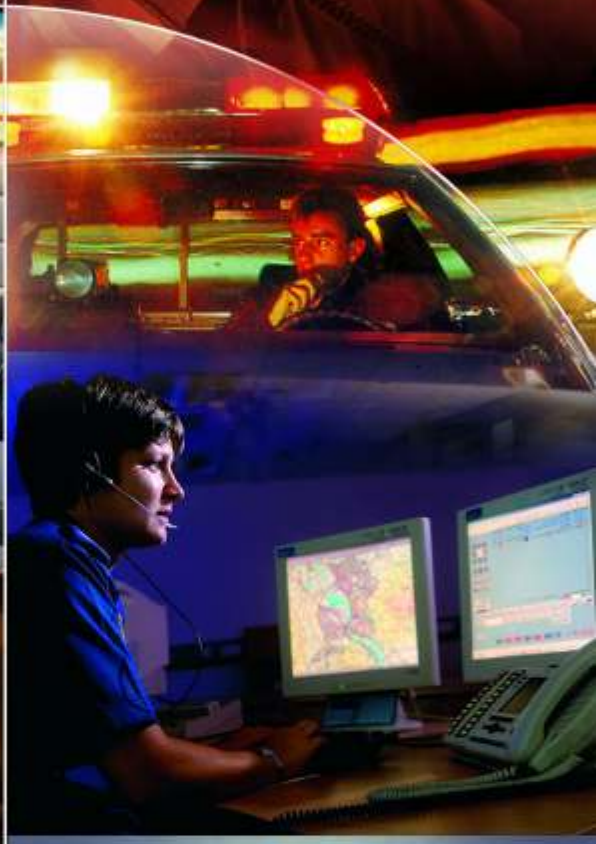
ST. MARY'S COUNTY MARYLAND

Radio Communications System Specifications

August 2011



RCC Consultants, Inc.

1.0 INTRODUCTION

1.1 DEFINITIONS

The meaning of certain words as used within this solicitation shall be controlled through the use of the following definitions unless stated otherwise in the document.

APCO means the Association of Public Safety Communications Officials

API means application programming interface, an interface that enables one program to use the facilities provided by another program

Autonomous Network means another land mobile radio network operated by an independent unit of government

Backbone means a network of redundant components that provides communications between network RF transmission sites, communications centers where consoles are located, and the master network control location

BER means bit error rate

Business Day means any day Monday – Friday that is not designated as a legal holiday by St. Marys County.

C or C++ means a compiled, computer software language

DTMF means dual tone multi-frequency

DSX means digital cross connection

Electronic Patch (or Network Gateway patch) means a device such as a Motorola Motobridge®, M/A-COM Network First®, Raytheon ACU-1000® or similar product designed to provide interoperability between radio systems employing incompatible electronic technologies or architectures

ECC means the County's Emergency Communications Center

FCC means the Federal Communications Commission

FDMA means frequency division multiple access

Fixed Network Equipment (FNE) means all hardware and software used to transmit and receive radio signals including but not necessarily limited to: the system's 700/800 MHz transceivers, comparator/voter, system control systems, combiners, multiplexers, antennae, microwave transceivers and dishes, etc.

Four-Slot TDMA means that a radio channel is divided to provide four separate talkpaths using a time division multiple access technology

Full Duplex means the ability to simultaneously transmit and receive a radio signal

In-building Coverage means the amount of signal margin in decibels or dB provided for in a radio system design for the purpose of overcoming signal attenuation due to building structure, in order to provide the minimum signal level necessary to provide acceptable portable radio communications inside a building

LMR means Land Mobile Radio system

Network Site means a location proposed by the supplier and approved by the County for the installation of FNE

Non-Responsive means that a requirement of the solicitation was not met and the proposal is subject to rejection

NPSPAC means the National Public Safety Planning and Advisory Committee

NPSPAC Region 42 means the coordinating body authorized by the National Public Safety Planning Advisory Committee with administrative authority over St. Marys County

Project 25 (P25) means a standard for digital radio communications for use by federal, state/province and local public safety agencies in North America to enable them to communicate with other agencies and mutual aid response teams in an emergency

Rebanding means the reconfiguration of certain frequencies in the 800 MHz band as required by the FCC and published in the Federal Register on November 22, 2004 (Volume 69, Number 224)[Rules and Regulations][Page 67823-67853] regarding [WT Docket No. 02-55; ET Docket No. 00-258; ET Docket No. 95-18, RM-9498; RM-10024; FCC 04-168] and entitled Private Land Mobile Services; 800 MHz Public Safety Interference Proceeding

Repeater means an electronic device deigned to instantly rebroadcast at a higher power the transmission of a subscriber

RF means radio frequency

Semi-Duplex (Half-Duplex) means the ability to non-simultaneously transmit or receive a radio signal

Sinusoidal means a waveform whose graph is identical to the generalized sine function $y = A\sin[\omega(x - \alpha)] + C$ where A is the amplitude, ω is the angular frequency ($2\pi/P$ where P is the wavelength), α is the phase shift, and C is the vertical offset

Solicitation means this document through which the requirements of the procurement are defined

SQL means structured query language, a relational database program used with a computer system

Supplier means the firm or entity in which the County has contracted to install the System (synonymous with "Contractor", "Offeror", and Successful Contractor)

System means all electronics, hardware, and software components routinely employed to operate the 800 MHz digital trunked network including but not limited to fixed network equipment, antennae, transmission lines, electronic control consoles, microwave system, towers, tower grounding systems, associated subsystems, etc.

Talkaround means the ability of a mobile or portable radio to communicate directly with another mobile or portable radio without the support of the network

TDMA means time division multiple access

Turnkey Solution means the entire system and all tasks or services associated with the system, including the preparation of sites or structures for the installation of System components, including the removal of any existing components of any kind, shall be performed under the responsibility of the supplier or the supplier's subcontractor(s)

Two-Slot TDMA means that a radio channel is time-divided to provide two separate talkpaths using a time division multiple access technology

VSWR means voltage standing wave ratio

700 MHz means the radio spectrum between 764 and 806 Megahertz as currently authorized by the FCC

800 MHz means the radio spectrum between 806 and 869 Megahertz as currently authorized by the FCC

2.0 BACKGROUND AND GENERAL DESCRIPTION OF WORK

2.1 SCOPE OF WORK

The supplier to whom a contract is awarded under this solicitation shall assume complete responsibility for engineering, furnishing, licensing, and installing the 800 MHz Countywide Radio Communications System hereinafter referred to as the "System". The supplier shall be responsible for system performance, including a guarantee of radio coverage; installation of FNE; identification and development of network sites, communication center equipment, portable/mobile equipment, microwave equipment, and control stations; optimization of the radio infrastructure and microwave backbone; and the training of system users, network administrators, and maintenance personnel. The supplier must complete and pass all acceptance tests of system components software and equipment to the satisfaction of the County. The supplier shall also be responsible for the integration of required existing/legacy radio equipment within the system.

The supplier shall propose a complete and fully operational system that meets or exceeds the specifications herein.

In addition, the supplier must demonstrate an extraordinary knowledge of security relative to system software operating programs, physical facilities, and electronic protection to safeguard the network from man-made attacks as well as acts of nature. The supplier must implement design strategies and techniques to provide a highly available and reliable LMR network to serve all County and interoperability radio users.

2.2 CURRENT SYSTEM DESCRIPTION

St. Marys County's existing analog voice radio network consists primarily of a four-site, 10-channel 800 MHz EDACS simulcast trunking network. The County supports a four-site, one/two-channel NPSPAC conventional multi-cast mutual aid infrastructure for interoperability purposes (although this subsystem is currently being upgraded-see details). STMC maintains a four-site simulcast VHF Paging subsystem for Fire/Emergency Alerting purposes. The County also utilizes several miscellaneous analog conventional mutual aid channels for interoperability purposes. All trunking and conventional mutual aid channels are currently available at the dispatch consoles.

A listing of all STMC frequencies is provided in the Appendix section.

2.3 SYSTEM FUNCTIONAL OBJECTIVES

The proposed LMR system shall:

A. Provide reliable on-street and in-building portable radio communications coverage pursuant to the standards defined in this solicitation.

B. Replace the County's existing countywide radio systems with no loss of present capabilities or functionality in a manner that will maximize resource sharing and interoperability among all STMC agencies through direct radio communications using a common digital trunked 800 MHz radio system with the following features:

1) Trunked digital voice communications between all portable, mobile, control station subscriber radios and dispatch consoles in the system. Automatic fallback subscriber modes of operation in the event of network failure or compromise.

2) Emergency call, individual private call, call alert paging, dynamic regrouping, priority talkgroup scan, radio inhibit/uninhibit capabilities, status/message, short message service, and PTT-unit identification from all radio units.

3) Automatic unit identification with alias throughout the duration of each call upon every push-to-talk on a radio unit.

4) Hardware-based multiple key encryption between suitably equipped subscriber units and dispatch consoles.

5) Maximize the capabilities of the assigned 800 MHz frequencies through the use of spectrally-efficient narrowband technologies.

6) Provide the capability of direct radio-to-radio conventional simplex "talk-around" communications in both P25 digital (Common Air Interface) and analog modes of operation.

7) Optionally, provide automatic vehicle location (AVL) capability from suitably equipped mobile and portable subscriber radios.

8) Optionally, provide for the transmission and reception of text messaging between mobile subscriber radios and the network's FNE.

C. Provide physical and logical redundancy throughout all of the system components such that there are no single points of failure in any aspect of the delivered system.

D. Employ technologies to:

1) Allow shared use of one or more autonomous network(s) with proposed subscriber radios. Allow shared use of proposed network with interoperability partners utilizing neighboring autonomous network(s).

2) Provide for system and subscriber expandability for future growth in the 700 MHz public safety band as well as Rebanded/Reconfigured 800 MHz frequencies.

3) Support industry standards for compatible, interoperable multiple vendor subscriber hardware such as mobile, portable and control station units.

5) Support and fully employ applicable APCO Project 25 Standards for Phase I and II

E. Interface with and integrate existing equipment and subsystems as specified in this solicitation.

F. Provide reliable and uninterrupted wireless communications in the vicinity of existing commercial wireless telecommunications facilities located within the County, as well as commercial facilities located near its borders.

2.4 MAJOR SYSTEM COMPONENTS

The major components of the supplier's system shall include:

A. A main dispatch control site to be located at the Emergency Communications Center (ECC) as specified by the County.

B. Remote network digital FNE RF transceiver sites with associated antennas and transmission lines required to provide in-building portable coverage as outlined in this specification.

C. Interfaces to integrate conventional analog NPSPAC ITAC, VHF Paging and miscellaneous VHF/UHF mutual aid infrastructure for interoperability and intra-County operations.

D. Dispatch communications consoles and logging recorder located at the ECC and any remote backup sites as specified by the County.

E. A high-capacity loop microwave backbone network with associated transport equipment to connect the master control components with all associated remote FNE RF transceiver sites.

F. Site development and improvements/modifications as required, to construct the LMR and microwave backbone networks.

G. Mobile, portable, and control station subscriber radios that meet the functional requirements of the user agencies.

H. Control stations at various County facilities and the ECC as specified in the solicitation.

I. PC-based diagnostic clients with a graphical user interface capable of site monitoring and providing network alarms that will report all fault management and system diagnostic information to the ECC and remote network administrator positions.

J. Fault-tolerant and/or redundant computers and associated server computers, as required, to control real-time trunked call processing and system database and user privileges.

K. Network timing and synchronization equipment required to provide transport and discrete network element clocking.

L. Custom in-building coverage solutions (only if absolutely required) to address critical building coverage requirements

2.5 SERVICES PROVIDED BY THE COUNTY

St. Mary's County has begun certain tasks related to system implementation. Ongoing work by the County includes:

1) Providing a Preliminary Design for the purposes of ease of bidding and protection of necessary assets and securing regulatory approvals for deployment.

2) Assisting the supplier in the identification of suitable network sites.

3) Designating a County Project Manager, assisted by a professional engineering and consulting firm, to guide the implementation of the system.

4) Coordinating the scheduling of meetings with other political jurisdictions or relevant governmental resources.

5) Securing approvals for the utilization of State tower and water tank site facilities.

6) Rebanding the existing ITAC/EDACS systems in concert with the 800 MHz Reconfiguration mandate, as required.

7) Completion of preliminary design and protecting the system deployment with preliminary MW link designs on certain high risk tower sites.

8) Completion of 800 MHz channel contour expansions and submission to Region 20 for consideration.

9) Advanced structural analyses to preserve antenna capacity for the future.

10) Submission of FAA applications for speculative tower sites in the preliminary design.

11) Detailed coverage testing of all 85 critical buildings.

2.6 STANDARDS OF WORK

The applicable sections or portions of the standards, regulations, and codes of the entities listed below shall apply to the supplier for site preparation and for the installation, operation, maintenance, and service of the System by the supplier:

- American Concrete Institute (ACI)
- American Institute of Steel Construction (AISC)
- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- American Welding Society (AWS)
- APCO Project 25
- Electronics Industries Association (EIA)
- Federal Aviation Administration (FAA)
- Federal Aviation Administration (FAA) Advisory Circular
- Federal Communications Commission (FCC)
- Federal Environmental Protection Agency (EPA)
- Harris Site Grounding and Lightning Protection Manual AE/LZT1234618
- Motorola R56 Standards and Guidelines for Communications Sites

- Institute of Electrical and Electronics Engineers (IEEE)
- National Fire Protection Association (NFPA)
- National Electronic Manufactures Assoc (NEMA)
- National Electric Code (NEC)
- Occupational Safety and Health Act (OSHA)
- Telecommunications Industry Association (TIA)
- TSB-88 Wireless Communications Systems Modeling, Simulations and Verifications
- Underwriters Laboratories (UL)
- Any State or local ordinances and building, fire, and zoning codes

In the event that the requirements of the standards, regulations, or codes differ, the most stringent shall apply.

3.0 SYSTEM INFORMATION

St. Marys County requires a countywide two-way radio system consisting of approximately 1,600 radio units as specified in detail in the Appendix section of these Specifications. An additional number of outside agencies may also decide to utilize the County's radio system for interoperability purposes. The specific number of users for this procurement is defined in the Appendix section of these Specifications. Exact quantities shall be determined from the successful radio vendor's design and be dependent upon technologies and RF coverage guarantees. Any changes in subscriber quantities from those in the associated Appendix will be accomplished during contract negotiations and subsequent change orders. The supplier shall provide voice radios, antenna subsystems, and ancillary equipment as specified in the solicitation to facilitate complete on-site installation, integration, testing, and commissioning. The supplier's solution must incorporate these issues into the system design(s) and provide the County with a satisfactory approach to each issue and concern as represented in the following paragraphs.

A training period will follow the installation period where the communications officers, radio users, and communications technical personnel are to become familiar with new system operations and maintenance prior to final cutover.

The system should be designed to support the County without requiring significant reinvestment for at least fifteen (15) years following system acceptance. System size, capacity, functionality, flexibility and in-building coverage must be sufficient to support the County's anticipated 50% growth in system subscribers and RF channels and changing needs throughout this period, as well as the possibility of other agencies within the County, participating in the system. The design approach shall have the flexibility to accommodate additional users, additional RF sites, and the seamless addition of 700 MHz and 800 MHz channels, at a later time.

The radio system described in the following may represent a multi-cast or simulcast design, or any combination of these architectures as the supplier deems appropriate to satisfy the totality of system requirements. For the purposes of deployment protection and regulatory licensing, the County has proceeded with channel expansion and acquisition efforts for a simulcast architecture.

3.1 SYSTEM IN-BUILDING COVERAGE

This system shall provide 95% reliable, balanced talk-in/talk-out portable coverage, with the portable radio worn on the hip in a leather swivel case, using a standard lapel speaker microphone and ½-wavelength style antenna mounted on the portable radio chassis. The RF coverage design is based upon the unique requirements of the County, TSB-88 (most recent edition at time of supplier proposal), signal strength testing, and subjective voice testing based upon the Delivered Audio

Quality (DAQ) criteria of 3.4. Coverage requirements are comprised of these elements at a minimum.

- Element 1 –800 MHz Portable On-Hip 6 dB Countywide service area
- Element 2 – 800 MHz Portable On-Hip Critical Level One buildings
- Element 3 – Meets or exceed the FCC Reconfiguration R&O specifications for protection from Commercial Mobile Radio Service providers.

Element 1 requires a 95% service area reliability using a portable on-the-hip with 6 dB in-building loss over the entire STMC County landmass and political territory, for both talk-in and talk-out configurations. Element 2 requires that all Critical Level One buildings, as defined in the Appendix section, provide 95% or greater in-building coverage reliability throughout the entire building structure. Element 3 requires that the supplier engineer a network that provides sufficient signal margins, in concert with the Interference Protection Standard guidelines specified in the August 6, 2004 FCC Report and Order on WT Docket 02-55 (FCC 04-168), throughout the County to mitigate and eliminate adjacent and in-band noise/interference. The System Acceptance Testing section thoroughly defines the testing requirements that pertain to coverage acceptance testing for the various Elements.

Provided further, control stations shall provide 99% service area reliability countywide and must be able to transmit to and receive from no less than three (3) different FNE sites without degradation to base station receiving equipment. Mobile radios shall exhibit equivalent or superior coverage reliability performance as compared to portable radios worn on the hip without degradation to portable devices operating within the vicinity of mobile units. The radio coverage design shall take into account the current noise floor environment as well as predictable degradations for the near future. The County requires the system to be tolerant and resistant of current and future interference from cellular and ESMR system deployments.

In addition to standard considerations for environmental losses, the coverage design shall take into account the following:

- Predictable Adjacent Band Noise/Interference from CMRS systems
- Predictable Co-channel Interference near the Contour
- Potential for Portable Receiver Desensitization from Mobiles Operating in the Fringe Coverage
- 8-point Body Absorption Averaging or Similar Assumptions.

These factors shall be taken into account in the supplier's MRSL (Minimum Receive Signal Level) figure. The supplier shall provide a detailed signal path loss calculation in its response that reflects all assumptions and loss values.

The delivered audio quality in each area defined below shall meet or exceed DAQ 3.4 per the guidelines of TSB-88 (the most recent version) as defined in the following table. Prior to conducting the CATP, the supplier shall provide thorough participant training that includes audio demonstrations and examples of the differences between the various DAQ levels listed below to assist in the ranking of audio quality for specific test messages.

DAQ (Delivered Audio Quality)	Grade of Performance
1	Unusable, Speech present but unreadable.
2	Understandable with considerable effort. Frequent repetition due to Noise/Distortion.
3	Speech understandable with slight effort. Occasional repetition required due to Noise/Distortion.
3.4	Speech understandable with repetition only rarely required. Some Noise/Distortion.
4	Speech easily understood. Occasional Noise/Distortion.
4.5	Speech easily understood. Infrequent Noise/Distortion.
5	Speech easily understood.

Table 1 - Definitions for Delivered Audio Quality

3.2 APCO PROJECT 25 CONFORMANCE

The trunked system shall conform to the objectives and user requirements outlined in the current APCO Project 25 Phase I specification (see TIA/EIA-102 family of specifications) in terms of digital modulation, spectral efficiency, enhanced audio quality, conventional and trunking modes, ID methodology, and direct interoperability with equipment from other manufacturers. The supplier proposal shall include comprehensive detail on all subscriber and fixed network equipment P25 conformance testing for equipment being offered to STMC. Such conformance testing detail shall include field and laboratory test results from the ongoing NIST/SAFECOM and TIA P25CAWG compliance assessment programs. For the life of the contract and maintenance period, the supplier shall provide on a quarterly basis, at a minimum, the results of industry-led conformance testing with the proposed system platform and subscriber base. All proprietary features and operational characteristics shall be identified to St. Marys County in writing, for all

proposed subscriber and fixed network equipment to identify the supplier's deviation from the P25 Phase I specification.

Because the APCO P25 specification and standards work continues to evolve, some of the features required by STMC in this specification may initially be outside of the current scope of the P25 standard. The County requires the supplier to adhere to the P25 standard for all features that are included in the P25 TIA/EIA-102 specifications, but the County will accept supplier-specific solutions for those features currently outside of the P25 scope in order to obtain a full-featured communications network. The supplier has the responsibility to demonstrate P25 conformance for those subscriber and network infrastructure features contained in the P25 specification, while clearly delineating those features that have been developed with proprietary solutions. The supplier accepts the added responsibility of working openly with all qualified industry vendors to facilitate P25 interoperability for those features that may initially be offered as proprietary solutions. For those features and solutions deemed initially proprietary in nature, STMC requires the supplier to provide all of the necessary details to all sanctioned P25 working groups and committees to continue to foster a truly open industry communications solution. Through this specification, STMC requires the supplier to guarantee its commitment to further promoting the APCO P25 specification by actively and openly working with LMR industry vendors in a manner of full disclosure for all features and functionality. For the life of the contract and maintenance period, the supplier accepts full responsibility and expense for remedying and correcting any identified P25 non-conformance issue for all affected system hardware and software.

As an option, the County will entertain a supplier proposal aligned with the evolving APCO Project 25 Phase II specification as long as complete backward compatibility and interoperability with all Project 25 Phase I initiatives are delivered. If a Phase II proposal is offered, then the supplier shall identify the extent to which such a system has been proposed and possibly deployed with specific customer references. Any proposed system must also conform to the reconfigured 800 MHz spectrum requirements and signal levels outlined by the FCC in the ongoing 700 MHz public safety spectrum allocation and 800 MHz Reconfiguration Plan. At a minimum, the supplier shall define and explain the subscriber and system migration path from its P25 Phase I-compliant offering to a P25 Phase II-compliant architecture.

3.3 INTEROPERABILITY

The system shall also be capable of direct conventional (analog and digital mode) and trunked (analog and digital mode) subscriber radio interoperability (or functional equivalent) with other local public safety agencies utilizing 700/800 MHz P25 digital trunked radio networks located in or around the County

boundaries, but which are not a part of St. Marys County Government or the St. Mary's system. This user community specifically includes, at a minimum, the public safety radio users from the State of Maryland and Prince George's County P25 systems when operated in full open P25 standard.

STMC also requires a design that includes mutual aid console and subscriber interoperability functionality with Calvert County, Charles Counties. Preservation of all existing infrastructure, subscriber, and console interoperability capabilities shall be preserved in the proposed system. The County intends to reuse its existing VHF fire alerting/paging and miscellaneous VHF/UHF conventional infrastructure which must be integrated into the proposed system. The County requires both its present two-channel and new five-channel conventional simulcast NPSPAC 800 MHz mutual aid infrastructure to be integrated into the proposed system through both subscriber radio programming and dispatch console access.

The supplier shall describe in detail the architecture, features, limitations, and overall compatibility that the proposed network offers in terms of maintaining and integrating the required subscriber and console interoperability. The supplier shall identify any proposed network gateway infrastructure integral to the system design for interoperability. The supplier shall address the County interoperability requirements in concert with current federal, state, and regional interoperability goals and best practices.

3.4 NETWORK BACKBONE

The supplier shall provide a high-capacity, loop microwave network backbone that provides redundant connectivity with 99.9999% availability between all network RF transmission sites, dispatch consoles, and network management components. The supplier shall provide traffic utilization, bandwidth consumption, and overall throughput assessment baseline reports for each backbone transport and Ethernet networks upon system commissioning in the field to baseline the as-built condition for each delivered network.

3.5 NETWORK COMMUNICATIONS CONTROL

STMC Emergency Operations are to be controlled primarily from the existing County 911 Emergency Communications Center. Secondary or back-up operations shall be controlled from the existing Back-Up Emergency Communications Facility.

3.6 CORE AND OPTIONAL TECHNICAL/OPERATIONAL NETWORK FEATURES

This section presents basic functional definitions and system requirements that apply throughout the solicitation. These definitions are supplemental to those found in previous sections and are intended to describe operational characteristics for all radio systems regardless of the technologies, media, or any feature proposed by a supplier. It is acceptable for a specific technology or offering to differ in technique; however, suppliers must describe how the offering achieves the same operational functionality/characteristic and compliance with the current APCO Project 25 standard.

As part of the Offeror's compliance response, Offeror shall respond to each definition by stating compliance or non-compliance as described. If the proposed technology offering differs in any way, then the supplier must offer a complete description indicating how the proposed technology or offering provides the required system functionality.

3.6.1 *Talkgroup Call*

A talkgroup call is defined as a one-to-many voice transmission to members of the same organizational unit known as a talkgroup. Group calls shall be a network-wide capability and shall be fully supported by the system in all locations. Group calls shall be capable of being initiated from a subscriber terminal or a dispatch console. Group calls are half duplex. Late entry must be supported. Talkgroups shall be either defined in advance by system administrators or assigned dynamically by dispatch operators or system administrators.

The proposed system shall provide the ability to authorize or deny system access in real-time for an individual subscriber and/or talkgroup by remote site. The proposed system shall provide the ability to configure the maximum call duration for a specific talkgroup call as well as the hang time associated with a group call. Priority scanning of group call activity shall be permitted from any subscriber terminal. The creation of new talkgroups in the proposed system shall be straightforward using the Network Management System (NMS). By talkgroup, the proposed system shall be capable of providing the capability to queue a group call or proceed immediately with a group call based on the availability of every affiliated site to provide voice channel service to every affiliated member of the active talkgroup. All subscriber terminals and dispatch consoles shall be equipped with configurable talkgroup call functionality.

3.6.2 *Talkaround (Direct Mode)*

Talkaround or Direct Mode is the ability of radio subscriber units to operate unit-to-unit (direct simplex mode) without requiring the use of radio tower site transceivers. If an individual terminal loses contact with its base station due to coverage difficulties, base station failure or trunking network failure, it shall be possible to

operate in talkaround or direct mode. Generally, the radio subscriber unit transmits and receives on the base repeater transmit frequency or some other frequency(s) not operational at the fixed radio sites. Range is limited to the power of the subscriber radio units. Talkaround allows unit-to-unit operations when out of range of the system or allows a tactical operation to exist within the system range but not load the system talk-paths. Talkaround channels may also be utilized for vehicular repeater operations. Talkaround can be utilized in either analog or digital modes. Talkaround usage is necessary for out-of-network or fringe coverage such as encountered upon entering a highly attenuated building or tunnel. Talkaround usage is also envisioned for times of limited network capacity.

All subscriber terminals shall be equipped with talkaround (direct mode) functionality that can operate in any combination of 700/800 MHz analog and digital conventional modes. All digital talkaround conventional modes shall be capable of utilizing the APCO Project 25 Common Air Interface (CAI) for interoperability. All talkaround modes of operation shall utilize FCC-approved channel bandwidths and, as appropriate, shall be in concert with the APCO Project 25 modulation schemes for spectral efficiency. All analog conventional modes shall utilize a radio programmable CTCSS/PL/DPL scheme to control transmit and receive functionality. All digital conventional modes shall utilize a radio programmable network access/unit identifier scheme to control transmit and receive functionality. All conventional modes shall be capable of multi-key encryption. Note that the appropriate Appendices will delineate the specific subscriber need for secure-equipped radios.

The proposed system shall allow direct mode communications at any time without degrading normal system performance. Direct mode communications while in range of the fixed equipment shall do no more than temporarily capture receivers from possible outbound messages. Direct communication shall be possible at any time while out of range of the fixed equipment with no degradation in system performance or capacity.

3.6.3 ***Push-To-Talk Unit Identification (PTT-ID)/Display***

In all modes of trunking operation, the proposed network and all subscribers shall be capable of operating in a PTT-ID mode of operation in which the programmable radio unit ID(s) are transmitted to the network upon every radio PTT for call logging and radio user recognition at the Network Management System and dispatch workstations. All radio IDs shall be capable of being alphanumerically aliased at the NMS and dispatch workstations. PTT-ID signaling shall not delay or degrade the radio transmission in any manner. All display wireless dispatch, dispatch consoles, and subscriber field radio units must display the transmitting radio unit ID and alternatively display a user alias as well.

3.6.4 *Emergency Alert/Call*

An emergency call is defined as a specialized talkgroup call with the highest assigned queuing priority. An emergency alert is defined as an instantaneous data service that signals the identity of the initiating unit to a dispatch console(s), dedicated network management terminal(s), and all other members of the affiliated talkgroup. Emergency calls shall be a network-wide capability and shall be fully supported by the system in all locations. Emergency calls shall be capable of being initiated from any subscriber terminal. The proposed network shall provide the ability to authorize or deny emergency access in real-time for an individual subscriber and/or talkgroup by subsystem. The proposed network shall provide the ability to configure the maximum call duration for an emergency call as well as the hang time associated with an emergency call.

Emergency functionality shall be configurable by talkgroup to operate in either a preempt mode or top of busy queue mode when operating under a channel busy scenario. If a second emergency call is placed while an earlier emergency call is in progress, the second call shall not preempt the first. Instead, the second emergency call should queue for available network resources. No emergency alerts/calls shall be terminated until the user clears the emergency status from the initiating subscriber terminal. All subscriber radios, dispatch consoles, and NMS workstations must be equipped with emergency alert/call functionality.

Emergency functionality shall be configurable to operate in either a tactical or revertive mode. Tactical emergency mode is defined as initiating and processing the emergency alert/call on the actively selected talkgroup mode. Revertive emergency mode is defined as initiating and processing the emergency alert/call on a pre-assigned talkgroup mode that may or may not be the actively selected talkgroup mode. Configurable duration "hot microphone" emergency (i.e., radio keys automatically for a predefined duration upon activation of emergency button or switch) capability shall be provided for all subscriber terminals. "Stay Alive" emergency (i.e., radio cannot be powered off upon activation of emergency button or switch until emergency condition has been cleared at the subscriber terminal) capability shall be provided for all subscriber terminals.

All subscriber terminals shall be notified audibly and visually when a talkgroup has been placed in emergency mode by another member of the talkgroup. All subscriber terminals and dispatch consoles shall also be capable of defeating the audible and visual alerts (i.e. clandestine or covert tactical operations) associated with emergency when a talkgroup has been placed in emergency mode by another member of the talkgroup. Emergency alert/call shall be fully operational through any vehicular repeater system operation (the dispatcher will observe the field user ID rather than the host mobile user ID connected to the vehicular repeater in use).

All proposed mobiles, portables, control stations and dispatch consoles shall be equipped with a dedicated switch or function that allows emergency notification. The switch shall be easily accessed while minimizing the chances for accidental activation. The radio emergency switch or button shall also be equipped with a configurable depress timer to adjust the length of time the button or switch must be depressed to activate and clear the emergency. Upon emergency activation, the field unit shall transmit the emergency message on a periodic basis until acknowledged by the console operator (dispatcher). Suppliers shall describe the proposed emergency functionality in detail.

3.6.5 ***Selective Alert***

Selective Alert is the capability for one voice/data radio and/or dispatch console/NMS workstation to selectively alert or "page" a specific voice/data radio. A "source" radio or console selectively alerts a "target" radio (or console) to indicate that the target radio should return to a "Home" or predefined talkgroup for a message. No talk-path or voice resource should be assigned for a selective alert, and the command shall be completed instantaneously.

Source radios can be equipped to initiate selective alerts via a pre-programmed list(s) stored in memory or through a full radio alphanumeric keypad. Properly equipped source radios or dispatch consoles/NMS workstations can selectively alert any radio in the system by entering the specific unit ID of the desired target radio. Radios can also be "target-only," thus only capable of receiving selective alerts. Positive or negative acknowledgement shall be provided to the subscriber terminal or dispatch/NMS console as to whether the target radio receives the individual call. All subscriber terminals and dispatch consoles/NMS workstations shall be equipped with selective alert functionality. Suppliers shall describe the proposed selective alert functionality in detail.

3.6.6 ***Individual Call***

An individual call is defined as a wide-area, one-to-one voice transmission between any combination of subscriber terminals and/or dispatch consoles operating within the network. Individual calls shall be a network-wide capability and shall be fully supported by the system. Such calls need only be half duplex. Users shall also be able to place individual calls to dispatch consoles. Identification of the calling party shall be made to the subscriber terminal in alphanumeric format. Positive or negative acknowledgement shall be provided to the subscriber terminal or dispatch console as to whether the target radio receives the individual call. The proposed network shall provide the ability to configure the maximum call duration for an individual call. The proposed network shall provide the ability to configure the real-time permission to initiate an individual call per subscriber terminal and dispatch console. All subscriber terminals and dispatch consoles shall be equipped

with individual call functionality. Suppliers shall describe the proposed individual call functionality in detail.

3.6.7 *Selective Radio Disable/Inhibit*

Selective Radio Disable/Inhibit is the ability of the system to indefinitely disable a specific subscriber radio unit or dispatch position from transmitting and receiving talkgroup calls, emergency alerts, emergency calls, selective alerts, selective calls, telephone interconnect calls, and status/message indications and receptions. The NMS shall be capable of issuing the selective radio disable/inhibit command as an instantaneous data service not utilizing a talk-path or voice resource. Likewise, the NMS shall be capable of issuing a Selective "Uninhibit" command as an instantaneous data service not utilizing a talk-path to re-enable the previously-disabled target subscriber terminal. Positive or negative acknowledgement shall be provided to the NMS console as to whether the target radios receive the selective radio disable/inhibit & uninhibit commands. All subscriber terminals and dispatch consoles shall be equipped with selective inhibit/uninhibit functionality. Suppliers shall describe the proposed selective radio disable/inhibit functionality in detail.

3.6.8 *Dynamic Regrouping*

Dynamic Regrouping is the ability of a radio system to create a new talkgroup(s) and automatically assign radios to that new talkgroup(s) without requiring the user to manually change the channel selector switch.

Dynamically regrouped radio units can either be forced to remain on the new talkgroup(s) (restricted mode) or be allowed to freely change talkgroups (selectable mode). Pre-defined "action plans" can be created and initiated to regroup an unlimited number of affiliated subscriber radios into a new talkgroup automatically with a minimum of keystrokes by the system manager or dispatcher.

The NMS shall be capable of issuing the dynamic regrouping command as an instantaneous data service not utilizing a talk-path or voice resource. Likewise, the NMS shall be capable of issuing a Dynamic "Unregroup" command as a data service not utilizing a talk-path to remove the target subscriber terminal from the regrouping scenario. Positive or negative acknowledgement shall be provided to the NMS console as to whether the target radios receive the dynamic regrouping and unregrouping commands. All subscriber terminals and NMS workstations shall be equipped with dynamic regrouping functionality. Suppliers shall describe the proposed dynamic regrouping functionality in detail.

3.6.9 *Talkgroup Patch/Merge*

Multiple talkgroups are combined together providing two-way communications between all talkgroups in the patch. A talkgroup patch may involve the use of multiple talk-paths to process the specific call. Similar in functionality to a talkgroup patch, talkgroup merge involves combining multiple talkgroups into a single talk-path for the duration of the call. All subscriber terminals and dispatch consoles shall be equipped to participate in a talkgroup patch and/or talkgroup merge call. The system shall be equipped to establish any talkgroup patch/merge in both a dynamic (i.e., dispatcher can enable or disable from console position) and permanent mode (i.e., dispatcher cannot disable), depending on specific St. Marys County configuration requirements.

3.6.10 ***Multi-Select (Simul-Select)***

A multi-select occurs when multiple talkgroups are linked together dynamically for one-way outbound communications from the dispatch console. A multi-select may involve the use of multiple talk-paths to process the specific call or shall also be configurable to regroup all target talkgroups to a common talkgroup that is broadcast by the system. The dispatch console shall simultaneously hear the audio from all multi-selected talkgroups on the select speaker of the console, but the field users only hear the dispatcher conducting the multi-select or talkgroup audio from other members of their talkgroup. All subscriber terminals and dispatch consoles shall be capable of participating in a multi-select call.

3.6.11 ***Priority Level Access***

In a busy talk-path condition, the system shall stack or queue call service requests from users on a first-in-first-out (FIFO) basis. The system shall be capable of rearranging the queue based upon a relative priority level associated with a specific radio unit ID or talkgroup ID allowing faster servicing of higher priority (i.e., public safety) calls. By system design default, emergency calls shall have the highest priority of any other call in the busy queue. Priority levels shall be configurable by individual ID and/or talkgroup ID.

The system must have a priority structure that is supported throughout the network. This must enable the following:

- Network administrators must be able to dynamically assign different priority levels to various types of calls and radio users.
- Emergency Calls must have the highest priority and be capable of preempting lower priority calls if no channels are available.
- Channels shall be assigned on the basis of the highest priority among calls waiting.
- At least ten priority levels should be supported.

- Recent users shall be capable of giving an elevated priority to maintain continuity of conversation.

Suppliers shall describe the proposed priority scheme in detail. All subscriber terminals and dispatch consoles shall be capable of participating in the proposed multiple priority access level scheme.

3.6.12 *Busy Processing/Queuing*

If no talk-paths or voice channel resources are available, radios requesting channels for new conversations should be placed in a busy queue. Users of the same priority should move through the queue in a FIFO sequence; however, users of higher priority should be elevated ahead of lower priority users in the queue.

When a voice channel becomes available, the radio at the top of the busy queue shall receive a channel assignment and generate a callback tone to the user. This callback tone alerts the user that a channel assignment has been made and communication is now possible on the selected talkgroup. All subscriber terminals and dispatch consoles shall be capable of providing the busy queuing/callback functionality.

3.6.13 *Site Registration/Affiliation*

Site registration is the ability for a subscriber unit to seamlessly roam into RF coverage of a specific site or cell and automatically transmit individual ID, current talkgroup, and other pertinent affiliation information. The network controller(s) can then dynamically manage and assign RF talk-path resources for the affiliated talkgroup/radio unit in this and other sites/cells containing other members of the talkgroup.

The proposed system must allow users to roam freely throughout all areas served by the system. It must also have the ability to restrict movement of individual terminals and/or talkgroups to specified sites or combination of sites. The proposed system shall be capable of activating a configurable deregistration timer upon a subscriber roaming out of system RF coverage so that channel resources are not unnecessarily keyed indefinitely.

The supplier shall describe how its system manages mobility, roaming, and site registration/deregistration. Subscriber handoff between remote sites shall be seamless and without voice or data interruption to the subscriber terminal or dispatch console. Handoff/roaming algorithms, registration/deregistration parameters, and network mobility configuration control shall be explained in detail.

All subscriber terminals shall be capable of dynamic site registration and wide area roaming.

3.6.14 *Talkgroup Steering*

Talkgroup steering is the system capability to manage and restrict the assignment of specific talkgroups to specific RF channels and talk-paths. Thus, some talkgroups may be limited to utilizing specific talk-paths while other talkgroups are limited to these and other talk-paths. Since the entire user base is made of users from different categories, the system must accommodate the network usage partitioning of these various categories. The proposed system shall be capable of multiple levels of talkgroup steering employing any combination of talkgroups. Shared use and interoperability agreements may dictate that certain talk-paths are reserved for some talkgroups and other talkgroups are restricted from particular channel access. Talkgroup steering and associated configuration control shall be explained in detail. All subscriber terminals and dispatch consoles shall be capable of participating in any talkgroup steering configuration configured by the network administrator.

3.6.15 *Broadcast/Announcement Talkgroup Call*

The proposed system shall provide Broadcast/Announcement Talkgroup Call functionality. Broadcast/Announcement Talkgroup Call functionality is defined as the ability for a properly configured dispatch console or subscriber terminal to transmit to multiple talkgroups simultaneously using a single talk-path for the duration of the call. A broadcast/announcement talkgroup call shall be configurable to either wait for all associated transmitting talkgroup members in active calls to de-key, or the proposed system shall be configurable to interrupt calls in progress when a broadcast/announcement talkgroup call is initiated. Talkgroup membership in a broadcast/announcement talkgroup call shall be configurable at the dispatch console or NMS workstation. The proposed system shall provide the capability to create multiple, different broadcast/announcement talkgroup call resources. All subscriber terminals and dispatch consoles shall be capable of generating and participating in a broadcast/announcement talkgroup call.

3.6.16 *Sub-Network (Subsystem) Call*

The proposed system shall provide Sub-Network (Subsystem) Call functionality which enables dispatch consoles or properly configured subscriber terminals to issue an announcement using a single talk-path to all affiliated radios and talkgroup members at a specific RF site or combination of RF sites. A sub-network (subsystem) call shall be configurable to either wait for all affiliated transmitting talkgroup members in active calls to de-key, or the proposed system shall be configurable to interrupt calls in progress when a sub-network (subsystem) call is initiated. The proposed system shall provide the capability to create multiple,

different sub-network (subsystem) call resources. All subscriber terminals and dispatch consoles shall be capable of participating in a sub-network (subsystem) call.

3.6.17 *Late Entry*

The proposed system must provide Late Entry capabilities. Late Entry is defined as the functionality whereby the proposed system can transmit late entry indications related to any active call thus allowing latecomer users (i.e., previously turned off radio, radio out of range, etc.) to join an active talkgroup, broadcast/announcement group, or sub-network call. All subscriber terminals and dispatch consoles shall provide late entry functionality.

3.6.18 *Transmission/Message Trunking*

In all modes of trunking operation, the proposed network shall be capable of operating both in transmission trunking and message trunking modes of operation configurable by talkgroup resource. Transmission trunking refers to the ability to configure the system so that the network does not associate any hangtime with a talkgroup call so that channel resources are immediately available for reassignment following a subscriber radio or console de-key. Message trunking refers to the ability to configure the system such that the network associates a configurable-length hangtime with a talkgroup call so that channel resources remain temporarily available following a subscriber radio or console de-key on a specific talkgroup to preserve continuity of conversation. All subscriber terminals and dispatch consoles shall be capable of working in either transmission trunking or message trunking modes.

3.6.19 *Audio Interruption*

The proposed system shall be capable of being configured to provide Audio Interruption functionality. Audio Interruption is defined as the ability for a subscriber or a talkgroup member with equal or higher priority (relative to the transmitting unit) to interrupt an active call in progress and become the source of the talkgroup audio. Audio Interruption shall be configurable: (1) to allow interruptions based on priority levels, (2) to never permit interruptions, and (3) to always permit interruptions. Radios not permitted to interrupt an active talkgroup call shall receive a distinguishable, audible "interrupt prohibit tone" to signify the inability to interrupt an active call. Audio Interruption and associated configuration control shall be explained in detail. All subscriber terminals shall be capable of working in any audio interruption mode.

3.6.20 *Scan/Priority Monitoring*

The proposed system shall be capable of being configured to provide talkgroup and conventional mode scan functionality. Scan is defined as the ability for a subscriber to monitor/temporarily join active talkgroup or conventional calls (other than the talkgroup or conventional mode currently selected/tuned on the subscriber radio) in progress based on a configurable subscriber scan list of talkgroup and/or conventional resources. Scan functionality shall be controlled either by a configurable subscriber switch/button/menu item or through radio programming using auto-scan functionality configured by talkgroup or conventional modes. Scan shall also be configurable to provide talkback scan functionality meaning that a subscriber user could key up on an actively-scanned mode if the subscriber PTT switch is activated. Scan and associated configuration control shall be explained in detail. All subscriber terminals shall provide multiple, user-configurable subscriber scan modes and lists. All subscriber terminals shall be capable of working in the various scan modes.

The proposed system shall also be capable of being configured to provide Priority Monitoring Scan functionality. Priority Monitoring Scan is defined as the ability for a subscriber or a talkgroup member to scan to an active higher priority talkgroup while involved in an active, lower priority talkgroup call. Various levels of priority shall be configurable for a subscriber terminal. Priority Monitoring Scan and associated configuration control shall be explained in detail. All subscriber terminals shall be capable of working in a priority monitoring scan mode.

3.6.21 *Out-of-Range Indications*

The proposed system subscriber terminals shall provide audible and visual Out-of-Range indications upon entering a service or geographic area in which trunked system RF coverage levels have dropped below an acceptable and reliable usage threshold. All subscriber terminals shall be capable of providing an audible and visual out-of-range indications.

3.6.22 *Console Priority*

The proposed system shall provide Console Priority functionality for all dispatch consoles. Console Priority is defined as the ability for a dispatch console to assume control of a talkgroup call at any time. The audio generated at a dispatch console position shall always be broadcast to all members of the talkgroup even if a subscriber terminal is actively transmitting. If a dispatch console assumes control of an active talkgroup call and asserts Console Priority, the dispatch console should still hear the transmitting unit's inbound audio but the rest of the members of the talkgroup shall hear only the outbound dispatch console audio.

3.6.23 *ID Scheme*

The proposed system and subscriber terminals shall adhere to the recommended APCO Project 25 ID coding structure (i.e., subscriber IDs, network ID, system ID, subsystem/site ID, talkgroup IDs, etc.) to facilitate inter-system interoperability and mobility management. Trunked user roaming between P25 networks supplied by various P25 LMR vendors shall be accomplished per the P25 specification. The proposed network shall be equipped to manage at least 48,000 unique radio subscribers and at least 2,000 unique talkgroups. The proposed ID methodology and associated database maintenance of these IDs shall be explained in detail. All proposed subscribers shall be equipped to program and interoperate on at least ten (10) different P25 trunked systems for interoperability purposes. The supplier shall define the delivered capacity and scalability of the proposed network.

3.6.24 *Area (Site) Selection*

The proposed system must have the ability to provide Area (Site) Selection functionality. Area (Site) Selection is defined as the ability to define areas for site control and call processing, on both a subscriber and talkgroup basis. The system shall provide the configuration capability to define a specific area/subset of sites to be used by the proposed system for establishing and processing call types. For an individual or group call, this means that called active users will not be alerted and engaged for the active call if the subscriber radio is affiliated outside the selected area or pool of valid sites for that specific call type.

3.6.25 *Site Preferences*

The proposed system must have the ability to provide Site Preferences functionality. Site Preferences is defined as the ability to rank/prioritize the affiliation and usage of specific sites and/or subsystems within a subscriber terminal. The system shall provide the configuration capability, at a radio subscriber level, to customize the site preferences for every proposed network site or subsystem. A "home" site or subsystem shall also be configurable for all subscriber terminals which would serve as the most-preferred (highest ranked) site or subsystem if configured. The site preferences database or configuration table governs the sites utilized by subscriber terminals for establishing and processing all call types. Multiple levels of site preference shall be provided for all subscriber terminals, and criteria such as real-time control or voice channel bit error rate (BER), received signal strength, and site channel capacity shall be used in executing the site preferences algorithms. Site Preferences and the associated configuration control shall be explained in detail. All subscriber terminals shall provide the site preferences functionality.

3.6.26 *Channel Beacon*

The proposed system must have the ability to provide Channel Beacon functionality. Channel Beacon is defined as the ability for a dispatch console to apply or generate a recurring, unique audible alert tone on a specific talkgroup and/or conventional resource to notify resource members of the need to refrain from using the channel or talkgroup (i.e. officer shot, stakeout in progress, working fire, etc.) while a serious event is being managed. Channel Beacon and the associated configuration control shall be explained in detail. All subscriber terminals and dispatch consoles shall provide the channel beacon functionality.

3.6.27 *Alert Tones*

The proposed system must have the ability to provide Alert Tones functionality. Alert Tones functionality is defined as the ability for a dispatch console and/or properly-equipped subscriber terminal to apply unique, audible alert tones on a specific talkgroup and/or conventional resource to notify resource members of a special situation or to preamble a special dispatcher broadcast. The system shall provide multiple (at least three) unique alert tones so that various routine situations and announcements can be associated with a specific alert tone for operational efficiency. Alert Tones and the associated configuration control shall be explained in detail. All subscriber terminals and dispatch consoles shall provide the alert tones functionality.

3.6.28 *Ready-to-Talk Tone*

The proposed system must have the ability to provide Ready-to-Talk Tone functionality. Ready-to-Talk Tone functionality is defined as the ability to configure a subscriber terminal with a unique, audible tone that signifies to the radio user that a trunked talk-path or voice channel has been assigned and is ready for use. The intent of the ready-to-talk tone is so that radio users do not begin speaking too quickly following the activation of the PTT switch creating a condition in which audio may be truncated to some degree. The ready-to-talk tone shall be configurable for all subscriber terminals.

3.6.29 *Talkgroup Misdirection*

The proposed system must have the ability to provide Talkgroup Misdirection functionality. Talkgroup Misdirection functionality is defined as the ability for a misdirected (i.e., inadvertent and inappropriate radio affiliation to an unselected talkgroup when user not selected to active talkgroup) subscriber terminal to be immediately removed from an active talkgroup call in which the subscriber radio should never have been a participant. All subscriber terminals and dispatch consoles shall provide the talkgroup misdirection functionality.

3.6.30 *Critical/Mandatory Site(s)*

The proposed system must have the ability to provide Critical/Mandatory Site functionality. Critical/Mandatory Site(s) functionality is defined as the system ability to delay the processing of a talkgroup or announcement group call until all critical/mandatory sites have talk-paths or voice channel resources available to serve the call. Critical sites must be real-time configurable in the NMS workstations. The proposed system shall provide the capability to create any permutation or combination of critical/mandatory sites by talkgroup or announcement group. Critical/Mandatory Site(s) functionality and the associated configuration control shall be explained in detail. All subscriber terminals, dispatch consoles, and fixed network infrastructure shall provide the critical/mandatory site(s) functionality.

3.6.31 *Call-Delay Defeat*

The proposed system must have the ability to provide Call-Delay Defeat functionality. Call-Delay Defeat functionality is defined as the configurable system ability to continue the initiation and processing of a talkgroup or announcement group call despite the fact that a subset of talkgroup/announcement group members may be affiliated at network sites which have no available talk-paths or voice channel resources to immediately serve the call. Although the system should normally delay the handling of the call until all affiliated members have the necessary talk-paths or voice channels to serve the call (so as to facilitate 100% affiliated member participation), the system shall provide the configuration capability to defeat the normal call-delay algorithm so as to be able to immediately process the talkgroup or announcement group call without all affiliated members participating. Call-Delay Defeat functionality and the associated configuration control shall be explained in detail. All subscriber terminals, dispatch consoles, and fixed network infrastructure shall provide the call-delay defeat functionality.

3.6.32 *Dynamic (Tactical) Priority*

The proposed system must have the ability to provide Dynamic (Tactical) Priority functionality. Dynamic (Tactical) Priority functionality is defined as the configurable system ability for a dispatch console and NMS terminal to dynamically elevate (above its normally configured priority level) the priority level of an active talkgroup or multigroup resource. The target elevated priority level shall be the priority level just below emergency priority status. Dynamic (Tactical) Priority functionality and the associated configuration control shall be explained in detail. All subscriber terminals, dispatch consoles, and fixed network infrastructure shall be capable of participating in the dynamic (tactical) priority functionality.

3.6.33 ***Repeat Disable***

The proposed system must have the ability to provide Repeat Disable functionality. Repeat Disable functionality is defined as the configurable system ability for a dispatch console and/or NMS terminal to disable the normal repeat mode functionality of the network infrastructure so that only dispatch console positions can monitor the talkgroup and multigroup audio generated by a subscriber terminal. Although the system should normally operate in a repeat mode configuration so that field users can hear each other, the system shall provide the configuration capability to engage a repeat disable mode by talkgroup and/or multigroup so that a dispatcher can restrict sensitive or strategic communications to only being heard by dispatch consoles. Repeat Disable functionality and the associated configuration control shall be explained in detail. All subscriber terminals, dispatch consoles, and fixed network infrastructure shall be capable of participating in the repeat disable functionality.

3.6.34 ***Multiple Key Encryption (OPTION)***

The proposed system shall include, as an option for selected subscriber units, as noted in the Appendix, multiple key hardware-based encryption utilizing the DES and AES encryption algorithms. No single key encryption configurations shall be proposed with this system. Security and confidentiality of system operations is a major and growing concern for some of the STMC public safety agencies. As a result, it is STMC's objective to protect the system from eavesdropping, corruption or compromise of information, denial of service, disruption or any other type of event through the use of scanners, hacking, electronic break-ins, use of unauthorized radios, stolen radios, etc.

Select subscriber terminals (portables, mobiles, control stations) and all dispatch consoles shall be capable of a dual encryption algorithm (DES-OFB & AES) approach with the ability to store at least 16 different encryption keys per algorithm and per subscriber terminal. The network infrastructure shall be capable of processing any combination of at least 256 different encryption keys per algorithm. Dispatch consoles shall be able to decrypt any of the 256+ encryption keys per algorithm created in the system on an end-to-end basis. Over-the-Air-Rekeying (OTAR) from the NMS shall be available for key distribution to remote subscriber terminals within the coverage range of the trunked system. Manual encryption key distribution shall also be available using a handheld, battery-operated, password-protected key fill device.

Multiple Key Encryption and associated configuration control shall be explained in detail. Encryption functionality shall be available in both trunking and conventional modes on both a user-selectable or hard-coded "mode-strapped" basis for select subscriber terminals and all dispatch consoles.

3.6.35 *Status & Message (OPTION)*

The proposed system shall include, as a system option, Status & Message functionality. Status & Message is the capability for a source radio unit to send pre-defined status indication updates and/or pre-programmed message definitions to a dispatch console and network management terminal. Radio users shall be capable of initiating status and message indications from a pre-programmed status and message list. A source radio shall be notified if a target does not receive the sent status message. The proposed network and subscriber terminals shall be capable of processing status and message data services without the use of a dedicated talk-path or voice channel resource. Status and message functionality should be quoted as a system option for all subscriber terminals and dispatch consoles.

3.6.36 *Discreet Terminal Monitoring (OPTION)*

The proposed system shall have Discreet Terminal Monitoring capabilities quoted as an option. Discreet Terminal Monitoring is defined as the service whereby a dispatch console/network control point may place a subscriber terminal into a special type of individual voice call mode whereby the target terminal begins transmitting without any action from, or indication to, the called user. The purpose of the discreet terminal monitoring functionality is for the dispatch console/network control point to discreetly listen to the activities of a field user that may be operating in a dangerous or volatile situation. Discreet Terminal Monitoring functionality should be quoted as a system option for all subscriber terminals and dispatch consoles.

3.6.37 *Short Message/Alphanumeric Text Service (OPTION)*

The proposed system shall have Short Message/Alphanumeric Text Service capabilities quoted as an option. Short Message/Alphanumeric Text Service is defined as the data service whereby any combination of subscriber terminals, dispatch consoles, and NMS workstations can exchange free text messages using alphanumeric characters. Alphanumeric message length shall be at least 150 characters. Users shall be capable of generating the free text messages from the subscriber terminal keypad and/or workstation keyboards.

Sent and received text messages shall be time and date-stamped in the respective source and target radios/consoles/NMS workstations. The proposed subscriber terminals/dispatch consoles/NMS workstations shall provide address book functionality so that target recipients can easily be stored and retrieved. Receipt of a message shall provide visual and audible indication to the subscriber terminals/dispatch consoles/NMS workstations. At least five messages shall be archived in the subscriber terminals on a FIFO basis and a user shall have the

capability to flag a message to be saved and not deleted. Messages received and generated at dispatch consoles and NMS workstations shall be capable of being archived and printed for historical record-keeping purposes. A source radio/dispatch console/NMS workstation shall be notified if a target does not receive the sent message.

The proposed network and subscriber terminals shall be capable of processing Short Message/Alphanumeric Text Services without the use of a dedicated talk-path or voice channel resource. Short Message/Alphanumeric Text Service functionality and the associated configuration control shall be explained in detail. Short Message/Alphanumeric Text Service functionality should be quoted as a system option for all subscriber terminals, dispatch consoles, and NMS workstations.

