limited to, the non-recurring engineering analysis to conduct the appropriate Electro-magnetic Compatibility (EMC), environmental impact studies, and real estate actions required to obtain siting approvals and permission to

operate, subject to EPRI stakeholder approval. All sites will be in compliance with Presidential Decision Directive 63, Critical Infrastructure Protection. All equipment and installation techniques used for this system will comply with the Uniform Building Code, the National Electric Code, best industry installation practices and all other applicable state, local codes and ordinances to include seismic and environmental considerations, in effect at the time of installation.

3.2 Frequency Plan

The Contractor shall assist the EPRI stakeholder in developing a recommended frequency plan. The Contractor shall develop a fleet map, develop an installation plan, and develop a test and acceptance plan. The Contractor shall develop plans for each site cutover implementation. EPRI stakeholder approval of the plan(s) is required prior to execution.

3.3 Procurement Services

The Contractor shall provide all equipment, software, minor material items, and disposables for the LMR system, which includes the infrastructure, management system, remotes, and user equipment except where the EPRI stakeholder chooses to provide the equipment as identified by the EPRI stakeholder. The Contractor shall install a system that has emergency back-up power, with uninterruptible power system (UPS) for the critical components. The Contractor shall furnish all equipment, tools, and test equipment for the installation, activation, test, and acceptance. The Contractor is responsible for any damage to existing EPRI stakeholder equipment or services lost as a result of their actions.

3.4 System Maintenance Services

The Contractor shall provide a variety of different categories of maintenance support with associated costs for each option, as related to specific geographical locations. The Contractor shall provide and install all software upgrades and patches, in accordance with the maintenance program and technology refreshment. The equipment shall be capable of operating in the conventional line-of-site, user-to-user mode, when user equipment is beyond the coverage of repeaters or during LMR system backbone outages. The Contractor shall provide a trouble-ticketing and LMR system management plan. As a minimum, the Contractor shall replace or repair subscriber equipment within 24 hours, and repair the central controller and repeaters within four (4) hours. Site specific maintenance requirements will be identified in the appendices.

3.5 System Management Services

For fee-for-service systems, the Contractor shall provide radio ID, talk-group/template administration, management and overall system administration of the LMR system. Where leased or purchased, the above items will be defined through task order modification. The Contractor shall manage and maintain the system on a 24/7 basis.

All deliverables must meet professional standards and the requirements as set forth in the contract, this SOW, and any work orders. Monthly Status Reports (MSRs) are also required, which provide information on work completed, work in progress, work outstanding, as well as highlighting problems encountered and anticipated, and identify team personnel, skill levels, labor hours, rates, monthly costs, ODCs, and cumulative costs.

In addition, the local client point of contact requires text and graphic information of a more detailed technical report, both in hard and soft copies, using the client's office automation suite. The format and software tools will be discussed and determined upon task commencement. Exceptions to use other software tools must be approved prior to delivery.

3.6 Contingency Plans

The Contractor shall implement the LMR system communications plans for Consequence Management operations and Disaster/Contingency/Operation plans as provided by the EPRI stakeholder within 4 hours of receipt. The Contractor shall develop LMR system communication restoral plans for consequence management and contingency situations to ensure system integrity and timely restoral of services. The LMR system restoral plan will be coordinated with the appropriate agencies and approved by the EPRI stakeholder.

3.7 Training

The Contractor shall provide user training to include systems manager/control equipment, communications console, base stations, mobile and portable radios. The Contractor shall provide a training plan to meet this requirement.

3.8 Testing

The Contractor shall conduct tests of equipment, system components, software, firmware, and complete systems to demonstrate the product ability to satisfy requirements of the LMR system. The Contractor shall also test the entire system including the air to ground and maritime interfaces to ensure that the LMR system meets the objective requirements. Tests shall be conducted in accordance with Contractor developed, EPRI stakeholder approved plans and procedures. All discrepancies will be corrected and re-tested to demonstrate conformance to test plan parameters. The results of all testing will be documented in reports.

3.8.1 In-Plant Testing

Systems built under this contract will be tested and certified for operational conformance to the SDID at the Contractor's facility prior to shipment to the customer's location. The test will be conducted by the Contractor with the EPRI stakeholder having the option to participate and/or witness the test. The in-plant test will be conducted in accordance with a Contractor prepared, EPRI stakeholder approved written test plan. The results will be documented in a written test report. All test deficiencies will be corrected and retested by the Contractor prior to the system being shipped to the customer.

3.8.2 On-Site Testing

The Contractor shall conduct an operational on-site test of the system to validate its conformance to the approved design. The on-site test will measure system performance in all criteria of the system requirements and design. The test will include the EPRI stakeholder as participants and/or witnesses at the EPRI stakeholder’s option. The test will be conducted in accordance with a Contractor prepared, EPRI stakeholder approved test plan. The test results will be documented in a test report with all deficiencies clearly noted. Deficiencies will be corrected and retested prior to EPRI stakeholder acceptance of the system.

3.8.3 Burn-in Testing

The Contractor shall operate the system in a fully functional capacity for a period of 30 consecutive working days. During this test, the system must meet the following performance conditions:

- No one failure causes total system downtime.
- No loss of ability for any user or talk group to communicate over the system.
- Successful demonstration of meeting the coverage requirements defined in the SDID.

3.9 Security

Contractor employees shall have United States citizenship. Prior to each person commencing work on a sensitive task, the Contractor must obtain approval from the EPRI stakeholder designated Security Officer.

4.0 EPRI Responsibilities

EPRI must provide list of equipment and resources to be provided.

5.0 Project Schedule

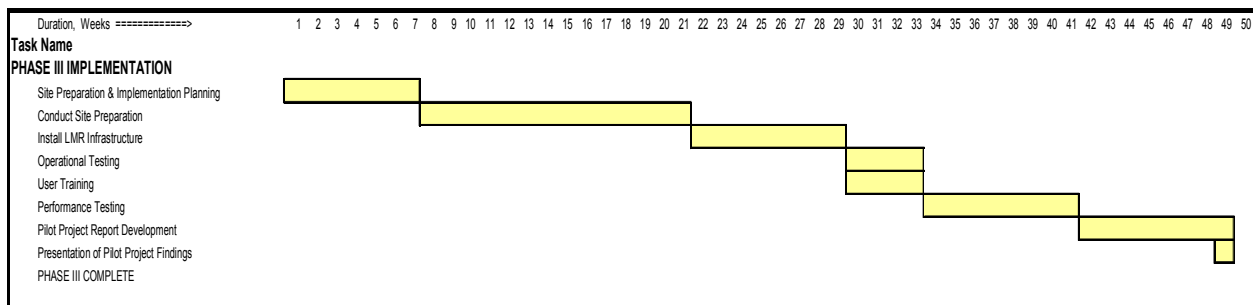


Figure E-1
Phase III Project Schedule

6.0 Deliverables

Deliverables will be determined based upon system design in Phase II.

Program:


Outage Mitigation and Recovery

About EPRI

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