3.6.38 ***Subscriber Tracking/GPS Location Services (OPTION)***

The proposed system shall have Subscriber Tracking/GPS Location Services capabilities quoted as an option for all subscriber types. Subscriber Tracking/GPS Location is defined as the service whereby a network control point or properly equipped dispatch console may monitor the real-time location of mobile or portable subscriber terminals (within coverage range of the proposed network) on a map display using the proposed network infrastructure. Automatic network polling and/or manual user polling functionality shall be offered to provide real-time location status, and the location information shall be displayed on a map that updates at specified time intervals.

Additional triggers for location updates shall include: (1) emergency alert/call activation, (2) user PTT channel request, (3) dispatcher/administrator query, and (4) power-up/affiliation. All subscriber location change data (latitude, longitude, time of date, subscriber ID, etc.) shall be capable of being archived to a *.csv file (comma delimited file) on a designated network control point client computer/server for a period of up to 30 days on a FIFO basis. Subscriber Tracking/GPS Location Services functionality and the associated configuration control shall be explained in detail. The supplier shall further identify and price any available API that may exist in which the subscriber GPS Location Services data may be exchanged with a third-party mapping system.

3.6.39 ***Telephone Interconnect (OPTION)***

The proposed system shall have the optional ability to connect a mobile or portable subscriber on the system to the Public Switched Telephone Network (PSTN). Connection of a subscriber radio unit to and from the PSTN is a specialized form of selective calling that requires appropriate processes for providing outbound call placement from a source radio and inbound call reception to a target radio.

A telephone interconnect call is defined as a wide-area, one-to-one voice transmission between any subscriber terminal operating within the network and a PSTN or PABX subscriber. Telephone calls shall be a network-wide capability and shall be fully supported by the system on an optional basis. Telephone calls may be half- or full-duplex, DTMF-initiated, and provide echo cancellation. The proposed network shall support landline-to-subscriber and subscriber-to-landline call types. Identification of the calling party shall be made to the subscriber terminal in alphanumeric format. Positive or negative acknowledgement through call progress tones shall be provided to the subscriber terminal when participating in a telephone call. The proposed network shall provide the ability to configure the maximum call duration for telephone calls.

The proposed network shall provide the ability to configure the permission to initiate a telephone call per subscriber terminal. The proposed network shall provide the ability to authorize or deny a configurable number of telephone calls in real-time by remote site. Authorized users shall also be able to place and receive calls on PABX/PSTN networks. The system must be able to restrict calls from individual terminals from calling specific numbers, locations or PABX systems. The system must be able to restrict calls by site or network subsystem. The system shall be capable of restricting the number of simultaneous telephone interconnect calls to preserve the intended system grade of service. Individual subscriber terminals shall be capable of being assigned a unique Direct Inbound Dial (DID) number and/or being served by a pool of DID numbers in conjunction with a unique subscriber unit ID. The proposed system shall support a PSTN interface of any combination of at least six unique loop-start or ground-start lines. Telephone Interconnect functionality and the associated configuration control shall be explained in detail.

4.0 RF SPECTRUM CONSIDERATIONS

This section describes considerations for use of the RF spectrum. The supplier shall review this section and determine the best possible technical solution for the development of the radio network based on the County's requirements. Radio coverage, future expansion, system life cycle, and regional interoperability considerations are all critical design issues for St. Marys County; thus, the supplier must give full consideration to all of these aspects when creating a system design.

Currently, preliminary channel coordination efforts indicate that all ten (10) 800 MHz channels will survive the coordination process without interference. However, the System shall be capable of deployment of 700 MHz frequencies, side-by-side, with 800 MHz channels, for the purposes of future expansion.

St. Marys County has identified all of its current FCC licenses in the Appendix of this document review by the Offeror. The County requires a system equipped with enough trunking RF channels and/or talk-paths to provide a 1% Grade of Service (GOS) using the Erlang-C queuing model. The County's existing fleetmap and talkgroup structure has also been included in the Appendix of this document as well as additional historical operational system utilization parameters to utilize in the required GOS calculations.

4.1 RF DESIGN REQUIREMENTS

4.1.1 *700 MHz & 800 MHz Operational Modes*

The proposed LMR system and associated subscriber radios shall all be equipped to operate throughout the entire frequency range from 764-869 MHz (764-862 MHz once the FCC Reconfiguration process has been completed) per the FCC-outlined channel plans in each portion of the 700 MHz and 800 MHz spectrum. Required operational modes and associated modulation schemes include:

- 764-869 MHz Trunking--APCO Project 25-Compliant Digital Mode
- 764-869 MHz Conventional--APCO Project 25-Compliant Digital Mode
- 764-869 MHz Conventional--Analog Mode (with CTCSS/PL/DPL).

Equipment proposed in the 800 MHz band must comply with the National Public Safety Planning Advisory Committee (NPSPAC) Mutual Aid requirements. All voice subscriber units and national NPSPAC base stations must be capable of operating in the conventional analog FM mode with Continuous Tone Coded Squelch System (CTCSS/PL/DPL). Additionally, all 700/800 MHz subscriber units must be capable of operating in both analog and digital conventional and trunked operational modes on 764-869 MHz channels.

There may be additional negotiations to add frequencies in the 700 and 800 MHz bands to the system. Whenever possible, and cost-effective, the supplier shall try to incorporate the use of dual-band 700 & 800 MHz fixed network antenna systems to create maximum flexibility from a fixed network equipment perspective and minimize antenna capacity loading on tower structures. Subscriber terminal antennas shall implicitly be capable of operating across the entire 764-869 MHz operating band using a single subscriber antenna.

4.1.2 *APCO Project 25 Conformance*

The County contractually requires a new 700/800 MHz digital trunked system that meets the APCO Project 25 (P25) Phase II requirements for modulation, spectral efficiency, and audio quality.

However, Bidders should consider the most practical method for the deployment of the system that maximizes the functionality overall performance and value of existing investments. Other factors to consider are:

-Timeliness of the completion of P25 Phase II standards sufficient for deployment with confidence
-Existing subscribers and their ability to migrate from Phase I to Phase II
-Cost of upgrades to existing subscribers for P25 compliance
-Regional deployments of P25 systems, their level of compliance, and benefits to the County for expanded interoperability
-Need for minimal interruptions with future upgrades
-Possibility of use of a dual mode infrastructure on a long term basis
-Channel capacity for dual mode operation
-With no current need for 700 MHz spectrum, migration to P25 Phase II is not mandatory by the FCC
-Maintain GOS in the event that Sprint does not provide new rebanded channels for deployment of the new System

At a minimum, the proposed system shall be equipped to operate in a 12.5 kHz channel with a 9600 bps bit rate using an FDMA access method. The digital modulation scheme shall be C4FM using the IMBE (Improved Multi-Band Excitation) vocoder. Subscriber terminal and fixed network equipment conformance testing results must be provided by the supplier to demonstrate complete alignment with the open P25 standard. The P25 Phase I Common Air Interface (CAI) shall be provided for all subscriber radios and fixed network equipment.

A fixed-cost migration plan to P 25 Phase II is mandatory.

4.1.3 *RF Engineering Data*

The supplier shall provide a comprehensive level of technical RF coverage design information relative to the proposed network. At a minimum, the information to be provided by the supplier for each proposed RF site shall include: (1) transmit and receive antenna models noting gain, orientations, azimuths, downtilt, sidearm lengths, and antenna base mounting heights; (2) type and length of transmission cable for transmit and receive antenna systems; (3) insertion loss values noted in decibels (dB) for all proposed transmit combiners/cavities, receive multicouplers, filters, duplexers, RF connectors, circulators, lightning arrestors, wattmeters, RF jumper cables, attenuators, etc.; (4) transmit power levels for all fixed network equipment base station transceivers and all subscriber terminals; (5) net amplification gain (if utilized) of each tower top amplifier system; (6) receive sensitivities for all fixed network equipment base station transceivers and all subscriber terminals; (7) the faded performance margin [C_f /(I+N)] utilized per TSB-88 for the required CPC (channel performance criterion) requirement of DAQ 3.4; (8) the portable antenna factor utilized per TSB-88 which accounts for all body, pattern, and polarization effects; (9) the minimum usable received signal level (MRSL) for all proposed mobile, portable, and control station subscriber terminals; (10) the propagation model, diffraction model, and effective antenna model utilized in the coverage modeling for the proposed St. Marys County system with actual environmental and adaptive loss parameters (i.e., land use land clutter) specified; (11) if proposed, the simulcast minimum capture ratio (in decibels) and maximum delay spread (in microseconds); (12) the terrain and land use database resolution in arc-seconds for all coverage modeling, and (13) intermodulation studies for all sites which factor in all RF equipment in use or intended for use at the specific site.

Additionally, the RF Engineering submittal must include a complete RF schematic for each transmit and receive antenna system per site noting all proposed antennas, transmission lines, tower top amplifiers, receiver multi-couplers, transmit combiners, circulators, filters, RF connectors, etc. The supplier shall indicate the effective radiated power of each site that accomplishes the coverage design for the County. A talk-in/talk-out RF link budget (quantifying any link imbalance) must be included for all proposed mobile, portable, and control station subscriber terminals. Color-coded talk-in and talk-out coverage maps shall be provided in a high resolution format (1 arc-second) for all proposed subscriber types in all coverage service areas noting the (1) FCC/Region 20-required coverage contours, (2) areas of 95%+ service area coverage reliability, (3) areas of simulcast (if proposed and where applicable) distortion, and (4) expected Bit Error Rate (BER) percentages. Product data sheets shall be provided for all proposed antennas, transmission lines, tower top amplifiers, receiver multicouplers, transmit combiners, circulators, filters, RF connectors, attenuators, etc.

The supplier shall provide coverage prediction maps indicating a service area reliability of 95% RF coverage for all required scenarios. Prediction maps shall indicate County borders including adjacent counties, RF base site location(s), interstate and primary roads, and areas of non-coverage. In addition, the RF coverage prediction maps shall be developed using the following map scale: (a) Non-Simulcast (Scale: 1 inch equals 1 mile) on "ANSI E" size paper, and (b) Simulcast (Scale: 1 inch equals 1 mile) on "ANSI E" size paper for ease of analysis and comparison. For each scenario and service area required, a second coverage prediction map shall be provided noting the guaranteed service area reliability with a proposed coverage test grid structure underlay per the TSB-88 grid size guidelines.

All engineering analysis and coverage modeling shall be executed in accordance with FCC/Region 20 parameters and restrictions. The supplier is responsible for preparing, coordinating, and obtaining all modifications to licenses to commission the proposed network. The County will serve as a signatory for all licensing efforts, but the supplier shall be responsible for all logistical and administrative work required to properly license the proposed network.

4.1.4 ***RF Sites***

In the Appendix section of this solicitation, the County has identified a number of sites and locations which may serve as candidates to support the proposed system. The use of these sites is not mandatory and the supplier has the ultimate latitude to propose alternative sites in which to achieve the desired engineering goals and coverage requirements of the system. However, the supplier shall note that re-use of existing sites, to the greatest extent possible, is highly preferable and should be considered the primary option to control system costs and optimize the timeframe to transition to the new system.

If the supplier finds other commercial sites to be suitable for the coverage design, then the supplier shall provide a detailed explanation of the site owner's proposed costs, accessibility, and certification that the structure can handle the proposed load. The cost of acquiring and leasing alternatively-owned tower sites shall be included in the supplier's price proposal. The use of an existing commercial site shall be secondary to the goal of re-using existing County/State sites, but this design alternative is still preferable to the County versus constructing a wholly new tower. The County also views collocation on an existing tower a viable alternative to control system costs and optimize the overall timeframe to transition to the new system.

A third option for the County is to construct brand new communications facilities to serve the proposed system. This specification outlines in a subsequent section how communications facilities shall be designed and implemented to meet the needs of STMC County. Whenever wholly new communications facilities are required and

proposed, the County highly encourages the deployment of such sites on County-owned land to expedite the site development process. The Appendix section outlines available County land which shall be strongly considered for use in the overall network design.

In general, the County prefers to own and operate critical communications sites within the bounds of St. Marys County. Justification includes better control of security and limited access, additional control over interference from co-locations, lower overall cost over the normal radio system life-cycle, and higher levels of reliability than typical commercial facilities. Ultimately, the County remains flexible in the site selection process for the new system as the most important design criteria for STMC users is the delivered RF coverage and resulting audio quality. The County requires the supplier to thoroughly justify and explain the rationale for the proposed sites and resulting tower heights/shelter sizes.

4.1.5 *FCC Licensing*

The County requires the supplier to utilize any combination of the County's existing LMR and microwave frequencies to complete the network design. The supplier must realize that most of these frequencies are currently in use as part of the existing trunking system, so the necessary arrangements shall be made to craft a workable cutover plan to re-use the same frequencies in the new system design. All FCC, Region 20, and frequency coordination licensing activities will be the sole responsibility of the supplier. The County will serve as the ultimate signatory and licensee, but the supplier is responsible for defining, designing, documenting, coordinating, and administrating all necessary licensing activities to commission a fully-functional and licensed radio system network that meets or exceeds these County specifications. If the supplier determines that additional channels are required, the supplier shall define, design, document, coordinate, and administrate all necessary licensing to obtain the additional frequencies to complete the network design. While Special Temporary Authorizations (STAs) shall be permissible during the implementation phase of the process, STMC requires that all licenses be fully granted in St. Marys County's name with FCC call signs prior to final system acceptance.

As part of the Deployment Protection initiative, STMC has applied for FAA permits for towers, secured sufficient MW channel spectrum for the deployment of a 155 Mps looped digital microwave system, and intiated the channel coordination process with Region 20 to expand the contours of the existing ten 800 MHz channel assignments at the thirteen sites associated with the Preliminary Design.

4.1.6 *Interference Mitigation/800 MHz Reconfiguration Compliance*

Radio coverage is defined as the minimum usable signal required to provide a clear message that is intelligible where each word is understandable in the presence of occasional noise and distortion (TSB-88 "DAQ 3.4"). Throughout the entire legal and political boundaries of St. Marys County, during full foliage conditions between May and September, the proposed system shall be designed to provide 95%+ service area reliability for both talk-in and talk-out configurations in 6 dB buildings using portable subscriber radios on-hip in a leather swivel case. Additionally, the proposed system shall be designed to provide 95%+ reliability for both talk-in and talk-out configurations in County-defined Critical Level One buildings (as noted in the Appendix) using portable subscriber radios on-hip in a leather swivel case.

The proposed radio system shall account for the current noise floor environment in St. Marys County as well as possible degradations into the near future. Interference and system degradation to public safety radio systems from adjacent band CMRS and SMR systems has proven to be a significant nationwide problem; and the supplier is required to engineer a network that provides sufficient signal margins, in concert with the Interference Protection Standard guidelines specified in the August 6, 2004 FCC Report and Order on WT Docket 02-55 (FCC 04-168), throughout the County to mitigate and eliminate adjacent and in-band noise/interference. The proposed system shall also be designed to mitigate and eliminate the effects of out-of-band emissions and intermodulation products originating from CMRS, SMR, and other nearby wireless radio networks. The proposed system shall not, in any way, be degraded by self-induced interference or noise that results from the normal, daily operation of the network. In the event that the proposed system experiences interference of any kind during the deployment and warranty phases, the supplier shall provide at no additional cost, the technical resources to the County to identify, characterize, and resolve the interference issues.

5.0 RADIO SYSTEM INFRASTRUCTURE REQUIREMENTS

5.1 SYSTEM ATTRIBUTES

The County intends to implement a wireless two-way digital trunked radio communication system providing highly reliable radio service throughout the entirety of STMC. The proposed radio system infrastructure shall utilize open protocols and be very scalable to allow migration and expansion as compared to existing legacy systems. The proposed network provided should allow STMC the option to choose various types of subscriber equipment from multiple vendors that can be readily supported by the system.

The proposed radio system shall be comprised of portable and mobile subscriber units, base station transceivers and associated antenna systems, control stations, real-time call processing controllers, network routing and switching equipment, microwave transport and channel bank equipment, network controllers and location registers, configuration and database servers, audio switching equipment, diagnostic and troubleshooting network management subsystems, dispatch console interface equipment, mutual aid and interoperability interfaces, and all other required equipment that comprises a complete system infrastructure.

The radio system must allow shared access to system services by the agencies while restricting access by unauthorized subscriber units. The radio system must be configurable such that individual agencies can communicate on talkgroups privately within their operation, as well as to interoperate with other County agencies, as required.

The radio system shall support the use of the following types of subscriber radio and control equipment configurations:

- Mobile (vehicle-installed) subscriber units including various tiers and different mounting configurations;

- Portable (handheld) subscriber unit including various tiers, configurations, and specialized accessories;

- Control stations subscriber units including various tiers, configurations, and remote deskset/handset-style controllers;

- (Optional) Vehicular repeater subscriber configurations facilitating in-band (800-800 MHz) or cross-band communications (800-700 MHz only);

- Dispatch consoles providing all required features and capabilities using wireline and optional RF interfaces.

The network management system shall provide for high system availability by monitoring of the voice radio system on a continuous basis through the use of automatic alarms and diagnostics that provide an immediate interface to maintenance technicians through both integrated monitoring equipment and optional supplier-provided central monitoring equipment. The radio system shall also provide a method for monitoring the use of the system through historical and real-time statistical reports by agency and for the entire system generated by network equipment on demand.

5.1.1 *Grade of Service*

Designing a mission-critical public safety system requires consideration for worst-case scenarios that may require a tremendous, rapid increase in radio traffic in any localized area of the County service territory as well as an increase in radio traffic for a wide-area incident. A well-designed public safety system should be able to easily provide the channel capacity for unblocked, routine, daily County radio operations as well as to embed sufficient additional capacity to cope with crisis and disaster circumstances. In order to facilitate this balancing act, the County requires the supplier to complete a comprehensive Grade of Service (GOS) analysis to determine the optimal number of trunked channels and/or talk-paths to meet St. Marys County's needs. Since the County maintains a limited number of 800 MHz frequencies currently licensed for immediate system use (see appropriate Appendix for list of STMC frequencies and historical system usage metrics), STMC has also provided its current trunking fleetmap information and some sample call logging data for use in the required Grade of Service analysis.

The County intends to deploy the new radio system on the County's rebanded 851-853 MHz channels, provided by Sprint as part of active negotiations to upgrade the EDACs radio system. It is possible that the existing ten (10) 866-869 MHz will not have to be utilized for the integration of the two radio systems. However, if the County is required to utilize existing channel capacity, Sufficient Grade of Service must be maintained during the transition.

STMC requires a target Grade of Service (GOS) metric of 1% using the Erlang-C traffic model. Using the County-provided fleetmap information, the requested number of subscriber radios and sample call logging data from the existing 10-channel EDACS simulcast trunked network, the County requires the supplier to perform a GOS analysis to determine the optimal number of trunked channels and/or talk-paths required to meet the 1% GOS target. The County requires all GOS assumptions to be clearly identified to explain the analysis and optimum channel number conclusion. To facilitate a uniform comparison, the suppliers shall utilize the following data and guidelines in the GOS analyses as a starting point:

- 75% of the requested subscribers will be active at the busiest time (~1,200 radios total)
- Average call duration is approximately 6 seconds
- Number of calls per subscriber per hour is approximately 2
- Number of system talkgroups is approximately 100
- Message trunking repeater hangtime is approximately 1 second
- Maximum acceptable wait time is 0.5 seconds
- Compute network GOS % value for system designs utilizing the following number of trunked channels:
    - 6 Trunked Channels/Talk-Paths
    - 7 Trunked Channels/Talk-Paths
    - 8 Trunked Channels/Talk-Paths
    - 9 Trunked Channels/Talk-Paths
    - 10 Trunked Channels/Talk-Paths

The supplier shall provide a detailed explanation of its analyses, additional assumptions, conclusions, and the engineering tools utilized. In order to standardize the responses, the County desires to commission all ten currently-licensed 800 MHz trunked channels (see Appendix for STMC licenses) as part of the initial countywide system network design. The supplier is at liberty to select the optimal frequencies for use in the system design and the County will rely on the chosen supplier to handle all required licensing activities to commission the proposed network for countywide operations. Through the use of this GOS analysis and supporting information, the County will define the additional capacity required, if any, and may attempt to expand the network as needed through the addition of 800 MHz channels made available through Rebanding or 700 MHz when authorized by the FCC.

5.1.2 ***Channel Access Time***

Channel access time, which is defined as the period of time/duration from PTT at an initiating trunking radio or console to the reception of audio/speaker unmute at any receiving radio on the same trunking talkgroup, shall be as follows:

A. No more than 250 milliseconds in direct simplex radio-to-radio communications;

B. No more than 350 milliseconds in radio-to-radio communications through a single conventional repeater;

C. No more than 500 milliseconds in radio-to-radio communications utilizing the proposed trunking network.

Audio buffering shall occur so that no audio is truncated or lost between the time the radio or console PTT switch has been pressed and the actual trunked channel grant. Radios shall be equipped to deliver, via programming, a ready-to-talk tone to operationally guide radio users and adjust usage behavior.

5.1.3 ***Trunking Operation***

The 700/800 MHz trunked repeaters should be managed by the Master Network and/or Primary Site Trunking Controller(s) that manages and selects available communications channels. When a request for communications from a subscriber unit or dispatch console occurs, the controller shall acknowledge the request and assign an idle channel for communications, based on user privileges and call access control parameters. The proper talkgroup or individual call also shall be assigned to the available trunked channel by the appropriate call processing controller which communicates through a dedicated or working control channel.

The trunking communications protocols simply organize all subscribers belonging to a specific configurable talkgroup address to electronically merge to an electronically assigned available talkgroup RF resource under the domain of the trunked system controller network for the duration of the voice transmission. Once talkgroup communications has ended, network logic causes subscribers to return to the system control channel awaiting further communications instructions.

The system shall allow a transmitting unit access to an available channel and unmute a receiving unit's speaker with the transmitting unit's audio, within 0.5 seconds of the transmitting unit's "Push-To-Talk" (PTT) switch activation. Should system traffic be at a level where all trunked channels or talk-paths are busy, the system will automatically give preference to higher priority units attempting access. The system shall indicate to the user that channels are busy, that the unit is placed in a busy queue, and that a requesting unit will be offered an available channel in a call back mode. The supplier shall describe in detail the priority access scheme that the proposed system offers.

5.1.3.1 Operations within Challenging RF Environments-VRS Compatibility

The proposed network shall incorporate a high degree of countywide in-building coverage; and if necessary, the system shall support the augmentation of network coverage through the use of trunked Vehicular Repeater Systems (VRS). VRS units can provide in-building coverage into non-critical buildings, provide continuity of portable coverage during major system outages due to weather emergencies and operate as localize repeater sites when operating outside of host trunking systems. The compatible VRS must be capable of extending both talk-in and talk-out coverage and associated trunking features for portable radios that reside in areas of inferior

coverage locations. A VRS configuration shall include a trunked system mobile radio and a properly-filtered vehicular repeater. VRSs must be designed to operate across the entire 764-869 MHz frequency bands.

Compatible VRS configurations shall offer the following features:

- Support for 764-869 MHz digital trunked communications
- Support for 764-869 MHz analog and digital conventional communications
- Capability for portable subscriber radios to remotely switch VRS talkgroup and channel modes
- Capability to extend talk-in/talk-out for encrypted conventional and trunked calls
- Capability to extend talk-in/talk-out for emergency calls and unique PTT-ID unit identifiers
- Support for multiple VRS assemblies to co-exist and operate without disruption or self-induced interference in the same localized area
- Capability to operate in a tactical repeater or "local-only mode" when both the VRS and nearby portables have roamed out of reliable network coverage
- Capability to operate in a "re-broadcast (system extension) mode" when the VRS remains in reliable network coverage but the nearby portable subscribers have roamed out of reliable network coverage
- Capability to operate in a "silent mode" (non re-broadcast mode) when both the VRS and nearby portable subscribers remain in reliable network coverage.

The supplier shall describe in detail the VRS features, limitations, and VRS compatibility that the proposed system and subscriber complement offers. Optional VRS assembly pricing with installation costs shall be quoted as part of this proposal response.

5.1.3.2 Operations within Challenging RF Environments-In-Building System Compatibility

The proposed network shall incorporate a high degree of countywide in-building coverage; and if necessary, the system shall support the augmentation of network coverage through the use of in-building repeater systems. The compatible in-building repeater systems must be capable of extending both talk-in and talk-out coverage and associated trunking features for portable radios that reside in areas of inferior network coverage. An in-building repeater system configuration shall include all electronics, antenna systems, power supplies, cabling, connectors, suppression, grounding, and

hardware necessary to provide reliable in-building coverage designed to meet St. Marys County's requirements as outlined in this specification. In-building systems must be designed to operate across the entire public safety 764-869 MHz frequency bands.

Compatible in-building system configurations shall offer the following features:

- Emergency backup power for a minimum of 4 hours continuous, uninterrupted runtime in the event that commercial power becomes unavailable
- Support for 764-869 MHz digital trunked communications
- Support for 764-869 MHz analog and digital conventional communications
- Capability to support fiber-optic, CAT-5 twisted pair, and/or radiating coaxial cable based signal distribution (as offered or permitted at each candidate in-building system location)
- Configurable level-setting and power output control to optimize signal levels inside the structure
- Craft interface to all configurable electronics with capability to archive and retrieve optimization/level settings
- Filtering and attenuation that eliminates out-of band emissions and interference
- Both a craft interface and discrete relay alarm/monitoring capability to remotely monitor and interrogate the performance and operating characteristics of the in-building system
- Rack-mountable and/or wall-mountable electronics
- Aesthetically pleasing cabling and disguised antenna placements per building design and layout
- Comprehensive documentation that defines as-built physical, electrical, and RF designs on scaled drawings.

The supplier shall describe in detail any required in-building system features, limitations, and system compatibility that the proposed offering includes. All proposed in-building systems included to meet the network coverage requirements shall be priced independently clearly noting all included equipment and installation costs.

5.1.3.3 Failure Mode Analysis

The entire FNE and backbone microwave systems shall be free of any single point of failure that totally disables the radio system. No failure, even the complete loss of a network control site, shall ever render the system totally

devoid of radio coverage and basic network talk-in/talk-out functionality. Wide-area trunking communications shall be preserved and maintained throughout all failure modes as feasible, but conventional modes of operation are deemed acceptable provided wide-area communications and coverage characteristics are maintained. The supplier shall provide a comprehensive analysis explaining how the proposed system will continue to provide radio service (noting specific coverage and functionality impacts) to the County's subscribers following the various failures of the hierarchical systems that control operation of the trunked network.

All fallback modes of communication shall be thoroughly described with an explanation of what must occur to trigger the specific fallback mode. The analysis shall thoroughly consider the impacts to coverage reliability, field subscriber trunking and conventional features, dispatch console trunking and conventional features, network management control, and interoperability. In addition, the analysis shall describe the complexities of operations restoration within the ECC. In particular, the supplier should describe how console positions controlling multiple talk groups will maintain communications with the different talkgroups operating in a countywide mode during the various failure modes.

The purpose of the failure mode analysis is to ensure that the supplier recognizes the criticality of the County's public safety radio network infrastructure in relationship to its unique role of protecting the citizens and property of STMC. The supplier must demonstrate through its network design that the level of redundancy proposed is exceptional and engineered to continue network operations without interruption in virtually any circumstance including attacks of terrorism and natural disaster.

The County requires the supplier to provide an extraordinary design for the electronic hardware and software as well as a separate plan to protect every aspect of the physical infrastructure supporting and protecting the network. For example, if a site is proximate to flooding or any other source of water, the design must contain strategies to protect the site from flooding and other acts of nature.

5.1.4 ***Simulcast Operation***

The following subsections pertain to a system design that may include a simulcast architecture to provide the wide-area coverage requirements. Wide-area coverage is defined as operation over an area that cannot be covered by a single base station transceiver site. The basic wide-area design concept for the STMC system shall be a countywide P25 digital trunked system providing ten trunked channels and a high degree of in-building coverage. Interconnection between the base station sites, console electronics and dispatch positions shall be provided by a high-capacity loop microwave system.

5.1.4.1 Transmitter Simulcast

If proposed, the simulcast design shall have the capability to connect audio and data between the prime control site and remote transceiver sites via DS-1 (T-1) microwave circuits. The system shall be capable of automatically adjusting the path delay and amplitude of any one or all DS-1 circuits utilized in the system. The automatic adjustment shall compensate for any change in microwave paths. The system shall be capable of maintaining a phase delay (launch time) of no more than +/- 3 microseconds and an amplitude of 0.1 dB between transmit sites. The path delays shall be dynamically adjustable to compensate for at least 60 milliseconds of inherent path delay. A simulcast design shall also be compatible with the use of leased PSTN T1 services (if necessary).

If proposed, a written response to the following items shall be included in the supplier's response:

- Renetting Interval - The recommended interval at which the system is to be "renetted" or verified with respect to adjustment of frequency, modulating signal amplitude and phase, shall be specified.
- Simulcast Time Delay Control - Once the path delays have been measured, the method by which audio path time delay will be automatically controlled and equalized shall be specified. The maximum amount of path delay compensation shall be specified.
- Frequency Stability - The method by which the frequency of base station transmitters is maintained within the required tolerance for satisfactory simulcast operation shall be specified, and this value shall be provided. Options for enhanced frequency stability, if any, shall be identified and the cost(s) listed in the Pricing section.

- Addition of Sites - The procedure and equipment required for the addition of base repeater or receiver sites shall be specified. Also, the maximum site capacity of the system's simulcast controller(s) shall be specified.
- Addition of Channels - The procedure and equipment required for the addition of base repeater or receiver channels shall be specified. Also, the maximum channel capacity of a single simulcast "Site" or "Prime" controller shall be specified.
- Control of Sites - The supplier shall describe the method by which the simulcast remote sites are controlled and interfaced with the trunked system controller. Link type and bit rate shall be specified.
- System Architecture - The trunked simulcast system architecture shall be described in detail, with written descriptions of all major system components and their functions. System and site block diagrams shall be provided to show the interconnection and the detailed audio/logic signal flow (e.g.; tx audio +/-, keying +/- etc.) between system elements (components/equipment racks).

5.1.4.2 Digital Comparator

If proposed for simulcast operation, a receiver voting/comparator system shall be furnished and installed which shall allow the automatic selection of the receiver providing the lowest Bit Error Rate (BER) and Error Correction Coding (FEC). The voting/comparator shall pass the selected audio to the dispatch consoles and the simulcast audio distribution network for rebroadcast to other mobile or portable field units. The receivers operating in the voting system shall, at minimum, be those included in the base station transceivers. The trunked system shall provide console priority. The operation of the comparator/selector shall not be evident; there shall be no clipped syllables and no noticeable delay in the selection process.

The comparator shall be radio frequency band independent. The digital comparator shall incorporate frame diversity that allows the comparator to utilize the best data frames of all the inputs to construct a better output signal than any one single input signal of the comparator. Each receiver shall generate "idle data" when it is in the idle (squelched) state. The idle data shall be transportable by a DS-1 (T-1) audio circuit.

The comparator shall provide an indication of a failed digital microwave audio circuit or input serving a receiver through loss of detection of idle data, or by other supervisory method. The receiver voting comparator shall be equipped to provide a real-time voting activity display and output. Voting

activity displays shall include receiver selected, receiver unsquelched, receiver failed and receiver disabled.

The digital comparator shall provide alarms for key operational parameters, and shall provide for remote inquiry display, disablement and diagnostic functions via RS232 and Ethernet connections. Alarms shall be displayed at all NMS workstations and through craft interfaces. The digital comparator shall provide high-level diagnostic information through front-panel LEDs and relevant indicators so that a technician or network administrator can quickly gauge the severity of a digital comparator fault by looking at the digital comparator. The digital comparator shall provide both alarm messages and fault conditions using SNMP and discrete Form-C relays. At a minimum, the digital comparator shall provide Critical, Major, and Minor relays which may be connected to a separate alarm subsystem. All digital comparator alarm information shall be time/date stamped in synchronization with the master network clock. All comparator ports shall be uniquely labeled and identified on the comparator chassis so as to highlight the specific receiver sites.

5.1.5 ***Digital Encryption***

The proposed system shall be capable of supporting and providing digital voice encryption calls. All properly-equipped subscriber units with multiple key encryption shall be able to scan between and converse on encrypted and clear talk groups. All dispatch positions shall be capable of end-to-end multiple key encrypted voice operations. The coverage range and reliability of the system in encrypted mode must equal the range of the system in the clear, unencrypted mode.

The encryption process shall not degrade the required delivered audio quality of the system. Encryption shall be available in trunked, conventional and talkaround modes. Encryption shall be available in all proposed fall-back modes of communication. Both DES-OFB and AES encryption algorithms shall be supported by the proposed system. The supplier shall state the number of encryption algorithms available in its system and the encryption algorithm capacity of all proposed radio units. Multiple keys must be provided in the fixed equipment and the subscriber units. The system shall be capable of re-keying the encryption algorithm for all properly-equipped subscriber radios over-the-air. The supplier shall fully discuss the encryption scheme in the proposal response.

5.1.6 ***Over-The-Air Subscriber-Provisioning***

The system shall offer the ability to provide over-the-air subscriber provisioning to download complete subscriber radio personality configuration changes. All subscriber radios shall be capable of being uniquely addressed and receiving, in

real-time, over-the-air subscriber provisioning data using the proposed trunking system infrastructure. All data contained in the subscriber radio personality shall be reconfigurable in an over-the-air exchange, and the personality data shall be transmitted in a discreet, protected mode to stymie eavesdroppers.

From a dedicated over-the-air subscriber provisioning workstation or network management terminal, a network administrator shall be able to download all or any subset of the radio personality data to one or multiple field subscriber radios that are actively affiliated with the trunked network. The over-the-air subscriber provisioning tools shall provide the same user functionality, user feedback, dialogue messages, and historical programming data as a traditional hard-wired programming configuration (i.e., laptop with required radio programming software, interface cables, adapters, etc.).

Target radios shall provide positive or negative acknowledgment as to the success of the intended over-the-air provisioning transaction. An over-the-air subscriber provisioning transaction shall take place in real-time and the transaction time shall be commensurate with the bit rates offered by the proposed network. Compression techniques are encouraged to reduce the necessary duration of an over-the-air subscriber provisioning transaction. The supplier shall fully discuss the over-the-air subscriber provisioning capabilities, methodologies, and limitations in the proposal response.

5.1.7 ***Over-The-Air Subscriber Software Download/Multiple Boot***

The system shall offer the ability to provide over-the-air subscriber software downloads to download complete subscriber radio boot code and operating system updates. All subscriber radios shall be capable of being uniquely addressed and receiving, in real-time, over-the-air subscriber software downloads using the proposed trunking system infrastructure. All data contained in the core subscriber radio boot code and operating systems shall be transmittable in an over-the-air exchange, and the boot code and operating systems data shall be transmitted in a discreet, protected mode to stymie eavesdroppers.

From a dedicated over-the-air subscriber download workstation or network management terminal, a network administrator shall be able to download all or any subset of the radio boot code and operating system data to one or multiple field subscriber radios that are actively affiliated with the trunked network. The over-the-air subscriber download tools shall provide the same user functionality, user feedback, dialogue messages, and historical programming data as a traditional hard-wired programming configuration used to update flash memory (i.e., laptop with required radio programming software, interface cables, adapters, etc.).

Target radios shall provide positive or negative acknowledgment as to the success of the intended over-the-air software download transaction. An over-the-air subscriber software download transaction shall take place in real-time and the transaction time shall be commensurate with the bit rates offered by the proposed network. The target radios shall be equipped to run either the existing boot code or updated boot code as decided by the network administrator and/or user. The updated radio shall always provide the ability to utilize the previous version of in the event that the update was corrupted or contained defects. Compression techniques are encouraged to reduce the necessary duration of an over-the-air subscriber software download transaction. The supplier shall fully discuss the over-the-air subscriber software download capabilities, methodologies, and limitations in the proposal response.

5.1.8 *Call Sign (Base Station) Identifier*

The proposed system shall be equipped to automatically generate and transmit all of the FCC-assigned call signs in International Morse Code format every 30 minutes at a minimum per FCC §90.425 guidelines. Every channel shall be capable of transmitting the appropriate call signs, so that in the event of a specific channel failure, the FCC call signs are assured to be transmitted without any manual intervention required. The proposed system shall offer the ability to easily modify/change all of the FCC call signs through a craft interface without the need to generate new hard-coded PROMS or codeplugs. The proposed system shall also provide the ability to change the timing between automatic call sign identifiers from the NMS (e.g., set the timer to every 15 minutes). The call sign shall be properly synchronized and phased with other call sign transmissions between sites so as not to cause distortion or a heterodyne effect in any possible overlap coverage areas.

5.1.9 *Interference Control*

The proposed system shall be designed to be resistant to interference from co-channel, adjacent-channel, and intermodulation effects in a manner that is minimally as effective as Continuous Tone Coded Squelch System (CTCSS) used today in conventional radio systems, trunking connect tone, network ID, or equivalent. The proposed system shall also be immune to intra-system interference and cross-talk caused by frequency re-use, intermodulation, or other relevant system design characteristics. Proper system/subscriber RF filtering as well as subscriber and system configuration control shall be provided to minimize and eliminate the effect of interference on system performance.

System receivers must be capable of detecting interference such that this interference is logged with a time/date stamp within the network management and diagnostics subsystem. Furthermore, the interfered channel must be temporarily shut down so that assignments on the interfered channel are not granted by the

network controller until the interference condition is resolved. The proposed system shall be configurable such that the continuous duration and signal levels of the interfering carrier can be specified before the network controller deactivates the channel from availability. The interfering carrier timer shall be configurable in seconds up to at least three minutes in time, and the interfering signal level threshold shall be configurable in dBm up to a minimum level of -120 dBm.

The supplier shall fully discuss the interference control capabilities, methodologies, and limitations for both fixed network equipment and subscribers in the proposal response.

5.1.10 *Access Mode (FDMA and/or TDMA)*

FDMA and TDMA are the two recognized LMR access methods that are in congruence with the evolving APCO Project 25 specification (although the P25 Phase II TDMA approach currently remains under review and analysis). There are two primary methods to provide a talk-path for a trunked talkgroup call - Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA). The talk-path is an important distinction that defines the difference between RF channel bandwidth and RF channel access and management.

The FDMA access mode requires the entire RF channel bandwidth for a single two-way radio call. RF channel bandwidth is fixed (e.g. 25 kHz, 12.5 kHz, etc.); thus only one two-way radio call can occupy the RF channel bandwidth at a time. Narrower channel bandwidths can allow higher call quantities per unit of RF spectrum (e.g. two 12.5 kHz channels carry two calls compared to one 25 kHz channel carrying one call).

The TDMA access mode segments the RF channel bandwidth into multiple time slots and allocates a time slot(s) for each single two-way radio call. RF channel bandwidth is fixed (e.g. 12.5 KHz or 25 kHz), however, multiple two-way radio calls can occupy the RF channel bandwidth simultaneously. Thus, higher call capacity can be achieved using more time slots per unit of RF spectrum.

All proposed fixed network equipment (FNE), subscriber terminals, and dispatch consoles shall be equipped with FDMA, and optionally TDMA, trunking system access mode functionality in alignment with the evolving APCO Project 25 specification.

5.1.11 *Inter-System Connectivity*

The supplier shall provide a network that easily provides for future subsystem integration to expand coverage areas and add other candidate, compatible P25 regional networks without the need to overhaul or replace the proposed

infrastructure. While the STMC network initially will serve the County and its associated internal agencies, the County requires the proposed network and subscriber fleet to be architected so that additional simulcast or multi-cast trunked subsystems could be integrated in the future for greater interoperability. St. Marys County requires that the proposed system be architected in congruence with the APCO P25 specification which necessitates that RF subsystems from any manufacturer must be interconnectable into a wide-area system, using the P25-defined RF ISSI (Inter Sub-System Interface) standard.

The supplier shall describe the proposed scalability and expandability of the system and subscriber fleet in detail. The supplier shall thoroughly define its conformance to the P25 RF ISSI requirements and cite several examples of successful P25 trunking system interoperability in 700/800 MHz as references.

5.1.12 ***System Roaming***

Although the County is not implementing a multi-jurisdictional network immediately, St. Marys County does require a network to be constructed that is capable of being expanded to create a larger, wide-area coverage footprint with additional channel capacity in the future. The proposed system should enable mobile and portable subscriber radios to roam over a wide coverage area with automatic connection and affiliation as the unit enters a new site coverage area within any radio subsystem. The system must provide for registration and authorization control over subscriber units and talkgroups roaming between radio subsystems. Manual and automatic roaming capabilities shall be provided between radio subsystems. The proposed network shall provide network controller functionality that tracks the real-time subscriber locations and affiliations through the use of Home and Visitor Location Register databases. Subscriber handoff between remote sites shall be seamless and without voice or data interruption to the subscriber terminal or dispatch console.

The supplier shall describe the wide-area roaming and mobility functionality being offered with the proposed network. Handoff/roaming algorithms shall be explained in detail.

5.1.13 ***Network Synchronization***

Suppliers shall propose a comprehensive design for master network timing and synchronization of the countywide radio communications system. All network elements and transport equipment shall be synchronized to the master timing source(s). The master timing source(s) shall be GPS-based with high stability, hot standby backup crystal oscillators. Redundancy shall be designed into the master timing source design to the greatest extent possible.

Stratum 1 timing should be provided for the system and transport infrastructure. All system DS-1/T-1 links shall be capable of deriving clock from the master timing source. Network element equipment clocks shall be synchronized to the master timing source time/date clock for synchronization of diagnostic and failure tracking for internal equipment status logs. All proposed system network/fault management, dispatch consoles, and infrastructure network elements shall derive time/date from the master timing source so that troubleshooting and diagnostic status logs are synchronized systemwide. The master timing source(s) shall provide several additional timing ports for additional synchronization of STMC network elements such as CAD/RMS, 911 telephone, logging recorder, mobile data, display clocks, etc.

5.1.14 *Integrated Network Security and User Authentication*

STMC requires the supplier to integrate reliable and adaptive network security and user authentication mechanisms into the proposed system to maximize system availability. The proposed system shall be hardened against such network breaches as viruses, worms, malware, spyware, denial of service attacks, and file corruption. The proposed network shall be equipped to quickly update virus definitions and security policies to rapidly prevent, adapt, and cope with malicious network outbreaks. Quarantine and remediation techniques shall also be utilized to prevent and minimize network outbreaks. Firewalls and authentication servers shall be utilized to restrict unauthorized network access while detecting, preventing, and responding to network attacks. Configuration techniques shall be implemented on all computing systems to prevent end-users without supervisor or administrator privileges from loading software or reconfiguring settings in any manner. The supplier shall provide all passwords and authorization codes for every computing system in a comprehensive list as part of the as-built documentation package.

The supplier shall describe the integrated network security and user authentication functionality being offered with the proposed network as it pertains to all client workstations within all proposed subsystems.

5.1.15 *Centralized Network Infrastructure Software Distribution*

The proposed system shall be equipped with the functionality to download network element upgrades and configuration profiles from a centralized location so as to eliminate the need for technicians and administrators to visit each remote site to deploy enhancements, patches, bug fixes, and configuration modifications. All core network elements, controllers, servers, and transceiver devices shall be equipped to receive software updates and configuration changes from a centralized location. Target network elements shall provide positive or negative acknowledgment as to the success of the centralized software download transaction. A centralized software download transaction shall take place in real-time and the transaction time

shall be commensurate with the network throughput offered by the proposed system. The target network elements shall be equipped to run either the existing software or updated software as decided and controlled by the network administrator. The updated network element shall always provide the ability to utilize the previous version of in the event that the software update was corrupted or contained defects.

The supplier shall describe the centralized network infrastructure software distribution functionality being offered with the proposed network.

5.1.16 *Platform Roadmap/Network Supportability*

St. Marys County intends to maximize and protect its system purchase investment. The supplier is required to provide vendor support for the proposed system offering for a period of no less than fifteen (15) years from the date of final system acceptance. The offering consists of all hardware, software, cabling, and services rendered to implement the proposed network.

Supplier support is defined as the ability of the supplier, without system redesign, to remedy to St. Marys County satisfaction any hardware and/or software problem with any equipment and services provided as part of this offering. Supplier support will take the form of a 24x7x365 technical support hotline, product engineering, field service technicians, and field engineering. Supplier support also requires the supplier to be able to provide new and/or spare/replacement equipment for the proposed offering for no less than fifteen (15) years from the date of final system acceptance.

St. Marys County requires the supplier to provide a comprehensive system platform and subscriber roadmap (noting timetable of initial release through end of supplier supportability) for the proposed network defining the product life cycles of all major network elements, software operating systems, software applications, subscribers, dispatch consoles, subsystems, and ancillary network components. St. Marys County further requires the supplier to define the OEM status of all major network elements, software operating systems, software applications, subscribers, dispatch consoles, subsystems, and ancillary network components. Throughout the manufacturer support period, St. Marys County shall be entitled to receive at no charge the appropriate quantities of any software/hardware upgrade kit(s) that addresses an identified product defect or bug fix.

5.1.17 *Mobile Data Optimization*

St. Marys County requires the proposed system to be optimized for mobile data communication services in alignment with the APCO P25 standard (as defined in the most recent version of the TIA/EIA-102.BAEA specification). While St. Marys

likely will not initially deploy mobile data computers and applications, the County does require that the proposed infrastructure and subscriber terminals be equipped to support circuit and IP packet data at some point in the near future.

Radio-to-FNE, Radio-to-Repeater, and Radio-to-Radio configurations shall be supported with any combination of Physical (i.e., RS232, USB) and Link Layer (i.e., SLIP, PPP) interfaces. The proposed system shall also offer an Application Programming Interface (API) and physical connectivity for the County CAD system to transfer future mobile data information in both directions (i.e., Radio-to-CAD, CAD-to-Radio). The supplier shall fully describe the delivered mobile data functionality and capabilities being offered with the proposed network.

The County is very interested in the following types of mobile data applications for its law enforcement and first responder workforce: data dispatch, unit status and history inquiry, NCIC/VCIN/DMV database access, real-time messaging and email, RMS access, AVL, in-vehicle mapping, and incident reporting. A complete description shall be offered by the supplier as to what mobile data functionality exists initially with the proposed network/subscribers and what optional features, hardware, and licensing must be purchased to achieve completely integrated voice and mobile data services on the proposed network. The County requires the supplier to identify any system limitations or constraints that should be expected with the proposed offering as it relates to a mobile data subsystem. The County requires the supplier to identify and price as an option all ancillary system and subscriber equipment and configuration changes necessary to implement a complete mobile data subsystem providing the aforementioned applications.

5.2 MASTER NETWORK CONTROLLER SUBSYSTEM INFRASTRUCTURE

5.2.1 *General Requirements*

The Master Network Controller (MNC) subsystem comprises all system-level, subsystem-level, and associated site controller(s) required to deliver mission-critical digital trunking call processing and features in real-time. The design shall provide for high availability under the most extreme operating conditions and redundant network controllers or fallback designs are required when feasible. General tasks to be performed by the MNC and/or associated site controllers include: receipt and decoding of digital data from mobile/portable/control station radios, selection and efficient assignment of available radio channels, transmission and encoding of digital data sent to mobile/portable/control station radios, control of base repeaters, transmission of station identification required by the FCC, authenticating and controlling radio system access, maintaining affiliation and subscriber location databases, mobility management, control of switching subsystem infrastructure, and monitoring of alarm functions.

5.2.2 *Availability/Reliability Requirements*

St. Marys County requires a digital trunked system that will not suffer the loss of trunking capability as a result of the failure of a single system component, in particular the MNC subsystem. Should any component of the MNC subsystem fail, sufficient redundancy shall be incorporated in the system design so that full trunking operation continues without interrupting existing communications. Trunking capability is defined in this context as the ability of the proposed system to assign voice channels to independent talkgroups, as required, and the ability of the system user groups to remain functionally independent (i.e., full APCO 16/25 trunked feature set with no loss of features). A single controller failure that reverts the proposed system to a non-APCO 16/25 trunked feature set operation is not acceptable.

In the case of redundant MNC subsystem controllers, both controllers shall remain online continuously with parallel updating and mirroring of all system database(s) to ensure no interruption or degradation of trunking service in the event of failure of an active or standby MNC controller(s). Switching from active to standby controller operation shall be fully automatic, with audible and visual indication of the switchover provided to all network fault management workstations and supervisory dispatch console terminals. Manual switching functionality between the active/standby MNC controller(s) shall also be provided from the network management terminals. The supplier shall identify the amount of time to switch between the active and standby MNC controllers. The supplier shall provide both MNC controller SNMP alarm diagnostic information and discrete MNC alarm relays to the network management and diagnostic terminals.

St. Marys County requires the proposed system and the MNC controller(s) to be designed to provide 99.9999% or greater availability. Any system component enclosure or power distribution design that could render the system or 20% of its trunked channel resources useless or unavailable for communication from a single point of failure, shall incorporate redundancy to eliminate this vulnerability. This vulnerability elimination may be in the form of a redundant component/enclosure or a distributed redundant design that distributes single points of failure among multiple card cages, cabinets or housings each operating on its own dedicated power circuit.

Switching between MNC controllers (manually or automatically) shall not cause radio subscriber units to attempt to roam away or de-affiliate from the site or subsystem at which they are currently affiliated. Subscriber units shall not have to re-affiliate with a site or subsystem after any type of MNC controller switch has occurred.

If a supplier's design requires an additional site or subsystem controller to serve and report to the MNC, then the MNC shall have complete control of wide-area call processing and channel assignments until its failure or failure of another critical

network component. At that failure time, the site or subsystem controller should assume trunking control, utilizing the same systemwide subscriber radio user database and functionality without user intervention or interruption to trunking communications.

The supplier shall fully define any hierarchical network controller relationship that exists to facilitate normal and fallback communications on the proposed system. The supplier shall fully explain all redundant and hot-standby functionality integrated into the design to achieve the highest system availability. The supplier shall fully identify the host network controllers/servers for critical call processing databases, mobility and location registers.

The supplier shall state in the response the procedure and time required for switchover to a reduced functionality or conventional failsoft operating mode in the event of the failure of all trunked controller equipment. The proposed system must suffer multiple system element failures before a conventional or reduced capability operating mode is encountered. Suppliers are nonetheless required to describe all such failure modes, regardless of how unlikely the occurrence.

5.2.2.1 Physical Separation of Critical MNC Components

The County prefers that all critical MNC and network management components be of a design that permits physically/geographically diverse installations whenever practical. Suppliers are encouraged to design the proposed network in a manner that employs physical diversity of installed components whenever practical; however, when such a design technique is employed, the supplier shall ensure that security measures designed to protect the network are equivalently maintained at all locations in which components have been installed.

The supplier shall fully identify the required network backbone transport and topology requirements to facilitate the proposed trunked system and MNC subsystem. For example, the nature of site interconnection (i.e, star network, mesh network, loop network, etc) shall be thoroughly defined. The supplier shall fully define all site interconnection bandwidth and throughput requirements to support the proposed MNC infrastructure and system as a whole. The network backbone timing and switching requirements shall be fully defined. The supplier shall define the proposed system's compatibility with various types of site interconnection media: microwave radio, fiber, PSTN leased line, satellite, broadband cable, etc.

5.2.3 *MNC Features and Functions*

Software and firmware to provide trunking functions and features described shall reside in the MNC subsystem and associated computer software/hardware. The

controller(s) and its associated computer software/hardware shall provide the following functions:

- Alarm Monitoring and Diagnostic Functionality - Monitoring of the operational status of all system devices and providing alarms when individual subsystems fail. Diagnostic functions shall allow an operator to view current status and status history of the system. It shall also allow for diagnostic tests to be performed on network devices (i.e. site controllers, base stations, comparators, routers/switches, etc.) to verify component and path integrity.

- Signaling (Control) Channel Backup/Rollover - Automatic transfer of signaling functions to another channel in the event of transmitter or receiver failure or interference on the signaling channel. The system shall have one active and a minimum of three backup signaling channels. Backup is defined as a channel of different frequency. Hot-standby backup of a signaling channel to a station of the same frequency is not acceptable. The supplier shall define its control channel methodology.

- System Signaling & Special Functions

  - Signaling (Control) Channel Updating - The signaling channel shall continually transmit the current channel assignments of the system. This feature is intended to ensure that radios "signing on", coming into range or switching talkgroup modes, are directed to calls in progress on their selected talkgroup.
  - Voice Channel Embedded Signaling - Embedded or sub-audible signaling shall be transmitted on assigned voice channels in order to prevent subscribers from being misdirected or allowed to transmit on an improperly assigned channel.

- Disabling of Failed Voice Channels - Automatic disablement of defective or degraded voice channels due to subsystem failure. Failures must be detected prior to the channel being assigned by the controller. Subsystem failures to be detected shall, at a minimum, include:

    - Low forward power
    - High-reflected power
    - Frequency drift
    - Unidentified carrier on unassigned voice channel
    - Signaling interface failure between base and controller
    - Audio and/or data circuit/packet failure between controller and base

- Receiver failed/disabled
- Voter failed/disabled.

- System Usage Reports - Collection and processing of data with regard to system usage. Suppliers are to describe how the data is parsed for displaying at the NMS workstations. All reporting functions shall be easily exported into real-time, standardized, spreadsheet and word processing formats for easy retrieval and custom report formatting.

- Talkgroup Steering – Talkgroup steering shall allow talkgroup and individual calls to be directed or steered to a single or group of channels. This steering capability shall not prohibit any group from being allowed access to all channels. Talkgroup steering shall be definable at the "subsystem" level. Subsystem steering means that if multiple subsystems are networked together by a Master Network Controller/Switch, that partitioning "tables" shall be defined in each subsystem.

5.2.4 ***Wide Area Scalability***

The proposed network infrastructure and MNC subsystem shall have the capability, despite no immediate St. Marys County plans, to network to other regional MNC subsystems in a higher-tier form of wide-area radio system networking (i.e., capability to have multiple MNC nodes within a larger regional system) per the APCO P25 ISSI standard. Networking or interfacing in this case means the linking of systems at the highest possible level to allow seamless radio roaming (assuming the same frequency band) and equivalent trunking functionality within a larger regional network. The proposed system shall not preclude the networking of separate, additional, compatible trunked systems, procured at some possible future date, but shall enhance such expansion designs wherever possible.

The MNC shall support authorized roamers from compatible P25 digital systems for interagency assistance. The site (or RF subsystem) location of all subscriber units, including authorized roamers, shall be maintained by the MNC. Calls shall not require resources at sites that do not contain affiliated subscriber units (unless specifically provisioned by the network administrator to do so). RF subsystems shall contain all the control intelligence to support full feature provisioning, call processing, and track unit location and roamers within the RF subsystem.

All RF subsystems shall support standard signaling and communications interfaces to be flexibly linked into wider-area networks via private or public networks.

5.2.5 ***MNC Minimum Equipment Specifications***

- Power Supply – Redundant, independent circuit 120 VAC/60 Hz power supplies to be protected by an uninterruptible power supply (UPS) that will prevent accidental shutdown of the MNC subsystem controller(s). Optionally, a secondary -48VDC power supply is encouraged to enhance the probability of maintaining MNC operations during a major commercial power failure. The MNC controller(s) shall be designed with an interlocking style power switch, protective cover, or secure cabinet so as to prevent an accidental, unintentional power-down. In the event of complete power failure, the MNC shall be capable of an unattended, automatic graceful shutdown to prevent the corruption of database files and real-time operating systems. Power cabling interfaces to/from the MNC controller(s) shall be supported from above using either overhead/aerial cable tray or from underneath via computer flooring. The supplier shall be responsible for all required electrical and alarm wiring to commission the MNC subsystem. The supplier shall provide all grounding leads and connectors/lugs of sufficient gauge to properly bond all supplier-provided equipment to the single point grounding system.

- Environmental – The supplier shall identify the environmental operating characteristics of the proposed MNC subsystem. The MNC controller(s) and any auxiliary site controllers required at remote base station transceiver sites shall be designed to operate under the following conditions:

  Temperature: -30 degrees Celsius to +60 degrees Celsius.
  Humidity: 90% non-condensing.
  RF Fields: Equipment shall be properly shielded to allow proper, uninterrupted operation in equipment rooms or buildings occupied by base station transmitters/control stations/microwave radios generating strong RF fields. The MNC equipment shall also be designed to suppress its own spurious emissions in concert with FCC Part 15 guidelines so that no detrimental interference is caused by the MNC subsystem to the larger system.
  EMP: Electromagnetic pulse shielding is also desired as a network defense against possible acts of terrorism.

- Duty Cycle – All proposed online and standby equipment shall be rated for continuous duty operation.

- Hardware/Software Platform – The MNC controller(s) shall be rack-mountable in standard 19- or 23-inch wide by 7.5-ft high EIA-style steel relay racks or in a 2-ft wide x 2-ft deep x 7.5-ft high standard computer

server vented steel cabinet. Modular construction of the MNC using plug-in circuit cards and blade-style servers is preferred. The MNC controller(s) chassis shall be NEBS (Network Equipment Building System) compliant. The supplier shall define the proposed MNC hardware and software platform(s) and list the OEM supplier for all key components and applications/operating systems. The supplier shall define the product roadmap and upgradeability for all proposed MNC controller(s). St. Marys County requires the supplier to meet or exceed all supportability and product lifecycle requirements for the MNC subsystem as outlined throughout this specification.

- Data/Control Interfaces - All necessary interfaces with base repeaters, peripheral computer hardware, and the radio interconnect system shall be provided by the supplier. Interfaces shall include cabling, networking equipment, and modems, all of which shall be identified in the supplier's functional system diagrams. Cabling interfaces to/from the MNC controller(s) shall be supported from above using either overhead/aerial cable tray or from underneath via raised computer access flooring. The supplier shall define all electrical and physical interfaces between the MNC and other system components in the required system functional diagrams. Cabling and equipment interfacing shall be executed in a manner to eliminate the MNC and peripheral equipment from being susceptible to RF and electromagnetic interference (EMI) from collocated equipment. Proper cable shielding and design shall be used to ensure that the MNC will not experience performance degradation due to collocated system equipment. Plenum-rated cabling shall be supplied whenever required by local code or system application.

- Craft Interfaces – The MNC controller(s) shall support two distinct and independent types of craft interfaces for remote and local provisioning and troubleshooting. The MNC controller(s) shall support an RS232 (VT100) style craft interface for a local or remote (if proper modem is utilized) terminal session craft interface to enable a technician or network administrator to provision or troubleshoot the controller(s). The MNC controller(s) shall also support an Ethernet style craft interface for a local or remote (if network connectivity exists) TCP/IP craft interface to enable a technician or network administrator to provision or troubleshoot the controller(s). The ability to provision or troubleshoot the MNC controller(s) through either interface shall not be dependent on the other interface being available. All craft interfaces shall provide password protection security. The MNC controller(s) shall be equipped to receive software upgrades/patch fixes through the craft interfaces, and the MNC controller(s) shall be capable of being upgraded without having to degrade or disturb the real-time

call processing functionality provided by the MNC. The MNC controller(s) shall provide archive functionality for all configuration, provisioning, and troubleshooting parameters using standard storage media such as CD-R/W, DVD-R/W, DAT, etc. In the event of complete MNC controller(s) failure, the restoration and/or commissioning of new, replacement MNC controller(s) shall be accomplished using archived provisioning/configuration images rather than requiring a technician to completely re-construct the configuration database from scratch. The supplier shall fully define the provided capabilities with respect to the MNC controller craft interfaces.

- Radio Channel/Site Expansion Capabilities - The MNC controller(s) and any auxiliary site controllers shall provide for expansion to 30 unique radio channels of operation at a minimum without hardware modifications. The MNC shall be equipped to interface to a minimum of four additional MNC controller(s) or "peer network" compatible P25 regional systems in the event of integration of a larger regional network.

- Local Site Control – Depending on the supplier's MNC network controller architecture and hierarchy, local site controllers (if utilized) shall maintain a localized system database in the event that the MNC controller is severed from the local controllers. This local database shall be updated in real-time and shall be accessible locally and remotely via a craft interface. The local database shall contain all of the system access and functionality privileges to ensure a consistent level of system access and integrity during a MNC controller outage.

- Alarms and Diagnostics - The MNC controller(s) and associated site controllers shall provide alarms for key operational parameters, and shall provide for remote inquiry display, disablement and diagnostic functions via RS232 and Ethernet connections. Alarms shall be displayed at all NMS workstations and through craft interfaces. The MNC controller(s) shall provide high-level diagnostic information through front-panel LEDs and relevant indicators so that a technician or network administrator can quickly gauge the severity of an MNC fault by looking at the MNC. The MNC controller(s) shall provide both alarm messages and fault conditions using SNMP and discrete Form-C relays. At a minimum, the MNC controller(s) shall provide Critical, Major, and Minor relays which may be connected to a separate alarm subsystem. All MNC alarm information shall be time/date stamped in synchronization with the master network clock.

5.3 SWITCHING & NETWORK MANAGEMENT SYSTEM (NMS) INFRASTRUCTURE

5.3.1 *General Requirements*

All subsystems, authorized radio subscriber units, and dispatch consoles that comprise the proposed radio system must be under the control of a unified switching and network management system (NMS) infrastructure. The scope of the unified NMS scheme includes the five basic elements of network management:

- Configuration Management
- Fault Management
- Security Management
- Performance Management
- Accounting Management.

The NMS must be a comprehensive suite of software and hardware, supported by embedded network intelligence and expertise needed to incorporate system information into a complete, single, unified network management tool. The NMS shall be developed with an emphasis on customizable graphical displays and simplified interfacing to the various proposed subsystems.

Management of all system components, software levels, configuration databases, authorization parameters, system usage, and fault management information shall be able to be performed from a single, unified network management terminal. This shall be accomplished in such a manner that an entry change to one database will automatically change all other associated databases without further user action. Overall system management shall be able to delegate vertical partitioning management to an organization/agency responsible for the operation of the partition.

The NMS must be of a modular structure providing end-users with the capability to expand the subsystem as the need arises. The software supporting the NMS must respond to network expansion by enabling modifications to the NMS as new devices are added or deleted. A single client workstation shall be provided that allows for the management and configuration of all proposed radio communication system subsystems.

The NMS shall be provided as an integrated subsystem. The supplier must provide all software and hardware, coordinate the entire installation, create customized graphical representations of the proposed network, perform acceptance tests, and conduct NMS subsystem administrator and end-user training. The supplier shall populate all system and subscriber databases to fully commission the network in concert with the final defined version of the St. Marys County fleetmap.

5.3.2 ***Subsystem Monitoring***

The proposed switching and NMS system shall be equipped in such a manner as to allow alarms and control functions from the various subsystems to be passed to all NMS client workstation(s) that shall monitor the entire integrated radio network. The supplier shall provide detailed information describing NMS functionality with respect to the various subsystems and the required connection/access between the subsystem element manager systems.

At a minimum, the NMS subsystem shall provide the capability of automatic monitoring on a 24/7/365 basis for the following infrastructure components:

- Communications Links to all Sites/Network Nodes
- Base Stations/Transceivers
- Comparators
- Antenna Subsystems
- Microwave/Transport Infrastructure
- Multiplexers/Channel Banks
- Timing/Frequency Reference Standards
- Dispatch Consoles
- Logging Recorder
- Remote Terminal Units/Site Environmental Alarms
- MNC/Radio Network Site Controllers/Base Station Controllers
- Audio/Data Switches
- Telephone Interconnect
- Network Gateways
- LAN/WAN Networking Equipment (Gateways, Routers, Switches, etc.)
- Client Workstations/Servers
- Power Equipment (Generators/UPS/DC Plant).

5.3.3 ***NMS Services***

At a minimum, NMS services shall include the following:

- Common client/server workstation platform to provision infrastructure and subscriber assets, diagnose/troubleshoot system faults, track real-time and historical network usage/utilization and availability by infrastructure and subscribers, and establish network and NMS access privileges

- Automatic system infrastructure component fault and failure detection and alarm generation
- Audible and visual alarm operator alerting
- Diagnostics for isolating and troubleshooting real-time faults and alarms including all communications links and link equipment
- Message volume statistics per hour of radio network controller, audio switch(s) and consoles(s)
- Message volume statistics by radio channels per hour
- Message volume statistics by base stations per hour
- Message volume statistics by subscriber units per hour
- Dynamic radio commands for all subscriber radios such as radio regrouping, inhibiting, affiliation monitor, status/messaging
- Control of critical network time-out and operational parameters (e.g., emergency hang-time, interfering carrier timer, fade timer, etc.)
- Real-time channel, talkgroup, user, and RF site activity monitoring
- Retrievable and printable alarm history log file(s)
- Remote dial-in and networked service support capability
- Customizable report generation and graphical display for real-time and historical system utilization/fault management/alarm history/dynamic radio commands information.

5.3.4 *NMS Features and Performance Requirements*

The following section describes requirements of the NMS as it pertains to features, functionality, and performance. The supplier must supply a NMS that can interface with and support different systems and elements.

The NMS shall be equipped to enable users to quickly detect, evaluate, and respond to changing network conditions. Manager and agent modules must manage network devices, and the system must automatically respond to the alert messages generated by all network devices. All reported network problems shall be entered into the NMS trouble tracking system, and problem history records shall be stored for each NMS user.

A point-and-click mouse operation shall provide access to detailed menus and update data fields on any window. The NMS shall also incorporate a feature that graphically illustrates network trends and statistics. The NMS shall provide accurate information in a format most useful for network management.

5.3.4.1 NMS Features and Functionality Requirements

The following list represents the minimum functionality, performance, and quality requirements that shall be included in the NMS. The list is not necessarily totally inclusive of all requirements since the supplier may offer additional functionality in its standard NMS offering. The following section briefly defines the required functionality, performance, and quality of the specific requirements in this list.

- Use of open system standards (e.g., SNMP, OSI CMIP, etc.)
- Use of client /server architecture
- Message and alarm processing
- Terminal reach-through
- Use of relational database(s)
- User-friendly
- Network management reports
- Graphical User Interface (GUI)
- Modular/upgradeable software
- Application Programming Interface (API)
- Redundant and fault-tolerant design
- Network time synchronization for correlation of system events and call transactions
- Security and user partitioning (suppliers to identify number and capabilities of partitions)
- Historical information storage/archive capabilities.

5.3.4.2 NMS Functionality Requirement Descriptions

The following list of functional requirements and requested information establishes the County's requirements for the network management system. Intended functionality for the NMS is defined in the following paragraphs. The supplier assumes responsibility to ensure it completely understands the relationship and impact of the NMS and all functional requirements as related to each of the subsystems.

The NMS hardware architecture shall provide multiple levels of computing power based on the size of the network being managed. The NMS system shall be a multi-tasking system capable of simultaneous access and control

from multiple users, each having a unique access level, operational capabilities, and information set as configured by a network administrator/superuser.

5.3.4.3 Use of Open System Standards

The NMS must be developed using industry-proven, open systems standards (e.g. SNMP, OSI CMIP, etc.) in order to provide maximum flexibility and scalability of the NMS. This functionality will also allow for easier enhancements from other compatible software/hardware providers. The NMS shall be provided with the capability of managing devices and elements through the use of different interfaces. The supplier shall describe the type of interfaces that are available in the response offering. The County is requesting information on standard interfaces such as HP OpenView, Tivoli NetView, CA Unicenter, BMC Patrol, etc.

The supplier shall fully define the proposed NMS platform and its alignment with industry standards for open standards. The supplier shall also define the compliance and overall readiness of the proposed NMS subsystem with respect to the APCO Project 25 E_n Network Management End System interface.

5.3.4.4 Use of Client/Server Architecture

The supplier shall provide a true multi-user/multi-tasking NMS, utilizing a client/server architecture which is capable of supporting at minimum 10/100 Mbps Ethernet connectivity with TCP/IP addressing for all network nodes. Client terminals shall be off-the-shelf Windows-based client workstations with the ability to remote from the server location using microwave T1, ISDN, 802.11a/b/g Wi-Fi, or dial-up/VPN connectivity. The operating system, coupled with standard programming languages such as C, C++, and SQL, shall allow for compatibility across many hardware platforms. The hardware architecture shall provide multiple levels of computing power based on the size of the network. The supplier shall define the operating system programming language and platforms that are used to develop the proposed NMS. The supplier shall define all bandwidth and timing requirements for each remote and local NMS workstation relative to each concurrent software application that may be launched at the client workstations.

5.3.4.5 Message and Alarm Processing

The NMS subsystem shall process messages sent by the network elements and other element managers to the NMS server(s) and associated client workstations. These alarm messages may be transported over the transport

overhead and/or traffic channel, system LAN/WAN, wireline modem or RF modem. The selected transport mechanism for alarm messages should not be susceptible to a single-point failure which would create an inability to properly provision/diagnose/troubleshoot a remote network element in the event of a system failure. Fault-tolerance and/or redundancy should be incorporated into the design of the NMS alarm message transport mechanism. Critical, major, minor and all other types of messages must be processed in real-time and made available for use by all NMS users.

All alarms and messages shall be automatically recorded to a relational database in real-time. The NMS shall be capable of processing each individual message from each managed element. The supplier shall provide detailed information, which should thoroughly define and describe, the message processing functionality of the proposed NMS. Additionally, the supplier shall describe the capabilities of interfacing and transferring alarm messages and call transaction information to/from the proposed NMS to compatible APCO P25 network management systems.

5.3.4.6 Terminal Reach-Through

The NMS shall allow authorized users access to all network elements, element management systems, and other support systems.

5.3.4.7 Relational Database(s)

The NMS shall be supplied with an industry-standard SQL relational database such as SQL Server, Informix, Oracle or equivalent. The supplier shall indicate manufacturer and software versions as part of the response proposal. All database entries shall be user-restricted and password-protected and all transactions shall be logged and tagged by user names. Other required features of the database and NMS software are:

- Capability to store objects and their relationships
- Capability to use other databases across the network.

Software tools shall be provided to automatically update both the database and the graphical network depiction as the County network expands or modifies.

5.3.4.8 User-Friendly

The NMS system shall be developed in a logical manner allowing the user to understand the conceptual layout of the application software as related to the overall network. The design shall allow for comprehensive on-screen help menus and prompts that provide direction and assistance to facilitate the

learning process. These learning tools shall be able to be placed in the background after user efficiency is achieved. Training and user manuals shall contain the same information provided by help screens and prompts. In conjunction with generic NMS object descriptors, the proposed NMS shall be customized with County-defined network element descriptors and user tags that facilitate a quick understanding and recognition of system failures.

5.3.4.9 Network Management Reports

The NMS shall be capable of performing time-based analysis and generating customized system statistical reports based on alarm and radio usage events/transactions. The system shall be able to retain report formats, layouts and schedules for future use, and report data shall be able to be routed to a retrievable file, printer, or screen. Alarm-related data shall be reported as text reports, spreadsheets, charts or line graphs and be used to depict network performance by various categories. At a minimum, all retrievable system data shall be equipped to format data in *.CSV (Comma Separated Value) and/or tab-delimited format so that external applications can also manipulate the specific information independent of the NMS.

5.3.4.10 Graphical User Interface

The NMS shall allow the user to access configuration data, utilization data, and alarms/messages in both graphical and text format. The graphical user interface (GUI) and its display shall be fully integrated and independent of supplier or protocol components. The GUI shall support the following features:

- Object-oriented
- Provide real-time updating of events
- Support industry standard graphic interfaces
- Provide multiple views hierarchically
- Provide point-and-click methodology
- Support customer network layouts (locations, equipment, geographic configurations, etc.)
- Provide a library of icon symbols and be expandable using edit tools
- Provide the capability of utilizing scanned-in graphic images
- Provide the capability of customizing all scenes with color, graphic symbols and linking
- Navigation shall be made through menus, dialog boxes and buttons

- Provide the capability to assign hot keys
- Provide the capability for prioritizing alarm indications
- Provide the capability of user-defined colors
- Provide a hierarchical view of objects in a network topology representation
- Provide the capability to display all event details and status in text
- Provide events in a scrolled list format
- Provide the capability to color code the events by priority and frequency of occurrence
- Provide the capability to attach messages to events
- Provide sorting of events by different categories
- Provide a unique fault tracking mechanism for each event/transaction
- Provide both audible and visual mechanisms for user alert and feedback.

5.3.4.11 Modular/Upgradeable Software & Hardware

The NMS shall be designed to support a suite of all available network management software applications, software/hardware interfaces, communications, and other software capabilities in a modular, licensable fashion. The proposed NMS shall be equipped to facilitate any number of concurrent NMS users running any combination of proposed applications concurrently on any combination of client workstations. The supplier shall describe how the proposed system is configured to meet this requirement and explain the overall upgradeability of the proposed NMS subsystem. The proposed NMS shall be designed to facilitate hardware upgrades in the form of more powerful server and client computers to realize greater efficiencies and throughput. The proposed NMS shall be designed to easily integrate additional NMS client workstations as the network expands without causing the active network to be taken offline or disrupted in any manner. The supplier shall also distinguish between core operating system, third-party software, and custom software while providing a comprehensive description of technical support provided for all software and hardware proposed. The supplier shall define all NMS licensing requirements and application usage constraints.

5.3.4.12 Application Programming Interface (API)

The NMS subsystem shall provide a comprehensive API and be capable of supporting custom applications with functions and library files to access the NMS directly for call processing, fault management, and configuration management purposes (e.g., CAD call processing and dynamic radio command interface, airtime billing/usage interface, logging recorder interface, etc.). As part of this response, the supplier shall provide an explanation, pricing, and details regarding the available API(s).

5.3.4.13 Redundant and Fault-Tolerant Design

The NMS shall ensure uninterrupted network provisioning, administration, and monitoring through support of multiple, redundant network management stations and remote background communications processing. The redundant and fault-tolerant architecture shall enable each network management station to operate independently in the event of equipment failure. The proposed NMS and associated network elements shall be equipped to indicate and capture a discrete network alarm or change of state even in the event of loss of power to the network element (i.e., absence of power to a network element shall trigger a change of state which is captured by the NMS).

The NMS shall be supplied with backup server(s) and associated equipment in order to support a failed primary NMS server or any component of the server network which will cause a system failure. Switching between primary and backup server(s) shall be transparent to the end-user and shall not interrupt any ability to provision, administer, monitor, and archive network management information. St. Marys County requires the proposed NMS subsystem to be designed to provide 99.9999% or greater availability. The supplier shall thoroughly describe the NMS architecture as well as any fault-tolerant equipment offered as a response to the RFP specifications.

5.3.4.14 Time Synchronization

The proposed NMS shall be time synchronized using a common timing reference scheme for the entire network (i.e., GPS, NTP, WWVB, etc.). All call transactions and network alarm events shall be time/date stamped with the master system clock for accurate NMS diagnostic and troubleshooting. All network elements with internal status/error logging capability shall be synchronized to the same master system clock for accurate diagnostic and troubleshooting and correlation to NMS alarm data information. In the event of master clock failure, the NMS shall provide a free-running clock which is originally disciplined from the master system clocking reference. The

supplier shall define the time synchronization methodology for the proposed NMS subsystem.

5.3.4.15 Security and User Partitioning

The NMS shall support multiple levels of access that are protected in a manner allowing users to control, monitor and use software applications that have been partitioned and provisioned for specific use by the end-user. The supplier shall provide a detailed description of this capability by defining the levels of partitioning and security, total number of end-users, the total number of simultaneous users with independent views, and the method used to achieve this requirement.

End-users shall be located at different locations such as dispatch centers, offices, maintenance facilities, and other remote sites. Therefore, this user partitioning feature must be provided to remote locations in order to allow restricted access to the overall radio network. User functionality and passwords must be configurable through a network administrator/superuser (root level) login. Superuser (root level) login and password must be re-configurable in the event of a network security breach. The NMS shall provide the administrative functionality to disable in real-time specific client workstation(s) and user login(s) as necessary in the event of malicious or unwanted activity.

5.3.4.16 Historical Information Storage/Archive Capabilities

The NMS shall be equipped to provide up to one year's worth of data for all call processing, fault management, and network utilization data from any client workstation. All historical NMS data shall be written to fault-tolerant server disk drives and/or RAID-5 hard drive arrays (or superior level) so that a single failure does not cause the loss of any historical data. NMS data shall be written to these hard drives on a FIFO basis. For the entire year period, historical NMS data shall be retrievable from a client workstation with the same granularity/level of detail as data is presented to the NMS client workstations in real-time.

The NMS shall provide a mechanism to store/write the NMS data at any time to such storage media as CD-R/W, DVD-R/W, and DAT drives. Both automated and manual NMS data archive techniques shall be provided with the proposed NMS system so that the archiving of NMS data can be handled routinely or as necessary. A visual warning or dialogue box shall be provided to the end-user and network administrator if/when NMS data, that has not been externally archived, is subject to being permanently overwritten. NMS data shall be archived in a format that is recognizable and capable of

being utilized in both the core applications NMS and off-the-shelf industry standard spreadsheet/database/word processing applications.

The supplier shall define the historical NMS information and archive capabilities for the proposed NMS subsystem. The supplier shall define all databases that are capable of being archived and retrieved.

5.3.5 *Monitoring and Control of Subsystems*

The NMS shall be equipped to control and monitor each and every subsystem contained in the integrated radio communication system. The supplier shall be responsible for all required electrical and alarm wiring to fully commission and test the NMS subsystem. A list of elements and alarms is provided as a conceptual starting point in the development of the proposed NMS. These systems shall include, but not limited to, the items listed below:

- Radio Infrastructure/Fixed Network Equipment
- Dispatch Consoles/Logging Recorder
- Legacy/Existing Mutual Aid Radio and Shelter Subsystem Infrastructure
- Network Management System
- Microwave Transport/Multiplex/Switch Infrastructure
- DC Power Plant
- In-Building Systems
- Shelter Systems (HVAC, Fire Suppression, TVSS, Leak Detection, Fuel)
- Emergency Generator/Transfer Switch
- Uninterrupted Power Supply
- Tower Lights.

Each of these items and subsystems shall be monitored and controlled for specific management and diagnostic reasons. The supplier shall define the entire NMS architecture and methodology utilized to capture diagnostic and control data from every proposed network element.

5.3.5.1 Monitoring of Tower Lighting System Alarms

The following alarm inputs, at a minimum, shall be supplied, installed and connected to the Network Management System:

-Beacon on (Red and/or White)

-Beacon off (Red and/or White)

-Side marker(s) lamp failure

-Photoelectric cell failure

-Loss of power

-Beacon failure (Red and/or White).

5.3.5.2 Monitoring of Shelter Subsystem Alarms

The following alarm inputs, at a minimum, shall be supplied, installed and connected to the Network Management System:

-Fire/Smoke Detector

-Intrusion (Door) Alarm

-High Temperature Alarm

-Power Surge Suppression Failure

-Low Temperature Alarm

-TVSS Surge Suppressor Failure

-Fire Suppression Agent Heat Detector

-Fire Suppression Agent Smoke Detector

-Fire Suppression Agent Discharge

-Fire Suppression On-Battery

-High Humidity Alarm

-Leak Detection

-HVAC Equipment Failure

-Loss of Commercial Power.

5.3.5.3 Monitoring of Emergency Generator/UPS System Alarms

The following alarm inputs, at a minimum, shall be supplied, installed and connected to the Network Management System:

-Utility Power Failure Alarm

-Generator Running

-Generator Failure to Start

-Generator Overcrank Shutdown

-Generator Overspeed Shutdown

-Generator High Coolant Temperature

-Generator Low Coolant Level

-Generator Low Oil Pressure

-Generator High Engine Temperature

-Generator Low Fuel

-Generator Battery Charger AC Fail

-Generator Battery Charger High/Low Current

-UPS Mains Failure

-UPS Low Battery Voltage

-UPS Static Bypass

-UPS Output Voltage (above/below threshold)

-UPS Overload

-UPS Battery Charging Failure

-Transfer Switch Normal Mode

-Transfer Switch Emergency Mode.

5.3.5.4 Monitoring of Transport/Microwave Subsystem Alarms

The following alarm inputs, at a minimum, shall be supplied, installed and connected to the Network Management System:

-Mod/Tx A

-Mod/Tx B

-Demod/RXU A

-Demod/RXU B

-Mux Tx A

-Mux Tx B

-Mux Rx A

-Mux Rx B

-APC on/off A

-APC on/off B

-Pwr Amp on/off A

-Pwr Amp on/off B

-Radio Minor

-Radio Major

-BER A

-BER B

-RFU PSU Alarm

-SP PSU Alarm

-TXU Alarm

-RXU Alarm

-Modulator Alarm

-Demodulator alarm

-ATDE Alarm

-Mux Alarm

-ACU Alarm

-OWU Alarm

-Summary Alarm A

-Summary Alarm B

-M12 Alarm (for each M12 card, if utilized)

-M12 Standby On-Line (for each M12 card, if utilized)

-Ring Switch/Loopswitch Working On-Line

-Ring Switch/Loopswitch Protected On-Line

-Dehydrator Low Pressure

-Dehydrator Summary Alarm

-Multiplexer High BER

-Multiplexer Loss of Synchronization

-Multiplexer AIS (Yellow and/or Red Alarms)

-Multiplexer Card Failure(s)

-Multiplexer Critical

-Multiplexer Major

-Multiplexer Minor

-Multiplexer Loss of Power

-DC Power Supply Loss of Power

-DC Power Supply On Battery

-DC Power Supply Low Voltage Disconnect

-DC Battery Failure.

External Controls: NMS shall provide control outputs for the following functionality:

Mod/TXU A switch

Mod/TXU B Switch

RXU/Demod A switch

RXU/Demod B switch

Mux/Tx A switch

Mux/Tx B switch

Mux/Rx A switch

Mux/Rx B switch

APC on/off switch

Pwr Amp on/off switch A

Pwr Amp on/off switch B

DS1 and Ethernet Loopback (for each DS1 and Ethernet facility available).

5.3.6 *Remote/Mobile NMS Client Access*

The proposed NMS subsystem shall be equipped to provide remote client access through dial-up and/or VPN network connectivity. A laptop computer shall be provided which is equipped with all necessary software and hardware to remotely connect to the NMS subsystem through both commercial dial-up and VPN broadband connections. The real-time functionality and application equipage of the proposed mobile NMS client shall be exactly the same as all fixed NMS client workstations.

This mobile client computer and NMS system shall also be configured to enable NMS access from any RF transceiver site, transport site, or switching site utilizing the core infrastructure network connectivity (versus commercial services when away from the network). For example, a technician utilizing the mobile NMS client shall be able to execute all NMS functionality from any RF transceiver node, network switching node, or transport node to fully maintain and troubleshoot the network without having to work in tandem with an NMS user at a fixed client workstation. Network connectivity and mobile NMS client application performance at any RF transceiver, network switching, or transport node shall be equivalent to any fixed NMS client workstation.

The supplier shall define all bandwidth, service, and timing requirements necessary to establish remote client connectivity in the variety of required forms to the NMS subsystem.

5.3.7 *Over-the-Air Trunked System Monitoring*

The proposed NMS subsystem shall include an over-the-air trunked system channel monitoring and activity logging diagnostic tool to augment the networked NMS clients. The over-the-air diagnostic tool shall be equipped to monitor the active control channel(s) while in all trunking modes to present real-time channel activity and call processing messages (i.e., call type, busy queue, active talkgroup, transmitting unit, call duration, affiliations, emergency activations, individual alerts, etc.) as defined on the RF signaling and/or control channel(s). The over-the-air diagnostic tool shall be equipped to log all control channel and system activity to an internal or external hard drive for historical archiving purposes. The over-the-air diagnostic tool shall not rely on the availability of any MNC or NMS server to monitor and log call processing information transmitted on the active control channel.

The over-the-air diagnostic tool shall run on a standard Windows-based PC client interfaced to a network subscriber radio and be capable of external timing synchronization (i.e., NTP, WWVB, IRIG, etc.). One (1) over-the-air diagnostic

tool shall be provided for use at the System Manager's office in the ECC. The supplier shall thoroughly define the capabilities of the proposed over-the-air diagnostic tool and any available options.

5.3.8 *NMS Client Workstation Locations*

The County requires the following locations and quantities of equivalently-equipped and fully-functional NMS client workstations with associated laser printers. All laser printers shall be networked so that NMS client workstations are capable of printing to any available network printer. At minimum, each fixed NMS client workstation shall be equipped with 21" flat-screen LCD monitor and upright tower style workstation computer. At minimum, the NMS laptop shall be equipped with a 17" LCD display. The specific locations and quantities of NMS workstations include:

- Prime Site/Network Control Center Equipment Room (Quantity 1)
- ECC Supervisor Dispatch Console Position (Quantity 1)
- ECC System Manager's Office (Quantity 1)
- County Radio Shop Supervisor's Office (Quantity 1)
- On-Call Technician NMS Laptop (Remote Access) Workstation (Quantity 1) [No printer required for this client workstation.]
- Spare NMS Laptop (Quantity 1) [Configurable and networked to function as a spare for any stationary client workstation in the event of workstation failure.]

All spare equipment shall be uniquely noted and itemized by line item unit independent of the primary system equipment/pricing matrices.

5.3.9 *NMS Alphanumeric Paging/Text Messaging*

The proposed NMS subsystem shall be equipped to generate alphanumeric text messages and/or pages using commercially available paging/text messaging services for on-call network administrators and technicians to alert of system faults and error conditions. The severity of individual alarm and fault messages shall be customizable so that text messaging and pages can be filtered based on severity for a variety of interested personnel. The alphanumeric paging/text messaging application shall enable group pages/text messages as well as individual pages/text. The length of the alphanumeric page/text message shall be customizable and constrained by the commercial service and not the NMS paging application. The supplier shall define all bandwidth, service, timing, and interface requirements necessary to establish NMS alphanumeric paging/text messaging.

5.3.10 *NMS Design*

The supplier shall provide the following NMS design information and documentation details based upon the County requirements and specifications:

- System Functional Block Diagrams
- Network Topology with Proposed Connectivity (LAN/WAN)
- Network Traffic Baseline/Utilization Baseline
- System License Matrix/Structure
- Equipment Layouts and Physical Dimensions
- Equipment Electrical and HVAC Requirements.

5.3.11 *Optional Features*

The supplier shall provide a detailed list of optional features that can be supplied for review and understanding. The supplier shall provide a complete listing and explanation of all available NMS options.

5.4 BASE STATION TRANSCEIVERS

5.4.1 *General Requirements*

The supplier is to provide base station transceivers which fully support the radio subscriber units on the radio network in all modes of voice/data communications. All base station transceivers shall be FCC type-accepted for transmission of the proposed digital modulation, RF channel bandwidths, frequencies, and appropriate emission masks. The base station transceivers shall be designed solely for the purpose of APCO P25 digital voice/data communications. Each base station transceiver and/or network controller must be capable of providing automatic station identification compliant with FCC Base Station Identification specifications. At a minimum, all base station transceivers shall be capable of operating at 100 Watts in both the 700 MHz and 800 MHz public safety spectrum allocations (764-869 MHz) in concert with FCC channel plans and requirements.

Each base station transceiver shall be capable of operation in a full-duplex mode in a both clear and encrypted format: sending an outbound transmission while simultaneously receiving an inbound transmission from a subscriber unit. Repeater operation with connectivity to wireline dispatch console systems is required. The equipment shall meet or exceed specified EIA/TIA standards for transmitters and for receivers. The equipment shall contain all the necessary base station transceiver control/interface circuitry and software to meet or exceed the County specifications.

The base station transceivers shall be flexible in design and software provisioning to work seamlessly in all primary and fallback modes of communications without the need for technician intervention or reprogramming. The base station transceivers shall operate in any proposed mode of trunking and conventional voice/data communications (i.e., single site, multi-cast, and simulcast). In the event of loss of trunking control, the base station transceivers shall be equipped and wired to function in both wide-area and localized repeater mode depending upon the specific failure scenario. The supplier shall define the various modes of operation for the proposed transceivers and identify any limitations/constraints with the proposed equipment.

5.4.2 ***Electrical & Mechanical Characteristics***

The transceiver equipment shall be rated for and be capable of continuous duty RF transmission operations in an operating environment with temperatures ranging from -30 degrees Celsius to +60 degrees Celsius. The physical and electrical architecture of the transceivers shall be such that the future addition of additional functionality shall not require the addition and/or replacement of circuit card shelves and/or chassis assemblies. The supplier shall be responsible for all required electrical and interconnect wiring to fully commission the base station transceiver subsystem. The supplier shall provide all grounding leads and connectors/lugs of sufficient gauge to properly bond all supplier-provided equipment to a single point grounding system.

The transceiver equipment shall be modular in design utilizing a card cage or chassis that facilitates replaceable boards or modules (e.g., power amplifier, exciter, transmitter, receiver, transceiver control module, high stability oscillator, power supply, etc.) in the event of component failure. The transceiver equipment subsystem shall be field-expandable up to at least 30 channels per RF site.

The base station transceiver equipment shall be frequency synthesized and field programmable to operate on any channel between 764-869 MHz. The base station transceiver equipment shall be capable of providing a high-stability internal frequency reference (<.1 PPM) or receiving frequency and timing signals from an external high-stability reference to meet or exceed FCC operating requirements.

To the greatest extent feasible, all transceiver equipment assemblies and subassemblies shall be shielded to minimize and eliminate electromagnetic interference which may be caused to/by electrical equipment co-located and/or adjacent to the transceiver. The base station transceiver equipment shall provide the necessary filtering and preselection to mitigate the presence of an interfering carrier or unwanted interference. After configurable time duration, the transceivers shall work in conjunction with the MNC subsystem and/or internal station control

circuitry to remove a channel from service that suffers from continuous interference.

If microprocessor-based equipment is provided, firmware or software used to determine the various functions to be performed shall be field programmable and configurable through the use of Electronically Erasable Programmable Read Only Memory (EEPROM) circuits. Power loss or electrical surges shall not alter/modify the repeater software or configuration parameters in any manner. In the event of upgrade and/or bug fix scenarios, the base station transceiver shall be capable of storing two versions of software/firmware to facilitate a seamless transition between existing and upgraded station code. Software downloads to the base station transceivers shall be accomplished from both a local craft interface and a centralized software download server.

The base station transceiver equipment shall be designed for a minimum of 12.5 kHz narrowband operation, but the County requires the integration of transceiver equipment that offers a straightforward migration path to 6.25 kHz or 6.25 kHz-equivalent operation.

The supplier shall thoroughly define the architecture and software complement for the proposed base station transceivers and identify the modules/components that are field replaceable with spares. Spare board kits or modules shall be available and one fully-functional, complete spare base station transceiver shall be provided for every two RF transceiver site(s). All spare equipment shall be uniquely noted and itemized by line item unit independent of the primary system equipment/pricing matrices.

5.4.3 ***Power Supply***

Bidder shall determine the most effective method for powering the critical communications equipment at each site. Existing EDCAs sites have high-capacity UPS systems in place. State of Maryland sites in STMC do not currently have UPS systems in place. The general concept for power reliability at remote RF sites is to provide short-term, full capacity power for the duration of the power transition from commercial power to back-up generator operation. Regardless of the power sourcing choice for the RF FNE, the MW system will be operated from a dedicated DC plant subsystem. The electrical connection from the power supply to the shelter facility electrical service shall be protected and secured using a latching connector or harness at the base station transceiver to prevent accidental transceiver power loss. Power cabling interfaces to/from the base station transceivers shall be supported from above using either overhead/aerial cable tray or from underneath via computer flooring.

The base station transceiver shall be designed with an interlocking style power switch, protective cover, or secure cabinet so as to prevent an accidental, unintentional power-down. In the event of complete power failure, the base station transceivers shall be capable of an unattended, automatic graceful shutdown to prevent the corruption of configuration files and real-time operating systems.

5.4.4 *Equipment Housing*

Repeaters shall be permanently housed in an EIA/TIA standard 19"-wide steel relay rack or 19"-wide stationary steel cabinet in each site shelter. Station equipment size shall allow for mounting of at least five (5) 100-Watt stations per 90"-high rack. The base station transceiver shall provide a grounding lug or grounding buss connection that facilitates a single point grounding methodology within the RF site shelter. The base station transceivers shall provide front and rear access for cabling and service purposes.

5.4.5 *Diagnostics/Alarm Interface*

Central metering, alignment, programming and diagnostic information of all essential circuits/modules shall be provided through both a local and centralized (off-site location) craft interface for all base station transceivers. This functionality shall be accessible and adjustable electronically by service personnel via both an RS-232 connection and Ethernet interface. The craft interface connections shall be accessible without the need to remove RF chassis shields or equipment circuit boards. Any external configuration software, hardware and/or interface cables needed to perform these functions shall be specified and provided on a per site basis (not to include a PC). The base station transceivers shall offer a mechanism to archive the configuration/service alignment parameters for quick restoration in the event of module failure or transceiver restoration.

The base station transceivers shall provide an internal diagnostic log of alarms and fault conditions that is stored locally in the transceiver as well as reported to the NMS subsystem. The internal base station transceiver logs shall be time/date synchronized to the master network timing source for correlation of alarm events with the NMS subsystem. Internal station transceiver logs shall be archiveable and printable in ASCII text format at a minimum. Alarm log information shall be written to internal station transceiver buffers on a FIFO basis with a minimum of 500 alarm events stored at any one time. The base station transceivers shall offer independent, front-panel LEDs to quickly gauge normal or abnormal station operation when on-site. The base station transceivers shall also offer independent discrete alarm relays (e.g., Form-C relays for fundamental station alarms) to connect to the NMS subsystem for remote alarm monitoring.

5.4.6 *Base Station Transceiver Accessories*

All primary base station transceiver circuits shall be fed by individual AC/DC breakers. For retrofitted sites with AC power, a rack-mounted AC power utility strip with surge suppression, providing a minimum of eight (8) outlets, shall also be mounted at the top of each transceiver rack.

Each base station transceiver site shall be equipped with an external wattmeter for each transmit combiner output port capable of reading the forward and reflected power of each transmitter. This meter shall be installed in series with the combiner transmit output.

For local control operation and for servicing, each base station shall be provided with a monitor speaker. The audio output level shall be rated at no less than ½ watt, and be provided with a volume control. Each base station transceiver site shall be provided with two (2) test microphones, any of which can be used to test or service any repeater at the site.

5.4.7 *Base Station Transceiver Antenna System Requirements*

5.4.7.1 General

The supplier shall furnish and fully install all antenna subsystem equipment. This includes, but is not limited to, the following equipment: antennas, transmit combiners, receiver multicouplers/amplifiers, transmission line, all mounting hardware (i.e., hangers, hoists, and mounting clamps, sidearm brackets, etc.), surge suppressors, lightning arrestors, jumper cables, grounding straps/cabling, transmission line boots, RF connectors and all ancillary items required to complete the installation at a shared radio site meeting industry-standard, good RF engineering practices. The supplier is solely responsible for the due diligence and engineering analysis necessary to accommodate the proposed antennae & transmission line loading for any existing or new tower utilized in the final network design.

The 700/800 MHz antenna system design shall be specified by the supplier to provide for balanced FNE system 'Talk-Out' & subscriber 'Talk-In' communications only. At the network sites, separate antennas shall be used for transmit and receive purposes. The supplier shall try to minimize the use of transmit and receive network antennas to minimize tower loading, but the antenna system shall be architected to provide a high-level of redundancy and fault tolerance with respect to the antenna system design. Whenever possible, the supplier shall try to incorporate the use of dual-band 700 & 800 MHz fixed network antenna and ancillary RF systems to create maximum flexibility from a fixed network equipment perspective.

The suppliers have the option to select any antenna configuration to reduce the potential for intermodulation or receiver desensitization, while providing the required coverage within the constraints of the FCC license and the requirements of NPSPAC Region 20. Additionally, the supplier shall provide all necessary filtering to prevent interference and receiver desensitization in the new base station transceiver equipment. Shielding and radio frequency filters shall also be provided as necessary.

All model numbers referenced in this section are merely representative of the performance and quality desired. Suppliers shall propose models and equipment that are equipped for the channels proposed at each site and are field expandable.

The antenna systems shall be provided with all necessary lightning and power surge protection devices. The supplier shall supply the necessary sidearm brackets and antenna mounts customized for the specific antennas at each site. Sidearms shall be compatible and rated for each applicable tower leg to eliminate drift and sway, and each sidearm shall be designed to offer no less than 6-foot separation from the tower. All LMR antenna mounts shall be equipped with appropriate tie-backs to ensure mount stability. Suppliers shall state the manufacturer and model number of the all antenna system equipment being proposed for each site. One (1) spare antenna for each unique antenna type utilized in the system shall be provided in addition to the required number of network antennas. All spare equipment shall be uniquely noted and itemized by line item unit independent of the primary system equipment/pricing matrices.

5.4.7.2 Transmission Line & Accessories

The supplier shall provide low-loss coaxial antenna transmission lines from the LDF series of transmission cable as manufactured by Andrew Corporation, or equivalent. The supplier shall state the size and type of transmission line being proposed at each site as well as the loss characteristics of the proposed transmission line.

All connectors used shall be state-of-the-art characteristic while exhibiting the least loss. Connectors must be of non-ferrous construction and of similar metallic composition to avoid an oxidation effect. No splices or adapters shall be used except as specifically authorized by the County for special "in-building" or similar installations. However, it is permissible to utilize different connectors on opposite ends of a cable to avoid the use of adapters. When transforming from one diameter cable to another, it is acceptable to use flange reducers, so long as the cable V.S.W.R. specification is not changed. The supplier shall state the size and type of all connectors/jumpers/suppressors/etc. being proposed at each site as well as the loss characteristics of all proposed connectors/jumpers/suppressors/etc. The

supplier shall provide a comprehensive copy of its most current standard, field-tested communications system installation guidelines that will be used to govern all field installation work. The supplier shall perform line sweeps for all transmission line systems and provide the comprehensive sweep and return loss data as part of the field as-built documentation package.

5.4.8 ***Transmitter Combiner***

The supplier shall design an appropriate number of transmitter combiners (and circulators if required) for all radio transceiver sites by optimizing the insertion loss characteristics, available number of antenna mounting locations at each site, and system availability requirements. The County requires a transmitter combiner design that is field-ready for the integration of all ten (10) County 800 MHz channels. The supplier shall integrate a combiner design that is completely frequency agile and capable of being easily re-tuned in the field. Combiners shall have no frequency-sensitive interconnection cabling and shall have no requirement for channel assignments in numerical order.

The supplier shall state the manufacturer and model number of the transmitter combiner(s) at each site and provide complete specifications and feature documentation. The supplier shall provide separate pricing for combiners designed to support specific "pre- & post-Reconfiguration" frequency agile devices, if applicable. One (1) spare transmitter combiner assembly for each unique combiner configuration shall be provided in addition to the required number of transmitter combiners. All spare equipment shall be uniquely noted and itemized by line item unit independent of the primary system equipment/pricing matrices.

5.4.9 ***Receiver Multicoupler***

STMC is currently deploying a new simulcast conventional ITAC subsystem with new RCR/Multi-couplers. Where possible, supplier shall modify/utilize existing components to the maximum extent possible. The supplier shall provide a multi-channel receiver multicoupler system for all radio transceiver sites. For greenfield sites, the County requires a receiver multicoupler design that is field-ready for the integration of all ten (10) County 800 MHz channels plus the five NPSPAC conventional mutual aid channels. Ultimately, the proposed receiver multicoupler system shall be capable of expanding to at least 30 700/800 MHz channels to maintain alignment with the required number of trunked channels offered by the network.

The supplier shall state the manufacturer and model number of the receiver multicoupler system being proposed at each site and provide complete specifications and feature documentation. The supplier shall provide separate

pricing for multicouplers designed to support specific "pre- & post-Reconfiguration" frequency agile devices, if applicable.

5.4.10 ***Receiver Pre-Amplifier***

The supplier shall provide equipment that utilizes low noise tower-top-mounted amplifiers, if needed, to provide for a balanced 800 MHz system. Redundant amplifiers and window filters shall be used in the tower-mounted assembly. The system shall have the following features:

A. Amplifier Bypass - the system shall be equipped to bypass around the amplifier system such that the main line, jumper assemblies, and antenna may be tested.

B. Hot-Standby Amplifier - the system shall be equipped with at least one hot-standby amplifier.

C. Automatic Switchover - Automatic switchover to the standby amplifier(s) shall be provided, and the means to accomplish the switchover shall be described in the response. Any performance degradation as a result of switchover shall be explained. Manual switchover shall also be provided at the control panel with indication of the amplifier in use.

D. Test Port - the system shall be equipped with a test port and test line to allow the frequency performance of either amplifier to be tested from the equipment shelter.

E. Alarming - the system shall be equipped to provide complete system operation alarming for all modes of operation to both the NMS and local on-site service technicians. The base unit of the pre-amplifier shall offer independent, front-panel LEDs to quickly gauge normal or abnormal station operation when on-site.

F. Variable Attenuation - the system shall be equipped to provide variable attenuation capabilities to uniquely optimize the receive performance characteristics at each site in the context of overall balanced system performance.

G. Power - the system power supply shall be of completely solid state design and shall operate from nominal 120 VAC/60 Hz single phase (with grounding) to be protected by an uninterruptible power supply (UPS). Optionally, a secondary -48VDC power supply is encouraged to enhance the probability of maintaining receiver pre-amplifiier during a major commercial power failure.

The supplier shall state the manufacturer and model number of the tower-top amplifier system being proposed at each site.

5.4.11 *Base Station Transceiver Design*

The supplier shall provide the following base station transceiver design information and documentation details based upon the County requirements and specifications:

- System Functional Block Diagrams
- Base Station Transceiver Architecture
- Site Topology with Proposed Connectivity and Interfaces (MNC, NMS, timing reference, multiplexer)
- System License Matrix/Structure
- Equipment Layouts/Racking and Physical Dimensions (Size, Weight, etc.)
- Equipment Electrical, Grounding, and HVAC Requirements.

5.4.12 *Base Station Transceiver Optional Features*

The supplier shall provide a detailed list and explanation of optional features for the base station transceiver subsystem that can be supplied for review and understanding.

6.0 DISPATCH CONSOLE REQUIREMENTS

6.1 GENERAL REQUIREMENTS

The supplier shall provide a complete primary radio dispatch console subsystem for St. Marys County public safety agencies to be operated in the main County 911 Emergency Communications Center. The main dispatch center shall be equipped with nine (9) dispatch positions that are networked and integrated with the proposed countywide radio communications system. Each console position shall be fully interchangeable and field reconfigurable through the NMS and a corresponding centralized dispatch subsystem configuration database. STMC requires a comprehensive suite of dispatch console features, as defined in this section and in previous sections, to interoperate with and manage the entire subscriber fleet.

The County also requires two (2) fully functional and interchangeable dispatch consoles to be located at the back-up dispatch center, a secondary, geographically diverse facility located on the existing backbone (e.g., prime site, network switch center, nearby remote RF site, etc.) for fallback communications in the event of a total ECC facility compromise. Bidders shall provide an optional quote to expand the back-up center from two to six fully operational console positions.

The supplier shall review the existing County dispatch consoles and entire complement of legacy equipment (e.g., VHF Fire Alerting Channels, 800 NPSPAC Mutual Aid Channels, Regional Fire Mutual Aid, regional control stations, Statewide EMS, etc.) to be controlled by the new dispatch consoles. The County requires a state-of-the-art communications console subsystem that is highly available and "user-friendly," incorporating radio control in a manner that shall provide for efficient and simple operation by the dispatchers in any combination of functions available. The proposed console equipment shall provide all of the necessary functions to control and monitor the countywide radio system and related subsystems. No loss of functionality shall be experienced upon migration from the existing dispatch console platform to the proposed dispatch console platform.

The supplier shall interface to the existing Zetron Model 25 paging encoders and accurately duplicate the current County VHF Tone & Voice Fire Alerting capabilities from the proposed dispatch console network. The supplier shall replicate the current permanent patch functionality between the primary 800 MHz Fire/EMS dispatch trunking talkgroup and the VHF Fire Alerting channel so that field users hear the paging tones and channel traffic on both the trunked network and designated simulcast VHF paging channel. Control station audio and control wiring at the individual Fire/EMS facilities shall replicate the current design so that the individual control stations/PA system throughout the facility continue to receive and broadcast Fire/Alerting tones and announcements.

The console system shall utilize TCP/IP over Ethernet in a client/server architecture to the greatest extent possible for maximum network flexibility, configurability, and expandibility. All consoles shall be equipped to transmit and receive with console priority on every trunked and conventional resource accessible to the console. Every dispatch console shall be equipped to transmit and receive on clear and encrypted resources (using any combination of encryption keys or algorithms deployed in the subscribers). Any console shall be equipped to intercom another console in a half-duplex or full-duplex mode. The proposed NMS subsystem shall provide complete administration and fault management control over the entire dispatch console subsystem. Radio subscriber assets and dispatch consoles shall utilize a common APCO P25 ID scheme and a common alphanumeric alias ID database. The supplier is responsible for populating all subscriber and console configuration and asset databases per the final County fleetmap prior to system cutover.

The supplier has the latitude to determine whether the proposed console subsystem shall be entirely IP-based or rooted in more traditional TDM-based console electronics architectures. Based on the County functionality and feature requirements, the supplier shall determine what platform meets or exceeds these County specifications. However, the County requires the supplier to provide complete supportability and upgradeability for fifteen years after final system acceptance as defined throughout this specification, so the supplier shall not propose any console product that is at the end of its product life cycle roadmap.

The supplier shall provide a comprehensive matrix of standard and optional features associated with the proposed console subsystem. The supplier shall provide comprehensive detail on the proposed console system architecture and any feature licensing structures all in the context of the console product life cycle roadmap. The supplier shall define all limitations and operational constraints with the proposed console system architecture. The supplier shall provide a detailed list of any special requirements needed for the installation and operation of the dispatch console equipment as deemed necessary. The supplier shall also define the compliance and overall readiness (down to the feature level) of the proposed dispatch console subsystem with respect to the APCO Project 25 E_c Dispatch Console interface.

6.2 INTERFACE TO VOICE RADIO SYSTEM

The supplier shall integrate the dispatch console subsystem with the radio system fixed infrastructure through highly available (99.9999% availability) microwave and/or fiber optic transport interfaces. The supplier shall fully identify the required network backbone transport and topology requirements to facilitate the proposed dispatch console subsystem. The supplier shall fully define all site interconnection bandwidth and throughput requirements to support the proposed dispatch console

subsystem. The network backbone timing and switching requirements shall be fully defined. The supplier shall define the proposed dispatch console subsystem's compatibility with various types of site interconnection media: microwave radio, fiber, PSTN leased line, satellite, broadband cable, etc. Private or leased telephone lines as a means for primary connectivity are not desired unless the supplier and commercial carrier can jointly demonstrate an extraordinary level of reliability relative to the operation of the PSTN circuits including the delivery of a service level agreement (SLA) that guarantees system availability at no less than 99.9999%.

Stand-by or backup radio control stations shall be incorporated into the design to ensure the ability to transmit and receive 700/800 MHz all trunked talkgroups and conventional resources in the event of a console subsystem failure. The backup control stations shall be integrated with the dispatch console electronics and equipped with both headset and handset functionality for dispatch flexibility and shall provide either a digital or tone remote control interface. PTT unit ID and alias information shall be provided to the dispatcher in all modes while operating the backup control stations. Trunking signaling information and advanced functionality tones (i.e., emergency, unit paging, individual call, etc.) shall be provided to the dispatcher in all modes while operating the backup control stations. The dispatcher shall be equipped to access all clear and encrypted 700/800 MHz trunking and conventional resources in any mode while operating the backup control stations. Backup control stations shall be physically remoted from the dispatch console position while the handset and headset interfaces are available at the dispatch console position. One (1) backup control station and associated accessories/peripherals shall be provided for each dispatch console position. Backup control stations shall be installed in a manner consistent with the installation of all other fixed network infrastructure (i.e., single point grounding, lightning/surge protection, plenum-rated cable as required, RF shielding, etc.) and the backup control stations shall have antennas mounted to reliably access the countywide network from multiple RF sites in any communications mode. All backup control station audio shall be logged at the logging recorder for all positions.

One (1) spare dispatch console and monitor with all associated electronics shall be provided for each dispatch center (i.e., primary ECC and secondary facility). One (1) spare backup control station with all associated electronics shall be provided for each dispatch center (i.e., primary ECC and secondary facility). All spare equipment shall be uniquely noted and itemized by line item unit independent of the primary system equipment/pricing matrices.

6.3 DISPATCH CONSOLE FEATURES AND PERFORMANCE REQUIREMENTS

In addition to the suite of features and functionality outlined in earlier sections, the supplier shall provide the following features, characteristics, and functionality with each proposed dispatch console and the entire subsystem:

- High quality, reliability, and availability to meet 24/7/365 continuous duty public safety dispatch standards (e.g. redundant power supplies, redundant processors, etc.)
- Meets or exceeds all FCC, EIA/TIA, IEEE and APCO standards
- Conform to local PSTN requirements as necessary
- State-of-the-art design with distributed processing and multi-tasking capability
- Redundant and fault-tolerant configuration/network server(s) with mirrored databases
- Separate electronics bank(s) with surge resistant, redundant power supplies (as required based on architecture)
- Continuous and automatic console diagnostics interfaced to proposed NMS and separate craft interface
- Digital audio processing with adjustable AGC level settings on an individual console basis
- Modular construction throughout circuitry and electronics banks (as required based on architecture)
- Main/Standby 120VAC/60 Hz power source(s) for all common infrastructure
- -Dual headset jacks (for training purposes) each with integrated telephone answering capability (switchable and independent headset interface for telephone/radio)
- Dual-pedal footswitch
- 12/24-Hour clock/month/day/year status synchronized to master network clock
- Select and Unselect speakers with adjustable volume controls for individual resources
- Physical or software-based VU meter to gauge audio levels
- 21" color plasma or LCD flat panel touch screen monitor dispatch positions with optical or wireless mouse and/or trackball and complete mounting compatibility with the proposed console furniture
- Internal and external Paging encoders and single icon/button capability that provides current VHF paging and group paging functionality with industry-standard paging formats (Quik-Call, Plectron, etc.)
- Monitor receivers (2 per console position)
- Auxiliary input/output interfaces (minimum combination of 16 inputs/outputs per position)

- Monaural, noise-cancelling, over-the-head Plantronics-style (or equivalent) headsets with integrated PTT switch and ability to switch between radio and telephone (Qty 2 total for compatibility test)
- Compatibility with Plantronics Wireless Six-Wire Headsets (P/N ML2867 A5 and ND6334 B5)
- Software-based Instant Recall Recorder/Playback application (e.g. "Call Check") with at least a 30-minute lookback for both radio and telephone audio at each dispatch and call-taker console position
- Remote dispatch position capabilities for expansion to other facilities
- User-friendly, field-reconfigurable independent GUI interface(s) for each console position
- Password-protectable console positions with comprehensive event log to note specific dispatcher time/date usage
- Full interoperability between IP-based, digital trunked, and conventional subsystems
- Interface to all proposed single and multiple site trunked and conventional systems (as required based on design)
- Fully-equipped individual conventional channel and talkgroup controls
- Access to any combination of clear/encrypted digital system talk-paths/resources
- Access to any combination of clear/encrypted conventional analog and digital system talk-paths/resources
- Interface to new logging recorder as defined in this specification (e.g trunked, conventional, and telephone resources)
- Access and control of single and multi-frequency base stations
- Console-enabled cross-patch function between trunked digital talkgroups and digital/analog conventional stations (permanent and dynamic patch equipped)
- Patch and Multi-Select with and without group regrouping
- Console-enabled announcement group functionality
- Console-enabled emergency activation/acknowledgement/reset functionality definable by talkgroup resource
- Console-enabled multiple alert tone generation (at least three unique tones 1) warble, 2) solid tone, and 3) high\low)
- Alphanumeric aliasing of all individual radio subscriber unit and console ID's
- Console-to-console intercom and console-to-base station transceiver site intercom
- Complete message activity system statistics with a selectable on-screen real-time activity display of variable call transaction length (at least 50 previous time-stamped call transactions/events)
- Console-enabled transceiver repeat-enable and repeat-disable functionality for trunked and conventional resources

- Full-duplex audio (console outbound transmit capability while receiving inbound audio from subscriber unit)
- Parallel operator usage status visual indication on each resource (i.e., busy indicate)
- Acoustic and RF cross-mute capability
- Call activity indication
- Configurable supervisory position takeover and individual position enable/disable functionality
- Independent inbound audio receive visual indication on each console resource
- Configurable time duration all-mute capability of all unselected resources
- Support for main/standby conventional resource interfaces with on-screen console switching mechanism
- General and instant transmit functionality
- PTT relay and wiring from each console position to turn on/off individual, external County-provided console activity lights
- Support for integrated PSTN-to-console interface (at least one analog phone line) so that console resources can be patched to PSTN resources and console dispatcher can utilize PSTN resources through dispatch console electronics.

6.4 DISPATCH CONSOLE CONFIGURATION AND INTERFACE REQUIREMENTS

The supplier shall provide a centralized console subsystem configuration management database that is integrated with the proposed network infrastructure and radio subscriber configuration database(s). The console subsystem shall consist of a client/server architecture that facilitates a single, common database entry (i.e., unit IDs, aliases, network access privileges, GUI/screen configurations, etc.) for radios, infrastructure, and consoles that is propagated throughout the communications network in real-time. All configuration, administrative, and alias changes shall take effect in real-time without propagation delay and/or data buffering.

The dispatch console subsystem shall be equipped to provide maximum flexibility and interchangeability for all dispatch consoles. Dispatch consoles shall be field-reconfigurable through a common configuration management application that defines GUI/screen layouts, overall subsystem functionality, console privileges, and subscriber databases. No hard-coding of functionality or features shall occur for an individual console so that each position remains flexible enough to serve any operational role in the event of crisis or console position failure. At a minimum, access to the centralized configuration management application(s) shall be provided

to both the primary dispatch facility and the secondary dispatch facility with the proper administrative logon(s).

The dispatch console GUI shall provide adequate screen resolution and useable window "real-estate" to provision all County trunking and conventional resources (i.e., mutual aid stations, paging, etc.) across multiple active folders for organizational and layout purposes. Each console position layout shall be equipped to permit/deny a dispatcher to reorganize (in real-time) console resources across organizational folders within a pre-defined screen layout template. Console layout templates shall be password-protectable (as required) to ensure that only authorized personnel have access to specific resources (i.e., encrypted resources).

Client dispatch consoles shall be equipped to function equivalently while networked to the redundant/fault-tolerant configuration management server(s) and/or while severed from the network using console layout templates and alias databases archived locally on the dispatcher client workstation. Client switching between the redundant/fault-tolerant configuration management server(s) shall be seamless and require no user intervention in the event of an online server failure. All configuration and alias databases shall be mirrored on redundant and/or fault-tolerant configuration management server(s) for maximum console subsystem availability and failure preparedness. Each console position shall provide real-time audible and visual feedback as to the networked status of the console and overall mode of system communications. All fallback modes of system communication shall be communicated to each dispatch screen in real-time so that a dispatcher's operational behavior can be adjusted as necessary to stay in constant communications with all field users.

Per logon ID, client dispatch consoles shall be equipped to disable all computer applications deemed irrelevant to the real-time voice dispatching mission. STMC requires the ability to deactivate miscellaneous computer applications (e.g., embedded games, productivity applications, network explorer, etc.) as required upon field installation so as to increase dispatch position availability and prevent dispatchers from becoming distracted while performing the real-time voice dispatching mission.

All distinct console functionality shall be defined and accessible through intuitive icons and/or user menus for quick access to necessary functionality. Each console position shall be equipped to provide the dispatcher with an embedded "Help" application that utilizes a search engine/topic index. The "Help" utility shall be configurable to turn on or off as the network administrator deems appropriate (i.e., training purposes).

Each dispatch console position shall be equipped to log the unique transaction data (i.e., time, date, resource ID, PTT-ID, alias, channel assigned, encryption status,

start of call, end of call, length of call, call type, assigned infrastructure resources, console ID, etc.) associated with every talkgroup and conventional conversation made from that console position. This transaction data shall be archived in *.csv (Comma Separated Value) or equivalent format to local and/or network repositories. The supplier shall define the availability of any dispatch console subsystem APIs that will facilitate the customization and retrieval of real-time console transaction information.

6.5 CONSOLE POSITIONS AND COMMON ELECTRONICS

6.5.1 *Description*

As necessary, the console electronics shall be housed in open, 19"-wide steel relay racks or vented cabinets in the 911 ECC Equipment Room. Adequate space for front and rear servicing shall be provided. The supplier shall provide the recommended floor space and the minimum footprint, to scale, for the proposed electronics equipment and associated hardware as well as all environmental considerations for the entire dispatch console subsystem (i.e., power requirements/consumption, heat load, physical dimensions, weight, etc.).

The console electronics shall contain the various microprocessor trunked base station transceiver and conventional mutual aid interfaces, console interfaces, auxiliary input/output functions, and other interfaces needed for proper and efficient system operation. The interface controller circuit cards shall be mounted in card cages or modular chassis. All controller cards shall be of plug-in design and shall be able to be inserted and/or removed from the card cage with both power applied and the system on-line.

To minimize dispatch operator confusion and subsequent errors, operators shall be able to perform all dispatch operations by either looking only at the LCD touch screen or with a screen-coordinated keyboard. The screen interface shall be designed to expose the operators to the minimum number of controls necessary to operate the console efficiently. The screen interface shall be implemented by a combination of the following methods: (a) optical or wireless mouse, (b) trackball, (c) keyboard, (d) touch screen monitor.

6.5.2 *Reliability*

The console system shall be designed such that no single failure point of any module or component results in a catastrophic failure, or disables more than one operator console or channel simultaneously. Reliability may be achieved through a distributed architecture, redundancy, or a combination of both. Any duplication of circuits, or multiple level redundancies, required to attain this level of performance shall be provided.

6.5.3 *Power Supply*

Electrical power losses or surges must not affect system operations or alter the system software or operating parameters at the radio dispatch positions. External power to the console shall be a nominal, single phase 120 VAC/60 Hz. AC power for all remote dispatch equipment in the dispatch centers will be backed up with a UPS and emergency generator system to be provided by the County. The supplier shall provide a detailed HVAC (BTU) and AC power load calculation matrix for all proposed electronics with their proposal.

The power subsystem for the console servers shall include hot standby power supplies. The transition from the primary to the hot standby power supply(s) shall not cause the consoles to lose and/or reset any functional and/or operational capabilities.

Console operators shall be alerted of the transition to the standby power supply(s) through the NMS and shall also be alerted of the failure of the standby power when the primary power supply(s) is in use.

6.5.4 *Auto Diagnostics/Self Healing and Diagnostic Features*

Due to the critical nature of the 911 communications services provided by the dispatchers, a high degree of reliability of the dispatch console equipment is required. The system shall be equipped with a number of self-diagnostic subsystems which shall continuously monitor and verify the correct operation of each distributed microprocessor and each audio path throughout the console electronics system, inclusive of dispatch consoles and radio system interfaces. Diagnostic capability shall be distributed among independent and redundant subsystems and shall not rely on one central diagnostic circuit.

Each message on the console electronics digital data bus shall include a Cyclic Redundancy Check or its functional equivalent. All data messages between the common console electronics equipment and individual dispatch positions shall include checksum security measures.

The console electronics shall periodically run audio diagnostics through each and every transmit and receive audio path in the system. The audio paths shall include the automatic audio level setting circuitry and the line coupling transformers. Should a console fault be detected, both the NMS and individual console workstation shall be notified through audible and visual alerts. Fault-minimizing routines shall be automatically activated and diagnostic information shall be logged on an associated NMS diagnostic printer. Diagnostic messages shall be presented in an easy-to-read text format, which shall enable non-technical dispatch personnel

to intelligently evaluate the situation and minimize disruption to normal operations. Diagnostic systems that require the dispatcher to cross-reference an error code to a fault message are not desired.

A high degree of modularity is required to reduce the number of subsystems affected by a single component failure. Repair of subsystems without totally disabling the console system shall be required, as continued console operation is necessary during repair. The common electronic assembly shall be interfaced with the NMS terminal to supply statistics and diagnostics identifying console subsystem failures and for the purpose of making service-related inquiries.

6.5.5 ***Subsystem Statistics***

The NMS terminal shall provide the following performance statistics (accessible for up to one year) on console activity by operator demand:

1. Number of PTTs by position and by talkgroup/channel
2. Total transmit time by position and by talkgroup/channel
3. Total receive time by position and by talkgroup/channel
4. Number of emergency alarms/calls by position and by talkgroup/channel
5. Number of individual calls by position and by talkgroup/channel
6. Number of telephone interconnect (as provided) calls by position and by talkgroup/channel
7. Number of system busies by position and by talkgroup/channel
8. An average of all of the above
9. List the above by hour of the day.
10. List by day of week.
11. List monthly.
12. Number of Fire/EMS pages by position.

6.5.6 *Grounding*

STMC will design a single point grounding system into all of its communications facilities for grounding connection of the supplier-provided dispatch console equipment. Exothermic welding and/or mechanical bonding shall be used to connect all equipment grounds to the single point grounding system. The supplier shall provide all grounding leads and connectors/lugs of sufficient gauge to properly bond all equipment to the single point grounding system.

6.5.7 *Dispatch Console Design*

The supplier shall provide the following dispatch console subsystem design information and documentation details based upon the County requirements and specifications:

- System Functional Block Diagrams
- Network Topology with Proposed Connectivity (LAN/WAN)
- Network Traffic Baseline/Utilization Baseline
- System License Matrix/Structure
- Equipment Layouts and Physical Dimensions
- Equipment Electrical and HVAC Requirements.

6.5.8 *Dispatch Console Optional Features*

The supplier shall provide a detailed list and explanation of optional features for the dispatch console subsystem that can be supplied for review and understanding.

6.6 OTHER REQUIREMENTS

Specific cable lengths and routing configurations will differ from each dispatch console location. The supplier shall inspect the existing dispatch center (or architectural plans as available) to investigate all requirements to ensure a fully functional dispatch console subsystem.

6.6.1 *Cabling*

The following subsections highlight the cabling requirements for console and related equipment. The supplier shall utilize this and any information obtained during the site visits (or plan review) to determine specific requirements. All cabling within the 911 ECC will be routed under raised computer flooring in cable troughs. Cabling shall be riser or plenum rated as required by the installation.

The supplier shall be responsible for all required electrical, alarm, and interface wiring to commission the dispatch console subsystem. All cabling between the common electronics, other system components, microwave transport/multiplexers, PSTN, and control lines shall be connected at a demarcation point consisting of an integrated or pre-wired connectorized panel (e.g, ADC Telecommunications, AMP, Ortronics, etc.) where feasible. Primary and secondary surge suppression shall be provided for all interface and demarcation cabling. All telephone circuits shall be equipped with surge suppression to prevent accidental damage to radio communication system and dispatch console subsystem equipment.

Circuit identification (i.e., to/from, purpose, etc.) shall be provided on all connectorized panels and cabling. All cabling shall be terminated with appropriate connectors for ease of field installation and shall be terminated to the nearest 1-foot length. All cabling used for system interconnection shall be tested during factory staging of the system. A description and detailed wiring diagram of each cable, adapter, and connectorized panel utilized shall be provided. All cabling shall be accounted for in a detailed matrix for each site and network node.

6.7 AUDIO LOGGING RECORDER (OPTIONAL)

The supplier shall provide a new computer-based, networked digital logging recorder system to be installed at the main 911 ECC and the Back Up 911 Center. The new logging recorder systems shall provide the ability to log all radio and telephone traffic in real-time. Both trunking and conventional radio traffic shall be logged by the new recorder. All dispatch console select audio and backup control stations shall also be logged by the new recorder. All call-taker 911 and administrative telephone traffic shall be logged by the new recorder. The proposed logging recorder system shall be equipped to archive radio and telephony audio traffic to various storage media: internal, redundant hard drive(s), CD-R/W, and/or DVD-R/W devices. The proposed logging recorder system shall store the real-time audio in a variable bit rate, industry-standard, digital format (i.e., WAV, AAC, MP3, AIFF, WMP, etc.) that can easily be transferred over an Ethernet-based computer network for easy playback.

6.7.1 *Logging Recorder Capacity*

The dispatch console subsystem shall provide logging recorder audio outputs for monitoring and logging dispatcher/radio traffic on a conventional radio channel basis, trunked user group basis, individual call basis and on an individual operator position basis. All recorder audio modes shall consist of transmit and receive audio for a particular radio channel/user group regardless of selected channel status of operator console. Dispatch console position audio shall consist of the operator's

transmit audio and selected receive audio. The recorded audio outputs shall be free of any control and functional tone signals.

A minimum recording capacity of any combination of 200 simultaneous sources of audio (i.e., dispatch console, trunking resources, individual calls, conventional resources, 911 telephone, administrative telephone, ringdowns, etc.) shall be provided. RAID Level 5 (or greater) hard drive storage methodology shall be utilized to provide fault-tolerant audio/data storage. The logging recorder system shall be sized to provide online and immediately accessible storage of at least 15,000 channel-hours before external storage/archival required. This storage threshold must be expandable to higher storage capacities and the supplier shall define storage options and upgrade strategies to enable greater future capacity.

6.7.2 ***Logging Recorder Network***

The new logging recorder system shall be of a client/server architecture that facilitates the access, playback, and transfer of digital audio files across a TCP/IP-over-Ethernet computer network. All of the new lookup/playback workstations shall be networked. The County strongly encourages a design in which the logging recorder subsystem applications co-exist and reside on the same client workstations as the NMS subsystem (when applicable) workstations to minimize the total number of client workstations. The logging recorder subsystem shall also be designed to facilitate a number of County-intranet client workstations to access the archived audio through a properly provisioned firewall or security appliance.

The County requires the following locations and quantities of equivalently-equipped and fully-functional logging recorder client lookup/playback workstations. At minimum, each fixed logging recorder client playback workstation shall be equipped with 21" flat-screen LCD monitor and upright, tower style workstation computer. The specific locations and quantities of fixed playback workstations include:

- ECC Supervisor Dispatch Console Position (Quantity 1)
- ECC Supervisor's Office (Quantity 1) [Requires administrative applications and privileges]
- Spare Playback Workstation (Quantity 1) [Configurable and networked to function as a spare for any stationary client workstation in the event of workstation failure.]

The client located in the Dispatch Supervisor's office will require complete network administrative rights and applications for management of the logging recorder subsystem. All three (3) of the client workstations require the comprehensive ability to lookup, playback, and write to transferable media. The County also

requires the ability for up to five (5) additional simultaneous County-intranet users (existing County computers) to have remote access/lookup/playback functionality through a secure logging recorder gateway.

All spare equipment shall be uniquely noted and itemized by line item unit independent of the primary system equipment/pricing matrices. The supplier shall propose optional incremental expansion of recorder audio outputs and simultaneous recording capacity in the design proposal. The supplier shall be responsible for fully testing and configuring all spare equipment for any of the proposed subsystems.

6.7.3 ***Logging Recorder Features and Performance Requirements***

The following list represents the minimum functionality, performance, and quality requirements that shall be included in the logging recorder system. The list is not necessarily totally inclusive of all requirements since the supplier may offer additional functionality in its standard logging recorder offering. The following section briefly defines the required functionality, performance, and quality of the specific requirements in this list:

- High quality, reliability, and availability to meet 24/7/365 continuous duty public safety dispatch standards (e.g. redundant power supplies, redundant processors, etc.)
- Meets or exceeds all FCC, EIA/TIA, IEEE and APCO standards
- Conform to local PSTN requirements as necessary
- State-of-the-art design with distributed processing and multi-tasking capability
- Redundant and fault-tolerant configuration/network server(s) with mirrored databases
- Capability for any combination of client workstations to access the logging recorder simultaneously for real-time monitoring or historical playback
- Access workstations capable of running Microsoft Windows-based operating system and archiving to CD-R/W or DVD-R/W
- Multiple search and playback techniques: console position, subscriber/console unit ID and/or alias, emergency call, talkgroup, multigroup/announcement group, individual call, telephone interconnect call, encrypted call (as required), time/date, call length, channel resource, site resource, ANI/ALI data, annotations, etc.
- Capability to package a group of independent, specific calls into a consolidated call sequence for documenting/describing a situation or event
- Capability to activate data compression to maximize data storage

- Redundant internal/mirrored hard drives or suitable automatic backup scheme to prevent loss of data
- System notification to user and network administrator that storage threshold close to being exceeded to prompt permanent archiving
- FIFO overwrite when storage threshold exceeded
- VOX-activation and/or ability to set audio level threshold for recorder activation to tailor recording style per channel/track
- Redundant 120 VAC/60 Hz power supplies for all common and core equipment
- Synchronized to master system clock
- Capable of logging any combination of system talkgroups and conventional resources per the ultimate system fleetmap
- Capability to annotate specific calls and/or call sequences using free text
- Capability to lookup call annotations for specific calls and/or call sequences
- Capability to add audible time/date stamping using a pre-recorded voice watermark
- User-friendly, field-reconfigurable independent GUI interface(s) for each lookup/playback position
- Password-protectable lookup/playback positions with comprehensive event log to note specific authorized user time/date usage
- Full interoperability between IP-based, digital trunked, and conventional subsystems.

6.7.4 ***Logging Recorder Interfaces***

The proposed logging recorder system shall provide the necessary radio and telephone interfaces to concatenate comprehensive call processing data (both radio and telephone) with the specific audio calls. Time synchronization of the logging recorder system with the master system clock and the telephone system is required so that all call sequences can reliably and accurately be re-constructed. The logging recorder system shall be equipped to receive real-time call processing data from the radio communications system and the ECC telephone system for advanced call lookup/playback functionality based on lookup criteria such as: talkgroup, channel, time, date, call length, radio/console unit ID, radio/console alias, specific call type, assigned network resources, annotations, ANI/ALI information, etc.

Logging recorder audio demarcations from the radio and telephone networks shall be made in the ECC equipment room via wall-mounted or rack-mounted punchblocks. The supplier shall provide all necessary logging recorder cabling and connectors to/from the demarcation punchblocks. The supplier shall provide all necessary radio communications system cabling and connectors to/from the demarcation punchblocks. St. Marys County will provide all necessary telephone

cabling to/from the demarcation punchblocks. The supplier shall provide all surge suppression, grounding leads, and connectors/lugs of sufficient gauge to properly bond all logging recorder equipment to the single point grounding system.

6.7.5 *Logging Recorder Management/User Partitioning*

The logging recorder subsystem shall support multiple levels of access that are protected in a manner allowing users to control, monitor and use software applications that have been partitioned and provisioned for specific use by the end-user. The supplier shall provide a detailed description of this capability by defining the levels of partitioning and security, total number of end-users, the total number of simultaneous users with independent views, and the method used to achieve this requirement.

End-users shall be located at different locations such as dispatch centers, offices, maintenance facilities, and other remote sites. Therefore, this user partitioning feature must be provided to remote locations in order to allow restricted access to the overall radio network. User functionality and passwords must be configurable through a network administrator/superuser (root level) login. Superuser (root level) login and password must be re-configurable in the event of a network security breach. The logging recorder subsystem shall provide the administrative functionality to disable in real-time specific client workstation(s) and user login(s) as necessary in the event of malicious or unwanted activity.

6.7.6 *Time Synchronization*

The proposed logging recorder subsystem shall be time synchronized using a common timing reference scheme for the entire network (i.e., GPS, NTP, WWVB, etc.). All call transactions and network alarm events shall be time/date stamped with the master system clock for accurate logging recorder call archiving. Any logging recorder internal status/error logging capability shall be synchronized to the same master system clock for accurate diagnostic and troubleshooting and correlation to NMS alarm data information. In the event of master clock failure, the logging recorder subsystem shall provide a free-running clock which is originally disciplined from the master system clocking reference. The supplier shall define the time synchronization methodology for the proposed logging recorder subsystem.

6.7.7 *Equipment Housing*

The logging recorder common equipment shall be permanently housed in an EIA/TIA standard 19"-wide steel relay rack or 19"-wide stationary steel cabinet in the 911 ECC. All logging recorder equipment shall provide a grounding lug or

connection that facilitates a single point grounding methodology within the 911 ECC. The logging recorder equipment shall provide front and rear access for cabling and service purposes. Power, audio, and data cabling interfaces to/from the logging recorder shall be supported from above using either overhead/aerial cable tray or from underneath via computer flooring.

6.7.8 *Diagnostics/Alarm Interface*

Service alignment, level setting, programming and diagnostic information of all essential logging recorder circuits/modules shall be provided through both a local and centralized (off-site location) craft interface. This functionality shall be accessible and adjustable electronically by service personnel via both an RS-232 connection and Ethernet interface. The craft interface connections shall be accessible without the need to remove chassis shields or equipment circuit boards. Any external configuration software, hardware and/or interface cables needed to perform these functions shall be specified and provided. The proposed logging recorder subsystem shall also be interfaced via SNMP and discrete alarm relays to the NMS subsystem for comprehensive diagnostic and troubleshooting through the unified NMS terminal.

6.7.9 *Logging Recorder Design*

The supplier shall provide the following logging recorder subsystem design information and documentation details based upon the County requirements and specifications:

- System Functional Block Diagrams
- Network Topology with Proposed Connectivity (LAN/WAN)
- Network Traffic Baseline/Utilization Baseline
- System License Matrix/Structure
- Equipment Layouts and Physical Dimensions
- Equipment Electrical and HVAC Requirements.

6.7.10 *Logging Recorder Optional Features*

The supplier shall provide a detailed list and explanation of optional features for the logging recorder subsystem that can be supplied for review and understanding.

6.8 DISPATCH CONSOLE SUBSYSTEM MANUFACTURING SUPPORT AND DOCUMENTATION

6.8.1 *Factory Testing*

The console system shall undergo extensive integrated factory testing with a staging and customer witness prior to shipment. This testing shall encompass all parts of the console equipment at the board level. Computer-assisted testing shall be used to assure proper operation of all circuit board components and functions furnished with the console.

6.8.2 *Dispatch Console and Logging Recorder Operator's Instruction Tutorial*

A customized dispatch console and logging recorder operator's instruction tutorial with associated embedded video demonstrations shall be clearly written and illustrated to instruct radio dispatch personnel in the proper use of all provisioned features available at the consoles. St. Marys County-specific drawings and/or photographs shall show the location of all operator controls and tools. This manual shall be provided in addition to all other installation and training manuals furnished.

A quantity of twelve (12) dispatch console and logging recorder operator's instruction tutorials shall be furnished. These instruction books shall be provided in both original file format (e.g., MS-Word, Powerpoint, Visio, Macromedia, etc.) and in *.PDF (Portable Document Format) format to be readable with the Adobe Acrobat Reader software. Twelve (12) DVD-ROM copies and twelve (12) paper hard copies shall be supplied at least one month prior to individual dispatcher training. There shall be no copy restrictions or licensing requirements for information provided as a system reference or used for training purposes.

6.8.3 *Installation and Maintenance Manuals*

The installation and maintenance manuals shall be clearly written and illustrated to instruct a radio technician skilled in the trade to unpack, assemble, and interconnect the various system components to prepare the system for operation. All base station site/console interconnect wiring, console and auxiliary function wiring shall be customized and included as part of this manual and its attachments.

The maintenance manual shall be written and illustrated such that a radio technician skilled in the trade can service any portion of the system to the component level, if desired. The manual shall include the theory of design for each unit, a schematic diagram of each assembly, assembly drawings of each circuit board, detailed part numbers where applicable, the description of each component used and the name and part number of the original component manufacturer to facilitate locating parts locally. The manual and its attachments shall include complete system configuration data, programming data, and customized as-built drawings. Where applicable, such information shall also be supplied for any items furnished as part of the system but not manufactured by the supplier. A quantity of five (5)

installation/maintenance manuals shall be furnished in both electronic and paper format. These instruction books shall be available in a *.PDF (Portable Document Format) format to be read with the Adobe Acrobat Reader software. Five (5) CD-ROM copies shall be supplied and four complete, bound paper copies shall also be provided. There shall be no restrictions or licensing requirements for information provided as reference or used for training purposes.

The console and logging recorder manufacturer (if other than the supplier) shall maintain a complete set of original, customized STMC reference documentation for the system, to be supplied upon request as individual replacement sheets or complete replacement manuals. The manufacturer shall certify that this support will be available.

Prior to system acceptance and subject to field review, the supplier shall provide customized "As-Built" drawings for all radio dispatch and logging recorder subsystem equipment supplied in response to this specification. One (1) original set of documents with reproducible drawings and four (4) complete copies shall be supplied. Five (5) CD-ROM copies shall be supplied with all as-built files provided in both original file format (e.g., MS-Word, Excel, Visio, AutoCAD, etc.) and in *.PDF format (Portable Document Format). There shall be no restrictions or licensing requirements for information provided as reference or used for training.

7.0 BACKBONE TRANSMISSION SYSTEM REQUIREMENTS

The supplier shall provide a turnkey, high capacity, primary and redundant interconnecting backbone network to connect all 800 MHz radio sites and dispatch centers into an integrated communications network. Such a system may make use of the existing STMC tower facilities as deemed feasible.

The supplier shall provide the most cost-effective solution to the County, providing that such a solution meets the reliability and availability criteria of a public safety communications system. The transmission network shall be designed with the maximum redundant path capability, such as path diversity or loop switching, etc., to insure the highest levels of availability.

The transmission network shall employ the industry standard digital hierarchy. The supplier shall provide all necessary interface equipment and cabling to interconnect the transmission network. This interface equipment shall include channel banks and multiplexers as required. The supplier shall indicate the multiplex and channel bank capacity requirements at each of the proposed sites, i.e. 1 T-1, 8 T-1, etc.

The County currently uses a daisy-chain topology 6 GHz microwave network as the backbone for its existing 800 MHz trunked simulcast system. The supplier shall research the County's existing microwave backbone in order to determine which of its existing microwave and facilities, if any, can be re-used in the deployment of the new microwave backbone, for either transitional purposes or permanent use. The supplier shall specify which components of its existing microwave backbone, if any, can be re-used in the new system deployment. Further details on the existing backbone can be obtained during the site visits.

The supplier shall provide itemized unit pricing, design methodology, system solutions, and microwave path design calculations for the purpose of allowing the County to compile information and solutions in order to support the final radio system design. The supplier shall interconnect the radio communications system with microwave and/or fiber optic facilities. The systems shall support ring redundancy, alternate routing, and future growth. The County expects that the supplier will propose the backbone infrastructure that provides the greatest amount of redundancy and reliability while meeting the capacity requirements of the network.

The supplier shall describe the entire interface, capacity, operational, and performance requirements to allow the microwave system and/or the fiber optic system to support the proposed system. The supplier shall also describe the interconnection requirements between the radio system with both the microwave and associated fiber optic systems. Items such as bit error rates, synchronization, switch timing, alternate routing, delay requirements, and any other topics that shall

affect the performance of the radio systems must be discussed and conclusively defined as part of the supplier's response.

Suppliers shall provide detailed path profiles and path availability calculations for all proposed microwave paths. The supplier is responsible for proposing all tower site selections in order to meet or exceed the County-specified two-way radio coverage specification.

7.1 DIGITAL MICROWAVE NETWORK

The requirements stated herein represent a functional specification for a new digital microwave communications network to support the next generation 800 MHz P25 digital trunked countywide radio system. The language used in the following portions of this section is predicated upon the assumption that the supplier will employ a digital microwave network to form the high capacity, system backbone. If another technology is proposed, the supplier may disregard any language related specifically to microwave media.

The supplier shall design the digital microwave system with sufficient capacity to accommodate the recommended channel requirements of the communications systems as well as provide for a minimum of 100 percent RF channel growth in 800 MHz frequencies beyond the initial stated requirements. In addition, the microwave system, if provided, shall include additional capacity in support of adjunct systems (e.g, broadband Ethernet, video, mobile data, etc.). To meet future growth requirements for networks external to the radio communications system, the supplier shall propose a digital microwave backbone with a minimum aggregate capacity of OC-3/STS-3 (155.52 Mbps data rate) based on the ANSI SONET standard. Additionally, the microwave transport system shall be equipped to multiplex/demultiplex standard DS-1 (T-1) and DS-3 (T-3) asynchronous hierarchical signals. The County also requires that the proposed digital microwave backbone be equipped to multiplex/demultiplex 10/100BaseT Ethernet at each node over the SONET backbone using a configurable number of Virtual Tributaries (VTs).

All RF site and dispatch center interconnection requirements shall be defined by the supplier, and every microwave network node shall be equipped to provide DS-1 (T-1) and associated DS0 channelized service to serve the countywide radio system and ancillary subsystems. Based on the countywide network requirements and stated growth factor, the supplier shall develop an OC-3/STS-3, DS-1 (T-1), and DS-0 microwave channel plan for the proposed high-capacity, loop microwave system. The supplier shall be solely responsible for design, integrated factory staging with County witness, field delivery and storage, field installation and optimization, and final performance verification and reliability testing of the

complete microwave system network. The new microwave system shall employ loop switching and/or path diversity for all critical systems.

The supplier shall propose a cost-effective digital microwave system ensuring network reliability and availability that is commensurate with the capacity requirements. Digital facilities provide stable, reliable, and predictable transmission routes that greatly simplify two-way radio communications system optimization and maintenance. Monitored hot standby radios shall be required for all spur or non-loop paths.

7.1.1 *Frequencies*

The RF paths determined for the digital microwave network, if utilized, should utilize Federal Communications Commission (FCC) Part 101 frequencies assigned for full-period service in the 6 GHz band. To the greatest extent possible, consideration shall be given to minimizing differences in product lines and types.

Applications for prior coordination notices, frequency coordination, and FCC licensing for all microwave radio paths shall be prepared and filed by the supplier. The results of the required frequency engineering analysis and the applications for FCC authorization shall be transmitted to St. Marys County for review and execution prior to filing with the FCC.

7.1.2 *Interfacing Requirements*

A description of all equipment and software required to interconnect the two-way radio communications system to the microwave and fiber optic network shall be included as part of the supplier's proposal. Channel banks, multiplexers, synchronization, data and bit error rate requirements, etc., are required as part of the provided information. The supplier's equipment list shall contain this interface equipment and be indicated as required for interfacing to the microwave and fiber optic system.

All electrical interfacing between channel bank and multiplexing equipment shall conform to Bellcore TR-TSY-000499, ANSI T1-102, and any other relevant specifications.

7.1.3 *Grooming*

The supplier shall specify to what extent DS-0 grooming between OC-3, DS-3, and DS-1 data rates are tolerable and any performance requirements that must be met. The supplier shall identify any constraints or limitations on aggregating multiple VTs to achieve higher data rates Ethernet circuits. STS-N concatenation capabilities shall also be defined.

7.1.4 *Routing*

The supplier shall specify routing (origination and termination of DS-0 circuits) and DS-0 capacity requirements for the proposed radio system per site. The supplier shall also specify to what extent alternate routing is tolerable and any performance requirements that must be met.

7.1.5 *Microwave System And Performance Requirements*

The microwave system needs to fully support the transport and timing requirements for the proposed 700/800 MHz RF countywide communications system. The final microwave network design shall require the network to have the following features and design parameters:

- Ring Reliability of 99.9995%
- Path Reliability of 99.9999%
- Alternate/Redundant Routing
- Grooming Capabilities
- Network Management System Interface
- Supporting Fiber Optic Interface
- Supporting Different Data Rates
- Interoperability with Different Vendor Systems
- Capable of Growth and Expansion.

7.1.6 *General Requirements*

Unless otherwise modified herein, materials, design and construction procedures shall be in accordance with the following codes as well as all federal, state and local building codes.

Installation of all electrical equipment, power distribution, lighting and outlet assemblies, alarm and grounding systems, including associated wireways and wiring, shall comply with the most recent edition of the National Electrical Code (NEC), National Fire Protection Association (NFPA), and Occupational Safety and Health Administration (OSHA).

All electrical equipment and devices shall be listed, approved, or certified by Underwriters Laboratories (UL).

All microwave radio equipment and microwave path design and construction shall comply with the latest editions of the following rules, regulations, and specifications:

Federal Communications Commission (FCC):

Rules, Part 2
Rules, Part 15, Subpart B for Class A devices
Rules, Part 101, Fixed Microwave Services.

Bellcore Technical References and Advisories and Compatibility Bulletins:

GR-1089-CORE – Electromagnetic Compatibility and Electrical Safety General Criteria for Network Telecommunications Equipment
TR-NWT-000063 – NEBS Generic Equipment Requirements
GR-NWT-000253, Issue 6 – Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria
TR-TSY-000332 – Reliability Prediction Procedures for Electronic Equipment
TR-TSY-000496, Issue 3 – SONET Add-Drop Multiplex Equipment (SONET ADM): Generic Criteria
GR-1400-CORE, Issue 1 – SONET Dual-Fed Unidirectional Path Switched Ring (UPSR) Equipment Generic Criteria
TR-TSY-000499 – Transport Systems Generic Requirements (TSGR) Common Requirements, Issue 2
TA-TSY-000752 – Microwave Digital Systems Criteria
TR-TSY-000009 – Asynchronous Digital Multiplexer Requirements and Objectives.

American National Standards Institute (ANSI) standards:

T1.105 – Digital Hierarchy Optical Interface Rates and Formats Specifications
T1.106 – Digital Hierarchy Optical Interface Specifications (single mode)
T1.102 – North American Digital Hierarchy – Electrical Interfaces
T1.403 – Extended Superframe Format Interface Specification
C37.90.1 – Surge Withstand Capability Tests
C37.90.2 – Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
TIA/EIA-222 – Structural Standards for Steel Antenna Towers and Antenna Supporting Structures
RS-252-A – Standard Microwave Transmissions Systems
TSB-10-F – Interference Criteria for Microwave systems
EIA-195 (revision C) – Electrical and Mechanical Characteristics for Terrestrial Microwave Relay System Antennas and Passive Reflectors.

7.1.7 ***Microwave Radio Requirements***

The technical requirements for the major equipment items comprising the digital microwave network are delineated in this section. Minor equipment and hardware including: wiring, connectors, cabling, fuses, circuit breakers, brackets, fasteners, power supplies, converters or conditioners, grounding kits, and other items which are necessary to provide a complete and fully-functioning system shall also be furnished by the supplier.

All equipment furnished by the supplier shall be new, meet the requirements of this specification and the manufacturer's published specifications, comply with all Federal, State, and County laws, rules, regulations, and/or ordinances, be in operable condition at the time of delivery, be finished (painted or surface treated in accordance with manufacturer's standard practices), reflect high quality workmanship throughout, and be suitable for the intended purposes delineated herein.

The equipment shall be designed and manufactured for continuous duty operation in a fixed station application, be of complete solid state design, and have an expected operational service life of at least 15 years with proper maintenance and service.

The County requires the supplier to propose a proven, high-quality design to ensure an extremely high level of reliability that anticipates and is designed to protect the network backbone against severe acts of nature and/or acts of terror. Threats of terror include potential man-made attacks upon the infrastructure or the non-proximate detonation of a nuclear device capable of emitting an electromagnetic pulse (EMP).

The following list represents the minimum functionality, performance, and quality requirements that shall be included in the digital microwave backbone system. The list is not necessarily totally inclusive of all requirements since the supplier may offer additional functionality in its standard digital microwave offering. The following sections briefly define the required functionality, performance, and quality of the specific requirements in this list:

- Available in multiple frequency bands
- Standard electrical and optical multiplexer interfaces
- Antenna coupling units
- Orderwire
- DSX cross-connect interface panels (active/passive) with in-service monitor functionality utilizing wire-wrap and/or modular connectors
- Loopback panels
- Ring protection switches
- Rack-mounted equipment
- Use of advanced Forward Error Correction (FEC) methods
- Time Domain Equalizer

- Local control, provisioning, and monitoring functions of all equipment through craft interface
- Remote control, provisioning and monitoring functions through NMS
- Automatic Transmitter Power Control
- Reverse path protection alarms and configurable path switching thresholds based on bit error rates
- Complete path switching and discrete facility resynchronization in less than 50 ms
- Physical (relays) and software (e.g., SNMP, RS232) NMS alarm interfaces
- Multiple overhead data and VF service channels
- Wayside traffic channel.

7.1.7.1 Digital Modulation Radios

The microwave radios shall be digitally modulated asynchronous units. No analog modulation radios shall be considered for this system design or offered as a solution to meeting the requirements of this specification.

7.1.7.2 Antenna Coupling Units

Antenna coupling units for RF coupling and distribution are to be provided with each microwave terminal consisting of the transmit filter, receive filter(s), waveguide branching network, and any alarm processing equipment necessary.

7.1.7.3 Use of Advanced Forward Error Correction Methods

The digital encoding scheme must utilize advanced forward error correction techniques. The method of correction must be stated and defined in the supplier's response. The supplier must state any improvements, due to error correction, to the microwave radio specifications or performance.

7.1.7.4 Time Domain Equalizer

The time domain equalizer shall provide digital feedback information for countermeasures that automatically and continuously adapt to changing atmospheric conditions, the net effect of which is to correct the inter-symbol interference caused by multi-path fading. The supplier shall state (in dB) the dispersive fade margins that are achieved by using this equalizer. The supplier shall also state how useful this method is in supplying information for clock recovery, carrier recovery and alarm indications.

7.1.7.5 Local Control and Monitoring Functions

The supplier is to provide local control and remote NMS monitoring of all microwave radios. In addition, performance monitoring of radio errors, errored seconds, severely errored seconds, BER, TX and RSL levels, etc. will be captured locally and by the NMS. Internal radio logs shall be archiveable and printable in ASCII text format at a minimum. Alarm log information shall be written to internal radio buffers on a FIFO basis with a minimum of 500 alarm events stored at any one time. All proposed microwave radio equipment shall derive time/date from the master timing source so that internal troubleshooting and diagnostic status logs are synchronized systemwide.

The microwave radios shall provide high-level diagnostic information through front-panel LEDs and relevant indicators so that a technician or network administrator can quickly gauge the severity of the radio simply by looking at the radio. The radios shall provide a comprehensive suite of alarm messages and fault conditions to the NMS through both a data stream (e.g., RS-232 and/or SNMP) and physical relays (discrete Form-C relays).

The supplier is to provide capability to monitor and control the system access port of all contiguously linked radios via a laptop PC. The user shall have access to the far end radio as well as each of the radios in the selected topology. This feature shall be totally independent of other network management and alarm systems. The supplier is to describe the offering and provide detailed information on remote monitoring functions, remote control functions software, laptop/desktop PC requirements, and method/medium of accessing this information.

The supplier must describe the manner in which local and remote programming parameters and options are performed. A description of this feature and the details associated with its operational use shall be included as part of the supplier's response. The description shall contain a list of programmable items, software options, computer access requirements, and manner of access to all of the microwave radio(s).

7.1.7.6 Automatic Transmitter Power Control

The microwave radios shall be supplied with an automatic transmitter power control. This automatic control of transmitter power will operate on the sensing of the path fade. The supplier is to provide information that defines the overall operation and the benefits that are provided to the system design.

7.1.7.7 MHSB (Monitored Hot Standby) Microwave Radios

Microwave radios used for linear spurs and fiber/microwave interconnect paths will be configured as MHSB (monitored hot standby terminals). All switching is to be hitless/errorless.

7.1.7.8 Space Diversity

Microwave radios shall be configured as space diversity paths as required to meet path reliability requirements. The space diversity receiver control system shall select the receiver with the best performance to be on line at any given time. The space diversity receiver control system shall use preemptive receiver switching by monitoring the incoming RF/IF signal for signal degradation and initiating a receiver switch before errors occur. The receiver switching shall be hitless/errorless.

7.1.7.9 Reverse Path Protection

Microwave radios configured as MHSB (monitored hot standby) shall have the capability to switch far end transmitters via a control signal through the reverse path when the BER of both receivers exceeds 10^{-5}.

Microwave radios configured as NP (non-protected) in a ring network shall have the capability to reverse the direction of the ring via a control signal through the reverse path when either a selectable BER threshold is exceeded or an AIS (alarm indication signal) is received.

7.1.7.10 Alarms and NMS Interfacing

All microwave radios shall be supplied with alarming capability. The supplier shall supply a list of alarms that are available for monitoring the microwave radios. The following list (note that any acronym or module abbreviation is used to merely describe basic card functionality and is not intended to limit, constrain, or define a specific microwave radio architecture in any manner) supplied for review and consideration and shall be considered as the minimum requirement:

- Mod/Tx A
- Demod/RXU A
- Mux Tx A
- Mux Rx A
- APC on/off
- Radio Minor
- BER A
- Mod/Tx B
- Demod/RXU B
- Mux Tx B
- Mux Rx B
- APC on/off
- Radio Major
- BER B

- RFU PSU Alarm
- TXU Alarm
- Modulator Alarm
- ATDE Alarm
- SCU Alarm
- WTU Alarm
- Summary Alarm A
- Pwr Amp on/off
- SP PSU Alarm
- RXU Alarm
- Demodulator alarm
- Mux Alarm
- OWU Alarm
- ACU Alarm
- Summary Alarm B
- SCE Fail.

All microwave radios shall be supplied with external control functionality. The supplier shall supply a list of external controls that are available for remote operation of the microwave radios. The following list (note that any acronym or module abbreviation is used to merely describe basic card functionality and is not intended to limit, constrain, or define a specific microwave radio architecture in any manner) is supplied for review and consideration and shall be considered as the minimum requirement:

- Mod/TXU A switch
- RXU/Demod A switch
- Mux/Tx A switch
- Mux/Rx A switch
- Pwr Amp on/off switch
- DS1/Ethernet Loopback
- Mod/TXU B Switch
- RXU/Demod B switch
- Mux/Tx B switch
- Mux/Rx B switch
- Pwr Amp on/off switch
- APC on/off switch.

7.1.7.11 *Power*

Power input shall be redundant, fused, -48 volts DC from an independent DC plant system with battery backup at each microwave network node. Redundant power supplies shall be provided. Optionally, a secondary 120 VAC/60 Hz power supply is encouraged to enhance the probability of maintaining microwave radio operations during a DC plant failure.

The radios shall be designed with an interlocking style power switch, protective cover, or secure cabinet so as to prevent an accidental, unintentional power-down. In the event of complete power failure, the radio shall be capable of an unattended, automatic graceful shutdown to prevent the corruption of database files and real-time operating systems. Power cabling interfaces to/from the radios shall be supported from above using either overhead/aerial cable tray or from underneath via computer flooring. The supplier shall be responsible for all required electrical and alarm wiring to commission the radio subsystem. The supplier shall provide all grounding leads and connectors/lugs of sufficient gauge to properly bond all supplier-provided equipment to the single point grounding system.

7.1.7.12 Temperature

The microwave radios shall operate over a temperature range from -30 degrees Celsius to +60 Celsius, minimum in an environment characterized by up to 90% non-condensing humidity.

7.1.8 *Antenna System Requirements*

7.1.8.1 General

The supplier shall propose all new antennas, transmission lines, mounting apparatus, and installation hardware for the digital microwave system. Solid parabolic dish antennas and jacketed copper elliptical waveguides shall be proposed. Antenna system VSWR shall be commensurate with the return loss specification of the supplier's microwave radio. The supplier shall perform line sweeps for all transmission line systems and provide the comprehensive sweep and alignment data as part of the field as-built documentation package.

The supplier shall furnish standard four-inch microwave pipe mountings and stiff-arm brackets, as required, for support of the microwave antennas. Additionally, should the supplier require any special mountings, mounting brackets, or apparatus for installation of antennas furnished under the contract, the supplier shall furnish the necessary equipment, hardware, labor, and procedures to securely attach the microwave antennas. The supplier is responsible for performing all structural analysis and site survey work to properly and safely implement the entire microwave antenna system.

7.1.8.2 Microwave Dishes

All microwave dishes shall meet Category "A" Regulatory Compliance requirements in accordance with FCC Rules, Part 101, Fixed Microwave Services.

All microwave dishes, including standard, high performance, and maximum or ultra high performance types, shall be provided with protective radomes.

Specific attention shall be given to intra-system interference, and Category A or high performance antennas shall be used to preclude intersystem interference.

All microwave dishes, regardless of size and frequency band shall be provided with stiff-arm bracing for mounting. Ice shields shall be provided with all mounting hardware for each size of microwave dish. Stiff-arm

bracing and ice shield mounts shall be attached to the tower in accordance with the requirements of the tower and microwave dish manufacturers.

7.1.8.3 Elliptical Waveguide

All elliptical waveguide provided shall be of premium quality, using pre-tuned connectors, low VSWR, rigid and flexible waveguide sections that allow a measurable return loss equal to or greater than 23 dB, with the return loss being the level of the reflected signal with respect to the incident signal in dB. Each waveguide shall include connectors, hangers, ground kits, flexible jumpers, waveguide entrance boots, mounting, and miscellaneous installation hardware. Jacketed copper elliptical waveguide shall be employed in continuous lengths for all transmission line runs and shall be installed in accordance with manufacturers' specifications. Cable splicing is not permitted. Flex waveguide shall not be used outdoors. Waveguide shall be Andrew Corporation EW Series (or functional equivalent). Using properly calibrated test equipment, the supplier shall provide sweep test and distance-to-fault test results and plots for each elliptical waveguide run installed for the microwave subsystem.

7.1.8.4 Waveguide Pressurization/Dehydrator Equipment

Dynamic waveguide pressurization equipment, consisting of an automatic dehydrator, line monitor, and accessory equipment, shall be provided for every microwave terminal and associated transmission line system.

The dehydrator shall be selected that provides the necessary volume for the waveguide(s) and feedhorn(s) plus an anticipated leak rate of 1%, and provide sufficient capacity to maintain a pressure during a 19°C (35° F) temperature drop in 60 minutes.

The pressure inside a waveguide system must be maintained at a positive pressure level and below the maximum pressure ratings of the components in the system. All dehydrators shall perform automatic regeneration of desiccant.

Separate pressure metering shall be provided for each waveguide pressurized. The pressurization system shall be an Andrew MT-050-101 Series Dry Line dehydrator with an ML Series Line Monitor (or equivalent), mounted in an EIA 19-inch rack or wall-mounted shelf.

All supplied dehydrators shall provide the following alarm relay indications to the NMS:

- Low Pressure
- High Pressure
- Excessive Run
- High Humidity
- Loss of Power.

7.1.9 ***Orderwire***

Service channel facilities are to be provided in each microwave terminal. The service channel shall be the means for transmitting voice (orderwire), protection switching, and maintenance (monitoring alarm and control) information between terminals of a microwave path. The service channel shall be digital and provide for a minimum of two (2) VF circuits and two (2) RS-232C data circuits. The service channel shall be implemented without external interface equipment and shall be protected in such a way as to prevent its loss due to the failure of just one specific radio channel.

Orderwire facilities are to be provided in each microwave terminal. The service channel shall transport the orderwire. The orderwire shall provide party-line voice communications between all stations of the microwave network.

The orderwire shall include a speaker, DTMF signaling, and a handset. The orderwire shall be capable of inter-station signaling with an audible output separate from the voice signal, with broadcast and uniquely addressable, selective signaling capability from each station to any other station.

The orderwire equipment at each station shall be a two-way bridge on the 4-wire orderwire circuit, with 600-ohm resistive balanced input and output impedance. Two (2) additional 4-wire ports for 600-ohm VF connections shall be provided. The orderwire interface shall provide level-setting circuitry to adjust and customize the volume independently at each microwave node as necessary.

In the event of a microwave radio failure at any site in a ring network, the orderwire should continue to function around the ring network. A failure of a single site should not interrupt orderwire or data channel service between other functioning sites.

7.1.10 ***High-Speed Multiplexer***

7.1.10.1 General

Depending upon the supplier's hardware configuration options, the multiplex arrangement at each site may be implemented in several ways to achieve the ultimate line rate. The supplier shall provide the most economical method to meet the overall OC-3/STS-3 capacity requirements, RF channel expansion requirements, and all other requirements delineated by this specification. Separate DSX cross-connect jack fields shall be provided if not an integral part of the multiplexer equipment.

For all sites, the multiplexer shall be integrated with the microwave radios through standard optical or electrical interfaces. Remote loopback capability shall be provided so that individual DS-1 and Ethernet facilities may be looped back for testing and troubleshooting purposes. Multiplexers may be furnished in the following configurations as required by the supplier's system design:

- Single end terminal
- Dual terminal
- Add/drop terminal.

7.1.10.2 Protection

The high speed multiplex level shall have 1:1 switched protection. The low speed levels shall have 1:N protection at a minimum.

Transmit and receive functions shall be treated independently. The protection switching shall be fully automatic and microprocessor controlled. Power supplies common to the cards shall be protected and redundant. All cards or modules shall be "hot" replaceable, with no one card responsible for more than fourteen (14) DS-1 circuits or four Ethernet connections. The multiplexer CPU or microprocessor card shall be protected through redundancy, as a multiplexer CPU failure shall not render the multiplexer inoperable. No single point of failure shall exist in the multiplexer implementation as the supplier shall incorporate the necessary redundancy or fault tolerance for all multiplexer elements to eliminate any single point of failure.

7.1.10.3 Mounting

The multiplexer shall mount in the same or similar steel 19"- or 23"-wide steel relay rack as the microwave RF terminals. Integral (to the RF terminal) multiplexers may be utilized. The supplier shall deliver scaled rack layout diagrams that define the location of all racked equipment as well as a scaled floor space layout diagram based on 2-ft. by 2-ft. footprints as

part of the microwave backbone subsystem design. Battery banks, DC rectifiers and other equipment floor space layouts must also be provided.

7.1.10.4 Power

Power input shall be fused, -48 volts DC or may be supplied from the microwave RF terminal power source when integral to the radio. Redundant power supplies shall be provided. Optionally, a secondary 120 VAC/60 Hz power supply is encouraged to enhance the probability of maintaining multiplexer operations during a DC plant failure.

The multiplexers shall be designed with an interlocking style power switch, protective cover, or secure cabinet so as to prevent an accidental, unintentional power-down. In the event of complete power failure, the multiplexer shall be capable of an unattended, automatic graceful shutdown to prevent the corruption of database files and real-time operating systems. Power cabling interfaces to/from the multiplexers shall be supported from above using either overhead/aerial cable tray or from underneath via computer flooring. The supplier shall be responsible for all required electrical and alarm wiring to commission the multiplexer subsystem. The supplier shall provide all grounding leads and connectors/lugs of sufficient gauge to properly bond all supplier-provided equipment to the single point grounding system.

7.1.10.5 Temperature

The multiplexer shall operate over a temperature range from -30 degrees Celsius to +60 Celsius, minimum in an environment characterized by up to 90% non-condensing humidity.

7.1.10.6 Synchronization

Suppliers shall propose a comprehensive design for master network timing and synchronization of the countywide radio communications system. All microwave backbone elements and transport equipment shall be synchronized to the master timing source(s). The master timing source(s) shall be GPS-based with high stability, hot standby backup crystal oscillators. Redundancy shall be designed into the master timing source design to the greatest extent possible.

Primary and secondary Stratum 1 timing should be provided for the system and transport infrastructure to guarantee network synchronization. Each multiplexer shall be equipped to synchronize and derive timing from: (1) the external master clock reference (primary mode), (2) line timing from any

OC-3 line source, and (3) an internal Stratum 3 clock (fallback mode). The multiplexer shall support synchronization status messaging (SSM) to maintain proper timing in the event of network or node failure.

Internal multiplexer equipment clocks shall also be synchronized to the master timing source time/date clock for synchronization of diagnostic and failure tracking for internal equipment status logs. All proposed microwave backbone equipment shall derive time/date from the master timing source so that troubleshooting and diagnostic status logs are synchronized systemwide.

7.1.10.7 Alarms

The multiplexer shall provide alarms for key operational parameters, and shall provide for remote inquiry display, disablement and diagnostic functions via RS232 and Ethernet connections. Alarms shall be displayed at all NMS workstations and through craft interfaces. The multiplexer shall provide high-level diagnostic information through front-panel LEDs and relevant indicators so that a technician or network administrator can quickly gauge the severity of multiplexer simply by looking at the multiplexer. The multiplexer shall provide a comprehensive suite of alarm messages and fault conditions to the NMS through both a data stream (e.g., RS-232 and/or SNMP) and physical relays (discrete Form-C relays).

The multiplexer shall provide Critical, Major, and Minor relays which shall be connected to the NMS. All multiplexer alarm information shall be time/date stamped in synchronization with the master network clock. Internal multiplexer logs shall be archiveable and printable in ASCII text format at a minimum. Alarm log information shall be written to internal multiplexer buffers on a FIFO basis with a minimum of 500 alarm events stored at any one time.

The high speed channel failure (switching) and loss of power shall generate a Critical alarm. A low speed channel failure (switching) and individual power supply/converter failure shall generate a Major alarm. The supplier shall state all other alarms provided from the multiplex equipment. In the event of a microwave radio failure at any site in a ring network, the multiplexer should continue to function around the ring network. A failure of a single site should not interrupt the multiplexer's ability to provide uninterrupted DS-1 and Ethernet facilities between other functioning sites.

7.1.10.8 DSX Panels – Active and Passive

DSX panel(s) is/are to be provided at every microwave and radio system site. The DSX panel(s) is/are to serve as the demarcation points between the microwave network and the 800 MHz two-way radio system, and the DSX panel(s) will interface the standard D4 PCM/TDM channel bank(s) or networking WAN circuits (as applicable per the system design) to the high-speed OC-3/STS-3 multiplexing equipment.

The DSX panel(s) is/are to be either passive, with hardwired cross connects between DS-1 inputs and outputs, or active, with software-configured cross connects between DS-1 inputs and outputs. The DSX panels are to include break/make jacks to allow loopback and DS-1 channel reconfiguration capabilities for each DS-1 channel in both the line (to the multiplexer) and equipment (to the channel bank) directions. The DSX panels are also to include monitor jacks for each DS-1 channel. DSX cross-connect panels shall include standardized, modular snap-in connection (RJ48) or wire-wrap interfaces using RF-shielded and grounded cabling at all times to prevent EMI to the microwave backbone facilities. Standardized, modular snap-in connection (RJ48) interfaces are preferred whenever feasible.

7.1.10.9 *Loopback Panels*

Loopback panels or jackfields are to be provided with every microwave terminal. The loopback panels are to include break/make jacks to allow loopback capabilities for each DS-1, DS-2, and DS-3 channel(s) in both the line and equipment directions. The DSX panels are also to include monitor jacks for each DS-1, DS-2, and DS-3 channel. A set of four (4) loopback plugs or patch cables shall be provided for every microwave network node to facilitate facility testing and optimization.

7.1.10.10 *Ring Protection Switches*

All microwave terminals configured in a ring network shall include a ring protection switch. The ring protection switch can either be a separate unit or be integrated with the multiplexing equipment. The ring protection switch shall switch each individual circuit/facility between the working and protected directions. The ring protection switches shall be able to be configured for either revertive or non-revertive switching for each DS-1 and Ethernet circuit. The switching threshold for each circuit shall be selected for either a specific measured BER (a minimum BER range from 10^{-7} to 10^{-3}), an AIS signal, or a complete loss of signal.

7.1.10.11 *Craft Interface*

The multiplexer shall support two distinct and independent types of craft interfaces for remote and local provisioning and troubleshooting. The multiplexer shall support an RS-232 (VT100) style craft interface for a local or remote (if proper modem is utilized) terminal session craft interface to enable a technician or network administrator to provision or troubleshoot the multiplexer. The multiplexer shall also support an Ethernet style craft interface for a local or remote (if network connectivity exists) TCP/IP craft interface to enable a technician or network administrator to provision or troubleshoot the multiplexer. The ability to provision or troubleshoot the multiplexer through either interface shall not be dependent on the other interface being available. All craft interfaces shall provide password protection security. The multiplexer shall be equipped to receive software upgrades/patch fixes through the craft interfaces, and the multiplexer shall be capable of being upgraded without having to degrade or disturb the real-time traffic services provided by the multiplexer. The multiplexer shall provide archive functionality for all configuration, provisioning, and troubleshooting parameters using standard storage media such as CD-R/W, DVD-R/W, DAT, etc. In the event of complete multiplexer failure, the restoration and/or commissioning of new, replacement multiplexer shall be accomplished using archived provisioning/configuration images rather than requiring a technician to completely re-construct the configuration database from scratch. The supplier shall fully define the provided capabilities with respect to the multiplexer craft interfaces.

7.1.11 ***Channel Bank Equipment***

7.1.11.1 General

This section states the basic requirement for "D4" type PCM channel bank equipment. The County recognizes that other equipment is available to the system designer to provide the service drops, routings, and protection required to accomplish system connectivity. The County also recognizes that networking solutions for wide area communications systems may require routing and use of entire DS-1 circuits as well as fractional T-1 facilities.

The use of intelligent channel banks and external DACS equipment is permitted to achieve the most flexible and cost-effective solution to the basic network requirements and subsequent expansion. Should the supplier propose alternative equipment to the standard D4 channel bank, the supplier must fully document and independently price these items. The proposed channel bank shall provide up to eight (8) T-1/E-1 WAN interfaces and all channel banks shall be equipped to provide internal software-defined cross-

connects at a DS-0 (T-1 timeslot) level between any of the eight (8) T-1/E-1 WAN interfaces.

PCM channel bank equipment shall be provided that is compatible with AT&T "D4" type channel bank equipment. Channel banks shall be provided at each site to meet the requirements of the network channel plan. Single channel codecs shall be mounted on plug-in cards. The proposed channel bank shall accommodate voice circuits, data circuits, or any mixture of the two in a single D4 channel bank. The basic requirement is for 24 channels, either VF, data, or both, to occupy one DS-1 channel. VF channel sampling shall be 8,000 samples per second, PCM word length shall be eight bits, and companding shall feature mu-law compression, μ=255.

The channel bank shall interface with the proposed multiplexers as previously specified.

7.1.11.2 *PCM Voice Channel Units*

Several types of VF circuits shall be available as circuit boards which plug into flexible, reconfigurable card slots in the channel bank. The types supplied shall satisfy the channel requirements denoted herein. The technical parameters for 2-wire and 4-wire channel units shall be as follows:

VF	**4-W**	**2-W**	**Condition**
Input	-16 dBm	0 dBm	Nominal
Output	+ 7 dBm	-2 dBm	Nominal
Adjustable	± 4 dB	±2 dB	Minimum
Impedance	600 ohms	600/900 ohms	Nominal
Frequency Response	± 0.3 dB	+0.5 to -1.0dB	300-3000Hz (ref. 1kHz)
Return Loss	23 dB	Min.@1000 Hz	
Echo Return Loss	28 dB	Min.@1000 Hz	
IDLE Channel Noise	23 dBrncO	23 dBrncO	Maximum
Crosstalk	65 dB	65 dB	Minimum
SF Distortion	-40 dBmO	-40 dBmO	Maximum
E&M DP Distortion	4 percent	4 percent	Maximum

The following circuit arrangements shall be available as required:

- 4-wire E&M, 600 ohm
- 2-wire E&M, 600, 900 ohm
- 2-wire, 20 Hz Ringdown
- 2-wire FXS
- 2-wire FXO.

**Legend: FXO - Foreign Exchange Office
FXS - Foreign Exchange Subscriber

7.1.11.3 Data Channel Units

Data channel units shall be available as plug-in circuit boards for the channel bank. The following circuit types shall be available:

OCU-DP	Configurable Bit Rate (2.4, 4.8, 9.6, 19.2, 56.0, and 64 kbps) Office Channel Unit-Data Port
RS-232/V.24	Configurable, Multi-Port Asynchronous/Synchronous Sub-Rate (a, b-5, b-10 framing) Data Channel Unit (0.3, 2.4, 4.8, 9.6, 19.2, 38.4, and 56.0 kbps)
V.35/RS-449/RS-530	Configurable Bit Rate (Fractional T-1/T-1), Multi-Port High-Speed Data Card
Frame Relay	Configurable Bit Rate (56, 64 kbps), Multi-Port Frame Relay Data Card.

7.1.11.4 Simulcast Channel Units

Regarding simulcast technology for the 800 MHz System solution, the County recognizes that VF/Data/DS-1 requirements for land mobile simulcast applications may require specialized codecs and/or channel bank equipment to meet stringent specifications for bandwidth, differential gain, differential phase, amplitude, absolute phase delay, and distortion. As such, the supplier shall have latitude in proposing the channel bank equipment necessary to satisfy any simulcast requirement of this specification. However, to the extent the supplier's proposed equipment differs from the D4 type channel bank equipment specified herein, the supplier shall fully support this offering with sufficient technical, engineering, and theoretical documentation to permit a thorough understanding of the approach and design methodology taken. Additionally, any changes in simulcast phase delay due to circuit routing changes brought about by loop/ring switching, DACS re-routing, path fade, etc., shall be automatically and internally compensated and not requiring any manual technician intervention.

7.1.11.5 Protection

No single point of failure shall exist in the channel bank implementation as the supplier shall incorporate the necessary redundancy or fault tolerance for all channel bank circuit cards or elements to eliminate any single point of failure. The channel bank CPU or microprocessor card shall be protected through 1:1 redundancy, as a channel bank CPU failure shall not render the

channel bank inoperable. The circuit and associated T-1/E-1 WAN interface cards shall be protected through 1:N redundancy, as a circuit card failure shall not render the channel bank inoperable. Power supplies common to the cards shall be protected and redundant.

7.1.11.6 Jackfields/Physical Interfaces

Circuit card and WAN interfaces shall utilize industry standard 25-pair amphenol (RJ27), EIA/TIA DB-style (DB-9, DB-15, DB-25), BNC, or modular connectors (RJ11, RJ45, RJ48, etc.) for physical interface demarcations. Standardized, modular snap-in connection (RJ48) and interface panels are preferred whenever feasible.

Bantam type telephone jackfields shall be provided for access to the 2-wire and 4-wire DS-0 VF terminals and signaling leads. Jackfields may be integral to the codecs or may be separate rack mount units. Operation of the jackfield shall be such that it is possible, with the proper cable and plug assembly, to (1) bridge across any VF line for monitoring purposes, (2) disconnect the drop side of any VF jack for the purpose of "looking" directly into the VF line, and (3) disconnect the line side of any VF jack for the purpose of looking directly into the codec.

7.1.11.7 Mounting

The channel bank shall mount in the same or similar steel 19"- or 23"-wide steel relay rack as the microwave RF terminals and multiplexers (as applicable). The supplier shall deliver scaled rack layout diagrams that define the location of all racked equipment as well as a scaled floor space layout diagram based on 2-ft. by 2-ft. footprints as part of the microwave backbone subsystem design. Battery banks, DC rectifiers and other equipment floor space layouts must also be provided.

7.1.11.8 Power

Power input shall be fused, -48 volts DC and shall be sourced from the same DC power supply system that feeds the microwave radios and multiplexer equipment. Redundant power supplies shall be provided. Optionally, a secondary 120 VAC/60 Hz power supply is encouraged to enhance the probability of maintaining channel bank operations during a DC plant failure.

The channel bank(s) shall be designed with an interlocking style power switch, protective cover, or secure cabinet so as to prevent an accidental, unintentional power-down. In the event of complete power failure, the

channel bank shall be capable of an unattended, automatic graceful shutdown to prevent the corruption of database files and real-time operating systems. Power cabling interfaces to/from the channel bank(s) shall be supported from above using either overhead/aerial cable tray or from underneath via computer flooring. The supplier shall be responsible for all required electrical and alarm wiring to fully commission the microwave and channel bank subsystem. The supplier shall provide all grounding leads and connectors/lugs of sufficient gauge to properly bond all supplier-provided equipment to the single point grounding system.

7.1.11.9 Temperature

The channel bank shall operate over a temperature range from -30 degrees Celsius to +60 Celsius, minimum in an environment characterized by up to 90% non-condensing humidity.

7.1.11.10 Synchronization

Suppliers shall propose a comprehensive design for master network timing and synchronization of the countywide radio communications system. All microwave backbone elements and transport equipment shall be synchronized to the master timing source(s). The master timing source(s) shall be GPS-based with high stability, hot standby backup crystal oscillator. Redundancy shall be designed into the master timing source design to the greatest extent possible.

Primary and secondary Stratum 1 timing should be provided for the system and transport infrastructure to guarantee network synchronization. Each channel bank shall be equipped to synchronize and derive timing from: (1) the external master clock reference (primary mode), (2) line timing from any DS-1 line source, and (3) an internal Stratum 3 clock (fallback mode).

Internal channel bank equipment clocks shall also be synchronized to the master timing source time/date clock for synchronization of diagnostic and failure tracking for internal equipment status logs. All proposed microwave backbone equipment shall derive time/date from the master timing source so that troubleshooting and diagnostic status logs are synchronized systemwide.

7.1.11.11 Alarms

The channel bank shall provide alarms for key operational parameters, and shall provide for remote inquiry display, disablement and diagnostic functions via RS232 and Ethernet connections. Alarms shall be displayed at

all NMS workstations and through craft interfaces. The channel bank shall provide high-level diagnostic information through front-panel LEDs and relevant indicators so that a technician or network administrator can quickly gauge the severity of channel bank simply by looking at the channel bank. The channel bank shall provide a comprehensive suite of alarm messages and fault conditions to the NMS through both a data stream (e.g., RS-232 and/or SNMP) and physical relays (discrete Form-C relays).

The channel bank shall provide Critical, Major, and Minor relays which shall be connected to the NMS. The channel bank shall provide standard AIS, CGA-RED, CGA-YEL, LOS, EER T-1 facility alarming. The channel bank shall provide individual circuit card alarms. Channel bank alarms shall be capable of being filtered and alarm thresholds configurable (as feasible) so as to customize the alarm reporting of the channel bank. All channel bank alarm information shall be time/date stamped in synchronization with the master network clock. Internal channel bank logs shall be archiveable and printable in ASCII text format at a minimum. Alarm log information shall be written to internal channel bank buffers on a FIFO basis with a minimum of 500 alarm events stored at any one time.

The supplier shall state all other alarms provided from the channel bank equipment. In the event of a microwave radio failure at any site in a ring network, the channel bank should continue to function around the ring network. A failure of a single site should not interrupt the channel bank's ability to provide uninterrupted DS-1 and data/voice facilities between other functioning sites.

7.1.11.12 *Craft Interface*

The channel bank shall support two distinct and independent types of craft interfaces for remote and local provisioning and troubleshooting. The channel bank shall support an RS-232 (VT100) style craft interface for a local or remote (if proper modem is utilized) terminal session craft interface to enable a technician or network administrator to provision or troubleshoot the channel bank. The channel bank shall also support an Ethernet style craft interface for a local or remote (if network connectivity exists) TCP/IP craft interface to enable a technician or network administrator to provision or troubleshoot the channel bank. The ability to provision or troubleshoot the channel bank through either interface shall not be dependent on the other interface being available. All craft interfaces shall provide password protection security. The channel bank shall be equipped to receive software upgrades/patch fixes through the craft interfaces, and the channel bank shall be capable of being upgraded without having to degrade or disturb the real-time traffic services provided by the channel bank. The channel bank shall

provide archive functionality for all configuration, provisioning, and troubleshooting parameters using standard storage media such as CD-R/W, DVD-R/W, DAT, etc. In the event of complete channel bank failure, the restoration and/or commissioning of new, replacement channel bank shall be accomplished using archived provisioning/configuration images rather than requiring a technician to completely re-construct the configuration database from scratch. The supplier shall fully define the provided capabilities with respect to the channel bank craft interfaces.

7.1.12 ***DC Power Plant***

7.1.12.1 General

Microwave station equipment shall be powered by a -48-volt (positive ground) battery-powered supply furnished by the supplier. The DC plant system shall include rectifiers, batteries, battery mounting or racking facilities, float-type battery chargers, battery monitoring equipment, low voltage disconnect, and DC load center with independent circuit breaker control.

When sizing the -48 VDC DC plant system, the supplier shall consider the initial load of the equipment specified in this project, plus a growth factor equivalent to a 50% total DC load expansion. The emergency battery runtime for the DC plant system shall be a minimum of eight (8) hours at each microwave network node assuming the initial and future expansion load criteria and all system equipment to be served by the -48VDC system.

7.1.12.2 Batteries

Modular stationary batteries shall be the sealed maintenance-free type with sufficient ampere-hour capacity to provide a minimum eight (8) hour continuous duty operating period for the supplier-furnished microwave station equipment (plus the 50% DC load expansion) following the loss of primary station commercial power. The ampere-hour rating of the batteries shall be based on an eight-hour discharge rate. Battery life expectancy shall be at least twenty (20) years in normal float-type service. No venting facilities or special battery rooms shall be required for normal operating conditions. Batteries shall be GNB Industrial Battery Company Absolyte IIP series, or engineer-approved equivalent. For the purposes of reliability and flexibility in maintenance, the battery plant shall be configured in two strings with 50% of the total capacity in each string. A maintenance disconnect switch shall be placed in series with each string.

Secure mounting facilities and shields shall be incorporated in the design of the battery bank including protection from ruptured battery cells. Batteries shall be rack-mountable in the same 19"- or 23" wide steel EIA/TIA steel relay racks used for the microwave radios and ancillary equipment. The supplier shall furnish the HVAC, AC, rack profiles/layouts, and floor loading requirements for each microwave backbone rack so as to properly equip the designated facilities.

7.1.12.3 *Battery Chargers*

Battery chargers shall provide sufficient current output to supply station load requirements (plus a 50% DC load expansion over the immediate requirement) and simultaneous charging of a discharged battery bank to full capacity in 24 hours. Battery chargers shall be capable of battery eliminator operation. The chargers' rectifier modules shall be provided on a redundant N+1 basis. The charger shall operate in ambient temperatures of 0 degree C to +50 degree C.

Rectifier modules shall be fed by redundant 208 or 240 VAC commercial power feeds, as appropriate to the site of installation. Rectifier modules shall be of a modular design and hot-swappable in the event of failure. The supplier shall be responsible for all required electrical, alarm, and interface wiring to commission the DC plant subsystem.

The battery chargers shall be rack-mounted in a 19"- or 23" wide EIA/TIA steel relay racks. The battery chargers shall be provided with an AC circuit breaker, DC circuit breaker, minimum two-percent accuracy DC voltmeter and DC amp meter, current limiting and high voltage shutdown circuitry, continuous float and equalizing voltage adjustment, and 24-hour equalizing timer. These features may be integral to the chargers or provided in separate rack mount assemblies. Each rectifier/charger assembly shall have the following minimum alarm points to be captured by the NMS:

- Major alarm
- Minor alarm
- Battery on discharge
- Low Voltage Disconnect
- AC power failure
- Rectifier module failure (one for each specific rectifier)
- Battery charger low voltage
- Battery charger high voltage
- Battery charger no charge.

7.1.12.4 DC Load Center

A rack-mounted DC load center with individual DC circuit breakers shall be provided with the battery power system to provide a protected DC distribution to all -48 volt DC-powered telecommunications equipment. Additionally, the supplier shall furnish and install a minimum of five spare DC circuit breakers of the same type/rating supplied on the breaker panel for future use.

7.1.12.5 Low Voltage Disconnect

To protect the battery supply, an automatic low-voltage disconnect shall be provided to remove the load from the battery bank at the point when the battery voltage reaches a preset, configurable dropout voltage level.

7.1.13 *Spares*

The supplier shall provide a recommended spares complement for all critical digital microwave system network elements. Such a spares complement shall include at a minimum: (a) one (1) complete high-speed multiplexer configuration assembly for every five (5) microwave network nodes; (b) one (1) complete channel bank configuration assembly for every five (5) microwave network nodes; (c) one (1) complete DC plant rectifier/charger configuration assembly for every five (5) microwave network nodes; (d) one (1) complete dehydrator configuration assembly for every five (5) microwave network nodes; and (e) three (3) complete microwave radio spares packages (e.g., transmitter, receiver, alarm card, CPU, service channel card, power supply, filters, orderwire, fuse/alarm panel, signal processing cards, etc.).

All spare equipment shall be uniquely noted and itemized by line item unit independent of the primary system equipment/pricing matrices.

7.1.14 *Cabling*

The following detail highlights the cabling requirements for the microwave backbone system and related equipment. The supplier shall utilize this and any information obtained during the site visits to determine specific requirements. Most, if not all, cabling within the RF shelters will be routed overhead in cable trays. Specific facilities such as the 911 ECC may require that cabling be riser or plenum rated as required by local code so the supplier shall be responsible for adhering to applicable regulations.

The supplier shall be responsible for all required electrical, alarm, and interface wiring to commission the microwave backbone system. All cabling between the common electronics, other system components, microwave transport/multiplexers and radios, PSTN, and control lines shall be connected at a demarcation point consisting of an integrated or pre-wired connectorized panel (e.g, ADC Telecommunications, AMP, Telect, etc.) where feasible. Primary and secondary surge suppression shall be provided for all interface and demarcation cabling. All telephone circuits shall be equipped with surge suppression to prevent accidental damage to radio communication system and microwave backbone system equipment.

Circuit identification (i.e., to/from, purpose, etc.) shall be provided on all connectorized panels and cabling. All cabling shall be terminated with appropriate connectors for ease of field installation and shall be terminated to the nearest 1-foot length. All cabling used for system interconnection shall be tested during factory staging of the system. A description and detailed wiring diagram of each cable, adapter, and connectorized panel utilized shall be provided. All cabling shall be accounted for in a detailed matrix for each site and network node.

7.1.15 ***Documentation***

The installation and maintenance manuals shall be clearly written and illustrated to instruct a radio technician skilled in the trade to unpack, assemble, and interconnect the various system components to prepare the system for operation. All microwave backbone system and auxiliary function wiring shall be customized and included as part of this manual and its attachments.

The maintenance manual shall be written and illustrated such that a radio technician skilled in the trade can service any portion of the system to the component level, if desired. The manual shall include the theory of design for each unit, a schematic diagram of each assembly, assembly drawings of each circuit board, detailed part numbers where applicable, the description of each component used and the name and part number of the original component manufacturer to facilitate locating parts locally. The manual and its attachments shall include complete system configuration and software/hardware version data, programming and cross-connect provisioning data, and customized as-built drawings. Where applicable, such information shall also be supplied for any items furnished as part of the system but not manufactured by the supplier. A quantity of five (5) installation/maintenance manuals shall be furnished in both electronic and paper format. These instruction books shall be available in a *.PDF (Portable Document Format) format to be read with the Adobe Acrobat

Reader software. Five (5) CD ROM copies shall be supplied and four complete, bound paper copies shall also be provided. There shall be no restrictions or licensing requirements for information provided as reference or used for training purposes.

The microwave backbone system manufacturer (if other than the supplier) shall maintain a complete set of original, customized STMC reference documentation for the system, to be supplied upon request as individual replacement sheets or complete replacement manuals. The manufacturer shall certify that this support will be available.

Prior to system acceptance and subject to field review, the supplier shall provide customized "As-Built" drawings for all microwave backbone system equipment supplied in response to this specification. One (1) original set of documents with reproducible drawings and four (4) complete copies shall be supplied. Five (5) CD-ROM copies shall be supplied with all as-built files provided in both original file format (e.g., MS-Word, Excel, Visio, AutoCAD, etc.) and in *.PDF format (Portable Document Format). There shall be no restrictions or licensing requirements for information provided as reference or used for training.

7.1.16 *Test Equipment*

The supplier shall provide a complete recommendation, with associated unit cost pricing, of microwave backbone system test equipment required to properly service the proposed digital microwave system. Such a test equipment list may include: spectrum and communications analyzer, RF power meter, frequency counter, OC-3 line tester, DS-1 line tester, data packet tester/protocol analyzer, etc.

All microwave test equipment shall be uniquely noted and itemized by line item unit independent of the primary system equipment/pricing matrices.

7.1.17 *Microwave Equipment/Topology Design*

The supplier shall provide the following microwave backbone system design information and documentation details based upon the County requirements and specifications:

- System Functional Block Diagrams
- Network Topology with Proposed Connectivity (OC-3, DS-1, Ethernet)
- Network Channelization/Utilization Baseline

- System License Matrix/Structure
- Alarm and NMS Interfaces
- Equipment Layouts and Physical Dimensions
- Equipment Electrical, HVAC, and Floor Loading Requirements.

7.1.18 ***Software/Hardware Roadmap***

St. Marys County intends to maximize and protect its microwave system purchase investment. The supplier is required to provide support for the proposed microwave system offering for a period of no less than fifteen (15) years from the date of final system acceptance. The offering consists of all hardware, software, cabling, and services rendered to implement the proposed microwave network.

Supplier support is defined as the ability of the supplier to remedy to St. Marys County satisfaction any hardware and/or software problem with any equipment and services provided as part of this offering. Supplier support shall take the form of a 24x7x365 technical support hotline, product engineering, field service technicians, and field engineering. Supplier support also requires the supplier to be able to provide new and/or spare/replacement equipment for the proposed offering for no less than fifteen (15) years from the date of final system acceptance.

St. Marys County requires the supplier to provide a comprehensive system platform (noting timetable of initial release through end of supplier supportability) for the proposed microwave network defining the product life cycles of all major network elements, software operating systems, software applications, and ancillary network components. St. Marys County further requires the supplier to define the OEM status of all major network elements, software operating systems, software applications, multiplexers, and ancillary network components.

7.1.19 ***Digital Microwave Optional Features***

The supplier shall provide a detailed list and explanation of optional features for the microwave backbone system that can be supplied for review and understanding.

7.2 DIGITAL MICROWAVE PATH DESIGN

The supplier shall provide path and site survey data for all proposed paths. This shall include path profiles and all link data.

7.2.1 ***Path Performance***

Path performance is described by two parameters: path outage and path quality. Path outage is a statistical reliability calculation of the percentage of time the path is unavailable during the period of time of one year. Path quality is the long-term BER experienced on an unfaded path.

7.2.1.1 Path Outage

All paths in the system, including spurs, low-, medium-, and high-capacity rings, will be designed for a minimum two-way path reliability of 99.9999% EFS (error free seconds) per year. This is equivalent to 31.5 SES (severely errored seconds) per year, two-way path outage. The 10^{-6} BER threshold shall be used as the outage point.

7.2.1.2 Path Quality

All paths in the system, including spurs, low-, medium-, and high-capacity rings, shall have a required RBER (residual bit error rate) of $<10^{-13}$ without fade.

7.2.2 ***Physical Path Surveys***

The supplier shall be responsible for the complete design of all microwave paths. The supplier shall be responsible to perform physical path surveys, as required, to locate existing or planned obstructions on the paths and ensure proper path clearances are maintained. The supplier shall guarantee the paths clear of any and all obstructions. The supplier is solely responsible for remedying the system design and re-coordinating any microwave paths that fail to meet or exceed the predicted reliability and availability service levels.

7.2.2.1 Path Survey Requirements

The supplier shall be responsible to provide all personnel, maps, proper instrumentation and any other equipment or material necessary to perform the physical path surveys. In executing the path surveys, the supplier shall search for existing construction plans, permits, etc. for proposed structures along the projected path. If a particular location along the path is already developed with existing structures not likely to be re-built or extended/expanded, the supplier shall state the pre-existence of these objects. If the new structure(s) are proposed, the supplier shall take the new construction into account in the microwave path calculations.

7.2.2.2 Path Survey Submittals

The supplier shall be required to provide results of the physical path surveys on every path based on a final statement of work. These submittals are to provide, as a minimum, the following information and material:

- Verified site geodetic coordinates in NAD27 and NAD83 formats
- Verified site elevations
- Microwave system schematic drawings
- Sites plotted on USGS 7.5 min maps, location map, and plot plan
- Verified ground elevations along paths
- Obstruction heights along microwave paths
- Path profile characteristics, path clearances at critical points along the path, potential reflection points, twenty-year tree growth forecast, and natural/manmade shielding along the paths are identified /notes and discussed in detail
- General site characteristics: access, nearest utility power location, soil conditions, surrounding land features, and optimum positioning for new towers.

8.0 SUBSCRIBER RADIO EQUIPMENT

The County requires the supplier to provide various types of radio subscriber equipment and devices for the different agencies and participants on the countywide radio communications system. The County intends to procure radio subscriber units that shall require a variety of different features and options depending on the various user departments and their respective operational needs. The County encourages the supplier to recognize a logical distinction in the tier and pricing of proposed subscriber radios along a public safety and non-public safety agency basis.

Public safety radios shall, in general, be of a higher tier and include a larger suite of features, functionality, and overall design to withstand the harsh operating environments encountered by the first-responder community. Non-public safety radios shall also be of high quality and design, but, in general, a non-public safety class of radio shall not require as advanced a feature set and overall capacity as a public safety radio. The County has adopted a further distinction between high-tier and mid-tier subscribers based on the overall mode capacity of the radio. For reference, the County has supplied a matrix of required functionality and equipment in the Appendix section of this document. Assumptions have been made as to the availability of specific accessories for the various radio configurations, and no equipment availability assumption shall be interpreted to imply the preference of any specific supplier. The supplier assumes responsibility for mapping and categorizing the proposed subscriber radios to address the County's organizational strategy of low-, mid-, and high-tier radios in mobile and portable radio families. The supplier shall thoroughly describe the features and functionality provided with each proposed subscriber.

Subscriber radio equipment refers to user radio configurations consisting of mobile radios, portable radios, and control station radios. Suppliers shall provide all cables (antenna, battery, control head[s], chargers, etc.), mounting hardware, antennas, fusing facilities, installation and programming services, and accessories to provide a completely functional subscriber unit. Suppliers are responsible for assessing and delivering all programming and installation services necessary to deploy and commission all radio subscribers obtained through this procurement. Any items omitted in the following agency lists, which may be unique to a specific supplier's offering, are to be added by the supplier to ensure complete and compatible integration with the proposed countywide radio communications system.

8.1 GENERAL REQUIREMENTS

Subscriber units are required in a variety of different configuration packages: mobiles, portables, control stations, vehicular adapters, remote desksets, and optional vehicular repeater systems (as necessary).

The subscriber radio equipment shall consist of an integral radio set, capable of frequency synthesis of multiple RF channels, with automatic channel switching under the control of external channel(s) and/or internal channel switching logic. Additionally, the radio shall include such other items as are necessary for a complete, highly reliable, two-way analog and digital radio suitable for communications in a multi-channel/mode trunked and conventional system.

All radio subscriber system parameters (programming personality) shall be software configurable without the need to replace internal components for parameter configuration. In addition to the suite of features and functionality outlined in previous sections, the supplier shall provide all features, characteristics, and functionality with all proposed radio subscriber equipment necessary to meet or exceed the County radio system specifications. The units shall be feature and function compatible with all fixed equipment supplied under this contract. The supplier shall provide a comprehensive feature and functionality matrix for each proposed subscriber by type.

All radio subscriber internal software shall be downloadable from a programming device (i.e., laptop, PDA, etc) without the need to replace internal components for new software versions. Suppliers shall provide radio subscribers equipped for over-the-air reprogramming of both system configuration parameters and internal operating software. The supplier is responsible for developing, implementing, and documenting the comprehensive County programming fleetmap to utilize in the provisioning of radio subscriber, dispatch console, and NMS configuration databases. The supplier shall populate all required databases with final St. Marys County fleetmapping and ID information to fully commission the radio communications system. Any equipment programming changes required to make the subscriber, console, MNC, and NMS databases match the final version of the system fleetmap shall be executed at the expense of the supplier.

The subscriber units shall be of current hardware and software production at the time of final system acceptance, and shall be capable of withstanding the harsh environment associated with use in emergency service vehicles. At a minimum, the mobile and portable equipment shall meet or exceed the MIL-STD-810E "Environmental Test Methods and Engineering Guidelines" specification, with some of the criteria noted as follows:

Method 506.3	Rain - Procedure I - Blowing Rain
Method 509.3	Salt Fog
Method 510.3	Sand and Dust Procedure I - Blowing Dust

Method 514.4	Vibration Procedure I, Category 10 - Minimum Integrity Test (3 axes)
Method 516.4	Shock Procedure I - Functional Shock

All subscriber radio equipment shall also meet or exceed the requirements of TIA/EIA-603 "Land Mobile FM or PM Communications Equipment Measurement and Performance Standards" when operated in the analog mode.

The radio subscriber units shall support all analog and digital communications within this system and compatible systems operating in the 700 and 800 MHz frequency bands. The subscriber units shall provide FM analog communications within this system when involved in a call from an analog unit on conventional mutual aid repeater and/or simplex channels or compatible analog trunking systems. Mobile subscriber radios and control station subscriber radios shall exhibit as good or greater talk-in/talk-out coverage reliability performance in the guaranteed coverage areas as handheld portable radios used on the hip in leather swivel case.

The radio subscriber units shall be equipped to concurrently priority scan both conventional channels (at least 8) and trunked talkgroups (at least 8) in both clear and encrypted voice. The radio subscriber units shall also be equipped to concurrently scan between trunked talkgroups on compatible trunked systems in both clear and encrypted voice. Channel or trunked mode scanning shall be completed in the minimum time necessary to reliably deliver audio traffic to the radio subscriber. The supplier shall provide the maximum scan time required between trunking and conventional reception. The scan shall be a selectable priority which means that the transmitter channel or talkgroup selected by the user is configurable to be the priority channel or talkgroup.

The subscriber units shall provide an ESN (Electronic Serial Number) for lookup and validation purposes by the fixed network infrastructure. The subscriber units shall provide a multi-point data port to multiple external peripherals. The subscriber units shall provide the functionality to be placed in a listen-only mode (no transmit capability) from the network management system on a dynamic basis. While in the listen-only mode, the receiver would still be capable of receive operation but the radio would not be capable of transmitting in any mode.

8.1.1 *Audible and Visual Signaling*

The subscriber units shall support audible and visual signaling to and from subscriber units for functions as described below. Radio users shall also be able to select and unselect audible and visual signaling (i.e., surveillance, covert operations, etc.) or any or all of the default types of signaling described below. The mandatory default audible and visual signaling shall include the following standardized signals

and the supplier shall thoroughly define the nature and characteristics of each type of signaling scheme:

- Emergency Activation/Reception
- Dynamic Regrouping
- Individual Call
- Telephone Interconnect Call
- Selective Alert
- Console Alert Tone(s)
- Subscriber-Generated Evacuation Tone
- Mode Announcement (voice directory for programmable radio modes)
- Failure Modes (e.g., loss of trunking control, loss of wide area communications, etc.)
- Trunks Busy
- Callback
- Battery Life Indication
- Charging Mode Indication
- Transmit and Receive Indicate
- Programming Mode Activation
- Software Upgrade Mode Activation
- Feature Acknowledgment
- Channel Beacon
- Voice Communications Mode
- Data Communications Mode
- Priority Scanning
- Home Mode Activation
- Talkaround/Direct Mode
- Ready-to-Talk
- Vehicular Repeater Mode.

8.1.2 *FCC Regulatory Compliance*

All proposed subscriber equipment shall be type accepted under current FCC Rules and codified regulations in concert with the APCO Project 25 specification. The supplier shall define the Type Acceptance designation and FCC Emission Designators for all proposed radio subscriber equipment. The supplier shall provide detailed performance specifications for all proposed radio subscriber equipment.

8.1.3 *Electrical & Mechanical*

The subscriber radio equipment shall be state-of-the-art, frequency synthesized, and microprocessor based. All configurable operating parameters shall be stored in electrically-alterable, non-volatile memory technology. All radio operating frequencies, features, functions and other operating parameters shall be field-configurable via PC-based programming equipment. The physical and electrical architecture of the equipment shall be such that addition of user features and/or functions at future dates shall not require the addition and/or replacement of circuit cards within the proposed radios.

To the greatest extent possible, all equipment assemblies and sub-assemblies shall be shielded to minimize electromagnetic interference which may be caused to/by electrical equipment co-located and/or adjacent to this equipment. Similarly and in acknowledgement of the County's proximity to possible areas of interest for terrorism activities, radios should be capable of shielding from electromagnetic radiation (EMR) resulting from the detonation of a nuclear device or other EMR pulse generating device.

Power loss and/or replacement of the portable unit's battery shall not alter the operating software and/or configuration parameters. Radios shall be equipped to operate with Nickel-Cadmium, Nickel-Metal Hydride, and Lithium Ion battery technologies. St. Marys County requires any proposed radio and battery technology to meet or exceed the Factory Mutual rating for intrinsically safe operation per Class I, Division II, Group A standards. St. Marys County requires the supplier to provide the highest capacity battery that operates within the County operating environment, for each proposed variety of subscriber radio.

The unit shall perform a self-diagnostic test each time it is turned on. This test shall be automatic and shall include all radio operating parameters and internal hardware. At the conclusion of a successful test, no operator intervention shall be required. A self-diagnostic test that is unsuccessful shall notify the operator with an error message or fault code.

The radio housing shall completely integrate the radio transmitter unit(s) and receiver unit(s). The housing shall be devoid of any louvers or other openings, thereby protecting the radio set from dirt, dust, moisture, and splashing water. All subscriber units shall be designed so that they are protected from damage if power is applied in reverse polarity or pins of connecting cables are shorted together.

Access and ease of operation are critical to the users and the maintenance personnel. Suppliers are to provide information and details on all vehicular mounted equipment, particularly equipment mounted in the passenger compartment. The equipment housings shall be suitable for mounting on vertical or horizontal surfaces. The equipment housings shall be suitable for trunk mount and dash mount vehicle configurations. Remote mounted transceivers for mobile radios

shall be interconnected to their respective control heads through a weatherproof, control cable connectorized at both ends.

Mobile transceiver radios shall support weatherproof dual control heads as well as any existing remote control speaker/microphone capabilities, siren/PA assemblies, and motorcycle configurations. The radio cabinet(s), control heads, and ancillary installations must be a package that can be mounted inside or outside of the vehicle without restricting the use of the front seat by a driver and one passenger or interfere with air bag deployment. Mobile and portable transceiver radios shall be inherently compatible with optional handheld control heads and vehicular repeater assemblies as required.

The supplier shall describe variations for shock mounting, stabilization, tilts and swiveling with locks, and customized mounting for different vehicle models and types. Prior to the deployment of any radio subscriber equipment, the supplier is responsible for developing County-approved installation prototype(s) for each unique radio configuration. The supplier is solely responsible for providing all of the necessary labor and services associated with the installation and programming of all subscriber radios. The supplier is solely responsible for all subscriber installation, programming, and flash upgrading required to remedy any hardware or software defect or bug encountered at any time throughout the project implementation. All radio installation and programming activities shall be performed in a facility internal to the County as selected by the County to simplify equipage and deployment logistics. The supplier is responsible for the removal and inventory of all legacy County subscribers following a successful system cutover and reliability test period as defined by St. Marys County. The supplier shall separately delineate the costs of installation per radio and the costs of de-installation/removal per vehicle.

8.1.4 ***Subscriber Operational Characteristics***

- All proposed subscriber radios shall be equipped to operate within the 764-869 MHz frequency range per FCC and P25 channel spacing requirements.

- Modulation modes shall include, at a minimum, analog and digital for both 12.5 kHz and 20/25 kHz channel spacing as required. The County ultimately requires a migration strategy to 6.25 kHz or equivalent operation which shall be defined by the supplier.

- Communications modes shall include P25 digital trunking and conventional operations. Trunking modes shall be half-duplex in normal mode. Conventional modes shall include both half-duplex

and simplex as programmed. All programmable modes shall function in either clear or encrypted mode as programmed. All modes of operation shall be programmable.

- Squelch modes provided by the equipment shall include: carrier, continuous tone coded, and continuous digital coded squelch. Squelch modes shall be "field programmable" by channel.

- Unit identification modes shall include on a standard basis for all display radios: Unit ID upon Push-To-Talk, Emergency Unit ID, Selective Alert, Telephone Interconnect (optionally), and Alphanumeric Text Messaging (optionally).

- All subscribers shall be programmable for a variable duration transmit time-out-timer for continuous activity to prevent stuck microphone, dead key or abusive key-up scenarios.

- All mobile and control station subscribers shall be programmable for a minimum variable RF Output Power between 5-30 Watts across the entire frequency operating range.

- All portable subscribers shall be programmable for a variable RF Output Power between 1-3 Watts across the entire frequency operating range.

- Mobile speaker audio output shall be 10 Watts, minimum.

- Portable speaker audio output operating in a vehicular adapter shall be 5 Watts, minimum.

- Handheld radios, not operating in a vehicular charger or adapter, should provide no less than 500 milliWatts of audio output.

- Specialized radio accessories to support motorcycles, special weapons teams, bomb technicians, and other first responder specialists shall be made available. The supplier shall provide a comprehensive list of compatible accessories with unit pricing for all proposed radio subscribers.

- All proposed subscriber radios shall be equipped with a button or switch that activates a programmable "Home" mode or preferred channel with a single key, button press, or switch change.

- All proposed public safety "mid-tier" subscriber radios shall be equipped with no less than 256 modes or total channel capacity. All proposed public safety "high-tier" subscriber radios shall be equipped with no less than 512 modes or total channel capacity. All proposed "non-public safety-tier" subscriber radios shall be equipped with no less than 64 modes or total channel capacity.

- All proposed subscriber radios shall be equipped with a button or switch that activates the emergency mode.

- All proposed portable subscriber radios shall be less than 1.5 lbs in total weight with attached battery (not to include external accessories).

- All proposed portable subscriber radios shall be equipped to provide a minimum duty cycle of 12 hours using a 10/10/80 (10% Transmit/10% Receive/80% Idle) operational behavior model.

- All proposed portable subscriber radios shall be equipped standard with a ½ wavelength whip style antenna operational across the entire 764-869 MHz frequency range per current FCC requirements.

- All proposed subscriber radios shall be equipped to provide both transmit and receive audio control to customize the equalization and audio gain control associated with the subscriber radios to optimize the overall subscriber audio quality. The supplier shall identify the appropriate subscriber audio gain control and equalization settings as part of the overall system design and fleetmapping process.

- All proposed subscriber radios and associated accessories shall be equipped to operate consistently and reliably according to manufacturer and system specifications in environmental conditions ranging from -30 degrees Celsius to +60 degrees Celsius at a 90% non-condensing humidity level.

- All proposed subscriber radios with display capabilities shall utilize a hardened LCD display capable of withstanding non-abusive vibration and direct impact encountered in the normal daily radio use without being rendered inoperable. The LCD displays shall provide configurable contrast levels to enable proper usage in direct sunlight and low-light operating conditions. All display radios shall provide user-enabled backlighting for nighttime and low-light usage.

- All proposed non-public safety tier (low-tier) portable subscriber radios shall be equipped with a standard noise-cancelling, remote speaker microphone.

- All proposed public safety tier (mid-tier and high-tier) portable subscriber radios shall be equipped with high performance noise-cancelling, remote speaker microphones that provide an emergency button, discrete volume control, rotary channel selector knob, and audio earpiece jack.

- All proposed portable subscriber radios shall be equipped with a personal, desktop-style single battery charger and spare battery of the same type and duty cycle rating as the primary battery provided with the radio.

- All proposed portable subscriber radios shall be equipped standard with a belt clip in addition to any accessories that may be also ordered with the portable radios.

- All proposed subscriber radios shall be equipped with a configurable button keypress timer to optimize the intended activation and clearing of emergency mode. The timer shall range from 0-to-3 seconds in millisecond increments.

- All proposed subscriber radios shall be equipped to mute all radio tones and/or audio when operating in covert or sensitive tactical situations (e.g., surveillance, SWAT, etc.).

- All proposed subscriber radios shall be equipped to provide a time and date indication on radios with a display. The time/date indicator shall be user configurable and maintained without the primary battery engaged.

- All proposed portable subscriber radios shall be equipped to provide an audible and visual battery status indication to warn of battery depletion and need to charge.

- All proposed subscriber radios shall be equipped to provide a configurable minimum and maximum volume setting for the radio so as to be able to customize audio levels for various operating environments.

- All proposed subscriber radios shall be equipped to provide configurable button, switch, and menu layouts to customize the radio operational characteristics for the various users and agencies. All buttons, switches, and menu items that are labeled or inscribed shall match the programmable functionality so as not to confuse the radio operators.

- All proposed subscriber radios shall be equipped to provide multiple configurable folders or zones of talkgroups and channels to uniquely organize the available modes programmed into each radio. Each folder or zone shall be accessible through any defined combination of button, switch, or menu item setting. Trunking and conventional channels shall be capable of being interleaved within a programmable zone or folder.

- All proposed subscriber radios shall be equipped to provide user-definable, priority scan functionality for all systems and channels programmed into the radio. Radio scan lists shall include at least sixteen (16) members each. Any combination of talkgroups and conventional channels shall be definable in a scan list.

- All proposed subscriber radios equipped for encrypted operation shall provide both infinite key retention capability and volatile key retention modes of operation which must be configurable in the individual radio programming.

- All proposed subscriber radios shall be equipped to provide a keypad lock functionality to prevent inadvertent mode or switch activation.

- All proposed subscriber radios shall be equipped to provide password-protection (on a configurable radio programming basis) to gain access to the radio for normal system usage.

- All proposed subscriber radios shall be equipped to provide selective radio disable/inhibit, un-inhibit, and dynamic regrouping functionality in conjunction with the system NMS and dispatch consoles.

- All proposed subscriber radios shall be flash-upgradeable.

8.1.5 *Mobile Subscriber Units*

8.1.5.1 Power Supply

- The equipment shall operate from an external negative ground primary power source supplying a nominal 12 VDC.
- All power circuits shall provide for reverse polarity protection and each power cabling assembly shall be properly fused and grounded.
- Mobiles shall be equipped to operate in both a continuous mode (always powered on) or in a switched mode (powered down with an ignition sense) as required on an individual basis by the County.
- There may be a limited number of units requiring positive ground kits as determined at time of installation. Unit costs related to these kits shall be clearly and individually identified in the pricing section of the supplier's response. If there is also an incremental installation cost related to the positive ground vehicles, the costs shall also be clearly and individually identified in the response.

8.1.5.2 Mobile Equipment Housing

- The transceiver housing shall house all electronic circuits and/or circuit cards associated with the equipment.
- Palm microphones, external speaker housings and transceiver housings shall be constructed of high impact polycarbonate plastic or other suitable high impact material.
- Trunk-mounted transceiver housings shall be equipped with a base plate. The base plate shall allow for the removal of the transceiver from its mounted location for replacement or servicing. Removal of the transceiver from the base plate shall not expose its internal circuitry.

8.1.5.3 Mobile Radio Features

- All mobiles shall be equipped with a backlit, alphanumeric character LCD display providing at least 12 characters to identify the operating folder/zone and trunked talkgroup and/or conventional channel mode. As a standard option, keypad configurations shall

conform to the North American telephone keypad standard numerical and symbol layout.

- The LCD display shall provide contrast adjustment and its brightness shall be user adjustable. The LCD display shall be equipped for dimming and complete turn-off for surveillance and covert operations.

- All mobiles shall be equipped with a user-operated, color-coded switch or button to activate the radio's emergency status mode. All provided button labels and stenciled switch descriptors shall match the programmed radio functionality as defined by the final St. Marys County fleetmap and programming configuration.

- All mobiles shall be capable of interfacing to the following accessories and ancillary assemblies as required by St. Marys County: horn and lights activation relays, siren/PA control head, status/message control head, external emergency switch or button, motorcycle assembly, dual control head-single radio, multi-band radio-single control head, handheld control head/keypad microphone, and mobile-in-a-tray control station.

- All mobiles shall be equipped with an external data port for connection to test equipment, radio programming devices, mobile data devices, etc.

- On dual control head units, the switch to enable or disable scanning shall be field programmable or designated by the user.

- On dual control head units, each control head shall be equipped with a switch to takeover control of the unit.

- On dual control head units, transmit and receive audio shall, at all times, be available from both front and rear positions regardless of the position of the takeover control switch.

8.1.5.4 Mobile Radio Accessories

- The units shall be equipped with a palm type microphone with coiled cord. The microphone shall be of the modular connector, plug-in type. Remote units for outside vehicle use shall have, at a minimum, a weatherproof rating.

- Each unit shall be equipped with an in-vehicle speaker. The speakers shall be of the modular connector, plug-in type. Remote speakers for outside vehicle use shall have, at a minimum, a weatherproof rating.

- Dual control heads shall be available for specialized fire apparatus, EMS ambulances, and other unique applications as defined.

- All mobile radios shall require the installation of a weatherproof, center-of-the-roof-mounted, low-profile 3dB gain type antenna operational across the entire 764-869 MHz frequency range per current FCC requirements. The supplier shall work with the County at the time of radio installation to define the re-use of an existing hole for antenna installation and possible temporary use of a magnetic mount antenna for the legacy radio to facilitate the cutover process and minimization of holes cut into the vehicle. The supplier shall define the unit cost for a magnetic mount antenna with associated cabling operational across the entire 764-869 MHz frequency range per current FCC requirements.

- Mobile radios shall be compatible with the installation of common fire/emergency services apparatus headset intercom systems (e.g., David Clark, Firecom, etc.). The supplier shall completely integrate and wire all new subscriber radios with the various headset interfaces in use or intended for use as required to fully complete a vehicle installation.

8.1.5.5 Installation of Mobile Radios

The supplier shall describe the requirements for the installation of mobile radios in vehicles of all types (cruisers, sedans, utility vehicles, fire apparatus, ambulances, etc.). This information shall include a description of any certifications required by the installation technician that ensures the mobile radio will be installed appropriately with all warranty/maintenance requirements protected.

8.1.6 ***Portable Subscriber Units***

8.1.6.1 Power Supply

The equipment shall operate from a negative ground internal battery power source. All power circuits shall provide for non-destructive reverse polarity and overcharge protection.

8.1.6.2 Portable Radio Equipment Housing

The transceiver housing shall house all electronic circuits and/or circuit cards associated with the equipment. The housing shall be constructed of high impact polycarbonate plastic or other suitable high impact material.

Removal of the battery from the unit shall not expose its internal circuitry and all battery leads/external connection points shall be properly sealed and covered to prevent any internal moisture damage to the radio.

8.1.6.3 Portable Radio Features

- All portables shall be equipped with a backlit, alphanumeric character LCD display providing at least 12 characters to identify the operating zone/folder and trunked talkgroup and/or conventional channel mode. As a standard option, keypad configurations shall conform to the North American telephone keypad standard numerical and symbol layout.

- The LCD display shall be top-mounted, front-mounted, or dual display as specified in the Subscriber Inventory.

- The LCD display shall provide contrast adjustment and its brightness shall be user adjustable. The LCD display shall be equipped for dimming and complete turn-off for surveillance and covert operations.

- All portables shall be equipped with a top-mounted rotary volume control knob.

- All portables shall be equipped with a primary, top-mounted trunked talkgroup or conventional channel channel selector knob.

- All portables shall be equipped with an external data port for connection to test equipment, radio programming devices, mobile data devices, etc.

- All portables shall be equipped with a user-operated, color-coded switch or button to activate the radio's emergency status mode.

- All portables shall be capable of interfacing to the following accessories and ancillary assemblies as required by St. Marys County: man-down emergency activation switch, public safety speaker microphone (i.e., elevated antenna at shoulder height), multiple unit charger/conditioner, surveillance headsets/earpieces, Bluetooth accessories, RF adapter switch for vehicular mobile adapter assemblies, GPS-speaker microphones, bone microphones, and temple transducers.

8.1.6.4 Portable Radio Accessories

- All portables shall be equipped to operate in a tri-chemistry, ruggedized, pocket-style vehicular mobile charger that does not cover up the LCD display and accommodates the attached remote microphone. The vehicular charger shall operate from the vehicle's battery, and provide a charger/conditioning system for the portable radio battery. The charger shall be mechanically configured to provide electrical contact to the radio battery upon insertion of the radio or separate battery into the charger. Rapid battery charging shall be possible whether the battery is out of or attached to the radio. The proposed vehicular charger shall be compatible with every proposed portable radio type, and different vehicular chargers shall not be required based upon the radio or battery type.

- All portable batteries shall be equipped to operate in a tri-chemistry, pocket-style vehicular mobile travel charger. The vehicular travel charger shall operate from the vehicle's cigarette lighter/accessory connector, and provide a charger/conditioning system for the spare portable radio battery. The proposed travel charger shall be compatible with every proposed portable radio type, and different travel chargers shall not be required based upon the radio or battery type.

- All portables shall be equipped to operate in a tri-chemistry, ruggedized, pocket-style portable vehicular adapter that converts the portable radio into a quasi-mobile radio configuration as required by

St. Marys County. The portable vehicular adapter shall operate from the vehicle's battery, and provide: an external, roof-mounted antenna system, external mobile-style audio speaker, handheld microphone, and battery charger/conditioning system for the portable radio battery. The charger shall be mechanically configured to provide electrical contact to the radio battery upon insertion of the radio or separate battery into the charger. Rapid battery charging shall be possible whether the battery is out of or attached to the radio.

- All portables shall be equipped to operate in a tri-chemistry, ruggedized, pocket-style 120VAC multiple unit charger that can simultaneously charge/condition a minimum of six portable batteries of any chemistry type. The proposed multi-unit charger shall be compatible with every proposed portable radio type, and different multi-unit chargers shall not be required based upon the radio or battery type.

8.1.7 *RF Control Stations*

The County requires wireless access to the trunked system from various fixed facilities throughout the County. The Appendix defines the specific control station locations and quantities throughout the County. The supplier shall be responsible for assessing, deploying, testing, and documenting all control station installation efforts. Control station installation efforts shall include: all mounting, 120VAC electrical and power supply wiring, grounding, surge suppression, antenna and transmission line cabling, connectorization, attenuation, audio and accessory cabling, radio programming and optimization necessary to fully commission each control station.

All control station radios shall meet all mechanical, electrical and operational requirements previously specified for "Mobile Subscriber Units." All control stations, with the exception of the dispatch center backup control stations or specialized digital remote control deskset interfaces, shall be of a mobile-in-a-tray configuration with dedicated desktop paddle microphone. The supplier shall be responsible for coordinating control station installations with the respective user agencies.

The control stations provided for Fire/EMS facilities throughout the County shall be integrated to mimic the functionality that currently exists with the legacy 800 MHz control stations at these facilities. Control station audio and control wiring shall be integrated with the station PA system to replicate existing functionality. Each Fire/EMS control station shall also be equipped with one (1) control station desktop, handset-style remote control unit to be situated at an optimal location

within the Fire/EMS facility as defined by the station chief at time of installation. Throughout the cutover period, audio shall be bridged by the supplier between the legacy EDACS and new 700/800 MHz control station radios inside of the Fire/EMS facility.

8.1.8 ***Subscriber Unit Inventory***

The Appendix section of this specification identifies and organizes the tiers, quantities and accessories for the intended user agencies of the proposed trunked system. Suppliers are required to study the enclosed inventory in order to properly quantify and price the necessary equipment for this proposal. The quantities described relate to those radios that shall be purchased by the County. In addition to radios acquired by the County, the supplier should anticipate that an additional, yet unknown number of radios will likely be purchased by other governmental agencies interoperating with the County network.

8.1.8.1 Warranty And Maintenance Service of FNE, Mobile, and Portable Radios

The supplier shall indicate the name and address of the factory authorized repair and service facilities proximate to St. Marys County. The supplier shall indicate the level of support that can be provided by these facilities in support of warranty and maintenance requirements for the FNE, mobile, portables, consoles, microwave, and other components to be provided under this solicitation.

The supplier shall complete the following table to provide information relative to the factory authorized center(s). The supplier shall also provide at least three customer references with contact information for each of the qualified service facilities listed below so that St. Marys County may independently assess the customer satisfaction levels achieved by these firms.

Item	Service Facility #1	Service Facility #2	Service Facility #3
Name			
Address			
City/State			
Number of available technicians trained in proposed system platform			
Years of operation for service facility			
Number of 800 MHz trunked systems supported by the			

service facility			
Guaranteed on-site emergency response time to County			

8.1.9 *System Programming Key*

The supplier shall provide three (3) complete sets of programming hardware and software for all subscriber equipment initially ordered. This equipment complement shall include all hardware and software necessary to program, troubleshoot, and flash upgrade each proposed subscriber type. Two (2) St. Marys County system-specific programming keys and/or software authentication files shall be included so that St. Marys County can uniquely provision its entire subscriber fleet internally following final system acceptance.

St. Marys County also requires the availability of a volatile system programming key that can be distributed to a regional interoperability partner for limited programming initiatives. The volatile system programming key shall be configurable with a finite number of programming transactions plus an expiration date so that external interoperability programming exercises can be controlled and properly managed without compromising system integrity.

Prior to final system acceptance and at St. Marys County's determination, the County requires the supplier to program the most current County fleetmap information and flash upgrade all radio subscribers so that the radio software/firmware is consistent with subscribers shipping from the manufacturer's factory at that time. Throughout the fifteen-year manufacturer support period, the supplier shall produce a semi-annual product bulletin for each proposed subscriber type that thoroughly defines the available flash upgrades and notes all product enhancements/bug fixes contained in the specific flash upgrade. Throughout the manufacturer support period, St. Marys County shall be entitled to receive at no charge the appropriate quantities of any subscriber flash upgrade kit that addresses an identified product defect or bug fix, regardless whether the fix for the defect is independent of associated software enhancements.

8.2 APCO P25 CONFORMANCE INTEROPERABILITY PROOF-OF-CONCEPT

The County requires the supplier to verify that its entire proposed subscriber complement conforms to the APCO Project 25 standard by providing for each proposed subscriber: (1) an independent, interoperability conformance testing certification of inter-vendor P25 trunking and conventional subscriber and infrastructure compatibility noting all compatible and incompatible proposed features as verified with actual field and laboratory system testing (e.g.,

NIST/SAFECOM, TIA P25CAWG; (2) a comprehensive list noting all P25-compliant open standard features and all proprietary, vendor-specific subscriber features; (3) a list of at least three (3) operational, compatible, field-installed, 700/800 MHz P25 trunking customer systems with system contact reference that utilize the same subscriber complement and system platform version; and (4) length of time that each subscriber has been in manufacturing production.

Prior to the closing of the bid process, Bidders shall propose a demonstration of their subscriber and FNE P25 interoperability on competitive systems.

8.3 SUBSCRIBER RADIO DESIGN

The supplier shall provide the following radio subscriber fleet information and documentation details based upon the County requirements and specifications:

- Fleetmap/Programmable ID Plan
- Subscriber Fleet Inventory by Serial Number, Part Number, Options
- Provisioning Databases/Radio Personalities/Firmware Versions
- Subscriber License Matrix/Structure
- Installation Prototypes
- Control Station Configuration/Antenna Orientation
- Equipment Layouts and Physical Dimensions
- Equipment Electrical, HVAC, and Floor Loading Requirements.

8.4 SUBSCRIBER SOFTWARE/HARDWARE ROADMAP

St. Marys County intends to maximize and protect its subscriber radio purchase investment. Unlike FNE equipment and networks that integrate third-party equipment/software/firmware, manufacturers are almost completely in control of the support of their subscribers. The supplier is required to provide support for the proposed subscriber fleet offering for a period of no less than fifteen (15) years from the date of final system acceptance. The offering consists of all hardware, software, cabling, and services rendered to implement the proposed radio subscriber fleet.

As part of their proposal, Bidders shall provide a roadmap/lifecycle map for the previous two major platforms for FNE and public safety subscribers.

Supplier support is defined as the ability of the supplier to remedy to St. Marys County satisfaction any hardware and/or software problem with any subscriber

equipment and services provided as part of this offering. Supplier support shall take the form of a 24x7x365 technical support hotline, product engineering, field service technicians, and field engineering. Supplier support also requires the supplier to be able to provide new and/or spare/replacement equipment and software for the proposed offering for no less than fifteen (15) years from the date of final system acceptance.

St. Marys County requires the supplier to provide a comprehensive product roadmap (noting timetable of initial release through end of guaranteed supplier supportability) for the proposed subscriber fleet defining the product life cycles of all major components and ancillary accessories. St. Marys County further requires the supplier to define the OEM status of all of all major subscriber components and ancillary accessories.

8.5 SUBSCRIBER RADIO OPTIONAL FEATURES

The supplier shall provide a detailed list (with associated pricing) and explanation of optional features and accessories for all proposed subscriber radios that can be supplied for review and understanding.

9.0 REDUNDANCY AND BACKUP CONSIDERATIONS

All critical components of the proposed system infrastructure shall be designed with extraordinary redundancy and fault tolerance in order to provide a high system availability of 99.9999% for the St. Marys County users. System Availability shall be defined by the following equation:

System Availability = 100 x (1- UNAVAILABLE Time / Total Time)

where 'UNAVAILABLE Time" is the total time in which the system is unavailable as defined and mutually-agreed by the County and supplier. The supplier shall provide its definition and method for calculation of the unavailable time.

At a minimum, the proposed system shall include the necessary redundancy as feasible for all core components, radio network controllers, base station transceivers, networking equipment, switching infrastructure, servers, backbone infrastructure, console electronics, power supplies, etc to maintain the high system availability and trunking operations. In the event that the proposed system design and architecture does not lend itself to hot-standby or fault-tolerant redundancy, the supplier shall identify and include an appropriate spares complement to quickly remedy a system problem. No single point failure shall be architected in the proposed design and the supplier maintains responsibility for guaranteeing, through a comprehensive single point failure analysis, that no such system vulnerability exists.

Such redundant equipment shall be in a hot-standby mode until such time as a failure requires that the redundant components be enabled. Enabling or switching over of redundant radio network controllers and subsystem components shall be automatically performed by the proposed radio system upon failure detection. The physically diverse distribution of redundant key components, whenever practical, is desired by the County. The supplier shall provide MTBF and MTTR data for the proposed system network elements and provide performance metrics from actual customer and development systems that support the ability to achieve the system availability required by St. Marys County.

9.1 INFRASTRUCTURE REQUIREMENTS

Critical infrastructure and subsystem components of the radio system infrastructures shall be designed with redundancy in order to provide high system availability. The supplier shall offer fault-tolerant, distributed processing and hot-standby equipment configurations as feasible. The County requires a system that will not suffer a loss of wide-area, Countywide trunking functionality resulting from the failure of a single system component or network element. Sufficient redundancy and fault

tolerance must be designed and provided so that fully-functional trunking operations will continue without interruption to existing communications.

The County further requires that any system component enclosure or power distribution design, that could render the system or 25% of its channel resources useless or unavailable for communication from a single failure, shall incorporate redundancy to eliminate this vulnerability. The County also requires redundancy and fault-tolerance to be implemented in the design so as to guarantee that a single network element or component failure does not render more than two of its dispatch consoles inoperable simultaneously. The County requires the necessary redundancy and loop transport topology so that a single network element/component failure or path fade does not orphan a network node or RF site and diminish radio coverage. The County requires the necessary redundancy and fault-tolerance to ensure that countywide, two-way digital voice communications remain operational even in the event of the loss of any individual site (although it is understood that coverage may be slightly diminished around the failed site if a specific site has been rendered totally inoperable). No single network element failure or loss of an individual site shall ever render the network with less than 85% in-street, portable on-hip in a swivel case talk-in/talk-out coverage reliability performance.

If redundant system controllers are supplied, both controllers shall remain on-line in continuous duty operation with real-time, parallel updating of static and dynamic system data so as to provided minimal disruption of service in the event of a failure of the primary controller equipment. Switching from main to standby operation shall be fully automatic, with audible and visual indication of the switchover provided to the NMS workstations as well as to the supervisory dispatch console positions. The supplier shall specify the amount of time it will take between primary controller failure and backup controller switchover. Remote switching functionality from main to standby controller operation shall be provided at the NMS clients and supervisory console as a manual override to automatic switchover. The supplier shall also specify the period of time required and the procedure for manual switchover to redundant system controller(s). No loss of system functionality shall be experienced during the transition from a main to standby network controller. Subscriber radios and dispatch consoles shall not be forced to re-affiliate with the network upon transitioning from main to standby network controllers.

Real-time notification and current system operating status information shall be made to all dispatch consoles and NMS client workstations when the system has entered any degraded mode of system communications so that operational user behaviors may be modified to workaround the specific failure. All user radios shall also be presented in real-time with audible and visual alerts that indicate the current mode of system communications if any system failure mode has been instantiated.

In the extremely unlikely event that failures shall cause system users to operate in conventional mode until trunking operation recovery can be made, the supplier shall describe the failure logic in complete detail, the mode of operation during such conditions, as well as the recovery process in the proposal responses. All failure modes shall be architected such that wide-area coverage and dispatcher connectivity are maintained countywide. Despite the possible loss of trunking functionality, the system fallback modes of operation shall deliver conventional talk-and-listen digital voice functionality countywide. Feature sacrifices shall be described in detail for infrastructure, consoles, and subscribers for all primary and fallback modes of communication. As a last resort, individual sites shall be equipped to provide repeated conventional digital voice functionality throughout the coverage area delivered by that respective site without interference from adjacent sites.

The supplier shall design and implement the County fleetmap to take advantage of all failure modes of communication so that voice communications are preserved to the greatest extent possible. The supplier shall describe the redundancy and preventive measures that are built in to the system design so that high availability levels can be met. The County considers this detail extremely important in the analysis and evaluation of the supplier's proposal.

9.2 COMPREHENSIVE REDUNDANCY DESIGN

The supplier's design for redundancy shall be comprehensive and incorporate support for every component required for network operation. The power systems required to support network components must include a comprehensive redundancy plan that prohibits failure to power the network's components. Infrastructure support elements such as system performance monitoring, HVAC, and structure security must also be supported.

9.3 INTERCONNECTION LINKS

The supplier shall describe all levels of link redundancy supported or required by the system and define the point-to-point link capacity impact on the microwave system.

9.4 PHYSICAL SECURITY AT NETWORK SITES

In addition to proposing a design that provides network redundancy, the supplier shall also consider the issues of physical security and redundancy in alarms, etc. employed to protect the system from abuse or external attack. Proximity, intrusion, and other alarms shall incorporate a redundant design to minimize the potential of damage from the disablement of any single alarm device. In the transmission of network alarm data, redundancy in the network used for signaling alarms and fault events to the NMS client workstations shall be provided.

10.0 COMMUNICATION SITE FACILITIES/SITE IMPROVEMENTS

10.1 SCOPE OF WORK

The supplier shall be responsible for the following:

As necessary, the deployment of new tower and shelter facilities equipped with commercial and emergency backup power to support the proposed radio system plus specified expansion margins.

As necessary, the refurbishment or enhancement of existing tower and shelter facilities equipped with commercial and emergency backup power to support the proposed radio system plus specified expansion margins.

Design, procurement, manufacturing, shipping, installation, and testing of all materials and equipment necessary to complete the site readiness work.

As necessary, the design and preparation of all proposed sites in accordance with all applicable ordinances and regulations.

Submittal for approval, all details, cuts, and drawings of proposed equipment and control systems.

Disposal and removal of debris and refuse from each site, as the result of performing any work, including any components removed from towers as authorized by the County.

All permits, licensing and required authorizations of any kinds including, but not necessarily limited to: NEPA, State Historic Preservation, Zoning/Planning, FAA, FCC, DOT, NFPA, OSHA, etc.

Compliance with all codes, safety regulations, and ordinances in accordance with the requirements set forth in the specifications.

10.2 GENERAL SITE WORK

The following requirements are specified for the communication facilities at all new and existing sites proposed by the supplier for use as part of the countywide radio communications system.

10.2.1 *Summary of Work*

Site work includes: all clearing and earthwork; geotechnical analysis, excavating and backfilling; compacting and grading; stone surfacing and fencing; drainage and

landscaping; and tower/shelter/generator foundation work. Further site and communication facility work required by the County includes:

Design and implementation of 100-foot x 100-foot (as feasible) site compounds including fencing, stone surfacing, and access road.

Design, manufacturing, delivery and installation of pre-fabricated, hardened concrete shelters.

Design, manufacturing, delivery and installation of self-supporting towers and ice bridges.

Design and installation of all foundations including required soil exploration and geotechnical analysis.

Design, manufacturing, delivery and installation of generators and associated fuel tanks.

Design and implementation of single point grounding system for entire site.

Coordination of electrical power and utilities to the site.

Permits and approvals required for site work.

Coordinate telephone line service as required.

Provide security hardware to protect sites.

Documentation of all construction efforts.

10.3 EXISTING FACILITY UPGRADES

To support the proposed system, the County anticipates the ability to re-use some or all of the current shelters and system infrastructure that serve the current four-site EDACS trunking network as well as various State of Maryland facilities. Re-use of any of the existing infrastructure may require facility enhancements and/or upgrades to adequately support the new network. Site upgrades shall be implemented in a non-intrusive manner so that the existing EDACS network experiences no system disruption while commissioning the proposed system in parallel. The supplier shall be responsible for thoroughly identifying, documenting, and implementing all required upgrades, modifications, and enhancements necessary to fully commission the proposed countywide radio communications system at existing facilities.

The Appendix section of this document identifies the current facilities serving the County's radio communications system as well a comprehensive list of County-owned property that shall be considered candidates for new tower/shelter locations to serve the proposed system. The supplier shall be responsible for all site surveys, structural analyses, and feasibility studies to determine the complete suitability of existing and candidate tower/shelter locations to serve the proposed network. To minimize the proliferation of towers within St. Marys County, the supplier is encouraged to identify any existing commercial towers and sites which could be used to support the supplier's proposed design.

10.4 GENERAL REQUIREMENTS

The supplier shall engineer, furnish, and install complete and fully operational base station transceiver, and if required, microwave sites necessary to support the proposed radio system. If new or upgraded sites are proposed by the supplier, all site design work shall conform to these specifications and be stamped by a professional engineer with an active State of Maryland certification. A State of Maryland-registered land surveyor or civil engineering firm shall prepare all site plans.

The supplier shall be responsible for a complete and fully operable installation in accordance with the latest version of the National Electrical Code, local building codes, environmental laws, zoning and planning regulations or ordinances, land use restrictions, Federal Aviation Administration and Federal Communications Commission rules and regulations, State of Maryland Department of Transportation regulations governing road access and entry, and all other applicable local, state or Federal codes, regulations, laws and/or ordinances. In the event of conflicting requirements the most stringent interpretation shall apply except as permitted by the County.

Materials furnished by the supplier shall be new and of first quality as defined in industry standards. The supplier shall not make substitutes unless prior approval has been obtained from the St. Marys County Project Manager.

On a daily basis (or sooner if directed by the County Project Manager), the supplier shall clean up and remove from the work site all rubbish and construction debris, resulting from project work. The supplier shall supply a dumpster or similar trash storage/removal device wherever a substantial amount of construction debris is generated. Upon completion of work, the entire job site areas shall be left clean and free of trash, debris, mud, dirt, dust, scrap materials, and excess materials. Construction work zone signs, tape, and pedestrian barriers shall be utilized at all times to prevent unwarranted site access.

Radio equipment shelters and equipment rooms shall be thoroughly cleaned (including walls and floors) to the satisfaction of the St. Marys County Project Manager upon completion of installation and construction work.

The supplier shall coordinate the work of all the trades under its responsibility to ensure that interference between electrical conduits, cable support trays, grounding wire, structural, and the radio system components shall be avoided so that the project is completed within budget and schedule.

The supplier shall keep current, marked-up prints of all Project Drawings. Markings indicating changes to the drawings shall be red or green and clearly visible. Three (3) complete sets of Final Site Facility "As-Built" drawings (containing all construction and design drawings for: towers, shelters, electrical, site plans, foundations, mechanical, fire suppression, site photos, alarm systems/annunciators, test results, permits, etc.), free of all field mark-ups, shall be furnished to the County Project Manager at the completion of the project. Original Project Drawings shall also be supplied on disk in AutoCAD and other unprotected native file format(s) (i.e., Visio, MS-Word, MS-Excel) as utilized so that drawings may be modified at some point in the future by County system management personnel.

10.4.1 ***Stone Surfacing***

The supplier shall install stone surfacing to a minimum depth of six inches within the fenced in site area. Material shall be ¾-inch broken stone with 10% binder material. Two layers of polypropylene liner shall be installed under the stone for foliage suppression. Prior to the laying of any surfacing material, an EPA-approved defoliant or herbicide shall be applied over the area to eliminate the proliferation of weeds and unwanted foliage.

10.4.2 ***Fencing***

For all newly-proposed sites, the supplier shall provide hot-dipped galvanized, 8-foot high chain link security fencing with top-mounted razor wire around the entire site compound perimeter (as determined by the ultimate site plan which ideally will be approximately 100-foot x 100-foot in area) with both a 16-foot vehicular gate and a 4-foot pedestrian gate. Fencing shall be no less than a 9 gauge, 2-inch zinc coated diamond mesh. Corner, line posts and gateposts (2½-inch, 2-inch and 4-inch diameters respectively) shall also be hot-dipped galvanized. Top rail (1¼", 17 gauge), brace rails (1¼-inch, 17 gauge), and tension wire (7 gauge) at bottom of fence to touch grade are required. Truss rods (3/8-inch) with turnbuckles shall be integrated as required to strengthen each individual fencing section design.

- The mesh fencing material shall be secured to terminal posts using stretcher bars and steel bands and line posts using wire clips. Individual fencing sections shall be no wider than 10-foot before a line post, gate post, or corner post is required.

- The top of the fencing shall have razor wire with 45-degree extension arms pointed outside the fence area. The bottom of the fencing shall be a knuckled finish and touch the finished grade of the compound being pulled taut enough so that no compound intrusion can be gained from the bottom of the fence.

- Gates shall be provided with a positive-type latching device needed for padlocks. A plunger rod and catch are also required to secure gate in the open position with a mushroom cap at the base of the plunger rod. Gates shall expose no more than 4 inches between the opening to prevent intruder access.

- All fence posts shall be secured using minimum 30-inch deep by 1-foot wide footers set in a suitable concrete mix for fence stability.

- Fence posts shall be bonded to the site grounding system using an exothermic welding process (Cadweld).

- The supplier should propose a design that affords maximum protection to the site based upon experience in other high security environments.

- Combination locks, with County-specified codes, shall be provided for all gate entrances.

10.4.3 ***Grounding Systems***

All power feeders and branch circuits shall contain an equipment grounding conductor which shall have green-colored THWN/THHN insulation or green identifying tape at both ends and which shall be suitably terminated to an equipment ground bus or device screw terminal at both ends.

At any site at which building structural members are used for grounds, connections to those main structural steel members shall be made with exothermic ("Cadweld", Burndy, or equivalent) type connectors. Any paint or fire-retardant material shall be scraped away down to bare metal (for good metallic contact) before applying the

connection. Surface preparation recommendations for the exothermic welding process to be used shall be followed.

All connections to ground halos shall be made as straight as possible with a minimum number of bends. Minimum bending radius of any ground wire shall be one foot.

A ground ring consisting of a #00 AWG tinned, bare copper wire shall be installed in a trench at a depth of no less than 30" below final grade or below the frost line (whichever is lower) at a maximum distance of 2 feet from the foundation of the equipment building where the equipment is installed.

If soil conditions allow, the ground ring shall be supplemented with copper clad steel ground rods. The ground rods shall have a minimum length of 10 feet and a minimum diameter of 3/4 inches. The use of ground rods will ensure contact with unfrozen soil during the winter season. All ground rods and ring shall be interconnected (including AC power service and telephone ground rods) to form a single, electrically contiguous site ground ring grid of 5 ohms (or less) resistivity. Megger ground testing shall be performed on the final installation with test results supplied to County and the results shall read a resistivity of 5 ohms or less. At least two grounding system inspection wells shall be provided at each tower/shelter facility.

The following requirements shall govern the deployment of the single point grounding system for the communications facility:

The minimum requirements for the quantity of ground rods shall be based on the following: (1) at least one ground rod at each corner of the shelter shall be installed; (2) the maximum distance between ground rods shall be 16 feet; (3) at least one ground rod shall be installed directly below the transmission line entry port; (4) the top of ground rods shall be 30" below grade; (5) the ground rods shall be bonded to the external shelter ground ring using an exothermic welding process, for example, Cadweld; (6) the supplier has the discretion to determine the type of connector to use in the welding process.

An anti-oxidant compound shall be applied to a bonding connection point after the bond is completed.

All connections to the ground ring shall be such that the ground wires are as straight as possible avoiding sharp bends.

- The exterior ground ring shall be bonded to the copper strap or grounding wire descending from the shelter's bulkhead panel.

- The internal ground ring (halo) shall consist of #2 AWG (or larger) tinned bare solid or stranded copper conductor, running continuously along the shelter wall, at a maximum of 6 inches below the ceiling. Insulated mounting standoffs shall be installed every 18 inches or as required to accommodate bends and avoid sag. The internal shelter halo shall contain an intentional break of approximately 4-6 inches to prevent a grounding loop.

- The transmission line entry port shall be installed directly beneath the internal ground ring (halo) at a point to be mutually agreed upon between the supplier and the County.

- The ice bridge shall be installed between the tower and equipment shelter to protect all transmission line and equipment interconnected between the tower and shelter. All ice bridge equipment shall be grounded to the exterior single point grounding ring.

- An internal and external copper ground buss bar (that is electrically contiguous) shall be installed such that it is located directly beneath the transmission line entry port. The ground bars shall be wall-mounted on insulators, and shall be pre-drilled to provide adequate internal and external ground connections for each incoming coaxial transmission line. The ground bar may be integrated with a cable entry panel or other special fabricated panel, which will support gas tube surge arrestors for each coaxial transmission line to be installed. The internal ground bar shall be directly connected to the internal ground ring using an insulated #2 AWG (or larger) stranded conductor.

The following connections shall be made directly to the internal ground ring (halo) using green jacketed/insulated #6 AWG or greater stranded copper wire (except where noted):

- Ventilation louvers and sheet metal duct-work.

- Metal doors shall be grounded to the door frames (using 1 inch wide solid copper flexible/braided straps) and door frames shall be connected to the internal ground ring (halo) with green insulated #2 AWG stranded conductor.

- Air conditioning and heating units.

- Fire suppression equipment and piping.
- Tower lighting system equipment and controls.
- Telephone terminal block enclosure, Telco repeaters and line surge protectors (#6 AWG is recommended).
- All microwave and radio system infrastructure equipment racks/cabinets, shelves, annunciator panels, and cable trays.
- Generators may have a separate ground system that must be ultimately be connected to the single point ground system via the external ground ring.
- All exterior (building entry) metallic conduit feeds (i.e., telco service, electrical service, tower lighting, etc.) that enter the shelter.
- Coaxial transmission line, microwave waveguide, and lightning arrestors.

All power distribution equipment such as breakers panels, disconnects, transfer switch, surge suppressors, conduits, UPS, battery racks shall be bonded to the grounding system. All power distribution neutral cabling shall be individually bonded to the ground as feasible.

- All connections made to the bulkhead panel(s) shall use non-oxidizing material. The type of connectors to be used to ground the equipment to the internal ground ring (halo) shall be of the split-bolt, bronze mounting lug, and the parallel connector types, for example, BURNDY KSU or equal. These connecting wires shall be such that sharp bends are avoided.
- The shelter external and internal ground rings shall be bonded together with #2 AWG bare solid tinned copper wire. The entrance to the equipment shelter ground system shall be made through a 3/4 inch PVC pipe terminated with bushings 6 inches above the finished floor (AFF) and 6 inches below finished grade (BFG). The PVC pipe shall follow the contour of the foundation. Each ground wire shall terminate at the corner ground rods and shall be bonded. The ground wire shall run vertically along the wall supported by 2-inch insulated standoffs similar to T&B, TY-RAP nylon standoff brackets (short). The PVC pipe shall be sufficiently filled with a duct sealing compound, O-Z/GEDNEY DUX1 or equivalent, through the interior

side of the shelter (this compound shall act as a water stop and moisture barrier). Alternatively, the supplier may use a Polyphaser Earthed Entrance Panel which will connect to the ground ring with copper strap, to which may be attached the halo and other internal building ground connections.

10.4.4 ***Ground Resistance Testing***

A component of the system acceptance test plan to be completed by the supplier shall be the testing of all existing grounding systems and any grounding systems installed, or utilized, for equipment associated with this procurement. This includes grounding at all base stations, dispatch centers, control stations and microwave terminal/repeater sites associated with this procurement.

All grounding systems shall be tested using an AEMC, or equivalent, clamp-on ground resistance tester or Biddle 500V Null Megger or equal (3-terminal fall-of-potential method). The resistance to ground shall measure 5 ohms or less.

Ground tests shall be conducted in the presence of a County installation representative and results shall be recorded on a form approved by the St. Marys County Project Manager. These forms shall be included as a part of the acceptance test documentation and are a component of final acceptance of the radio communications system.

10.4.5 ***Lightning Protection***

Coastal Maryland is quite susceptible to damaging, seasonal storms with severe lightning, and the County requires the supplier to significantly reduce possible system damage and failure due to strikes or induced currents. The supplier shall adhere to current best engineering practices in providing maximum protection to sensitive electronic equipment. At a minimum, the supplier shall comply with the following lightning practices. The County requires the supplier to supply its current internal Site Installation Best Practices Guidebook and/or Communications Site Installation Standard manual for review.

10.4.5.1 Tower Lighting Control

Tower lighting controls shall be equipped with gas tube surge arrestors which will prevent a lightning strike to the tower or lighting system from back feeding into the electrical distribution system of the equipment shelter. This device shall shunt surges to the tower grounding system, and shall protect the tower lighting controller. An acceptable protector is Polyphaser IS-7WFU (single flasher unit) or IS-12WFU (dual flasher unit).

10.4.5.2 Radio Frequency Transmission Lines

Each transmit transmission system shall be protected by coaxial surge/lightning protectors, Polyphaser IS-CT50HN or equivalent, between the transmitter combiner output and the antenna. Lightning arrestors shall be grounded to the bulkhead panel.

On each receive transmission system with a tower mounted amplifier, a Polyphaser IS-DC50LN series lightning arrestor, or equivalent, shall be installed in the transmission line.

Control stations shall be equipped with a coaxial lightning arrestor, Polyphaser IS-50NX-C2 or equivalent. These lightning arrestors shall be grounded to a 5/8-inch x 8-foot driven ground rod by a #2 AWG tinned solid copper wire attached to the rod using a bronze transition clamp.

Each transmission line shall be grounded at a point above the bend required to exit the tower-mounted cable ladder to the ice bridge leading to the radio equipment shelter or room. Each transmission line system shall also be grounded to the exterior shelter grounding buss bar near the shelter waveguide feedthru/bulkhead leading to the radio equipment shelter or room. Each transmission line system shall also be grounded to the interior shelter grounding buss bar near the shelter waveguide feedthru/bulkhead exiting the radio equipment shelter or room. These grounds shall be installed in accordance with the manufacturer's specifications, and shall be sealed against entry of moisture at any location where the outer sheath of the transmission line has been cut or removed.

10.4.5.3 AC Power Supply for Electronic Equipment

All AC-powered equipment to be installed in equipment shelters or rooms shall be equipped with a surge arrestor, (MOV/SAD/gas tube combination), in addition to any surge protection equipment which may be installed across the shelter/room power mains.

10.4.5.4 Telephone Circuits/Low Voltage Wiring

All telephone company circuits or other twisted pair cable that may enter an electronics equipment room or shelter shall be protected with gas tube surge arrestors. These arrestors shall be intrinsic to the punch blocks being used and shall be grounded to the equipment shelter/room ground ring.

10.4.5.5 GPS Receivers

If GPS receivers are used as frequency/time references in the proposed system, the antenna line shall be equipped with a gas tube surge arrestor, Polyphaser IS-MR50LNZ+6 or +15, or equivalent.

10.4.6 *Wiring and Devices*

Power conductor insulation shall be color coded (with tape at each termination end). Identification shall be by color tape (e.g., black-phase A, red-phase B, blue-phase C, white-neutral and green-ground). Branch circuit conductors shall be labeled (using Brady or approved equivalent wire markers) at each end with the appropriate circuit numbers. Generator set and A/C unit control wiring shall be labeled with the terminal numbers corresponding to the supplier's wiring diagrams furnished with the equipment.

All outlet boxes shall be surface-mounted metallic and suitable for the quantity of devices enclosed. Faceplates shall match the outlet boxes and identified circuit per building scheme. The outlet boxes shall be marked with the associated circuit numbers which shall follow the same numbering convention utilized in the breaker panel(s).

Radio equipment power feeds (from UPS power panel) shall contain separate identifiable white neutral conductors. Common or shared neutrals for these protected loads are unacceptable.

All wire for power, lighting, control and grounding systems shall be stranded copper with UL THWN/THHN 600V insulation, sizes as indicated. Minimum size for power shall be #12 AWG and minimum size for controls shall be #14 AWG.

Electrical equipment, such as UPS, generator, A/C (air conditioning units), heater, etc. shall be wired in accordance with manufacturer's wiring diagrams furnished with the equipment.

10.4.6.1 Commercial Power

St. Marys County will assist in arranging for commercial power installation to the meter at each base station/microwave radio site; however, the supplier has ultimate responsibility for coordinating electrical service and any other commercial facilities necessary to fully commission the site. The supplier has the discretion to select single-phase or three-phase electrical service as required by the proposed system design, but the County encourages the use of at least 200 Amp single-phase service where feasible (and 400 Amp service if required to meet expansion requirements). The County requires the supplier to size the incoming commercial service to at least double the channel capacity of the proposed system without the need to modify the

proposed service. The County requires the supplier to identify the required service, factoring in the expansion requirements, for each new or existing site in the proposed network.

St. Marys County requires that all new tower/shelter facilities be equipped with a six-stack meterboard to accommodate any future lessees/collocation tenants. The supplier is only responsible for supplying one service meter, as deemed sufficient by the electrical service provider, for County usage and the meterboard shall be prepped for the addition of five more service meters for collocation partners. The site compound meterboard shall be weatherproof, maintenance-free, consist entirely of galvanized steel construction, and be capable of withstanding sustained winds of up to 95 mph. The location of the meterboard stack shall be at the front of the site compound nearest the vehicular gate in a logical, unobstructing location with close proximity to the incoming electrical service.

The supplier is responsible for all power installation services past the service meter bay. Power feeds shall be buried and shall enter the building through minimum 4-inch conduits (Schedule 40 PVC is suitable) and an elbow described in the equipment shelter specification. All conduits feeding the equipment shelters shall be completely waterproof with gaskets and designed not to allow any water to ever enter the shelter. If a main cutoff switch is required outside of the shelter, this disconnect switch shall be padlocked with a Best lock (or equivalent) keyed to the County's specification.

10.4.6.2 *Conduits and Raceways*

All wiring inside of the building/shelter shall be enclosed in EMT (electrometallic tubing) with compression type fittings (setscrew type fittings are unacceptable). EMT shall be surface-mounted in a neat, professional manner and done so as not to create an effective ground loop that undermines the functionality of the internal grounding halo. UL-approved locknuts and grounding bushings (or EMT box connectors) shall be used at boxes and equipment enclosures.

- All wiring outside of the building/shelter shall be enclosed in heavy wall galvanized rigid steel conduit with gasketted fittings. Weatherproof grounding type hubs shall be used at boxes and equipment enclosures.

- All wall penetrations shall be sealed with weatherproof compounds and 20-year urethane-based caulk, or equivalent.

Empty, future use conduits that are exposed to exterior shall be sufficiently capped and waterproofed.

- Telephone company cable(s) shall be enclosed in GRS conduit.

- Flexible metallic conduit (UL "Sealtite" or approved equal) with UL fittings shall be used as final connections to all mechanical vibrating/rotating machinery (A/C units, heaters, motors, transformers, UPS and generator set, etc.).

- All new conduit routings shall be horizontally and vertically straight, neat in appearance, indicative of professional workmanship and conform to existing conduit routings. Where existing conduit supports are adequate, there shall be used. If new supports are required, these shall be installed at intervals in accordance with the NEC. Only structural members suitable for conduit supports shall be used; piping, HVAC ducts etc. shall not be used for conduit supports. Conduit support intervals shall be based on the NEC Table 346-12.

- Minimum size conduit shall be ½-inch diameter NPT trade size.

- Pre-fabricated equipment distribution panels are acceptable for providing AC power to individual pieces of equipment. All electrical circuits shall be uniquely labeled at breaker panel and at connection point closest to equipment connection.

- All unused or future use conduit shall be provided with nylon pull rope to facilitate cable pulling.

- Quantity two (2) 4-inch buried Telco Schedule 40 PVC conduits shall enter the equipment shelter at a point near the shelter entrance and connecting back to an area near the electrical service meterboard that will serve as the PSTN distribution point for the entire site compound. The Telco conduit shall be provided with nylon pull rope to facilitate cable pulling and both ends shall be capped and waterproofed initially.

- All buried conduits for commercial service, exterior generator, and/or tower lighting controls shall be of Schedule 40 PVC or equivalent and sized to accommodate any extra cabling necessary. All buried conduit shall be sealed with weatherproof compounds and 20-year silicon caulk, or equivalent.

10.5 EQUIPMENT SHELTER SPECIFICATIONS

10.5.1 *General Description*

For each site proposed by the supplier that does not involve an upgraded or refurbished equipment shelter, the supplier shall deliver in turnkey fashion a pre-fabricated, bullet-proof, high-wind resistant, concrete electronic equipment shelter with associated concrete foundation and ancillary equipment. The specifications included herein relate to minimum requirements and the supplier shall thoroughly define all features, options, and specifications related to the proposed pre-fab concrete shelters.

10.5.2 *Reference Standards*

Unless otherwise modified herein, materials, design and construction procedures shall be in accordance with ANSI/NFPA-70, National Electrical Code, all federal, state and local building codes.

10.5.3 *Submittal*

The supplier shall prepare and submit for approval, three (3) sets of engineering drawings of each shelter depicting its overall dimensions, electrical layout, equipment materials list, and general floor plan. These construction drawings shall be used, as required, for obtaining zoning/planning and building permits. The County shall conduct a detailed design review at the shelter manufacturing facility with the supplier and shelter manufacturer prior to the construction of the pre-fabricated shelters to determine all specifics of the final shelter construction.

10.5.4 ***Design Specifications***

10.5.4.1 Dimensions/Construction

For all new sites, St. Marys County requires the minimum equipment shelter to be sized at 12-foot (W) x 28-foot (L) x 10-foot (H), but the proposed shelter shall be sized at an area of no less than is required to house all newly-proposed equipment plus the future space for a minimum of 100% system equipment racking expansion. All shelters shall provide a minimum of 9.5-foot interior ceilings. The building and generator foundations shall be rebar-reinforced, concrete slabs installed in compliance with local building codes and meeting or exceeding a minimum compressive strength of 3000psi at 28 days. All above grade concrete work shall be formed and finished with a ¾-inch chamfer at all exposed edges. The foundation design shall be of a type to prevent the entry of rodents and pests into the shelter. A 40-inch (W) x 48-inch (L) x 12-inch (D) concrete entrance pad/stoop shall be installed at the entry door. The supplier shall provide a detailed description of the equipment building being proposed.

Shelter construction shall be exposed, washed concrete aggregate exterior with several coats of waterproof stain. The roof shall be a trowled surface exhibiting a 2-to-3-inch overhang around the perimeter of the building. Roofing shall be designed to prevent penetration by ice falling from the tower at the site. The roof shall be sloped to prevent accumulation of water. The base of the shelter that sits on the foundation shall be caulked around the perimeter with an exterior grade 20-year caulk that matches the color of the exterior finish. Interior walls shall be designed to allow mounting of electrical and electronic equipment using standard fasteners. Interior walls and ceiling shall be constructed of no less than 5/8-inch thick plywood with covered paneling. Interior walls and ceiling shall be insulated at a minimum with 1.5-inch thick R-11 grade foam insulation. Interior flooring, ceiling, and walls shall be reinforced with steel rebar as necessary to meet or exceed the proposed system design equipment loads. Interior flooring shall be covered with static-dissipative white industrial grade vinyl tile applied in 1-foot square tiles, mounted over the concrete subflooring. Base cove moldings of 4-inch or greater size shall be installed around all perimeter walls for a finished look that matches the chosen tile color scheme.

10.5.4.2 Design Loads

The shelter shall be minimally designed to withstand wind speeds of 150 miles per hour (mph). The shelter roof shall be designed to minimally withstand a load of 150 pounds per square foot (psf). The shelter floor shall be designed to minimally withstand a load of 300 pounds per square foot (psf) while factoring in all anticipated equipment floor loading for each site. The shelter shall be minimally designed to meet seismic performance categories A-E. As a minimum ballistic protection requirement, the shelter should meet Underwriter's Laboratory Standard 752 Level Eight (8) related to rifles and Level Six (6) relative to shotguns.

10.5.4.3 Doors

One 40-inch (W) x 84-inch (H) door shall be provided for entry in to the equipment room. The exterior door shall be of steel/aluminum design with a solid core. Doors shall be equipped with a Best mortise lockset and a single cylinder deadbolt lock. The lockset shall be protected on the exterior by an anti-prying plate. Hinges shall be tamper resistant to prevent removal of the pins from the outside of the shelter. The exterior doorway entrance and stoop shall be protected by an overhang or drip awning/canopy affixed to the exterior of the shelter to prevent water entry into the building. Doors shall be sealed using adjustable weather stripping and an adjustable saddle.

10.5.4.4 HVAC

Low ambient temperature air conditioning/heating equipment shall be provided. Electric heat strips or other devices shall be provided which will maintain the interior temperature of the shelter between 55 and 85 degrees Fahrenheit when outside temperatures are -5 degrees Fahrenheit or greater. Relative humidity shall be maintained at a level acceptable to the equipment to be furnished in this procurement. Redundant, exterior vertically wall-mounted HVAC units shall be utilized (or acceptable equivalent) to provide air conditioning/heating reliability in each shelter. The shelter shall provide an adjustable thermostat and the HVAC units shall provide a standard lead/lag switch control unit. Separate circuit breakers for each unit shall be installed in the main load panel. The outside portions of the units shall be weather-, rodent-, and tamper-proof. Air handling returns shall automatically louver and close in the event of a fire suppression activation so that a fire suppression agent discharge is not dissipated to the exterior. The HVAC units shall be designed to facilitate easy technician maintenance and preventive maintenance access for filter, compressors, etc. The HVAC unit shall be sized to meet the equipment loads specified in the proposal plus excess future capacity to support 100% system equipment racking expansion of the same equipment type. All HVAC equipment shall be supported by the emergency power generator. The HVAC system shall provide dry closure

alarm relay indications to the site alarm system and the NMS when a failure of either HVAC unit has occurred.

10.5.4.5 Power

A 120/240-VAC Single Phase service of no less than 200 Amps shall be provided under normal conditions to all equipment shelters unless specific site design criteria necessitates 3-Phase service. The AC service shall be sized to meet the specific equipment loads specified throughout the proposal plus excess future capacity to support 100% system equipment racking expansion of the same basic equipment type. AC power shall enter the shelter through a waterproofed, entrance elbow, which can be rotated to accommodate connection to conduit from the power company feed. A main fused cutoff/disconnect switch shall be provided outside the shelter with a provided enclosure lock, followed by a primary interior load center distribution panel backed up by emergency generator power which provides a minimum of forty (40) branch circuit breakers each rated for 20 Amps or greater.

The shelter shall be equipped with a properly-sized, interior uninterruptible power supply (UPS) and compatible exterior backup emergency generator configuration to support all of the shelter equipment in the event of loss of commercial power. The shelter shall be equipped with one or more wall-mounted UPS sub-panel(s) physically located in a logical fashion to minimize conduit runs and bends in order to serve rack-mounted equipment situated in the shelter. Each individual UPS sub-panel shall provide a minimum of thirty (30) branch circuit breakers each rated for 20 Amps or greater.

The shelter power distribution scheme shall provide for an emergency generator automatic transfer switch that switches between commercial and generator power. Generator power shall be supplied by a properly-sized external diesel genset that sits above an elevated fuel tank sized to provide seven (7) days of continuous backup power. The shelter shall also be equipped with a pre-wired, exterior, mobile genset receptacle in the event that the primary generator is rendered inoperable and a mobile, transportable generator assembly needs to connected to the shelter. The shelter UPS shall be equipped with a UPS Bypass Switch and cutoff for service mode and/or maintenance purposes.

The interior equipment room AC power shall be distributed in minimum ½-inch EMT conduit with cable-tray or rack-mounted distribution panels over top of each equipment rack footprint with enough outlets to independently serve each piece of AC-powered equipment. Each outlet shall be served on

separate circuits with each neutral separately grounded to the single point grounding system. Two (2), non-UPS but generator-fed wall-mounted duplex outlets at a height 2-feet above the finished floor shall be located on each wall separated in a logical fashion to easily facilitate technician testing anywhere inside the facility. The string of wall-mounted duplex outlets shall be served by one primary 20 Amp breaker. One (1), non-UPS but generator-fed wall-mounted, enclosed GFCI duplex outlet at a height 2-feet above the foundation shall be centrally located on each exterior wall separated in a logical fashion to easily facilitate technician testing anywhere outside the facility. The string of wall-mounted exterior GFCI duplex outlets shall be served by one primary 20 Amp breaker. One (1) wall-mounted, UPS-fed quad outlet shall be located near the shelter Telco service entry wall at a height of three (3) feet above the finished floor for PSTN power requirements. All -48VDC rectifier and power supply circuits shall ultimately be connected to the primary load center (with properly sized breakers as defined in the system design) backed up by the emergency generator, and each -48VDC rectifier/charger shall be interconnected to the load center from overhead using Seal-Tite flexible conduit or equivalent. The primary load center shall also be sized to accommodate the tower lighting control equipment, a wall-mounted microwave dehydrator, the fire suppression control equipment, the HVAC system, UPS, and all lighting requirements.

An all-mode surge arrestor device shall protect AC power mains. All electronic equipment in the shelter shall be protected by transient voltage suppressors. The primary suppression system shall be silicon avalanche diode type, with MOV backup (Northern Technology Model TCS250BL or equivalent). The TVSS units shall include a dry closure alarm relay, which shall be connected to the site alarm system and NMS.

All electrical equipment supplied shall be UL listed. The entire electrical installation and wiring shall be in strict compliance with the latest approved edition of the National Electrical Code and all state, County and local codes and ordinances.

10.5.4.6 Waveguide/Transmission Line Entry

One (1) 16-port, 4-inch diameter waveguide feed-thru assembly (or greater) with opening caps shall be installed at the opening of the shelter adjacent to the waveguide/ice bridge from the tower, and in alignment with interior cable ladders arranged over the equipment rack space (e.g., Microflect B1447, Polyphaser Earth Entry Port, Andrew part number 204673-8, or equivalent). The feedthru plate shall be equipped with rubber boots and with galvanized clamps to seal the coaxial transmission line to be supplied pursuant to this

procurement. Blank cable boots shall be used to seal all unused entry ports (Andrew or Microflect). A quantity of sixteen such blanks shall be shipped installed on the waveguide entry panel to prevent entry of birds, insects, or rodents during shipping or installation of the equipment shelter. The waveguide entry port shall be attached to the exterior ground ring by #2 AWG solid copper wire or by copper ground strap.

10.5.4.7 *Cable Tray/Ladder*

A minimum 24-inch wide cable tray ladder shall be installed over all equipment rack spaces, and to the telephone equipment panel, and to any future equipment expansion space in the shelter. Two (2) cable bridge sections shall be included to link each distinct ladder assembly above each equipment racking row to facilitate minimal inter-racking cable runs. Cable tray sections shall be bonded to one another and to the building ground halo by #2 AWG copper wire and compression fittings. The cable tray ladder shall be suspended from the ceiling using a unistrut style hanging fastener and the ladder design shall support all equipment and power cabling to support the proposed system plus the stated expansion requirements. Corner clamps and bolts shall be used all cable ladder connection points to stabilize the entire ladder configuration. The ladder configuration shall be no lower than 8.5-feet above the finished floor and shall be designed not to obstruct any overhead lighting, fire suppression, or power cabling.

10.5.4.8 *Lighting*

The shelter shall provide sufficient interior lighting to provide a level of 75 foot-candles at 3 feet above the floor. Light shall be provided by fluorescent fixtures using two standard four-foot tubes per fixture. The switch for the light fixtures shall be located inside and next to the entry door. Light fixtures shall be installed to the front and rear of electronic equipment racks to provide sufficient lighting for service personnel to perform equipment maintenance. In the event of loss of shelter power, the shelter shall be equipped with an battery-powered emergency exit sign and lamp to guide an individual safely out of the shelter. The emergency light fixture shall automatically sense the loss of shelter power and immediately activate.

Exterior lighting shall be provided adjacent to the entry door to the shelter and on the far side of the equipment shelter opposite the entry door to illuminate as much of the shelter area and site compound as possible. A photoelectric switch that allows automatic illumination and extinguishment at twilight and sunrise shall control this exterior lighting. Exterior lighting shall be rated at 100 Watts (or greater), heavy-duty, shatter, and tamper-resistant.

All interior and exterior lighting shall be backed up by the emergency generator.

10.5.4.9 Fire Suppression

Each new shelter shall be equipped with a complete FM-200 fire suppression system. Per NFPA guidelines, the FM-200 fire suppression system shall be engineered to discharge enough suppressive agent in the proper timeframes to extinguish a fire caused by the equipment associated with the new system as well as the future shelter racking expansion requirements. The supplier shall conduct field testing of the FM-200 system to demonstrate that the engineered FM-200 system contains enough agent to dissipate a fire in the specified shelter volume within the NFPA-specified timeframes. The FM-200 fire suppression system shall also include: an interior and exterior horn and strobe assembly to warn/notify of discharge, ionization smoke detector, photoelectric smoke detector, abort station, manual release, pre-alarm bell, annunciator control panel with battery backup, and agent cylinder with associated piping. Other co-located environmental systems such as HVAC air flow systems, fuel control systems and ventilation systems shall be automatically coordinated with the activation of the fire suppression system to ensure expedient suppression of fire conditions per NFPA standard guidelines. The FM-200 system shall be backed up by the emergency generator. The FM-200 system shall be interconnected to the NMS system for remote monitoring and control.

10.5.4.10 Shelter Alarms

At a minimum, the following alarm inputs shall be installed and connected to a centralized shelter alarm punchblock which feeds the radio alarm system and NMS with individual alarm indications. The supplier is responsible for identifying the alarm type (i.e., Normally Open, Normally Closed, etc.), interconnecting, and testing every shelter alarm point with the proposed system NMS.

- Tower Light Alarms (Strobes, Marker Side Lights, Power Fail)
- Fire/Smoke Suppression (Activation/Discharge, Power Fail, Smoke Detector, On Battery, Heat Detector)
- Intrusion (Door Entry) Alarm
- High Temperature Alarm
- Low Temperature Alarm
- High Humidity
- Commercial Power Failure Alarm

- TVSS Failure
- Automatic Transfer Switch (Normal, Emergency)
- Generator Alarms (Engine Run, Low Fuel, Oil Pressure High/Low, Overcrank, Overspeed, Engine Temp, Coolant Levels, Coolant Temperature High/Low, etc.)
- Leak Detection/Water on Floor
- HVAC Alarms (Compressor Fail, Power Fail, etc.)
- UPS Alarms (Summary Alarm, On Bypass, Battery Status Normal/Low, Normal On/Inverter, etc.).

10.5.4.11 Miscellaneous

The proposed shelter shall also include the following miscellaneous equipment: CO_2 fire extinguisher, dry chemical fire extinguisher, leak detection, document holder for as-built manuals, eye wash station with integrated water catch basin, interior and exterior RFI and FM-200 warning placards, tower ASR number sign, contact information sign, and wall-mounted tower lighting control boxes.

10.6 TOWER SPECIFICATIONS

10.6.1 *New Tower Facilities*

The County anticipates that the supplier will be required to provide a number of new communications towers as part of the proposed design. The County prefers the use of self-supporting, lattice-style steel towers to minimize the site compound footprint, but properly-supported guyed towers shall be acceptable if the proposed tower meets all design requirements and if enough land is available. The supplier shall provide a structural load analysis for all proposed structures in accordance with the required design loads specified in the Appendix. All new towers shall be designed to fully support the proposed system design antenna load (RF and microwave) including all transmission cables, miscellaneous appurtenances, amplifiers, ice shields, lightning rod, mounts, etc. as well as the additional future loads identified in the Appendix. For all new towers proposed, a structural load analysis is required to be compliant with TIA/EIA-222 (latest revision) factoring in as-built and future load considerations.

10.6.1.1 Structural Load Analysis – Existing Sites

For County-owned towers currently used in the existing radio system, a structural load analysis is required prior to deploying any additional load on the structure, either temporarily or permanently. For all other towers proposed in the above listed categories, a structural load analysis is

required, compliant with TIA/EIA-222 (latest revision) to identify the baseline and future load capacities.

10.6.2 ***Reference Standards***

Unless otherwise modified herein, materials, design and construction procedures for any towers proposed by the supplier shall be in accordance with the latest version of Electronic Industries Association (EIA) standard EIA-222, Federal Aviation Administration (FAA) Advisory Circular AC 70/7460-1G, ACI/ASTM concrete standards and all applicable local codes.

10.6.3 ***Submittals***

The supplier shall prepare and submit for approval, scale drawings of the tower depicting its overall height, the number and height of sections, the horizontal spread of each section, guy points (if applicable), antenna loading at specified heights, engineered failure points (if applicable), and obstruction lighting details.

For each tower, the supplier shall submit for approval a profile view of the tower containing structural details and engineering notes as well as a comprehensive tower foundation design with a supporting geotechnical analysis. Any documentation on the tower needed by the County for planning approvals shall be supplied. Drawings shall be sealed by a registered professional engineer (structural) licensed in the State of Maryland.

10.6.4 ***Antenna Towers***

10.6.4.1 Height

Tower heights, excluding appurtenances, shall be as specified by the supplier to meet or exceed the specified system coverage performance levels.

10.6.4.2 Materials

All galvanized steel materials used in the construction of the towers shall be new, and shall conform to the provisions of EIA-222 (latest version) with respect to physical properties, manufacture, workmanship and factory finishes.

10.6.4.3 Loads and Stresses

The design of the tower shall take into account dead and live loads induced by the structure itself and all appurtenances, and all stress applied to the tower and its appurtenances by wind forces. The minimum safety factors

listed by EIA-222 (latest version) shall apply under the most severe combination of dead load plus live loading. The proposed tower design shall factor in all applicable strength limit states and serviceability limit states as defined by the current version of EIA-222. Towers shall properly be categorized and reliability requirements determined appropriately per EIA-222 for each structure incorporating the relevant environmental loads for St. Marys County such as wind, ice, seismic, and foundation loading.

Wind loading and wind gust load factors shall be calculated per EIA-222 (latest version), with all appurtenances installed plus the required future system growth factor. The structures shall also be designed per EIA-222 (latest version) to withstand additional horizontal wind pressures and dead loading produced by the accumulation of radial ice. Each tower shall be designed to meet twist, sway and displacement specifications for all loading conditions as recommended by EIA-222 (latest version) for the antennas proposed by supplier.

10.6.4.4 *Appurtenances*

The proposed self-supporting towers shall be designed to support all required immediate and future appurtenances. Appurtenances include, but are not limited to, the following: antennas, antenna mounts, antenna platforms, microwave antennas and radomes, lighting, transmission line, transmission line hangers, cable ladder, climbing ladder and safety device, lightning rods, conduit, waveguide bridge, lighting control, amplifiers, and ice shields. The tower shall be equipped with an integrated lightning rod as necessary.

10.6.4.5 *Antenna and Transmission Line*

The towers shall be designed to support, at minimum, the antennas and transmission lines proposed by the supplier plus a future use growth factor as specified in the Appendix. All transmission line assemblies shall be grounded to a copper grounding buss bar at the base of the tower at the junction between the waveguide ice bridge and the tower waveguide ladder. The copper grounding buss bar shall be affixed to the base of the tower to facilitate this grounding interconnection. All transmission lines shall be installed with a proper drip loop or bend radius at the tower base transition so as to prevent the flow of water into the shelter.

10.6.4.6 *Transmission Line Support*

A 24-inch wide waveguide transmission line cable ladder pre-drilled, for universal snap-in hanger kits shall be installed along each face of the tower and each ladder assembly shall extend the entire height of the tower (as

feasible). The cable ladder shall be of galvanized steel construction, and shall have mounting hardware of stainless steel or galvanized steel construction. No drilling of the tower legs or cross bracing shall be required to install the cable support device.

Transmission lines shall be attached to the transmission line cable ladder using stainless steel hangers and adapters of the appropriate size for the transmission line supplied. Hangers shall be Andrew models 43211, 42396A-1, 2, 4, 5, 9, or equivalent. Andrew E Angle Adapter, or equivalent, kits shall be used to attach the hangers to the transmission line support ladder. Hoisting grips shall also be used as necessary to properly support and install the transmission line assemblies.

Transmission line shall be supported on the cable ladder or ice bridge at intervals of not more than six feet, or as recommended for 100 mph wind with ½ inch radial ice. (Andrew LDF5-50A, if used, shall be supported at intervals of 5.5 feet or less; LDF4-50A should be supported at intervals of three feet or less).

A 12-foot high waveguide bridge/ice shield shall be installed between the tower and the equipment room/shelter to support transmission lines and to protect them from ice falling from the tower or antennas. The waveguide bridge shall be designed to accept support devices to properly attach the transmission lines at the intervals specified above. The waveguide bridge shall be supported by galvanized steel pipe columns if any horizontal span is 10 feet or greater, or if so required by local building codes. Galvanized steel construction shall be used for the entire waveguide bridge and its ancillary components. A 48-inch wide grip strut grating type of waveguide bridge is required to reduce snow accumulation. The supplier shall provide the necessary suspended hanger kits for use with the waveguide bridge to properly secure all transmission line and tower cabling at maximum interval spacings of no more than 3-feet between the tower and shelter. Microflect waveguide cushions, hangers, and crosses are the preferred method of attachment to the waveguide bridge. The waveguide bridge shall be properly secured with concrete footers or piers of a depth no less than 30 inches, and every post of the waveguide bridge shall be bonded to the site single point grounding system.

10.6.4.7 *Lighting and Controls*

The towers shall be lighted and/or marked in accordance with the applicable chapters of FAA Advisory Circular AC 70/7460-1G, or latest revision, as required by the particular Aeronautical Study performed by the FAA for each tower.

Activation of any required lighting systems shall be via a redundant light-sensitive, photoelectric type switch and controller which will activate the lights at dusk (or other cloud-darkened condition) and extinguish the lights at sunrise. If a dual lighting system is required at any site, the controller shall automatically switch from red lights at sunrise to strobe lights, and back to red lights when the sky darkens.

Wiring for the tower lighting shall be enclosed in rigid galvanized steel conduit, which shall be vented sufficiently to eliminate condensation buildup. Wiring and conduit shall be provided and installed in conformance with the tower manufacturer's specifications and in accordance with local electrical codes. Tower lighting control and electrical cabling shall be affixed with hanger kits to the tower waveguide ladder in the same manner as transmission line.

The tower lighting control system shall be equipped to provide Form-"C" dry contact closure alarm indications of bulb failure for strobes, marker side lights, and power failure which shall be connected to the NMS system. The tower lighting control system shall also provide dial-up telco connectivity with a modem for remote diagnostics of the tower lighting system. All tower lighting control equipment shall be wall-mounted and installed inside of the pre-fabricated shelter in a manner so as not to obstruct any of the useable racking footprints. The supplier shall properly ground all tower lighting control boxes and equipment to the facility single point grounding system. All tower lighting control equipment shall be backed up by the emergency generator power system.

10.6.4.8 *Ice Shields*

Each tower shall be equipped with steel mesh ice shields to be installed above each of the microwave antennas to fully protect parabolic dishes, microwave antennas, and waveguide from falling ice. The ice shield shall cover the width and length of the dish, microwave antenna and cabling it is intended to protect.

10.6.4.9 *Climbing Ladder*

Each tower provided shall be equipped with an OSHA-approved climbing ladder with safety climbing cable with belt that extends the entire length of the tower (as feasible).

10.6.4.10 *Grounding*

The supplier shall bond all tower legs to the site compound single point grounding system using a minimum #2 AWG bare tinned copper wire which shall be bonded exothermically (Cadweld) to the site ground ring. The entire perimeter of the tower foundation shall be surrounded by a ground ring using ¾-inch x 10-foot copper clad ground rods spaced a maximum of 16-feet apart and interconnected using a minimum #2 AWG bare tinned copper wire. The tower ground ring shall be interconnected with the ground rings that surround the exterior generator and shelter to create a single point site compound grounding system. All grounding of the tower shall be in conformance with the specifications provided in ANSI/IEEE Std 142-1982, and the guidelines contained in this specification.

10.6.5 *Scope of Work*

Supplier Responsibility: The supplier shall be responsible for: obtaining all permits/authorizations; designing and installing suitable tower foundations for all associated hardware and appurtenances; designing, manufacturing, shipping, and erecting the towers, for providing all project management, construction management, testing, and installation services necessary for tower erection and for site restoration/cleanup. The supplier shall be responsible for ensuring that the tower meets or exceeds all design criteria, labor services, guarantees and installation requirements contained in these specifications, or in national or industry standards to which this specification refers.

County Responsibility: St. Marys County will provide an installation representative as necessary to coordinate field installation activities and to act as a liaison between the supplier, and the property owner (if the County is not the property owner).

Scope: The work to be performed under this section of the specification shall include: site preparation, tower erection, installation of antennas, transmission lines, lighting systems, ice shields, climbing ladders, cable ladders, waveguide bridges, antenna support brackets, platforms, tower foundations, tower lighting controls, lightning rods, grounding systems, guy anchors (if applicable), and touch-up of any nicks in the galvanizing or paint. The supplier is responsible to dismember and remove any existing antennae and support cables as required by the County if the re-use of a County tower is determined by the supplier. The supplier is responsible for all site/tower enhancements to existing facilities.

10.6.5.1 Construction

Soil Analysis: The supplier is responsible for geotechnical exploration at the locations of each tower leg, tower foundation or guy anchor point. A geotechnical engineer licensed in the State of Maryland shall be employed to

perform soil exploration and analysis. A copy of the soil reports prepared by the geotechnical engineer shall be furnished to the County by the supplier prior to commencement of work.

Foundation Design: The proposal price for the foundation design will be assumed to be based on presumptive soil conditions as defined by the latest version of the EIA-222 standard. The County recognizes that the final foundation design and price shall be determined when the geotechnical report is provided to the supplier. At such time as the geotechnical report is available for each site, presumptive soil conditions shall be compared to the actual soil conditions to adjust (positively or negatively) the final foundation design price.

The supplier shall meet or exceed the requirements outlined in the latest editions of ACI301 and ACI318 as it pertains to workmanship and materials. Concrete test cylinders shall be properly cast with copies of all test reports being provided to the geotechnical engineer for review and analysis. The supplier maintains complete construction management and engineering responsibility for ensuring that the foundation and tower design(s) have been met and are in compliance with geotechnical reports during the tower foundation and erection process. All field certification and reports shall be provided to the County as performed.

Site Plan: A site plan shall be prepared for County site plan and conditional use permit approval at each site at which construction of a tower or installation of an equipment shelter is required. The supplier shall install the tower and shelter in conformance with the site plan. The supplier shall note that regardless of its size at the base, the tower shall be installed such that a minimum 10-foot spacing is maintained between the building and the tower face nearest the building.

Power: The supplier shall be responsible for connecting to the commercial AC power at the meter. Temporary power may be required for the obstruction lighting on the tower during construction. The supplier is responsible for arranging and installing this temporary power. Temporary obstruction lights shall be installed while the tower is being erected.

FAA Notification: The supplier is responsible for meeting all FAA required notifications and preparing, on behalf of the County, the Antenna Site Registration (ASR) for the location.

10.6.5.2 Painting

If the FAA Aeronautical Study requires any tower to be painted, the paint shall be applied at the factory with touch up painting to be completed at the site. Touch-up galvanizing, if needed, shall be done in dry weather. Galvanizing shall not be applied over wet surfaces. The County highly encourages the supplier to avoid communication sites that require tower painting to minimize long-term maintenance costs.

10.6.5.3 Site Landscaping

The supplier shall be responsible for landscaping, grading, and seeding of the disturbed soil. The supplier shall adhere to any buffer zone and landscaping requirements as outlined in applicable local or State ordinances. The supplier shall use fescue grass seed at all tower sites. The supplier shall restore the site to its original condition and properly address all grading and drainage requirements to County satisfaction.

10.7 GENERATOR SPECIFICATIONS

The supplier shall furnish standby emergency power generators where required and upgrade existing generators as required to meet the backup emergency power requirements for each site facility. No generator is currently required for the existing ECC facilities.

10.7.1 *General Requirements*

The supplier has the responsibility to design, provide, install, and test a complete and operable standby, heavy-duty diesel-powered generator designed for continuous operation over a multi-week period with associated automatic transfer switch inside each electronic equipment shelter used in the network. Equipment shall be factory tested new at 0.8 power factor for 3 hours, and shall be installed in a standard outdoor cabinet placed above an elevated steel fuel tank on a concrete pad foundation in the radio site compound. Generators provided by the supplier shall be designed for the intended use of network support and shall include all necessary shielding to protect the network from electrical noise, if any, caused by the generator. The generator must be of a size as to fit within the shelter compound and provide sufficient room around the entire unit for technicians to perform maintenance on and fuel the device while it is in operation.

10.7.1.1 Type of Generator

Generators shall be an exterior-housed, weatherproof, diesel-powered four-cycle, engine-driven set with a low reactance brushless generator. Generator sets shall be equipped with a temperature compensated automatic

voltage regulator with underspeed/overspeed protection function, a control panel, and high ambient temperature cooling system.

The County reiterates the importance of providing a heavy duty generator designed for continuous operation over a multi-week period. As has been learned following major hurricanes and other events of nature, electrical outages can last for protracted periods of time calculated in weeks instead of days. The proposed generators should be designed to continuously operate under full load for a period of up to fourteen days with a fuel tank capacity for seven days of continuous duty at full load.

10.7.1.2 *Ratings*

Output power rating of the generator shall be based on the load requirements of the supplier's proposed system equipment complement and shall provide for 100% excess expansion load capacity (above immediate site load requirements). The generator shall be capable of full single-phase output @ 1.0 pf.

Site conditions include the following:

Voltage Regulation: +/- 2% of rated voltage for constant load between no load and full load.

Frequency Regulation: .5% from steady state no load to steady state rated load.

Single Step Load Pickup: 100% of rated output power, less applicable de-rating factors, with the engine-generator at operating temperature.

10.7.1.3 *Generator Set Control/Alarms*

The generator shall be a remote start type compatible with the automatic transfer switch to be supplied pursuant to this procurement. Manual starting and stopping shall also be provided from the generator control panel.

Specific generator control functionality shall include the following:

Cranking Control: Generator shall provide a minimum of three cranking cycles of at least 15 seconds before lockout and activation of an overcrank alarm condition.

Generator Protection Controls: (per NFPA 110). The generator shall shut down and lock out upon: (1) failure to start (overcrank), (2) overspeed, (3) low lubricating oil pressure, (4) high engine temperature/low coolant.

Alarms: Individual alarm contacts shall be provided to allow transmission of fault alarms for any of the above conditions, plus low oil pressure pre-warning, high coolant temperature pre-warning, low coolant temperature, low coolant level, utility power failure, generator overcrank shutdown, generator overspeed shutdown, low fuel and an alarm indication when the generator set is running. These individual alarm contacts shall be wired into and shall be reported to the NMS system being supplied pursuant to this procurement. All generator alarm wiring and sensor points shall be implemented and tested by the supplier to both the interior shelter alarm punchblock and NMS system.

Meters: Meters shall be provided to indicate output voltage, output current, running time, frequency/RPM. An AC rheostat shall be supplied for voltage adjustment.

10.7.1.4 *Fuel Supply*

The supplier shall provide an above-grade, painted and galvanized steel diesel fuel tank (on which the exterior generator sits) for the generator near the equipment shelter and which is easily accessible for refueling. The fuel tank shall provide sufficient fuel to provide no less than seven (7) days continuous operation of the generator set at full load under low ambient temperature (0 degrees Fahrenheit). The tank shall be filled completely before conducting acceptance tests and any recommended fuel stabilizers shall be added to the fuel supply to properly condition the fuel supply. The fuel tank shall provide a visual analog fuel gauge meter or display to identify the available diesel fuel level. The complete generator fuel tank shall be bullet-resistant.

The fuel tank and its lines shall be above grade and all fuel lines shall be insulated to reduce condensation at the regulator. Above grade components shall be protected from manmade assault or act of nature. All necessary regulators, drip pots, piping, meters, or other supplies needed for an installation which meets local fire and building codes shall be furnished and installed. The supplier shall provide a full fuel tank at all sites at the time of final system acceptance. The fuel tank and generator shall both be bonded to the site compound single point grounding system using an exothermic connection (cadweld) of #2 AWG tinned bare copper wire.

10.7.1.5 *Exhaust System*

A residential grade exhaust silencer shall be installed on the generator for noise suppression.

10.7.1.6 *Battery and Charger*

A lead acid starting battery rated for the engine type to be supplied shall be furnished and installed with the generator set. This battery shall be float charged by a 10-amp voltage regulated charger, which is powered by 120 volts AC. Float, taper and equalize charge settings shall be provided.

Form-C alarm contacts shall be provided and connected to the shelter alarm and NMS system to report loss of AC power, low fuel level, status of battery charger, and power on conditions.

10.7.1.7 *Cooling System*

A radiator-cooled engine is required. The radiator shall be filled with a water and coolant mixture in accordance with the engine manufacturer's recommendations. A thermostatically controlled water jacket coolant heater shall be provided and installed in accordance with the manufacturer's recommendations.

10.7.1.8 *Housing*

The generator set shall be mounted on top of the elevated steel diesel fuel tank. The housing/mounting assembly shall be equipped with the proper bushings, springs and anchoring to properly support the generator on top of the elevated fuel tank while actively running. The weatherproofed generator housing shall provide the appropriate exterior screening and shielding to provide rodent control and eliminate rodent/pest access. The complete generator housing shall be bullet-resistant. The generator control panel and all access doors shall be secured by a key lock mechanism to prevent unintended generator access. The generator housing shall provide sufficient protection to the generator and internal electronics in the event of driving rain, hail, and blowing snow conditions.

10.7.1.9 *Foundation*

The supplier shall supply an exterior concrete pad foundation for the generator/fuel tank assembly in close proximity to the prefabricated equipment shelter. A minimum 6-inch concrete slab (or greater) rated at 3000 psi at 28 days installed over compacted soil shall be provided as the

design load specifies for the generator/fuel tank assembly. The proposal price for the generator foundation design shall be assumed to be based on presumptive soil conditions. The final foundation design and price shall be determined when the geotechnical report is provided to the supplier. The supplier shall meet or exceed the requirements outlined in the latest editions of ACI301 and ACI318 as it pertains to workmanship and materials. Concrete test cylinders shall be properly cast with copies of all test reports being provided to the supplier's geotechnical engineer for review and analysis. The supplier maintains complete construction management and engineering responsibility for ensuring that the generator foundation design has been met during the generator deployment process. All field certification and reports shall be provided to the County as performed.

10.7.1.10 *Documentation*

The following documentation shall be supplied to the County for each generator set and transfer switch supplied or upgraded:

- Specification and data sheets for the exact type and model generator and transfer switch supplied pursuant to this procurement, including all options and accessories
- Manufacturer's certification of prototype testing
- Manufacturer's warranty documents
- Shop drawings showing plan and elevation views of the equipment
- Interconnection wiring diagrams showing all external connections required; with field-wiring terminals marked in a consistent point-to-point manner
- Manufacturer's installation instructions
- Operator's and maintenance manuals that outline routine maintenance and trouble shooting procedures
- Transfer switch manual and wiring diagrams.

10.7.1.11 *Warranty*

A no-deductible warranty, which provides for on-site 24x7x365 service by a factory-authorized service contractor, shall be provided. This warranty shall provide coverage against all defects in materials and workmanship for a period of two years from the final acceptance date of the radio communications system.

10.7.1.12 *Start-Up Service*

A factory authorized service representative shall provide initial start-up service and shall conduct acceptance testing at each site at which generator equipment is installed. All testing shall be witnessed by the County and test records shall be furnished to the County.

10.7.2 ***Transfer Switch***

An automatic transfer switch, which provides switching of the equipment shelter electrical load between commercial power and generator power, shall be supplied and installed for each generator set. The transfer switch shall be completely factory-assembled and shall contain electronic controls designed for surge voltage isolation, with voltage sensors on all phases of both input power sources. Permanently-attached manual handles shall also be installed on the transfer switch. The switch shall provide positive mechanical and electrical interlocking and mechanically held contacts. Quick-make and quick-break contact mechanisms shall be provided for manual transfer under load.

The transfer switch shall be installed in a key-locking, UL-listed, wall-mounted NEMA cabinet. The transfer switch shall be fully wired and integrated with both the stationary exterior engine generator set and the mobile generator hookup receptacle (in case temporary genset has to be placed in service at site) in accordance with local electrical and fire codes.

All transfer switches and accessories shall be UL-listed and labeled, tested per UL Standard 1008 and CSA Approved.

10.7.2.1 General Specifications

Transfer switches shall be double-throw electrically and mechanically interlocked and mechanically held in both positions.

Main switch contacts shall be high pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishment. Arc chutes shall have insulating covers to prevent interphase flashover.

Form-C contacts shall be provided in each position for alarm reporting purposes to the shelter punchblock and NMS system. These contacts shall be connected and tested to the network alarm system for NMS reporting transfer status.

The transfer switch shall be continuously rated for operation in ambient temperature ranges of -30 to +60 degrees Celsius. Transfer switches shall be rated to carry 100% of the rated current in the enclosure.

10.7.2.2 *Automatic Controls*

Transfer switch control shall be solid state and designed for a high level of immunity to power line surges and transients. The device shall be tested in accordance with IEEE Standard 587-1980 (or latest revision). Controls shall have optically isolated logic inputs and isolation transformers for AC inputs. Relays shall be installed on all outputs.

Solid state undervoltage sensors shall simultaneously monitor all phases of the standby power source and the commercial power source. Pick-up and drop-out voltage settings shall be adjustable. Voltage sensors shall allow for adjustment to sense partial loss of voltage on any phase.

Controls shall be provided with solid-state overvoltage sensors, adjustable from 100-130% of nominal input voltage to monitor the source. An adjustable time delay shall be provided.

Automatic controls shall signal the engine-generator to start upon signal from normal source sensors. A time-delay start, variable from 0 to 5 seconds, shall be provided to avoid nuisance start-ups. Battery voltage starting contacts shall be gold, dry type contacts, which have been factory wired to a field wiring terminal block.

The switch shall transfer when the emergency source reaches the set point voltage and frequency. A time delay shall be provided for transfer, which is variable from 0 to 120 seconds.

The switch shall retransfer the load to commercial power after a time delay retransfer. This time delay shall be variable (adjustable) from 0 to 30 minutes to avoid short engine run times. The retransfer time delay shall be immediately bypassed if the emergency generator fails.

A control shall automatically signal the engine generator to stop after a time delay, which shall be adjustable from 0 to 10 minutes, the time starting on return to commercial power.

Power for transfer operation shall be from the source to which the load is being transferred.

Diagnostic indicators shall be provided to allow the last successful step in the sequence of control functions to be pinpointed. The present status of the control functions shall also be indicated. These functions, at a minimum, shall include:

- Source 1 OK
- Start generator set
- Source 2 OK
- Transfer timing
- Transfer complete
- Retransfer timing
- Retransfer complete
- Timing for stop.

10.7.2.3 *Front Panel Control Devices*

A key-operated selector switch shall be provided which will provide the following functions:

Test - to simulate commercial power loss to allow testing of the generator set with or without transfer of the load

Normal - leaves the switch in its normal operating position

Retransfer - a momentary position, which will provide an override of the retransfer time delay and cause immediate return to the commercial power source (if available).

10.7.2.4 *Exerciser Clock*

The transfer switch shall be equipped with a digital, electronic exerciser clock which allows setting the day, time and duration of a generator set exercise/test period. Tests under load or with no load shall be selectable.

10.8 UNINTERRUPTIBLE POWER SUPPLY (UPS) SPECIFICATIONS

UPS systems shall be furnished by the supplier for each of the proposed base station transceiver sites. There shall be no potential for single point failure in the UPS design.

The proposed UPS system shall have minimum 4-hour battery back-up time assuming the initial and future expansion load criteria and shall incorporate single-phase input and output over current protection and maintenance bypass switch. The system shall be "on-line" ferro-resonant transformer technology or an alternate static Pulse Width Modulated (PWM) technology. The proposed UPS shall be UL 1778 and 1449 listed. Acceptable vendors are Powerware/Best, Liebert, APC, or an approved equivalent. The proposed UPS system shall be capable of battery backup expansion through the insertion of additional battery cabinets or modules.

10.8.1 ***General Requirements***

The supplier shall design, provide, install, and test a complete and operable UPS system for each electronic equipment shelter to be supplied pursuant to this procurement. Equipment shall be new, compatible with the proposed generators, and factory-tested with all results supplied to the County.

10.8.1.1 Ratings

The proposed UPS shall employ the latest, state-of-the-art, solid-state components incorporating microprocessor based Pulse Width Modulated (PWM) technology or ferro-resonant transformer design. The UPS system shall consist of free-standing cabinets consisting of a rectifier section, inverter section, batteries, isolation transformer, manual synchronized make-before-break bypass switch and input and output over current protective devices. The UPS shall also include all status and alarm displays, a remote interface communicator (typically RS-232 type), control devices, meters, components, cabling and connectors. Alarm monitoring and wiring shall be fully interconnected to both the shelter alarm punchblock and the NMS system.

The UPS and associated components shall be housed in heavy-duty reinforced steel freestanding finished cabinets requiring front access only. Batteries shall be housed within the UPS or, if necessary, matching cabinetry.

The UPS rating shall be based on the load requirements of the supplier's proposed equipment and shall provide for 100% excess expansion load capacity (above immediate site load requirements). The proposed UPS shall be designed and field-tested by the supplier to work in concert with the proposed generator equipment so that no power oscillation and unstable load transfer occurs due to UPS/genset incompatibilities.

10.8.1.2 *Description and Operation*

The capacity of the solid state rectifier section shall be sufficient to maintain the battery in a fully-charged condition and continuously supply the required load through the inverter while floating the battery.

The proposed UPS system shall not include any switching device or devices which will interrupt the continuity of power in any way.

The output voltage of the UPS shall be maintained within ± 3% over the nominal output voltage under any load conditions within UPS rating and ambient temperature range specified.

The sine wave output shall have a maximum of 5% total harmonic distortion over the entire range of output voltage at any load or power factor.

Automatic Frequency regulation shall maintain the output frequency to within ± 0.1 Hz for all combinations of temperature, input voltage variation and load variation. The output shall not follow the reference source beyond ± 0.3% Hz of nominal frequency. When input returns to normal, the UPS shall automatically synchronize to the line frequency.

The components shall be selected to provide sufficient voltage capability and ample current-carrying capacity to furnish reasonable margin for handling over-currents and minor voltage variations. In no case shall components be operated at greater than 80% of the device's maximum steady state rating.

The UPS shall be capable of withstanding, without failure, short circuit currents and surges of magnitude and duration in accordance with ANSI/IEEE Standard C62.41, categories A and B.

The UPS shall be capable of carrying 100% of the rated UPS output current continuously and shall be capable of carrying 150% of rated output current for approximately 10 minutes.

The system transient response shall be ±5% from nominal peak voltage for 100% load step. Voltage recovery shall be within 4 msec. to ±3% of nominal voltage.

The battery system shall be of the lead acid maintenance-free sealed, non-gaseous type with a minimum twenty (20) year life.

The rectifier shall maintain a DC output voltage regulation of ±1% with a maximum of 2% RMS ripple. The rectifier shall be of the solid-state full-wave SC bridge design to limit AC wave-shape distortion on the power system.

As a minimum, over-current protection (10KAIC circuit breakers or 100 KAIC C. L. Fuses) shall be provided for:

- AC Input
- Rectifier Input
- Inverter Input
- AC Output
- Battery Input.

10.8.1.3 *Accessories*

The following items shall be mounted on the instrument panel of the UPS cabinet via microprocessor-based LED or equal display (including lights/meters) for the following characteristics:

- Mode Select Switch (UPS Normal, UPS Bypass & Battery Modes)
- Input AC Voltage
- Battery DC Voltage
- Rectifier DC Voltage
- Output AC Voltage
- Output AC Amperage
- Output AC Frequency
- Synchronizing verification
- Low Battery DC Voltage Indication
- Static Switch Position Indication
- Manual bypass Mode Indication
- Float-Equalize Switch/Timer DC Circuit Indication
- % Rated Load Indication
- Battery back-up time available in Minutes.

The following conditions shall have audible and visual alarms in addition to dry contacts to be integrated by supplier with County NMS system:

- Low & High Battery Voltage
- Automatic By-pass operation
- Emergency Operation (UPS on Battery)
- Rectifier/Inverter Failure

- Common Summary Alarm (Form "C").

All external power and control connections shall be terminated on terminal blocks and identified clearly on wiring diagrams for the County's external connections. The UPS shall provide the ability to monitor the battery voltage and overall health of individual batteries/cells with an integrated battery monitoring system to easily identify compromised batteries.

The UPS cabinet and battery cabinet (if not in UPS cabinet) shall be provided with a ¼-inch x 1-inch copper ground bus with mechanical type lug connector to interface to County's single point grounding system. The UPS manufacturer shall indicate on applicable drawing(s) requirements for neutral-ground bonding per UL Listing qualifying as "Separately Derived System" per NEC Art. 250.

10.8.1.4 *Remote Alarms*

At a minimum for each UPS, the following alarms shall also be remotely and individually wired and tested by the supplier to the shelter alarm punchblock and NMS system:

- Over-voltage
- Frequency
- Load Drain
- Battery Normal
- Battery Low
- Summary Alarm
- On Bypass
- Normal/On Inverter.

10.8.1.5 *Documentation*

The following documentation shall be supplied to the County for each UPS supplied:

- Specification and data sheets depicting dimensions, weight, location of conduit entry, grounding, and wiring requirements and details for bolting assembly frames to floor
- Schematic wiring diagrams showing input and output protective devices and field connections, battery connections, interconnect wiring, controls and instruments
- Manufacturer's certified standard factory test data
- Manufacturer's warranty documents

- Manufacturer's installation instructions
- Manufacturer's Operating and Maintenance Manuals.

10.8.1.6 Warranty

A no-deductible warranty that provides for on-site 24x7x365 service by a factory authorized service contractor shall be provided. This warranty shall provide coverage against all defects in materials and workmanship for a period of two (2) years from the acceptance date of the radio communications system. All batteries shall be warranted for twenty (20) years on a prorated basis from the acceptance date of the radio communications system. No batteries shall be shipped and installed until the UPS system can be properly integrated into the equipment shelter and commissioned for use/charging.

10.8.1.7 Start-Up Service

A factory authorized service representative working on behalf of the supplier shall provide all electrical wiring necessary to commission the UPS, conduct an initial start-up service, and shall conduct acceptance testing at each site for which a UPS is installed. A complete load test of the UPS system shall be required which identifies actual field runtimes that meet or exceed manufacturer's specifications for the rated loads. The supplier shall also conduct field testing of the UPS and generator under full rated load to ensure that complete compatibility between the UPS and generator equipment. All test records shall be furnished to the County.

11.0 SYSTEM ACCEPTANCE TESTING

The Acceptance Testing Procedure (ATP) for all systems shall consist of a series of tests, inspections, and verifications that are generally defined in this section. System acceptance testing shall be conducted at several distinct junctures in the project as the integration effort unfolds. Much of the proposed network shall be tested with County witness both in a factory staging environment as well as the ultimate field environment prior to final system acceptance. A subset of the equipment (e.g., generator, UPS, tower, antennas, fire suppression, tower lighting, transmission line, etc.) shall only be tested with County witness in the ultimate field environment as practical, but all manufacturer factory test data shall be supplied to the County in conjunction with the final field testing.

The ATP testing process shall cover all factory and field testing procedures and those inspections that shall be made in order to show supplier compliance to the solicitation specifications as well as to define each and every required subsystem interface. All ATP test scripts and testing methodologies are subject to the ultimate approval of St. Marys County prior to the conducting of any customer witness testing. This section briefly defines some of the testing requirements, but the final test plans shall not be limited to the guidelines contained in this document. At least forty-five (45) days prior to the conducting of any contractual factory or field functionality testing, the County and supplier shall finalize the ATP for the equipment or systems under test. Based on field integration developments and scheduling, the County reserves the right to require the supplier to test or verify the required performance of any subsystem or piece of equipment at any time as deemed necessary by the County. The County requires the supplier to provide a comprehensive matrix of acceptance test scripts with explanation for factory staging, field staging, and coverage testing phases as part of this response to fully illustrate the depth at which the supplier typically conducts acceptance testing to guarantee quality.

The County's team and at least one system supplier's representative shall conduct these acceptance tests and inspections as defined. The results of the tests and the associated punchlist of outstanding items to be completed or re-tested shall be signed by both parties and forwarded to the County for review and acceptance. The outstanding items shall be resolved within seven (7) business days and these items shall be re-tested at no additional expense to the County. If the outstanding items have an effect on other previously performed tests, then re-testing of those tests shall also be included. Final acceptance of each individual subsystem shall include, but not be limited to, the list of tests and inspections contained in the following sections.

11.1 DETAILED DESIGN

St. Marys requires the supplier to perform a comprehensive detailed design prior to the commencement of any manufacturing or field integration work. The County will actively participate in the detailed design review of the system implementation with the supplier, and the County shall provide signature signoff upon completion of this work effort to trigger the manufacturing and field integration process. Completion of the detailed design review process shall take place upon mutual agreement between the supplier and County. Detailed design documents shall be supplied to County in both electronic (e.g., original native file format-MS Word, MS-Excel, AutoCAD, Visio, etc.) and paper format. The supplier shall supply five (5) copies of the detailed design document in both electronic (CD-ROM) format and paper format. The detailed design must include, at a minimum, the following items for every affected St. Marys site and network node:

- Network and Subsystem Block Drawings
- Line Item Equipment and Pricing Lists
- Infrastructure, Console, and Network Element Programming Parameters
- Console and MNC/NMS Database Parameters/Design
- Fleetmapping Parameters (Talkgroups, Radio Configuration Personalities, IDs, Features, Templates, GOS, etc.)
- Transport Requirements (Design, DS0, DS1, DS3, STS-n, OC-3 Channelization, Switching Parameters)
- Racking/Floorplan Drawings
- Physical Site Requirements/Facilities/Tower Design
- Power and HVAC Requirements
- MNC and Switch Layouts/Configurations
- Channel Bank and Multiplexer Layouts/Configurations
- Final Coverage and Site Configuration Design
- Final Microwave Path Design and System Availability/Reliability Calculations
- Software Version Control/Equipment Hardware and Software Roadmaps
- Network Timing Requirements/Design
- Antenna Subsystems
- Feature and License Matrices
- Failure Mode Analysis/System Availability
- LAN/WAN Design
- TCP/IP Network Addressing Scheme
- Preliminary Factory and Field ATPs
- Final Coverage ATP
- Preliminary Cutover Plan/Migration Strategy/Downtime Requirements

- Subscriber Installation Prototypes
- Revised Statement of Work (if modified)
- Operations, Administration, Installation, and Maintenance Manuals for all subsystems
- Change Orders
- Spares Equipment List and Pricing Matrix.

11.2 SYSTEM STAGING

Any proposed system equipment that is reasonably capable of being integrated in a factory, laboratory staging environment shall be configured and installed in a manner conducive to testing hardware and software prior to being released to the field from the supplier for installation and optimization. At a minimum, the staging of this equipment shall include: the labeled and pre-cut interconnect cabling, configured and certified software, completed configuration and provisioning databases, operational network backbone connectivity supporting all of the subsystems mentioned in the solicitation specifications, and all interfaces operational to demonstrate a working and fully integrated system.

11.2.1 *Factory Staging*

The supplier shall provide comprehensive staging of the proposed equipment at or near the radio supplier's primary land mobile engineering/manufacturing facility. The factory staging effort shall include all new components, subsystems, certified system software, and ancillary equipment required to complete the entire system, including but not limited to: microwave backbone, channel banks, frequency standards/GPS receivers, voting equipment, base station transceivers, transmitter combiners, receiver multicouplers, controllers, redundancy equipment, MNC and switching infrastructure, networking equipment, dispatch consoles, logging recorder, system management equipment, NMS, alarm systems, programming equipment, interconnect equipment and cabling, simulated legacy equipment, power supplies, etc. A pair of each type and tier of proposed St. Marys County subscriber radios purchased shall be provided for staging and testing. Any existing subscribers upgraded for re-use shall be included in the factory staging performance tests.

At staging, all equipment shall be set up in its ultimate configuration, as it will appear in the designated installation site. The system shall be tested in the staging area in such a manner as to minimize the actual installation and optimization time in the field. The final St. Marys system staging as-built documentation shall be available at the time of system demonstration and customer witness. Simulation of any existing County equipment required to demonstrate the system in staging shall be provided wherever possible.

As part of the supplier's proposal, a sample-staging document defining proposed staging tests shall be provided for County review. This document shall be considered for use in the development of the final factory acceptance test document which shall cover all subsystems, interfaces, required functionality, supplier responsibilities, County responsibilities, staging requirements, test procedures, and documentation required for field release. The staging ATP documentation shall be made available to the County's project manager forty-five (45) calendar days prior to the date of the staging test for County review and refinement.

An example of the topic areas to be analyzed in depth shall include, but not be limited to, the following testing areas which must show conformance to all of the specifications contained in this document:

- Subscriber functionality and performance
- Dispatch console and logging recorder functionality and performance
- MNC Controller and Switching infrastructure functionality and performance
- NMS functionality and performance
- Base station transceiver functionality, optimization, and performance
- P25 and interoperability conformance
- Microwave/fiber backbone functionality and performance
- Failure mode analysis and fallback/reliability testing.

11.2.2 ***Equipment Cabling***

The supplier shall determine cable lengths between all interconnected equipment and cut cables to length to aid in field installation. Specific cabling shall be plenum rated as determined by site surveys and field analysis. Circuit identification shall be provided on the modular panels and the cabling using customized, circuit-specific labels that are consistent with all as-built documentation.

The use of any conventional, industry-standard type punch block is acceptable. All cabling shall be terminated with appropriate connectors for ease of field installation and shall be terminated to the nearest 1-foot length. All cabling used for system interconnects shall be tested during factory staging of the system prior to shipment to the field. All cable pinouts shall be provided with the staging as-built information.

All cables shall be clearly labeled on both ends with pre-printed (not hand-written) adhesive labels with "To-From" information to clarify interconnection for field installation and maintenance. Cable label information shall directly correlate to system documentation/drawings that define or depict the interconnecting cables (i.e.

cable label text shall match drawing text). Cables that are not staged initially but installed in the field shall be equipped with the same cable label information as provided for every cable in staging. Cables that are modified or rearranged in the field shall be equipped with the same cable label information as provided for every cable in staging. A spare set of cable labels shall be provided with the final site documentation package as prepared in the field. Hand-written cable label markups is not acceptable.

A description and detailed wiring diagram of each modular panel and wiring adapter utilized shall be provided. The remote site equipment of the system shall be assembled as complete sites for direct shipment to the site locations in the field. All cabling, wiring, programming, and equipment configurations shall be completely integrated in the final configuration prior to shipment. Upon arrival to the final destination, the hookup of racks, external power, grounding and antennas to the site equipment should complete the physical integration of the sites and allow the sites to be "on-air" ready. No additional work should be needed to ready the site for operation.

Suppliers are to describe in detail the manner in which the entire system shall be factory staged. The County's Project Team shall visit the supplier's staging facility for the purpose of examining the system and witnessing a comprehensive factory acceptance test. The supplier shall develop a functional test plan in the prescribed timeframes and schedule this factory visit at the appropriate time prior to field delivery. The County's project manager, prior to the actual test, shall approve the functional test plan. Final system drawings, cabling diagrams, interconnect cabling matrices, rack profiles, as-built photographs, level setting diagrams, software version control matrices, equipment programming and provisioning data, equipment jumpering and strapping, and interconnect diagrams shall be part of the staging as-built documentation and be available for viewing at time of factory staging visit.

11.2.3 ***Hardware Testing***

Each hardware component shall be inspected and tested per the ATP. A test procedure and checklist shall be used to perform these tests based upon the ATP.

11.2.4 ***Software Testing***

Each software feature and version shall be tested per the ATP. A test procedure and checklist shall be used to perform these tests based upon the ATP.

11.2.5 ***Factory Acceptance and Shipping***

At the time that all equipment and subsystems are functioning as designed, the County shall inspect and test the equipment as it is staged, cabled, tested, and

burned-in per the agreed-upon factory ATP. At the successful completion of the staging demonstration and ATP, a County representative shall approve the shipment of the equipment to the County sites for installation. If the factory demonstration or staging effort fails to meet the County's expectations, another date for re-testing and customer witness shall be set to repeat the event solely at the supplier's expense which includes all transportation and lodging costs for the original County project team back to the staging facility. No system equipment, subsystem, or components shall ship from the staging facility without the County's express approval. Shipment can also be delayed if the project schedule has changed and the County requests a shipping delay.

Prior to shipment from the staging facility, all software/firmware version numbers, jumper configurations, and equipment programming data shall be recorded by the supplier and recorded in the staging as-built documentation for verification in the field. An as-built manual shall be produced for each network site or node. Any changes to the system following shipping shall be properly recorded and updated in the final field as-built documentation in a manner consistent with the original staging as-built document. The use of hand-written labeling on equipment firmware is unacceptable.

11.3 FIELD ACCEPTANCE TESTING

At the time that all equipment and subsystems are functioning as designed in the field, the County shall inspect and test the equipment as it is field-installed, cabled, tested, and burned-in per the agreed-upon field acceptance ATP. If the field ATP fails to meet the County's expectations, another date for re-testing and customer witness shall be set to repeat the event solely at the supplier's expense which includes all logistical costs to reproduce the field ATP. The County's team and at least one system supplier's representative shall conduct these acceptance tests and inspections as defined.

The results of the tests and the associated punchlist of outstanding items to be completed or re-tested shall be signed by both parties and forwarded to the County for review and acceptance. The outstanding items shall be resolved within seven (7) business days and these items shall be re-tested at no additional expense to the County. If the outstanding items have an effect on other previously performed tests, then re-testing of those tests shall also be included. Final acceptance of each individual subsystem shall include, but not be limited to, the list of tests and inspections contained in the following sections.

The acceptance testing for all systems shall consist of a series of tests, inspections, and verifications that are highlighted in this section. The ATP shall cover all field testing procedures and those inspections that shall be made in order to show

supplier compliance to the solicitation specifications as well as define each and every required subsystem interface.

All system equipment that comprises the proposed network shall be configured and installed in a manner conducive of testing hardware and software prior to beginning the field ATP. All optimization procedures shall be executed prior to conducting the field ATP and the final as-built documentation shall be complete and ready for County review.

An example of the topic areas to be analyzed in depth in the field shall include, but not be limited to, the following testing areas which must show conformance to all of the specifications contained in this document:

- Subscriber functionality, programming, and performance
- Dispatch console and logging recorder functionality and performance
- Legacy mutual aid interface infrastructure functionality and performance
- MNC Controller and Switching infrastructure functionality and performance
- NMS functionality and performance
- Base station transceiver functionality, optimization, and performance
- Antennas and transmission line functionality and performance
- Coverage design verification
- Site facilities functionality and performance (e.g., generators, UPS, tower lighting, HVAC, shelter alarms, fire suppression, grounding, etc.)
- P25 and regional interoperability conformance
- Microwave/fiber backbone functionality and performance
- Failure mode analysis and fallback/reliability testing.

11.3.1 ***System Testing Acceptance Sequence***

Field system testing acceptance shall take place in the following sequence:

- Notification by the supplier that the field installation is complete and site as-builts ready for review
- Completion of inspections by County Project Manager
- Notification by supplier that final punchlist is resolved and field acceptance tests can commence
- Microwave transport system testing
- Hardware functionality and performance acceptance tests

- Software functionality and performance acceptance tests
- Interconnect testing
- Coverage acceptance test
- All testing punchlist and re-test items corrected and resolved by supplier
- 45-day system reliability performance test
- Supplier provides draft system acceptance test report
- Acceptance test results approval granted by County Project Manager
- All project deliverables and final as-builts received by supplier
- All implementation phase punchlist items resolved to County satisfaction.
- System testing acceptance granted.

11.3.2 *Hardware Testing*

Each hardware component shall be inspected and tested per the ATP. A test procedure and checklist shall be used to perform these tests based upon the ATP.

11.3.3 *Software Testing*

Each software feature shall be tested per the ATP. A test procedure and checklist shall be used to perform these tests based upon the ATP.

11.3.4 *Interconnect Testing*

Interconnects are defined as the electrical connections between two subsystems; for example, the connection between a channel bank and the microwave multiplexer. Each system interconnect shall be tested per the ATP. A test procedure and checklist shall be used to perform these tests based upon the ATP.

11.4 MICROWAVE TESTS AND INSPECTION

The acceptance testing for all microwave backbone system equipment shall consist of a series of tests, inspections, and verifications that are highlighted in this section. The County's representative and the supplier's representative shall conduct these tests and inspections as defined in the ultimate Acceptance Test Plan (ATP).

The microwave factory acceptance testing shall include simulated system conditions for hop-to-hop and end-to-end BER measurements and availability calculations. The field acceptance testing shall consist of actual path measurements to ensure compliance with system design requirements. Factory NMS testing shall simulate conditions of operational systems. The field acceptance testing shall consist of actual operational conditions. The tests and inspections listed in the

following paragraphs shall be performed. Final Acceptance of each individual microwave line, section, and path shall include, but not be limited to, the following list of tests and inspections.

11.4.1 *Microwave Factory Acceptance Testing*

The following tests, in addition to other standard manufacturer's test procedures and any County-required tests, shall be performed. Complete documentation of factory acceptance testing shall be delivered with each microwave terminal.

11.4.1.1 DC Power Supply Checks

Verify all DC power supply voltages in accordance with published specifications.

11.4.1.2 Perform/Verify Complete Terminal Provisioning

Provision microwave terminal and associated multiplexer in accordance with proposed County network.

11.4.1.3 Receiver Checks

- Frequency
- Sensitivity
- AGC Calibration
- Alarm Adjustments/Verification

11.4.1.4 Transmitter Checks

- Frequency
- Power

11.4.1.5 Transmission Tests

- Orderwire Levels
- Modem Alignment
- Elastic Store Alignment
- Reverse Channel Switch (MHSB only)
- Alarms/Protection Switching
- Trunking System/Ring Switching Interconnection & Timing

11.4.1.6 DS1 Data Transmission Tests

Utilize a BER test set to verify minimal 24-hour error-free operation of every OC-3, DS1, and Ethernet facility.

11.4.1.7 *Burn-In*

Following the completion of all preliminary testing, the supplier shall perform temperature cycling tests of each complete radio hop in accordance with manufacturer's published procedure.

11.4.1.8 *Post Burn-In Tests*

- RF Power Adjustment and APC Calibration
- Transmit Insertion Loss
- PA Monitor Calibration
- APC Hop Tests
- Receiver RSL Threshold and Voltages, AGC Curve Generation
- Receiver Switching Tests
- Common Loss Switching Tests
- Alarms Checks
- Local and Remote Terminal Monitor Operation
- Radio Command Path Operation
- Orderwire Check
- NMS Integration and Diagnostic Functionality

11.4.1.9 *Final Adjustments*

- Label Verification
- LO Frequency Adjustments
- Strapping/Configuration Verification

11.4.2 ***Microwave Field Acceptance Testing***

The following tests, in addition to other standard manufacturer's test procedures, must be performed. Complete documentation of field acceptance test results shall be provided to County upon completion of testing.

11.4.2.1 *Path Alignment*

- The supplier shall be responsible to perform microwave dish alignments for all microwave paths
- Dishes shall be aligned for maximum AGC level
- The supplier shall provide all material, equipment, and personnel required to perform path alignments in accordance with path design criteria.

11.4.2.2 *Installation Inspection*

Inspection of the completed microwave network equipment installation shall be performed to ensure compliance with standards set forth in final contract.

11.4.2.3 *Sweep Waveguide*

- Antenna waveguide shall be swept and plotted in accordance with manufacturer's specifications
- Measured return loss shall be a minimum of 23 dB across the full bandwidth capability of the MW transmission system.

11.4.2.4 *Waveguide Pressurization Verification*

- Antenna waveguide shall be pressurized in accordance with manufacturer's specifications
- Waveguide leak down tests will be performed to ensure leak rate does not exceed manufacturer's specifications.

11.4.2.5 *Power Plant Tests*

- Measure and record individual cell and power plant total output voltages
- Measure specific gravity of wet cell systems
- Set float and equalize voltages on charger
- Set and verify alarm thresholds on charger in accordance with manufacturer's specifications.

11.4.2.6 *DC Power Supply Voltage Checks*

Verify all DC power supply voltages in accordance with published specifications.

11.4.2.7 *Transmitter Checks*

- Measure and record Transmit Power
- Measure and record Transmit Frequency
- Verify operation of APC
- Compare measured values to Factory Test Records.

11.4.2.8 *Receiver Checks*

- Measure and record RF receiver local oscillator frequency
- Measure and record IF frequency
- Verify error-less receiver switching
- Verify space diversity receiver switching as applicable
- Compare measured values to Factory Test Records.

11.4.2.9 *Protective Switching Tests*

- Verify protective switching operation, as applicable, for associated module failure
- Verify operation of reverse path protection, as applicable
- Measure reframe time and frame-lossed seconds.

11.4.2.10 *Alarm Checks*

- Verify individual alarm reporting for module faults, as applicable.

11.4.2.11 *Radio Loop Back Checks*

- Verify radio loopback capabilities, as applicable (local and remote IF, local and remote RF, etc.)
- Loopbacks shall be performed with a BER test set for 15 minutes and results recorded.

11.4.2.12 *Fade Test*

- Simulate path fade by use of a variable attenuator and BER test set
- Measure and record AGC voltages and RSL at BER thresholds of 10^{-6} and 10^{-3}
- Compare measured values to Factory Test Records and Path Calculation sheets
- Measure and record T/I ratios in both directions on each path.

11.4.2.13 *Bit Error Rate*

- BER test is to be performed for 24 hours on each microwave hop
- Test to be performed 12 hours on A side and 12 hours on B side, if applicable
- Unfaded BER shall be $<10^{-13}$
- Record results.

11.4.2.14 *Multiplex Checks*

- Verify OC-3, DS1, and Ethernet facility operation using BER test set at DSX demarcations at origination and termination points

- Verify that synchronization is maintained on each facility equipped or unequipped.

11.4.2.15 *Synchronization*

- Verify operation of synchronization network in normal and backup operating modes
- Measure timing jitter on a representative number and length of DS1 paths
- Inject timing jitter into a representative number and length of DS1 paths to verify input jitter accommodation in accordance with Bellcore TR-TSY-000499.

11.4.2.16 *Delay Measurements*

- Delay measurement testing to be performed following integration of microwave and RF radio systems
- Tests to be performed on a representative number and length of DS1 and/or DS0 paths.

11.4.2.17 *Alternate Route Tests*

- Verify automatic alternate route switching with uninterrupted radio system traffic.

11.4.2.18 *Audio Quality*

- Audio quality measurements shall be performed following integration of microwave and RF radio systems per the RF radio manufacturer
- Tests shall be performed on a representative number and length of DS1 and/or DS0 paths.

11.5 RF COVERAGE ACCEPTANCE TEST PLAN

The purpose of this RF Coverage Acceptance Test Plan (CATP) is to verify, through in-place testing, that the delivered radio system meets the performance specifications required under this solicitation. This section establishes the requirements with a generic, supplier-independent methodology. The supplier shall submit the appropriate and source-peculiar details in its offering to permit evaluation of compliance with this section.

Successful passing of the coverage portion of the ATP shall consist of a talk-out/talk-back (TO/TB) audio quality evaluation in addition to a minimum signal

strength measurement. For all proposed service areas and operational characteristic/attenuation settings, both audio quality and signal strength tests must pass for each test location/grid for that particular grid to be considered a "Pass". This coverage testing shall only pertain to the primary 800 MHz trunking radio system and every associated transmission system. Grids with in-building tests must also satisfy the in-building testing requirements as defined below for the grid to be considered a "Pass." Consistency of performance amongst all site transmission systems shall be tested and verified. The proposed antenna systems shall exhibit no more than a 2% differential in the overall service area coverage reliability countywide between the various site antenna systems. For example, the CATP will not be considered a "Pass" for a given service area if Antenna System 1 exhibits an effective coverage reliability of 98% and Antenna System 2 exhibits an effective coverage reliability of 95.9% as the differential between the two systems equates to 98%-95.9%=2.1%.

This CATP shall not only verify compliance with the RF coverage requirements but shall also concentrate on the identification of locations where coverage does not meet the requirements. CATPs are generally developed to validate the accuracy of the supplier's propagation model and utilize statistical methods that do not take into account in-band interference levels similar to those found in St. Marys County. With the knowledge of the locations where coverage is not compliant with the solicitation, the County can take alternative action to document those locations and provide this information to the emergency personnel responsible for those areas.

The CATP shall consist of the following tests for all proposed antenna systems utilizing the specified behavioral and operational guidelines of radio usage as defined previously in this specification:

IN-STREET TESTING INCLUDES:

- Appropriate In-Street Signal Strength Levels
- TO/TB Audio Quality Test
- Continuous Audio Quality Monitoring Test
- Continuous Receiver Desensitization Test
- Noise Floor Measurements.

IN-BUILDING TESTING INCLUDES:

- TO/TB Audio Quality Test for all Critical Level One and Critical Level Two buildings
- Appropriate In-building Signal Levels for all Critical Level One Buildings
- Signal Levels and TO/TB Audio Quality Test for the specified 6 dB in-building coverage service areas Countywide

11.5.1 *Clarity of Proposal*

The supplier shall, consistent with its individual offering, address testing only in context with its offering. If, for example, a supplier offers a countywide simulcast system, the requirements for testing in the simulcast environment shall be observed. Testing requirements for the non-simulcast environment would not pertain under this scenario and should not be addressed by the supplier.

Conversely, non-simulcast offerings need not address simulcast-testing requirements. Suppliers are specifically cautioned, therefore, that if some "hybrid" form of simulcast and non-simulcast technologies are offered, the proposal must be clear as to exactly which technology is being tested and how testing is proposed to be conducted.

11.5.2 *Test Teams*

The test teams shall consist of County representatives and a supplier representative. There shall be at least one test team located in the 911 ECC and multiple test teams in the field. The County shall provide the drivers for the in-street testing 6 dB service area as well as the critical in-building testing process. The driver shall only be responsible for the proper and safe operation of the vehicle and shall not participate in the audio quality testing. All navigation directions shall be the responsibility of the supplier's representative and is expected to be provided via the automatic computerized signal measurement system.

Each member will classify a transmission as a "Pass" or "Fail". Then the test team must reach a consensus as to whether the test point is a "Pass" or a "Fail" in the event the message classification is not unanimous. When the talk-out test is conducted, the dispatch operator will state the following message: "*Dispatcher to Portable Team. Grid Number #.[Random Test Language]. Grid number #, How do you copy grid number* #?" When the talk-in test is conducted, the portable operator will state the following message: "Portable Team to Dispatcher. Grid Number #. [repeated Random Test Language]. Grid number #, How do you copy grid number #?" Each team member will then classify the message as "Pass" or "Fail". The speakers shall speak the test messages as clearly as possible and occasionally incorporate voice inflections characteristic of typical police and fire emergency transmissions. Tests may be repeated at any or all grids as determined by the County to reflect any differences between male and female voice characteristics.

The test language to be used shall be mutually agreed upon between the County and the supplier prior to testing. The County shall provide a list of potential test messages representing commonly used dispatch language, void of acronyms, and not to exceed 10 seconds in length, for evaluation. From the potential list of

messages, one hundred shall be selected as the pseudo-random messages to be used for testing purposes. The phrase to be used during each test will be determined by the speaker. The final list will be determined prior to testing.

11.5.3 *Test Equipment and Apparatus*

The basis for this RF coverage design is a portable in-building design. Therefore, the supplier shall execute the RF Coverage Test utilizing the *portable radio operating configuration* specified in this solicitation. It is understood that de-rating of the test portable is required to simulate the portable-in-street or portable-in-building design criteria for the appropriate test locations. The supplier shall thoroughly describe and quantify any required de-rating of the test portable for accurate simulation, and the supplier shall field verify, with County witness, all intended attenuation settings to demonstrate consistency between the intended de-rating and actual in-building loss conditions with the chosen operating configuration.

The supplier shall be required to provide all test equipment associated with the CATP processes including all portable and mobile radios. These test radios shall ultimately be transferred to the County as part of its subscriber inventory. The radio equipment shall be configured with the most current software and firmware available at the time of testing. For in-building testing, this equipment shall include a test backpack system or mobile cart system, as appropriate. For in-street testing and simulated countywide in-building testing (i.e., 6 dB), this equipment shall include any materials and equipment required to modify a standard vehicle such as DC to AC power inverters and the test equipment cabinet. The supplier is required to install all test equipment and apparatus in the test vehicles with no damage and restore the vehicles to reasonable condition upon completion of testing. The supplier shall verify proper calibration for all equipment utilized during the CATP and all test records and relevant data shall be provided to the County in both paper and electronic format.

11.5.4 *Test Vehicle*

The County shall provide all vehicles required for the coverage testing. It is anticipated that the standard test vehicle shall be sufficient to hold the test cabinet and equipment as well as team members plus sufficient room for occasional observers. The same vehicle types and equipment installation configuration shall be used throughout the CATP so that a consistency of data is ensured.

11.5.5 *Continuous Audio Quality Monitoring*

The nature of statistical coverage validation tests involve a single audio TO/TB test in a predetermined size and number of test tiles. This test is valid under most

conditions except testing in high-noise environments where cellular interference, if any, from high-density deployments exists. These cell sites represent small circular areas of approximately 800-foot radius of the cellular structure. The CATP can still pass in many instances; however, the County would not be aware of the failure points unless the randomly selected audio TO/TB test happened to fail at these particular locations. In order to identify the *specific locations* where audio quality is defective, a continuous talk-out audio message will be transmitted from the system and monitored in the field during performance testing. *Locations identified with interference from cellular systems shall have no impact on the pass/fail criteria for the CATP*. However, if the source of interference is identified as simulcast distortion, the tiles associated with the audio distortion shall automatically fail regardless of the results of the randomly selected single audio test point. A pre-defined audio message is recorded and injected at a console position on a specific test talkgroup. The talkgroup is restricted to a specific frequency during testing so that the tests are consistent. While IM-related interference is frequency-dependent and may not fail on the specific channel under test, the receiver desensitization testing shall assist in the identification of these specific modes of interference.

11.5.6 ***Continuous Receiver Desensitization Test***

A continuous receiver desensitization test shall be executed in order to identify any excessive interference or noise floor degradations that would impact the coverage margin requirements. This test can be used to identify intra-system interference, inter-system interference, co-channel interference and the more prevalent interference from in-band cellular systems. *The results or the impact of this test is not a part of the pass/fail acceptance criteria*. Since the impact of this interference is only applicable to receiver operation in the street, this data will only be accumulated for the in-street portion of this CATP. In the event that interference is revealed that is in excess of the supplier's system design margins and assumptions, the County shall investigate the source in order to mitigate the impact. The supplier is required to assist the County as required in order to identify, characterize, and isolate the source of interference at these locations. The test data shall include the following information for each location measuring receiver desense greater than 6 dB. Only information available, on-site signage, and other methods of identification from outside the facility fence shall be required. No other effort need be expended in order to obtain the following information:

- Location Information (Latitude/Longitude by GPS)
- Basic Geographical Address
- Basic Information on any cell sites in close proximity
- Wireless Carriers co-located on site
- Site Owner or Operator Identification
- Desired Signal Strength in dBm
- Measured Receiver De-sense in dB

- Three channels 500 kHz apart.

11.5.7 *RF Signal Level Measurement Test*

The signal measurements test portion of the CATP is required in order to verify that the Minimum Received Signal Level (MRSL) is present in the specified number of test tiles, thereby proving that the coverage prediction model for each service area is accurate. This test verifies the Service Area Reliability of 95%+ for all required service areas, operating conditions, and County requirements.

The test shall utilize a GPS-based computer automated signal measurement system tuned to channels keyed on every transmission system at each site that will average the carrier signal over a 40 wavelength sample, one sample per test tile. This test shall be utilized for both in-street, 6 dB service area testing and the testing of all Critical Level One buildings. BER data shall also be collected for information purposes for every transmission system at each site utilizing the GPS-based computer automated signal measurement system. The SSI and BER data for each transmission system under test shall be collected, archived, and provided to the County on a daily basis during the CATP for each test location/grid in a *.csv (comma separated value) file format noting specific channel number, mean Lat/Lon, median Lat/Lon, grid number/coordinate, mean SSI in dBm, median SSI in dBm, mean and median BER, and SSI standard deviation.

11.5.7.1 Determination of Number and Size of Test Tiles

The supplier shall ascertain the statistically correct number and size of test tiles. Consistent with this section, the County clearly requires square or rectangular grids or tiles to be defined. Tile sizes shall be no less than ½ mile by ½ mile in dimension.

The product of these computations will be a test tile definition as to number and size for the coverage area. In all cases, consistent with TSB88 Paragraph 7.4.1, a confidence level not less than ninety-nine percent (99%) shall be utilized. The supplier shall provide the proposed grid maps and overall number of grids for all respective service areas that form the basis for the supplier's methodology to be utilized during the CATP.

11.5.7.2 Reciprocity and System Balance

Under normal circumstances, a 800 MHz system that is properly designed with high-gain tower-top amplifier systems and effective receiver voting will be talk-out limited in performance, that is, a portable that can "hear" the system will likely be successful in accessing the system. With this in mind, a talk-in RF signal measurements test would not be cost-effective. In order

to eliminate this portion of the test, the supplier shall provide a TO/TB signal analysis followed by field verification with this proposal which shall prove that all radio sites are indeed balanced from a TO/TB perspective. The tower-top amplifier analysis shall include a Noise Figure Calculation and multicoupler Inter-Modulation Rejection (IMR) Performance Calculation. This analysis is critical to show system design balance is feasible without sacrificing receiver sensitivity or exposing the receiver to intermodulation interference. A signal flow diagram is required that will outline the signal flow from base station transmitter to portable receiver port and portable transmitter to base station receiver port. All gains and losses along the path are to be shown. If the supplier utilizes other signal processing that results in overall improvement in audio or signal quality, these enhancements should also be characterized and included in the calculations.

11.5.8 ***Talk-Out and Talk-Back Audio Quality Test***

"The delivered audio quality (DAQ) for digital and analog units must meet or exceed the DAQ 3.4 as per TIA Standard TSB88-A, which is defined as "Speech understandable with repetition only rarely required. Some Noise/Distortion".

"Rarely" shall be quantified as not greater than 10% re-test. This means that a maximum of 10% of all the grids to be tested for that service area shall be allowed a repeated transmission within three feet of the original test location and shall be identified as a "pass-retry". If the message meets or exceeds this criterion, as agreed by a majority of the test team, it shall be considered "passed". If the message does not meet this criterion, as agreed by the majority of the test team, it shall be considered "failed". The supplier may then move no more than three feet in any one direction and repeat the audio test once. If this re-test meets or exceeds the original criterion, the tile is considered a pass and is recorded as a "retry-pass". The test team may then move to the next test point. System access shall be reliable and per specified channel access timeframes within each test grid for the grid to be considered "passed" throughout all CATP service areas under test.

11.5.9 ***In-Building Tests***

11.5.9.1 Critical Level One Buildings

As part of the initial system design and proposal response, the supplier shall conduct a predictive analysis of all Critical Level One buildings based on the Critical Building List and the actual field test data contained in the Appendix of this document. Critical Level One buildings are all of those facilities that require mandatory 95% or greater coverage reliability throughout the entire facility. The supplier shall test all Critical Level One

buildings for signal strength and for talk-out and talk-back audio quality during the CATP. The specification requires all Critical Level One buildings to provide 95% or greater in-building coverage reliability for both signal strength and audio quality. Should a Critical Level One building fail to demonstrate adequate communication in 95% or more of its interior test locations, then that building shall be identified as a "failed" test location and the grid under test shall also be considered a failure.

A statistically valid number of test points on each floor shall be determined by both the County and supplier to validate the 95% coverage criteria. At a minimum, 40 test points on each floor, that include the four corners of each floor plus the center of each floor shall be tested. Elevators, and below-grade areas are to be included in the testing methodology, but elevators and below-grade test points are not subject to be counted in the building reliability calculation.

The supplier shall take corrective action to meet the in-building coverage requirements of the failed building and re-test the building. In order to constitute acceptance, no Critical Level One buildings tested shall fail. Corrective action, system redesign, or the deployment of in-building solutions to remedy and re-test a coverage deficiency of a Critical Level One building shall be at no cost to the County.

11.5.10 *Density of Grid Failure Provision*

The County requires the supplier to avoid a situation in which multiple "failed" test grids are clustered in a small geographic area rendering coverage unreliable for that geographic area. Of the total number of "failed" test grids, all of the proposed antenna systems shall exhibit no more than 10% of the maximum allowable number of total "failed" grids in a geographic area bounded by five (5) square miles (using the x/y contractual grid structure as the bounding mechanism). For example, no more than nine (9) total grids shall fail within a bounded five (5) square mile geographic area assuming a ½ square mile grid size and 94 maximum number total "failed" grids for the specific countywide service area. Consistency of performance amongst all site transmission and receive systems shall be tested and verified. The supplier shall identify and explain how the proposed coverage design avoids an unacceptable density of grid failures within the County.

11.5.11 *Inaccessible Test Grids*

Grids that are considered inaccessible by the test vehicle shall be discarded from the reliability calculations for RF coverage acceptance and neither counted as a pass nor a fail.

11.5.12 *CATP Submittal*

The supplier shall prepare and submit a detailed outline of the CATP with its proposal. This outline shall conform to the specifications set forth herein and shall be in sufficient detail that it may become a definitive section of the resulting contractual agreement. Subsequently, the selected supplier shall complete the final CATP prior to completion of the contractual Detailed Design Review process.

11.5.13 *Forms of Testing*

The CATP shall consist of multiple forms of testing generally described as Automated Signal Strength ("Automated"), Talk Out/Talk Back Delivered Audio Quality ("DAQ"), Continuous Audio Quality ("Audio Quality"), Noise Floor, and Subscriber Receiver Desense ("Desense") testing. Successful completion of all forms of testing is required as a part of system acceptance testing. In each and every instance, however, DAQ testing and signal level measurements shall prevail as the determining criteria in the derivation of specific service area coverage reliabilities in order to gauge the supplier's compliance with the coverage specifications and shall constitute coverage acceptance.

11.5.14 *Schedule*

Coverage acceptance testing shall be scheduled by mutual agreement as soon as practical following commissioning and testing of the Fixed Network Equipment ("FNE" or "Backbone"). All contractual coverage testing shall occur while the forestation in the coverage area exhibits a full foliage condition (beginning of May through September).

11.5.15 *Coverage Testing as a Part of Final System Acceptance Testing*

RF Coverage Testing is a subset of total final system acceptance testing. Once the supplier has completed testing in accordance with the approved CATP and the CATP results are accepted by the County, the supplier shall have satisfied all RF system CATP elements required for final system testing acceptance so long as the requirements set forth in this section continue to be met.

11.5.15.1 FNE Integrity

The FNE must remain essentially unmodified from the configuration which existed at the time of CATP, continuing through successful completion of final system acceptance testing.

11.5.15.2 RF System Configuration

The RF system actually tested must remain essentially unmodified from the configuration which existed at the time of CATP, continuing through successful completion of final system acceptance testing.

11.5.15.3 Documentation

The supplier shall provide all CATP test data in final report fashion to the County for review. The final CATP test report shall include all measured data in paper and electronic format, final coverage maps noting Pass/Fail for each test location/grid for all transmission systems and service areas, final coverage maps indicating retry metrics, In-Building test reports and test log sheets, final map noting all inaccessible grids according to the coordinate grid structure, final coverage maps noting SSI and BER data according to the coordinate grid structure, final coverage maps noting receiver desense and noise floor data according to the coordinate grid structure, and final talk-in/talk-back coverage modeling maps using measured field data to calibrate or discipline the original modeling projection to portray as-built coverage conditions for each transmission system and service area.

11.5.16 *Remedies For Coverage Failure*

Remedies for coverage failure shall address the entire problem area and not be limited to correcting a portion of the failed area. Remedies may not degrade areas of coverage that were previously accepted. A retest of coverage shall be conducted in any area (previously failed or not) potentially affected by the remedy in order to verify that the composite coverage is maintained. All remedies must meet the performance, feature-functionality, and reliability requirements of the specification. These remedies may include the following:

- Modification of antenna or transmitter configurations, as long as those modifications comply with regulatory and zoning restrictions placed on the County, at no additional cost to the County.

- Complete integration of remote simulcast sites or multi-cast sites, at no additional cost to the County.

11.6 45-DAY RELIABILITY PERFORMANCE TEST

Upon completion of the field RF Coverage Test, a complete system performance reliability test shall be executed that will consist of 45 consecutive days of uninterrupted system operation. The supplier shall issue up to 100 subscriber units to County personnel for random verification of operation of the system for the duration of the test. Subscribers and infrastructure shall be equipped with the most current software and firmware for this test. During this test period, the supplier shall keep detailed records of any failures or adjustments of the system or subscriber units.

The specific parameters governing the pass/fail criteria of the 45-day reliability test shall be determined by mutual agreement between the supplier and St. Marys County at least ninety (90) days in advance of the reliability test period. The test shall be considered a failure if any of the following events occur and the test will be repeated from the beginning, at the discretion of the County at the sole expense of the supplier. At a minimum, the proposed system or any subsystem experiences a significant failure that results in:

- Failure or loss of any APCO 16/25 features, functions or capabilities
- Failure of MNC system control equipment
- Failure of site control and transport equipment
- Failure of 20% of the channel assets anywhere in the system
- Failure of two or more dispatch console positions
- Failure of logging recorder
- Loss of coverage due to orphaning of site
- Failure of same device two or more times during the reliability performance test
- Failure to restore a non-critical failure, as defined in the warranty section of this solicitation, according to the contracted response time.

11.7 AS-BUILT DOCUMENTATION

St. Marys requires the supplier to deliver a comprehensive as-built design package prior to the final system acceptance process. Completion of the system documentation process shall take place upon mutual agreement between the supplier and St. Marys. As-built design documents shall be supplied to St. Marys in both electronic (e.g., original native file format-MS Word, MS-Excel, AutoCAD, Visio, etc.) and paper format. The supplier will supply five (5) copies of the as-built design document in both electronic (CD-ROM) format and paper format. The as-built design documentation must include, at a minimum, the following items for every affected St. Marys site:

- Network and Subsystem Block Drawings
- Comprehensive Equipment Lists/Inventory

- Infrastructure, Console, and Network Element Programming Parameters
- Console and MNC/NMS Databases/ProvisioningParameters
- Fleetmapping Parameters (Talkgroups, Radio Configuration Personalities, IDs, Features, GOS, etc.)
- Transport Requirements (Design, DS0, DS1, DS3, STS-n, OC-3 Channelization, Switching Parameters)
- Scaled Racking/Floorplan Drawings
- Physical Site Requirements
- Power and HVAC Requirements
- MNC Controller and Switch Layouts/Configurations
- Channel Bank and Multiplexer, Multiplexer, Layouts/Configurations
- Channel Bank and Network Element Programming Images/Scripts/Configurations
- Network Timing Requirements/Design
- LAN/WAN Design
- TCP/IP Network Addressing Scheme
- Network Traffic Utilization/Bandwidth Consumption/Throughput Assessment for Each Network/Quality of Service/Packet Loss Metrics
- Completed Testplans and Results
- Final RF Propagation Coverage Maps for all Configurations
- Antenna and Transmission Line Mounting Locations/Azimuths/Tower As-Built
- Equipment Configuration, Installation, Administration, Maintenance, Troubleshooting Manuals (both OEM and supplier equipment)
- Password Matrix for all Network Elements and Equipment
- Level Setting and Optimization Documents/Procedures
- Equipment Jumpering/Switch Setting/Board Version Documentation
- Software Version Control Matrix
- Cabling/Interconnect Wiring Matrices and Spare Cable Labels
- Punchblock Wiring Matrices
- PSTN Circuits/Interfaces
- Training Guides
- Change Orders
- Meeting Minutes
- Spares Equipment List.

12.0 DISPATCH CONSOLE FURNITURE

12.1 GENERAL CONSIDERATIONS

The County is currently in the process of procuring updated console furniture for the primary 911 call center. It is expected that this equipment will be purchased and installed by the 4th quarter 2011. Upon completion of this procurement and installation detailed layout and configuration plans will be provided to the responders of this contract.

13.0 SYSTEM SHIPPING AND INSTALLATION

The supplier is responsible for the shipping, unloading, permitting, storage, and installation of all proposed equipment. The following paragraphs describe the details of the suppliers's logistical responsibilities.

13.1 SHIPPING

The supplier is responsible for providing safe and legal transportation and delivery of all materials provided within this specification from the place of origin to designated locations within St. Marys County. No equipment shipments shall be made without the approval of the County.

All packaging of material shall conform to good packing practices to protect against any possible shipping damages. Deliveries shall be made to ensure that the system is installed to meet the County's critical dates as defined in the final implementation schedule.

The supplier shall indicate how equipment or systems shall be delivered (i.e. identifying the carrier and method of transport) and will notify the County's Project Manager of shipping dates. The County's Project Manager shall be informed of any changes in shipping dates. All bills of lading and shipping information shall be archived and provided to the County Project Manager. The supplier shall create a comprehensive system inventory database of all equipment and associated serial numbers to supply to the County in both native electronic file format and paper copy.

Title to and ownership of the equipment shall remain with the supplier until the equipment is delivered, successfully installed, operational, tested for use at the radio site as characterized in the Acceptance Test Plan, and accepted by the County.

Charges for freight express, cartage, or packing shall not be allowed or paid by the County unless otherwise expressly stated by the County. Every package, bill of lading, shipping memorandum, and invoice must be marked with a purchase order number of the purchaser. An itemized delivery ticket, bearing the County's purchase order number must be left with the goods to insure their receipt. If a carrier makes delivery, an itemized delivery ticket must be attached to the outside of the package.

13.2 RADIO SYSTEM SHELTER/EQUIPMENT ROOM INSTALLATION

All installation work performed shall be in accordance with laws, regulations, and ordinances of all state, local, and federal agencies. The supplier shall provide all

the necessary personnel, tools, equipment, and transportation for the successful installation of all equipment provided under this solicitation procurement.

The supplier (and any subcontractors) performing the installation shall be required to provide a Certificate of Insurance indicating the coverage limits as outlined by the County. The supplier shall bear responsibility for the safety of its workers and all others during the implementation phase of this solicitation contract.

The supplier is responsible and shall provide all the hardware, training, and supplies necessary for the proper and complete installation of their equipment. The supplier bears sole responsibility for providing a turnkey installation of all proposed equipment. Optimization, troubleshooting, and adjustment of each subsystem shall be the supplier's responsibility. This responsibility includes any changes and/or additions to the systems in order to meet performance criteria. Any additional equipment required after the proposal is awarded to meet the system performance criteria of the defined standards and/or specifications will be at the sole expense of the supplier unless the County authorizes a change order.

All existing radio communications systems shall remain fully operational during installation of the new radio systems and until the County decides to de-commission legacy gear. Because existing systems support public safety operations, interruptions in service due to supplier or supplier activities cannot be tolerated. If interruptions in service are deemed by the supplier to be unavoidable, written notification detailing the nature and duration of such interruptions shall be provided in advance of the disruption to the County for review and approval.

Equipment shall be installed in a neat and highly professional manner, in accordance with good practice, by competent technicians or mechanics. Personnel designated by the County shall provide inspection and approval of all installations. Such approval shall be limited in scope to the specific subsystem physical installation, and shall not be construed to imply full acceptance of the system or subsystem.

Subcontractors performing installations of any equipment or any subsystem shall be identified in the supplier's response. All subcontractor installation experience and qualifications (with at least three different customer references) to perform the tasks associated with this procurement shall be outlined in the proposal response.

Notwithstanding the details presented in these specifications, the supplier bears responsibility to verify the correctness of the material lists and suitability of devices proposed to meet the intent of the specifications. The supplier shall be

responsible for providing or arranging for all parts necessary for the equipment and its installation, up to and including final system acceptance.

The supplier, without any claim for additional payment, shall provide any equipment or parts required to provide a complete and operational system, and not specifically mentioned herein. It shall be understood that the final contract and agreement contemplates and requires the "turnkey" construction and installation of a completely operational system, which meets the standards of the County. In concert with all specifications and functional requirements outlined in this specification, the supplier shall deliver the appropriate intra-system physical, logical, and functional interfacing necessary to deliver a complete and fully functional network.

13.2.1 ***Equipment to be Installed***

At a minimum, the supplier shall install the following system equipment into the appropriate equipment shelters and equipment rooms:

- Radio Base Station Transceivers
- Antennas and Transmission Systems
- Combiners and Multicouplers
- Radio Switching and Routing Equipment
- MNC, Controller, and NMS Equipment
- Dispatch Consoles/Logging Recorder/Furniture
- Channel Bank Equipment
- Microwave Backbone and Multiplexer Equipment
- Power Supplies
- Environmental Control Equipment
- Emergency Power Systems
- Equipment Racks
- Interconnect Cabling/Demarcation Blocks/Equipment
- Lightning and Surge Protection/Grounding Connections to Site Ground.

All equipment racks shall be mechanically bonded to the equipment shelter's internal ground system using green insulated stranded copper wire. All ground connections are to be made with minimum length conductors and vertical or horizontal runs where possible. Ground conductors shall have a minimum-bending radius of eight (8) inches. Ground conductors routed in cable trays parallel with transmission lines, telephone lines, power lines, etc., shall be separated by a distance of more than 6 inches. End-to-end cable routing diagrams shall be supplied for all shelter and equipment room installations.

The supplier shall install any additional equipment not included in the list above that is required for a complete and fully functional system. The supplier shall coordinate with any landlords/site owners for all installations in shelters or equipment rooms not owned by St. Marys County.

13.3 DISPATCH CONSOLES

13.3.1 *General*

The installation of the new dispatch consoles and associated equipment shall be provided by the supplier at all designated locations. The supplier shall supply and install all required punchblocks, terminal strips and interconnect cables needed to interface the new console electronics to the new or existing facilities such as radio equipment, telephone equipment, logging recorder equipment, and auxiliary function and control circuits.

All new console cabling, including those which are to terminate at the existing punchblocks, shall be labeled with pre-printed adhesive cable labels. The markers shall be placed at each cable end, adjacent to the connector or plug. All cables and/or cable bundles shall be hidden from view and will be neatly secured by means of plastic tie wraps. End-to-end cable routing diagrams shall be supplied for all shelter and equipment room installations.

All cabling to the operator positions and to console electronic equipment shall be provided with sufficient slack to permit movement of at least ten (10) feet in any direction, especially as it pertains to console workstation furniture capable of being raised or lowered by a dispatcher.

13.3.2 *Physical Interface Requirements*

At a minimum, the supplier shall be responsible for all physical interface(s) between the radio system, communications consoles, and ancillary equipment.

The physical interfaces are expected to include, at a minimum, the following:

- Wire connections from telephone company provided circuit termination block(s) to the appropriate console punchblock(s)
- Wire connections from logging recorder circuit termination block(s) to the appropriate console punchblock(s)/terminal strips
- Wire connections from auxio and NMS circuit termination block(s) to the appropriate console punchblock(s)/terminal strips
- Wire connections from headset and footswitch circuit termination block(s) to the appropriate console punchblock(s)/terminal strips

- Wire connections to the corresponding terminal and source locations on the voting comparator (if utilized), audio distribution network, and the console
- Proper termination of all used and unused I/O ports on the voting comparator (if utilized) and audio distribution network.

13.3.3 ***Functional Interface Requirements***

At a minimum, the supplier shall be responsible for the functional interface(s) between the radio system, communications consoles, and ancillary equipment.

The functional interfaces are expected to include, at a minimum, the following:

- Adjustments and optimization of the input and output signal level(s) between dispatch consoles and the audio distribution network/voting comparator (if utilized)
- Adjustments and optimization of the output signal level(s) from the consoles to the audio distribution network and/or voting receivers to the comparator (if utilized)
- Adjustments and optimization of the input and output signal level(s) between the corresponding conventional channel interface and dispatch consoles
- Optimization of the necessary base station control format(s) (e.g., tone, DC, relay, etc.)
- Optimization of all data interfaces for NMS and API control (e.g., SNMP, TCP/IP, RS232, RS485, etc.).

13.4 MOBILE/VEHICLUAR AND CONTROL STATION RADIOS

The supplier shall perform all mobile radio installations and de-installations in locations within St. Marys County that shall be subject to County approval. Pricing shall include all of the appropriate installation costs including mobile radio antenna (typically center-mounted in roof but subject to specific installation conditions). The supplier shall work with the County at the time of radio installation to define the re-use of an existing hole for antenna installation and possible temporary use of a magnetic mount antenna and associated transmission line for the legacy radio to facilitate the cutover process and minimization of holes cut into the vehicle. The supplier shall define the unit cost for a magnetic mount antenna and RF cable operational across the entire 764-869 MHz frequency range per current FCC requirements.

The supplier shall inspect all existing mobile installations to develop an Installation Guideline Manual for all common and specialized vehicles and apparatus as well as control stations. The manual shall include digital photographs with detailed explanations to ensure consistent, high-quality installations across the entire fleet. The manual shall discuss the existing radio system installations, the units to be removed and the units to remain (if any). This manual shall be supplied to the County at least six weeks prior to commencing any mobile and control station installation activities.

The mounting assembly, which may consist of the mounting tray, radio control head, and its external interfaces (i.e., roof-mounted antenna, logic unit, etc.) shall be configured such that all testing, diagnostic, and alignment ports (including antenna connectors) are easily accessible. The finished assembly shall be secured and remain in a fixed and motionless position under all operating conditions, excluding physical vehicle accident.

All coaxial cable connectors shall be soldered to its cable or to its interface circuitry. Crimp-style connectors for this application are acceptable. Low loss Teflon antenna cable is preferred. Cabling internal and external to the vehicle shall be dressed in flex loom where feasible with all cabling neatened and secured to prevent damage or disturbance to the vehicle operator. Weatherproofing of all exterior connections shall be provided to maximize the lifetime and performance of the entire vehicular radio assembly. All antenna assemblies and connections shall be tested for adherence to manufacturer's specifications and operating guidelines.

All wiring shall be appropriately dressed and connectorized in accordance with good engineering practices. All main power leads shall be connected as close as practical to the battery using approved methods and hardware. Each main power lead shall be attached to its own in-line fuse rated for the maximum current drain of the associated circuit. Obtaining power by connecting to existing radio equipment or any other device is unacceptable. All ground connections shall be provided from the main battery. Bonding to the vehicle frame is not acceptable.

All cabling that is exposed shall be dressed with a flexible tubing and secured to the vehicle frame by tying to any stationary support element using solid copper wire or fasteners. Plastic tie wraps should be used within at least 2 feet of the end connection points in areas not directly exposed to the weather.

The cable length shall allow repositioning the equipment within a radius of 5 feet to allow for changing operating conditions. A representative from each County subscriber agency shall inspect the first installation of equipment. A County representative will inspect each vehicular installation. Each vehicular installation shall successfully complete an operational performance test and shall be approved via signature of the County inspector. The supplier is responsible for the removal

and inventory of all legacy County subscribers following a successful system cutover and reliability test period as defined by St. Marys County.

The mobile assembly shall be positioned on a mounting assembly. The mounting plates, base plates, brackets, etc. shall be a minimum 18-gauge steel construction. The support bar, of similar high steel gauge construction, bolts, support plates, etc., shall be coated with a high quality black matte finish. The finished assembly shall be secured and remain in a fixed and motionless position under all operating conditions, excluding physical vehicle accident.

14.0 SALVAGE OPERATIONS

The supplier is responsible for removing all existing or legacy equipment no longer required to remain in operation in order to meet the performance requirements of this specification. All removed or de-installed equipment shall be properly stored at a location provided by the County. The supplier shall provide the County with a detailed inventory list of all equipment including model number, serial number and location of removal. The County encourages the supplier to offer a salvage credit in its proposal for the supplier to take possession of any desired salvaged material.

15.0 WARRANTY MAINTENANCE AND SYSTEM SUPPORT

The supplier guarantees that all equipment supplied pursuant to this solicitation will be new and of first quality throughout. The system warranty shall commence on the day that the County grants final system acceptance.

All items (material and labor) shall be warranted for a minimum of one (1) year after the date of final system acceptance, unless otherwise specified in the specification. This warranty shall include repair or advanced replacement of any defective equipment, system, subsystem, hardware and/or software which becomes defective through normal wear and usage or is deemed as such between the County and the supplier. The supplier shall guarantee an on-site, two-hour response time to any County site, network node, or subscriber radio installation to remedy a failure during the system warranty and maintenance period.

When parts under warranty are replaced, the County requires that the replacement part also be new and not factory-refurbished. The supplier shall fully integrate and test all spare parts prior to final system acceptance. No replacement parts shall be integrated that provide less functionality or diminished capacity than the original equipment to be replaced. A new twelve-month warranty period should begin when a new part is installed as a replacement to a defective part under warranty. All warranty and maintenance issues shall be tracked by the supplier and its service organization using an electronic database that the County can query at any time.

Supplier support is defined as the ability of the supplier to remedy to St. Marys County satisfaction any hardware and/or software problem with any equipment and services provided as part of this offering. Supplier support shall take the form of a 24x7x365 technical support hotline, two-hour on-site response time, advanced board replacement, product engineering, field service technicians, and field engineering. Supplier support also requires the supplier to be able to provide new and/or equivalent spare/replacement hardware and software equipment for the proposed offering for no less than fifteen (15) years from the date of final system acceptance. Equivalent spare/replacement hardware and software provided during the entire support timeframe shall not necessitate any platform upgrade or subsystem reconfiguration.

15.1 SYSTEM SOFTWARE AND HARDWARE WARRANTY

The equipment supplied pursuant to this solicitation and any subsequent agreement is warranted by the supplier to be free from defects in materials, workmanship and otherwise for one (1) year from final acceptance of the proposed system unless otherwise provided in this solicitation and any subsequent agreement.

The supplier shall warrant that the system and each component of the system shall perform in strict accordance with the requirements of this solicitation and any subsequent agreement and shall be completely free of system defects, including latent defects for at least one (1) year after the date of final system acceptance. Unless otherwise provided herein, all equipment shall be warranted for a period of one (1) year after the date of final system acceptance. The warranty period for non-supplier manufactured equipment is as specified by its manufacturer, but not less than one (1) year after the date of final system acceptance. The supplier maintains sole responsibility for settling and coordinating all warranty issues with OEM suppliers on behalf of St. Marys County throughout the entire warranty and maintenance period.

The proposed system release/platform being offered shall not be the last of its type or version with regard to future software and hardware compatibility. The next software release compatible with the system shall not require new hardware to support the existing functions of the system. In the event that parallel system software development has been undertaken by the supplier, and the software release in the County's system is abandoned (no further development or support) or obsoleted, the supplier shall completely upgrade the County's system to the surviving software release at no expense to the County.

At no additional cost to the County, the supplier shall provide and completely integrate all hardware, firmware, software releases or patches that are required to correct any latent functionality or software defect that may exist in the proposed system (including system failures resulting from software problems, functionality fixes, and software upgrades to the County's system), for a fifteen (15) year period from the date of final system acceptance. This responsibility is to include any upgrades to fixed network equipment, system management systems and subscriber units. For the life of the contract and the contract maintenance period, the supplier shall provide, at a minimum, the opportunity to refresh software for all system and subscriber equipment on a semi-annual basis to take advantage of enhancements and defect resolutions.

In the event a defect is found in another customer or field system that utilizes the same or similar release as the County's system, the supplier shall notify and advise the County of the defect and when a new hardware, firmware, software release or patch will be available to correct the problem. At such time, the County shall decide whether it will require an upgrade prior to observing the defect. Notification should occur regardless of whether the County is currently affected by this defect. The supplier shall be responsible for providing monthly product quality bulletins for all supplier and OEM equipment and software contained in the proposed network in electronic fashion to the County Project Manager and System Manager during the course of system implementation and the entirety of the warranty and contract maintenance phases.

The software release in the County's system at the time of final system acceptance shall be the latest version available at the time of shipment from the supplier's development and manufacturing facility. The supplier assumes responsibility for all equipment and services to implement the latest system and subscriber software versions prior to final system acceptance. Under all warranties provided, all parts shall be replaced free of charge including labor. The supplier may replace equipment, software or components rather than repair them, at the supplier's option.

Whenever defective work (and damage resulting from such a remedy) has been corrected, removed, or replaced under warranty, the warranty period with respect to such defective work shall be extended for an additional period of one (1) year after such correction or removal and replacement has been satisfactorily completed.

15.2 EQUIPMENT SUPPORT

The supplier shall warrant support in the form of replacement parts for all system and subscriber hardware and software equipment for fifteen (15) years from the last date of manufacture of the product. The supplier shall use commercially-reasonable efforts to identify and to obtain replacement parts to meet or exceed the County's specific maintainability requirements. The supplier shall electronically issue all product cancellation notices to the County Project Manager and System Manager throughout the entire system implementation and maintenance periods. The supplier shall provide product cancellation notices within two weeks of the official announcement. These cancellation notices serve the basis for the fifteen (15) year support guarantee. The supplier is responsible throughout the project implementation and contract maintenance period for remedying and re-designing, at no cost to the County, any system design affected by the cancellation of equipment or software which reduces the fifteen (15) year product support guarantee. Prior to final system acceptance, no equipment or software shall be included with the system offering that has been identified or announced for cancellation.

15.3 SPARE PARTS INVENTORY

The cost for replacement parts shall be quoted as part of the supplier's proposal. Parts pricing shall be in the form of a standard discount off of the OEM or supplier's list price equivalent to those provided to dealers or supplier-authorized service shops. This discount level shall be part of the attached pricing sheets. The supplier shall also provide a comprehensive pricing matrix or book defining the OEM and supplier list prices for all relevant hardware and software for the proposed system platform. This comprehensive pricing matrix shall serve as the definitive ordering guide for all future system and subscriber purchases. The parts pricing level shall remain intact for a period no less than fifteen years following final system acceptance.

Spare parts required for this system shall include sufficient parts, modules and components to restore the system to full redundancy during a system or subsystem failure, within the restoration times assigned in the warranty section of these Specifications. The supplier shall fully integrate and test all spare parts prior to final system acceptance. When not specifically addressed in this specification, the supplier shall recommend and price accordingly the spares necessary to maintain the required availability levels for the various subsystems.

15.4 WARRANTY MAINTENANCE PERFORMANCE LEVELS

Normal, non-critical warranty maintenance shall be performed during normal business hours of 7:00 am-5:00 pm M-F. Some equipment and subsystems deemed critical by the County shall be protected by warranty and extended maintenance that provides guaranteed response and restoration times on a 365-day by 24-hour basis. The following lists identify response and maintenance performance level required for the various subsystems:

24-hour by 7-day – 30-minute phone response, 2-Hour On-Site Response, 2-Hour repair:

- Voice Radio System Infrastructure
- NMS System Infrastructure
- Microwave Backbone/Transport
- Dispatch Console/Logging Recorder Infrastructure
- Tower/Shelter Subsystems.

10-hour by 5-day – 4-Hour On-Site Response, 8-Hour repair:

- Subscriber Units (Mobile, Portable, Control Stations)
- In-Building Systems (if utilized)
- Vehicular Repeaters (if utilized)
- Alternative Support Systems and Specialized Equipment.

Malfunctions that cannot be immediately or unequivocally diagnosed and pinpointed to a certain item of equipment or service shall require the immediate participation of **all** service suppliers until responsibility for the problem has been established. In no instance shall the failure to resolve the issue of responsibility relieve any of the suppliers of the mutual obligation to restore system operability with the least impact on the availability of the system to the end-users. The supplier shall be the sole point of responsibility to resolve any and all maintenance matters to the satisfaction of the County. The supplier shall guarantee that the turn-around time for all subscriber repairs requiring factory depot involvement shall be no more than 7 calendar days.

Proposals shall provide a complete description of the intended preventive maintenance methodology and shall specify the frequency of preventive maintenance required for all proposed equipment and systems. Preventive maintenance shall be performed according to a schedule that is mutually acceptable to the County and the supplier. The supplier shall include in its proposal an example of an actual, completed preventive maintenance regimen representative of what will be provided with the proposed system and corresponding maintenance phases. The schedule shall be consistent with the operation requirements of the County and shall be based upon the specific needs of the equipment being maintained. The supplier and/or service provider shall be responsible for collecting failed subscribers and delivering repaired subscribers to a location designated by St. Marys County on as-needed basis.

The supplier shall include in its proposal a description of any remote administration and maintenance service arrangements that will be provided with the proposed system. The qualifications and individual resumes (noting years of experience, training, schooling/degree, customer references, etc.) of all proposed maintenance service provider staff shall be provided in the supplier's proposal response. All service providers may be required to submit to routine background investigations conducted by St. Marys County to ensure system integrity in concert with security policies and initiatives. In the pricing response, the supplier shall quote the annual costs for comprehensive, turnkey system and subscriber maintenance for all proposed equipment for a period of fifteen (15) years following final system acceptance noting all available discounts, incentives, and economies of scale. The supplier shall also include a standard contractual service agreement and associated comprehensive, detailed statement of work with the maintenance quotation.

15.5 WARRANTY MAINTENANCE PERFORMANCE REPORTS

The supplier shall furnish the County with a monthly report of all system and subscriber maintenance requests and resolutions during the warranty and contracted maintenance periods. The supplier's proposal must include information that will be provided in their reports as well as actual sample warranty maintenance report forms used for other active supplier customers. At a minimum, the following data is required:

- Date and time notified
- Date and time of arrival on site
- Description of equipment and malfunction reported
- Original equipment manufacturer (OEM)
- Diagnosis of failure and corrective work performed
- Root cause analysis
- Date and time failure was corrected

- Charges for service (if applicable)
- Name of person/technician performing service.

15.6 LIFE CYCLE MAINTENANCE PERFORMANCE

Bidders shall provide firm and fixed pricing options for life cycle maintenance for a term of 15 years from Final System Acceptance. The following categories of services are required and shall be priced by category in the detailed pricing sheets as part of this Specification, as well as any discounts for packaged offerings.

-Subscriber Maintenance and Support. This element includes any and all failure maintenance and annual preventative maintenance (one annual PM check per subscriber) for all subscriber devices. Failed mobile subscribers, fixed subscribers and associated accessories shall be repaired on site. Failed portable subscribers and associated accessories shall be picked up at the designated central County location, replaced with a spare radio, repaired by depot and returned to County.

-Infrastructure Maintenance. This element includes the actual repair and restoration of all fixed network equipment. This includes, but is not limited to: consoles, telecommunications network, microwave subsystem, RF FNE, tower systems, UPS and generators.

-Technical Support. This element includes factory technical support to local maintenance shop or direct support to the County, as required, for the entire System.

-Advanced Parts Replacement. This element provides immediate shipment of replacements for parts or components identified by the service shop or County as defective.

-24x7x365 System Monitoring and Service Dispatch. This element includes the active network monitoring of the radio system by the manufacturer's customer network operations center, dispatch call-out to the maintenance shop, monitoring all repairs to the point of full restoration, monthly maintenance reports, monthly statistical performance reports.

-Software/Firmware Upgrades. This element includes costs to provide any software/firmware upgrades to the entire System (including subscribers) in order to maintain manufacturer support.

-Hardware Upgrades. This element includes costs to provide any hardware upgrades or replacements for the System.

15.7 TEST EQUIPMENT

When not specifically addressed in this specification, the supplier shall recommend, organize uniquely in the equipment list, and price accordingly the test equipment necessary to properly maintain the network infrastructure, various subsystems, and the active subscriber fleet. The same level and types of test equipment mandated by the supplier for its own service organizations shall be identified and priced as an option for St. Marys County. All test equipment shall be delivered new and of first quality with the proper calibrations. The supplier shall present a matrix of all recommended test equipment with an explanation of purpose and need as it applies to maintaining the proposed system.

16.0 OPERATIONAL, TECHNICAL AND USER TRAINING

The supplier shall fully describe all proposed and available training courses. This shall include, at a minimum, classroom style instruction, operational style classes, a detailed training plan, description of available training material, resume of potential course instructors and a customer reference list of trained personnel (to include: names, telephone numbers, company, and system description).

The supplier shall train County employees, County contractors, and County designees. The supplier shall permit videotaping of training sessions for use within the County for re-fresher training. All written and presentation training materials shall become property of the County.

The following sections describe the radio system operational, maintenance, and user type of training that is required for the system. The supplier shall complete development of the entire customized County training program prior to completion of the Detailed Design Review process.

16.1 RADIO SYSTEM OPERATIONAL TRAINING

The supplier shall provide on-site, customized operational training for up to ten (10) people. Training shall include system orientation and familiarization that includes discussion and equipment demonstration. The supplier shall propose a training schedule that correlates to the implementation schedule. The supplier's highly skilled personnel, familiar with the same equipment as that being implemented, shall conduct the training. This training shall be designed for administrators, agency coordinators, and system managers that require a solid, high-level understanding of the radio system and all supporting infrastructure.

The supplier shall provide one (1) set of manuals per student plus an additional five (5) sets of manuals. Additionally, all manuals shall be provided in an electronic version such as *.PDF (Portable Document Format) and read with the Adobe Acrobat Reader software. Fifteen (15) CD-ROM copies shall be supplied.

The supplier's program shall include training in orientation, management, and operation of all equipment provided under the following items:

- Overview of the Radio System
- Use of Radio System/Consoles
- Use of Microwave System
- Use of Diagnostic Tools
- Fleetmapping
- Database Management and Network Administration
- Use of NMS/Alarm Monitoring Equipment

- Familiarization and Orientation with Communication Facilities
- Reporting and Utilization Analysis.

The supplier shall provide a list of courses required along with the duration (hours, days, weeks, etc.) cost for each course. Whenever possible, the training should be conducted with substantial hands-on involvement using the County's actual system/equipment.

The training shall be designed so that, upon completion, a user will be qualified to comprehend radio system management, the network, fallback design, perform system diagnostics, and operate the subscriber units. The supplier's highly skilled personnel shall conduct the training. Instruction material should be included as a part of each course and shall become property of the County.

16.2 RADIO SYSTEM MAINTENANCE TRAINING

The supplier shall provide on-site, customized training for up to ten (10) people. Training shall include system orientation, management, operation, and maintenance of all system infrastructures and associated system equipment provided. The training shall include education on the theory of operation and practical maintenance procedures for the entire system infrastructure and all systems contained therein. This training shall be designed primarily for technical and telecommunications personnel within the County that may require sufficient education to assist in the restoration of the system during a failure.

The training shall be designed so that upon completion, a technician will be qualified to perform all levels of installation/setup, optimization, troubleshooting and maintenance of the system infrastructure and subscribers to the board level. The contractor's highly skilled personnel shall conduct the training. Instruction material should be included as a part of each course and will become property of the County. Since this training is customized to the County's proposed system design, the supplier shall provide technicians from the assigned local maintenance service provider shop to attend this training at additional cost to the County.

The supplier shall provide one (1) set of manuals per student plus an additional five (5) sets of maintenance manuals. Additionally, all maintenance manuals shall be provided in an electronic version such as *.PDF (Portable Document Format) and readable with the Adobe Acrobat Reader software. Fifteen (15) CD-ROM copies shall be made available.

The course content shall include the following, at a minimum, for all network subsystems:

- As-Built documentation structure, numbering system, and configuration control system
- Principles of digital transmission and RF troubleshooting
- Level setting
- Network traffic analysis and bandwidth utilization measurement
- Block diagram and circuit description - all units
- Installation and turn-on procedure
- Service alignment and testing procedures
- Troubleshooting and fault diagnosis to unit and board level
- Test equipment configuration and usage
- Unit replacement procedures
- Operating and safety procedures
- Subscriber repair and programming
- NMS design and use
- Network security
- Client/server architecture and network administration
- Database maintenance and optimization
- Software refresh and flash upgrades
- System restoration and failure modes
- Shelter subsystems maintenance and operation
- In-Building systems (if utilized)
- Traffic continuity procedures.

The suppliers shall provide a list of courses required along with the duration (hours, days, weeks, etc.) cost for each course. Whenever possible, the training should be conducted with substantial hands-on involvement using the County's system/equipment.

16.3 RADIO SYSTEM MANAGEMENT TRAINING

The following section describes the Radio System Management system operational, administrative, and diagnostic type of training.

The supplier shall provide on-site training for ten (10) people. Training shall include system orientation and familiarization that includes discussion and equipment demonstration. Ongoing training opportunities for new or updated components via Internet or CD-based self-paced programs developed by the supplier are also encouraged by the County. The supplier shall provide on-site training for ten (10) people in orientation, management, operation, and maintenance of all radio system management subsystems and associated network elements. The training shall include education on the theory of operation and practical administration and maintenance procedures for the entire system infrastructure and all systems contained therein.

The supplier shall conduct comprehensive classroom operator training for the communications management personnel operating and administering the new radio system. This training shall be conducted in a classroom environment, using training aids, and a comprehensive model of the entire radio system. Training aids such as videos, system diagrams, training manuals showing working functionality and a qualified instructor shall be available for these classes. There shall be handouts available for all attendees. Each student shall receive a customized system management training manual. In addition to the system management training manual, an electronic version such as *.PDF (Portable Document Format) readable with the Adobe Acrobat Reader software shall be provided. Ten (10) hard copies and ten (10) CD-ROM copies shall be supplied. The supplier shall provide, in addition to the customized training plan, and handout material, ten (10) videotape copies that would instruct a user on the operational functions and features of the proposed radio system and subscriber fleet.

The course content shall include the following, at a minimum, for all network subsystems:

- As-Built documentation structure, numbering system, and configuration control system
- Block diagram and system description
- Installation and as-built documentation comprehension and analysis
- Radio programming and fleetmapping
- Use of software applications
- Troubleshooting/diagnosis to element level
- Troubleshooting techniques and use of NMS
- Console configuration and management
- Logging recorder configuration and management
- In-Building systems (if utilized)
- Microwave backbone training
- Database development, optimization, and management
- Shelter subsystems operation
- Failure mode analysis.

The supplier shall submit a resume, a list of training classes, and prior client references that have been trained by the supplier's training personnel. The County shall interview the supplier's training team, and shall mutually agree on the training package and the qualifications of the training personnel prior to the development and execution of the customized County training program.

16.4 USER TRAINING – "TRAIN THE TRAINER"

16.4.1 *On-Site Radio Usage Training*

The supplier shall provide on-site, "Train the Trainer" type courses for the following categories of equipment:

- Subscriber Mobiles
- Subscriber Portables
- Subscriber Control Stations
- Vehicular Repeaters (if utilized)
- Alternative Support Systems and Specialized Equipment (if utilized).

Training shall include system orientation and familiarization that includes theory of operation discussion and equipment demonstration. The training shall be designed so that, upon completion, each student will be qualified to train system end-users on the customized St. Marys County operation of the specific equipment. For example, the student shall be qualified to train County first-responders and general government users on the operation of all proposed mobiles and portables. The supplier shall customize all "Train the Trainer" courses per St. Marys County satisfaction in conjunction with the specific programming and configuration parameters utilized by the County.

The supplier shall provide training for up to two (2) classes of fifteen (15) students per class. The supplier's highly skilled personnel shall conduct the training. Instructional material shall be included as parts of each course and will become property of the County. Training aids such as videos, system diagrams, training manuals showing working functionality and a qualified instructor shall be available for these classes. There shall be handouts available for all attendees. Each student shall receive a personal "Trainer's Guide" training manual. In addition to the "Trainer's Guide" training manual, an electronic version such as *.PDF (Portable Document Format) readable with the Adobe Acrobat Reader software shall be provided. Thirty (30) hard copies and thirty (30) CD-ROM copies shall be supplied. The supplier shall provide, in addition to the training plan, and handout material, five (5) videotape copies that would instruct a user on the operational functions and features of all proposed radio system subscribers.

16.4.2 ***On-Site Dispatch Console Operator Training***

The supplier shall conduct comprehensive, dispatch console operator training in five (5) separate sessions. Training sessions shall be coordinated for all of the dispatch personnel before the new console system is placed in service. Sessions are to be scheduled so that all personnel can be coordinated into one of the sessions with minimum impact on shift personnel. This training shall be conducted in a classroom environment, using training aids, and actual St. Marys County dispatch radio consoles. Training aids such as videos, system diagrams, training manuals showing functionality, and a qualified instructor shall be available for these classes. There shall be handouts available for all attendees. Additionally, there shall be five

(5) master quality hard copies of the Dispatcher Operator Training manual for future reference and follow-up training. The County intends to duplicate these "masters" for distribution to other personnel as personnel requirements change. In addition, the Operator's Training manual shall be available in a *.PDF (Portable Document Format) readable with the Adobe Acrobat Reader software. Five (5) CD-ROM copies shall be supplied. There shall be no restrictions or licensing requirements for information provided as reference or used for future training purposes.

Additional training classes shall also be conducted using operational console equipment and ancillary subsystem equipment required by the dispatch personnel (e.g., logging recorder, NMS, etc.). All required training shall be conducted in the St. Marys County 911 Backup Center utilizing the proposed system consoles. Each trainee shall become thoroughly familiar with the operations of the new console to become experienced and fully qualified to operate the new consoles.

The supplier shall provide a list of course objectives and core competency skills for each of the five (5) training sessions prior to completion of the Detailed Design Review. The supplier shall provide, in addition to the training plan and handout material, five (5) videotape copies that would instruct the user on the customized use of the operational functions and features of the St. Marys County console system.

The supplier shall submit a resume, a list of training classes, and prior client references that have been trained by the proposed training personnel. The County shall interview the supplier's training team, and shall mutually agree on the training package and the qualifications of the training personnel prior to the development and execution of the training program.

16.5 MICROWAVE SYSTEM TRAINING

The following sections describe training for microwave maintenance and operation.

16.5.1 *Microwave System Maintenance Training*

The supplier shall provide on-site microwave backbone system training for up to ten (10) people and shall be coordinated with the comprehensive Radio System Maintenance Training Program. Training shall include system orientation, theory of operation, management, customized operation, and maintenance of all system infrastructures, and associated proposed subsystem equipment. The training shall include education on the theory of operation and practical maintenance procedures for the entire microwave system infrastructure and all ancillary subsystems contained therein.

The supplier shall provide fifteen (15) sets of manuals for the training course. Additionally, all manuals shall be provided in an electronic version such as *.PDF (Portable Document Format) readable with the Adobe Acrobat Reader software. Fifteen (15) CD-ROM copies shall be supplied.

The customized course content shall include the following, at a minimum for all microwave subsystems:

- As-Built documentation structure, numbering system, and configuration control system
- Principles of digital microwave transmission and loop microwave topology
- Block diagram, wiring, and circuit description-all units/subsystems
- Level setting and RF troubleshooting
- Multiplexer provisioning, cross-connects, and configuration
- Installation and turn-up procedures
- Test equipment configuration and usage
- Alignment and testing procedure
- Troubleshooting and fault diagnosis to unit and board level
- Unit replacement procedure
- Preventive maintenance procedures
- Orderwire, DC Plant, Pressurization operation and troubleshooting
- Operation and safety
- Failure mode analysis
- Traffic continuity procedures.

The supplier shall provide a list of courses required along with the duration (hours, days, weeks, etc.) cost for each course. Whenever possible, the training should be conducted with substantial hands-on involvement using the County's actual system/equipment.

16.5.2 ***Microwave System Operational Training***

The supplier shall provide on-site operational training for up to ten (10) people and shall be coordinated with the comprehensive Radio System Operational Training Program. Training shall include system orientation and familiarization that includes discussion and equipment demonstration. The supplier shall propose a training schedule that correlates to the implementation schedule. The supplier's highly skilled and experienced personnel shall conduct the training.

The supplier shall provide fifteen (15) sets of manuals for the training class. Additionally, all manuals shall be provided in an electronic version such as *.PDF (Portable Document Format) readable with the Adobe Acrobat Reader software. Fifteen (15) CD-ROM copies shall be supplied.

The supplier's program shall include customized training in orientation, management, and operation of all equipment provided under the following items:

- Theory of operation
- FCC licensing
- Use of microwave terminals
- Use of diagnostic tools
- Use of alarm monitoring equipment
- Use of orderwire
- Provide an overview of the microwave network
- Provide an understanding of the alternate routing and failure mode analysis
- Provide an understanding of traffic management and provisioning.

The supplier shall provide a list of customized courses required along with the duration (hours, days, weeks, etc.) cost for each course. All training shall be conducted on-site with substantial hands on involvement using the County's system and ancillary equipment.

17.0 DETAILED EQUIPMENT LIST BY SITE/NETWORK NODE

The supplier's proposal shall contain detailed equipment lists with unit cost/line item pricing as required in the solicitation specifications. The detailed equipment list shall be easily cross-referenced to the supplier's itemized pricing sheets (see Appendix for pricing and equipment list requirements).

Detailed equipment lists shall be provided by radio sites and/or each network node, and the lists shall include details of requirements needed for the installation and operation of the equipment as deemed necessary. Equipment lists shall also contain all radio subscriber information organized by County agency/user group. Equipment lists shall make clear distinctions between hardware and software with unique versions or types delineated.

The equipment list shall contain equipment OEM and supplier model numbers with associated options, OEM and supplier nomenclature/description, quantities and/or amounts ordered, OEM and equipment supplier, manufacturing facility location/origination, planned site and/or node for installation, and the associated cross reference to the provided pricing sheet items. The supplier must provide this detailed equipment list as part of their technical support and documentation response to the solicitation specifications. Failure to comply with the equipment list and pricing matrix requirements will lead to a dismissal of the supplier proposal for non-compliance.

Detailed Design Review (DDR) and final system as-built information shall also contain system equipment lists in the same format as the original proposal response for straightforward tracking of project change orders and equipment reconciliation. Spare equipment and test equipment shall be uniquely noted and organized separately in the proposal response and all subsequent equipment list iterations. Pricing discounts and incentives shall be clearly noted, if applicable, for all equipment list items. The supplier bears sole responsibility for delivering all equipment, software, and services necessary to fully commission a system that meets or exceeds the specifications outlined in this document.

18.0 DETAILED SITE LAYOUTS BY EQUIPMENT RACKS

The supplier shall provide, as part of the proposal response and subsequent DDR process, scaled equipment rack profiles and layouts and scaled floorplan drawings indicating dimensions and the model numbers of all equipment specified. Equipment rack numbers shall identify all proposed site equipment racks with detailed rack profiles identifying all proposed equipment. These layout drawings shall be provided by site and cross-referenced to the detailed equipment list.

As part of the proposal response, the proposed design shall also demonstrate the space in each facility available for future growth. Each supplier shall also provide all equipment specifications including: equipment AC and DC power consumption; commercial and backup power requirements and load; emergency backup runtimes for UPS, generator, and -48V batteries; heat dissipation; size; rack or cabinet height/width/depth; floor loading; weight and environmental requirements in a spreadsheet format by rack and site noting every piece of equipment. Detailed Design Review and final system as-built information shall also contain system layout and racking information in the same detailed format as the original proposal response for straightforward tracking of all design changes.

19.0 SYSTEM PERFORMANCE GUARANTEES

The supplier shall provide a thorough description of all equipment, subsystems, RF coverage and system-related guarantees that are part of its offering. These guarantees shall be clearly defined for the County's review and comments. The County expects these guarantees to cover terms, conditions, and timeframes for each type of guarantee. The supplier shall provide all types of guarantees as part of the response support material.

19.1 EQUIPMENT AND SOFTWARE

The County requires the supplier to respond to equipment guarantees by defining each guarantee by product offering. The supplier shall list each product and define the guarantee as it applies to each product offered. All equipment, at a minimum, must meet published specifications and/or solicitation specifications in order to meet or exceed product performance. The supplier is required to provide published specifications as part of the response support material. The supplier shall provide MTBF and MTTR data for all proposed equipment to support performance reliability and availability guarantees.

As part of the proposal response, the supplier shall provide a comprehensive history of the proposed system platform history in terms of defect resolution and platform enhancements since the platform was initially introduced. Subsequent to the proposal submission, the supplier shall provide all system platform and equipment performance history upon County request and on a quarterly basis, at a minimum, in both paper and electronic format.

19.2 SUBSYSTEMS

The supplier shall provide guarantees on each subsystem offered as part of the supplier's response. The supplier shall list each subsystem and clearly define the guarantee as it applies to the proposed subsystem. Each subsystem must meet or exceed the solicitation specifications and performance requirements in order to be accepted as a compliant guarantee.

19.3 RF COVERAGE

The supplier shall guarantee RF Coverage as specified in the solicitation specifications. The supplier shall submit a RF coverage guarantee that is based on the coverage predictions. The supplier must utilize the system design, coverage predictions, and coverage acceptance testing as the minimum elements of the RF Coverage guarantee.

Any and all changes in system design that may be necessitated due to the system's inability to meet the system coverage performance criteria shall be provided by the supplier at the supplier's sole expense. Any additional sites or changes in antennas that may be required to correct deficiencies where the supplier has failed to satisfy the coverage requirements of this solicitation and any resulting agreement shall be provided by the supplier at the supplier's sole expense. Any modifications of antenna or transmitter configurations by the supplier to address coverage issues shall comply with all regulatory and zoning restrictions placed on the County. All design changes must be properly coordinated by the supplier at no cost to St. Marys County to comply with the requirements of NPSPAC Region 42 and neighboring NPSPAC regions. The entire system implementation effort and field equipment configuration shall be in strict compliance with all FCC and Region 42 guidelines and authorizations.

20.0 EXPANSION AND MIGRATION CAPABILITIES

The supplier shall provide detailed information on the expansion and scalability capabilities of the proposed system and ancillary subsystems. These details shall include the following items that facilitate a total County understanding of the supplier's offering as related to expansion capabilities.

- Maximum Number of Sites/Subsystems (Multi-Cast, Simulcast, RFSS, etc.)
- Maximum Number of Talkgroups
- Maximum Number of Unit IDs
- Maximum Number of Dispatch Consoles
- Maximum Number of Channels/Talk-Paths
- Maximum Number of NMS Clients/Concurrent Applications
- Maximum Number of Discrete Alarm Points Per Site
- Maximum Number of Conventional Mutual Aid Interfaces
- Maximum Number of Console Auxiliary Inputs/Outputs
- Maximum Number of Logging Recorder Channel Hours
- Maximum Number of Encryption Keys Manageable by Infrastructure
- Expandability of Microwave Network
- Upper and Lower Limits of the Controllers and Network Elements Inputs and Outputs
- Maximum Number of Control Channels
- Impact to the System Architecture
- Impact to System Access
- Impact to Other Support Systems
- Impact to Shelters
- Impact to Towers
- Impact on Existing Users
- System Expandability Incremental Costs.

21.0 SYSTEM OWNERSHIP

In the event that the supplier's proposal response is developed using a supplier-owned, existing commercial, or a joint venture/limited ownership network, the division of ownership, liabilities, access, and control of the proposed system solution meeting the solicitation specifications shall be clearly and thoroughly defined for the County. This may also include supplier offerings of access to rights-of-way, subscriber units, frequencies, and software.

The supplier shall provide a definition of specific ownership and the terms and conditions that are being offered to the County. All costs, life-cycle analysis, and contractual terms shall be defined by the supplier's description of the offering.

The supplier is expected to provide a detailed cost analysis based on the life expectancy of the proposed system. The supplier shall define the system's life expectancy and cost analysis based on sound business practices and professional criteria as related to telecommunication networks and the County's demonstrated procurement practices.

21.1 SITES

If the supplier proposes the use of privately-owned sites which are not part of the County's suggested sites as contained in the solicitation, the supplier shall provide a detailed disclosure on the ownership and associated costs. These costs, terms, leasing arrangements, etc., must be clearly defined as part of the supplier's proposal. If the supplier determines that raw land must be acquired to facilitate a new communications site, the supplier shall identify and define all costs, terms, leasing arrangements associated with the raw land as part of the supplier's proposal.

21.2 TOWERS

If the supplier proposes the use of privately-owned towers, the supplier shall provide a detailed disclosure on the ownership and associated long-term costs. These costs, terms, leasing arrangements, access, etc., must be clearly defined as part of the supplier's proposal.

21.3 INFRASTRUCTURE

If the supplier proposes the use of privately-owned infrastructure, the supplier shall provide a detailed disclosure on the ownership and associated costs. These costs, terms, leasing arrangements, access, etc., must be clearly defined as part of the supplier's proposal.

21.4 FREQUENCIES

If the supplier proposes the commercial acquisition of frequencies to construct the radio network by means of leasing, renting, or selling, the supplier shall clearly define the ownership and associated costs. These costs, terms, leasing arrangements, use, etc., must be clearly defined as part of the supplier's proposal.

21.5 SOFTWARE

If the supplier proposes software to support the radio network by means of leasing, renting, or selling, the supplier shall clearly define the ownership and associated costs. The supplier shall provide definitions of software upgrades, fixes, and enhancements. These costs, terms, leasing arrangements, use, etc., must be clearly defined as part of the supplier's proposal. As deemed necessary by the County to protect its investment, the supplier shall provide the necessary source code for all software to be kept in escrow.

APPENDICES

The County offers this reference information to the supplier in order to assist the supplier in generating a complete and comprehensive system design and turnkey proposal. Most of the Appendix items will also be provided electronically on the RFP CD-ROM for added clarity and supplier use in its response formulation.

APPENDIX I: FCC LICENSES

APPENDIX II: EDACS FLEETMAP

APPENDIX III: EXISTING FACILITY INFORMATION

Mechanicsville Site
- Facility Photos
- Site Suitability Report
- Site Photos
- Shelter Floor Plans

Leonardtown Site
- Facility Photos
- Site Suitability Report
- Site Photos
- Shelter Floor Plans

Dameron Site
- Facility Photos
- Site Suitability Report
- Site Photos
- Shelter Floor Plans

California Site
- Facility Photos
- Site Suitability Report
- Site Photos
- Shelter Floor Plans

Existing MW System DS1 Channel Plan
Existing 4-site Coverage Maps
Consoles
Audio Recording
EDACs Simulcast Block Diagram
Console –Audio Switch Interface and Interconnections
Subscriber Inventory
RF Control Station Inventory and Location Data
EDACs Traffic Analysis Report
VHF Paging Subsystem
Original ITAC Subsystem
PSIC ITAC Expansion System
Site Alarm Monitoring Points Inventory

APPENDIX IV: DEPLOYMENT PROTECTION

Comsearch MW Channel Coordination and PCNs
FAA Permits/Determinations
800 MHz Contour Expansion Channel Coordination and Analysis
Preliminary Design
- Preliminary 800 MHz Site Selection
- RF Site Inventory
- New Tower Loading Profiles
- MW Subsystem Design Deployment

Crown Structural Analysis
State of Maryland Tower Antenna Configurations
- -Three Notch
- -Bethune
- -Valley Lee

Existing Antenna Positions and Capacity Reservations

APPENDIX V: COMMERCIAL TOWER SUITABILITY SURVEYS

Alternative Commercial Tower Site Suitability Results

APPENDIX VI: COUNTY INFORMATION

County Zoning Maps
County Development Plan
County Ordinance on Tower Siting
County-owned Property Inventory

APPENDIX VII: CRITICAL BUILDINGS INVENTORY AND TESTING RESULTS

APPENDIX VIII: DETAILED PRICING SHEETS